Titanic's Lifeboat Capacity

By Bob Read, D.M.D.

Introduction

The subject of the capacity of *Titanic's* lifeboats is usually discussed with the premise that she had insufficient capacity. It is true that *Titanic* did not have lifeboat capacity for everyone onboard. This article will not engage in the debate about the adequacy of *Titanic's* lifeboat capacity. The purpose of this article is to show how *Titanic's* lifeboat capacity was determined according to the regulations of the Merchant Shipping Act of 1894-1906. No value judgments will be made as to whether the regulations were adequate. No discussion about *Titanic's* lifeboat capacity should begin without an understanding of the facts of that capacity.

Classification of Boats

The British Board of Trade Marine Department set forth a classification system for lifeboats in the 1894 Merchant Shipping Act. This system of classification was based on the construction particulars of lifeboats. This classification system is reproduced here:

Section (A) – A boat of this section shall be a life-boat, of whale-boat form, properly constructed of wood or metal, having for every 10 cubic feet of her capacity, computed as in Rule (2), at least 1 cubic feet of strong and serviceable enclosed air-tight compartments, so constructed that water cannot find its way into them. In the case of metal boats an addition will have to be made to the cubic capacity of the air-tight compartments, so as to give them buoyancy equal to that of the wooden boat.

Section (B) – A boat of this section shall be a life-boat of whale-boat form, properly constructed of wood or metal, having inside and outside buoyancy apparatus together equal in efficiency to the buoyancy apparatus provided for a boat of Section (A). At least one-half of the buoyancy apparatus must be attached to the outside of the boat.

Section (C) – A boat of this section shall be a life-boat properly constructed of wood or metal, having some buoyancy apparatus attached to the inside and (or) outside of the boat equal in efficiency to one-half of the buoyancy apparatus provided for a boat of Section (A) or Section (B). At least one-half of the buoyancy apparatus must be attached to the outside of the boat.

Section (D) – A boat of this section shall be a properly constructed boat of wood or metal.

Section (E) – A boat of this section shall be a boat of approved construction, form, and material, and may be collapsible.

For large emigrant ships like *Titanic* the following regulation applied:

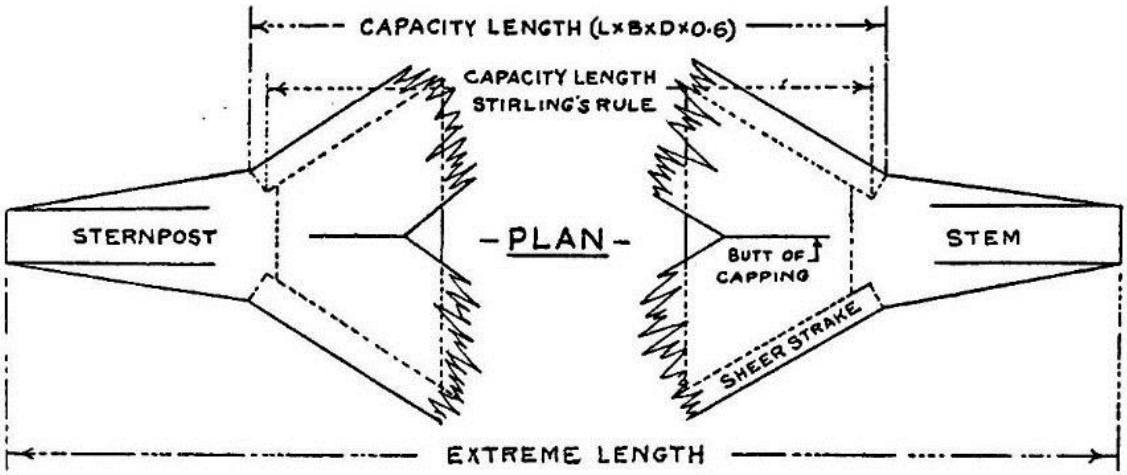
"Not less than half the number of boats placed under davits, having at least half of the cubic capacity required by the Tables, shall be of Section A and Section B. The remaining boats may be of the same description, or may, in the option of the ship owner conform to Section C, or Section D, provided that no more than two boats shall be of Section D.

Titanic's lifeboats under davits were fourteen 30 ft. wooden boats which were Section A boats and two 25 ft. emergency cutters which were Section D boats. The four Engelhardt collapsibles were arranged with two under the emergency cutters and two on the roof of the officers' quarters. All of the Engelhardt collapsible boats were classified as Section E boats.

Individual Boat Capacity

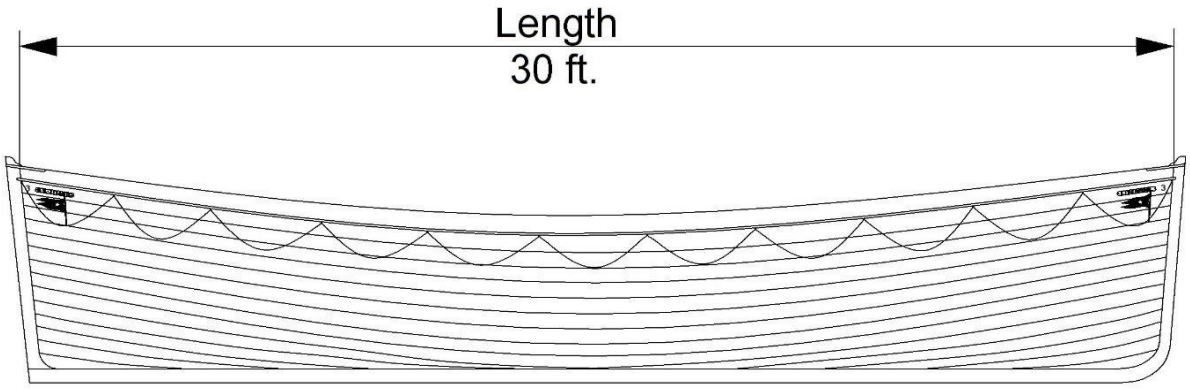
Regulatory lifeboat capacity requirements for vessels like *Titanic* were based on the sum of the capacities of the individual boats. Before discussing the aggregate capacity requirements, it is necessary to look at how the capacities of individual boats were measured and calculated. The measurements taken on boats were its length, breadth and depth.

Length: The length of the boat was measured from where the upper planking strake met the stem and sternpost. Figures 1 and 2 show this measurement.



Lifeboat Length Measurement Landmarks

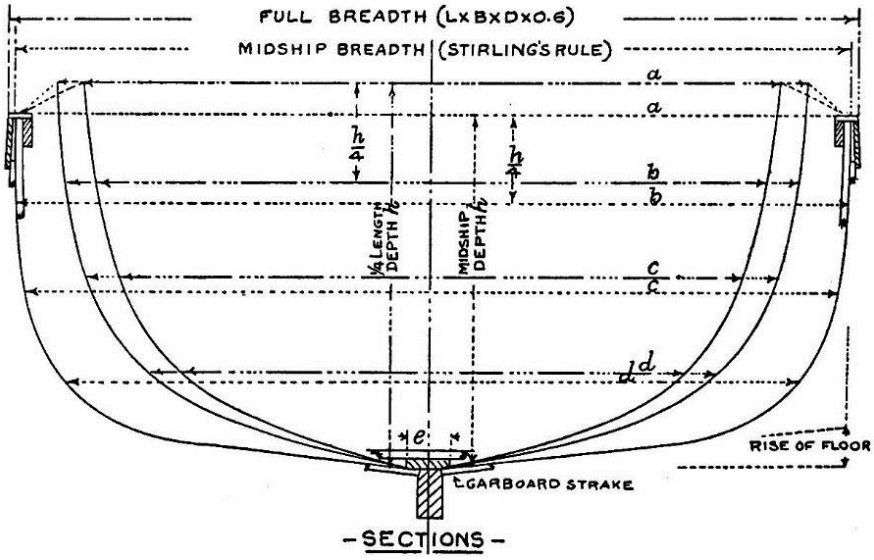
Figure 1



Titanic Lifeboat Length Measurement

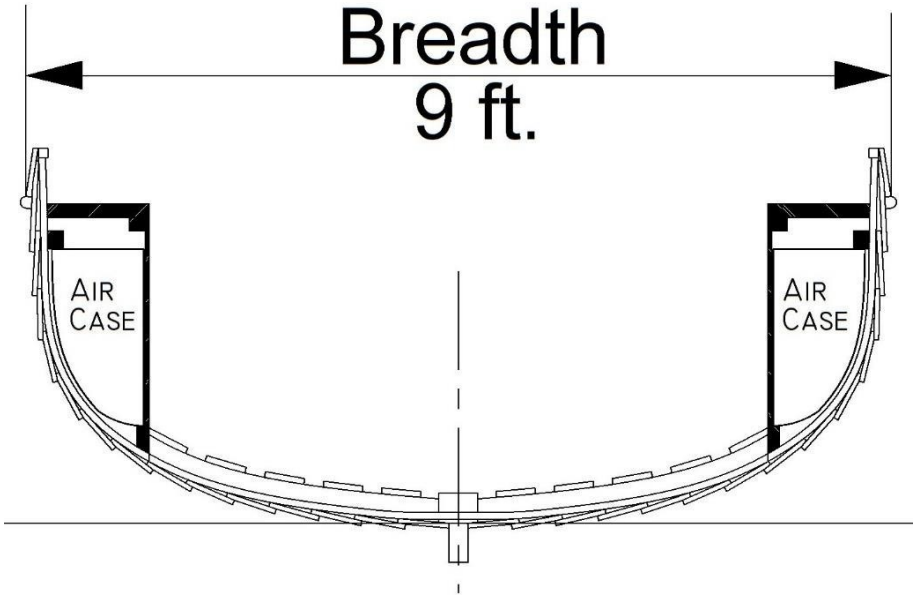
Figure 2

Breadth: The breadth was measured from the widest point outside the planking on one side to the other. Figures 3 and 4 show these measurements.



Lifeboat Breadth and Depth Measurement Landmarks

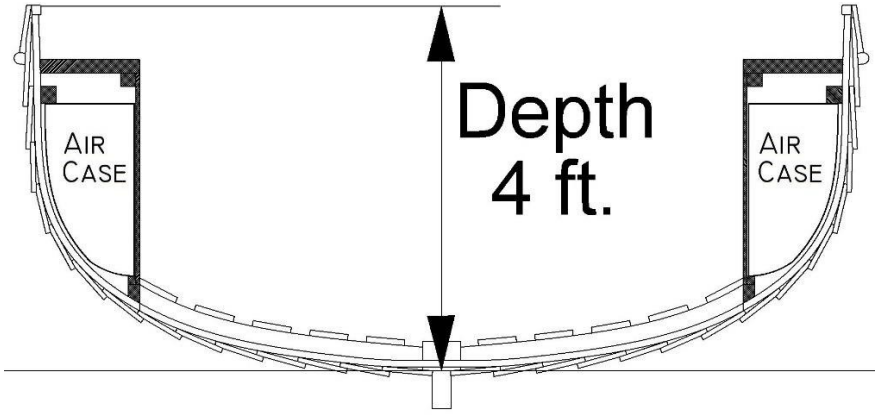
Figure 3



Titanic Lifeboat Breadth Measurement

Figure 4

Depth: The depth was measured from the lowest point of the gunwale to the keel. Figures 3 and 5 show this measurement.



Titanic Lifeboat Depth Measurement

Figure 5

The capacity of a boat could be most accurately be determined by an equation known as Stirling's Rule. This was a laborious calculation to perform on a regular basis. Consequently the method adopted was to multiply the length by the breadth by the depth by .6 to calculate the capacity of the boat in cubic feet. This equation is (length x breadth x depth) x .6 = capacity.

For Section A boats like the 30 ft. boat, the nominal capacity was:

(30ft. x 9ft. x 4ft.) x .6 = 648 cubic ft. capacity.

The owner of the vessel had the option of using actual measurements rather than nominal measurements. This would result in a slightly larger cubic ft. capacity.

For Section A boats the passenger load capacity was determined by allowing 10 cubic ft. for each passenger while all other Sections allotted 8 cu. ft. per passenger. This was a guide rather than a hard and fast rule. The officers in charge of loading would use their judgment in loading based on conditions. While the nominal passenger capacity was considered within safety limits when the boat was fully supported on the water, it was not considered safe by experienced officers when the boat was suspended from the davits.

Total Lifeboat Capacity

Titanic's total lifeboat capacity was determined by regulations as the total cubic ft. capacity rather than the number of persons which would be accommodated. In the Board of Trade's tables for determining the total cubic ft. capacity for *Titanic* we must refer to their table shown in Figure 1.

41. The TABLE referred to in the foregoing Rules, showing the minimum number of boats to be placed under davits and their minimum cubic contents.

Gross Tonnage. 1.	Minimum Number of Boats to be placed under Davits. 2.	Total Minimum Cubic Contents of Boats to be placed under Davits, L. × B. × D. × .6. 3.
10,000 and upwards	16	5,500
9,000 and upwards	14	5,250
8,500 and under 9,000	14	5,100
8,000 " 8,500	14	5,000
7,750 " 8,000	12	4,700
7,500 " 7,750	12	4,600
7,250 " 7,500	12	4,500
7,000 " 7,250	12	4,400
6,750 " 7,000	12	4,300
6,500 " 6,750	12	4,200
6,250 " 6,500	12	4,100
6,000 " 6,250	12	4,000
5,750 " 6,000	10	3,700
5,500 " 5,750	10	3,600
5,250 " 5,500	10	3,500
5,000 " 5,250	10	3,400
4,750 " 5,000	10	3,300
4,500 " 4,750	8	2,900
4,250 " 4,500	8	2,900
4,000 " 4,250	8	2,800
3,750 " 4,000	8	2,700
3,500 " 3,750	8	2,600
3,250 " 3,500	8	2,500
3,000 " 3,250	8	2,400
2,750 " 3,000	6	2,100
2,500 " 2,750	6	2,050
2,250 " 2,500	6	2,000
2,000 " 2,250	6	1,900
1,750 " 2,000	6	1,800
1,500 " 1,750	6	1,700
1,250 " 1,500	6	1,500
1,000 " 1,250	4	1,200
900 " 1,000	4	1,000
800 " 900	4	900
700 " 800	4	800
600 " 700	3	700
500 " 600	3	600

Figure 6

Since *Titanic* was over 10,000 tons she would require 5500 cu. ft. of boat capacity under 16 davits. There was an additional requirement for ships over 5000 tons. If the capacity of

lifeboats under davits did not provide space for all on board then an extra three quarters of the required total capacity would be required. For *Titanic* this would be 5500 cu. ft. + 4125 cu. ft. for a total of 9625 total cu. ft. required capacity.

The total cu. ft. capacity of the 16 lifeboats under davits was 9821.5 cubic ft. This satisfied the statutory requirements for lifeboats to be carried aboard *Titanic*. However this was not *Titanic's* total lifeboat capacity. In addition to the boats under davits she carried four Engelhardt boats with a total cu. ft. capacity of 1506.4 cubic ft. resulting in a total cu. ft. capacity of all *Titanic's* boats of 11,327.9 cu. ft. This represented a capacity of more than 17% over the statutory requirement.

The 30 ft. Boats

Figure 7 shows three views of the 30 ft. lifeboats carried aboard *Titanic.*

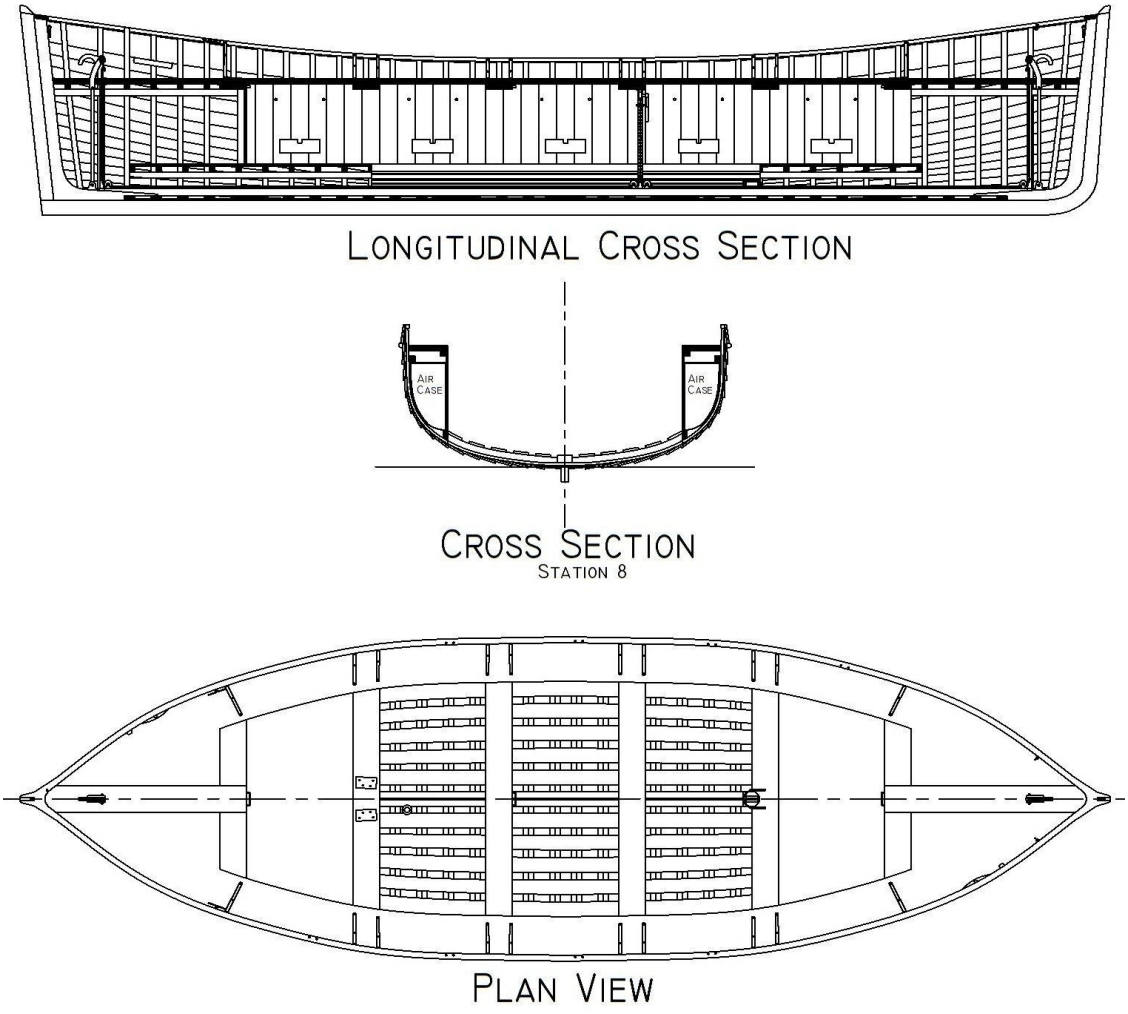


Figure 7

Titanic's 30 ft. lifeboats were Section A boats. As such, they were built to the highest standards for safety. Section A boats were required to have internal buoyancy in the form of metal air cases with a capacity of one tenth of their total cubic ft. capacity. They also were required to have the most room per occupant by the provision of 10 cubic ft. of capacity for each occupant.

Titanic's 30 ft. boats had nominal measurements of:

Length = 30 ft.

Breadth = 9 ft.

Depth = 4 ft.

These measurements were taken from the landmarks shown in Figures 2, 4, and 5.

The formula for determining the cubic foot capacity was fairly straightforward:

(length x breadth x depth) x .6 = cubic foot capacity

The passenger rating for each boat was calculated by the following equation:

Total cubic foot capacity/10 = passenger capacity

There are aspects of the capacity of the 30 ft. boats of Titanic which are not as straightforward. As ships grew larger there was a trend toward building larger and larger lifeboats. Part of that trend was that the depth of the boats likewise increased. It was found that boats with depths over 45% of their breadth were inherently unstable because the weight of the passengers sitting on thwarts and side benches shifted the center of gravity upward which caused the boat to be unstable except in very calm conditions.

The depths of Titanic's 30 ft. boats were actually more than 4 ft. so according to the regulations the depth for purposes of calculating capacity defaulted the depth down to 4 ft which brought them under the 45% limit of depth to breadth. The other measurements of length and breadth were true measurements of the boat. There is no record of how much over 4 ft. the depth of the 30 ft. lifeboats was.

When determining the survey capacity of the boat by the Board of Trade Surveyors, the owner could opt for using actual measurements rather than nominal measurements. Since there were 14 boats of the 30 ft. size, a representative boat was measured and its measurements were used for all the other 30 ft. boats. In the case of Titanic's 30 ft. boats, the representative "as measured" dimensions were: L= 30 ft., B= 9.1 ft., D= 4 ft. The calculations for each of the 30 ft. boats on Titanic was calculated in the equation below:

(30 ft. x 9.1 ft. x 4 ft.) x .6 = **655.2 cubic feet**

The passenger capacity was found by dividing the capacity by 10 or 655.2/10 = **65 passengers**

Multiplied by the 14 boats of 30 ft. length we get 9172.8 cubic ft. capacity with a passenger capacity of 910 passengers.

The 25 ft. Boats

The two 25 ft. boats aboard *Titanic* were variously referred to as cutters, emergency boats or emergency cutters. They were Section D boats. As such, they were not required to incorporate any buoyancy measures. However we have evidence that they did, in fact, incorporate buoyancy measures. Figure 8 is an excerpt from the so-called Andrews Notebook. The notations are for *Olympic's* original boats which were the same as *Titanic's*.

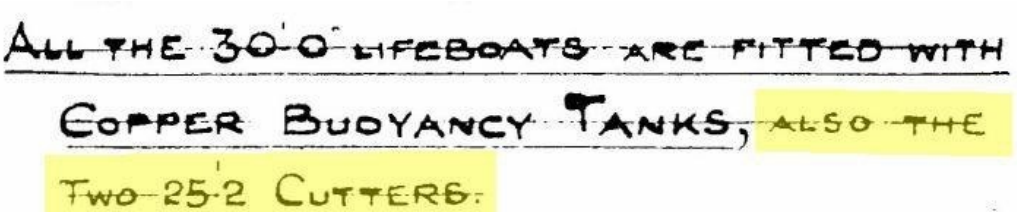


Figure 8

These boats were required to have a capacity allotment per person of 8 cubic ft. The same formula for determining the cubic ft. capacity of the 30 ft. boats is also used for the 25 ft. boats. The nominal measurements of the 25 ft. boats were

Length = 25 ft.

Breadth = 7 ft.

Depth = 3 ft.

These measurements were taken from the landmarks given at the beginning of this article.

The formula for determining the cubic foot capacity was the same as was used for the 30 ft. boats:

(length x breadth x depth) x .6 = cubic foot capacity

The passenger rating for each boat was calculated by the following equation:

Total cubic foot capacity/8 = passenger capacity

Like the 30 ft. boats, when being evaluated for their capacity, the owners could opt for actual measurements of the boats rather than the nominal measurements. Since there were only two 25 ft. boats, each was measured individually. For Titanic's two 25 ft. boats the measurements were:

Length = 25.2 ft. , breadth = 7.2 ft. , depth = 3 ft.

Length = 25.2 ft. , breadth = 7.1 ft. , depth = 3 ft.

So the capacity calculations for the two boats were:

25.2 ft. x 7.2 ft. x 3 ft. x .6 = **326.6 cubic ft.** Passenger capacity = 326.6/8 = **40**

25.2 ft. x 7.1 ft. x 3 ft. x .6 = **322.1 cubic ft.** Passenger capacity = 322.1/8 = **40**

The Engelhardt Collapsible Boats

It is at this point that we encounter a complexity in determining the total cubic ft. lifeboat capacity for Titanic. The capacity of the Engelhardt boats was calculated differently because they were "decked" boats. This means that they had a broad shallow wooden hull with a deck atop the hull completely covering it. Therefore the Board of Trade devised rules for determining not the cubic foot capacity but rather the number of persons that decked boats could carry. The excerpts below in Figure 9 are from the Merchant Shipping Act 1894-1906.

(9) *Number of persons—how determined.*

Under clause 3 of the Rule, when a practical test of a decked lifeboat afloat is not considered by the Board of Trade to be necessary for determining the number of persons it is fit to carry, the number shall be deemed to be the whole number obtained by dividing the area of the deck, in square feet, by 3·8.

A practical test is not considered to be necessary for this purpose unless the proportion of the boat's breadth to its depth is, in the opinion of the Surveyor, insufficient to give the necessary stability when the full number of persons is on board, or unless the mean effective depth of the boat, determined in the manner provided by clause 10 of these instructions, is less than 1 foot 7 inches, or unless the Surveyor has reason to doubt whether the necessary freeboard will be preserved with the full number of persons on board at 3·8 square feet of deck area for each person.

When a practical test is considered to be necessary it is to be made in the following manner :—

The boat is to be placed in the water with the statutory equipment on board and loaded with weights until it is floating at the freeboard required by clause 8 of these instructions. The total weight in pounds avoirdupois required to bring the boat to this freeboard, divided by 140, gives the number of persons to be allowed, provided that the stability of the boat is satisfactory and that the number allowed is in no case to exceed the whole number obtained by dividing the area of the deck in square feet by 3·8. If the water in which the boat is tried is not fresh, a correction should be made for the density of the water.

(10) *Number of persons—approximate rule.*

When it is not practicable to carry out the test afloat before the boat is placed on board a ship the number of persons to be allowed is to be determined by the following approximate rule :—

Find the effective depth of the boat by adding to the depth in inches, measured as described in clause 8, one-fifth of the mean sheer in inches at stem and stern post, and one-fourth of the round of beam in inches. The number of persons to be allowed is to be found by dividing the area of the deck in square feet by the divisor obtained from the following table provided that in the opinion of the Surveyor the stability of the boat will be satisfactory with this number of persons on board :—

Effective depth of boat.	*Divisor.*
1 ft. 4 ins. and below 1 ft. 5 ins.	4·9
1 ft. 5 ins. „ 1 ft. 6 ins.	4·5
1 ft. 6 ins. „ 1 ft. 7 ins.	4·2
1 ft. 7 ins. and above	3·8

If the owner of the boat is not satisfied with the number of persons found by this approximate rule he may at any time apply to the Surveyors to witness a test of the boat in water as provided for in clause (9), and the number of persons allowed is thereafter to be determined by the test and not by the approximate rule.

Figure 9

There were three methods in the regulations for determining the passenger carrying capacity of decked boats.

Simple measurement method - In this method the square foot area of the deck of the boat is determined using Stirling's rule. The equation is shown below.

$$\text{Area} = L/12\ (2a + 1.5b + 4c + 1.5d + 2e)$$

The variables are shown in the Figure 10.

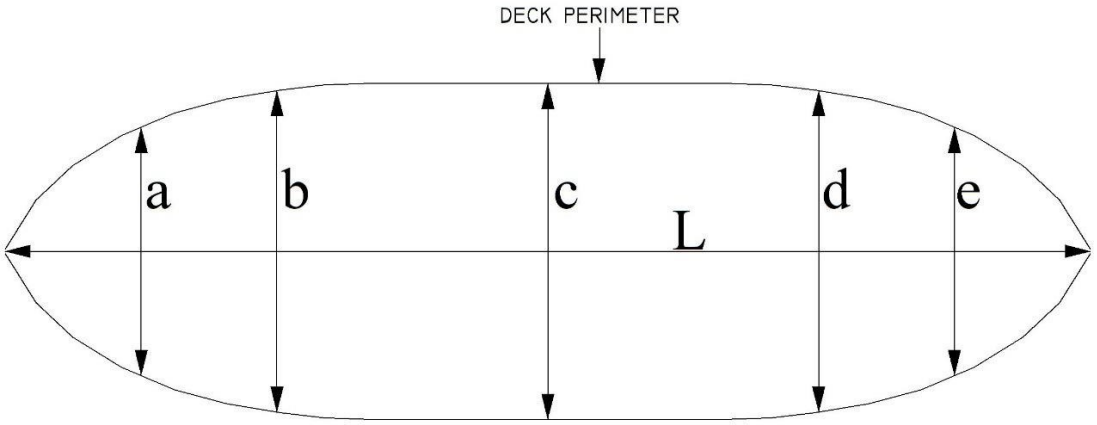


Figure 10

L = Length of deck between where it meets the stem and sternpost

c = width at midpoint of L

b & d = width at midpoint between c and end of deck along L

a & e = width at midpoint between b or d and end of deck along L

When the area of the deck has been calculated it is divided by 3.8. The resulting number is rounded down to the nearest whole number for the passenger capacity.

Direct measurement method – In this method the boat is loaded with weights until it is brought down to the freeboard specified in Clause 8 of the Board of Trade regulations. The resulting total load is divided by 140. The resulting number is rounded down to the nearest whole number for the passenger capacity.

Approximate rule method – In this method the "effective depth" is determined by adding to the depth in inches described in Clause 8 of the Board of Trade regulations plus one fifth of the mean sheer at the stem and sternpost plus one fourth of the round of beam in inches. The number of passengers allowed is the square ft. area of the deck divided by the divisor

corresponding to the effective depth which was determined. The resulting number is rounded down to the nearest whole number for the passenger capacity.

The cubic ft. capacity for a decked boat is a virtual number. It has no real meaning when determining the passenger capacity for a boat. However, this number is needed to be able to report the total cubic capacity of all boats. To calculate the virtual cubic ft. capacity of a decked boat the following equation is used.

Passenger capacity (before rounding) = Cubic ft. capacity of boat/8

The cubic ft. capacity for the Engelhardt boats is listed as 376.6 cu. ft. Therefore using the above equation we can determine that the passenger capacity before rounding was determined to be 47.075. This would have been rounded down to 47 persons.

There is no evidence which has been found which indicates which method was employed to determine the passenger capacity of the Engelhardt boats. We can only use their resulting figures of a cubic ft. capacity of 376.6 cu. ft. per boat to calculate what they would have determined the passenger capacity be before rounding down to the nearest whole number.

The British Wreck Commissioner's Inquiry report gives the principal dimensions of the Engelhardt boats as: length = 27 ft. 5 in., breadth = 8 ft., depth = 3 ft.

These dimensions were not used to calculate any dimensional or passenger capacity. Those calculations as was previously explained were based on the square footage of the deck. The dimensions given above were measured as shown in the Figure 11.

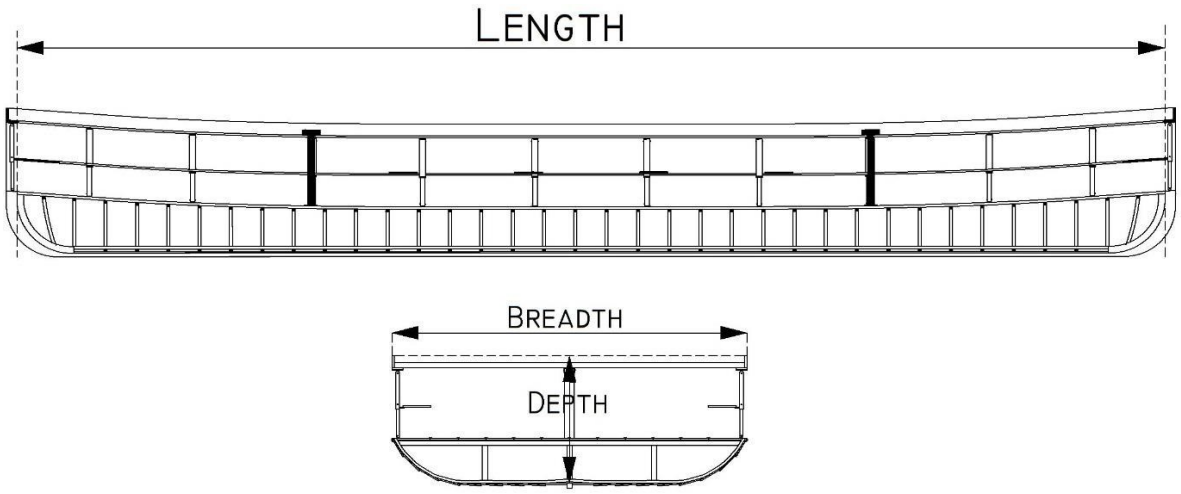


Figure 11

These particular dimensions may have been used when ordering the Engelhardt boats so that they would be compatible with the Welin davits used aboard Titanic but beyond that they were not used for calculating capacity.

Total Cubic Ft. Capacity of *Titanic's* Lifeboats

There may be some confusion regarding *Titanic's* total lifeboat capacitybecause it was reported differently on two separate documents. The first document was a report which responded to capacity requests from the British Wreck Commissioner's Inquiry. The excerpted portion of that report about total capacities is shown in Figure 12:

Life Saving Appliances :

14 boats of A Section each 30'.0 x 9.1 x 4.0 giving a total capacity of 9172.8 cubic feet.

2 boats of B.Section one 25.2 x 7.2 x 3.0. and one 25.2 x 7.1 x 3.0 . Total capacity 648.7 cubic ft

4 Engelhardt collapsible boats each suitable for 47 persons each.

Figure 12

These were the total of cubic capacity of the lifeboats found by totaling the capacity figures for each of the boats under davits.

The cubic ft. capacity of the Engelhardt boats was taken from the British Wreck Commissioner's Inquiry Report:

> 4 Engelhardt collapsible boats, 27 ft. 5 in. long by 8 ft. broad by 3 ft. deep, with a cubic capacity of 376·6 cubic ft., constructed to carry 47 persons each. [**1506.4** total]

By adding the totals of the three types of boats we get the total cu. ft. capacity of *Titanic's* lifeboats:

9172.8 cu. ft. + 648.7 cu. ft. + 1506.4 cu. ft. = **11,327.9 cubic ft.**

Total Passenger Capacity of *Titanic's* Lifeboats

The total passenger capacity of *Titanic's* lifeboats was enumerated in the Board of Trade survey certification certificate shown in Figure 13.

The total passenger capacity certified for each type of boat was:

30 ft. boats: 655.2 cu. ft./10 cu. ft. per passenger = **65 passengers**.

25 ft. boats: 326.6/8 cu. ft. per passenger = **40 passengers** and 322.1/8 cu. ft. per passenger = **40 passengers.**

Engelhardt boats: 376.6 cu. ft./ 8 cu. ft. per passenger = **47 passengers**.

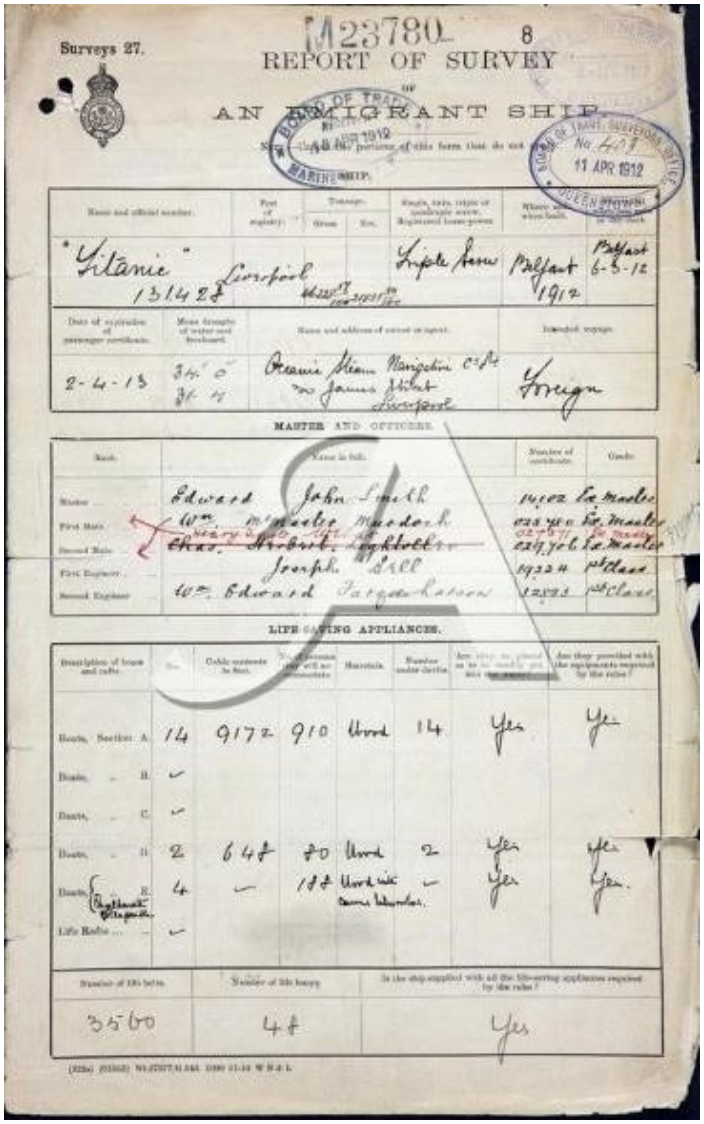
So the total certified passenger capacity for *Titanic* was:

30 ft. boats: 65 passengers x 14 = 910 passengers

25 ft. boats: 40 passengers x 2 = 80 passengers

Engelhardt boats: 47 passengers x 4 = 188 passengers

Total: 1178 passengers certified total boat capacity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REPORT OF SURVEY

OF

AN EMIGRANT SHIP.

BOARD OF TRADE 18 APR 1912 MARINE DEPT.

BOARD OF TRADE SURVEYORS OFFICE No. 407 11 APR 1912 QUEEN STREET

Name and official number	Port of registry	Tonnage: Gross	Tonnage: Net	Single, twin, triple or quadruple screw. Registered horse-power	Where and when built	
"Titanic" 131428	Liverpool			Triple Screw	Belfast 1912	Belfast 6-5-12

Date of expiration of passenger certificate	Mean draught of water and freeboard	Name and address of owner or agent	Intended voyage
2-4-13	34' 0" 31' 11"	Oceanic Steam Navigation Co. Ltd. per James Pilkington Liverpool	Foreign

MASTER AND OFFICERS.

Rank	Name in full	Number of certificate	Grade
Master	Edward John Smith	14,102	Ex. Master
First Mate	Wm. McMaster Murdoch	028,958	Ex. Master
Second Mate	~~Chas. Herbert Lightoller~~	024,706	Ex. Master
First Engineer	Joseph Bell	19324	1st Class
Second Engineer	Wm. Edward Farquharson	12583	1st Class

LIFE SAVING APPLIANCES.

Description of boats and rafts	No.	Cubic contents in feet	Number of persons which it is considered they can carry	Materials	Number under davits	Are they so placed as to be readily got at?	Are they provided with the equipments required by the rules?
Boats, Section A.	14	9172	910	Wood	14	Yes	Yes
Boats, " B.	✓						
Boats, " C.	✓						
Boats, " D.	2	648	80	Wood	2	Yes	Yes
Boats, " E. (Engelhardt Collapsible)	4	—	188	Wood with canvas bottoms.	—	Yes	Yes.
Life Rafts	✓						

Number of life belts	Number of life buoys	Is the ship supplied with all the life-saving appliances required by the rules?
3560	48	Yes

Figure 13

The total passenger capacity for each boat type was calculated by adding the capacities for each individual boat. If the total cubic ft. capacity for each boat type is divided by the cubic ft. space allotment for that type of boat, the resulting total passenger capacity is higher. The reason is because when each individual boat's passenger capacity is calculated, the number is rounded *down* to the nearest whole number. If all of the rounding remainders were added together, they would add a few more passenger capacities. However these "fractional passengers" could not be realized through their addition to equal whole passengers. So the passenger capacities for individual boats are the ones which were added to get the total passenger capacity.

Conclusion

The regulations regarding *Titanic's* lifeboat capacity requirements were subject to a number of different applicable rules. The calculations of the cubic ft. capacity of each type of lifeboat carried aboard *Titanic* were different. This article has sought to make sense of the Board of Trade requirements and the actual calculations used to arrive at both the total cubic ft. capacity of *Titanic's* lifeboats and the total passenger capacity. These explanations are not easy to keep close at hand in one's memory. It is understood that this article will serve more as a reference.