# *TITANIC*'S LIST AT 2:05 AM

**by Samuel Halpern**

Recently, in April of 2026, the team of Tad Fitch, J. Kent Layton and Bill Wormstedt made available a new article dealing with lifeboat launch sequencing and launch times entitled, "Titanic: The Lifeboat Launching Sequence – A New Study,"[1] That article was highly critical of a two-part article that I wrote called, "Lifeboats, Launch Times, List, and Trim," that was published in September of 2023.[2] In particular, a number of areas where their results differed from my own were highlighted, namely:

1. Which port-side lifeboat was launched first, No. 6 or No. 8,
2. the launch sequence and timing of the aft portside lifeboats,
3. the timing of the aft starboard lifeboats,
4. the list to port of *Titanic* when collapsible boats C and D were launched, and
5. the state of the davits seen at the wreck site.

This article will only address item No. 4, the list the ship took on at the time that collapsible boats C and D were launched. The other differences that were mentioned will be addressed in separate articles when time allows.

**Trim and Heel Study of 2017**

One of the first arguments presented by Fitch, et al is how much of my work was dependent on analytical results that used mathematical models developed by others such as the early flooding study of Hackett and Bedford in 1996.[3] Their new article even quoted a statement that I wrote in a 2005 posting on the *Encyclopedia Titanica* message board:

> "There are 'problems' with all theories. The biggest problem is that nobody has reliable input data. Much is based on what people said they saw and when they saw it. Much of the timing I'm afraid is very subjective, as is the extent of observed flooding in some cases."

That situation is still true and is not likely to change. However, Fitch, et al go on to imply that because Hackett and Bedford may have used what some believe to be unreliable input data taken from the British Wreck Commission report to develop a model of trim versus time, that their flooding work cannot be trusted, and that any work based off of that model must therefore be taken as faulty. They go on to say:

> "As early as our 2021 animation of the disaster, we began to see the need to study the angles of list and trim more carefully than to simply rely on Halpern's older calculations, which we based some of our statements in *On a Sea of Glass* on. It seemed important to us to move the flotation pivot point for *Titanic* slightly further aft from the time that Boiler Room No. 5 flooded suddenly through the end of the sinking; this seemed fair since the flotation pivot point was no longer constant as the weight of water continued aft from the

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[1] Published on-line at: https://wormstedt.com/titanic/TITANIC_THE%20LIFEBOAT%20LAUNCHING%20SEQUENCE_A%20NEW%20STUDY_v.%201.3.pdf.

[2] Published on-line at: *Encyclopedia Titanica*, Part-1, ref: #716, published 19 March 2023, and Part-2, ref: #717, published 22 March 2023. https://www.encyclopedia-titanica.org/lifeboats-launch-times-list-and-trim-1.html, and https://www.encyclopedia-titanica.org/lifeboats-launch-times-list-and-trim-part-2.html.

[3] Hackett and Bedford, "The Sinking of S.S. *Titanic* - Investigated by Modern Techniques," 1996 RINA Transactions.

> original compartments breached by the collision, and led us to think slightly differently about the forward trim angles that *Titanic* attained at certain points. Although our analysis of the ship's movements is not yet complete, the 2021 animation placed *Titanic* at a forward trim of about 9° degrees instead of Halpern's previously-estimated angle of 11°."

To be clear, my work that they referred to in the above statement was made available in an article called, "Angles of Trim and Heel," which was revised and released in August of 2017.[4] The time they were referring to when citing those trim angles above was the time when Second Officer Charles Lightoller went into the water, around 2:15am. Their mentioning of a flotation pivot point goes back to a 2011 article of mine entitled, "Finding the Apparent Floatation Pivot Point (AFPP)," which explained why the ship would appear to be slowly pivoting about an axis on her original waterline located somewhere opposite her fourth funnel as she slowly trimmed down by the head over time.[5]

The 2017 Trim Vs. Time curve that I put out several years ago (reproduced below in Figure 01) was based on observed flooding conditions as reported by eyewitnesses, some from specific locations within the ship, and some who reported what they saw while they were in the boats. The curve was not based on the trim conditions derived by Hackett and Bedford using Wreck Commission input data. The trim versus time results of Hackett and Bedford, however, were included in the same figure as my observational results for the purpose of comparison.

It should also be noted that the recent Fitch article had said that their "2021 animation placed *Titanic* at a forward trim of about 9° degrees instead of Halpern's previously-estimated angle of 11°." What they were referring to in that statement was the last data point on the observed data trim curve taken for 2:15am. A careful examination of that **observational data curve** (shown in red in Figure 01 below) shows that my derived trim point for 2:15am, which was based on an observation by Second Officer Charles Lightoller, was 10° down by the head, not the 11° as claimed in their new study. It was the 11th data point of the derived observational data curve.

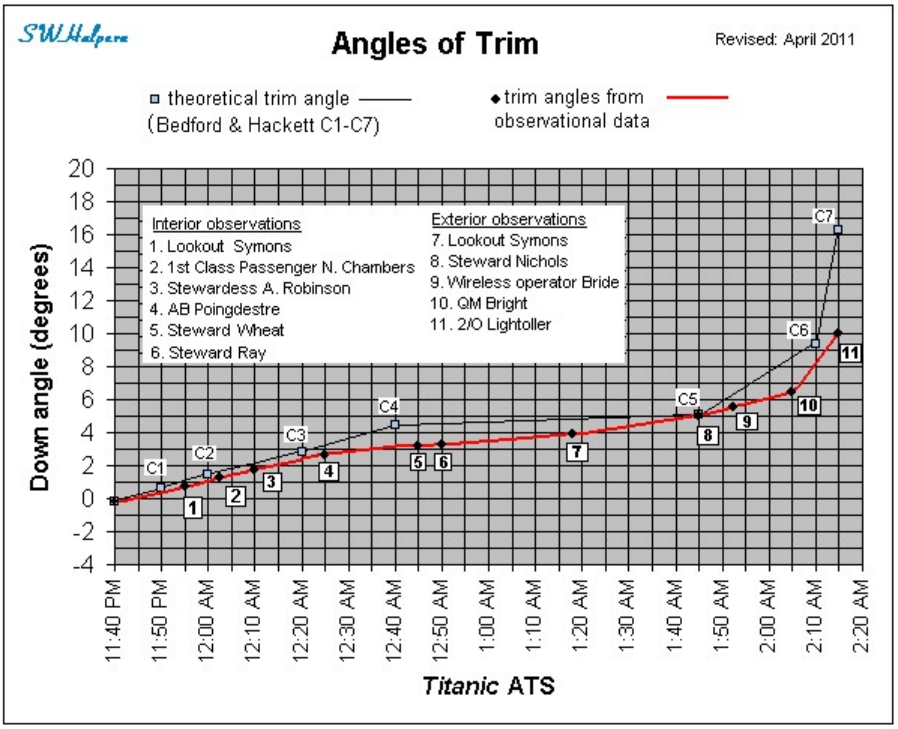


**Fig. 01 – Angles of trim from my earlier work.**

[4] Available at: http://www.titanicology.com/Titanica/TrimAndHeel.pdf.
[5] Available at: http://www.titanicology.com/Titanica/Finding_the_AFPP.pdf

How was that 2:15am data point derived? It came directly from what *Titanic*'s Second Officer Charles Lightoller described in his testimony before the American inquiry and then at the British inquiry:

> Mr. LIGHTOLLER. Well, roughly, the crow's nest was level with the water when the bridge went under water.
> Senator SMITH. The crow's nest, at the fore point?
> Mr. LIGHTOLLER. That is on the foremast. The lookout cage.
> Senator SMITH. The crow's nest at the highest point?
> Mr. LIGHTOLLER. Yes, sir.
> Senator SMITH. Was in the water?
> Mr. LIGHTOLLER. Was just about level with the water.
> Senator SMITH. When the bridge was submerged?
> Mr. LIGHTOLLER. Yes, sir.
> Senator SMITH. And about what was the angle?
> Mr. LIGHTOLLER. I am afraid I could hardly tell you the angle, sir.
> Mr. KIRLIN. Get the plan and find the height of the crow's nest above the deck, and that would give it.
> Mr. LIGHTOLLER. The plan showing the height of the crow's nest and the bridge would give it to you, roughly.
>
> 14052. Then what happened? - Well, she seemed to take a bit of a dive, and I just walked into the water.
> 14053. Had you got a lifebelt? - I had.
> 14054. You had better just tell us what your own experiences were. What happened to you? - Well, I was swimming out towards the head of the ship, the crow's-nest. I could see the crow's-nest.

Lightoller was on the roof above the officer's quarters just before the ship took that bit of a dive. He noticed that the crow's nest was level with the sea when the bridge went under. His suggestion about using the ship's plans to get the vessel's trim at that point in time was spot on. When doing that, one measures an angle of 10°. No guessing involved. No calculations based on some flooding model. Nothing about having to shift a floatation pivot point further aft. Yet Fitch, et al somehow are saying that their 2021 animation gives an angle of 9° for that point in time. Should we assume that their simulation model can produce a trim situation for the ship that is better than what we get from the observation of the person who was actually there?

Their argument seems to be a case of circular reasoning. The results of an animation model that was built to show the condition of the ship at various points in time, cannot be used to confirm the output results of that animation model.

**My Revised Work of 2023**

Fitch, et al have noted that in my earlier work, when I contributed to their lifeboat timeline, I talked about the ship carrying a 10° list to port at 2:05am when collapsible boat D was launched. However, in my 2023 work it seemed to them that I arbitrarily changed the list for 2:05am from 10° to 15°. The change to 15° in my 2023 work was not arbitrary. An explanation of that change is certainly well worth providing.

In their most recent article, they said regarding my previous work that "Halpern calculates that there was a 10° port list at the time Boat No. 10 was lowering, based on there being a 2½ foot gap between *Titanic* and the lifeboat, as observed by Able Bodied Seaman Frank Evans," and that they agree

with that result. They also agree that boat No. 10 was launched around 1:50am, about 15 minutes before Collapsible D was launched, and they also agree that *Titanic* had shifted from carrying no list at 1:20am, when boat No. 16 was launched, to carrying a 10° port list 30 minutes later at 1:50am when No.10 was first lowered. It was then assumed at the time that the listing of the ship over to port completely stopped by 1:50am after shifting at an average rate of about 1 degree every 3 minutes during the previous half hour.

In my 2017 work I did not actually derive a list to port for 2:05am, but assumed it was the same as what it was at 1:50am. With a 10° port list, the port side of the ship would be about 8 feet *lower* than the height of the centerline of the deck, and the starboard side of the ship would be about 8 feet *higher* than the height of the centerline of the deck. I then assumed that water had reached about the level of B deck on the centerline of the section where the collapsible boats were when they were being launched based on a statement by QM Bright that the forecastle was about 20 feet below the level of the bridge, and that the forecastle (which was at B deck level) was just going under water when boat D was being launched. Then, using published dimensions for the ship, I calculated that B deck was exactly 18.5 feet below the level of the boat deck,[6] and therefore the port side of the forward part of the boat deck would only be 18.5 - 8 = 10.5 feet above the level of the water at that time. That distance of 10½ feet closely agreed with Lightoller's observation that collapsible D had to be lowered only about 10 feet to reach the water.[7] (See Figure 02.)

Notice that this simplistic analysis *assumed* that the ship had taken on list of 10° thus lowering the port side of the vessel 8 feet from the centerline level, and that the water was at the level of B deck on the ship's centerline on the cross-section where the foremost davits were at 2:05am.

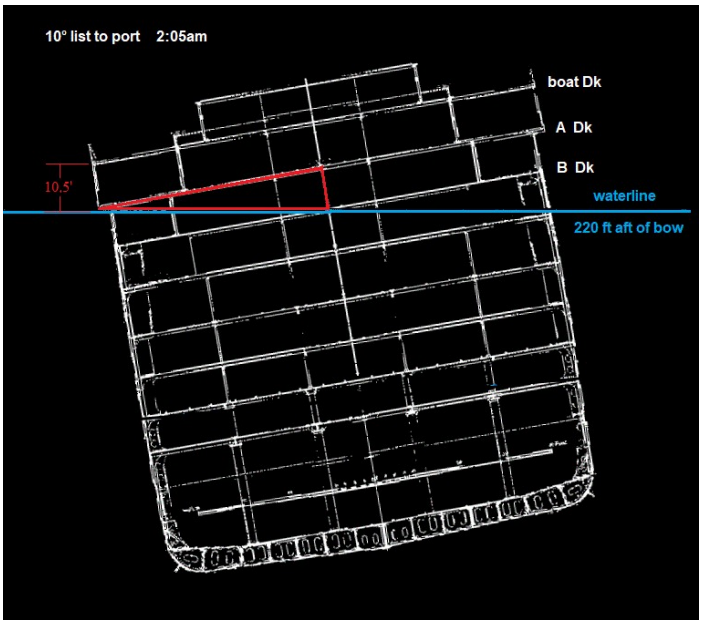


**Fig. 02 – List 10° port looking forward.**

So why did I decide to revisit this in 2023? To me the assumption that the ship's listing to port remained at 10° after 1:50am seemed to be somewhat arbitrary, as the shifting of the ship's list from starboard over to port, as well as the down tilting of the bow, were both progressing relatively slowly in their respective directions over time. (Only near the very end did things begin to happen much more quickly.) So I decided to challenge my own assumptions that I made in my earlier work. Among those

[6] From the Wreck Commission Report: Deck A was 9' 6" below the boat deck, and Deck B was 9' 0" below Deck A; thus Deck B was 18' 6" (18½ ft) below the boat deck.
[7] British inquiry, 13486.

was the assumption that the water level had reached *exactly* to the level of B deck on the ship's centerline where collapsible boat D was at 2:05am.

**Deriving the Angle of List for 2:05am**

QM Arthur Bright, who was placed in charge of boat D, said "When I left, the forecastle was going under water… the forecastle head was just going under water."[8] QM George Rowe, who was in charge of boat C and launched a few minutes earlier, had just about reached the sea after experiencing great difficulty when lowering due to its "rubbing strake" catching on the ship's rivets on the way down the side. Rowe said that he saw the ship's forward well deck was "submerged" when his boat got down to the water, and that it took them "a good five minutes" to lower boat C on account of that rubbing. For the well deck to have been submerged, the forecastle had to be under water.[9]

Based on these observations, it occurred to me that we could determine (using some trigonometry) the likely trim angle that the ship carried when boat D was first lowered from a set of detailed waterline curves as shown in Figure 03 below.

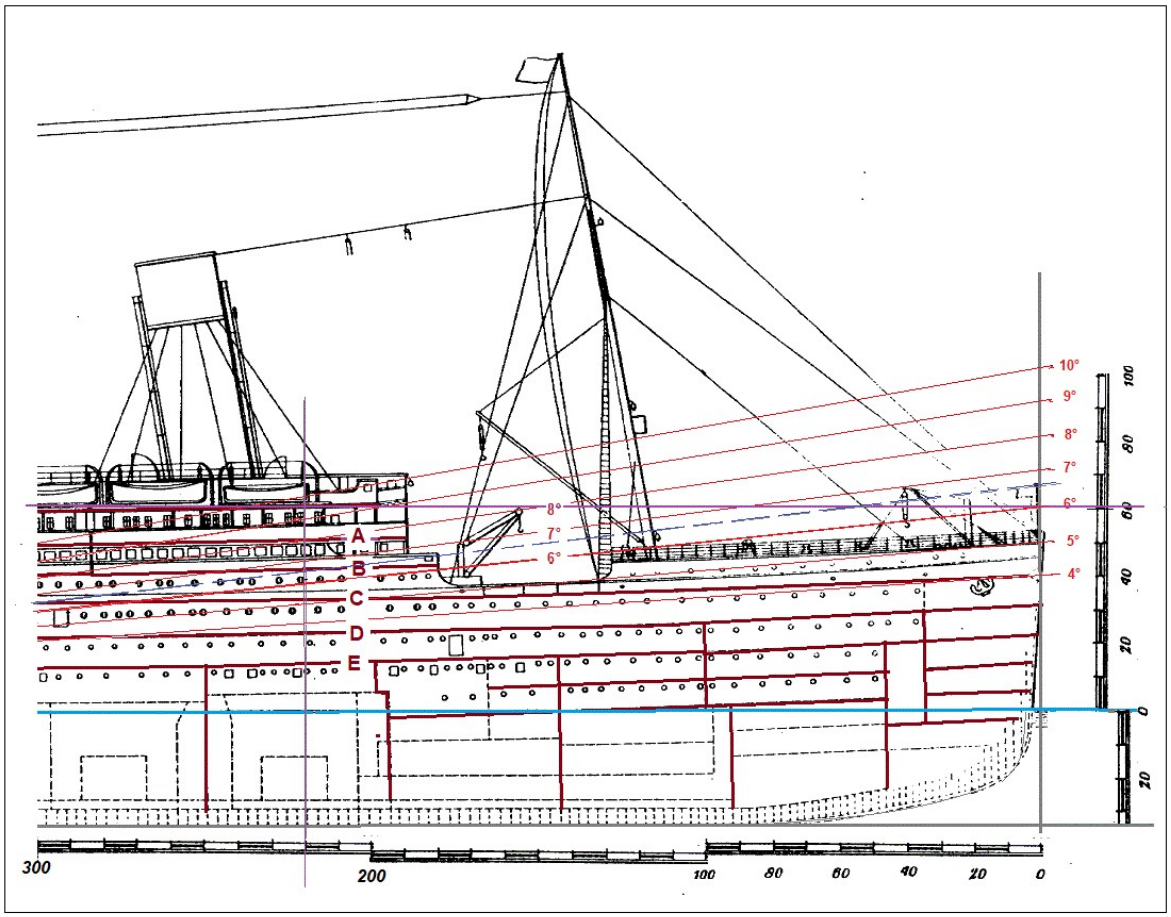


**Fig. 03 – Waterline curves showing bow section detail.**

[8] American inquiry, p.837 and p.839.

[9] The reader should also be aware that the launch times of boats C and D, though listed as 2:00am and 2:05am, respectively, are only best estimates. The 2am time for boat C comes from QM Rowe who when asked how long after he left the ship did she sink, replied: "Twenty minutes, I believe." Since boat D left after boat C, it was taken that D was lowered about 5 minutes after C based mostly on QM Rowe's observation that the forward well deck was submerged when he reached the water "a good 5 minutes" after his boat C began lowering, and QM Bright noting that the forecastle was just going under (thus completely submerging the well deck) as D started down.

As *Titanic* trimmed down by the head, she seemed to pivot around a point in the longitudinal plane that we have been calling the apparent floatation pivot point, over a period of time. That point *late in the sinking process* was located about 585 feet back from the bow. It is the point where a set of waterline curves intersect the intact 0° waterline curve, and includes the 10° waterline curve for 2:15am which was obtained by geometrical measurement, not some model calculation, based on Lightoller's specific observations that we previously talked about.[10] Notice that in that set, the 6° waterline curve is just above the ship's forecastle which would match the condition described by QM Bright just as boat D was being lowered, only about 10 minutes before Lightoller left the ship. Moving back along that 6° waterline curve to a point 220 feet from the bow, to about where the forward part of boat D would be, the height of the 6° waterline curve there calculates to:

$$H = (585 - 220)\ \tan(6°) = 38.4 \text{ ft, or just about } 38\tfrac{1}{2} \text{ feet above the intact } (0°) \text{ waterline}$$

Since B deck was 18½ feet below the boat deck, and the boat deck on the night of the accident was about 60½ feet above the intact waterline,[11] we know that B deck had to be 60½ - 18½ = 42 feet above the intact 0° waterline at that location. Thus we find that at 2:05am, the height of the water on the ship's centerline opposite to where the fore part of boat D was located would be 42 - 38½ = 3½ feet *below* B deck when the forecastle just went under. Since B deck is exactly 18½ feet below the boat deck, the water level on the ship's centerline at 2:05am would have been 18½ + 3½ = 22 feet below the boat deck at that time on the centerline.

We are now at a point where we can actually calculate the angle of list for 2:05am, rather than assume an angle of list for that particular time.

According to passenger Hugh Woolner, water was just coming onto the fore part of A deck at its open end where he was just as boat D was being lowered. This observation places A deck at the level of the sea on the port side of the ship where the fore part of boat D was at 2:05am. We also know that A deck is exactly 9½ feet below the boat deck, and thus we see that boat D had to drop almost 10 feet when it was lowered, just like Second Officer Charles Lightoller had described.

We also know that the distance from the ship's centerline to the edge of the deck is half its maximum width, or about 46 feet. Furthermore, we also have just seen that the water at 2:05am was about 22 feet below the level of the boat deck on the ship's longitudinal centerline at the location of interest. To calculate the angle of list, θ, we make use of the right triangle shown in red in Figure 04 below.

From Figure 04, we see that length ***b***, the adjacent side of the right triangle, has to be 46 ft, the distance from the ship's centerline to the edge of the deck. The length of side ***a***, the opposite side of the right triangle, is the distance to the water on the ship's centerline below deck A. Since deck A is 9½ feet below the boat deck, and the distance from the boat deck to the water was found to be 22 feet on the centerline, we see that the distance from A deck to the water along the centerline, side ***a*** of the right triangle, is:

$$\boldsymbol{a} = 22.0 - 9.5 = 12.5 \text{ feet.}$$

From the geometry of the situation, the angle of list for 2:05am is simply:

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[10] It should be mentioned that different flooding condition scenarios showed that the apparent flotation pivot point (AFPP) does not change very much throughout the sinking process. (See my article "Finding the AFPP" previously referenced.) Although water inside the ship starts to flow further back toward the stern overtopping some watertight bulkheads, water in the forward compartments of the ship continues to rise in those compartments as the bow continues to trim downward until they are fully submerged. Thus the center of gravity of the flood water along the longitudinal plane does not move as far back as one might intuitively suspect, and therefore, neither does the AFPP.

[11] British Wreck Commission Report p. 8-9.

$$\theta = \arctan (a / b) = \arctan (12.5/46) = 15.2°$$

This is the list of the ship for the situation at 2:05am as derived, and as shown in Figure 04.

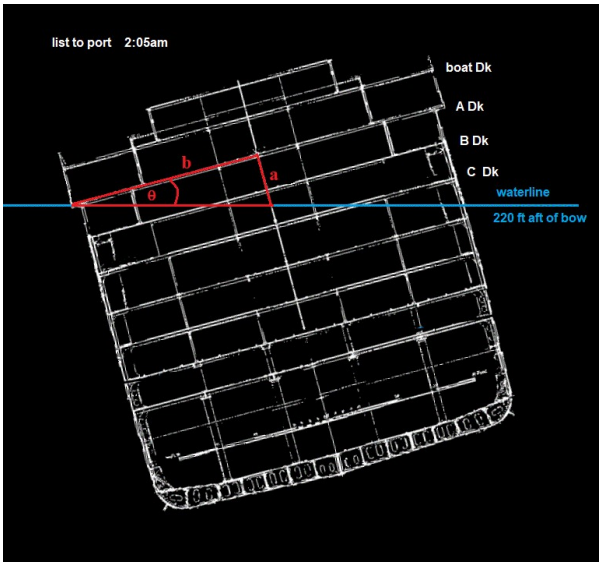


**Fig. 04 – Deriving the angle of list for 2:05am looking forward.**

**How Accurate is a 15° List For 2:05am?**

It should be obvious that any analytical result is only as good as the assumptions and data input that are used in setting up the problem to be solved. The key assumption in the above problem was that water on the ship's longitudinal centerline opposite to where the fore part of the collapsible boats were, had reached a level 22 feet below the longitudinal centerline of the boat deck, or 12½ below the centerline from A deck. We based that off of the 6° trim curve seen in Figure 03 for the reasons described. But what if we are wrong? What if the ship had trimmed down a little more than the forecastle "just" becoming submerged at that time? So let's parameterize the problem and consider 3 situations for 2:05am:

1. water was 22 feet below the boat deck (12½ feet below A deck) on the centerline,
2. water was 20 feet below the boat deck (10½ feet below A deck) on the centerline,
3. water was 18 feet below the boat deck (8½ feet below A deck) on the centerline.

Based on the geometry shown in Figure 04, we get the following angles of list (rounded to nearest ½ degree) when keeping the port side of deck A at the level of the sea at the time boat D was lowering:[12]

1. $\theta_1 = 15°$
2. $\theta_2 = 13°$
3. $\theta_3 = 10½°$

These results show how the calculated list at 2:05am depends on how far down by the head the ship had sunk by that particular time. The greater the ship was down by the head, the smaller the list would appear

[12] Time is taken as 2:05am. Figure 04 as drawn actually shows the situation for water 22 feet below the boat deck along the centerline resulting in a $\theta = 15°$. Changing the level of water along the centerline would only change the length of side *a* of the right triangle and the angle θ for the other two conditions being considered.

to be in order for the port side of A deck to be at water level at the cross-section of the ship where the fore part of the boat was located.

Is it possible that the rate at which the ship was listing over to port had eased up after 1:50am when boat No. 10 was launched so that it stayed closer to 10° rather than continuing on to 15° by 2:05am?

The answer is yes, but it also would imply that the vessel had trimmed down to just over 6½ degrees instead of the 6° angle shown back in Figure 03, with the forecastle having been submerged a little before boat D was actually lowered. This would seem to imply that QM Bright's observation that "the forecastle head was just going under water" had occurred a little before they were able to actually lower his boat. We know that the after fall at boat D got hung up when they first tried to lower the boat, and it had to be cleared before the boat could actually be let down.[13] All the while, the forward end of the ship would continue to sink lower and lower toward the sea. Once the fall was cleared, it would take only about 40 to 60 seconds at most to lower the boat about 10 feet to the water.[14]

The other thing that would have been affected by changing the angle of list for 2:05am is the trendline curve for list as a function of time that was developed back in 2023. That curve was based on six data points:

1. A port list of 2° at the moment of iceberg impact, taken at 11:40pm.
2. A starboard list of 5° based on QM Hichens inclinometer reading at 11:50pm.
3. A starboard list of 2° when lifeboat No. 1 being launched, taken at 1:05am.
4. Zero list when boat No. 16 was launched, taken at 1:20am.
5. A port list of 10° when lifeboat No. 10 was launched, taken at 1:50am.
6. A port list of 15° when lifeboat D was launched, taken at 2:05am.

Since the only real challenge to the values of list for the times shown was that for item 6 above,[15] I decided to see how the trendline curve would change if we use the three list angles we just considered ($\theta_1 = 15°$, $\theta_2 = 13°$ and $\theta_3 = 10½°$) for the list of the ship at 2:05am. The three resulting curves, obtained for a range of time from 11:40pm out to 2:15am, are shown in Figure 05 below.

What is interesting is that the trendline curve seems to change shape only beyond the 1:50am point in all three sets of curves. Beyond the 1:50am point, the trendline curves tends to suggest that the swinging of the ship toward port would eventually come to a halt, and then start to swing back toward starboard as if the ship wanted to straighten itself out again sometime before the breakup began. It must however be acknowledged that this may only be an artifact of curve-fitting rather than some physical cause. Nevertheless, it may be interesting to note that H&W marine architect Edward Wilding believed that the ship would have eventually righted herself as far carrying a list if she had not sank when she did.[16]

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[13] American inquiry, p. 839.

[14] The foremost pare of davits where the emergency cutter boats and collapsible boats were kept, had a pulley arrangement of only 4-to-1. Paying the falls out at rate of 1-foot per second would therefore lower the boat 3 inches every second. Thus it would nominally take 40 seconds to lower a collapsible boat 10 feet (or 4 minutes if lowered from a height of 60 feet). The larger 30-foot long wooden lifeboats used a pulley arrangement of 6-to-1, and would nominally take about 6 minutes to lower them from a height of 60 feet with the falls payed out at a rate of 1-foot per second.

[15] Challenges to those listed points were on grounds mostly unrelated to the list angle, which is the sole focus of this article.

[16] British inquiry, 20250-20251.

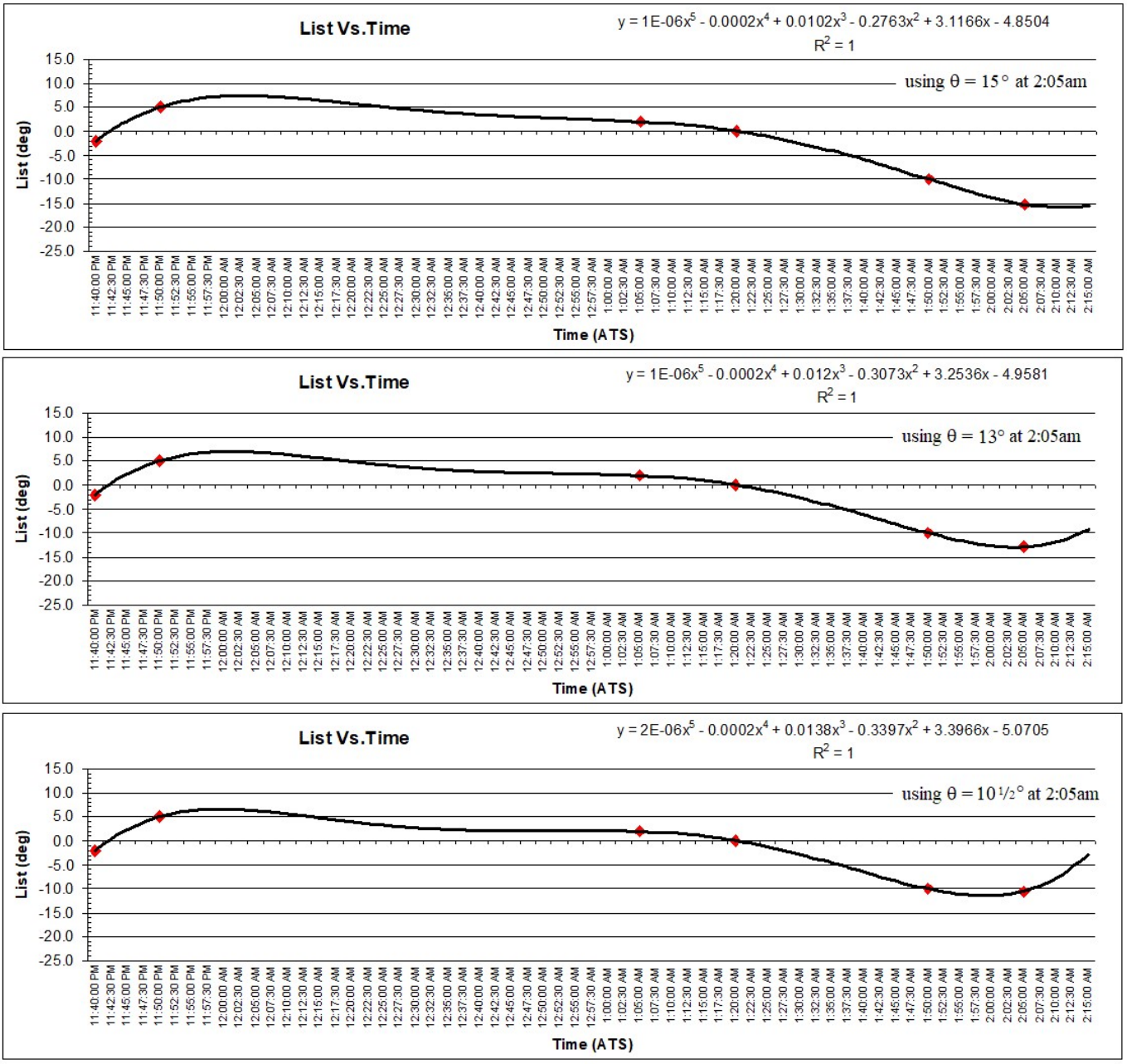


**Figure 05 – Trendline curves for values of list at 2:05am of: θ = 15.2°, 12.9° and 10.5° port.**

Is there any evidence that the list may have started to correct itself sometime before the breakup began? Consider this written account by 17-year old John B. Thayer, Jr.:

> "We went and stood by the davits of a boat which had left. There was such a big list to port that it seemed as if she [the ship] would turn over on her side as she sank. In such a case we would not have had the slightest chance, so I told him I was going to jump out and slide down the davit ropes into the water and try to swim to the boats in the distance. I started to do this three times, and each time he caught hold of me and asked me to wait awhile. *In a few minutes she straightened up on an even keel* [my emphases]. We hurried back and stood by the rail about even with the second funnel. She started to shoot down fast at an angle of about thirty degrees. We shook hands, said goodbye and wished each other luck. We did not give each other any messages for home, because neither of us thought we would ever get back. Then we jumped upon the rail. Your son put his legs over the side,

> holding onto the rail with his hands, he looked up at me and said, 'You're coming, boy, aren't you?' I replied, 'Go ahead, I'll be with you in a minute.' He let go and slid down the side and I never saw him again. Almost immediately after I jumped. All the last part took a very short time, and when we jumped were about ten yards above the water. Your son was perfectly calm all the time and kept his nerve, even to the very end."

The above was written on April 23rd 1912 by the young Jack Thayer to the parents of his on-board acquaintance Milton Long who did not survive the sinking.[17]

Although we may question Thayer's subjective judgment of the down angle the ship had taken on when things started to happen very quickly, his mentioning of the ship having reached a very severe list to port beforehand was of obvious concern to him. He also wrote that the list had appeared to have straightened up before he and his friend Milton Long hurried back to the rail opposite the ship's second funnel where he and Long departed from the ship as she started to go down fast.

In a statement given to the press a few days earlier, on April 20th 1912, Thayer was quoted as describing essentially the same events that he wrote about to Long's parents three days later:

> "The list to the port had been growing greater all the time. About this time the people began jumping from the stern. I thought of jumping myself, but was afraid of being stunned on hitting the water. Three times I made up my mind to jump out and slide down the davit ropes and try to make the boats that were lying off from the ship, but each time Long got hold of me and told me to wait awhile. He then sat down and I stood up waiting to see what would happen. Even then we thought she might possibly stay afloat. I got a sight on a rope between the davits and a star and noticed that she was gradually sinking. About this time she straightened up on an even keel and started to go down fairly fast at an angle of about thirty degrees. As she started to sink we left the davits and went back and stood by the rail about even with the second funnel. Long and myself said good-bye to each other and jumped up on the rail. He put his legs over and held on a minute and asked me if I was coming. I told him I would be with him in a minute. He did not jump clear, but slid down the side of the ship. I never saw him again. About five seconds after he jumped I jumped out, feet first. I was clear of the ship, went down, and as I came up I was pushed away from the ship by some force."[18]

Jack Thayer went on to describe seeing one of the funnels falling off, and seeing what looked as if the ship "broke in two just in front of the third funnel." He then talked about being sucked down again and coming up and getting on top of an overturned boat [collapsible B] with some help from a stoker, seeing the stern of the ship rise up in the air and then sink below the surface, and then went on to describe how those on the overturned lifeboat were eventually rescued.

According to what Jack Thayer claimed in that April 20th press statement, as well as in his letter to Milton's parents, his friend Milton Long did not jump away from the ship as he did, but instead, let go and "slid down the side of the ship" and was never seen again. That would indicate that the vessel had not actually straightened out completely from her list to port as Thayer thought, but instead was still carrying some degree of port list at the time they left. If not, Long could not possibly have slid down the ship's side as Thayer said he did. Jack Thayer and Milton Long left the ship from the boat deck on the starboard side of *Titanic*, about opposite the second funnel, a little aft of the empty davits where boat No. 7 had been.

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[17] Letter from John B. Thayer, Jr. addressed to Judge Charles L. Long of Springfield, MA, dated April 23, 1912.

[18] John B. Thayer, Jr.'s Statement to the Press Regarding the Sinking of the R.M.S. *Titanic*, April 20th 1912, The Thayer Collection, housed at the Independence Seaport Museum Library in Philadelphia, PA.

**Launching a Boat From the High Side With a 15° List**

In their recent article, Fitch, et al were trying to make the case that it would have been almost impossible to launch a boat successfully from the starboard side if *Titanic* had taken on a list to port of 15°. They even brought up the *Lusitania* sinking to support their claim by citing how all but possibly one boat reached the water without sustaining some serious damage or capsizing while lowering from the high side of the deck with the ship sustaining a 15° list to starboard after being torpedoed by a German U-boat.

Does what happened to *Lusitania* really prove anything? What do we really know?

The *Lusitania* inquiry concluded that time was very short, with only *twenty minutes* elapsing between the first alarm and the sinking of the ship. They also concluded that the ship instantly took on a great list to starboard, and that many passengers attempted to push some of the boats on the port side, the high side of the ship, off the ship to get them into the water. They also said that some of these boats caught on the rail and capsized, and that one or two did reach the water, and were seriously damaged in the operation. The report went on to say that they "were lowered a distance of 60 feet or more" with people in them, and must have been fouling the side of the ship the whole time as they were being lowered down.

Where did the inquiry find that the ship had taken on a list of 15°, and did she carry that degree of list all the time that they were trying to lower the boats?

What we find is the following from those who testified at the *Lusitania* inquiry. (Emphasis shown in bold is from this author.):

Testimony from *Lusitania* Commander William Turner:

> 92. Will you tell his Lordship and the Assessors in your own way what happened? - The officer called out "There is a torpedo coming, sir," and I went across to the starboard side and saw the wake, and there was immediately an explosion and the ship took a heavy list.
> 93. Could you observe where she was struck-which side first? - The starboard side.
> 94. Do you know where she was struck? - A big volume of smoke and steam came up between the third and fourth funnels, counting from forward-I saw that myself.
> 95. Did you say that you yourself saw the wake of the torpedo? - I saw a streak like the wake of a torpedo.
> 96. Somebody cried out that there was a torpedo? - Yes, the Second Officer [Percy Hefford], on the bridge.
> 97. When the ship was struck tell us what happened? - I headed her for the land to see if I could make the land.
> **98. Did she list? - Heavily to starboard.**
> 99. Were you yourself thrown down? - No.
> 100. What did you do then? - Ordered the boats to be lowered down to the rails, to get the women and children in first.
> 101. Before doing that, did you go on to the navigation bridge? - Yes.
> 102. I want to take it in order, you know. You went up to the navigation bridge? - Yes.
> 103. What did you do then? - Put her head on to the land, and then I saw she had a lot of way on her and was not sinking, so I put her full speed astern, to take the way off her.
> 104. When you did that, was there any response from the engines? - None whatever.
> 105. What did you conclude from that? - That the engines were out of commission.
> 106. When you had ordered full speed astern and had headed her for the land, what did you do? - I told them to hold on lowering the boats till the way was off the ship a bit, which was done. I told the staff captain [James Anderson] to lower the boats when he thought the way was sufficiently off to allow them to be lowered.

107. Did you notice any other concussion that would lead you to believe there was a second torpedo? - One immediately after the first.
**108. When you told them to lower the boats, was there any difficulty about any of the boats? - They could not very well lower them on the port side because of the heavy list.**
**109. Can you give us a little more information as to the extent of the list? - I should say about 15 degrees.**
**110. What happened to the boats on the port side? - They caught on the rail and capsized some of the people out. Some [boats] were let go on the run, and some of them [boats] fell inboard on the deck and hurt some of the passengers.**

Testimony from QM Hugh Johnson, *Lusitania*'s quartermaster at the wheel when the torpedo struck:

566. ... (To the Witness.) Tell us what it was you first observed, or knew, as regards the ship being torpedoed? - The report that came to the bridge, "Here is a torpedo coming."
567. Whom did you hear say that? - I heard Mr. Heppert [sic, actually Mr. Percy Hefford], the second officer, repeat it from the look-out.
568. What happened next? - Shortly afterwards the torpedo struck us.
569. Did you get any orders from the Captain when that happened? - Not before the torpedo hit the ship.
570. What was the next order? - "Hard-a-starboard."
571. Who said that? - That was from the Captain.
572. What did you do when he said "Hard-a-starboard"? - I carried out the order and put the wheel hard a starboard - 35 degrees.
573. What did you say; did you report that to the Captain? - I reported " Helm hard-a-starboard."
574. What did he say? - He said "All right."
575. When you did that did the vessel answer the helm? - Yes.
576. And swung round. Would her head go toward Kinsale then? - Yes.
577. Did you get any order from the Captain when you had done that? - Yes.
578. What was it? - To steady and keep her head on to Kinsale, as she was swinging towards the land.
579. Did you carry out that order? - Yes, I repeated the order and carried it out.
580. What happened then? - I was doing all I was supposed to do, steadying the ship; but she was swinging off again and he gave me another order to hard-a-starboard again.
581. What did she do then; did she answer her helm? - I put the wheel round, but she would not answer her helm but kept on swinging out towards the sea.
582. After the Captain had given you the first order "Hard-a-starboard," did you hear him say anything to the second officer, Mr. Heppert [sic], as to the list on the ship? - Yes.
583. What did he say? - He said "Have a look what list the ship has got."
**684. What did Mr. Heppert [sic] say? - "15 degrees."**
**586. To starboard? - Yes.**
**586. Did he say that? - Well, it is not likely the ship would list to port.**
**587. I am only asking you what he said. Did he say merely "15 degrees"? - "15 degrees to starboard."**
**588. What did the Captain say then? - "Keep your eye on her to see if she goes any further."**
589. Were you given any instructions then as to watching the indicator? - Not until Mr. Heppert [sic] was given an order to go down to the forecastle head to close the doors leading down to the forecastle. Mr. Heppert [sic] looked into the wheelhouse and said

"Keep your eye on the indicator on the compass and the spirit level, and sing out if she goes any further."

**590. What did Mr. Heppert [sic] say to you when he was going down to carry out the Captain's order? - He told me to keep my eye on the indicator on the compass and sing out if she listed any further.**

**591. That was the object of the order? - Yes.**

**592. Then what happened. Did she list further? - She stopped at 15 degrees for a matter of just a couple of minutes.**

**593. The Commissioner: And then what happened? - Then she steadily started to go further over, and I sung out what she was doing - 20 and 25.**

594. The Attorney-General: Accordingly as she listed more and more you gave information? - I gave information, and sung out to the Captain on the bridge.

595. As the list increased did the Captain say anything to you? - When I sung out that she had 25 degrees of list, the Captain told me to save myself.

596. Was there anything else you could have done at that time? - No.

So we have first-hand, direct evidence that the immediate list to starboard that *Lusitania* took on did not stop at 15° for very long, but continued on to 20° then to 25° as seen on an inclinometer in the wheel house before the helmsman was told to save himself. These were not subjective estimates, but true quantifiable observations of the condition of list on *Lusitania* after the torpedo struck.

So what are the forces acting on a boat as it goes down the high side of a ship that has a list of some number of degrees, and how do those forces change relative to each other as the list continues to increase?

Consider the diagram in Figure 06 below.

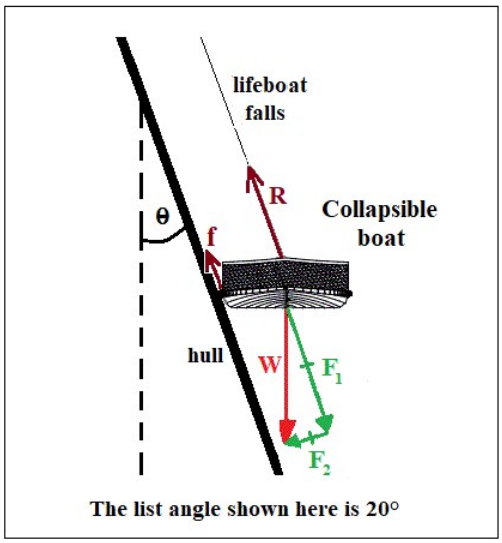


**Figure 06 – Forces acting on a boat lowering from vessel's high side.**

In Figure 06, force **W** is the weight of the boat including its occupants, **R** is the force pulling on the falls of the boat keeping it from dropping freely, **f** is the frictional force caused by the rubbing of the boat along the side of the ship and acts parallel to ship's side, $\mathbf{F_1}$ is the component of **W** that is acting parallel to the ship's side pulling the boat downward along the side, $\mathbf{F_2}$ is the component of **W** that is acting perpendicular to the ship's side causing a frictional force to exist, **f**, that is proportional to $\mathbf{F_2}$, and $\theta$ is the list of the ship**.**

For different angles of list, the components of **W** will change, with $\mathbf{F_1}$ decreasing somewhat, and $\mathbf{F_2}$ increasing somewhat, thereby increasing the frictional force **f** as the angle of list increases.[19] The following table shows how the percentages of these component forces change relative to the weight of the boat for angles of list of 0°, 5°, 10°, 15°, 20°, and 25°.

| Component force | List 0° | List 5° | List 10° | List 15° | List 20° | List 25° |
|---|---|---|---|---|---|---|
| $\mathbf{F_1/W}$ (x100%) | 100% | 99.6% | 98.5% | 96.6% | 94.0% | 90.6% |
| $\mathbf{F_2/W}$ (x100%) | 0% | 8.7% | 17.4% | 25.9% | 34.2% | 42.3% |

It is extremely rare that a damaged vessel in distress and taking in water will remain perfectly level while lifeboats are being loaded and lowered. That is why some boats were designed with fenders (or rubbing strakes) to help prevent damage while rubbing and bumping along the side of a ship's hull as the boat was being lowered. The collapsible boats on *Titanic* had such fenders that were filled with cork which can easily be seen in the many pictures taken of these boats. (The cross-section of the boat shown in Figure 06 shows these cork fenders as does the picture taken of boat D in upcoming Figure 12.)

So the question is, how much of a list can a ship take on before it becomes very difficult, if not impossible, the let a boat down safely to the sea?

The answer to when that point is reached is not clear. A list as much as 15° or 20° was referred to as "considerable" with regard to launching lifeboats as well as keeping the bulkhead deck of a damaged ship above water.[20] (Today, the requirement is that lifeboats must be able to be successfully loaded, swung out and launched from vessels having a list of up to 20° either way and a trim of up to 10° either way.[21]) As we have seen, the launching of collapsible boat C was indeed very difficult, with those in the boat having to almost continuously push off the side of the ship as its cork filled fender got caught on the round rivet heads in the hull as the boat was being lowered. According to Bruce Ismay, who escaped in boat C shortly before it was launched:[22]

> "It was very difficult to judge [how far we had to lower the boat down the side], because we had considerable difficulty in getting our boat down at all. ...The ship had quite a list to port. Consequently this canvas boat, this collapsible boat, was getting hung up on the outside of the ship, and she had to rub right along her, and we had to try to shove her out, and we had to get the women to help to shove to get her clear of the ship. The ship had listed over that way."

At exactly what list angle would it become impossible to lower a collapsible boat filled with occupants? It is difficult to say exactly when that point is reached. However, what we can say for certain is that the task becomes more and more difficult as the list approaches what was termed to be "considerable" as stated above.[23]

There is one more thing to consider when comparing to the launching of boats on the sinking *Lusitania*, which developed a list of 15° before the order to abandon was even given, and that is the shape of *Lusitania*'s hullform in relation to *Titanic*.

*Lusitania*'s hull bulged outward somewhat starting at the Shelter deck (the second deck below her boat deck) as one looks down the side of the ship. The initial slope of the bulge would have effectively

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[19] Note: $\mathbf{F_1} = \mathbf{W} \cos \theta$, $\mathbf{F_2} = \mathbf{W} \sin \theta$, and $\mathbf{f} = k\mathbf{F_2}$, where k is a coefficient of fiction.

[20] British inquiry, 25297.

[21] SOLAS regulations 2025, Ch. III, Life-Saving Appliances and Arrangements.

[22] American inquiry, p. 965.

[23] It should be mentioned that QM George Rowe, who was put in charge of collapsible boat C, stated at both the American inquiry (day 8) and at the British inquiry (day 15) that he thought the ship was listing only 5° or 6° when his boat was lowered. He also said he never noticed any list prior to leaving the vessel in boat C. Rowe's estimates of list were of course very subjective, and demonstrates how one needs to be very careful about taking such subjective claims as reliable.

changed the slope of the deck by some 10° more, making it even harder for a boat to be successfully lowered down when it reached that point. On the other hand, *Titanic*'s hullform had a much straighter slope to it from A deck on down. This can be seen in the midship-section views of both vessels that are shown in Figure 07 below.

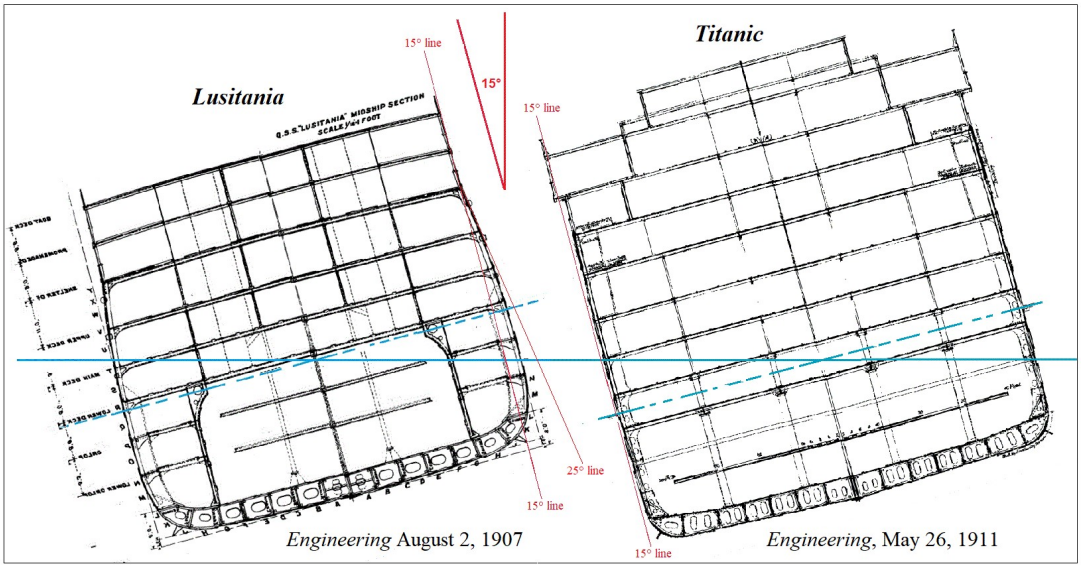


**Fig. 07 – Midship sections of *Lusitania* (left) and *Titanic* (right) with 15° lists.**

In the case of *Lusitania*, there was very little time to lower her boats. Unlike *Titanic* which had stayed afloat for 2 hours and 40 minutes, those on board *Lusitania* had only about 20 minutes to get off the ship from the time the torpedo struck. They did not have the luxury of time to pay out boat falls at a relatively slow, safe rate. Is there any wonder why some of the boats capsized trying to be lowered, or broke up along the hull as they were being let down (or should it be said dropped down)?

With collapsible boat C on *Titanic*, it took a "good 5 minutes" to lower the boat about 34 feet if she was carrying a list close to 15° by the time that it was launched.[24] Normally, if there were no rubbing along the side of the ship, it should have taken about 2¼ minutes to safely lower the boat that distance,[25] but because of the rubbing against the riveted hull as it was being lowered, it took a lot more than twice as long to lower the boat. Unfortunately, time was something that those on *Lusitania* did not have.

**The Escape of Woolner and Steffansson**

In the recent Fitch, et al article, it was said that it would be almost impossible for first-class passengers Hugh Woolner and his shipboard acquaintance Mauritz Håkan Björnström-Steffansson to have successfully made it into collapsible boat D if *Titanic* had taken on a list of 15° at the time they jumped for the boat. According to Woolner's testimony before American inquiry:

> Mr. WOOLNER. …Then that boat [Collapsible C] was finally filled up and swung out, and then I said to Steffanson: "There is nothing more for us to do. Let us go down onto A deck again." And we went down again, but there was nobody there that time at all. It was perfectly empty the whole length. It was absolutely deserted, and the electric lights along

[24] The starboard side of the ship would be about 24 feet higher than the port side with the ship carrying a list of 15°, and the boat deck was 9½ feet higher than A deck, and A deck was at the level of the sea on the port side by the time boat C had reached the water.

[25] Based on paying out the falls at an average rate of 1 foot per second, a pulley arrangement at the collapsible davits of 4-to-1, and a drop distance of 34 feet.

the ceiling of A deck were beginning to turn red, just a glow, a red sort of glow. So I said to Steffanson: "This is getting rather a tight corner. I do not like being inside these closed windows. Let us go out through the door at the [forward] end." And as we went out through the door the sea came in onto the deck at our feet.
Senator SMITH. You were then on A deck?
Mr. WOOLNER. Yes, sir.
**…**
Senator SMITH. You remained down there with your friend until the sea came in - water came in - on A deck?
Mr. WOOLNER. On that A deck. Then we hopped up onto the gunwale preparing to jump out into the sea, because if we had waited a minute longer we should have been boxed in against the ceiling. And as we looked out we saw this collapsible [boat D], the last boat on the port side, being lowered right in front of our faces.
Senator SMITH. How far out?
Mr. WOOLNER. It was about 9 feet out?
Senator SMITH. Nine feet out from the side of A deck?
Mr. WOOLNER. Yes.
…
Senator SMITH. The ship listed to the port side?
Mr. WOOLNER. Yes; and that is why I judge the boat was hanging out so far away.
Senator SMITH. And that threw this lifeboat out away from the side of the ship?
Mr. WOOLNER. Yes, sir; that is how I judged it.
Senator SMITH. About 9 feet?
Mr. WOOLNER. Yes, sir; I should judge it was about that; about 8 feet 6, perhaps. It was not less than 8 feet, and probably 9.

Figure 08 gives a good idea as to where Woolner and his shipboard friend Mauritz Steffansson were when they saw boat D being lowered.

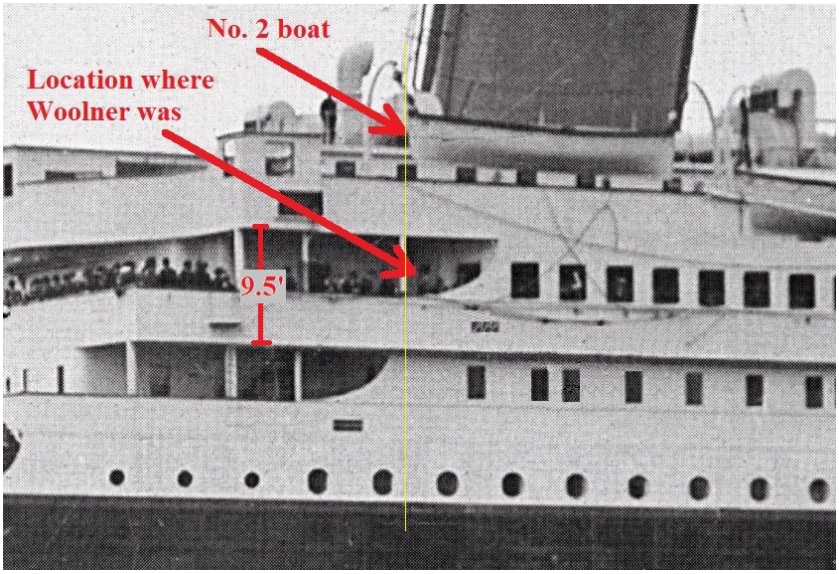


**Fig. 08 – The place where Woolner and Steffansson jumped from.**

In that photograph, taken when *Titanic* was leaving Southampton, you can see emergency lifeboat No. 2 swung out. At the time Woolner and Steffansson where there, boat No. 2 had already been long

gone, replaced with collapsible boat D, which was slightly wider and longer than boat No. 2.[26] It also hung a couple of feet more forward by time it reached the water because of the down tilt of the bow at the time. As the collapsible boat was being lowered, the two men saw their chance to jump into the fore part of the boat as it neared the water. Climbing up onto the railing of the ship, they would have jumped out and down into the boat. Assuming *Titanic* had taken on a list of 15° to port at the time, the picture of what they were faced with is shown in the scaled diagram of Figure 09.

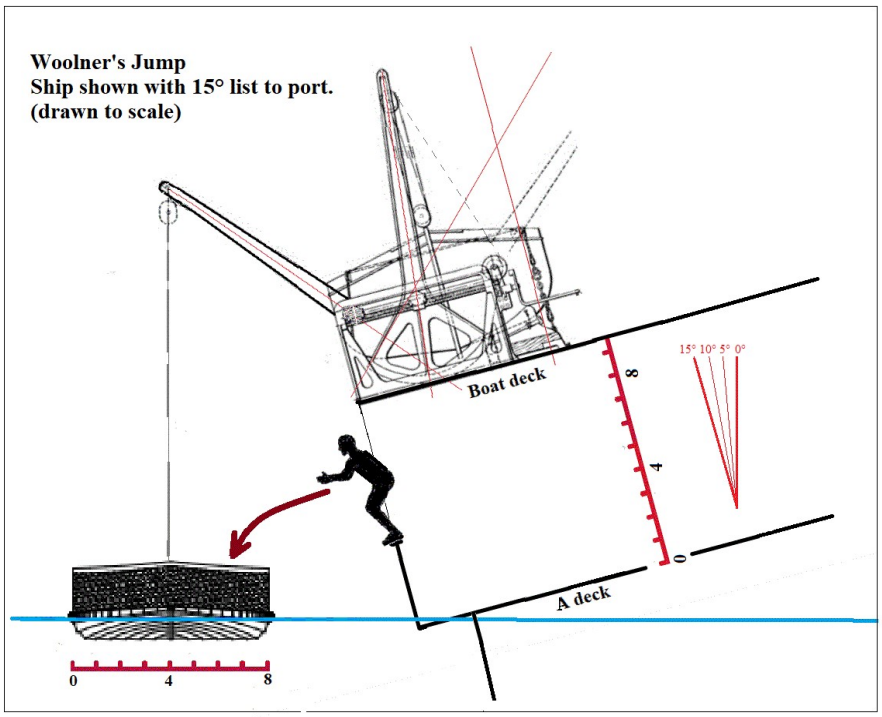


**Fig. 09 – Woolner's jump with 15° list on *Titanic*.**

As it turned out, Woolner did not make it into the boat. As he described it at the American inquiry:

> Mr. WOOLNER. ... I said to Steffanson: "There is nobody in the bows. Let us make a jump for it. You go first." And he jumped out and tumbled in head over heels into the bow, and I jumped too, and hit the gunwale with my chest, which had on this life preserver, of course and I sort of bounced off the gunwale and caught the gunwale with my fingers, and slipped off backwards.
> …
> Senator SMITH. You pulled yourself up out of the water?
> Mr. WOOLNER. Yes; and then I hooked my right heel over the gunwale, and by this time Steffanson was standing up, and he caught hold of me and lifted me in. Then we looked over into the sea and saw a man swimming in the sea just beneath us, and pulled him in.

The man that was pulled in after Steffansson and Woolner got into the boat was first-class passenger Frederick Hoyt.

If we take the situation as described, and knowing the dimensions of the boat and the ship itself, reducing the angle of list on *Titanic* from 15° would bring the boat closer to the vessel's edge by a little

[26] The two emergency cutter lifeboats were about 25 feet long, 7 feet wide, and 3 feet deep. The four collapsible boats were about 27½ feet long, 8 feet wide, and 3 feet deep. The 14 regular wooden lifeboats were 30 feet long, 9 feet wide, and 4 feet deep.

over 3 inches for every 1° of reduced list. Thus for a 10° list, the boat would be only a little over a foot closer. This can seen in Figure 10 below. In either case, it seems that Woolner's 8 to 9 foot estimate as to how far he had to jump out and down to reach the collapsible boat seems not that far off.

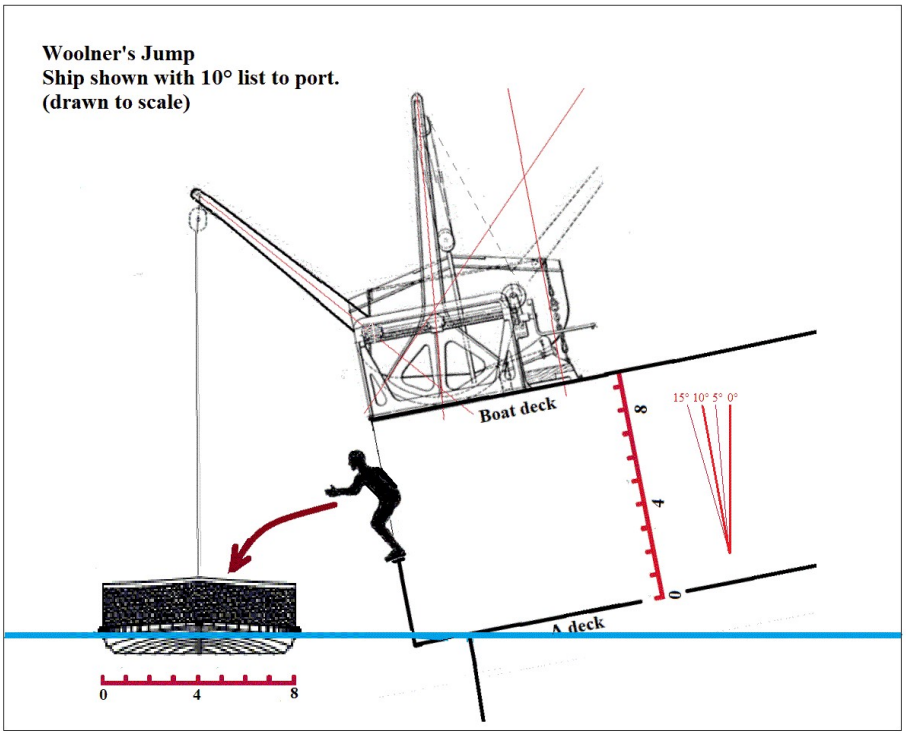


**Fig. 10 – Woolner's jump with 10° list on *Titanic*.**

In an account attributed to Steffansson in the *New York Herald* on April 19th 1912, it was written:

> "'Let's not take any chances,' I shouted to Woolner, and as it [the lifeboat] came nearly opposite us, swinging in and out slowly, we jumped, and fortunately, landed in it. The boat teetered a bit and then swiftly shot down to the water."

If this story is true, boat D was slowly swinging in and out like some pendulum as it was being lowered. However, the swinging could not have been a simple in and out as described because the lengths of the falls at the bow and stern of the boat would not have been the same. They would have differed about 3 feet in length because of the need to keep the boat level with the sea while the ship, the launching platform, was experiencing a down tilt of some 6° or more. It would have produced a complex swinging pattern, with the boat's bow and stern at times appearing to swing in the same direction, and at other times, would appear to swing in opposite directions. The swing periods would have been on the order of about 4½ seconds, more or less, with the bow end having a slightly shorter period of swing than the stern end.[27]

Steffansonn's timing must have been just right for him to make it into the relatively broad bow area of the collapsible boat at the peak of one of its inward swings, assuming he was telling the truth about this in his story. Woolner, as he himself had pointed out under sworn testimony, was not so lucky to make it into the boat at all when he jumped. Swinging or not swinging, making the jump into the boat or just missing it and having to be pulled in, they both eventually were able to get themselves into boat D shortly before *Titanic* sank.

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[27] For a simple pendulum, the swing period T in seconds is given by $T = 2\pi \sqrt{(L/g)}$, L is the pendulum length in ft, and g=32 ft/sec$^2$.

For what it may be worth, Mauritz Steffansson was 28 years old at the time the event took place, and Hugh Woolner was 45 years old at the time.

A detailed drawing plan of the Engelhardt collapsible boats carried on *Titanic* is shown below in Figure 11. It is taken from the work of Bob Reed.[28]

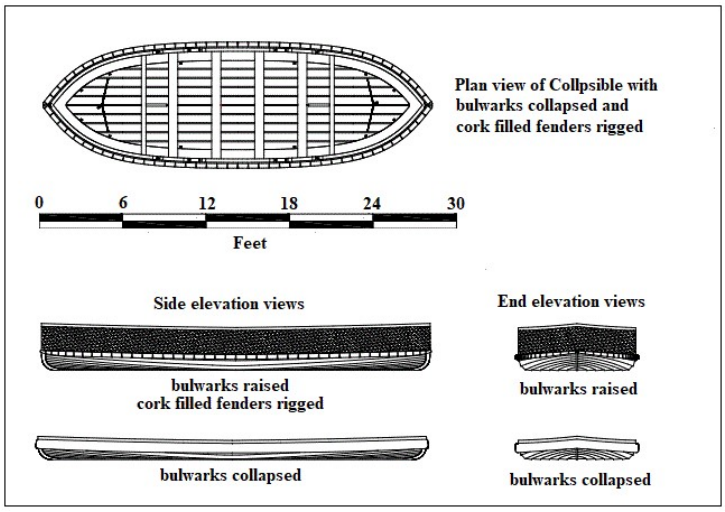


**Fig. 11 – Plan of *Titanic*'s Engelhardt collapsible lifeboats.**

Figure 12 below shows a photograph taken of collapsible boat D as it neared *Carpathia* on the morning of April 15th 1912. Some of the survivors in that photograph have been identified.[29] Of those survivors that we have talked about, Mauritz Steffansson seems to be the man holding an oar on the aft starboard side of the boat (1), Hugh Woolner appears to be the man seated next to him (2), and QM Arthur Bright is the man holding the steering oar in the stern of the boat (3).

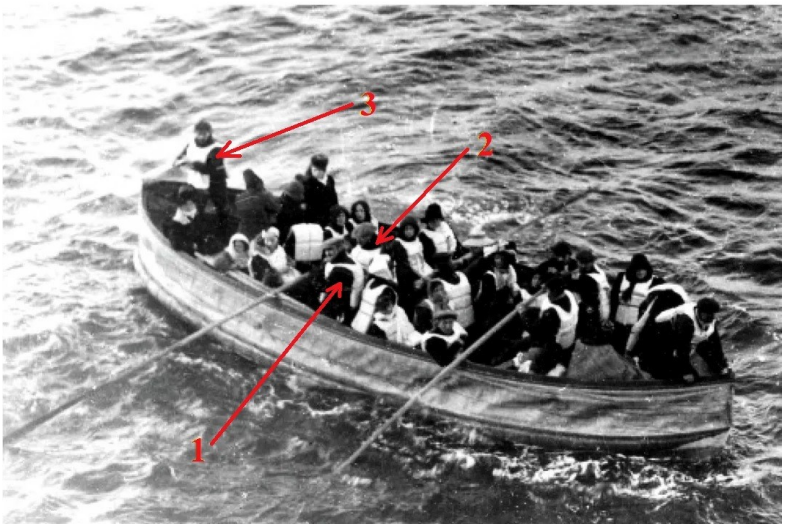


**Fig. 12 – Collapsible boat D seen nearing *Carpathia*.**

## What Can We Conclude About *Titanic*'s List at 2:05am?

To summarize, this article has dealt with the question of quantifying the list *Titanic* took on as collapsible lifeboats C and D were being launched around 2am *Titanic* time. In 2023, when I decided to

[28] http://titanic-cad-plans.website/wp-content/uploads/2024/08/Engelhardt-website.pdf.
[29] Private correspondence with Ioannis Georgiou, May 16, 2026.

see if I can develop a model of list versus time for *Titanic*, I became somewhat concerned about the assumption I made in my earlier work that the list *Titanic* had at 2:05am, when boat D was being lowered, somehow managed to remain same as it was 15 minutes earlier when boat No.10 was lowered. It was noted that from 1:20am to 1:50am, *Titanic* swung a full 10° to port in just 30 minutes of time. I therefore decided not to assume anything about the list for 2:05am, but instead to derive a value of list for that time based on the specific observation of QM Arthur Bright regarding the forecastle *just* going under when he left the ship in boat D, and the observation by Hugh Woolner that water was *just* coming onto A deck by his feet on the ship's port side as boat D was being lowered right in front of him. As explained in this article, the result obtained indicated that *Titanic* was down by head about 6° and had a list to port of about 15° at the time of 2:05am. That 15° list has recently been challenged by the team of Fitch, Layton and Wormstedt.

What we have shown here is that a list from about 10° to 15° can easily be accounted for, depending on the specific condition of how far down by the head was the ship when collapsible boat D was being let down. As pointed out in this article, if water had reached a point 22 feet below A deck on the ship's centerline when boat D started down, then that would imply a list to port of about 15°. If the water reached 20 feet below A deck at that time, then that would imply a list of nearly 13°. If the water was as high as 18 feet below A deck at that time, then that would imply a list of about 10½°. The truth is we really don't know what the precise level of the water was, but I believe that it was somewhere in the range just considered based on how one interprets what these eyewitnesses had to say. One thing is certain, nobody was looking at an inclinometer at the time.

Can a list as much as 15° be easily dismissed as the team of Fitch, Layton and Wormstedt seem to think? I do not believe it can. Their argument about the *Lusitania* situation does not really apply, and claiming that Steffansson and Woolner could not make it into the boat when they jumped to save themselves if the ship was carrying a 15° list, is also far from convincing.

For some people, especially if they have invested a great amount of effort in creating sinking animations, making videos, writing books, and promoting their work, having that work challenged may appear threatening. However, when it comes to *Titanic*, there are no absolutes. There are very few things that can be nailed down with certainty, whether it's the launch times of lifeboats, or the values of trim and list on a sinking vessel. My own approach is to go beyond what eyewitnesses had to say, and to look for ways to quantify things by modeling and testing, yet fully aware of its values as well as its limitations. As I've stated many times before, results are only as good as the assumptions and data used that drive them no matter how accurate the model.

How invested am I in holding onto a 15° port list for 2:05am? For me its not an investment. For me it is just another point on a curve that I worked on. If you say that you believe the port list of the vessel at 2:05am had not gone far beyond what it was around 1:50am, then from the work I did I could point out that QM Bright's observation about the forecastle just going under was likely seen a little time before boat D was actually lowered, and furthermore, the trendline curve for list versus time would then suggest that the listing to port would likely have started to noticeably reverse somewhat before the ship broke in two. Of course you can then bring up what young Jack Thayer wrote to support that trend in the trendline curve, and thereby make most everyone happy.

Is there some definitive statement that can be made about the list that *Titanic* took on around 2:05am? Based on a detailed quantitative analysis of the situation, it can safely be said that *Titanic* was listing to port in a range from about 10° to 15° when collapsible boat D was lowered.