It's A CQD Old Man
41.46 North, 50.14 West

By Samuel W. Halpern

Note to the reader: This paper is a revised work of my original two-part article, "A Minute of Time," first published in 2005 in the Titanic Historical Society's *Titanic Commutator*.[1] The article deals with the issue of the two CQD distress positions transmitted from *Titanic* by wireless on the night of the disaster. Items written in quotations between brackets […] are insertions by this author. In the footnotes of this article, the notation AI are references to page numbers in the transcripts of the American Inquiry into the loss of *Titanic*, while the notation BI are references to question numbers in the transcripts of the British Inquiry into the loss of *Titanic*. - SWH

FOREWORD

The author of this article has deftly drawn together the existing data and testimony to elegantly tie up the loose ends in this century old mystery of why the two CQD positions were so far west of the wreck site. As is still the case today, maritime disasters large and small are usually the result of a series of small missteps and oversights. In so thoroughly examining this portion of the Titanic story the author has outlined an entirely plausible error chain. That a misreading of the navigation watch and an easily made error in addition could contribute so much to the drama of April 14, 1912 is an important reminder to mariners today.

Captain Peg Brandon
Assistant Professor of Marine Transportation
Maine Maritime Academy
Castine, ME 04220, USA

INTRODUCTION

On the night of April 14, 1912 at 10:35 p.m., New York time, *Carpathia*'s wireless operator Harold Cottam decided to pick up his headphones to call up *Titanic*'s senior wireless operator Jack Phillips to tell him that there were messages waiting for him to pick up from Cape Cod. What Cottam heard back was:[2]

> CQD CQD SOS SOS CQD SOS. Come at once. We have struck a berg. CQDOM (It's a CQD old man). Position 41.46 N., 50.14 W. CQD SOS.[3]

[1] Samuel Halpern, "A Minute of Time," THS *Titanic Commutator*, Issue No. 171, 2005, and Issue No. 172, 2006.

[2] Sir James Bisset, *Tramps and Ladies*, Angus & Robertson, 1959, p. 278.

[3] The standard international call sign for distress had recently been changed from CQD to SOS. During the night of April 14 and morning of April 15, Jack Phillips was sending out both.

The position in the CQD message that Cottam received was worked up by *Titanic*'s fourth officer Joseph Boxhall. As it turned out, the position was about 13 miles to the west of the *Titanic* wreck site which was first discovered 73 years after the tragic event. But Boxhall's position was not the position sent in the first set of distress messages from *Titanic* that night. Ten minutes earlier, at 10:25 p.m. New York time, *Mount Temple*'s wireless operator John Durrant picked up a CQD from Jack Phillips which he handed to his ship's master Capt. James Henry Moore. The message given to Moore read:[4]

> *Titanic* sends C. Q. D. Requires assistance. Position 41° 44' north, longitude 50° 24' west. Come at once. Iceberg.

Capt. Moore prepared to take action.

> "Before we had laid the course off I received another position, which read 41º 46' north, 50º 14' west; so that was 10 miles farther to the eastward, and it was that position that I laid my course for."

The position in the first message that Moore received, latitude 41° 44' north, longitude 50° 24' west, was some 7 miles further to the west of the Boxhall CQD location, or little over 20 miles west of the wreck site. This initial position, which is attributed to Capt. Smith, was being sent out by Phillips for almost 10 minutes before Boxhall's revised position was sent out. In addition to the *Mount Temple*, it was also picked up by other ships in the North Atlantic including *La Provence*, *Frankfurt*, and *Ypiranga,* and by the land station at Cape Race.[5]

One of the long standing mysteries surrounding *Titanic* was why were these two CQD positions so far west of the wreck site? How could this have come about?

There has been much speculation over the years since the discovery of the wreck to explain these positions. Some of these explanations are quite imaginative, almost bordering on the absurd. In 2002, Captain L. Marmaduke Collins suggested that Boxhall's CQD position was correct, but it was the submerged hulk of the *Titanic*, still holding some buoyancy from trapped air inside, that was carried by strong underwater currents until it came to rest several miles to the east from the CQD position. Capt. Collins also believes *Titanic* did not strike an iceberg, but instead struck a patch of pack ice. He also believes that the ship later broke in two while on the bottom of the Atlantic from a 7.2 magnitude earthquake centered about 100 miles from the wreck site on November 18, 1929.[6]

A little more recently, David G. Brown put forth his idea that fourth officer Boxhall misunderstood what Captain Smith asked him to do and backed a projected "civil midnight" position for the ship, a position that was deliberately put in the initial CQD message by Captain

---

[4] AI p. 759.

[5] From the transcript of Robert Hunston's Wireless Document, "The Titanic Disaster as Viewed from Cape Race," we have: 10:25 pm (EST) - J.C.R. Goodwin on watch hears *Titanic* calling C.Q.D. giving position 41.44 N 50.24 W about 380 miles SSE of Cape Race; 10:35 pm (EST) - Titanic gives corrected position as 41.46N 50.14W. A matter of 5 or six miles difference. He says "have struck iceberg."

[6] Capt. L. Marmaduke Collins, *The Sinking of the Titanic – An Ice-Pilot's Perspective*, Breakwater Books, Ltd., 2002, pp. 179-182.

Smith, by 20 minutes of steaming at 22 knots along the line that runs across the two CQD positions. His article also suggested there was confusion caused by the way clock adjustments were made on *Titanic* which not only led to the misunderstanding between Smith and Boxhall, but has hidden the true time of the accident from researchers until his paper was published. His article also claimed that an undocumented course change of 11 degrees took place at 11:30 p.m., just 34 minutes prior to the accident itself to avoid a field of ice laying across the ship's track. This places the time of the accident at 4 minutes past twelve on clocks set for April 14, not at 11:40 p.m. as most people were led to believe. Mr. Brown also offered in his article that "misdirections like Boxhall's claim of a late turn at the corner" effectively hid this 11:30 p.m. course change from researchers and historians for nearly a century.[7]

Other reasons suggested for why these distress positions were so far off included overestimating the ship's speed, errors in time, and errors in calculations. After the discovery of the wreck, Dr. Robert Ballard suggested that fourth officer Boxhall may have overestimated *Titanic*'s speed by about 2 knots when he worked up his CQD position.[8] In the 1992 report of the British Marine Accident Investigation Branch concerning the *Californian* affair and its relative location to *Titanic*, it was suggested that "Perhaps the error in the position as transmitted [by *Titanic*] was caused by the wrong distance being allowed along the course line from the last known position – a simple mistake to make under stress."[9] Another suggestion came from researcher and author Dave Gittins. In 1998 he suggested that Boxhall may have made an error in computing a change in longitude by reading from the wrong column of a traverse table. Instead of getting the longitude change for a latitude of 42°, Gittins suggested that Boxhall may have taken the longitude change for the complementary latitude angle of 48° instead. Such an error would push the CQD position 14 minutes-of-arc to the west of where it should have been.[10]

In 2005 this author wrote an article, "A Minute of Time" [referenced above in the note to the reader], in which I suggested that a misreading of the chronometer by third officer Pitman by just 1 minute may have caused the star sights taken by second officer Lightoller, and later worked up by fourth officer Boxhall, to be shifted westward by 15 minutes-of-arc.

In this article I will re-examine the issue of these two CQD positions. I will show that an error in the '7.30 star fix' would not only cause Boxhall's CQD position to be far off, but would have also caused the initial CQD position, which we will refer to as the Smith CQD, to be far off as well. Using the methods of obtaining changes in latitude and longitude that both Capt. Smith and fourth officer Boxhall would have used, I will show how the two positions were likely derived, and why they would differ from each other. The explanations presented in this article have nothing to do with projected midnight positions, undocumented course changes, or any clock setbacks that were due to take place later that night. Furthermore, there is no need to assume anything about miscommunications between individuals, or the highly implausible

---

[7] David G. Brown, "*Titanic: Changing Course*," January 13, 2008, originally posted on the GLTS website at http://www.glts.org/articles/brown/changing_course.pdf.

[8] Dr. Robert Ballard, *The Discovery of the Titanic*, Madison Publishing Inc., 1987, p. 199.

[9] Marine Accident Investigation Branch (MAIB) report, "RMS *Titanic* - Reappraisal of Evidence Relating to SS *Californian*," March 12, 1992.

[10] Dave Gittins, *Titanic: Monument and Warning*, an e-book, copyright 2005 by D. Gittins. Also refer to: "The SOS 'Position.' Boxhall gets all boxed up.," at: http://users.senet.com.au/~gittins/sospos.html.

suggestion that a knowingly wrong position report was deliberately sent out in an attempt to get ships turned around before a valid distress position could be worked up. The basis of this work will be from evidence given within the historical record.

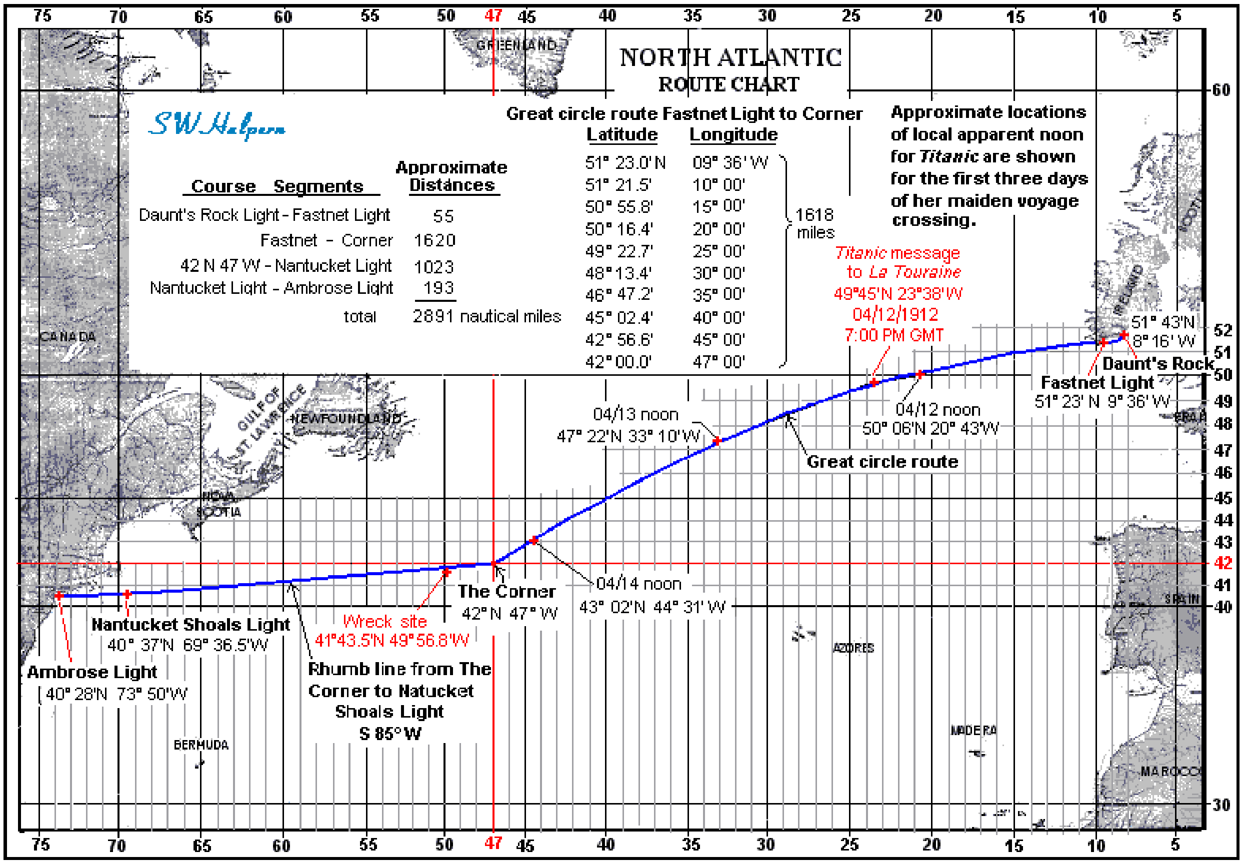
Walter Lord was reported to have said, "It is a rash man indeed who would set himself up as the final arbiter on all that happened the incredible night the *Titanic* went down." In this work, as in all works regarding *Titanic*, there is some degree of speculation that has to be made. Some things cannot, and most likely never will, be proven. But unlike the works of some others, evidence will not be simply dismissed because it doesn't fit, nor will evidence be twisted in such a way to fit something that was never intended.

So let the journey begin. We will start with the course that *Titanic* was following since leaving Queenstown.

FROM DAUNT'S ROCK TO THE CORNER

The intended track of *Titanic*'s maiden voyage Atlantic crossing is shown on the chart below. The starting point was taking departure off the Duant's Rock lightship outside of Queenstown harbor at 2:20 p.m. GMT on April 11, 1912. From there *Titanic* hugged the southern coast of Ireland to a point just south of Fastnet light off Ireland's southwestern coast, and then followed the great circle route to a turning point in the Atlantic known as "the corner," at 42° N, 47° W. From the corner, *Titanic* was to follow a rhumb line course of S 85° W (265°) true to a point a little south of the Nantucket Shoals lightship, and from there direct to the Ambrose Channel lightship that marked the channel entrance to New York harbor.[11]

[11] BI 15661 and BI 15670. Also from the Wreck Commission Report on the Loss of the *Titanic*: "Before the *Titanic* disaster the accepted mail steamers outward track between January 15th and August 14th followed the arc of a great circle between the Fastnet Light and a point in latitude 42° N. and 47° W. (sometimes termed the 'turning point'), and from thence by Rhumb Line so as to pass just south of the Nantucket Shoal light vessel, and from this point on to New York. This track, usually called the Outward Southern Track, was that followed by the *Titanic* on her journey."



The reported distance traveled from Daunt's Rock to local apparent noon (LAN) on April 14, 1912, was 1549 nautical miles.[12] The remaining distance from noon to the corner was about 126 nautical miles. This comes about by two independent methods. The first is from information given by *Titanic*'s fifth officer Harold Godfrey Lowe at the American Inquiry. The second is from subtracting the distance traveled up until noon April 14 from the distance to the corner over the planned route *Titanic* traveled; a distance that is confirmed from log-card data taken from three westbound voyages of *Titanic*'s sister ship *Olympic* in 1911.[13]

At the American Inquiry, fifth officer Lowe was extensively questioned by Senator Smith about his role in working out the course and position of *Titanic* on Sunday afternoon. Lowe pointed out to Smith that he worked the course from noon to the corner, as well as working up the 8 p.m. dead reckoning (DR) position for the ship.

> "I worked the course from noon until what we call the 'corner'; that is, 42 north, 47 west. I really forget the course now. It is 60º 33 ½' west [meaning S 60° 33.5' W] - that is as near as I can remember - and 162 [nautical] miles to the corner."

[12] Samuel Halpern, "Keeping Track of a Maiden Voyage," ITHS's *White Star Journal*, Vol. 14, No. 2, August 2006. And also posted as an *Encyclopedia Titanica Research Article* at http://www.encyclopedia-titanica.org/keeping_track.html.

[13] Courtesy of Mark Chirnside.

The 162 miles quoted in the transcript is clearly an error since we know how far the ship already had traveled by noon that day and the route that she was following. Most likely it was a transcription error resulting from the transposition of the last 2 digits. How do we know this? The evidence comes from an exchange between Senator Smith and fifth officer Lowe regarding the speed of the vessel.[14]

> "Her speed from noon until we turned the corner was just a fraction under 21 knots…I used the speed for the position at 8 o'clock, and got it by dividing the distance from noon to the corner by the time that had elapsed from noon until the time we were at the corner…If you take the average speed from 12 to 6 - that is giving her a run of six hours - she will not jump up in two hours, from 12 to 6 o'clock, from that average speed. You have six hours in there to take a mean on."

Lowe handed Smith a slip of paper and said, "This is the only figuring that is required to get the speed." Smith then asked, "And you are able to say that the speed at that time was 21 knots?" Lowe then replied, "Twenty-one knots or under; it was really 20.95, about. If the speed had been increased or reduced during the interval when I was off duty, I would have been informed of it."

What was written on the paper Lowe handed Smith? Lowe said he calculated the speed of the ship to get his 8 p.m. DR position by taking the distance from noon to the corner and dividing it by the time from noon to the corner. The time he said he used was from 12 to 6 o'clock, a six hour run. The speed he showed Senator Smith was 21 knots. If you now take that speed and multiply it by the time he used you will get 21 x 6 = 126 nautical miles.

The slip of paper that fifth officer Lowe handed to Senator Smith probably looked something like what is shown below.

time from Noon to the Corner "12" to "6" = 6 hours

dist. to the Corner = 126 miles

speed of the ship $= \dfrac{\text{dist.}}{\text{time}} = 6\overline{)126}$ = 21 knots

We will revisit Lowe's claim that the speed was really 20.95 knots later on, but there is a second method for verifying the distance from noon to the corner. If the remaining distance to the corner was 126 miles, then the total distance from Daunt's Rock to the corner over the route *Titanic* traveled should work out to 1549 + 126 = 1675 miles. Luckily we have 1911 log card data from the first three westbound voyages of *Olympic*, *Titanic*'s sister ship, to compare this with.[15] What we find is that *Olympic*'s first westbound crossing had a total distance run from Daunt's Rock to the corner of 1677 miles. For *Olympic*'s second westbound crossing, the total

---

[14] AI pp. 383-386.

[15] The departure dates and times for *Olympic* at the Daunt's Rock lightship were: Voyage 1 - 4:22 p.m. GMT, June 15, 1911; Voyage 2 - 2:02 p.m. GMT, July 13, 1911; and Voyage 3 - 1:47 p.m. GMT, August 10, 1911.

distance to the corner came to 1674 miles. And for *Olympic*'s third westbound crossing, the total distance to the corner came to 1676 miles.

Noon positions and distance data for the first three days of each of these three *Olympic* crossings are given in the table below.[16]

SW Halpern

Distance From Daunt's Rock to Corner RMS *Olympic* 1911

Olympic V1 W		**Olympic V2 W**		**Olympic V3 W**	
dist. D. Rk. to Corner		**dist. D. Rk. to Corner**		**dist. D. Rk. to Corner**	
Location	Dist.	Location	Dist.	Location	Dist.
50.22N, 19.17W	428	49.59N, 21.48W	525	50.04N, 21.32W	516
47.51N, 32.20W	534	46.56N, 35.05W	560	47.08N, 34.26W	543
43.45N, 43.52W	542	42.36N, 46.03W	534	42.39N, 45.24W	536
42N, 47W	173	42N, 47W	55	42N, 47W	81
D. Rk. to Corner	1677	D. Rk. to Corner	1674	D. Rk. to Corner	1676

What we see from all this data is that the distance from Daunt's Rock to the corner falls between 1674 and 1677 nautical miles. The value we get for *Titanic* using the 126 miles derived from Lowe's testimony is 1675 miles, a value which fits nicely within that narrow range. Knowing the route of travel and the distances ran for the first three days of *Titanic*'s maiden voyage, approximate positions for *Titanic* at local apparent noon for each day have been made. This data is provided in the table below.[17]

SW Halpern

Distance From Daunt's Rock to Corner RMS *Titanic*

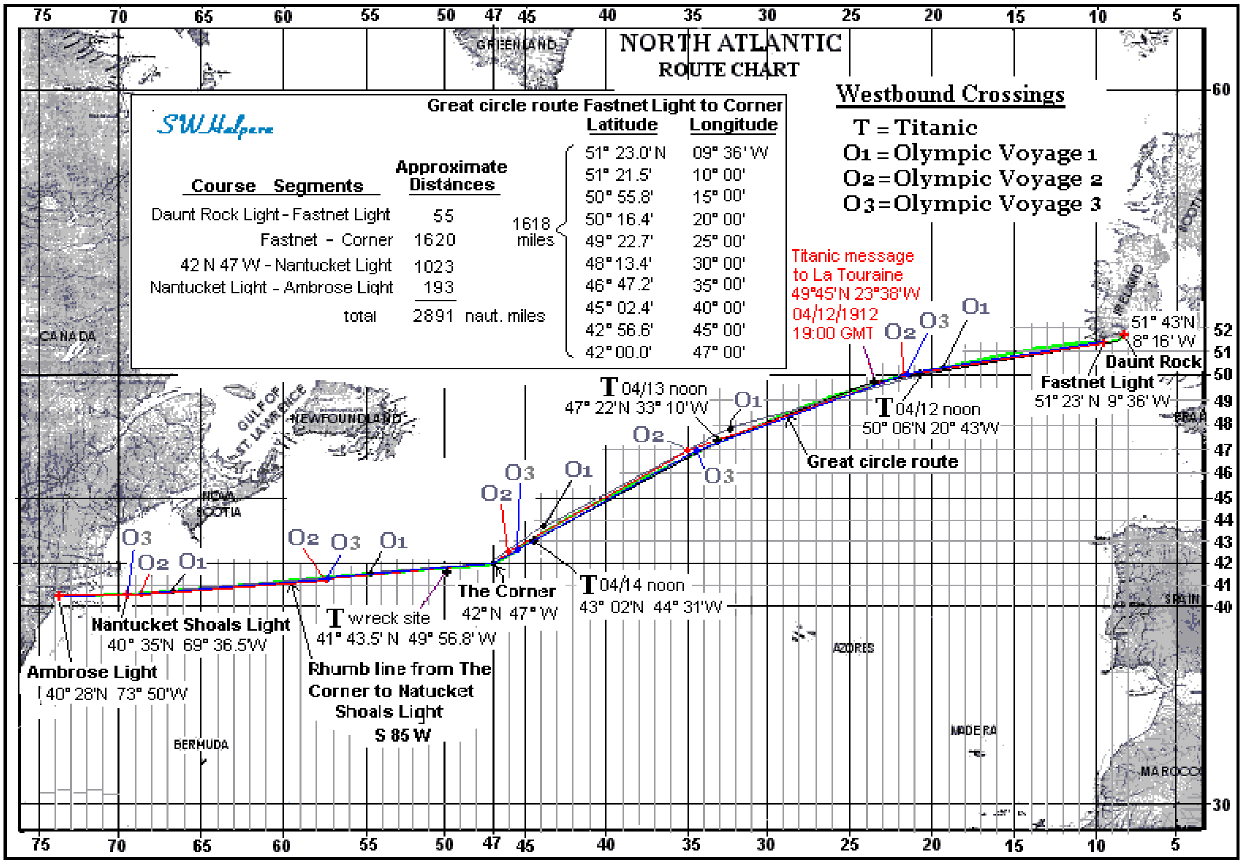
Titanic V1 W	
dist. D. Rk. to Corner	
Location	Dist.
50.06N, 20.43W	484
47.22N, 33.10W	519
43.02N, 44.31W	546
42°N 47°W	126
D. Rk. to Corner	1675

The chart below shows the noontime positions for each of *Olympic*'s first three westbound crossings of 1911, as well as *approximate* noontime positions for *Titanic* on her 1912

[16] The run distances from noon of the third day to the corner (42N,47W) that are shown were based on *Olympic's* noontime position on the day she was at the corner.

[17] *Keeping Track of a Maiden Voyage.*

maiden voyage. Also included on the chart is the location of the *Titanic* wreck site, and *Titanic*'s reported position by wireless to *La Touraine* at 7 p.m. GMT on April 12.



LOCAL APPARENT NOON TO THE CORNER

So what was *Titanic*'s likely position at local apparent noon April 14, 1912? To get the coordinates of local apparent noon we take the course given by fifth officer Lowe, 240.6° using modern notation, and go back 6 hours at 20.95 knots (125.7 nautical miles) on the reciprocal of that heading. When we do this we find *Titanic*'s noon position for Sunday, April 14, at 43° 01.7' N, 44° 31.4' W.[18]

According to second officer Charles Lightoller and third officer Herbert Pitman, *Titanic*'s course was set at noon that Sunday.[19] The course heading given to the helmsman and marked on

---

[18] Rounding off to the nearest whole minute-of-arc gives: 43° 02' N, 44° 31' W. Middle-latitude sailing computations are used here. The change in latitude is computed by multiplying the distance by the cosine of the course angle. The change in longitude is computed by multiplying the distance by the sine of the course angle and dividing the result by the cosine of the mean latitude. (Ref.: *The American Practical Navigator* [Bowditch], 2002, Bicentennial Edition, Ch. 24, section 2415.) Traverse tables can also be used in the solution, but because the traverse tables are for integral values of the course angle and distances, interpolation for intermediate values are required.

[19] BI 13468 and BI 15173.

the course board was S 85° W (265°) by the steering compass in the wheelhouse.[20] But we have just seen that the course to the corner from the ship's noon position was about 240.6° true. The difference between the true heading and the compass heading, about 24.4° in this case, represents the compass error caused by magnetic variation and compass deviation. According to third officer Pitman and fourth officer Boxhall, *Titanic*'s course was altered at 5:50 p.m., a time that was also recorded in the night orders book.[21] After the course was altered, *Titanic* was heading N 71° W (289°) by the steering compass in the wheelhouse.[22] The change in compass heading from S 85° W to N 71° W was a change of 24 degrees to starboard on the steering compass. From this information it seems clear that the intended change in the ship's true heading at 5:50 p.m. was to put the ship on a rhumb-line course close to 265° true taking it to a point south of the Nantucket Shoals lightship, the proper course from the corner to New York for westbound steamers for that time of year.[23]

At the British Inquiry second officer Lightoller was asked about the course that the ship was making when it was handed over to him at 6 p.m. His answer was: "I cannot remember the compass course. *I know from calculations made afterwards* [author's emphasis] that we were making S. 86 true."[24]

The calculations that Lightoller was referring to were made by fourth officer Boxhall after he worked up a set of celestial star sights taken by Lightoller and third officer Pitman about 7:30 p.m. As Boxhall explained to Senator Burton at the American Inquiry, "After I had worked these [stellar] observations of Mr. Lightoller's I was taking star bearings for compass error for myself, and was working those out. That is what kept me in the chart room most of the time. I was making computations most of the time."[25]

From Boxhall's testimony at the British Inquiry:[26]

---

[20] BI 17587.

[21] BI 15663-15664, and BI 15176. It should be mentioned that QM George Rowe was at the wheel when *Titanic*'s course was altered for the Nantucket lightship. He said the course was altered at 5:45 p.m. which was 5 minutes earlier than what Boxhall and Pitman said (see BI 17584-17585). It is likely that Rowe may have noticed the time that Boxhall or sixth officer Moody would have sent out to the standard compass platform located amidships in preparation for the course change. Since the night order book called for the course change at 5:50 p.m., that would be time when the ship was expected to be on her new course as signaled on the bell-push by the junior officer out on the standard compass platform.

[22] BI 17590. At the British Inquiry second officer Charles Lightoller said: "The [steering] compass course is not the compass we go by. I believe by standard [compass] we were steering N. 73…I think that works out as 73 by [standard] compass, and 71 was the steering compass." If Lightoller was correct, it would indicate a 2° difference in deviation error between the standard compass amidships and the steering compass in the wheelhouse when the ship was on that particular heading (see BI 13501).

[23] BI 15661. Adding 24° to Lowe's 240.6° gives a course of 264.6° true which is very close to Boxhall's S 84 ¾ W (264.75° true) when asked about the rhumb line course that was marked on the chart (see BI 15670).

[24] BI 13498.

[25] AI p. 932.

[26] Boxhall also told the British Inquiry (on Day 13) that: "I had the 7.30 position in my work book...I had used that same position two or three times after giving it to the Captain, and that same course I used two or three times after giving it to the Captain as well, between 10 o'clock and the time of the collision, for the purpose of working up stellar deviations...checking the compass error."

15315. Between 4 and 6, while you were on watch do you remember the course being altered? – [*Boxhall*] The course was altered at 5.50.

15316. Do you remember what it was altered to? - I do not remember the compass course, but I remember the true course was S. 86 W. [266° true.]

15317. I think you worked that out yourself? - *Yes, I had stellar observations afterwards* [author's emphasis].

It is quite clear from both Lightoller and Boxhall that the ship's true heading after altering course at 5:50 p.m. was 266° true. However, it is also quite clear that a heading of 266° true was determined much later on when Boxhall was able to ascertain the ship's correct heading after working up the ships position from the 7:30 p.m. star sights. When the ship's course was altered at 5:50 p.m., the intent was to have her make 265° true for the Nantucket lightship, the charted course to New York from the corner.[27]

THE DELAYED TURN AT THE CORNER

On the fourth day of the American Inquiry, *Titanic*'s third officer Pitman was asked:[28]

Senator FLETCHER. Did you change the course of the ship after leaving Queenstown?
Mr. PITMAN. Change the course of the ship?

Senator FLETCHER. Yes.
Mr. PITMAN. A number of times.

---

[27] On page 27of the Wreck Commission Report they wrote: "At 5.50 p.m. the *Titanic*'s course (which had been S. 62° W.) was changed to bring her on a westerly course for New York…altering course at 5.50 p.m. about four or five miles south of the customary route on a course S. 86° W. true." The course S 62° W is 242° true. They got that result by simply subtracting 24°, which was the change in magnetic heading that the ship took at 5:50 p.m., from the 266° true heading that Boxhall gave them. However, Lowe seemed very sure that that the course to the corner from noon was 240.6° true as we have seen. Some *Titanic* researchers have used 242° as the true course for the ship prior to the turn at 5:50 p.m. for same reason the Wreck Commission did. However, this is not necessarily the correct answer even if the true heading after the turn was later seen to be 266° true. The reason is that a change of 24° in compass heading may not correspond to a 24° change in true heading because compass deviation error is a function of the ship's magnetic heading, which depends on the true heading and magnetic variation. Compass deviation is simply *not* a constant. We can easily see this in compass data taken from *Olympic* for both the standard compass and the steering compass. In one example, at 4:40 p.m. on March 29, 1931, *Olympic* turned from a heading 243.25° true to a heading of 260.75° true, a change of 17.5°in her true heading. However, on the steering compass the course went from 269° to 284°, a change of 15°. It was noted that the steering compass deviation was 1 ¼ degrees east when heading 269°, and changed to 3 degrees east when heading 284°; almost a 2 degree increase in compass deviation for a 17.5° change in true course.

[28] AI p. 303.

Senator FLETCHER. Where was the last change of direction made?
Mr. PITMAN. 5.50 on Sunday night.

Senator FLETCHER. Sunday night?
Mr. PITMAN. Yes.

Senator FLETCHER. Where was that change made?
Mr. PITMAN. I can not remember the position.

Senator FLETCHER. Before that, were you traveling along the southerly track?
Mr. PITMAN. Yes.

The southerly track for westbound ships to the coast of the United States and Canada that was being talked about was the great circle track from Fastnet light to the corner at 42° N, 47° W. That was referred to as the southern track which steamships followed to avoid running into ice between January 15 and August 23. The rest of the year the great circle track ran further north shortening the overall distance of the Atlantic crossing by about 110 nautical miles.

Pitman was further asked:

Senator FLETCHER. What course were you on, if you can remember, at 5.50 p. m., Sunday?
Mr. PITMAN. No, I can not remember. If I had the true course, I could make it.

Senator FLETCHER. What extent of change did you make in the course at 5.50 p.m., or about that time, Sunday?
Mr. PITMAN. I am not quite certain about that.

Senator FLETCHER. Do you know any such designation as the "corner?"
Mr. PITMAN. *Yes, we were supposed to be at the corner at 5.50* [author's emphasis].

Senator FLETCHER. What do you mean by that?
Mr. PITMAN. That is 47° west and 42° north.

Senator FLETCHER. At 5.50 p. m. you turned what you call the "corner?"
Mr. PITMAN. The corner, yes.

Then 36 days later at the British Inquiry we have this from Mr. Pitman:

15174. And, so far as you know, was the steamer's course deflected at all from the course that had been marked out at noon; did it vary to the south, or in any way from the course which had been marked out at noon? – [*Pitman*] Yes, I considered we went at least 10 miles further south than was necessary.

15175. Do I understand you rightly that in marking the course at noon, the course was marked 10 miles further south than you considered necessary? - No. *We had* *a certain distance to run to a corner, from noon to certain time, and we did not alter the course so early as I anticipated. Therefore we must have gone much further south* [author's emphasis].

15176. When did you alter the course? - 5.50.

15177. Who was responsible for the alteration? - The Commander.

15178. To whom did he give the order? - The Officers of the watch.

15179. Do you know their names? - Mr. Wilde.

15180. Were you there? - No.

15181. Do you know what conversation took place? - No.

15182. But you say he gave instructions to alter the course of the ship? - The course was altered at 5.50. They were the Commander's orders.

15183. Ten miles further south. Was any record made of that at the time? - No, and I thought that the course should have been altered at 5 p.m..

15184. Why did you think so? - Judging from the distance run from noon.

This is a very different story from what he told in America. Now he is saying that the ship was not turned at the corner but went *at least* 10 miles further south. Furthermore, he said that he had expected the ship to be at the corner by 5 p.m. which is 50 minutes earlier than the time the ship's course was actually altered.

And Pitman was not alone in claiming that the ship turned the corner late. Fourth officer Boxhall had this to say about it at the British Inquiry:

15661. Am I right in thinking that the course as marked on the chart is S. 85 W. when you take your turn. I believe it is about S. 85 W. [265° true]? – [*Boxhall*] Yes.

15662. So that as I follow, the "Titanic" had run on, you say for 50 minutes longer than she otherwise would? - Did I say that?

15663. I thought you said 5.50? - I have not said that so far, but I wish to say it now. I wish to explain it. The night order book was written out and there was an order for the course to be altered at 5.50.

15664. You saw that in the order book? - Yes, I saw it and I remarked to the Chief Officer [Wilde] between 4 o'clock and 6 o'clock that I considered the course ought to have been altered some considerable time before 5.50 - that is, if it was meant to be altered at the corner, 42 N., 47 W. Whether we spoke to the Captain about it

> or not I do not know. I just remarked that to the Chief Officer, and the course was altered at 5.50. *I consider that the ship was away to the southward and to the westward of that 42 N. 47 W. position when the course was altered* [author's emphasis].

A chart was then given to Boxhall and the questioning continued:

> 15666. We have all noticed there is a point on the course, as marked on the chart, where a westbound ship turns, what you call the corner, is that what you refer to as 42 N. 47 W.? - That is so.
>
> 15667. And then your view is that the ship, when she turned on her new course at 5.50 had run beyond that corner? - Yes.
>
> 15668. And, therefore, was to the south of it? - Yes, to the south and to the westward of it.
>
> 15669. Then when she is put on her new course, her new course you tell me was S. 86 W.? - S. 86. W. [266°]
>
> 15670. Though your impression is that as it is marked on the chart the course there marked is S. 86 W.? - I think it is about S. 84 3/4 W. [264.75° true] as a matter of fact.

The course line on the chart shown to him was the proper course from the corner to just south of the Nantucket lightship, a course that was very close to S 85° W (265°) true. Notice that Boxhall thought the proper course was just under 265°, but he knew that the ship was really making 266° true *after* he worked up the 7:30 star sights later that night.

> 15671. The effect would be she would have run a little bit further on the old course and then on the new course she is gradually making back to the line? - That is my impression of the idea which Captain Smith had in altering that course and setting it to that time.
>
> 15672. If she was going 22 knots and ran past the corner for 50 minutes that means she? - I did not say 50 minutes.
>
> 15673. No, I know you did not? - I do not remember what time it was but it was some considerable time; the difference I make between my time and the time that was given in the book - well there was such a big difference that I considered it worth mentioning to the Senior Officer of the watch.

Unlike Pitman, who said he thought the ship should have been at the corner 50 minutes before her course was actually altered, Boxhall was not about to get himself pinned down with any estimate for the overrun. But, like Pitman, he was claiming that the ship ran past the corner for some time before her course was altered, and believed that it was what Capt. Smith intended to do. Furthermore, he assumed that the 266° course that the ship was really on was intended to work the ship gradually back to the original 265° course line.

Before we examine why these two officers believed that the ship must have gone beyond the corner, let us consider the evidence as we know it.

Based on the total distance the ship traveled since taking departure off Daunt's Rock lightship, and also from data independently supplied by fifth officer Lowe, we find that *Titanic* was about 126 miles from the corner at noon, April 14. The time from noon to when the ship's course was subsequently altered was 5 hour and 50 minutes.

According to third officer Pitman, he thought the ship was making about 21 ½ knots Sunday afternoon. He said he based his estimate "by the log and the revolutions." "I think about 75 [revolutions]. She never exceeded 76 revolutions at any part of the trip."[29] If *Titanic* was 126 miles before the corner at noon and traveling at a speed of 21.5 knots over ground as Pitman suggested, she would be at the corner 5 hours and 52 minutes past noon. If Titanic was making 22 knots over ground, as Boxhall later used when working up his CQD position, she would be just a little over 2 miles past the corner when her course was altered at 5:50 p.m. No matter how you look at it, it appears that Capt. Smith intended to be at the corner when he wrote 5:50 p.m. into the night orders book, baring any drift caused by the effects of leeway, steering error, or current.

So what did Capt. Smith assume about the speed of the ship Sunday afternoon? If we take 126 miles and divide it by 5 hour 50 minutes we get a speed of 21.6 knots over ground. But the *Titanic* ran 546 nautical miles from local apparent noon April 13 to local apparent noon April 14, a period of time that lasted 24 hours and 45 minutes.[30] This means that the average speed over ground since noon the previous day was about 22.1 knots. Did Capt. Smith use a speed that was ½ a knot less for Sunday afternoon because of sea conditions that existed near noontime when the ship's course was set? We know that the revolutions carried at that time had not changed much since noon Saturday.[31]

Evidence suggesting that sea conditions may have been a bit rougher that afternoon comes from Archie Jewell, one of the lookouts on *Titanic* and a witness called before the British Inquiry. Jewell was asked about the practice of conducting a lifeboat drill by the deck crew using the ship's two emergency boats (lifeboats No. 1 and No. 2) that were always kept at the ready. Jewell explained that it was the practice on White Star Line vessels to do so on a Sunday, once on the outbound voyage, and once on the inbound voyage. However, that Sunday it was not done because of strong wind conditions. "It was blowing hard that day; there was a strong wind that day; that was the reason why it was not done." He was then asked about the sea becoming smooth, to which he said that it was smooth at the time of the accident. When asked when was it that the wind had gone down, Jewell replied, "It went down as the sun began to go away."[32] We

---

[29] AI p. 274.

[30] The reason that the time was greater than 24 hours is that clocks were adjusted back by 45 minutes at midnight on April 13 because of the westward change in the ship's longitude. Just like today you have to set your watches back by one hour for each time zone that you cross when traveling westward.

[31] Samuel Halpern, "They Were Gradually Working Her Up," at http://www.geocities.com/samuel_halpern/WorkingThenUp.htm.

[32] BI 272-280.

also have supporting evidence from the log of the *Californian* that indicates that there was a "fresh wind" (17-21 knots)[33] out of the "north-northwest" with a "moderate sea" (6-8 ft)[34] and "clear weather" in the vicinity of the corner just six hours before *Titanic* arrived there.[35] These conditions are shown in the following photograph, courtesy of the U.S. National Oceanic and Atmospheric Administration (NOAA).

BEAUFORT FORCE 5
WIND SPEED: 17-21 KNOTS
SEA: WAVE HEIGHT 2-2.5M (6-8FT), MODERATE WAVES TAKING MORE PRONOUNCED LONG FORM, MANY WHITE HORSES, CHANCE OF SOME SPRAY

It would be no surprise that some small allowance for sea state *may* have affected what Capt. Smith assumed for a speed-made-good over ground in setting the time for the corner to 5:50 p.m. instead of allowing 5:44 p.m. by assuming the ship was still making close to 22 knots. Later that evening, after the ship entered calm conditions, an average speed-made-good of 22 knots was indeed used for dead reckoning work. As Boxhall said, "taking into consideration that it was smooth water and that there ought to have been a minimum of slip, I allowed 22 knots."[36]

So we have just seen why Capt. Smith may have allowed 21.6 knots from noon to the corner, but what about fifth officer Lowe's 20.95 knots? We have already seen that Lowe derived that speed by dividing the distance from noon to the corner by 6 hours of time. But the

---

[33] Beaufort Scale Force 5. See "Estimating Wind Speed and Sea State," National Oceanic & Atmospheric Administration (NOAA), National Weather Service, http://www.wrh.noaa.gov/pqr/info/beaufort.php.

[34] Ibid.

[35] AI p. 720.

[36] BI 15646.

ship did not turn the corner at 6 p.m. as Lowe seemed to suggest. The course was altered at 5:50 p.m. If we divide 126 mile by 5 hours 50 minutes we get a speed over ground of 21.6 knots, which is close to Pitman's estimate for the speed of the ship. Was Lowe trying to hide something from Senator Smith when he handed him his calculation? Not necessarily. Lowe was on duty from noon to 4 p.m., and then again from 6 p.m. to 8 p.m. When he came back on at 6 p.m. he replace sixth officer James Moody who was on duty when the ship's course was altered. If Moody told Lowe that they just completed the turn minutes just before without being any more specific than that, Lowe may have assumed that it was close enough to 6 p.m. that using the precise time, which was written in the night orders book, was just not worth worrying about. When he went to work up the 8 p.m. dead reckoning position for the night orders book he may have simply divided 125.7 miles by 6 hours to get 20.95 knots. He then multiplied this speed by 2 hours to get a distance of 41.9 miles from the corner on the 265° course line. If this is what he did to get the 8 p.m. DR position, then the coordinates that he would have given Capt. Smith to mark on the chart would be at 41° 56' N, 47° 56' W, on the rhumb line from the corner to the Nantucket Shoals lightship.

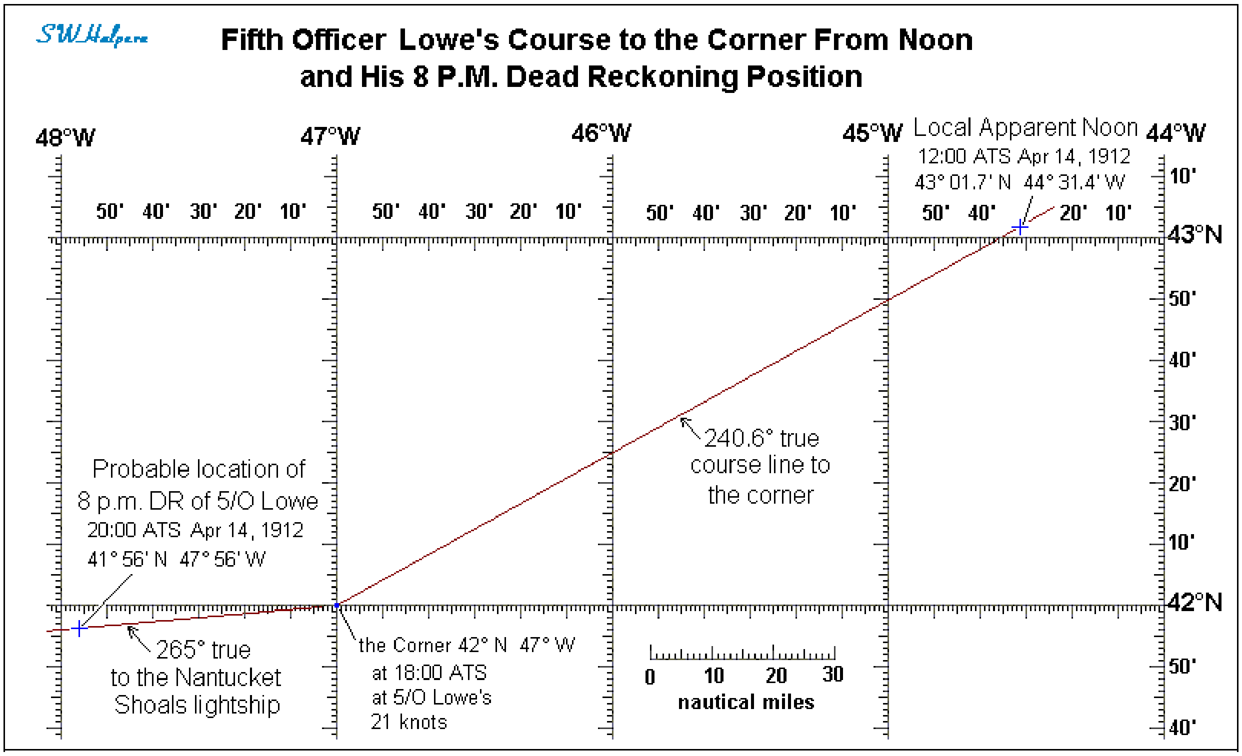
As fifth officer Lowe told Senator Smith at the American Inquiry:[37]

> "From 6 to 8 I was busy working out this slip table…and working a dead-reckoning position for 8 o'clock p.m. to hand in to the captain, or the commander of the ship…That was to indicate the position of the ship at that time, 8 o'clock…We simply put the slip on the table; put a paper weight or something on it, and he comes in and sees it. *It is nothing of any great importance* [author's emphasis]…It has always been done, so that the position of the ship might be filled in the night order book…I am saying that in the general run of things *it is not of any importance* [author's emphasis]."

The chart below shows the ship's likely position at local apparent noon for April 14, 1912. Also shown is the 8 p.m. DR position that was worked up by fifth officer Lowe from the information he provided. Position times on the chart are noted in ship's time, called Apparent Time Ship (ATS), and is written using 24 hour format.[38]

[37] AI p. 383.

[38] To convert *Titanic* ATS for April 14 to GMT, you need to add 2 hours 58 minutes to the ATS times.



We will come back to the question of why third officer Pitman and fourth officer Boxhall later believed that the ship had to have gone a significant distance past the corner after we consider the 7:30 p.m. stellar observations taken by Lightoller and Pitman, and the CQD position that was subsequently worked out by Boxhall from that position.

THE BOXHALL CQD POSITION (41.46N, 50.14W) AND '7.30 STARS'

Sunday evening a set of stars were taken by *Titanic*'s second officer Charles Lightoller to obtain the ships position. This is known as a celestial fix. He was assisted by third officer Herbert Pitman who recorded the time of each sight. According to Pitman, the observations were taken "between half past 7 and 20 minutes to 8."[39] Following that, Pitman went inside the chartroom to begin the job of working up the sights. He was there for almost 20 minutes when fourth officer Boxhall and sixth officer Moody came on watch. Boxhall went to the chartroom where he found Pitman working on the star sights. Upon seeing Boxhall, Pitman handed him the set of sights and said, "Here is a bunch of sights for you, old man. Go ahead."[40] And with that simple exchange, the job of working out the sights was handed off to Boxhall to complete.

At the British Inquiry fourth officer Boxhall was very specific about how he computed the ship's distress position that was sent out in the CQD message picked up by the *Carpathia*. The information he provided was that he started from the ship's 7:30 position, allowed a speed of

[39] AI p. 272-273.

[40] AI p. 275.

22 knots on a course of 266° true, and used a collision time of 11:46 p.m.[41] Although the celestial fix is often referred to as the "7.30 position," the actual position that would have been charted would be for the sight time of the last star that was taken.[42] The process would be to advance the lines of position of all the stars along the ship's track to the time of the last sight. According to Pitman, the last sight was taken about 20 minutes to 8, which means that the fix position would be charted for 7:40 p.m. if the last sight was taken at that time. What this means to Boxhall's position is that he would compute the distance the ship ran from 7:40 p.m. to 11:46 p.m. by multiplying his 22 knots, which was his assumed speed over ground, by 4 hours and 6 minutes (exactly 4.1 hours) to get 90.2 nautical miles. He then needed to find the change in latitude and change in longitude from the fix position by moving 90.2 miles on a course of 266° true from the fix. For this he would most likely have used a set of traverse tables. One table, for the ship's course, would given him the difference in latitude (called D. Lat.) in minutes-of-arc from north to south, and the change in distance, called the departure (or Dep.) in nautical miles from east to west. The second table, for the ship's mean latitude, would give him the difference in longitude (called D. Lon.) in minutes-of-arc to the west by using the departure distance taken from the first table. All of this would take him less than 5 minutes to work out since he had the position of the celestial fix and the ship's course already written down in his workbook.[43]

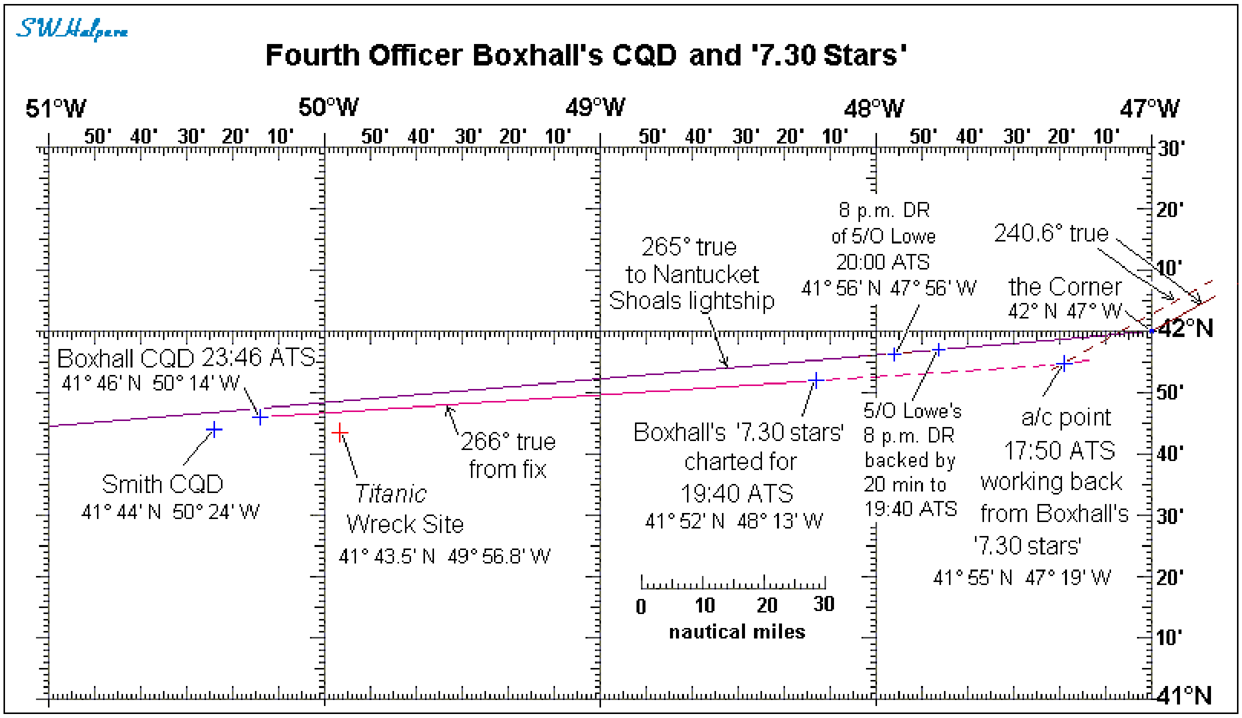
Since we know the CQD position he obtained, what we can do is work Boxhall's problem in reverse to find the position for the celestial fix using the information provided. We start at 41° 46' N, 50° 14' W, his CQD position, and go 90.2 nautical mile on the reciprocal course heading of 266°, which is 086° true. What we find, using the same traverse table data that Boxhall would have used, is a position at 41° 52' N, 48° 13' W for the celestial fix that he worked up.

Shown on the chart below is Boxhall's CQD position, Boxhall's celestial fix, and Lowe's 8 p.m. DR which we derived before. In addition, I extended the 266° course line back from Boxhall's celestial fix to a point that corresponded to where the ship would have been at 5:50 p.m. (17:50 ATS) when her course was altered. What is quite clear from this picture is why third officer Pitman and fourth officer Boxhall believed that the ship had turned the corner late. Notice that this point, worked back from the star sight position, is about 15 miles southwestward of the corner. And since all of *Titanic*'s surviving officers believed the CQD position worked out by Boxhall was absolutely correct, it can only mean that the ship had to have turned the corner late for it to have traveled as far as it did when those star sights were taken. We of course know now that the CQD positions were not correct which means that an error worked its way into the overall process somehow.

[41] BI 15639-15644 and 15658-15660. The time he used may have been to simplify his calculations since at the American Inquiry Boxhall told Senator Smith: "There is a question about that [the time of collision]. Some say 11.45, some say 11.43. I myself did not note it exactly, but that is as near as I can tell I reckoned it was about 11.45." (see AI p. 918.) Using 11:46 allows for some drift following the collision, and it makes the time from a charted fix for 7:40 to a stopping point at 11:46 exactly 4.10 hours.

[42] *The American Practical Navigator* [Bowditch], 2002, Bicentennial Edition, Ch. 20, section 2004.

[43] BI 15676-15677.



WORKING UP THE STAR SIGHTS

At the American Inquiry fourth officer Boxhall explained the process of how the '7:30 star sights' were taken to Senator Burton:[44]

> "The officer who takes the observations always is the senior officer…He simply takes the observations with his sextant. The junior officer takes the time with the chronometer, and then is told to work them out…When you take stars you always endeavor, as they did that night, to take a set of stars. One position checks another. You take two stars for latitude, and two for longitude, one star north and one star south, one star east and one star west. If you find a big difference between eastern and western stars, you know there is a mistake somewhere. If there is a difference between these two latitude stars you know there is a mistake somewhere. But, as it happened, I think I worked out three stars for latitude and I think I worked out three stars for longitude…They all agreed."

Assuming he did not make any mistakes in his calculations, Boxhall should have obtained a valid celestial position for *Titanic*. As he said, "one position checks another" and that night "they all agreed." But in a 1962 BBC radio broadcast he said that the ship's position was "just over 20 miles ahead of the dead reckoning."[45] As we can see in the area chart above, if you

---

[44] AI pp. 931-932.

[45] For a transcript of the broadcast, see: http://www.encyclopedia-titanica.org/boxhall.html.

back the 8 p.m. DR of fifth officer Lowe by 20 minutes of steaming to 7:40 p.m. ATS, and then compare that to the position of the celestial fix for the same time, you can easily see what Boxhall was talking about. And there lies the clue to unlocking this mystery; a clue that should have produced some concern when that fix was first computed.

To fully understand what may have gone wrong, we need to understand a little bit about how a stellar position was actually determined during the period of time known as nautical twilight, when it was dark enough to see the stars yet bright enough to clearly see the horizon. Once the senior officer taking the sights determines which "navigational stars" should be used, he goes out on the wing of the bridge with his sextant to measure the altitude of each star; i.e., the angular height of the star above the horizon. At the same time, the junior officer would be looking at a watch, today referred to as a hack watch, to get the exact time of each sight to the nearest second at the instant the senior officer calls out "mark." This hack watch would have been set close to the time on the ship's chronometer which was keeping Greenwich Mean Time (GMT).[46] The junior officer would also take the sextant to read off the vernier scale after each sight to get the exact angular measurement, and write down both the sextant reading and the exact time of the sight. This process would continue until all sights were taken, a process that was completed about "20 minutes to 8 p.m." according to third officer Pitman.

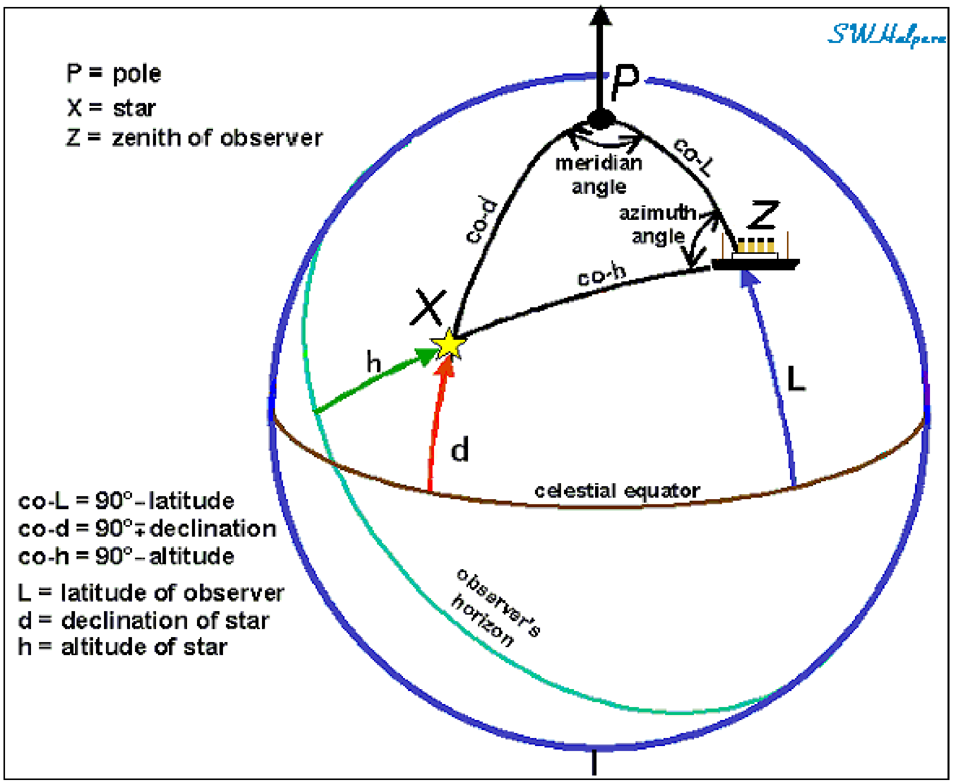
With the times and angles recorded, the process of sight of reduction would begin. This process was started by Pitman a little after 20 minutes to 8. The first step in the reduction process would be to adjust for known errors and corrections. These include the dip of the horizon for the height of eye above the water (a correction of about 8 minutes-of-arc for the 65-70 foot height of eye on *Titanic*), as well as the sextant index error, both of which apply to all sights taken. In addition, an altitude correction would be subtracted for each individual star sight to compensate for atmospheric refraction. Then there are time adjustments to be made. The first would be to correct for the difference in hack watch time and chronometer time, and then to correct for any chronometer error based on the known chronometer gain or loss rate. This single time correction would then apply to all sights, and once done, would give the time of each sight to the nearest second in GMT.

All of these are the relatively easy things to do and were probably completed by Pitman when he handed the set of sights over to Boxhall to finish with at 8 p.m. What Boxhall had to do was to reduce the corrected sight data to get the ship's position in latitude and longitude. Essentially, the task was to solve what is called the navigational triangle for each sight taken. This navigational triangle is formed from three points on the celestial sphere, the imaginary sphere of the heavens upon which we can consider the stars to be fixed for navigational purposes. For an observer in the northern hemisphere, the first point would be the north celestial pole, *P*, the point in the heavens directly above the north pole of the earth. The second point would be the observed star's location, *X*, on the celestial sphere which we can get from a nautical almanac. Just like geographic locations, a star's location on the celestial sphere is expressed by two coordinates. The first is called declination (d), the equivalent of the stars latitude, and measured in degrees north or south of the celestial equator. The second is called Greenwich Hour

---

[46] The *Titanic* actually carried *two* chronometers in the officer's chart room, one as a check against the other. (Report of Survey of an Emigrant Ship, Board of Trade Surveyors Office, Belfast, 3rd April, 1912.) The hack watch used on deck would normally be set to match the time on the chronometers. Any difference in seconds would be noted for correction afterward. For the short period of time that it takes to take the star sights, the accuracy of the hack watch would be more than adequate.

Angle (GHA), the equivalent of the star's longitude, and measured westward from the Greenwich meridian in degrees or in units of time. The third point is the observer's zenith, *Z*, the point on the celestial sphere directly overhead at the time the observation was taken. If we can determine exactly where the zenith point is for the time of the observation, then that can easily be converted to a point on the surface of the earth expressed in terms of latitude and longitude. It is the location of this zenith point that is being worked. The figure below shows the navigational triangle and these three points.



By 1912 there were a number of methods in use to work out star sights to fix a ship's position. But whatever method Boxhall actually used, the longitude of the ship depended on an accurate measurement of time. And this is where I believe a misreading took place.

When Pitman started to work up the sight data before the change of watch at 8 p.m. he had to correct the time on the hack watch to the time on one of the ship's chronometers located in the chart room. To do this he needed to know the exact time difference between the two. That difference was taken by comparing the time on the two clocks. As the second hand of one clock struck 12, he would note the position of the second hand on the other clock, then note the position of the minute hand, and finally the position of the hour hand in that sequence. The times on both clocks would then be recorded, and the difference in time to the nearest second is the correction that would be applied when converting the time taken on the hack watch to chronometer time for each sight. A simple misreading of just 1 minute would affect all of the sights taken by moving their Greenwich Hour Angles by 1 minute of time, which is equivalent to

15 minutes-of-arc (1/4 of a degree), either way.[47] The result is that any derived fix that was worked from these sights would off by exactly that amount.

Unless Boxhall suspected a conversion error such as this, he would have no way of really knowing if his sights were off or not. The sights would appear to all agree, which they did. The result of this error is that the celestial fix that he calculated would be just over 11 nautical miles from where it should have been. This would then put his CQD position, which is a dead reckoning position derived from the celestial fix, 11 miles from the location where it should have been. I believe that a one minute error in the comparison of the hack watch time and the time on the chronometer added a 1 minute increase to the GHA of all the star sights taken thereby shifting the lines of position of these sights to the west by 15 minutes-of-arc.

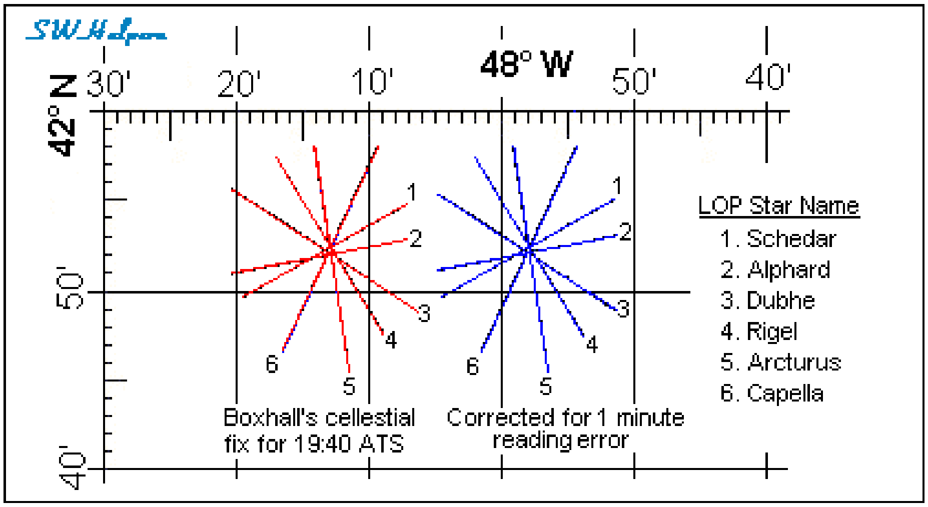
How can such an error happen? Consider the chronometer pictured below.

When time is read off the dials it is taken by reading the second hand first at the "mark," then the minute hand, then the hour hand. What you see on the chronometer above is 52 seconds, 7 minutes, and 11 hours. But the time on the chronometer is really 11:06:52, not 11:07:52. A mistake that is very easily made if one is not being very careful. The result of such an error is an advancement in GMT time by exactly 1 minute. A result that would shift the lines of position for all star sights by 15 minutes-of-arc to the west.

---

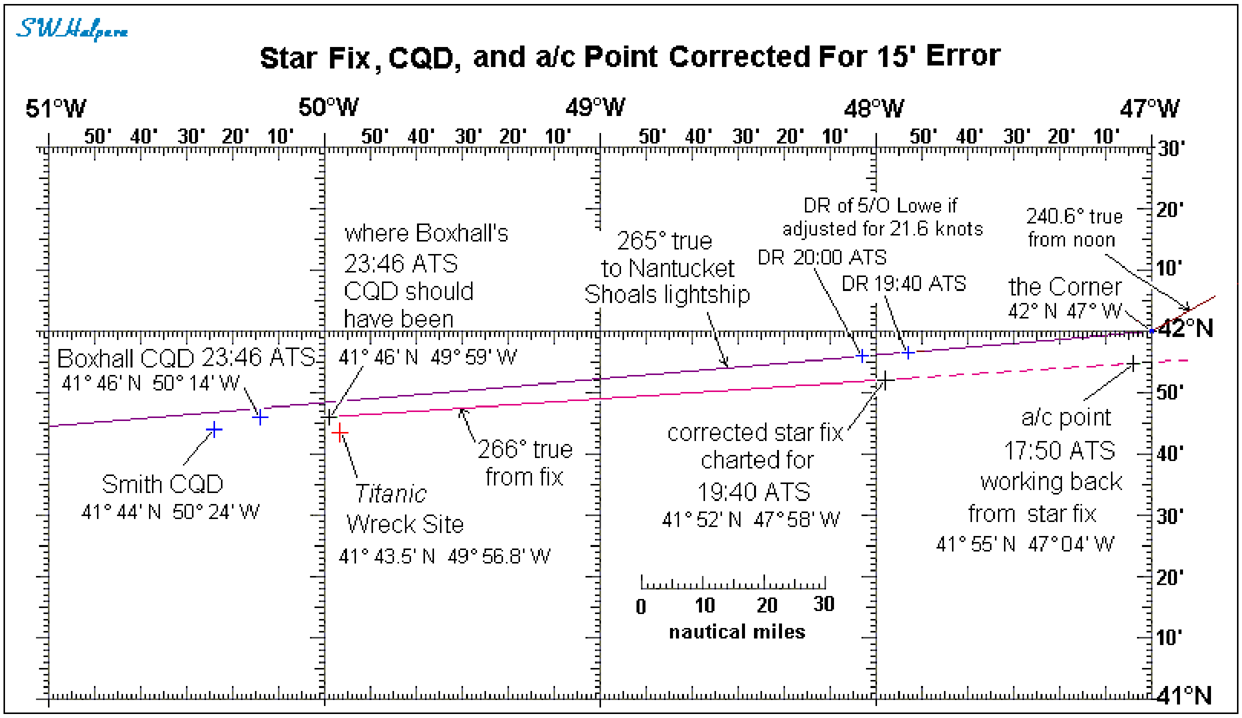
[47] The earth rotates 360° in 24 hours, or 15° per hour. Therefore, in 1 minute of time it would rotate 15°/60-min = 1/4 of a degree, which is equal to 15' of arc.

The diagram below shows the result of such a shift on the lines of position of six navigational stars that were available to Lightoller that night. The fix on the left is what Boxhall would have computed. The fix shown on the right is where it should have been if a one minute misreading error had not taken place.



If this is what happened, then we have a plausible explanation for why Boxhall's CQD position was so far off. Boxhall's '7.30 stars' charted for 7:40 p.m. (19:40) ATS should have worked out to be 41° 52' N, 47° 58' W. His CQD position should have been 41° 46' N, 49° 59' W, less than 3 miles from the wreck site instead of 13 miles away. And if fifth officer Lowe would only have taken the time to be more careful in using the time that the ship actually turned the corner, 5:50 p.m. instead of using 6:00 p.m. in estimating speed, then he would have obtained a speed over ground of 21.6 knots for his dead reckoning work, and his 8 p.m. DR would have worked out to 41° 56' N, 48° 03' W. Backing that for 20 minutes to 7:40 p.m. ATS, we find a DR position for the ship at 41° 57' N, 47° 53' W, a distance that is only 5 ½ miles from our corrected celestial fix instead of 20 miles from the uncorrected fix.

The chart below shows what should have been.



THE SMITH CQD POSITION (41.44 N, 50.24W)

We now come to question of why was the initial CQD position worked by Capt. Smith even further away from the wreck site than that of fourth officer Boxhall? What Smith had available to him was the celestial fix worked out by Boxhall which was put on his chart about 10 p.m. that night.[48] What he would have noticed from the position on the chart is that *Titanic* was about 3 nautical miles south of the intended track line from the corner to the Nantucket Shoals lightship. This would come as no real surprise since he already knew that ice was reported well south of where it usually was expected for that time of year, and that the water temperature had already dropped below the freezing point indicating that his ship was likely being set southward by the "arctic current." At the time he worked up the initial distress position he would have used the star fix that was on his chart as the logical starting point. After all, all lines of position had crossed at that point. However, the course that he set for the ship when they altered course at 5:50 p.m. was to put her on 265° true toward the Nantucket lightship. It was only after Boxhall worked out the deviation of the standard compass after first coming up with the star fix did he realized that the true course being followed was 266° true as we have seen.

Did Boxhall mention to Capt. Smith that the ship was making 266° true instead of 265° true? According to Boxhall it appears that he did.

> 15678. You would not have to return to look at the [Captain's] chart after the accident? – [*Boxhall*] No, I had used that same position two or three times after giving it to the Captain, and that same course I used two or three times after

[48] BI 15551-15554.

> giving it to the Captain as well, between 10 o'clock and the time of the collision, for the purpose of working up stellar deviations.
>
> 15679. That is to say checking where you were? - No, checking the compass error.

Compass checks were required at regular intervals on board White Star Line vessels.[49] Compass error would be checked by comparing the true azimuth angle of a celestial body, calculated from celestial sight data, with a measured compass azimuth angle for the body using the azimuth mirror and ring on the standard compass located on the amidships platform. The difference between the computed azimuth angle and the true azimuth angle is the total compass error. To get the deviation error of the compass, you would just subtract the local magnetic variation for the ships location from that result.[50]

Boxhall first needed to find the compass error for him to realize that the ship was really on a heading of 266° true instead of 265° true. It may be that he gave the celestial fix to Capt. Smith to put on his chart before working up the compass error. According to Boxhall, Capt. Smith "put down the ships 7.30 position on his chart...approximately [at] 10 o'clock." And then "between 10 o'clock and the time of the collision" Boxhall said he was working "up stellar deviations" to check compass error. To get an accurate value for the ship's true course heading, you first must have an accurate value for the compass error.

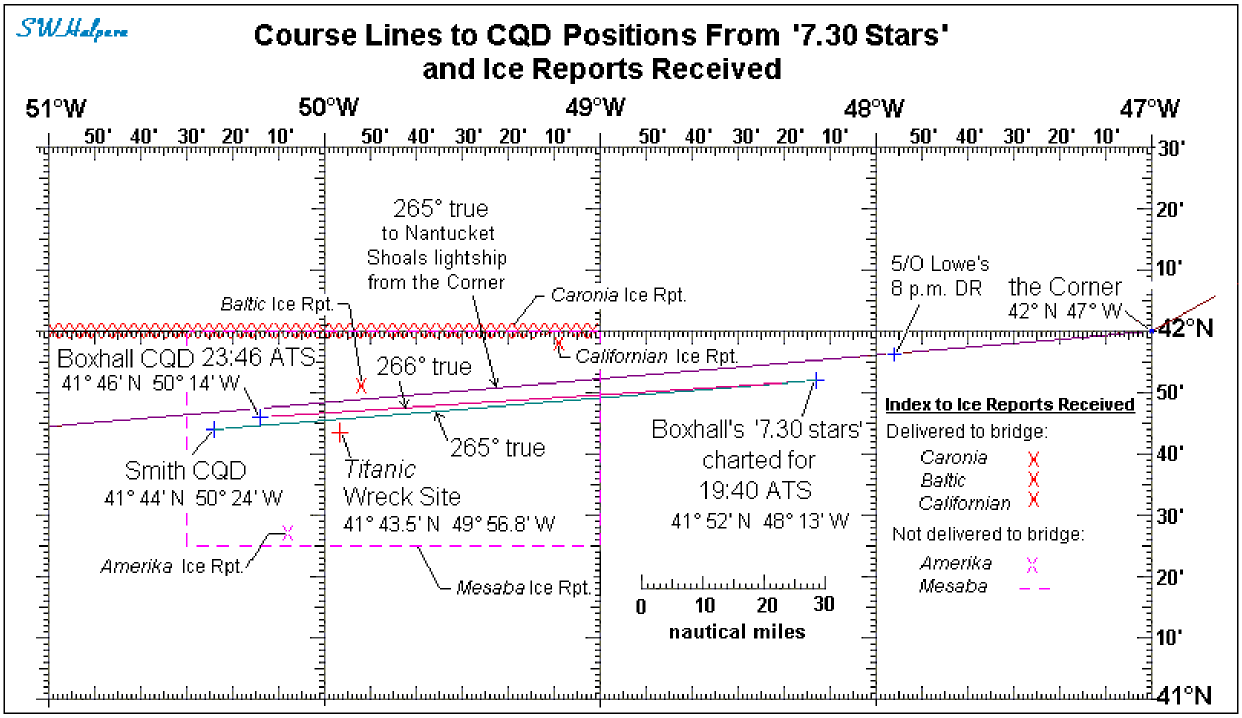
So the question is what was the course used by Capt. Smith when he worked up his distress position? If you start from the celestial fix worked out by Boxhall, 41° 52' N, 48° 13' W, and draw a line to the Smith position at 41° 44'N, 50° 24' W, you find a course line that runs 265° true, exactly parallel to the course from the corner to the Nantucket lightship but about 3 miles to the south. This is shown on the chart below along with the 266° course line from the celestial fix to the Boxhall CQD, and the 265° course line from the corner to the Nantucket Shoals lightship. (For additional reference, all the known ice warnings received by wireless on *Titanic* that Sunday, April 14, 1912, are also indicated on this chart.)[51]

---

[49] IMM Co. Ship's Rules and Uniform Regulations, Issued July 01, 1907, Rule 253.

[50] National Geospatial-Intelligence Agency, *Handbook of Magnetic Compass Adjustment*, Bethesda, MD, 2004, Ch. VII (Ship's Headings) and VIII (Azimuths).

[51] Wreck Commission Report on the Loss of the *Titanic*, July 30, 1912, Section 2, Subsection: "Ice Messages Received."



In dead reckoning work you always start from a known fix at a known point in time. To get to a position for some other time, you take the ship's heading and assumed speed and calculate the distance traveled along the course line for a given time interval. If Capt. Smith was indeed informed by Boxhall that the ship was actually making 266° instead of 265°, then he should have used 266° for the course. But from the chart above it seems that he used a heading of 265° true from the fix. Why? One reason may be that Captain Smith did not have the course line that Boxhall worked out after Boxhall gave him the celestial fix position to put on his chart at 10 p.m. The other reason may be that Capt. Smith realized from the position of the celestial fix that the ship's course-made-good over ground was being set to the south of the actual heading she was on, and smartly decided to use the older course heading instead. Either way, the undeniable fact is that the Smith CQD is located on a line 265° true from the charted Boxhall celestial fix.

With the knowledge we have, let us work through the steps that Capt. Smith would have taken to find the initial distress position.

According to Quartermaster Robert Hichens, when the accident occurred, "the first officer told the other quartermaster standing by [QM Olliver who just came onto the bridge] to take the time, and told one of the junior officers [Moody most likely] to make a note of that in the logbook. That was at 20 minutes of 12; sir."[52] So what Capt. Smith had available to him was an accident time of 11:40 p.m., a celestial star fix charted for 7:40 p.m., and a course line of 265° true that he decided use. He also knew that *Titanic* was running on smooth seas for the last several hours since the sun went down. Just as Boxhall assumed, he probably would have allowed 22 knots over ground for same reasons that Boxhall noted.[53]

---

[52] AI P. 456.

[53] The ship's measured speed through the water as noted on the taffrail log averaged 22.29 knots from noon to the time of collision at 11:40 p.m. Between 8 p.m. and 10 p.m., the ship averaged about 22.5 knots through the water by the taffrail log. (See AI pp. 519 and p. 523, and BI 17608-17630, and BI 965-966.)

Using a course of S 85° W true (265°) and a speed of 22 knots, let us try to reproduce the computations that Capt. Smith would have made and see what may have happened to produce the result he obtained.

The first thing Capt. Smith needed to do was find the distance that the ship had run since departing the celestial fix position. If the fix was charted for the time the sights were completed, 7:40 p.m. according to Pitman, and the accident was logged at 11:40 p.m. according to what Hichens said, then we have a run of 4 hours of time at 22 knots for a distance of 88 nautical miles. The next thing Capt. Smith needed to do is find the change in the ship' latitude and longitude for the course she was making. For this he would refer to the use of traverse tables since no tedious mathematical calculations would be need. One table would give him the change in latitude to the south as well as the departure distance to the west for the distance traveled from the fix. The second table would give him the change in longitude to the west using the departure distance obtained from the first table. The entire process would literally take just a couple of minutes to do.

So let's look at what he found. A traverse table similar to the one below for a course of 265° true would be used first.[54] Starting from the columns on the bottom of the table marked: ***Dist.***, ***Dep.***, and ***D. Lat.***, he would first find the distance traveled (88 miles) above in the ***Dist.*** column, then get the departure distance (in nautical miles) from the ***Dep.*** column, and then the difference in latitude (in minutes-of-arc) from the ***D. Lat.*** column. He would write those items down on a piece of paper:

Dist. = 88 miles
Dep. = 87.7 miles
D. Lat. = 7.7'

[54] The table is actually intended to be used for eight difference course angles, include two running northward (005° and 365°), two running southward (175° and 185°), two running eastward (085° and 095°), and two running westward (265° and 275°). On his table courses would have been written as N5°E, N5°W, S5°E, S5°W, N85°E, N85°W, S85°E, and S85°W.

SWHalpern **Table used by Capt. Smith to get D.Lat. and Dep.**

Traverse **5°** Table — 355° | 005° / 185° | 175°

D.Lon.	Dep.		D.Lon.	Dep.		D.Lon	Dep.		D.Lon.	Dep.		D.Lon.	Dep.	
Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1.0	0.1	61	60.8	5.3	121	120.5	10.5	181	180.3	15.8	241	240.1	21.0
2	2.0	0.2	62	61.8	5.4	122	121.5	10.6	182	181.3	15.9	242	241.1	21.1
3	3.0	0.3	63	62.8	5.5	123	122.5	10.7	183	182.3	15.9	243	242.1	21.2
4	4.0	0.3	64	63.8	5.6	124	123.5	10.8	184	183.3	16.0	244	243.1	21.3
5	5.0	0.4	65	64.8	5.7	125	124.5	10.9	185	184.3	16.1	245	244.1	21.4
6	6.0	0.5	66	65.7	5.8	126	125.5	11.0	186	185.3	16.2	246	245.1	21.4
7	7.0	0.6	67	66.7	5.8	127	126.5	11.1	187	186.3	16.3	247	246.1	21.5
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
18	17.9	1.6	78	77.7	6.8	138	137.5	12.0	198	197.2	17.3	258	257.0	22.5
19	18.9	1.7	79	78.7	6.9	139	138.5	12.1	199	198.2	17.3	259	258.0	22.6
20	19.9	1.7	80	79.7	7.0	140	139.5	12.2	200	199.2	17.4	260	259.0	22.7
21	20.9	1.8	81	80.7	7.1	141	140.5	12.3	201	200.2	17.5	261	260.0	22.7
22	21.9	1.9	82	81.7	7.1	142	141.5	12.4	202	201.2	17.6	262	261.0	22.8
23	22.9	2.0	83	82.7	7.2	143	142.5	12.5	203	202.2	17.7	263	262.0	22.9
24	23.9	2.1	84	83.7	7.3	144	143.5	12.6	204	203.2	17.8	264	263.0	23.0
25	24.9	2.2	85	84.7	7.4	145	144.4	12.6	205	204.2	17.9	265	264.0	23.1
26	25.9	2.3	86	85.7	7.5	146	145.4	12.7	206	205.2	18.0	266	265.0	23.2
27	26.9	2.4	87	86.7	7.6	147	146.4	12.8	207	206.2	18.0	267	266.0	23.3
28	27.9	2.4	88	87.7	7.7	148	147.4	12.9	208	207.2	18.1	268	267.0	23.4
29	28.9	2.5	89	88.7	7.8	149	148.4	13.0	209	208.2	18.2	269	268.0	23.4
30	29.9	2.6	90	89.7	7.8	150	149.4	13.1	210	209.2	18.3	270	269.0	23.5
31	30.9	2.7	91	90.7	7.9	151	150.4	13.2	211	210.2	18.4	271	270.0	23.6
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
55	54.8	4.8	115	114.6	10.0	175	174.3	15.3	235	234.1	20.5	295	293.9	25.7
56	55.8	4.9	116	115.6	10.1	176	175.3	15.3	236	235.1	20.6	296	294.9	25.8
57	56.8	5.0	117	116.6	10.2	177	176.3	15.4	237	236.1	20.7	297	295.9	25.9
58	57.8	5.1	118	117.6	10.3	178	177.3	15.5	238	237.1	20.7	298	296.9	26.0
59	58.8	5.1	119	118.5	10.4	179	178.3	15.6	239	238.1	20.8	299	297.9	26.1
60	59.8	5.2	120	119.5	10.5	180	179.3	15.7	240	239.1	20.9	300	298.9	26.1
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.
D.Lon.		Dep.	D.Lon.		Dep.	D.Lon.		Dep.	D.Lon.		Dep.	D.Lon.		Dep.

275° | 085° / 265° | 095° ← Course

85°

Next he would take the traverse table corresponding to the parallel of latitude that they were closest to (42°) and use the columns labeled ***D. Lon.*** and ***Dep.*** at the top of the table.[55] As shown below, he would go down the column marked ***Dep.*** until he got to the 87.7 mile departure distance he obtained from the first table, and then take the value for the difference in longitude (in minutes-of-arc) under the ***D. Lon.*** column that is next to it:

D. Lon. = 118'

He now has everything he needs to get the distress position coordinates from the star fix coordinates. All he had to do is *subtract* D. Lat. = 7.7' from the latitude of the star fix, and *add* D. Lon. = 118' to the longitude of the star fix. Some very simple arithmetic using a pencil and paper.

[55] Since each table can be used for handling two different latitudes, one being the complementary angle of the other, the table he would use is the one marked for 42° and 48°.

SWHelper

Table used by Capt. Smith to get D.Lon.

Traverse **42°** Table ← Latitude

318° | 042°
222° | 138°

D.Lon	Dep.		D.Lon	Dep.		D.Lon	Dep.		D.Lon	Dep.		D.Lon	Dep.	
Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0.7	0.7	61	45.3	40.8	121	89.9	81.0	181	134.5	121.1	241	179.1	161.3
2	1.5	1.3	62	46.1	41.5	122	90.7	81.6	182	135.3	121.8	242	179.8	161.9
3	2.2	2.0	63	46.8	42.2	123	91.4	82.3	183	136.0	122.5	243	180.6	162.6
4	3.0	2.7	64	47.6	42.8	124	92.1	83.0	184	136.7	123.1	244	181.3	163.3
5	3.7	3.3	65	48.3	43.5	125	92.9	83.6	185	137.5	123.8	245	182.1	163.9
6	4.5	4.0	66	49.0	44.2	126	93.6	84.3	186	138.2	124.5	246	182.8	164.6
7	5.2	4.7	67	49.8	44.8	127	94.4	85.0	187	139.0	125.1	247	183.6	165.3
8	5.9	5.4	68	50.5	45.5	128	95.1	85.6	188	139.7	125.8	248	184.3	165.9
9	6.7	6.0	69	51.3	46.2	129	95.9	86.3	189	140.5	126.5	249	185.0	166.6
10	7.4	6.7	70	52.0	46.8	130	96.6	87.0	190	141.2	127.1	250	185.8	167.3
11	8.2	7.4	71	52.8	47.5	131	97.4	87.7	191	141.9	127.8	251	186.5	168.0
12	8.9	8.0	72	53.5	48.2	132	98.1	88.3	192	142.7	128.5	252	187.3	168.6
13	9.7	8.7	73	54.2	48.8	133	98.8	89.0	193	143.4	129.1	253	188.0	169.3
14	10.4	9.4	74	55.0	49.5	134	99.6	89.7	194	144.2	129.8	254	188.8	170.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
46	34.2	30.8	106	78.8	70.9	166	123.4	111.1	226	168.0	151.2	286	212.5	191.4
47	34.9	31.4	107	79.5	71.6	167	124.1	111.7	227	168.7	151.9	287	213.3	192.0
48	35.7	32.1	108	80.3	72.3	168	124.8	112.4	228	169.4	152.6	288	214.0	192.7
49	36.4	32.8	109	81.0	72.9	169	125.6	113.1	229	170.2	153.2	289	214.8	193.4
50	37.2	33.5	110	81.7	73.6	170	126.3	113.8	230	170.9	153.9	290	215.5	194.0
51	37.9	34.1	111	82.5	74.3	171	127.1	114.4	231	171.7	154.6	291	216.3	194.7
52	38.6	34.8	112	83.2	74.9	172	127.8	115.1	232	172.4	155.2	292	217.0	195.4
53	39.4	35.5	113	84.0	75.6	173	128.6	115.8	233	173.2	155.9	293	217.7	196.1
54	40.1	36.1	114	84.7	76.3	174	129.3	116.4	234	173.9	156.6	294	218.5	196.7
55	40.9	36.8	115	85.5	77.0	175	130.1	117.1	235	174.6	157.2	295	219.2	197.4
56	41.6	37.5	116	86.2	77.6	176	130.8	117.8	236	175.4	157.9	296	220.0	198.1
57	42.4	38.1	117	86.9	78.3	177	131.5	118.4	237	176.1	158.6	297	220.7	198.7
58	43.1	38.8	118	87.7	79.0	178	132.3	119.1	238	176.9	159.3	298	221.5	199.4
59	43.8	39.5	119	88.4	79.6	179	133.0	119.8	239	177.6	159.9	299	222.2	200.1
60	44.6	40.1	120	89.2	80.3	180	133.8	120.4	240	178.4	160.6	300	222.9	200.7
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.
D.Lon		Dep.	D.Lon		Dep.	D.Lon		Dep.	D.Lon		Dep.	D.Lon		Dep.

312° | 048°
228° | 132°

48°

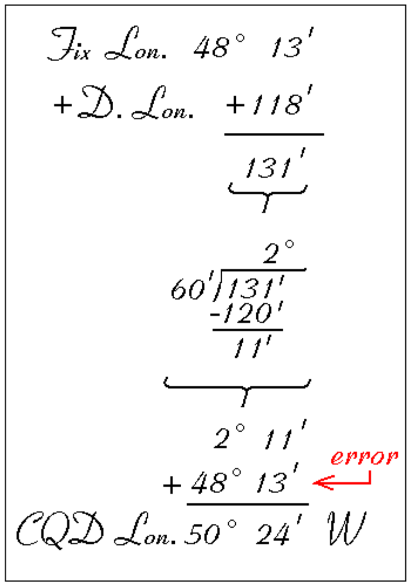
So let's do the simple math taking one coordinate at a time. We begin with the latitude calculation. Boxhall's star fix latitude was 41° 52' N. From this Smith subtracts 7.7' which gives him 41° 44.3' N. Rounding off to the nearest whole minute-of-arc, he writes: 41° 44' N for the CQD latitude. This is shown in the work up below:

Fix Lat. 41° 52.0'
− D. Lat. − 7.7'
44.3'

CQD Lat. 41° 44' N

Next he works on the longitude. Boxhall's star fix longitude was 48° 13' W. To this Smith adds 118' which gives him 48° 131' W. But 131 minutes-of-arc needs to be converted to degrees and minutes of arc, there being 60' in every 1° of arc. So he just divides the 131 by 60 to get 2° with a remainder of 11'. Now he can easily add the 2° to the 48° of the fix, and the 11' to the 13' of the fix. Right?

This is where I believe a simple error was made after having made such an error myself when first working this up. If you add 2° 11' to the longitude of the star fix, 48° 13' W, you get what is shown in the work up below:



But the error is adding 2° 11' to the star fix longitude. The reason is that the value 2° 11' already contains the 13' from the star fix longitude. The correct answer is obtained by adding 2° 11' to 48° 00' to give you 50° 11' W, not the erroneous 50° 24' W shown above.

A simple error possibly made by in the haste to work up the ship's distress coordinates. Under other circumstances, such an error would probably have been quickly realized. But under the conditions of a sinking ship, having been told that the ship may be gone in an hour or an hour and a half, it probably went unchecked.[56]

If we accept this possibility as the means in which the coordinates of the initial CQD came about, then we should realize that if such an error was *not* made, Capt. Smith would have obtained 41° 44' N, 50° 11' W as the initial CQD position, just about 2 miles east and 2 miles south of the Boxhall CQD location. Still, because of the common 15' error in the celestial fix, it would have been over 10 miles west of the wreck site. Ironically, if we also remove the 15' error in the celestial fix from this result, the Smith CQD would have worked out to 41° 44' N, 49° 56' W, a position almost directly over the wreck site and very close to the where the collision took place.[57]

---

[56] BI 15610.

[57] The wreck site coordinates to center of the boiler field is at 41° 43.5' N, 49° 56.8' W. The location of this corrected Smith CQD, 41° 44' N, 49° 56' W, is just over 5 ship lengths to the northeast, and also very close to where the collision most likely took place. (See: Samuel Halpern, "Collision Point," on the GLTS Website at http://www.glts.org/articles/halpern/collision_point.html.

"HE TOLD ME TO TAKE IT TO THE MARCONI ROOM"

It was "approximately 20 minutes to half an hour" after the collision that fourth officer Boxhall returned from his second inspection down below and "reported to the Captain" about the flooding he saw in the mail room. He then went to call upon Lightoller, Pitman, and Lowe. After calling upon those officers:[58]

> "I think I went towards the bridge, I am not sure whether it was then that I heard the order given to clear the boats or unlace the covers. I might have been on the bridge for a few minutes and then heard this order given…I went right along the line of boats and I saw the men starting, the watch on deck, our watch…I went along the port side, and afterwards I was down the starboard side as well but for how long I cannot remember. I was unlacing covers on the port side myself and I saw a lot of men come along - the watch I presume. They started to screw some out on the afterpart of the port side; I was just going along there and seeing all the men were well established with their work, well under way with it, and I heard someone report a light, a light ahead. I went on the bridge and had a look to see what the light was…But before I saw this light I went to the chart room and worked out the ship's position."

Why did Boxhall go to work out the ship's position after coming onto the bridge after someone reported a light? It is obvious that someone had told him to do that. That person had to be Capt. Smith.[59]

> "I encountered him [Capt. Smith] when reporting something to him, or something, and he was inquiring about the men going on with the work, and I said, 'Yes, they are carrying on all right.' I said, 'Is it really serious?' He said, 'Mr. Andrews tells me he gives her from an hour to an hour and a half.' Evidently Mr. Andrews had been down."

We know from what Boxhall said that he came back onto the bridge to have a look at the light of a ship that someone reported ahead. However, when he gets to the bridge he encounters Capt. Smith who, having most likely just returned from the Marconi room after handing Phillips the CQD coordinates for the initial distress message,[60] asks him how the work was progressing on getting the boats out. Boxhall then asks Smith if the situation is really serious, and Smith shares with him what Thomas Andrews had said. It was at this time that the subject of a distress message must have been brought up. It may have been Boxhall who suggested that he check the

---

[58] BI 15383-15388.

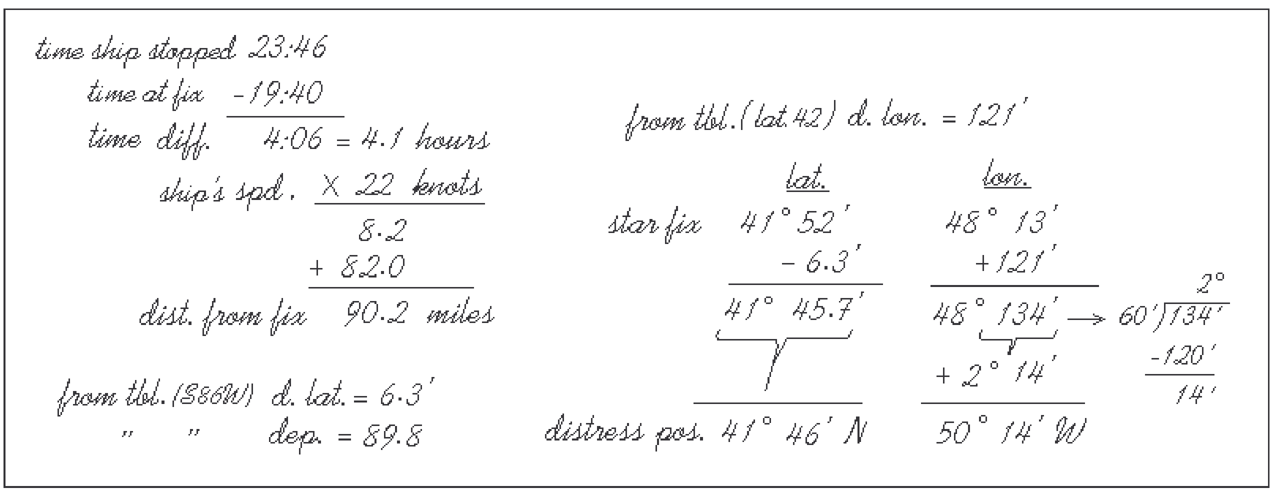
[59] BI 15610.

[60] Harold Bride said "The Captain gave him [Phillips] the latitude and longitude of the *Titanic*, and told him to be quick about it or words to that effect." See BI 16508.

position since the celestial fix showed the ship well ahead of the DR, and that the ship's true heading was S 86° W instead of the S 85° W originally intended. In any case, Smith must have thought it was a good idea for Boxhall to check the position, and Boxhall was sent to the chart room to do so.[61]

> "But after seeing the men continuing with their work I saw all the officers were out, and I went into the chart room to work out its position…It was after that, yes, [that I saw this light] because I must have been to the Marconi office with the position[62]…I submitted the position to the Captain first, and he told me to take it to the Marconi room."

The time Boxhall needed to work out his CQD position would be a less than five minutes. He had the celestial fix location already recorded in his workbook as well as the ship's true heading that he worked out earlier. A set of traverse tables were readily available to him, and he only need to open the one for a course of S 86° W and another for a latitude of 42°. Interpolation between different tabular values would not have been necessary. His worksheet probably looked something like what is shown below.



CONCLUSIONS

From the work presented in this article, we see how a simple 1 minute error in reading the time difference between a hack watch and the time on a chronometer can offset a set of star sights by 15 minutes-of-arc. This type of systematic error would tend to go unnoticed since all

[61] BI 15388-15391.

[62] The transcript from the British Inquiry read: "15390. *Was it after that you saw this light? - It was after that, yes* [author's emphasis], because I must have been to the Marconi office with the position after I saw the light." However, it was very clear from the overall context that Boxhall saw the light *after* having worked up his CQD position and taking it to the Marconi room. The punctuation in the transcript makes more sense if it had read: "It was after that, yes, because I must have been to the Marconi office with the position. After, I saw the light."

sights would be affected exactly the same way. We also noted that such an error would affect all positions derived from that celestial star sight reference, including the two distress positions that were transmitted by wireless from *Titanic* that night. Furthermore, we saw how such a misplacement of this celestial fix would cause third officer Pitman and fourth officer Boxhall to conclude that the ship must have turned the corner much later than what was originally thought.

We also looked at the ships position for local apparent noon on April 14 from two independent sources. One from evidence provided by fifth officer Lowe, and the other from the distance the ship made good since departing Queenstown on April 11. We also compared this to data taken the year before from *Titanic*'s sister ship *Olympic*. Additionally, we took a detailed look at how fifth officer Lowe worked up the ship's 8 p.m. dead reckoning position for the night orders book. We found that fifth offer Lowe tended to be very precise in the numbers he gets such as the ship's course from noon to the corner, and the speed of the ship from noon to 8 p.m. However, his results may not have been very accurate since it appears that he did not bother to use the correct time that the ship actually altered course when computing the ship's speed that he used to work up the 8 p.m. DR. As we have seen from Lowe's own description, he did not consider the 8 p.m. DR to be of much importance.

In addition, we also saw how a simple and understandable oversight in adding a tabulated difference in longitude to a star sight longitude could have shifted the initial CQD position further westward from where it should have been. We also noticed that if simple errors such as these were not made, the initial CQD position would have fallen almost directly on top of the wreck site location.

Although the results presented in this article appear to give rational explanations as to why the two CQD positions transmitted from *Titanic* were so far off, the reader is cautioned by the assumptions that were necessarily made in coming up with these explanations. Unfortunately, there is no direct proof that a misreading of a clock took place by third officer Pitman, or that Capt. Smith actually made that simple oversight error in his haste to work up the initial distress coordinates. But what we do know is that both CQD positions were well to west of where *Titanic* foundered. The explanations presented here are entirely consistent with what we do know about how ship positions were calculated back in 1912, and they make use of evidence presented in the historical record, including the use of data presented by *Titanic*'s surviving officers and several others.

There were many things that affected the course of events for *Titanic* and the people who sailed upon her that memorable night in April 1912. Some were caused by nature, while others were caused by simple human error. There were a number things that seemed to go wrong. A possible misreading of a clock, a DR location that was considered not to be "of any importance," a possible oversight in adding two numbers together, and a failure to recognize that something may not be quite right when an otherwise perfectly good fix was put down on the chart too far ahead of the DR.

For the survivors of *Titanic* that night there were also a few things that did go in their favor. They were fortunate that *Carpathia*'s wireless operator decided to call up *Titanic* instead of turning off his set and going to bed. They were fortunate that fourth officer Boxhall had the foresight to have some green flares put in his boat before he left *Titanic*.[63] And they were very lucky that *Carpathia* just happened to be coming up from the southeast having to pass close to the wreckage and lifeboats on her way to the wrong location.

---

[63] BI 15448.

ACKNOWLEDGEMENT

I would especially like to thank Captain Peg Brandon, Assistant Professor at the Maine Maritime Academy, for reviewing this work and also for taking the time to write the foreword to this article. I would also like to thank Captain Charles Weeks, also of the Maine Maritime Academy and respected *Titanic* researcher, for his review of this work and for the suggestions that he offered.