Mistakes In The Night

By Samuel W. Halpern

PREFACE

In 2005 I published an article in the Titanic Historical Society's journal *The Titanic Commutator* called, "A Minute of Time."[1] The article dealt with the issue of how two erroneous distress positions transmitted from *Titanic* by wireless on the night of the disaster may have come about. Three years later I published a somewhat revised work called, "It's a CQD Old Man."[2] Now I offer an alternate explanation on this very same subject, presenting once again an entirely plausible explanation on how the coordinates of both CQD positions may have come about; erroneous positions that were far west of the now known position of the wreck.

As I pointed out in my previous articles and in most works regarding *Titanic*, there is some degree of speculation that has to be made. Some things cannot, and most likely never will, be known with certainty. But unlike the work of a few others, evidence will not be twisted in such a way as to fit something that was never intended.

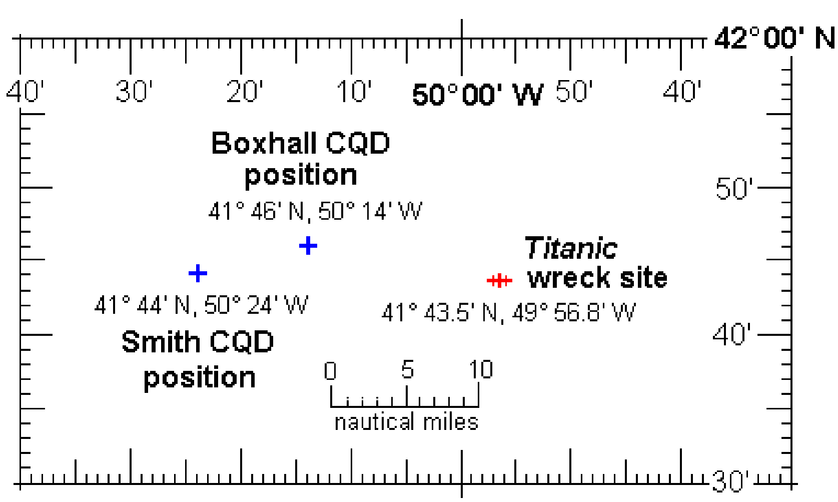
INTRODUCTION

On the night of April 14, 1912 at 10:25 p.m. New York time, *Mount Temple*'s wireless operator John Durrant picked up a distress call from *Titanic*'s senior wireless operator Jack Phillips which he then handed to his ship's master Captain James Henry Moore. The message given to Moore read:[3]

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

As Captain Moore prepared to take action he received an amended position, which read 41º 46' north, 50º 14' west, and it was that position that he laid down a course for to go to the rescue.

The position in the initial distress message that Moore received, latitude 41° 44' N, longitude 50° 24' W, turns out to be a little over 20 miles west of the *Titanic* wreck site which was first discovered 73 years after the tragic event. The position in the revised CQD message, latitude 41° 46' N, longitude 50° 14' W, turns out to be about 13 miles to the west of the *Titanic* wreck site.



In addition to *Mount Temple*, the initial distress position that was transmitted at 10:25 p.m. New York time 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.[4] It was a position that was worked up by *Titanic*'s Captain E J Smith, and was being sent out by Jack Phillips, *Titanic*'s senior wireless operator, for almost 10 minutes before the so called "corrected" position, worked up by *Titanic*'s Fourth Officer Joseph Boxhall, was transmitted. It was this revised position, first transmitted at 10:35 p.m. New York time, that was picked up by *Carpathia*'s wireless operator Harold Cottam.

As I pointed out in my original article on this topic, there has been much speculation over the years since the discovery of the wreck to explain why both of these CQD positions were so far west of where *Titanic* foundered. Some of the reasons suggested include overestimating the ship's speed, errors in time, and errors in calculations. Some of these explanations are quite imaginative, and backed with very little evidence, while others are somewhat more plausible.

After the discovery of the wreck in 1985, 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.[5]

In the 1992 report of the British Marine Accident Investigation Branch concerning the *Californian* affair and her 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."[6]

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.[7]

In 2002, Captain L. Marmaduke Collins suggested that Boxhall's CQD position was correct, but it was the submerged hulk of *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 of the CQD position. Captain Collins also believed *Titanic* did not strike an iceberg but instead struck a patch of pack ice. He also believed 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.[8]

In 2005 this author wrote the article, "A Minute of Time" – referenced above – 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 2008, 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 Brown claims was deliberately put in the initial CQD message by Captain Smith, by 20 minutes of steaming at 22 knots along the line that runs across the two CQD positions. His article also suggested that 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, which he claims was 4 minutes past twelve on clocks still set for April 14. 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. 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.[9]

More recently James Currie put forth his idea that the erroneous Boxhall CQD position is tied to the issue of a partial clock adjustment of 24 minutes taking place sometime before the accident, and that the true time of the collision, like David Brown believes, was 12:04 a.m. in unadjusted April 14th hours. According to what Currie believes, the famous Boxhall coordinates, 41° 46' N, 50° 14' W, were in error due to *Titanic*'s fourth officer applying the 24 minute partial time adjustment twice in his work instead of only once. Currie also believes that the first set of CQD coordinates, the so called Smith coordinates, turned out to be 20 miles west of the wreck site because the 8 p.m. dead reckoning (DR) position that Captain Smith started his work from was about 20 miles ahead of the ship's true position. How such an error in the 8 p.m. dead reckoning work could have gone unnoticed was not offered.

In this article I will re-examine the issue of the two erroneous CQD positions. This time, however, I will show that if we assume that a misreading of a traverse table by Boxhall, as originally suggested by Dave Gittins in 1998, was the primary cause of Boxhall's position being in error, then we can work backward to find the coordinates of the 7:30 p.m. celestial fix from which he started from in deriving his famous CQD position. I will also show that a very simple mental arithmetic error on part of Captain Smith could have thrown the first CQD position far off to the west of where it should have been.

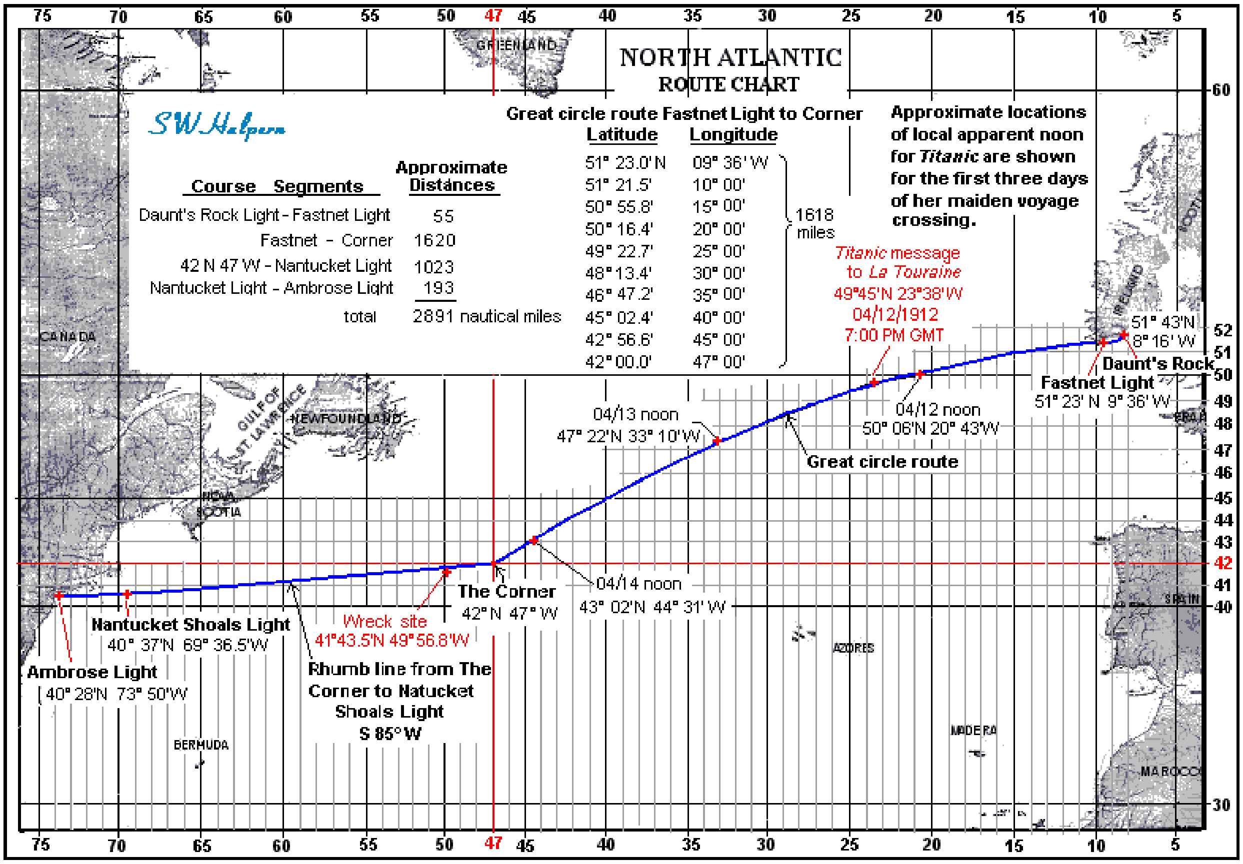
As in my previous work, I will be using the methods of obtaining changes in latitude and longitude that both Captain Smith and Fourth Officer Boxhall would have used at the time. Furthermore, the explanations presented in this article again have nothing to do with projected midnight positions, undocumented course changes, clock adjustments that were due to take place later that night, miscommunications between individuals, or the highly implausible 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. Once again, the basis of this work will be from evidence given within the historical record.

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.[10]

The reported distance traveled from Daunt's Rock to local apparent noon (LAN) on April 14, 1912, was 1549 nautical miles.[11] The remaining distance from noon to the Corner was about 126 nautical miles. This can be confirmed 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 obtained by subtracting the distance traveled up until noon April 14 from the distance to the Corner over the planned route that *Titanic* traveled; a distance that is confirmed from log-card data taken from three westbound voyages of *Titanic*'s sister ship *Olympic* in 1911.[12]

As derived from the available data, *Titanic*'s most likely position at local apparent noon April 14, 1912, rounded to the nearest whole minutes-of-arc, was 43° 02' N, 44° 31' W.[13]



Track of RMS *Titanic* April 1912

According to Second Officer Charles Lightoller and Third Officer Herbert Pitman, *Titanic*'s course was set at noon that Sunday.[14] The course heading given to the helmsman and marked on the course board was S 85° W (265°) by the steering compass in the wheelhouse.[15] The course to the Corner from the ship's noon position as given by Fifth Officer Lowe 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.[16] After the course was altered, *Titanic* was heading N 71° W (289°) by the steering compass in the wheelhouse.[17] The change in compass heading from S 85° W to N 71° W was a change of 24 degrees to starboard as seen on the steering compass in the wheelhouse. 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 point to New York for westbound steamers for that time of the year.[18]

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."[19]

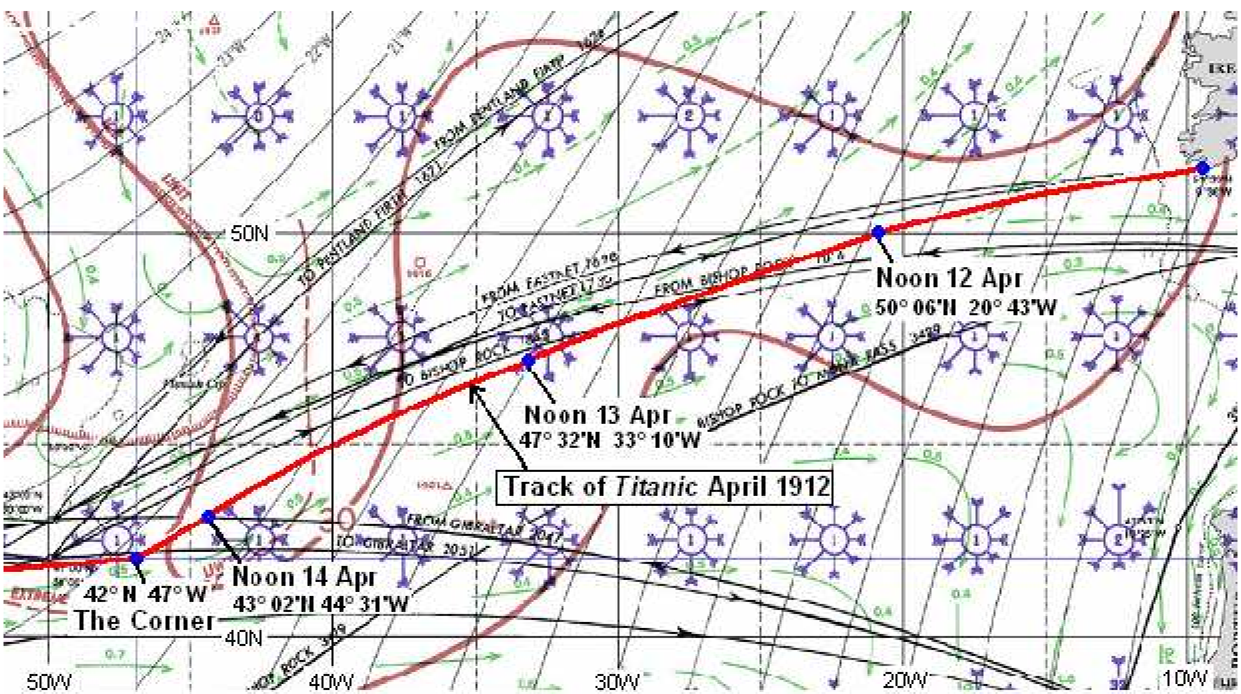
The calculations that Lightoller was referring to were made by Fourth Officer Boxhall after he worked up a set of celestial star sights taken earlier by Lightoller and Pitman around 7:30 p.m. As Boxhall explained to Senator Burton at the American Inquiry, "After I had worked these [stellar] observations 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."[20] He also claimed that the ship was making S 86° W true after the 5:50 p.m. course change.

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, a heading determined some time later on when Boxhall was able to ascertain the precise compass error after first working up the ship's 7:30 p.m. position from the star sights taken by Lightoller and Pitman. When the ship's course was altered at 5:50 p.m., the intent however was to have her make 265° true for the Nantucket lightship, the charted course to New York from the Corner.[21]

We also know that Boxhall used a speed of 22 knots when he worked up his distress position.[22] As explained before the Wreck Commission, "taking into consideration that it was smooth water and that there ought to have been a minimum of slip, I allowed 22 knots."[23] However, a valid question to ask is what speed did Captain Smith use when he ordered *Titanic*'s course be altered for New York at 5:50 p.m.?

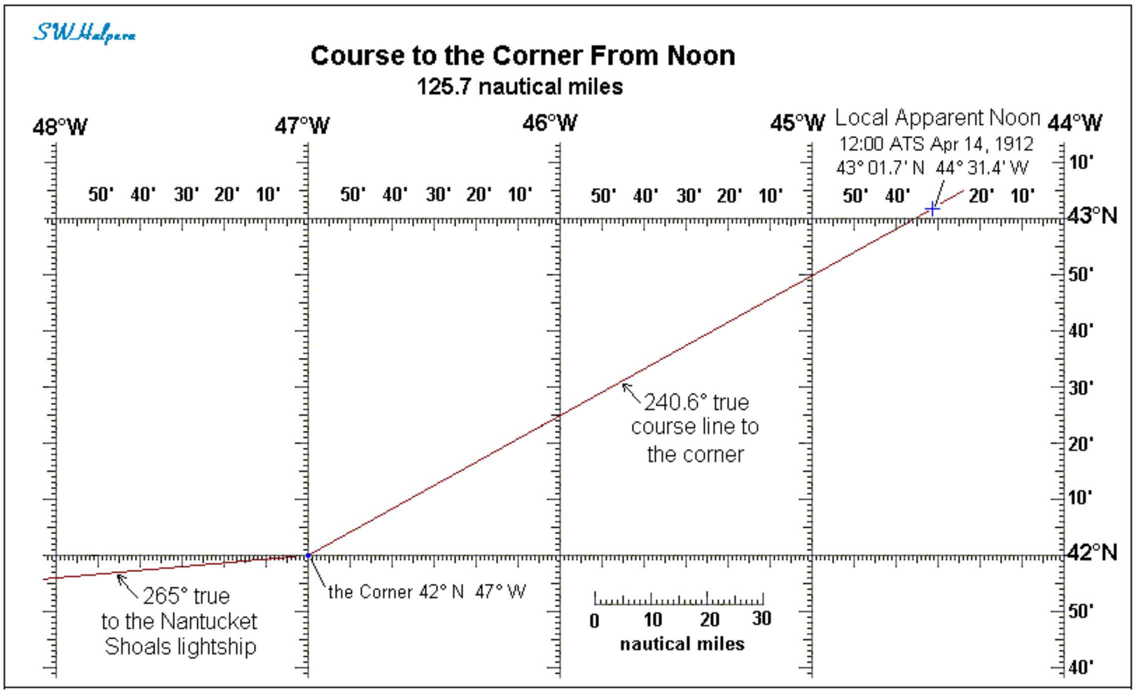
If we take 126 miles, the distance from *Titanic*'s noontime position to the Corner, and divide that by 5 hour 50 minutes we get a speed of 21.6 knots. But we also know that *Titanic* ran 546 nautical miles from local apparent noon April 13 to local apparent noon April 14, a period of time that lasted 24 hours and 45 minutes against the North Atlantic Drift.[24] This means that the average speed over ground since noon the previous day was about 22.1 knots. We also know that the revolutions on *Titanic*'s engines carried on Sunday had not changed from what was carried at noon Saturday.[25]

According to pilot charts of the North Atlantic, one would expect to see a current running about ENE true at about ½ knot in the vicinity of the Corner and over the region that *Titanic* traveled during her previous day's run. (See chart below.) This would be a current almost directly opposite *Titanic*'s route of travel. However, if Captain Smith allowed for an extra ½ knot of current drift for the run down to the Corner, then that would explain why he set the time to turn the Corner at 5:50 p.m. since another half-knot of current would reduce the ship's speed-made-good from 22.1 to 21.6 knots. At that speed it would take *Titanic* 5 hours and 50 minutes to travel the 126 nautical miles from noon to the Corner instead of 5 hours and 42 minutes if she was still making 22.1 knots as she did the previous day. The other possibility is that Captain Smith simply wanted to make sure that his ship was slightly south of 42° N before altering course for New York because of an ice message he received at 9:12 a.m. that morning from Captain Barr of *Caronia* which said that westbound steamers reported "bergs, growlers and field ice" in latitude 42° N, from 49° to 51° W.



Pilot chart of the North Atlantic for the month of April

As far as weather conditions that afternoon, evidence from the logbook of the SS *Californian* indicated that there was a “fresh wind” (17 to 21 knots)[26] out of the “north-northwest” with a “moderate sea” (6 to 8 foot waves)[27] and “clear weather” in the vicinity of the Corner just six hours before *Titanic* arrived there.[28] Later, after *Titanic* turned the Corner, she entered a region of very calm conditions, with no wind and a flat sea and dropping temperatures.[29]



***Titanic*’s Intended course to ‘the Corner’ from Noon, April 14, 1912**

The chart above shows the ship’s intended course from local apparent noon, Sunday, April 14, 1912 to the Corner, and the intended course after the course alteration at the Corner.[30]

7:30 STARS

Sunday evening a set of star sights 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.”[31] 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.”[32] And with that simple exchange, the job of working out the sights was handed off to Boxhall to complete.

At the British Inquiry, Boxhall was very specific about how he computed the ship’s distress position that was sent out in the CQD message that was later picked up by *Carpathia*. The information he provided was that he started from the ship’s 7:30 position, allowed a speed of 22 knots on a course of 266° true, and used a collision time of 11:46 p.m.[33]

Since we know the CQD position he obtained, it would be easy to work Boxhall’s problem in reverse to find the position for the celestial fix using the information that he provided. However, this process assumes that Boxhall did not make any errors when he derived his CQD position, which is our starting point for deriving the location of the celestial fix. Unfortunately, we know that the Boxhall CQD position was 13 miles west of the wreck site, therefore it is obvious that a mistake was made somewhere.

In my 2005 article, "A Minute of Time," I suggested that the coordinates of the 7:30 p.m. star sights that were put down on the chart were shifted to the west by 15 minutes-of-arc of longitude due to a misreading of the chronometer by 1 minute of time by Third Officer Pitman when comparing its time to the time on a hack watch used to record the time of each star sight taken. The major criticism of this theory was that it would be unlikely for such a mistake to be made because the normal practice was to compare the time on a hack watch both before and after the sights were taken. Of course we have no evidence that this normal procedure was actually followed that night, and even if it was, there is the possibility that only a comparison of the second hands of the clocks were looked at after the sights were taken if it was previously known that the difference between clock readings would change by a few seconds at most during the 10 minute interval it took to take the set of sights. Nevertheless, in this work I will *not* assume any misreading of the chronometer took place; rather I will assume, as suggested by Dave Gittins back in 1998, that an error in reading from the wrong column of a traverse table led to the erroneous Boxhall CQD coordinates being in error by 14 minutes-of-arc too far to the west.

Based on this assumption, the coordinates for the 7:30 p.m. celestial fix could easily be ascertained.[34] What we find is a set coordinates for the ship at 7:30 p.m. that is about 6 ½ minutes-of-arc to the north and 140 minutes-of-arc to the east of the famous Boxhall CQD coordinates. This gets us to **41° 52.5' N, 47° 54' W** for the position of the ship at 7:30 p.m. (22:28 GMT).[35]

The next step is to show how the two erroneous CQD positions transmitted from *Titanic* that night may have come about.

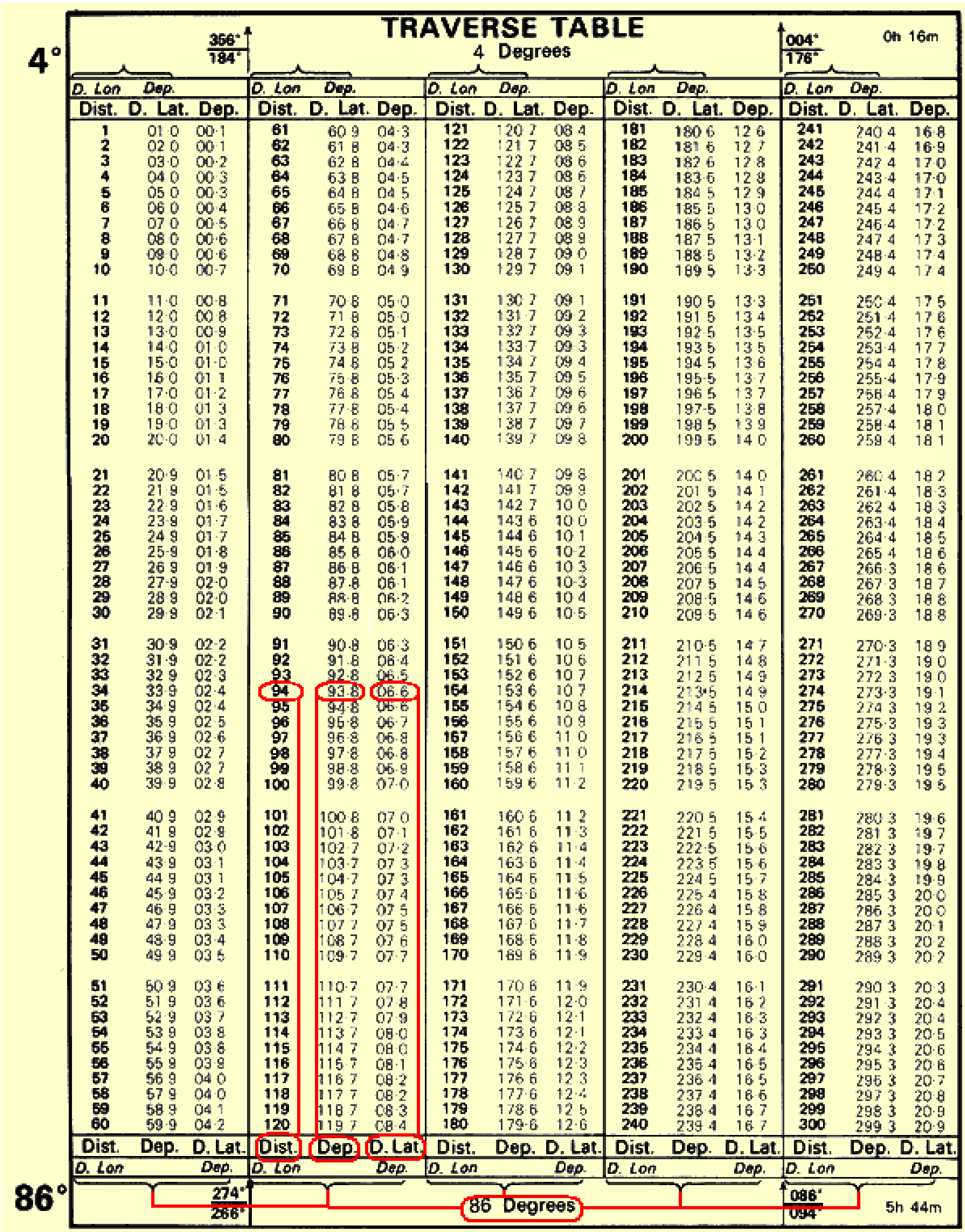
THE BOXHALL CQD POSITION (41° 46' N, 50° 14' W)

In 1912 Joseph Boxhall said that he took 11:46 p.m. as the collision time and assumed a speed for the ship of 22 knots on a course of S86°W true from the 7:30 p.m. celestial fix in getting to his distress position. What Boxhall would have done is first compute the distance the ship ran from 7:30 p.m. to 11:46 p.m. by multiplying his 22 knots by 4 hours and 16 minutes (exactly 4.27 hours) to get 93.9 nautical miles. The next step was to find the ship's change in latitude and longitude by moving that distance on a course of 266° true from the charted position of the fix. For this he would 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 to the south, and also the change in distance, called the departure, or **Dep.**, in nautical miles to the west. As shown on the next page, using the same traverse table that Boxhall would use, we get the following values for the difference in latitude and departure using a value of distance of Dist. = 94 nautical miles:

D-Lat. = 06.6 minutes-of-arc
Dep. = 93.8 nautical miles

Notice that we had to use the marked columns from the bottom of the traverse table because they correspond to a course for S 86° W true (266°). Since the latitude of our derived celestial fix was 41° 52.5' N, moving 6.6' to the south gives a CQD latitude of 41° 45.9' N, which when rounded to the nearest whole minutes-of-arc, gives us the Boxhall CQD latitude of **41° 46' N**.

Next Boxhall would have to obtain the change in longitude, called **D. Lon.**, in minutes-of-arc west of the star fix by using a departure distance nearest to the 93.8 miles obtained above in a second table for the ship's mean latitude. The mean latitude in this case is 41° 49.3' N, which is close enough to the parallel of 42° N that he would simply use the traverse table for 42 degrees. It is in the use of this table that Boxhall may have made a mistake by using a departure distance in the column corresponding to the complimentary latitude angle of 42° N, which is 48° N. If this is what Boxhall did, as shown in traverse table for 42°, then we see that he would have obtained a value for D. Lon of 140 minutes-of-arc instead of the correct value of 126 minutes-of-arc.



4° — 356° / 184° — TRAVERSE TABLE — 4 Degrees — 004° / 176° — 0h 16m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	01.0	00.1	61	60.9	04.3	121	120.7	08.4	181	180.6	12.6	241	240.4	16.8
2	02.0	00.1	62	61.8	04.3	122	121.7	08.5	182	181.6	12.7	242	241.4	16.9
3	03.0	00.2	63	62.8	04.4	123	122.7	08.6	183	182.6	12.8	243	242.4	17.0
4	04.0	00.3	64	63.8	04.5	124	123.7	08.6	184	183.6	12.8	244	243.4	17.0
5	05.0	00.3	65	64.8	04.5	125	124.7	08.7	185	184.5	12.9	245	244.4	17.1
6	06.0	00.4	66	65.8	04.6	126	125.7	08.8	186	185.5	13.0	246	245.4	17.2
7	07.0	00.5	67	66.8	04.7	127	126.7	08.9	187	186.5	13.0	247	246.4	17.2
8	08.0	00.6	68	67.8	04.7	128	127.7	08.9	188	187.5	13.1	248	247.4	17.3
9	09.0	00.6	69	68.8	04.8	129	128.7	09.0	189	188.5	13.2	249	248.4	17.4
10	10.0	00.7	70	69.8	04.9	130	129.7	09.1	190	189.5	13.3	250	249.4	17.4
11	11.0	00.8	71	70.8	05.0	131	130.7	09.1	191	190.5	13.3	251	250.4	17.5
12	12.0	00.8	72	71.8	05.0	132	131.7	09.2	192	191.5	13.4	252	251.4	17.6
13	13.0	00.9	73	72.8	05.1	133	132.7	09.3	193	192.5	13.5	253	252.4	17.6
14	14.0	01.0	74	73.8	05.2	134	133.7	09.3	194	193.5	13.5	254	253.4	17.7
15	15.0	01.0	75	74.8	05.2	135	134.7	09.4	195	194.5	13.6	255	254.4	17.8
16	16.0	01.1	76	75.8	05.3	136	135.7	09.5	196	195.5	13.7	256	255.4	17.9
17	17.0	01.2	77	76.8	05.4	137	136.7	09.6	197	196.5	13.7	257	256.4	17.9
18	18.0	01.3	78	77.8	05.4	138	137.7	09.6	198	197.5	13.8	258	257.4	18.0
19	19.0	01.3	79	78.8	05.5	139	138.7	09.7	199	198.5	13.9	259	258.4	18.1
20	20.0	01.4	80	79.8	05.6	140	139.7	09.8	200	199.5	14.0	260	259.4	18.1
21	20.9	01.5	81	80.8	05.7	141	140.7	09.8	201	200.5	14.0	261	260.4	18.2
22	21.9	01.5	82	81.8	05.7	142	141.7	09.9	202	201.5	14.1	262	261.4	18.3
23	22.9	01.6	83	82.8	05.8	143	142.7	10.0	203	202.5	14.2	263	262.4	18.3
24	23.9	01.7	84	83.8	05.9	144	143.6	10.0	204	203.5	14.2	264	263.4	18.4
25	24.9	01.7	85	84.8	05.9	145	144.6	10.1	205	204.5	14.3	265	264.4	18.5
26	25.9	01.8	86	85.8	06.0	146	145.6	10.2	206	205.5	14.4	266	265.4	18.6
27	26.9	01.9	87	86.8	06.1	147	146.6	10.3	207	206.5	14.4	267	266.3	18.6
28	27.9	02.0	88	87.8	06.1	148	147.6	10.3	208	207.5	14.5	268	267.3	18.7
29	28.9	02.0	89	88.8	06.2	149	148.6	10.4	209	208.5	14.6	269	268.3	18.8
30	29.9	02.1	90	89.8	06.3	150	149.6	10.5	210	209.5	14.6	270	269.3	18.8
31	30.9	02.2	91	90.8	06.3	151	150.6	10.5	211	210.5	14.7	271	270.3	18.9
32	31.9	02.2	92	91.8	06.4	152	151.6	10.6	212	211.5	14.8	272	271.3	19.0
33	32.9	02.3	93	92.8	06.5	153	152.6	10.7	213	212.5	14.9	273	272.3	19.0
34	33.9	02.4	94	93.8	06.6	154	153.6	10.7	214	213.5	14.9	274	273.3	19.1
35	34.9	02.4	95	94.8	06.6	155	154.6	10.8	215	214.5	15.0	275	274.3	19.2
36	35.9	02.5	96	95.8	06.7	156	155.6	10.9	216	215.5	15.1	276	275.3	19.3
37	36.9	02.6	97	96.8	06.8	157	156.6	11.0	217	216.5	15.1	277	276.3	19.3
38	37.9	02.7	98	97.8	06.8	158	157.6	11.0	218	217.5	15.2	278	277.3	19.4
39	38.9	02.7	99	98.8	06.9	159	158.6	11.1	219	218.5	15.3	279	278.3	19.5
40	39.9	02.8	100	99.8	07.0	160	159.6	11.2	220	219.5	15.3	280	279.3	19.5
41	40.9	02.9	101	100.8	07.0	161	160.6	11.2	221	220.5	15.4	281	280.3	19.6
42	41.9	02.9	102	101.8	07.1	162	161.6	11.3	222	221.5	15.5	282	281.3	19.7
43	42.9	03.0	103	102.7	07.2	163	162.6	11.4	223	222.5	15.6	283	282.3	19.7
44	43.9	03.1	104	103.7	07.3	164	163.6	11.4	224	223.5	15.6	284	283.3	19.8
45	44.9	03.1	105	104.7	07.3	165	164.6	11.5	225	224.5	15.7	285	284.3	19.9
46	45.9	03.2	106	105.7	07.4	166	165.6	11.6	226	225.4	15.8	286	285.3	20.0
47	46.9	03.3	107	106.7	07.5	167	166.6	11.6	227	226.4	15.8	287	286.3	20.0
48	47.9	03.3	108	107.7	07.5	168	167.6	11.7	228	227.4	15.9	288	287.3	20.1
49	48.9	03.4	109	108.7	07.6	169	168.6	11.8	229	228.4	16.0	289	288.3	20.2
50	49.9	03.5	110	109.7	07.7	170	169.6	11.9	230	229.4	16.0	290	289.3	20.2
51	50.9	03.6	111	110.7	07.7	171	170.6	11.9	231	230.4	16.1	291	290.3	20.3
52	51.9	03.6	112	111.7	07.8	172	171.6	12.0	232	231.4	16.2	292	291.3	20.4
53	52.9	03.7	113	112.7	07.9	173	172.6	12.1	233	232.4	16.3	293	292.3	20.4
54	53.9	03.8	114	113.7	08.0	174	173.6	12.1	234	233.4	16.3	294	293.3	20.5
55	54.9	03.8	115	114.7	08.0	175	174.6	12.2	235	234.4	16.4	295	294.3	20.6
56	55.9	03.9	116	115.7	08.1	176	175.6	12.3	236	235.4	16.5	296	295.3	20.6
57	56.9	04.0	117	116.7	08.2	177	176.6	12.3	237	236.4	16.5	297	296.3	20.7
58	57.9	04.0	118	117.7	08.2	178	177.6	12.4	238	237.4	16.6	298	297.3	20.8
59	58.9	04.1	119	118.7	08.3	179	178.6	12.5	239	238.4	16.7	299	298.3	20.9
60	59.9	04.2	120	119.7	08.4	180	179.6	12.6	240	239.4	16.7	300	299.3	20.9
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.

Top headings over each column group: D. Lon, Dep.

86° — 274° / 266° — 86 Degrees — 086° / 094° — 5h 44m

Traverse table used by navigators for 4° and 86°

42° | 318° / 222° | **TRAVERSE TABLE** | 42 Degrees | 042° / 138° | 2h 48m

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	00·7	00·7	61	45·3	40·8	121	89·9	81·0	181	134·5	121·1	241	179·1	161·3
2	01·5	01·3	62	46·1	41·5	122	90·7	81·6	182	135·3	121·8	242	179·8	161·9
3	02·2	02·0	63	46·8	42·2	123	91·4	82·3	183	136·0	122·5	243	180·6	162·6
4	03·0	02·7	64	47·6	42·8	124	92·1	83·0	184	136·7	123·1	244	181·3	163·3
5	03·7	03·3	65	48·3	43·5	125	92·9	83·6	185	137·5	123·8	245	182·1	163·9
6	04·5	04·0	66	49·0	44·2	126	93·6	84·3	186	138·2	124·5	246	182·8	164·6
7	05·2	04·7	67	49·8	44·8	127	94·4	85·0	187	139·0	125·1	247	183·6	165·3
8	05·9	05·4	68	50·5	45·5	128	95·1	85·6	188	139·7	125·8	248	184·3	165·9
9	06·7	06·0	69	51·3	46·2	129	95·9	86·3	189	140·5	126·5	249	185·0	166·6
10	07·4	06·7	70	52·0	46·8	130	96·6	87·0	190	141·2	127·1	250	185·8	167·3
11	08·2	07·4	71	52·8	47·5	131	97·4	87·7	191	141·9	127·8	251	186·5	168·0
12	08·9	08·0	72	53·5	48·2	132	98·1	88·3	192	142·7	128·5	252	187·3	168·6
13	09·7	08·7	73	54·2	48·8	133	98·8	89·0	193	143·4	129·1	253	188·0	169·3
14	10·4	09·4	74	55·0	49·5	134	99·6	89·7	194	144·2	129·8	254	188·8	170·0
15	11·1	10·0	75	55·7	50·2	135	100·3	90·3	195	144·9	130·5	255	189·5	170·6
16	11·9	10·7	76	56·5	50·9	136	101·1	91·0	196	145·7	131·1	256	190·2	171·3
17	12·6	11·4	77	57·2	51·5	137	101·8	91·7	197	146·4	131·8	257	191·0	172·0
18	13·4	12·0	78	58·0	52·2	138	102·6	92·3	198	147·1	132·5	258	191·7	172·6
19	14·1	12·7	79	58·7	52·9	139	103·3	93·0	199	147·9	133·2	259	192·5	173·3
20	14·9	13·4	80	59·5	53·5	140	104·0	93·7	200	148·6	133·8	260	193·2	174·0
21	15·6	14·1	81	60·2	54·2	141	104·8	94·3	201	149·4	134·5	261	194·0	174·6
22	16·3	14·7	82	60·9	54·9	142	105·5	95·0	202	150·1	135·2	262	194·7	175·3
23	17·1	15·4	83	61·7	55·5	143	106·3	95·7	203	150·9	135·8	263	195·4	176·0
24	17·8	16·1	84	62·4	56·2	144	107·0	96·4	204	151·6	136·5	264	196·2	176·7
25	18·6	16·7	85	63·2	56·9	145	107·8	97·0	205	152·3	137·2	265	196·9	177·3
26	19·3	17·4	86	63·9	57·5	146	108·5	97·7	206	153·1	137·8	266	197·7	178·0
27	20·1	18·1	87	64·7	58·2	147	109·2	98·4	207	153·8	138·5	267	198·4	178·7
28	20·8	18·7	88	65·4	58·9	148	110·0	99·0	208	154·6	139·2	268	199·2	179·3
29	21·6	19·4	89	66·1	59·6	149	110·7	99·7	209	155·3	139·8	269	199·9	180·0
30	22·3	20·1	90	66·9	60·2	150	111·5	100·4	210	156·1	140·5	270	200·6	180·7
31	23·0	20·7	91	67·6	60·9	151	112·2	101·0	211	156·8	141·2	271	201·4	181·3
32	23·8	21·4	92	68·4	61·6	152	113·0	101·7	212	157·5	141·9	272	202·1	182·0
33	24·5	22·1	93	69·1	62·2	153	113·7	102·4	213	158·3	142·5	273	202·9	182·7
34	25·3	22·8	94	69·9	62·9	154	114·4	103·0	214	159·0	143·2	274	203·6	183·3
35	26·0	23·4	95	70·6	63·6	155	115·2	103·7	215	159·8	143·9	275	204·4	184·0
36	26·8	24·1	96	71·3	64·2	156	115·9	104·4	216	160·5	144·5	276	205·1	184·7
37	27·5	24·8	97	72·1	64·9	157	116·7	105·1	217	161·3	145·2	277	205·9	185·3
38	28·2	25·4	98	72·8	65·6	158	117·4	105·7	218	162·0	145·9	278	206·6	186·0
39	29·0	26·1	99	73·6	66·2	159	118·2	106·4	219	162·7	146·5	279	207·3	186·7
40	29·7	26·8	100	74·3	66·9	160	118·9	107·1	220	163·5	147·2	280	208·1	187·4
41	30·5	27·4	101	75·1	67·6	161	119·6	107·7	221	164·2	147·9	281	208·8	188·0
42	31·2	28·1	102	75·8	68·3	162	120·4	108·4	222	165·0	148·5	282	209·6	188·7
43	32·0	28·8	103	76·5	68·9	163	121·1	109·1	223	165·7	149·2	283	210·3	189·4
44	32·7	29·4	104	77·3	69·6	164	121·9	109·7	224	166·5	149·9	284	211·1	190·0
45	33·4	30·1	105	78·0	70·3	165	122·6	110·4	225	167·2	150·6	285	211·8	190·7
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.

48° | 312° / 228° | 48 Degrees | 048° / 132° | 3h 12m

The Mistake

Traverse table used by navigators for 42° and 48°

A value of **D. Lon = 140 minutes-of-arc** is a change of 2° 20' in longitude westward from the celestial fix longitude. Since the longitude of the derived celestial fix was 47° 54' W, moving 2° 20' to the west gets us to the Boxhall CQD longitude of **50° 14' W**.

However, as noted before, the assumption that is being made here is that the D. Lon. value of 140 came about by using a departure distance from the wrong column, something easy to do in the haste to work up a distress position since the word 'Dep.' appears near the top of the page on the same line as

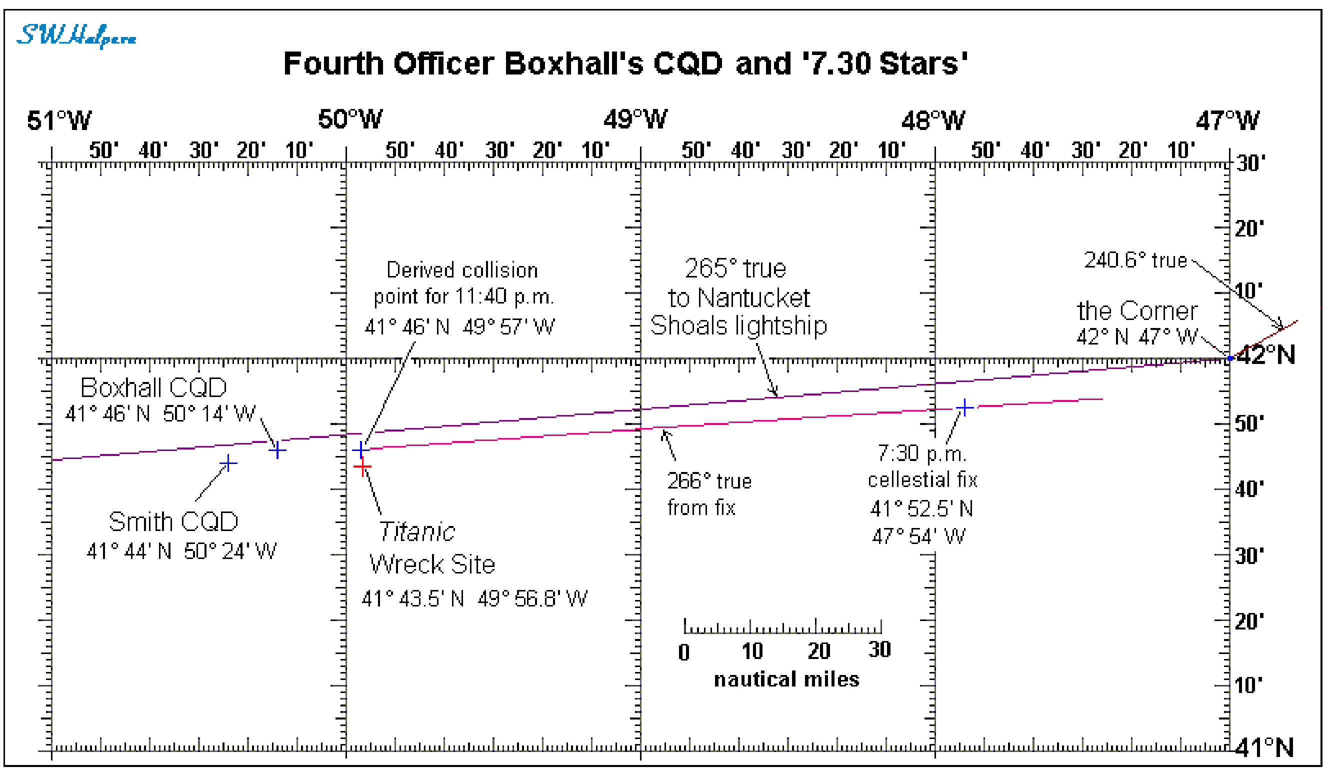
'Dist.' and 'D. Lat.' The correct value should have been obtained by looking up a departure distance of 93.6 shown near the top of the table under the column marked '*Dep.*' which is to the right of the column marked '*D. Lon.*' This would have given a correct value for D. Lon of 126 minutes-of-arc, or 2° 06' west of the celestial fix longitude 47° 54' W. If Boxhall would have used that, he would have obtained a CQD longitude of 50° 00' W based on his 11:46 p.m. collision time.

Nonetheless, let us do one more thing. Let us find the CQD position using a collision time of 11:40 p.m. instead of using the 11:46 p.m. time that Boxhall used. A time of 11:40 p.m. for the collision was given in evidence by a number of eyewitnesses, including QM Robert Hichens who was at the wheel at the time the ship struck the iceberg and reported: "the first officer told the other quartermaster standing by [QM Olliver] to take the time, and told one of the junior officers [most likely James Moody] to make a note of that in the logbook. That was at 20 minutes of 12; sir."[36]

Using 11:40 p.m. for a collision time, what we now find is run time of exactly 4.17 hours at 22 knots from the charted celestial fix position to the collision. This is a distance of 91.7 nautical miles. Using this as the run distance on a course of 266° true from our calculated celestial fix, we find a difference in latitude of D. Lat = 6.4 minutes-of-arc to the south, and a difference in longitude of D. Lon. = 123 minutes-of-arc (2° 03') to the west. Using these values, we come to a DR collision point for 11:40 p.m. (rounded to the nearest minutes-of-arc) at:

41° 46' N, 49° 57' W

This is shown in the chart below.



The Boxhall CQD and the 7:30 p.m. Celestial Fix

It should be noted that the position of the *Titanic* wreck site, taken to the center of the boiler field, is located at 41° 43.5' N, 49° 56.8' W. From this we see that our derived DR position for an 11:40 p.m. collision time, which was based on the location of our derived celestial fix, gets us to a position that is about 2 ½ nautical miles due north of the wreck site. This derived DR position for the point of impact with the iceberg also turns out to be extremely close to a derived final stopping point for *Titanic* of 41° 45.9' N, 49° 55.8' W that was independently obtained using the local average current set and drift measured in the vicinity of the wreck for the night of April 14, 1912.[37] In a sense, this is a confirmation of the derived celestial fix position from which the above collision point DR was subsequently derived.

THE SMITH CQD POSITION (41° 44' N, 50° 24' W)

We now come to question of why was the initial CQD position that was worked up by Captain Smith located even further away from the wreck site than that of Fourth Officer Boxhall's position? According to Boxhall, the celestial fix for 7:30 p.m. was put down on Captain Smith's chart about 10 p.m. that night.[38] If that was true, then it would seem logical that Captain Smith would use that celestial fix position as his starting point when he worked up the ship's CQD position. On the other hand, it is somewhat interesting to note that when Third Officer Pitman was questioned by the Commissioner during the British Inquiry about putting various positions on the chart, he had this to say:

> 15223. [Commissioner] How often when you are on watch do you mark the position of the ship on the chart? – [Pitman] Only at noon.
> 15224. Do not you mark it again? - No, not when we are well at sea.
> 15225. You do not mark it when you go off watch for the purpose of letting the man who succeeds you see at once on the chart where the ship is? - No, only when we are making the land.
> 15226. Do you do it when you get a stellar observation? - No, my Lord, unless we are making the land.

In either case, 50 years later, in a BBC interview, Joseph Boxhall claimed that Captain Smith used the 8 p.m. DR position for the ship as his starting point in working up the coordinates for the first CQD that was transmitted. According to this account, the reason that Boxhall was asked to work out his own distress position is that he pointed out to Smith that the ship was actually running well ahead of her dead reckoning that night.[39]

In dead reckoning work you always start from a known fix position at a known point in time. Then, to get to a position for some other time, you take the ship's heading and speed and calculate the distance traveled along the given courseline from the known position for the time interval that is involved. We already have noted that Captain Smith set the time to turn the Corner at 5:50 p.m. that Sunday afternoon, and that he may have assumed a speed of 21.6 knots, a ½ knot less than the ship's previous day's run. We surmised that this was because he might have expected to encounter an extra ½ knot current working against him while making the run from noon to the Corner. On the other hand, we also speculated that he may have deliberately set the time to turn the Corner at 5:50 p.m. to insure that his ship was south of 42° N latitude to avoid ice reported between longitudes 49° W to 51° W.

Nevertheless, it was standard practice on board these vessels, besides working the dead reckoning and taking a set of star sights when conditions allowed, to always take a morning time sight and azimuth of the sun when it was in its most favorable position for that purpose, also to take a meridian altitude of the sun to get the ship's noontime latitude, and later an afternoon time sight and azimuth of the sun if it was also in a favorable position to do so.[40] As Third Officer Lowe once put it to Senator Smith at the American Inquiry, "We do not take observations once a day. We perhaps take 25 or 30 observations a day."

The morning and afternoon time sights are best taken if the sun is close to due east or due west; i.e., when it is on or near the prime vertical. The resulting line of position then happens to run north and south, and therefore corresponds to a line of longitude that ship must be on at that time.[41] On April 14, 1912, in the vicinity of the Corner, the sun was on the prime vertical in the west close to 5:30 p.m. ship's time. Given that visibility conditions were clear, it is very likely that such a time sight of the sun was taken, and a line of longitude for the ship worked up shortly afterward. If that longitude line showed that *Titanic* was actually running ahead of her dead reckoning longitude for the time of the sight, then it is possible that after being informed of this, Captain Smith would have revised any assumption he may have made about the speed of the ship that afternoon. We know that Fifth Officer Lowe was given the task to work up the ship's 8 p.m. DR position soon after he came on duty at 6 p.m., and that he wrote it down and left it on the captain's chartroom table. Unfortunately, Lowe was unable to recall afterward what that position was.[42]

Assuming that it was noted that the ship was actually running ahead of her dead reckoning, let us derive an 8 p.m. position using the information that we do have available to us. We will start at the ship's noontime position of 43° 02' N, 44° 31' W. We will assume the vessel continued to average the same speed that she did over the previous 24 hours, which was 22.1 knots while carrying 75 revolutions per minute on her reciprocating engines, and head down toward the Corner on a course of 240° true for 5 hours 50 minutes. We will then compute the DR position of where *Titanic*'s course was altered at 5:50 p.m., and then put her on the intended course of 265° true for the Nantucket Shoals lightship for another 2 hours and 10 minutes to get us to an 8 p.m. DR position.

Using once again the same computational techniques that would have been used at the time, we find a distance run from noon to the alter-course point of 129 nautical miles. From this we find a difference in latitude of D. Lat. = 64.5 minutes-of-arc, or 1° 4.5' to the south. We also find a departure distance of Dep. = 111.7 nautical miles west which gives us a difference in longitude of 151.5 minutes-of-arc, or 2° 31.5' west using a middle-latitude value of 41.5° N. This puts the derived DR alter-course point for 5:50 p.m. at 41° 57.5' N, 47° 02.5' W, or about 3 miles southwest-by-south of the actual Corner point.

From this alter-course point we turn onto a course of S 85° W true (265°) for the next 2 hours and 10 minutes at 22.1 knots. The calculated distance is 47.9 miles, which then gives us a D. Lat. = 4.2 minutes-of-arc south, a departure distance of 47.8 miles west, and a D. Lon. = 64 minutes-of-arc, or 1° 04' west. Working with these from our 5:50 p.m. alter-course position gets us to an **8 p.m. DR position at 41° 53.3' N, 48° 06.5' W**. This will be our assumed starting point for Captain Smith's CQD work.

According to all accounts, at the time of the collision Captain Smith came rushing out from his quarters, passing through the wheelhouse, onto the navigating bridge. He then asked First Officer William Murdoch what had happened and was told that the ship collided with an iceberg. Smith then ordered Murdoch to close the watertight doors, and Murdoch told him that he had already done so. Since Captain Smith was out on the bridge within a minute of the collision, he would have known that the accident happened about 11:40 p.m., the time given to us by QM Hichens who was there at the time.

Assuming that Captain Smith worked up his distress position from the 8 p.m. DR as Boxhall later claimed,[43] then he would first determine the run time from 8 p.m. to the time of the collision, then compute the distance traveled along the intended courseline, and then figure out the change in latitude and longitude needed to get to the ship's impact point with the iceberg to hand to the wireless operators.

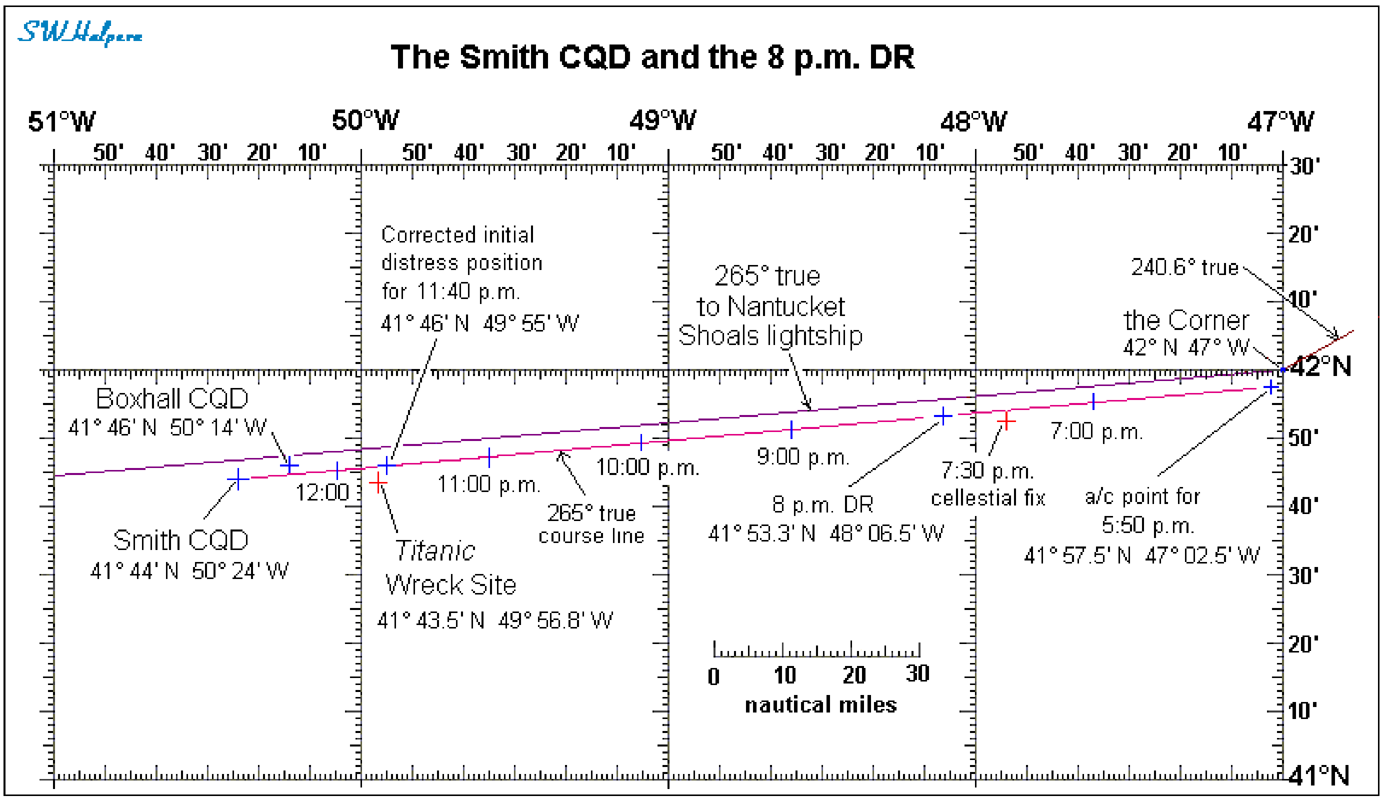
The first step needed, the time between 8 p.m. and 20 minutes to 12, was easy to figure out, and was probably worked out in his head. However, it is also very easy to make a very simple error if not too much thought was put into it. Obviously, the correct time interval from 8 p.m. to 20 minutes to 12 is three hours and 40 minutes. But what if Captain Smith in his haste to work out a position thought four hours and 40 minutes, not three hours and 40 minutes? All the other work he needed to do would be by pencil and paper and the use of the appropriate set of traverse tables. It should be noted that an error of just one hour in time is worth about 22 nautical miles at the speed *Titanic* was going, and the Smith CQD just happens to be a little over 20 miles west of the *Titanic* wreck site.

Using a courseline of S 85° W true (265°) from the 8 p.m. DR that we just derived, and again using an average speed of 22.1 knots, the same speed *Titanic* was making over the previous 24 hours, let us try to reproduce the computations that Captain Smith would have made and see what the results would be. We will first do this for a difference in time of 4 hours and 40 minutes, then do it for a difference in time of 3 hours and 40 minutes, and then compare the two results.

Using a run time of 4 hours and 40 minutes from the 8 p.m. DR, we find values of Dist. = 103.2 miles, D. Lat. = 9.0 minutes-of-arc south, Dep. = 102.6 miles west, and a D. Lon. = 138 minutes-of-arc, or 2° 18' west. Applying these from the 8 p.m. DR position that we derived, we arrive at a latitude of 41° 44.3' N, and a longitude of 50° 24.5' W, which if rounded down to the nearest minute-of-arc gives us the initial CQD coordinates of 41° 44' N, 50° 24' W; the first set of coordinates transmitted by wireless from *Titanic* that night.

Now, if we instead use a correct run time of 3 hours and 40 minutes from the 8 p.m. DR, we find values of Dist. = 81.1 miles, D. Lat. = 7.1 minutes-of-arc south, Dep. = 80.7 miles west, and a D. Lon. = 108.5 minutes-of-arc, or 1° 48.5' west. Applying these from the 8 p.m. DR, we arrive at a latitude of 41° 46.2' N, and a longitude of 49° 55.0' W, which when rounded gives us a set of distress coordinates at 41° 46' N, 50° 55' W. This set of coordinates happens to lie less than 3 miles from the *Titanic* wreck site.

All of this is shown on the chart below.



The Smith CQD and the 8 p.m. Dead Reckoning Position

Once again we see that if no mistake was made, an initial distress position very close to the wreck site would have been the result.

CONCLUSIONS

From the work presented in this article, we see how very simple mistakes can produce very serious errors in some very important results. The first, a simple mental error when comparing the time difference between two events, and then another error when taking a reading from the wrong column of a traverse table. Fortunately for the survivors of *Titanic*, the rescue vessel *Carpathia* just happened to be coming up on course that took her close to the wreckage and lifeboats while headed to the wrong position.

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 Captain Smith was off by an hour when did his calculation, or that Boxhall misread a traverse table. But what we do know is that both CQD positions were well to the west of where *Titanic* actually 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 by *Titanic*'s surviving officers and others.

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[1] Samuel Halpern, "A Minute of Time," THS *Titanic Commutator*, Issue No. 171, 2005, and Issue No. 172, 2006.
[2] Samuel Halpern, "It's a CQD Old Man," Titanic International Society's journal *Voyage* (Issues 64 and 65) and also in the British Titanic Society's journal *Atlantic Daily Bulletin* (September and December 2008). This article is also available on-line at: http://www.titanicology.com/Titanica/CQD_OM.pdf.
[3] American Inquiry (AI) p. 759.
[4] 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."
[5] Dr. Robert Ballard, *The Discovery of the Titanic*, Madison Publishing Inc., 1987, p. 199.
[6] Marine Accident Investigation Branch (MAIB) report, "RMS *Titanic* - Reappraisal of Evidence Relating to SS *Californian*," March 12, 1992.
[7] 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://www.titanicebook.com/sospos.html.
[8] Captain L. Marmaduke Collins, *The Sinking of the Titanic – An Ice-Pilot's Perspective*, Breakwater Books, Ltd., 2002, pp. 179-182.
[9] 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.
[10] British Inquiry 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."
[11] Samuel Halpern, "Keeping Track of a Maiden Voyage," ITHS's *White Star Journal*, Vol. 14, No. 2, August 2006. Also posted on-line at: http://www.encyclopedia-titanica.org/keeping_track.html.
[12] Courtesy of Mark Chirnside.
[13] The derived position was: 43° 01.7' N, 44° 31.4' W. From that position, the Corner point is located 125.7 nautical miles bearing 240.6° true. Middle-latitude sailing computations were used. 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 course angles and distances, interpolation for intermediate values are required.
[14] BI 13468 and BI 15173.
[15] BI 17587.
[16] 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.
[17] 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).
[18] 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) courseline when asked about the rhumb line course that was marked on the chart (see BI 15670).
[19] BI 13498.
[20] AI p. 932.

[21] 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 made 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 ship's true heading and the 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.

[22] The ship's measured distance through the water from noon to the time of collision as noted on the taffrail log was 260 nautical miles. This gives an average of 22.29 knots from noon to the time of collision at 11:40 p.m. Between 8 p.m. and 10 p.m., it was noted that the ship advanced about 45 miles through the water as measured by the taffrail log. (See AI pp. 519 and p. 523, and BI 17608-17630, and BI 965-966.) We were also told that the ship's reciprocating engines had been averaging about 75-76 revolutions per minute since noontime Saturday.

[23] BI 15646.

[24] 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.

[25] Samuel Halpern, "They Were Gradually Working Her Up," at: http://titanicology.com/WorkingThemUp.htm.

[26] 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.

[27] Ibid.

[28] AI p. 720.

[29] BI 13574.

[30] Local Apparent Noon for *Titanic*, 12:00 Apparent Time Ship (ATS), came at 2:58 p.m. GMT on April 14, 1912.

[31] AI p. 272-273.

[32] AI p. 275.

[33] 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.

[34] Although we are charting the celestial fix for 7:30 p.m., we just as easily could have put it down for 7:40 p.m., the time the last start sight was taken. It really doesn't matter as long as we are consistent in the technique that we use to get to the CQD position. The usual practice of navigators is to put the fix on the chart for the time of the last sight. However, this fix was always referred to as the position of the ship for 7:30 p.m. Therefore, we use that time in work here,

[35] Ship's time was 2 hours 58 minutes behind GMT based on *Titanic*'s noontime longitude for 14 April 1912.

[36] AI p. 456.

[37] Samuel Halpern, "Collision Point," GLTS website, at: http://www.glts.org/articles/halpern/collision_point.html.

[38] BI 15551-15554.

[39] In 1962 Joseph Boxhall said: "And I got back to the Boat Deck and saw the captain, and I told him and I said, 'The Mail Room is filling, sir. Should I send a distress signal?' And the captain said, 'I've already sent a distress signal.' 'What, what position did you send it from?' He said, 'From the eight o'clock DR.' 'Well,' I said, 'that was about, she was about twenty miles ahead of that sir. If you like I will run the position up from the star position up to the time of the contact with the ice berg.'" If the ship was really running 20 miles ahead of her DR, then someone should have immediately suspected that something was not quite right with the navigation, or the speed that the ship was actually making. Over a period of 7 ½ hours from noon to 7:30 p.m., a 20 mile increase in distance-made-good amounts to a speed of nearly 3 knots faster than what was being assumed.

[40] Nathaniel Bowditch, *The American Practical Navigator*, 1906, CH. XVI "The Practice of Navigation at Sea," pp.124-125.

[41] When on the prime vertical, the sun changes its azimuth most slowly, therefore an error in noting the exact time will also have a minimum affect on the computed bearing.

[42] In his confrontational exchanges with Senator Smith at the American Inquiry, Fifth Officer Lowe claimed that *Titanic* was only going about 21 knots Sunday afternoon, the lowest estimate given by any of *Titanic*'s surviving officers. He said he used

the same speed that *Titanic* was making from noon to the Corner to get his 8 p.m. DR. At one point he handed a chit of paper to the senator saying, “This is the only figuring that is required to get the speed.” Senator Smith then asked, “And you are able to say that the speed at that time was 21 knots?” to which Lowe 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 he showed Senator Smith was a calculation of distance divided by time. The distance was 126 miles and the time was 6 hours. Lowe also said, “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 [Lowe obviously meant to say 6 to 8 o’clock here], from that average speed. You have six hours in there to take a mean on.” Of course if you would divide the distance from noon to the Corner (126 miles) by the time that had elapsed from noon to the Corner (5 hours 50 minutes) you would get 21.6 knots, which also assumes that you had actually reached the Corner exactly at 5:50 p.m. It should also be noted, that if *Titanic* was actually making 20.95 knots, as Lowe claimed, then it would imply that over a run of 5 hours and 50 minutes from noon to the Corner, she would run 122.2 miles. Her total distance run from Daunt’s Rock to noon April 14th was 1549 nautical miles. Adding 122 miles to that would yield a total distance to the Corner of 1671 miles; a distance which is 2 miles *shorter* than what was even possible for any vessel to do, even one that was perfectly tracking the Great Circle route from Fastnet to the Corner using GPS.

[43] It is entirely possible that the coordinates of the 8 p.m. DR, which we were told were written down a on a chit of paper and left on his chart table, just happened to be handy for Captain Smith to use instead of reading off the celestial fix position that was pricked off on his chart about 10 p.m. that night.