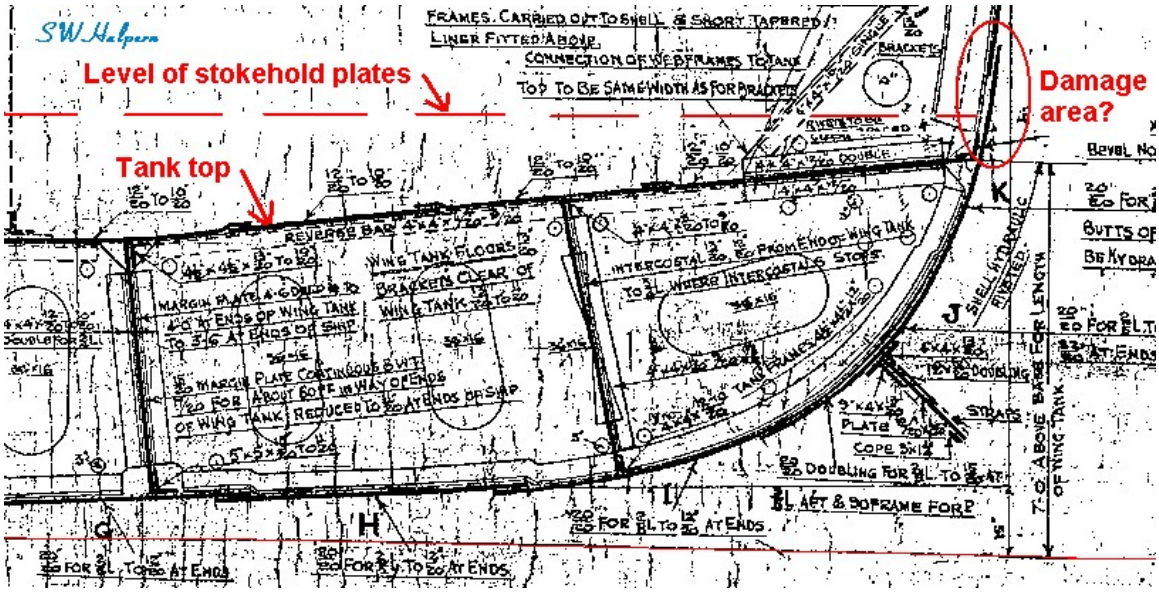
Where Did That Water Come From?

About an hour and a half after *Titanic* collided with an iceberg trimmer George Cavell saw water gradually coming up over the stokehold plates from below in the forward part of Boiler Room No. 4 (BR 4). At the time, Cavell was busy with other men drawing down the fires in the furnaces. When he left the room he said they were standing in about a foot of water (BI 4252-4267). George Cavell made it to the boat deck and was ordered into lifeboat #15 just before it was lowered to A-deck and loaded up with passengers.

Trimmer Thomas Dillon was also in BR 4 "knocking about" in the area of Stokehold No. 6 at the after end of the same room after helping open up all the watertight doors from the engine room forward into that section. Before being sent back to the engine room he noticed water coming up through the stokehold plates forward (BI 3816-3827). According to Dillon, the time he left the engine room until the time he came back from BR 4 was about 1 hour and 10 minutes. When he got back to the engine room they gave the order for all hands to go up on deck with life belts on. He estimated that this was about 1 hour 40 minutes since the collision (1:20 a.m.) making the time he went forward to open the watertight doors about 12:10 a.m.

The stokehold plates were about 2 1/2 feet above the tank top of the vessel on the ship's centerline. At 1:20 a.m. (1 hour 40 minutes after the collision) *Titanic* had trimmed down by the head approximately 4 degrees. ["Angles of Trim and Heel"]

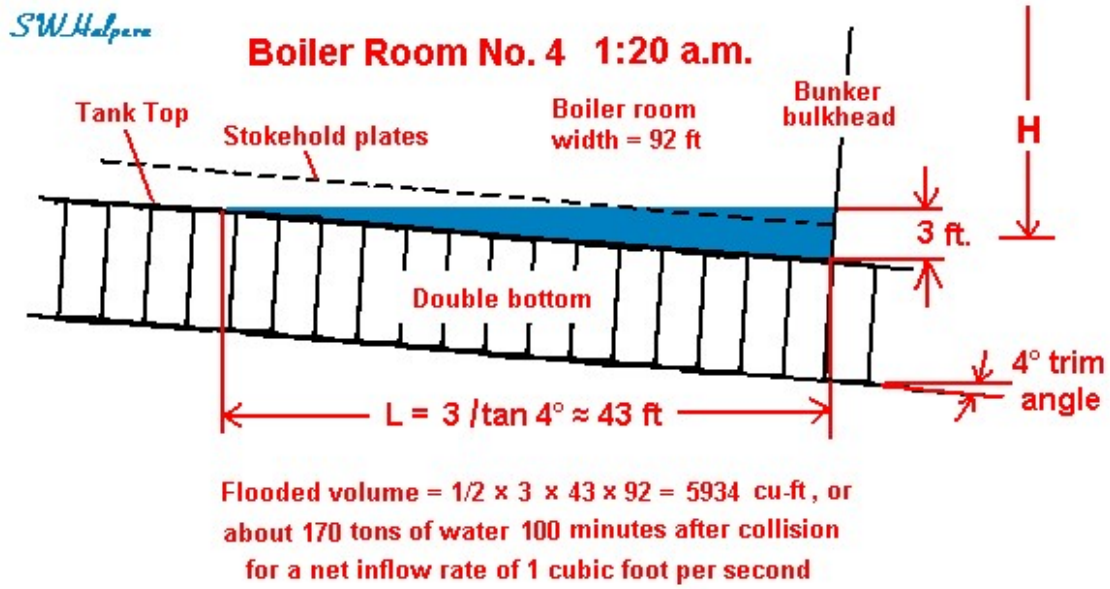
Where did this water come from? For most of the time BR 4 looked apparently dry to those working the furnaces. The boiler room just ahead, BR 5, had water coming in from the starboard side of the ship in the forward bunker from about 2 feet above the stokehold plates; about what would be expected from an ordinary fire hose according to leading fireman Frederick Barrett. The watertight door to that room, between BR 4 and BR 5, and all those ahead of it, remained shut since the time of the collision. Could it also be that there was some small amount of collision induced damage in BR 4 which, though mostly unnoticed, caused water to come in above the level of the tank top by the ship's side where the tank top and stokehold plates tend to converge as shown below? And if this were the case, can we quantify the extent of such damage?



We do know that the iceberg remained in close contact with the ship as it went aft along the starboard side. Ice was reported to have fallen in through some open portholes and water was seen on the windows of the Café Parisian just after the berg had passed by. The iceberg was observed by QM George

Rowe to have passed within less than 10 feet of the afterbridge on the poop deck. So it is very possible that a small seam could have been opened up in the side shell plating of BR 4 as the berg glided by. If so, how much of an opening would it take to produce what was observed?

The answer can easily be derived from the information that we were given. We will take the situation at 1:20 a.m., 100 minutes after the collision. We will assume that in the forward part of BR 4 water had risen to 3 feet above the tank top bringing it above the stokehold plates as observed by Cavell. Due to the ship being trimmed down by the head, we will take the average height (H) of water to be about 35 feet from the surface to an assumed damage point just above the tank top on the starboard side. By 1:20 a.m., the trim of the ship had reached about a 4-degree down angle. The width of the boiler room was 92 feet.



As shown in the diagram above, we can easily calculate the volume of water that was seen in the room 100 minutes after the collision. This comes out to 5934 cubic feet, or just about 170 tons of water. However, there is evidence that the engineers became aware that water was coming into this boiler room earlier on because they asked for a portable suction-pipe, which was stored aft in the last shaft tunnel compartment, to be carried forward into the stokeholds. To do that they needed to get all the watertight doors aft of the engine room raised. According to greaser Frederick Scott, he and others were ordered to open all the doors aft about an hour after the collision (BI 5600-5604). Given 15-20 minutes to get 4 doors cranked all the way up, it would be about 1 a.m. that the portable suction pipe was first carried forward into the stokeholds. Scott, like Dillon, said he was ordered up on deck at 1:20 a.m.

H&W's Edward Wilding (BI 20682-20686) speculated that this portable pipe was used to connect the ash ejector pump in BR 3 with the bilge piping in BR 4 to help augment a 250-ton/hr ballast & bilge pump in BR 3 (which was connected to the permanent bilge main under the plates) and a 150-ton/hr ash ejector pump that was located in BR 4 itself. Wilding assumed that the decision to connect an extra pump was made after it became clear that they were not getting ahead of rising water in BR 4 with what they had and needed to add this temporary connection. This portable piping had to lay across the open watertight door separating BR 3 from BR 4. Wilding also thought that it would take them at least a ½ hour to bring the pipe forward and get it connected up once all the doors were raised. For the purpose of analysis we will assume that they connected up the one 250-ton/hr pump in BR 3 and the one 150-ton/hr pump in BR 4 to pump out BR 4 as early as 12:10 a.m., after the lights came back on in the stokeholds and several trimmers and firemen were ordered down to draw the fires. This would also be about the time

when Dillon and two others were sent to open the watertight doors forward of the engine room. The amount of water that these two pumps would draw out of BR 4 (from 12:10 a.m. to 1:20 a.m.) would have been about 467 tons. It is also assumed that the portable piping that was brought forward after the doors aft were opened up was still being connected up to augment those pumps when Cavell and Dillon had left the scene. So by 1:20 a.m. there would have been about 170 tons of water that came into the compartment that was unchecked while 467 tons was already pumped out. Therefore, the total amount of water that would have come into the compartment is 467 + 170 = 637 tons in 100 minutes. **And 637 tons in 100 minutes is an inflow volume rate of 3.7 cubic feet of water per second.**

Now the velocity of water entering an opening in the shell plate is given by:

$$v = \mathrm{sqrt}(2gH)$$

where **g** is the acceleration of gravity (32 ft/sec/sec) and **H** is the height of the water head taken here at an average of H=35 ft. This works out to 47.3 ft/sec. If we divided the volume flow rate (3.7 cu-ft/sec) by the inflow velocity (47.3 ft/sec), we get the size of the area of the opening in the hull. This comes out to be 0.079 square feet, or 11.3 square inches of opening; the same as **a split in a seam of only 5/16 inch taken over a length of 3 feet,** the length between two adjacent frames.

Other suggestions for the source of water in BR 4 was that it may have been caused by damage to the double bottom as the ship grounded on a spur from the iceberg, or that water had overtopped the watertight bulkhead between BR 4 and BR 5 and flowed down into the forward bunker space and then onto the tank top under the stokehold plates. The first seems highly unlikely since it would have meant major damage to both the bottom plates as well as the tank top plates of the double bottom as far aft as BR 4. Most of the major damage to the ship was ahead of BR 5, and the grinding sound associated with the collision had ended by time the iceberg came alongside BR 6 (QM Alfred Olliver). As far as water overtopping watertight bulkhead F (between BR 4 and BR 5), this too does not seem to be likely because water was first seen to have reached the first-class staircase on E deck about 12:45 a.m. by first-class saloon steward Frederick Ray (AI p. 803-804), and about the same time water was first seen running down those stairs from E deck onto F deck by steward Joseph Wheat after checking the rooms by the Turkish baths located just aft of that watertight bulkhead (BI 10957-10972). It was about the same time, 12:45, that Scott was ordered to open all the watertight doors aft of the engine room so they could get to that portable suction pipe suggesting that water was coming in from below some time prior as discussed above. So it appears that there simply would not have been enough time for enough water to have made it into the forward bunker space below if it were about an hour after the collision that it first started to come down from E deck onto F deck.

There may be other reasons for water coming up from below the stokehold plates in BR 4. But what was presented here is one possibility, short of forensic evidence that would prove otherwise, that explains the cause and quantifies the amount of that water.

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