being blown through the ship structure. From the explosive detonation, the ship will heave and there will be a shock that goes through the ship. As the bubble collapses, the water will then cause another damage effect on the hull.

CMDR RUSH: Are gases and fumes created from the torpedo?

MR BUCKLAND: From all explosions, there will be a generation of the explosive gases that will be pushed into the air spaces and volume, and that's from the bubble itself. The bubble itself is just hot gases, and they will be pushed throughout the ship.

CMDR RUSH: The flooding consequences of torpedo damage --

DR CANNON: I was going to make a recommendation, CMDR Rush, that as the tools that were used for this flooding compartment were done by Mr Turner, it might be appropriate if we swap one of us and ask him to deal with that.

CMDR RUSH: Mr de Yong, we will come to your section a bit later. Perhaps if you withdraw.

<TERRENCE GERARD TURNER, affirmed: [2.21pm]

CMDR RUSH: Would you state your full name to the Commissioner, please?

MR TURNER: Terrence Gerard Turner.

CMDR RUSH: And your address?

MR TURNER: [redacted]

CMDR RUSH: Your occupation?

MR TURNER: Defence scientist.

CMDR RUSH: What are your qualifications?

MR TURNER: I have a Bachelor of Science and a Master of Science. I'm a chartered engineer and I'm also a Member of the Royal Institution of Naval Architects.

CMDR RUSH: At DSTO, what is your general area?

MR TURNER: I have been at DSTO for 19 years. In the early stages of my career, I worked in the vulnerability and survivability area that Mr Buckland has given an overview of over the last two days. For the last eight years, I have worked in the Naval Architecture Group looking at seakeeping and stability of Naval vessels.

In the latter part of 2007 and the early part of 2008, I spent 12 months over in The Netherlands working on a collaboration looking at damage stability of Naval vessels, which considers the effect that floodwaters have on the stability of vessels.

CMDR RUSH: Mr Turner, in relation to the flooding consequences from torpedo damage, did you bring to bear that experience and also various tools together for the analysis of that?

MR TURNER: Yes, I did. The program of work that I undertook whilst overseas is a collaboration between six Navies and the US Coast Guard on developing tools whereby we specifically focus on the stability of flooded conditions of Naval vessels.

CMDR RUSH: Are there computer software packages involved in bringing that together?

MR TURNER: Yes.

CMDR RUSH: As a consequence of the torpedo damage, did you undertake a study as to whether the ship would have survived the torpedo without the additional damage that we've been through today?

MR TURNER: Yes. The first part of the analysis that I undertook was considering the damage from the torpedo alone and whether the Sydney would have survived that event.

CMDR RUSH: In relation to establishing that and looking at that, you set out at page 222 figure 205. That represents what?

MR TURNER: That is a diagram that was used by the crew on board Sydney to look at the flooding condition of a typical weapon strike of a 700-pound warhead.

This damage extent has not been used in this analysis, as reviewing the footage from the ROV, the damage extent is significantly larger than what is demonstrated on this diagram. This diagram was created from the knowledge that was at the time during World War II.

CMDR RUSH: Who created this diagram?

MR JEREMY: It is an Admiralty document.

THE PRESIDENT: Of the 1940s?

MR JEREMY: It is dated 1940, yes.

CMDR RUSH: Mr Turner, after looking at that and assessing that the damage was greater and the applicability of that diagram, did you go on then to look at other materials to bring it together?

MR TURNER: Yes. We looked at the footage from the ROV, the work that Mr Buckland and others had done on determining the actual location of the torpedo hit and information also from Mr Buckland's area looking at the torpedo damage extent as well. We included all of that in the analysis.

CMDR RUSH: At figure 206, after assessing that, did you produce a representation of what you considered to be the flooding effect of the torpedo damage?

MR TURNER: Yes. This diagram actually shows the region that potentially could flood, but it must be noted that this region will only flood up to the new water level when the Sydney trims down by the bow.

With the ROV footage, we saw that a lot of the internal structure was now missing. Whether that was a consequence of the torpedo damage or the sinking was yet to be determined, but we assumed that all internal damage within that region was missing.

We went back to approximately frame 53, which is one watertight bulkhead aft of where we assumed all the damage would have occurred. So this analysis is going to give us the worst-case scenario that possibly could have happened due to the torpedo strike alone.

CMDR RUSH: On the worst-case scenario, what is represented as flooded in that diagram would be the event?

MR TURNER: Yes, but the entire blue section won't have flooded just due to the torpedo strike alone. If we can go up to table 23, I undertook a series of analysis where I worked from the forward perpendicular aft, one watertight bulkhead at a time, which coincides with these frames. I looked at the change in the draughts at the aft and the forward perpendiculars to determine how far we would need to go back, up to frame 53, such that the vessel still remained float. Even with the flooding back to frame 53, which, as I said, is one watertight bulkhead beyond where we believe the damage occurred, these figures indicate that although she has trimmed significantly by the bow, there was still enough buoyancy to remain afloat.

CMDR RUSH: At figure 207, there is an animated outline of Sydney intact in calm water. That is to represent the state that would be expected of her in her normal condition?

MR TURNER: That's correct.

CMDR RUSH: At figure 208, there is shown the Sydney in calm water after sustaining the flooding through the torpedo damage.

MR TURNER: Yes. That figure there is after sustaining the damage from the torpedo and flooded back to that one watertight bulkhead aft of where we believe the damage has occurred. You will notice on the forward perpendicular, if you compare that with figure 207, the previous figure, the change in their draught. This representation is also consistent with some of the accounts from the German survivors, where they believe that at various stages they could see the propellers coming up out of the water as well.

CMDR RUSH: How would that occur?

MR TURNER: Due to the flooding in the forward section, she will trim down by the bow, which means that the aft section of the ship will be sticking higher out of the water.

CMDR RUSH: That is Sydney in calm water?

MR TURNER: This is in calm water, yes.

CMDR RUSH: Is that flooding damage impacted if the sea state is not calm; would it be different?

MR TURNER: The level of flooding will change by only a minor state. What will change is the actual motion of the Sydney itself. In sea state 3, you are probably more likely to see the rudder coming in and out of the wave than what you would see in calm water, but the actual flooding extent would be very similar.

CMDR RUSH: Turning now to the shell damage to the Sydney and going back to an area we've covered but just trying to interpret the damage, if we could have figure 209, which shows the shell detonations aggregated on port side. I'm not sure whether it is Mr Jeremy or Mr Buckland or Dr Cannon who will want to go to this, but the general areas of the ship that that covers - we're talking about the bridge, the midships generally?

MR JEREMY: We're talking about some of the most important areas of the ship - the bridge superstructure and that area of the hull which happens to contain the main switchboard rooms, transmitting stations, lower power rooms and some of the W/T compartments, as well as the lower steering position.

CMDR RUSH: So is there any opinion formed as to the effect of the damage on the capacity in that area of the ship for control of the ship?

MR JEREMY: Substantially incapacitated.

CMDR RUSH: Over the course of this morning, there was evidence of shell damage. If we start with A and B turrets, at figure 214 there is reference to the damage to B turret. As far as A and B turrets are concerned and port side damage, have you any opinion as to the ability of those turrets, as a consequence of the damage, to operate or to move in general terms?

MR JEREMY: I think that neither turret would be operable. B turret would have been out of service as a result of the hits. It probably would not be trainable, in any case, because of damage to the roller bearing path, and A turret

is likely to have been damaged beyond further use by the torpedo, if not by shellfire.

MR BUCKLAND: May I just add a point, that the hit in between the barrels of B turret would indicate that those turrets were pointing directly at Kormoran at some stage.

CMDR RUSH: With director control removed from the ship, the turrets move into operation, as far as the turrets are concerned, operating by themselves, effectively. Looking at that photograph that is currently depicted, can you point to the gun port or the gunsight there? It appears to be closed.

MR JEREMY: It is open on B turret.

CMDR RUSH: From your review of the photographs of the turrets, was that the position with all turrets or not?

MR JEREMY: No. The gunsighting ports are open on B and open on X; they're closed on A; and Y is substantially obscured by the funnel, which is draped over it, so we're not sure what the position is with Y turret.

CMDR RUSH: For the turret to operate manually and to bring the guns to bear, is it necessary for the gunsight to be open?

MR JEREMY: Not if B turret is, for example, leading A. B might be sighting for A, and X for Y, which is one possible combination. But if all the turrets are operating independently, we would expect to see all the gunsight ports open.

CMDR RUSH: Are you able to tell us what the method of communication between A and B turrets and X and Y turrets would have been?

MR BUCKLAND: Yes. They used telephone communication, but they say that that was really difficult to do because of the noise in the turrets. The thing about operating the gun is that the control orders who is going to fire the gun. There was a gun controller for A and B and X and Y, so that the guns would fire together in that line of command. As you come down from the command, the gunnery officer himself would be taking control of the gun turret.

CMDR RUSH: I will come back to the damage to the ship's boats. As far as smoke and toxic gas are concerned, you have referred, Mr Buckland, to that being generated as a consequence of torpedo fire. Would you anticipate that that would affect an immediate area around where the torpedo hit the ship or not?

MR BUCKLAND: It definitely would be getting to that area where the detonation occurred, but on each of the 15cm shells, the detonations inside would also generate gaseous products. It would just become a black cloud after the detonation. This is without fires even originating. So in those rooms, then, you wouldn't be able to see through to be able to get damage control crews into those areas.

CMDR RUSH: Could I ask you, gentlemen, to turn to page 242. Something that Mr Jeremy referred to this morning, the turn to port, is discussed there. I think largely it is a reiteration of what you have already referred to, Mr Jeremy, but in the context of the report it states there that if the ship was maintaining a straight course and the telemotor pipes in use were damaged, the helmsman would find the wheel dead in his hands.

MR JEREMY: Yes, it would be unresponsive. He could turn it and find nothing happening.

CMDR RUSH: I think you anticipate that the turn to port was a deliberate move by the crew of Sydney?

MR JEREMY: I believe it must have been, yes.

CMDR RUSH: The starboard side shell damage is examined, and I think, Mr Buckland, you referred to this this morning in relation to damage to the turrets. The damage to the turrets could be said to look as though it is on the port side, but it could in fact be as a consequence of the way the guns were facing as the ship came to its change of position after the turn to port?

MR BUCKLAND: For A turret, and there is a hit in the side of X turret, which indicates that the turrets by that time weren't pointing towards Kormoran, so they have been hit in the side of the plate. I think that the shots in the starboard side of A turret, by this time, too, showed that there was continuous firing from the Kormoran as it was

doing the turn.

CMDR RUSH: At page 246, there is reference at figure 235 to the starboard side torpedo tubes. From your examination of the torpedo tubes both port and starboard, do you have an opinion as to whether Sydney fired any torpedos?

MR BUCKLAND: No, you can't tell whether it has fired any torpedos. Obviously, these torpedos in the starboard side tube were designated to fire in a set sequence.

CMDR RUSH: That's what I want to ask you about. You have referred, for instance, to the sequence F, I, R, E. From looking at the torpedos that are missing from the port and starboard sides and having regard to the sequence, are you able to inform us as to whether the torpedos that are missing are out of sequence of what would be the normal firing sequence?

MR BUCKLAND: In the case of the starboard torpedos that we see on the screen at the moment, the sequence of firing was Q, X, Y, Z. In this case, the torpedo that is missing is Z, which would have been the last to be fired from that sequence.

CMDR RUSH: Would that tend to suggest that it wasn't fired?

MR BUCKLAND: It would tend to suggest that it wasn't fired.

CMDR RUSH: The other three torpedos, as we see, are extant.

MR BUCKLAND: Yes.

CMDR RUSH: In relation to the port side?

MR BUCKLAND: They were fired in the order of F, I, R, E, and F and I are missing, which would be the first two that would be fired.

THE PRESIDENT: If there is one missing on the starboard side, two are missing on the port side and one is found on the seabed, that means that a maximum of two could be fired?

MR BUCKLAND: That's correct.

THE PRESIDENT: And if Z is missing on the starboard side, it is unlikely to be that, which means that the probability is that it was F and I which were fired on the port side?

MR BUCKLAND: If there were any fired, they would be the ones on the port side, most probably. However, we can't tell whether they have been fired or they are missing in the debris field.

THE PRESIDENT: Is there any mechanism at all whereby they could have fired Z on the starboard side before firing Q, X and Y?

MR BUCKLAND: I don't have enough understanding of why they needed to fire the three, as in whether there was a shut-off switch that they couldn't fire it. As I understand it, that's the firing order they would have gone for, and, based on the damage, you would think that they wouldn't have been able to fire. But I don't think that we can come to the conclusion of which ones were fired and which ones weren't.

THE PRESIDENT: Why not?

MR BUCKLAND: Because we don't know if those tubes have been emptied as the one that's just sitting out on the seabed.

THE PRESIDENT: But if you can't fire Z before you fire Q, X and Y, then Z wasn't fired.

MR BUCKLAND: That's right, yes.

THE PRESIDENT: So the one on the seabed is likely to be Z?

MR BUCKLAND: There is a possibility, yes.

MR JEREMY: It is equally possible that it is one from the port side and that there were in fact only six torpedos on board. It is equally possible that the other torpedos are lying around somewhere. There is no way of knowing.

THE PRESIDENT: It is improbable beyond belief, in my view, that they had only six torpedos on board. Their

fleet torpedoes would have been manned fully, I should have thought, with four on each side.

MR JEREMY: One would think so.

THE PRESIDENT: On that thesis, if Z could not be fired before Q, then any which were fired would have to be from the port?

MR BUCKLAND: Yes.

THE PRESIDENT: And the maximum from port would be two?

MR BUCKLAND: Exactly.

THE PRESIDENT: Which is in conflict, if I may say so, with all of the German evidence --

MR BUCKLAND: Yes.

THE PRESIDENT: -- which is that they were unable to fire from the port side, because they were strafing the respective operators with small-arms fire.

MR BUCKLAND: Yes. They could have possibly fallen out, like Z has or Q has.

CMDR RUSH: Mr Buckland, I want to take you back to the damage to the starboard side torpedo tube. I asked you questions about it before the lunch break. In relation to the damage to those tubes, as I understand it, your belief is that at the time of that damage, the tubes may have been pointing out rather than stowed fore and aft?

MR BUCKLAND: Yes.

CMDR RUSH: I just wonder whether the damage is also consistent with their being stowed?

MR BUCKLAND: They could be damaged; it is just that depending on the direction of the weapon, it is more likely that they were deployed. However, it could have been a weapon that came through from the port side and hit those three tubes.

THE PRESIDENT: Could I ask a layman's question. Looking at that picture on the screen now, as I understand your

evidence, it is that the shell which hit it came from bottom to top diagonally across it, with the last damage being the greatest damage shown on the top torpedo. Why is that so? If you look at it now, why could the missile not have come diagonally from the top side to the bottom side, causing the greatest damage with the first hit and bending, as you can see, that intervening piece of metal, on a trajectory which causes lesser damage to the second and minimal damage to the third?

MR BUCKLAND: That's a possibility. It is very hard from that to see which way the metal has been bent. It is just that as you go through, it is likely that once it connects first, the velocity would cause it to yaw up and take out the larger section on the furthest side. The largest damage is on the inboard, if it was stowed. It is almost impossible to judge. You can come up with arguments on both directions.

CMDR RUSH: That photograph shows the torpedo tube as it lies on the sea floor, obviously, in an inverted or upside-down state.

MR BUCKLAND: That's right.

CMDR RUSH: Could I ask you to go to page 251. As I understand it, what we are dealing with here, Mr Buckland, is the application of what was referred to as the XVAM analysis and the results of that analysis using the 87 15cm shell hits to Sydney.

MR BUCKLAND: That's right.

CMDR RUSH: If you look at figure 243 on page 252, we're looking at the superstructure and bridge compartments. You have set out there in the right-hand side the areas affected by weapons, and there is a red, grey and blue section. Can you indicate to us what the different colours represent?

MR BUCKLAND: These indicate areas that have been damaged by weapons or have a high probability of fragment in those areas. The red areas are the areas predicted to be affected by fragment damage from the 15cm shell.

The grey areas are areas which we have overlaid, which would have had a high risk to the small-calibre fire

because of the exposed nature of those areas. In this case, we've indicated torpedo damage just to say that that is being ignored from our study, because there was no damage by the torpedo.

CMDR RUSH: Going through this deck by deck, that's the superstructure and bridge, and then figure 244?

MR BUCKLAND: Then we go down to the forecastle deck. Again, these are the areas that have been predicted to be affected by the 15cm fragment hits. The grey areas are areas that have a high likelihood of being exposed to the small-calibre weapons.

CMDR RUSH: And figure 245 is the upper deck?

MR BUCKLAND: Now we're in the upper deck. In this case, we're showing the area that we're ignoring for torpedo damage, because by this time, the torpedo has affected that area. Again, as you can see, just below the superstructure area has all been affected by fragment damage.

CMDR RUSH: Then at figure 246, the lower deck compartments?

MR BUCKLAND: This is a very important deck for people to flow through the ship. You will see that there is going to be a widespread effect from fragments entering into the ship on this deck.

CMDR RUSH: Figure 247 relates to the platform deck?

MR BUCKLAND: We have areas below the superstructure deck and the forward engine room, boiler room.

CMDR RUSH: Figure 248, in the hold, is just torpedo damage?

MR BUCKLAND: Just torpedo damage, yes.

CMDR RUSH: As a consequence of all of that analysis, you go on to look at the probability of crew casualties.

MR BUCKLAND: Exactly, yes, if we go up to figure 249.

CMDR RUSH: In figure 249, you are looking at the casualties in the superstructure deck compartment from the

15cm shells?

MR BUCKLAND: These are spaces that have a high probability for crew casualties in confined spaces from the 15cm shells. In the areas that are coloured red, you would expect that all crew within these areas have become casualties. You will see that the yellow is a medium risk and green is low risk. The areas that haven't been coloured haven't been assessed.

CMDR RUSH: You have done the same at figure 250 in relation to the --

MR BUCKLAND: We go through each deck. Figure 250 is the forecastle deck, and you will see the areas that have been affected by 15cm shellfire. In figure 251, we have areas forward and aft that have been affected.

CMDR RUSH: That's in the upper deck?

MR BUCKLAND: Yes.

THE PRESIDENT: Just pausing there, you said that the red areas represent where there is likely to have been 100 per cent casualties. Is there a percentage that one can put on the yellow or not?

MR BUCKLAND: Yellow represents approximately 80 per cent casualties; and the green, low, is 50 per cent casualties.

CMDR RUSH: Figure 252 represents the lower deck?

MR BUCKLAND: Again, you will see that there is less effect at the aft end and in the lower deck area. These regions are very critical for damage control, for people going up to try to do any damage control on the torpedo damage. We're talking about a time delay thing, as you saw with Dr Neill's simulation this morning, in that we're looking at hits randomly over the ship, so as crew were moving in and out of these areas to do damage control, we're having various effects on being able to calculate where crew are. However, if they were in these compartments at the time, they would have had that high risk of becoming a casualty.

CMDR RUSH: The platform deck is shown at figure 253?

MR BUCKLAND: Yes. These become some of the critical regions in the breaker room and the transmitter room.

CMDR RUSH: And the hold, for 15cm shells --

MR BUCKLAND: There is nothing.

CMDR RUSH: Then, as a consequence of that assessment, did you make an estimate, as best you could, of the casualties caused as a consequence of the battle?

MR BUCKLAND: Correct. Table 24 gives a summation of a scenario where we've located crew based on our best assumption of crew at Action Stations. Obviously, this is a time domain, in that we've put down casualties from weapon effects, and in the second column we have put down probable casualties being trapped in the lower decks due to fire, smoke and evacuation effects.

The problem is that this isn't purely an effect from the weapons damage from the fragment or blast damage. We now have fires; we have structure being displaced throughout the ship; we have the flooding up the forward; we have the smoke being pushed through the ship, and it's not a nice place to be.

CMDR RUSH: Is it your estimate that 70 per cent of the crew would have been incapacitated as a consequence of the weapons damage and being trapped in spaces due to fire?

MR BUCKLAND: Correct. On the scenario in that case, it is at least 70 per cent. Based on this, the crew that would have survived are now in the aft area of the ship.

THE PRESIDENT: Could we scroll down table 24, please.

MR BUCKLAND: That space is the space where we've predicted that there has been no weapons damage and that is still sealed off from the effects from the smoke, mostly.

THE PRESIDENT: The last column sets forth the probability of casualties due to fire, smoke and evacuation effects. That is additional to the second-last column, which addresses the weapons effects?

MR BUCKLAND: Yes, that's correct.

THE PRESIDENT: Could we continue scrolling down. That table accounts, as best you can, for all of the crew on the assumption that they may have been at Action Stations?

MR BUCKLAND: Correct. Again, for this type of event, as it is over 25 minutes, the crew would be moving through to do damage control procedures.

CMDR RUSH: Under "Weapons Effects", Mr Buckland, at page 258, you conclude that there was a total weight of 3,900kg of 15cm shell that hit Sydney, with a minimum of 200,000 individual shrapnel fragments generated as a consequence?

MR BUCKLAND: Correct, and there would be the extra fragments from the secondary effects of the high-velocity 15cm shells as they punched through the ship.

CMDR RUSH: Just dealing briefly with damage control, as a consequence of the damage that has been established, is there any view formed as to the effect on damage control parties through the ship?

MR BUCKLAND: With regard to damage control, the main stations are DC1 and DC2. The damage control stations were both hit by weapons, so there would have been a large number, especially in the forward lower mess 2, I think it was, where damage control 1 was positioned. That would have generated a lot of casualties from that one space.

THE PRESIDENT: There is a diagram somewhere.

CMDR RUSH: Figure 255, Commissioner.

MR JEREMY: No, these DC stations are a different illustration.

DR CANNON: It is halfway down page 267, I think. It is figure 259.

MR BUCKLAND: The green areas on that diagram indicate where the damage control stations were. The forward damage control space was affected badly by weapons damage; the middle damage control station in midships was affected; and there was a slight effect on Damage Control 3 at the rear. By this stage, there would be people trying to put out fires and help other casualties within the ship, so the

exact numbers throughout the ship would be a dynamic number.

CMDR RUSH: Looking at page 260, there is reference to access through the ship as a consequence of the damage. If there were damage control parties trying to get about and perform their duty, would you indicate your opinion of how difficult it would have been to get in and about to various parts of the ship as a consequence of this damage?

MR BUCKLAND: It is very hard to appreciate what it would have been like. The ship is generating smoke. Each weapon hit has created a lot of internal damage to electricity. The power has gone out, so it's dark. You have smoke in the ship. You will have the non-structural bulkheads being blown out into corridors, so there is no access for crew to get in and out of spaces.

The crew in the lower decks need to exit up through the higher upper decks, and that will be limited as doors and hatches will also become jammed from the blast overpressure and the weaker doors will be blown out into the corridors.

Every time a shell hit, there would have been more fires being generated. As we go along over the 25 minutes of the engagement, these fires are starting to coalesce and become larger, and because of the nature of the hits across the ship, the crew would not have known where it was safe to be.

MR TURNER: In addition to all of that, you also have flooding that the crew is having to contain at that stage as well.

MR JEREMY: Perhaps it is also worth mentioning the way that the minor bulkheads within the ship were built. The photograph at figure 257 shows a damaged, blown-out bulkhead in HMAS Derwent caused by a charge, as stated there, but the minor bulkheads within HMAS Sydney were of two kinds: bulkheads around wet spaces or electrical spaces were constructed of lightweight swaged mild steel, which was welded; but around other spaces, they were constructed of three-sixteenths of an inch thick steel-faced plywood, and this did not go all the way to the deck head. It stopped one foot short of the deck head, and the space above it was filled with wire mesh. Those

bulkheads would have offered no resistance, effectively, to blasts and would have also helped to feed the fires. The lack of the bulkheads going up to the deck head would also have meant that the passage of smoke would have been very easy, very simple.

THE PRESIDENT: Passages for crew to traverse would have been blocked?

MR JEREMY: Many of them would, I fear, yes.

CMDR RUSH: That brings to point the ability to fight fires in the circumstances that prevailed as a consequence of the damage. In general terms, do you have a view as to what that ability was?

MR BUCKLAND: I'm not sure whether you would like to cover that with Mr Gamble tomorrow or later.

CMDR RUSH: Yes. Dealing, then, with smoke, Mr Jeremy, you just answered the Commissioner's question, in essence, from the fires generated, that it is likely that there was smoke through the ship. You spoke yesterday about the ventilation. To go back to that, with the fires in the ship and on the deck of the ship, that was likely to create smoke inside the ship?

MR JEREMY: Yes. In a modern warship, you have the opportunity to crash stop ventilation fans and remotely operate ventilation flaps, which can close off sections of the ship very, very rapidly in the event of damage and fire, but this wasn't the case in Sydney. Ventilation fans would have to be stopped locally or damaged to stop, and you had only predominantly natural exhaust ventilation throughout the ship and no means of clearing the smoke.

CMDR RUSH: What we've seen thus far indicates that the aft section of the ship was relatively undamaged and there was implosion damage there. Would that section of the ship have been affected by smoke?

MR JEREMY: Possibly, but I don't think we have any way of knowing.

CMDR RUSH: In relation to the electrical circuitry, as a consequence of the damage sustained to Sydney what was the impact on it and what was the likelihood of its complete

operation?

MR BUCKLAND: Again, I think this is like an increasing amount of damage. Initially, you could cross your ring main to do damage control operations, but eventually, with the switchboard and the breaker rooms being damaged, you would probably have lost electricity to at least the forward part of the ship.

CMDR RUSH: Mr Turner deals with the loss of Sydney.

MR TURNER: Yes, the subsequent flooding leading up to the loss of the Sydney.

CMDR RUSH: We may come back to the ship's boats and try to complete a section here, sir.

At page 268, in relation to the loss of Sydney, there is a discussion in relation to its structural integrity. It then goes on to sea loads and ultimate strength.

MR TURNER: Dr Cannon is dealing with the structural side of things, and I will be dealing with the flooding.

CMDR RUSH: In relation to the loss of Sydney and the structural integrity of the ship, Dr Cannon, what was involved here? What were you looking at? What were you trying to do?

DR CANNON: A number of suggestions have been made that the trigger for the loss of Sydney was the separation of the bow whilst the ship was on the surface, so the purpose of this investigation was to determine whether that was feasible or not.

The investigation undertook a number of different phases. First of all, it was to build a structural model of the Sydney, particularly around frame 27, which is where the torpedo damage was. We picked frame 27 purely because that was where we had the information of the plating thicknesses, the stiffeners, the structure in that region.

The second part of the analysis involved building a model of the ship, the hull form, so that we could determine its buoyancy. We also imposed on that model the mass distribution of the ship, and this enabled us to run a simulation to determine the wave loads that were

experienced by the ship in the sea conditions experienced.

Both these models were compared to other ships. They were compared to the original design conditions to make sure that the model was validated.

Then we ended up running an ultimate strength calculation. This ultimate strength calculation is basically taking the ship as abeam, applying some loads onto it and increasing the loads slowly until we get to a point where some form of structure fails.

If you go to figure 260, you will see the intact segment of the ship at frame 27. We apply a load to it and we plot the maximum load that the ship can withstand whilst it is intact. That is given by that point there.

The next thing we did to this particular structural model was to impose a certain amount of damage. You can see that in the lower figure there, we have taken 47 per cent of the structure away from the bow region where the torpedo hit. Again, we apply a load slowly, and that follows the pink line in that diagram up to the point of failure, which is the end of the straight line there. That gives us the capability or the residual strength of the structure.

If you then go to the next figure down, figure 261, this is quite a complex diagram, but I will try to talk you through it. The first point, up towards the end where the dark blue line is, the end of that straight line on the previous figure, is giving you the capability of the structure whilst it is intact. You can go down to where it says "47 per cent". That's about there (indicating) - 47 per cent damage. That is showing you the reduction in the end of that pink line in the previous graph. So we have a big torpedo hole. The capability of my structure is not as much.

The lower blue line underneath it, which is running more or less parallel, is a factor that I have put on the calculations because I'm dealing with a partly riveted, partly welded structure, so it is a bit of uncertainty that I am bringing into my analysis and reducing the strength of the ship's structure. That tells you the capability of the structure.

Then also on this graph, the horizontal lines in different colours going across the graph are the loads that I would expect from various sea states. You can see the maximum of sea state 8, there are the loads that I would expect that part of the ship to experience in sea state 8, and because the capability of the structure is above it, it is remaining intact. As I go down, you end up at sea state 6. The waves are a lot smaller and therefore the safety margin is much, much greater.

As we go further down, ultimately to the green line, sea state 4, as Dr Neill indicated earlier, is an average wave height of about 2.5 metres. That's the sea state that has been suggested was occurring at the demise of Sydney. You can see that the loads there at that part of the ship are incredibly small. Even if I accept 47 per cent of the damage, the capability of the ship's structure is much bigger than the wave loads I would experience.

Therefore, this figure, along with the next figure, which is laid out in exactly the same format, apart from this time I have assumed the torpedo has taken out the entire cross-section of the Sydney, so I am going up by deck level from the keel, show that Sydney was a sufficiently tough ship, with that size of hull, to keep the bow intact.

That's the analysis we did to come to the conclusion that the bow stayed intact.

CMDR RUSH: The ultimate conclusion being that the bow remained intact prior to the sinking of Sydney?

DR CANNON: Yes. That must be taken in concert with the other evidence that was shown earlier. Firstly, the compactness of the debris field suggested that the bow remained intact. Secondly, the tearing of the hull plate around the side suggested that it was a more violent process and there was no compressive buckling occurring. Thirdly, the loads are suggesting that it wouldn't break off. So there are three pieces of evidence there that come together to conclude that she would have remained intact in that particular environment.

CMDR RUSH: Did you also conduct a test in relation to the watertight bulkheads?

DR CANNON: Yes. Yesterday, we talked about watertight bulkheads that were in the lower compartment of the ship. The design of watertight bulkheads is for a damaged case. So if we flood a ship, we flood a compartment, and we would expect some plastic deformation of those bulkheads. They are due to contain that damage in that compartment. Then you bring the ship back and repair the bulkheads. That was a standard design practice of the day.

We looked through Sydney and picked some typical bulkheads to confirm that this was the design practice that was used. If you go to figure 264, again this is probably another complicated diagram, but on the left-hand side, if we imagine the axis as being a watertight bulkhead, if that watertight bulkhead had water on one side of it and it had air on the other side of it, then the green line gives you an indication of what the yield strength or the loads that you could put on that plate would be, such that you don't get any permanent deformation.

The red line shows the load that you would have to put on to get quite a significant amount of plastic deformation. If that bulkhead was loaded on one side with water and not on the other side, the blue line is showing you the loads that I would expect on that bulkhead.

As with normal design practice, I would expect that all watertight bulkheads that had water on one side and no water on the other would experience significant deformation.

If there was any hole, fragment damage or defect within that bulkhead, the loads to cause that plastic deformation would come down drastically. Given these loads and given the materials, it is highly probable that some of these internal bulkheads were lost during the sinking of Sydney. We can't go in to confirm that, but it is highly probable, given the state that we have, that a bulkhead did give way and initiate some rapid flooding.

CMDR RUSH: Was that during the sinking or prior to sinking?

DR CANNON: Immediately prior to sinking, if it was one of the forward bulkheads.

CMDR RUSH: The impact of one bulkhead giving away is

what?

DR CANNON: It depends on where that particular bulkhead is located within the ship. If it is one of the forward ones and it is contained by the next bulkhead, it may stay afloat. If it is a watertight transverse bulkhead, it may improve the list of the ship. If it is the after-most one, it might be the one that caused the rapid sinking.

CMDR RUSH: Then was analysis conducted of the time to float?

MR TURNER: That's correct.

CMDR RUSH: Was that undertaken by you, Mr Turner?

MR TURNER: Yes.

CMDR RUSH: The purpose of this was to ascertain what?

MR TURNER: To ascertain the duration that the Sydney potentially remained afloat after the battle.

CMDR RUSH: There were a number of assumptions that you took in relation to forming the opinion?

MR TURNER: Yes. The first assumption was damage extent, so what damage penetrations the floodwaters could actually move through. I have considered this in two different scenarios. The first scenario was where I just used the penetrations that were observed by studying the ROV footage and the torpedo damage. The second scenario was using that damage as well as the additional internal damage that was predicted by Mr Buckland's analysis as well.

Another assumption I was using was the sea states. Based on the assumptions from the assumption list that was provided to DSTO by the Commission, as well as some of the accounts from German survivors, I have undertaken analysis of the top of sea state 3, which we believe was the sea state that the ships were in when the battle took place. When the Germans evacuated their ship, they were saying that the sea states were moving to sea state 4 and deteriorating, so I also undertook an analysis at the top of sea state 4 to look at the effect that a change in sea state would have on the survival time of the Sydney.

The other assumption I have used is the speed of the Sydney. If you look at the distance between the location of the wreck of the Kormoran and the wreck of the Sydney and utilising the time that the German survivors say that they observed the glow from the Sydney to disappear on the horizon, we believe that the Sydney travelled away from the site of the battle at an average speed of about 2.93 knots. This speed would have been affected by the change in sea state and the additional flooding that was occurring throughout this time, so for this analysis I used a constant speed of 5 knots.

I have also assumed that the Sydney was at Action Stations, which implies that all the doorways and hatches were closed. If they were open, that would have also contributed to additional progressive flooding throughout the vessel.

CMDR RUSH: Was the heading of the ship of relevance in relation to this analysis?

MR TURNER: Yes, it was. I considered various headings around the compass, which I will show you on a plot in a minute. If you look at the relative positions of the two wreck sites - that's the wreck site of the Kormoran and the wreck site of the Sydney - and the recorded sea directions at the time from meteorological data, we believe that the Sydney was travelling off in what we refer to as beam seas. That's the relative direction of the waves to the heading of the ship. In other words, the Sydney was travelling potentially in that direction, and the waves were coming to the starboard side of the vessel.

CMDR RUSH: Mr Turner, in relation to this analysis, did you work to two scenarios?

MR TURNER: Yes. As I described before, there were two scenarios: the first was utilising the ROV footage and the damage extent that was observed from that alone; the second was the additional information from Mr Buckland.

CMDR RUSH: Could I ask you to go to the figures that you have set out at page 280. There are a number of profiles through the decks. Would you indicate to us what they represent?

MR TURNER: The shaded-in areas indicate the compartments

that could potentially flood from the time of the battle to the eventual loss of the Sydney. They don't give an indication as to the floodwater heights in each of those compartments; they just highlight that at some stage during that duration, potentially there could have been floodwaters in those compartments.

CMDR RUSH: How do you ascertain that potential?

MR TURNER: Once again, using the information obtained from the ROV footage and the information on damage obtained from Mr Buckland's analysis and doing some simulations myself, I can see where the floodwaters are moving into the vessel.

CMDR RUSH: If we compare the profile that we had of the flooding damage due to the torpedo alone and then the profile, for instance, at figure 265, there is, obviously, more extensive flooding. What is the cause of that flooding or the potential of that flooding?

MR TURNER: The forward section flooding that you see in this image that is on screen at the moment, from the forward perpendicular up to B turret, so all the section through there (indicating) is due to the torpedo damage.

All of the other sections that you see shaded in are through penetrations that were initially above the waterline, but as the sea states deteriorate, with the waves running along the side of the ship, those penetrations sometimes go below the waterline, hence you get the ingress of floodwaters. And as the vessel changes trim due to the floodwaters as well as starts rolling due to the progressive flooding of the vessel, some of those higher-up penetrations would eventually go under the water as well.

CMDR RUSH: You have produced figures in relation to each of the decks as far as that flooding is concerned?

MR TURNER: That's correct.

CMDR RUSH: At figure 266, we see the upper deck.

MR TURNER: Yes.

CMDR RUSH: At figure 267, we see the lower deck.

Figure 268 is the platform deck and figure 269 is the hold. The area in the hold that is forward there, I take it, comprised the watertight compartments?

MR TURNER: That's the flooded region due to the torpedo strike. The white sections are watertight.

CMDR RUSH: Have you detailed the results of this analysis?

MR TURNER: May I go to figure 270. I will explain how to read this plot, initially. This is using the assumption of the damage from the ROV footage alone. The only penetrations that the floodwaters can actually go through are through the openings in the hull observed from the ROV and the torpedo damage that was observed from the ROV.

If you look at the axes heading north-south up the page and east-west across the page where they are labelled "head seas", "following seas", "port seas" and "starboard seas", that's indicating the relative direction that the ship is heading into the waves. As I said before, we believe that the Sydney, after the battle to the demise of the vessel, was travelling along the starboard seas direction.

CMDR RUSH: So if we were to look at the way Sydney was travelling through this plot, it was travelling from the bottom of the plot to head seas at the top?

MR TURNER: No. If you look at this plot, you have to think of it travelling out towards the "starboard seas" label, out to the right-hand side.

Also on the plot is a series of concentric rings. They indicate the analysis that has been undertaken after the time of the battle. The very middle of the plot is time zero in terms of my simulation. I have assumed that all the damage has occurred instantaneously, because we can't put an accurate time record as to where the actual hits occurred relative to each other. Then, as you move out to the 2, the 4, the 6, the 8, et cetera, right out to the 12, that's how many hours over which the analysis has taken place.

Where you observe the green areas, that's where the Sydney has remained afloat for that duration. In further

plots, you will see some red area, and that is where the Sydney has foundered or is no longer afloat.

This particular plot here is for sea state 3 and, as I said, considering just the damage from the ROV footage. You can see, regardless of the direction in which the Sydney was heading, this analysis is showing that the Sydney remained afloat for up to at least 12 hours.

The reason why I have chosen to go out only to the 12-hour period is the time constraints imposed on us by the Commission. We needed to come up with some results, and this is actually three times the believed duration that she remained afloat, anyhow, so I believe that this was a fairly reasonable duration to consider whether she had sunk within that 4.5-hour period.

CMDR RUSH: So that relies on sea state 3?

MR TURNER: Yes, this is top of sea state 3, which is a significant wave height of 1.25 metres. This is the sea state at which the battle took place.

CMDR RUSH: On that scenario, Sydney remained afloat with that damage, as far as you have taken it, for 12 hours?

MR TURNER: For at least 12 hours, yes.

CMDR RUSH: At least 12 hours, with the potential of more?

MR TURNER: Potentially more, yes.

Could we scroll down to figure 271. This figure shows a time history of the roll of the Sydney when she was sailing off in the direction in which we believe she was sailing at 5 knots at the top of sea state 3. So although this analysis indicates that Sydney survived up to at least 12 hours, you see that after a bit under the 4-hour mark, the Sydney was rolling somewhere between 15 degrees and 42 to 45 degrees to port. This was the analysis that Dr Neill's animations were based on - the time history of the roll that he referred to this morning.

CMDR RUSH: So that roll is taking place even in sea state 3?

MR TURNER: Yes, and this has implications on any crew

movements or damage control that may have been attempted to be undertaken. With the vessel rolling to these angles, it would have made it virtually impossible.

Could we go to figure 272. This is a screen shot from Dr Neill's animation showing the roll angle of the Sydney at approximately 40 degrees in the beam seas, so the direction that we believe she was sailing, in the top of sea state 3. It just gives you a visualisation of how difficult it would have been to move about the vessel.

CMDR RUSH: That, again, is sea state 3. As Dr Neill explained, that is a roll down and back up again, going through the motion.

MR TURNER: Yes, it is all to the port side, so it's rolling down to approximately 40 degrees, back up to 15 degrees to the port. As Dr Neill mentioned this morning, each one of those rolls will actually go to a different angle, depending on the wave environment coinciding with that particular roll and the actual movement of the floodwater inside the vessel.

CMDR RUSH: It is caused by the floodwater inside the vessel?

MR TURNER: It's caused by a combination of the floodwater inside the vessel and the ship's motion in the waves, the induced motion due to the waves.

THE PRESIDENT: Are those degrees that you mentioned, 15 degrees to 42 degrees, all to port?

MR TURNER: Yes.

THE PRESIDENT: She never reaches an even keel?

MR TURNER: Not in this scenario, no.

CMDR RUSH: I take it that the deck on that roll to that extent is starting to be covered in water?

MR TURNER: Yes. Occasionally, you will get what we call deck edge immersion. Literally the deck edge is starting to dip below the water and the waves, and this has implications on any holes or penetrations that were originally in that deck level. They were now getting below

the water level and additional water was coming in through those penetrations.

If we now go to figure 273, this is exactly the same scenario but now looking at the top of sea state 4. So we have the same speeds, the same series of ship headings and the same penetrations. So these are just considering the penetrations through the hull from the ROV.

If you see the red region now, if you move out from the centre of the plot to the edge of the green and the red, say where that "2" mark is along the starboard axis, this will indicate that if Sydney was sailing in that direction and the sea states were in top of sea state 4, it would have been just under two hours before she foundered, or before she was no longer afloat.

We have a couple of regions, 60 and 120 degrees, so either side of the "starboard seas", where it indicates that if she had been sailing in those directions, potentially she could have remained afloat for longer than 12 hours, but any deviation off those headings would have put you back into that red zone and she potentially would have gone under. That's the effect of the increase in sea state alone.

The duration that we are observing here, just under the two hours and up to the four hours, is consistent with the duration of the accounts from the German survivors that they saw the glow of the Sydney on the horizon disappear as well.

I will move on to the next diagram. If we go to figure 274, this scenario is now considering the damage observed in the hull from the ROV footage, the torpedo damage observed from the ROV footage and the additional predicted internal damage due to blast and fragmentation, as predicted from Mr Buckland. As Mr Buckland explained before, the internal detonation of some of these munitions can result in bulkheads and deck and deck heads being damaged and fragmentation all through which floodwaters can flow.

The one assumption I have used here is that all doors and openings still remain closed, so in the event where internal detonation may have dislodged some of those, I did not have time to consider those in these analyses as well,

but that would have just accelerated some of the flooding across the vessel.

This particular plot is looking at the vessel in the top of sea state 3. So if you recall the plot before, which was all green, and compare it with this one, the only difference now is the consideration of the extra internal damage, as predicted by Mr Buckland.

Once again, you have a region where Sydney may have survived up to 12 hours, but you can see that with any deviation, for instance, off starboard seas down to about 120, you are up around the four-hour mark where she may have sunk.

If we now go to figure 275, this has exactly the same damage definitions but considering the seas in the top of sea state 4. You can now see where the boundary between the green and the red areas lies is within the two to maybe four, four and a bit hour mark that Sydney has survived after the battle.

CMDR RUSH: So that's the impact of the difference between sea state 3 and --

MR TURNER: Yes, the only difference between the previous figure and this one, once again, is the sea condition, so we have gone from the top of sea state 3 to the top of sea state 4.

CMDR RUSH: From that, Mr Turner, you conclude, obviously, that the sea state was important in relation to Sydney's survival?

MR TURNER: I think that the sea state definitely had a significant effect on the survival time of the Sydney. We weren't able to get an appreciation of the true extent of damage internally within the ship, even considering some of the predicted damage that Mr Buckland found, which has significant implications on the survival time of the ship as well.

THE PRESIDENT: Quite apart from the sea state, if it had remained at 3, unless she remained in a purely starboard seas condition, she was in serious jeopardy?

MR TURNER: Exactly right. We have really no

understanding as to the manoeuvrability or the controllability that they had at that time as well, so how easy or how difficult it was to maintain heading we're not sure. So you are right, any deviation from it could have significantly changed the duration that she remained afloat.

CMDR RUSH: Then, Mr Turner, you look at the sinking of Sydney and the way in which Sydney sank and attempt to draw conclusions in relation to that.

MR TURNER: Stuart, do you want to cover this, the final demise?

DR CANNON: If you move to figure 276 first, I will start off with this and then probably pass over to John. This small flow chart is giving you an indication of the types of processes that could have gone on during the sinking of Sydney. She was obviously intact and fighting at the start of the battle there. The first event is the torpedo hit.

One of the questions that we were asked was, did the bow separate from the rest of the ship? The answer, we think, is no. There are other reasons why we think the bow remained intact. If the bow did break off, the structure up at the bow is very heavy. There are a lot of anchor chains. There are collision bulkheads. There is a lot of metallic structure there. The ship itself is very fine. There is not much buoyancy in that compartment.

If you take away the bow, generally the ship will trim by the stern. She will be deeper in the water by the stern and lift out towards the bow area. Many of the holes that have been described earlier may be above the water now and not underwater. So we've assumed that she was trimmed by the head and that some sort of progressive flooding occurred.

Then there are a number of options available. As to the loss of buoyancy, she may have flooded suddenly and eventually there was more water inside than air spaces to hold the ship up, and that would have caused some sort of rapid sinking.

We talked earlier about whether a bulkhead would collapse, and, again, if an internal bulkhead collapsed, that would change the times that Mr Turner has talked

about.

The total rollover - this is where the ship rolls over upside-down. We believe there is evidence from the wreck site that this didn't occur - things such as the 6 inch guns would have fallen off the ship during that process.

Eventually, the ship would have sunk fairly rapidly, and this would have been as a result of the motion that Dr Neill showed in his video. She would have rolled over to 45 degrees and eventually got to a roll angle from which she couldn't recover. Once she couldn't recover, she would start to sink to the seabed. It is probably appropriate that I pass over to John on that one.

MR JEREMY: We can never really know exactly what happened, of course, towards the end. It might have been a slow process or it might have been sudden. We don't know whether the ship still had power. If she was rolling from 15 degrees to 40 degrees, it is quite possible that even an intact and operating diesel generator was no longer functioning. The ship may have been in darkness.

It's quite possible that, towards the end, there was a bulkhead collapse and the ship immediately lost buoyancy, went down by the bows and plunged towards the ocean floor.

We described earlier the effect that this would have had on intact compartments within a relatively short space of time. Possibly within 30 metres of the surface, and almost certainly within 100 metres of the surface, the intact compartments would have imploded and the ship would have continued her plunge towards the sea floor. As she accelerated, the bow would have been torn off, with the loss of other structure which has passed by the ship.

The ship, being heavier, is more likely to overcome the resistance that the blunt end of the hull imposes, and she appears to have been hit by quite a few pieces of wreckage as she has gone on the way down.

This illustration shows what might have happened on the way down as the ship initially plunged, and then, as she loses the bow and fills with water right throughout, she would tend to level off and then perhaps assume a slight angle by the stern as she descends to the sea floor. We think that she probably hit the sea floor with her stern

first with a little bit of forward motion, which has resulted in some buckling damage, of course, to the bottom of the ship. It has resulted in the propeller shafts being extracted from within the ship to some degree, and it has broken some of the shaft brackets.

If we go back to the previous illustration, you can see roughly what the stern of the ship looks like now at about frame 167, where you can see the shaft brackets for the inner propellers, the after-most propellers, have been broken off and bent out from the ship. You can see where the deck has collapsed downwards and the side has been pulled inwards above the lower deck. Below the lower deck, there is evidence that the ship's side, in way of those watertight compartments, has collapsed inwards.

Other things would have happened, of course, during that impact with the bottom. Structure weakened by fire would partially have collapsed and we can see some evidence of that in the forward superstructure, although some of that might also be the effect of 67 years of corrosion. However, the 4 inch gun deck has also partly collapsed, and that is probably the result of hitting the sea floor. We don't know how fast she might have been going, but the time might have been somewhere between 5 and 10 minutes.

CMDR RUSH: Examples have been given in the report of warships that have been hit by torpedo and survived. From the analysis here, I appreciate that we've covered it generally, but could I ask what is the difference here to put Sydney out of the category of ship that has survived torpedo damage?

MR JEREMY: It has to be the intense shellfire and the perforation of the hull, which caused multiple sources of flooding both from the outside of the ship to the inside and between compartments internally.

CMDR RUSH: Sir, unless you have any questions, I intend to call Mr de Yong to go back to the lifesaving boats and deal with the search and survivors.

THE PRESIDENT: There is just one thing. There is a great deal of evidence from a very large number of German witnesses that the battle occurred at distances which have been estimated between 900 metres and up to 2,000 metres, with the predominance of the evidence being probably in the

order of 1,000 metres to 1,200 metres. The tables that have been set out in your report show velocities and angles of impact of 15cm shells. Are you able to tell me whether or not the shell impact damage that you observed is consistent with gunnery occurring in that range of, say, 1,000 metres to 1,500 metres?

MR BUCKLAND: Not from the damage itself; probably more from the accuracy and the number of hits. It may have been at close range, but from the elevation tables, we can see that even up to 10,000 metres, the 15cm guns still have a very high velocity to rip through the ship. So that is still within that close range, but it is further than 900 metres to 1,000 metres.

THE PRESIDENT: Commonsense suggests that the more distant a target, the less accurate you are likely to be.

MR BUCKLAND: Extremely. It is a very hard thing to shoot from a ship accurately.

THE PRESIDENT: Is there any more science, apart from commonsense?

MR BUCKLAND: Not really. Because of the velocities from the 15cm shells even from a great distance, you are still getting enough velocity from the shell to penetrate through the bulkheads. We cannot give you an exact range of the battle, based on the evidence that we have.

THE PRESIDENT: Can you tell from the photographs that you have the angle of entry of shells?

MR BUCKLAND: I'm not sure whether Mr de Yong will show you a picture of a boat reconstruction showing the angle of reconstruction that they did with the shell coming in.

CMDR RUSH: I think it is figure 220.

DR CANNON: I think it is figure 218.

THE PRESIDENT: That is the port side whaler, yes.

MR TURNER: I will allow Mr de Yong to return to the witness chair.

MR de YONG: This is a visualisation. When I gave

evidence earlier, I talked about the fact that one of the whalers, the whaler on the port side, I believe, had suffered a significant weapons hit. We then went back and looked at the weapons damage on the port side that Mr Buckland had identified. If we go to the image above, figure 217, you will see that there is a shell hit to the aircraft store that we identified should have caused damage to the whaler.

In fact, Dr Neill recreated that shell hit on the whaler. If we go down to the image at figure 218, figure 218 is exactly that. Dr Neill was able to reconstruct, from the damage to the whaler, the trajectory of the shell. He matched it almost perfectly with the shell hit on the structure itself. The angle or the trajectory of that shell was virtually zero degrees; it was virtually horizontal, which indicates that it was fired from very close range.

THE PRESIDENT: Thank you.

MR BUCKLAND: There is a lot of other evidence with the shell hits on the hull that shows that it hit fairly well normally rather than having an angle of fall, so they are close. Also, there have been groups of shots that have landed in one area, which show that as the gun could fire only six to seven shots per minute, there wasn't much movement away, from the relative movement of the ship, so that would indicate that it was close range.

THE PRESIDENT: Thank you very much.

CMDR RUSH: Sir, may I have an idea of whether you want to keep going today?

THE PRESIDENT: I am happy to keep going. How long do you think you would be?

CMDR RUSH: We would probably be another 40 minutes, sir.

CMDR RENWICK: I have no objection, sir, to proceeding.

SHORT ADJOURNMENT

CMDR RENWICK: Sir, with your leave, may I ask one question arising from the evidence. Immediately before the break, Mr Buckland and Mr de Yong gave some evidence about

what could be deduced from figure 218 on page 230. You will recall their evidence, sir. Might I ask either of you gentlemen to look at page 217, paragraph 2, where the first sentence says this:

> Many of the shots on Sydney hull appear to have a shallow impact angle; however, it is impossible to measure with any accuracy the actual impact angle from the photographs of Sydney.

Do I take it that what is at figure 218 is the sole exception to that general principle at page 217, because you have two points of reference, namely, the round going through the whaler and then the impact on the side of the structure of the ship itself?

MR BUCKLAND: That's correct.

MR de YONG: That's correct, yes.

CMDR RENWICK: Thank you. That was the only matter.

CMDR RUSH: Sir, there is just one matter that has been brought to our attention - a photograph from the Sea Power Centre that I might ask be brought up. The Australian War Memorial brought it to our attention. I will just ask for comment. It is depicted as the armour plating that was erected around the 4 inch gun deck. The reference is at Alexandria, Egypt, July 1940, the erection of that armour plating on the 4 inch gun deck. In relation to height and location, is that consistent with piece of the gun deck that was identified I think by Mr Jeremy earlier in your evidence? Is that consistent with the height and the type and the nature of the material?

MR JEREMY: It is completely consistent and it is also consistent with another image in the report - figure 72. Figure 72 shows it quite clearly. We can see it on the right-hand side of that photograph.

CMDR RUSH: I tender the photograph.

THE PRESIDENT: That will be exhibit 108.

EXHIBIT #108 PHOTOGRAPH FROM SEA POWER CENTRE, DEPICTING ARMOUR PLATING ERECTED AROUND THE 4 INCH GUN DECK ON

HMAS SYDNEY

CMDR RUSH: I have no other questions of these gentlemen. I call Mr de Yong.

THE PRESIDENT: You have no other questions?

CMDR RENWICK: No, thank you, sir.

THE PRESIDENT: Thank you very much, gentlemen.

CMDR RUSH: Mr de Yong, if I may briefly deal with the likely damage to ship's boats as a consequence of the battle damage that we've discussed this afternoon. You have identified in previous evidence where the boats are. Taking an overall perspective, what do you say as to the consequences for ship's boats in the context of the damage that has occurred to the ship?

MR de YONG: I have already discussed this, to a degree, in earlier evidence, but the evidence of the ship's boats on the seabed indicates that there is damage to the whaler, and we've just had a discussion about that. If we look at the port side first, we have the damage to the whaler. The pinnace seems relatively intact on the seabed, but I clarify that by saying that it is very difficult to look at and detail fragment damage on the wooden boats.

As for the cutter, the davits are gone. We've seen the damage around the davit holders, and the cutter would have fallen off very early in the engagement.

If we move to the boats on the starboard side, both motorboats are on the seabed. One is in good condition; one is in not-so-good condition. Because of the absence of the davit holders and the davits, I believe that the cutter was blown off and was unavailable for any lifesaving operation.

As to the whaler on the starboard side, as I identified earlier in my evidence, I believe there is a single shell hole to that whaler as well, which would have rendered it fairly useless for lifesaving.

CMDR RUSH: What about the Carley floats?

MR de YONG: As I commented earlier, there is no evidence

of any Carley floats on board the wreck or in the debris field. Carley floats, as I also indicated earlier, were held to the ship fairly lightly. In my opinion, they would have been blown off during the engagement and possibly seriously damaged due to fragments and possibly fire during the engagement.

CMDR RUSH: Mr de Yong, did you also examine information in relation to the search that was conducted for Sydney, and did you particularly look at the air search and the results of that search?

MR de YONG: Yes, I did. The action between Kormoran and Sydney occurred on 19 November. The search was initiated on 24 November. That was a limited fan search conducted from Rottnest Island. If you look at figure 279 in the report, this is a compilation of all the search sorties that were flown, excluding the first search on the 24th, because it was too far to the south to have really been of any use, so it is not included in this compilation here.

In total, there were 118 sorties flown. That involved 825 flying hours, six Naval ships and 15 merchant ships in total. A number of items were found, predominantly the Germans from the Kormoran in their lifeboats, and a number of other items, such as lifebelts, Carley floats and various other smaller items were discovered.

THE PRESIDENT: Only one Carley float, I think, that may have come from Australia, and two Carley floats from the German ship.

MR de YONG: That's correct.

CMDR RUSH: They were located by ships that were searching?

MR de YONG: All the items of that nature were discovered by the ships. No items of that nature were discovered by any of the air sorties.

The initial search was directed to look for Sydney. They were therefore looking for an object in the ocean that was over 550 feet long. Therefore, the search would have been conducted at a commensurate height. At that height, it would have been virtually impossible to detect possibly lifeboats, let alone Carley floats or individuals floating

in the water. Subsequent sorties were instructed to find Sydney or to find lifeboats.

CMDR RUSH: Just to clarify from the figure and diagram currently being shown, were the sorties flown over the areas where Carley floats and lifejackets were eventually found by ships?

MR de YONG: Yes. The red arrow gives a very approximate indication of where the wrecks were found. The dots to the direct north of that - the two purple dots and a green dot - indicate the areas where those items were discovered. As you can see, a large number of air sorties were flown over those items as they drifted from where the battle occurred to where they were eventually discovered, and none of them were detected by any of the aircraft.

CMDR RUSH: Mr de Yong, did you have available to you research that had been undertaken by the US Coast Guard in relation to surveillance by aircraft and the heights that it is necessary to fly at to pick up the objects that were picked up - the Carley floats or the lifejackets or, indeed, persons in the water?

MR de YONG: I believe that the air sorties were flown at a height of approximately 1,500 feet. The US Coast Guard has done extensive work looking at search and rescue of individuals. The particular reference that appears in the report is to some recent work done by the US Coast Guard trying to spot individuals in the water.

The evidence from an extensive evaluation conducted by the US Coast Guard is that any individual in the water distanced from the searching aircraft by more than approximately 0.6 nautical miles would have very, very low probability of being detected.

That search was conducted by a US Coast Guard aircraft flying at 627 feet. However, it was probably flying faster than the aircraft that were used during the search for the survivors of Sydney. So there are some differences, but it does point to the fact that there is a high probability that it was very difficult to detect individuals floating in the water from 1,500 feet during that search process.

CMDR RUSH: Did you also examine, Mr de Yong, the likelihood of survivors from either of the ships if they

had abandoned ship into the water?

MR de YONG: One of the interesting things about the search process was that we tended to concentrate on the survivors from Sydney, but there were some 60 crew from Kormoran who actually attempted to abandon ship, and their life raft or their rubber raft overturned during the possess of abandoning ship and they all fell into the water. They had personal life vests on, but none of them were detected by any of the search aircraft, either.

CMDR RUSH: Was hypothermia a consideration in the area of the loss of Sydney and Kormoran?

MR de YONG: No, it wasn't. The water temperature around the battle site was 23 or 24 degrees, based on historical meteorological data. If an individual is in the water, hypothermia is generally only a problem when the water temperature drops certainly below 20 degrees but usually below 10 to 15 degrees.

Let's look at figure 283. This is some recent data looking at the survival of individuals in the water. This is from modelling data, as you will appreciate. None of this data could be verified, but it gives you a general idea of how long a person can survive in the water at different water temperatures.

There is a wide spread there, but essentially it tells you that at a temperature between 20 and 25 degrees a person can survive in the water for periods up to 40 or 50 hours before drowning or other consequences cause major problems and the person will not be able to survive.

CMDR RUSH: Did you also examine the consequences for a body in the water in the area of the engagement between Sydney and Kormoran?

MR de YONG: One of the things that happens when a person drowns is that the body doesn't remain on the surface; the body sinks, because it loses its buoyancy. Generally, it sinks to the seabed. What happens then is that a process occurs within the body where the body starts to decompose. Gas forms within the abdomen. That causes the body to retain or increase its buoyancy, and the body floats back up to the surface again.

That usually occurs within a time period of approximately three to ten days, but it is very broad. It is heavily dependent upon the temperature of the water and it is also heavily dependent upon the depth to which the body sinks.

In the case of Sydney, my analysis suggests that any body that would have drowned would have sunk to the bottom of the seabed. The putrefaction process, the decomposition and gas-formation process, would have occurred, but the weight of water above the body would simply have been far, far too great for any of the bodies to have floated back up to the surface.

CMDR RUSH: Do the temperatures of the water at the depths that we're talking about have any impact on that?

MR de YONG: If there was any chance of the body floating to the surface - and I couch that with a very, very big "if" - the water temperature at 2,500 metres I think was approximately 2.5 degrees, based on historical data. It is highly likely that at that water temperature, a body would not have floated back to the surface, if it was able to float or to rise again, until well after five to ten days.

The air search was terminated during that period of time, so it is highly likely that if any body was able to rise, it would have risen to the surface after the air search was terminated.

CMDR RUSH: In your report, you refer to the average surface temperature of the water as being between, I think, 23 and 24 degrees.

MR de YONG: Yes.

CMDR RUSH: Is there any material or evidence as to the risk of shark attack with temperatures of that nature?

MR de YONG: It is certainly an issue. Again, we know from a number of examples of World War II ship sinkings that, in warmer waters, shark attacks on survivors were common. There are a number of particular examples - the USS Indianapolis. In the case of Sydney, we know that one of the German lifeboats reported that their lifeboat was followed by a number of sharks, so shark attack on any survivors is certainly a high probability.

Again, US Coast Guard and US Navy data suggests that the probability of a shark attack on someone who is floating in an ocean increases significantly when the water temperature increases above 20 degrees C.

THE PRESIDENT: But the high probability is that none of these bodies would have risen?

MR de YONG: The high probability is that none of the bodies would have risen, that's correct.

CMDR RUSH: I have no further questions, sir, at this stage. Thank you, Mr de Yong.

Sir, I wish to call Mr Gamble and Ms Suendermann in relation to a couple of matters - the operational aspects of Sydney in relation to fire and also in relation to damage control.

<BRIGITTA SUENDERMANN, affirmed: [4.20pm]

<GRANT IAN GAMBLE, affirmed: [4.20pm]

CMDR RUSH: Mr Gamble, would you state your full name and address to the Commission, please?

MR GAMBLE: Grant Ian Gamble [redacted]

CMDR RUSH: And your qualifications?

MR GAMBLE: A Bachelor of Science degree, majoring in physics and computer science.

CMDR RUSH: You are employed, and have been for some time, by the DSTO?

MR GAMBLE: I'm a Defence scientist within the DSTO. I've been there since 1991.

CMDR RUSH: Your particular area?

MR GAMBLE: I work in an area that deals with fire and smoke, damage control and lifesaving and evacuation systems.