THE PRESIDENT: Yes, CMDR Rush.

CMDR RUSH: Sir, we propose to deal with the wreck site of HMAS Sydney and the imagery that was taken by Geosounder. The witnesses involved in the preparation of the report concerning this aspect are Mr Jeremy, Dr Cannon, Mr Buckland and Mr de Yong. I ask that they come forward.

THE PRESIDENT: Come forward, gentlemen.

<JOHN CHRISTOPHER JEREMY, on former affirmation: [10.01am]

<STUART MARTIN CANNON, on former affirmation: [10.01am]

<LEO VINCENT de YONG, on former affirmation: [10.01am]

<MICHAEL EDMOND BUCKLAND, on former affirmation: [10.01am]

CMDR RUSH: Dr Michael Skeen, sir, has been responsible for a great deal of the preparation of the report. For this aspect at least, he will use the pointer.

Gentlemen, if I could ask you to go to page 144 of the report and if we could have figure 111 placed on the screen.

While it is coming on the screen, may I ask about the site of the wreck of Sydney. Firstly, the bow, as I think has been discussed, was separated from the main section of the ship. Were you able to determine the distance between the bow and the ship?

DR CANNON: Yes. The two images that we have are, firstly, the side scan sonar image from Sydney that is taken from John Perryman's report, and, secondly, we also lifted one of the images from the real-time video. By overlaying the distance of the remainder of the ship, the length of the bow, we have overlaid on the figure the distance, and the distance between the bow and the stern of Sydney is approximately 470 metres, which means that it is a relatively compact wreck site in terms of the debris field.

CMDR RUSH: In relation to the sinking of the ship, is the compactness of the debris site of any significance?

DR CANNON: We'll probably come to that later. Yes, the

compactness of the debris field is one of the indicators that we have to suggest that the bow would have remained intact on the surface and that she separated during the sinking process. We'll come to that later on in the report.

CMDR RUSH: Does the compactness of the debris site mean anything in relation to the manner in which equipment and material separated from the ship as it sank?

MR JEREMY: Yes, it does. The compactness also indicates that the sinking was a fairly rapid process and it gives us some idea of which bits of the ship left before others. As we would expect to find, masts and items like that left quite early, and they are further away from the ship, for example, than some other items.

CMDR RUSH: We have figure 111 on the screen, which is described as the side sonar scan of Sydney. What is detailed on that scan?

MR JEREMY: This is an image, as Stuart mentioned, from John Perryman's report, and it shows a side scan sonar image of the site of the wreck and the debris field. The Finding Sydney Foundation have marked items which they were able to visually identify. As you can see, right towards the top of the screen, there is the foremast and part of the mainmast, which is quite close to the bow section. There is a funnel also in that area.

CMDR RUSH: We have the bow section and the main part of the ship.

I might firstly ask some general questions. Probably, Mr Buckland, they relate to you. We'll come back to the debris field, but in general terms were you able to identify from the wreck site where the torpedo hit Sydney?

MR BUCKLAND: From the wreck, yes.

CMDR RUSH: In general terms, how were the marks on the hull as a consequence of the torpedo damage shown?

MR BUCKLAND: It would be easier if we could bring up the figure, because it shows the indentation in the side of the bow.

CMDR RUSH: We might have to wait, then.

MR JEREMY: This shows the location of the bow of Sydney, and you can see nearby the foremast. There is the base of the mainmast just there (indicating).

THE PRESIDENT: Perhaps it would be convenient if we went round clockwise from where we are now.

MR JEREMY: I will do that, certainly. One of the funnels is just nearby. The other funnel is still draped over one of the turrets. There is one of the 4 inch guns. There's a boat, a catapult, a set of torpedo tubes. The supporting structure, the base of the high-angle control system, is there. If we move further down clockwise, we have another set of torpedo tubes and then there are some miscellaneous pieces of debris quite close to the ship. We can see the body of the ship lying there facing towards the bottom of the screen. Just behind the ship, we can see a boat cradle and then a boat lying there.

We have two boats located there (indicating), then a sole torpedo. There's one identified there as "not seen", which they weren't able to locate with the ROV, I believe. There is another boat. There is the high-angle control centre, from the top of the tower. The director control tower is there with the roof of the bridge lying up against it. Then we have returned to the bow.

That northern area, which has the bow and those other items, would be fairly close to being underneath where Sydney left the surface. We would expect to see the foremast, possibly funnels and things like that, which would offer considerable resistance to the water but very little strength, to have been removed as the ship plunged, and they are, predictably, lying in that area. The hull of the ship, of course, is a bit further away.

THE PRESIDENT: The ship, absent the bow, is, as I understand what you just said, facing south-east or south-south-east, if it is north and south up and down the screen?

MR JEREMY: I'm not certain that that is accurately north and south, but I believe it is approximately so, yes.

THE PRESIDENT: But for present purposes, the question I'm

asking is this: the bow is what we'll call north of the stern?

MR JEREMY: Yes.

THE PRESIDENT: Whereas the ship is facing south?

MR JEREMY: Yes.

THE PRESIDENT: So the ship, in some fashion, minus the bow, has ended up in a position where the bow is closer to the stern than where the bow was?

MR JEREMY: That's correct. We have an illustration towards the end of the report that shows how that might have happened in the descent to the bottom. Whilst the extent of the debris field is over a circle of about 500 metres, it sounds a lot, but when you look at it in relationship to the depth of water in which she sank, it is actually very compact. The ship was probably maintaining a little bit of forward motion through the water, but that is probably best illustrated by the drawings that we have later on in the report.

CMDR RUSH: Is it possible, moving on from the debris field, to determine where the bow broke off from the main structure of the ship?

MR JEREMY: Not precisely, but we would be reasonably confident that it broke off fairly close to the surface.

CMDR RUSH: You refer to frame 19?

MR JEREMY: The location on the ship, yes. The separation of the deck we have in the report here at frame 19.

CMDR RUSH: We will show that in due course. You mention that the bow is inverted on the ocean floor. I think that figure 113 is a photograph of the bow on the ocean floor. Mr Buckland, is there damage that can be seen on the bow of the ship that relates to torpedo damage?

MR BUCKLAND: Yes. We had to separate the damage from the sinking process of the bow ripping away from the main section of the ship, but if you go to figure 114, in this image here you can see an indentation on the keel of the bow. That's typical of an explosion happening next to the

surface. So this would be the very edge of the damage from the torpedo, so this is around frame 19. The actual torpedo hit would be aft of frame 19. We estimate that the actual detonation would have occurred around frame 25.

CMDR RUSH: Can you tell us what figure 115 depicts?

MR BUCKLAND: That depicts where the hit on the port side has occurred; where the actual detonation has occurred.

CMDR RUSH: In the vicinity of that hit, from the ship's point of view, what was the area in and around the frame?

MR BUCKLAND: The detonation from that explosive - we're talking about 300kg of explosive - would have knocked the plating through into the structure. At that point, we're getting down to the breadth of the ship of about 4 to 5 metres. It is close enough to the forward tanks, the fresh water tanks just forward of that hit point, which, if full of water, would have pushed the explosive energy across to the other side of the bow. In the next image, image 117, you will see where the bow has flared out on the other side. If Mike points to where the flaring has occurred, this is the hull on the other side of that hole where we expect that the explosive energy has pushed that out, either transferred through the fresh water tanks or pushed some of the deck through to that spot.

CMDR RUSH: Are you able to determine whether there was a hole on that side of the ship or whether there was just a bulge?

MR BUCKLAND: No, we can't determine if there was a hole. Probably more bulging or bending there.

CMDR RUSH: If I could ask you to go to figure 116, it gives another view of the ship and the torpedo hit. Again, that is another aspect of the ship showing the torpedo hit. The bulge or hole is pretty much opposite that on the starboard side?

MR BUCKLAND: Yes, directly opposite that.

THE PRESIDENT: But the torpedo, or its blast, did not penetrate right through the hull on its starboard side?

MR BUCKLAND: There would have been damage on the

starboard side. The amount of damage that is on the starboard side is undetermined.

CMDR RUSH: We have examined the damage to the hull. Was there damage which could be identified to the internal sections of the ship as a consequence of torpedo damage?

MR BUCKLAND: If you go to figure 119, this is the view inside the bow section. We see that all the platforms have been removed from that bow section, but that could have been through the sinking process of the actual hull. But there would have been a lot of damage within that structure to some of the decks and some of the watertight bulkheads in that area.

CMDR RUSH: Figure 120, shows the forecastle deck. Did you consider that there may have been damage rippling through the ship to the forecastle deck as a consequence of the torpedo?

MR BUCKLAND: We did consider that, but it is more likely that, if you look at the damage, there may have been some damage to that as there was a heaving of the ship, but not from the explosive energy itself. So this would have been more from when it was tearing away in the sinking process.

CMDR RUSH: From torpedo damage, is there a rippling effect through the structure in the hull of the ship?

MR BUCKLAND: The general process from a torpedo is that from the explosion you'll get a large hole in the side of the hull. Those bits of hull that have been torn off through the explosive will cause fragmentation, and they will be thrown through that part of the ship and cause extra damage. You will also get, from a large explosion, a push of the water away from the hull. Then that wall will collapse into that hole, so you will get a large generation of water into the hull, and that will cause extra damage as well.

CMDR RUSH: I might address my next question to Dr Cannon and Mr Jeremy. As a consequence of the separation of the bow from the ship, was there a ripping effect on the ship and, if so, what were the consequences of that?

DR CANNON: When you say "a ripping effect", are you talking about the global response of the ship or the

structure?

CMDR RUSH: The structure - both, really.

DR CANNON: Yes, as the torpedo would have hit the ship, certainly the ship would have heaved significantly, as in come out of the water, trimmed by the stern, and then, as she flooded, she would have come slightly deeper by the bows, so that global response would have occurred.

CMDR RUSH: I think if we look at figure 120, which is on the screen, we have a tear in the forecastle deck on the main hull. That is due to the separation of the bow?

DR CANNON: Yes. This picture is linked in with some of the other pictures that we will show you later. It indicates that the decks around the keel area have actually been torn away from the hull. If the bow had come apart due to the torpedo, we would have expected some sort of compressive damage or buckling damage, but we don't really identify that. That's one of the key factors that have led us to say that it probably occurred during the sinking process.

CMDR RUSH: Did you consider whether it could have been caused as a consequence of the detonation in magazine?

MR BUCKLAND: Yes, we had a look at that, but we can see the actual deck still in place through the main hull section of the magazine, still intact.

CMDR RUSH: So that, as a consequence, is discounted?

MR BUCKLAND: That's right.

CMDR RUSH: If we could look at figure 122, that shows the starboard side of the main hull bent upwards?

MR BUCKLAND: Yes.

CMDR RUSH: Was that caused, again, as a consequence of the bow separation?

MR BUCKLAND: We believe so. There is a lot of damage to the main section of the ship from the sinking process, the tearing and also the final resting on the seabed, so it is fairly difficult to interpret some of the tearing that's

there now.

CMDR RUSH: Going backwards to figure 121, that shows a section of the deck that appears to be wrapped around A turret on the ship. Again, what would be the cause of that?

MR JEREMY: We think that has occurred during the sinking, but it has been very hard to formulate the mechanism which did that, because the plating has been wrapped around the barrels. Almost certainly, it's a combination of the bow tearing away and the subsequent plunging through the ocean.

CMDR RUSH: Is the sinking a violent process?

MR JEREMY: It's an extremely violent process. HMAS Sydney, probably in her final plunge, left the surface in less than a minute and would have dived nose-first towards the bottom of the ocean. The pressure of the water rushing into the open bow would have torn the remaining bow off the ship. In that process - we can't imagine or detail just exactly how this would happen - there would have been significant tearing and breaking of structure. The structure that's left on the hull would have been further distorted and bent by the process of passage through the water towards the bottom.

CMDR RUSH: Mr Buckland, were you able to determine, in a general sense, the nature of the hole in the port side of Sydney?

MR BUCKLAND: Yes, from viewing the video evidence, I think figure 124 is the extent of that hole.

CMDR RUSH: What frames is the hole covering?

MR BUCKLAND: You can see from frame 19, that's an obvious section that we can identify from the drawings and the actual pictures. So we can identify exactly where frame 19 ends. The hole starts at that section, and then the extent is down to almost frame 35.

CMDR RUSH: The areas within that section of the ship are identified in the diagram?

MR BUCKLAND: Yes. The section on the hull is near the fresh water tanks and the type 125 gear compartment and the

compressor room. You can see that is above the waterline there, so it is probably a fairly shallow torpedo depth.

THE PRESIDENT: I see that it impinges upon the aviation spirits compartment, which I understand to be highly inflammable.

MR BUCKLAND: Yes.

THE PRESIDENT: Do you think that the aviation spirit ignited?

MR BUCKLAND: No - oh, it's very difficult to say, but that's the extent of the hole in the side. The detonation would have been closer to the type 125 gear room, so the actual explosion was at a distance. That is a mid cut-through, so the aviation spirit room was protected externally by the hull. It could have released aviation fuel into the water that could have caught fire at a later stage, but there wouldn't have been a detonation of the aviation fuel.

CMDR RUSH: Is the damage consistent with one torpedo or two torpedoes or three, four?

MR BUCKLAND: It is consistent with one torpedo.

CMDR RUSH: Apart from that one torpedo, is there any other suggestion of damage by torpedo to Sydney?

MR BUCKLAND: No other damage.

CMDR RUSH: You discuss the shell and fragment damage in the report at page 152. Mr Buckland, if I could ask you, firstly, how difficult or easy was it to identify the shell hits, from all of the armament, on Sydney as it lay in the water at this time?

MR BUCKLAND: We're looking at the ROV footage and the photographs from the Finding Sydney Foundation. The wreck is 2.5km down, so they did a good job of getting the images. However, with silt, and after 67 years of being at the bottom of the ocean, there are other a lot of other damaging processes that have occurred, which we will identify later on in this chapter, but with regard to the actual weapon hits that we could positively identify, as you'll see, they're very clear. In the state that the ship

is in now, they're very clear.

CMDR RUSH: If we look at the summary of weapon damage at table 18, firstly in relation to the port side of Sydney, you have attempted, as far as the location is concerned, to identify the general areas on the port side of Sydney of the 15cm shell hits?

MR BUCKLAND: Yes, we identified the 15cm shell hits, so we're looking at holes to 15cm. As you'll see from some of the images, it's hard to get the resolution. We're looking at a ship that is 180 metres long.

CMDR RUSH: When you say you're "looking at holes", does that mean that the shell has detonated or exploded?

MR BUCKLAND: As you will see in table 18, we have identified contact detonation. There were nose-fuse detonated shells, and they will have large holes or a lot of fragments on the hull surface. There are shells that have clearly just penetrated without exploding on the surface, so they were most probably armour-piercing shells. There are a lot of indentations on the hull, but we have clearly identified ones large enough to be 15cm shells that haven't penetrated, but they have detonated on the surface.

CMDR RUSH: If we look at this table and, for instance, go across the structure - we will have a look at it more closely very soon - you're looking at and identifying 15cm shell hits specifically in relation to areas of bridge or director control and the like. So there were 17 contact detonations. Perhaps if you would explain exactly what you mean by that?

MR BUCKLAND: Yes. On this table, we have identified structure, then we have identified the A turret, B turret and catapult. We have separated them with the asterisk, because they are operating structures, so even though they're identified on the port side, operationally they may have been hit from the starboard side at some stage. The structure is both the hull and superstructure, the barbette and some other structures that we have identified as having been hit, and I think you'll see some of the images later on.

CMDR RUSH: So if we look at "structure", you were satisfied, as best you could be, that 17 detonated on

contact; 14 involved shells that penetrated the hull; and 2 were shells that didn't penetrate the hull but exploded?

MR BUCKLAND: Most probably exploded. You will see in some of the images that you can't actually see fragment marks but an indentation where the weapon may have broken up once it hit the hull.

CMDR RUSH: And "unknown". What is that?

MR BUCKLAND: It is unknown in that we couldn't identify whether it was a 15cm shell. There were a lot of fragments.

CMDR RUSH: So we get to 41 15cm shell hits, as best can be identified, on port side. Then the same system was adopted for table 19 of identifying hits on starboard side of Sydney?

MR BUCKLAND: Yes. In this table, we have the 4 inch gun locker. That's lying on the sea floor. We know that the gun lockers come from the starboard side, but not where that actual weapon has come from.

CMDR RUSH: In addition to structure, there was a shell penetration of X turret --

MR BUCKLAND: Yes.

CMDR RUSH: -- and the director control tower starboard, a torpedo which lay in the debris field and the 4 inch gun locker, so you were able to count 46 15cm shell hits on the starboard side of Sydney?

MR BUCKLAND: Yes, correct.

CMDR RUSH: In relation to the other the Kormoran armament fired at Sydney, were you able to identify any damage as a consequence of that armament?

MR BUCKLAND: There is one area on one external door that could be light arms fire or light-calibre fire, but when you get a look at the images with the corrosion deposits, the small-calibre is 2cm or 3.6cm - we just don't have that resolution with the images.

CMDR RUSH: Figure 125 gives the location of weapon damage

to the port side of the Sydney around B turret.

MR BUCKLAND: It might be worthwhile looking at the extended diagram of the hull profile first.

CMDR RUSH: That is at page 317, figure 284.

MR BUCKLAND: Here we have tried to put the actual measured sizes of each of the holes that we have identified on the port side on to this diagram, so we tried to make it to scale. You will see a lot of little red dots, but each of those red dots are 6 inches in diameter.

CMDR RUSH: From that diagram, it appears that it is a concentrated fire towards the midships, effectively, on the bow area of the ship?

MR BUCKLAND: In this case, it's very easy to resolve the hits along the actual hull section. This is the lower and upper decks. If you go from the forward, from the lower mess, there is the hit below A turret there (indicating). Then if you go aft, you have further hits into what is called the ammunition lobby, but we're looking at the surface here, it's penetrated. Below into the lower mess, you'll see a large hole in that watertight bulkhead, so we're talking about a large hole here. This is 1.5 metres.

CMDR RUSH: A 1.5 metre hole?

MR BUCKLAND: Yes. That would be a surface detonation. That would have been a contact detonation, so the fragments would have blown a hole in and blown all that damage into the ship.

THE PRESIDENT: Is it likely that it was caused by more than one hit?

MR BUCKLAND: No. It was probably just one hit. It is more likely, if there was another hit there, that would have gone through and hit another bulkhead inside that.

There are lots of shell hits, about four or five shell hits, in the lower mess areas, which we can discuss later. This is where Damage Control 1 would be. Below the superstructure, we have four or five hits into lower mess 4.

Straight above that we have the recreational space. This is a very hard area to resolve from the photographs, because there was a lot of damage and collapsing from secondary damage, but there was a lot of damage and build-up of silt and other things, so there would be a lot of other shots here that we could not identify. We would presume, just because of the state of the ship. As you go up, you will see some major hits below the director control tower and to the HAC tower.

CMDR RUSH: The major hit below director control seems to be of the same dimensions that you spoke of with regard to the hole being in excess of --

MR BUCKLAND: 1.5 metres?

CMDR RUSH: So that hit also made a hole of that nature?

MR BUCKLAND: That's right.

THE PRESIDENT: Would the shrapnel spray from a hit of that nature extend throughout the bridge?

MR BUCKLAND: Yes. With the shrapnel, in line of sight, it will keep going. Even shrapnel from there, if it was in line of sight and it wasn't stopped, it would even hit at the aft end of the ship. It's just a matter of what's in between that hit. The blast effects from that shell would be probably 4 to 5 metres, so any personnel or vital bits of equipment would be damaged within that radius, but in line of sight, the fragments could extend to the aft of the ship.

CMDR RUSH: So do I understand that, as a consequence of the detonation of the shell, the shrapnel itself has the potential to spray and spread completely around the ship until stopped?

MR BUCKLAND: Until stopped. If you look at a lot of the surface detonations, even though they haven't penetrated, the fragment spray would have sprayed the external section with anything in the water around those shell hits.

CMDR RUSH: I know we'll come to this later in the report, but the fragments themselves, I understand, are hot?

MR BUCKLAND: They're hot, yes.

CMDR RUSH: Are they capable themselves of creating fire?

MR BUCKLAND: If they lodge into a flammable material, they will cause a fire. They will generate a fire. They will pass straight through without transferring the heat to most things, but once they lodge into the flammable material, the fire will be created.

So as we move aft, you will see there are more major hits in the ship's galley area. There is a large amount of damage there. Then below that, we're into the telephone exchange area. What's important about this area is that you have the transmitter station and the HA calculation area below these hits, and the main switchboard room.

With these hits that penetrated in, it would be likely that they would be detonating inside the ship itself, so the compartments inside there are going to be damaged and create fires, so we're likely to lose any communication to the transmitting room from the bridge and the director control.

If we go back up, you'll see the hits below the smith shop. You will see that this is around where some of the boats are.

As we go aft, again, even though we have a collection of shots near the bakery, between the bakery and the galley you will see that there aren't any large detonation areas, but the image can't be resolved underneath that deck, below that other boat where the seaplane crane is. It is likely that there are hits in there, but the ROV couldn't see underneath into that area.

As we move further aft, you will see two hits onto the catapult and another hit into the engineering workshop where Damage Control 2 would be set up.

CMDR RUSH: And aft of the hit?

MR BUCKLAND: Going further aft, we have a hit on X turret, on the port part of that gun. However, it is unlikely that the gun was pointing in that direction at the time, so we have assumed that that was probably a starboard shot, in the end. I will explain that later.

As we go further aft, you will see that there are no other hits further aft than that that we could identify.

CMDR RUSH: Was the shell hit to the catapult the most, if you like, aft hit on port side?

MR BUCKLAND: It was the most-aft hit, but I should explain that on Y turret there is a lot of debris. One of the funnels is lying across Y turret. We can see some of Y turret but we can't see the entire Y turret, so we have not identified whether there is any damage there.

THE PRESIDENT: It may have been hit as well?

MR BUCKLAND: It may have been hit, but it is covered by one of the funnels.

CMDR RUSH: Can we turn to figure 285 and adopt the same process, Mr Buckland, from forward to aft?

MR BUCKLAND: You will see these large hits on starboard side of A turret. Once you see the image of where the guns are now, you will see that obviously the guns weren't pointing towards Kormoran at this stage and it was hit directly on there. We have calculated that that was when the Kormoran was firing over the bow of Sydney, so the guns were pointing away from the page.

CMDR RUSH: Could I ask one question unrelated to the shellfire. Is it your opinion that the torpedo damage caused any damage to A or B turrets and the capacity of those turrets?

MR BUCKLAND: Definitely to A turret. The A turret would have lost all power and operation. B turret possibly. Very likely, but possible. We can't really give a 100 per cent guarantee on that. Just from the shock, as the boat lifted up and down, it would have lost that, plus you could have been losing power. We are talking about a ship that has old technology, so it didn't take that much shock to break circuits and stop the power.

As we come back aft, there are again hits in the lower mess areas. Again, this is where damage control would be setting up to do action for the bow damage, the torpedo damage, yet it has still been hit there and up in the seamen's heads, above, in that recreational space. Again

with regard to some of the damage around the superstructure area, because of the state of the ship at the moment, it is hard to get resolution on some of the hits.

There are further hits again to the director control tower. Then you'll see that there is a large concentration of hits around the stokers' mess, the ship's galley and the forward boiler room. Here we have the forward boiler room. That has been hit. As we come back further, we have hits around the engineering workshop, again where Damage Control 2 would be.

You will notice that all these hits are above the waterline. Then around the aft boiler room. In our appendix to this report, each of these hits has been identified and measured. We know that the starboard torpedo pods have been hit, but how that was positioned at the time we are uncertain. Then we have hits to the main W/T office and the fan chamber.

As we come further aft, there is another hit to the officers' galley. Then the most-aft hits are near the senior officers' cabin and the captain's cabin.

CMDR RUSH: Again, what is the size, for example, of the depiction of the shell hit to the main W/T office?

MR BUCKLAND: That would be a contact fuse again. I think that is about 600mm to 800mm diameter. Again, the same thing with Y turret; it's difficult to see all of Y turret to know whether any hits have hit the Y turret, but there is no further damage aft.

CMDR RUSH: You mentioned that each one of the shell hits was examined and measured and that that is picked up in an appendix to the report. I wonder if we can get an idea of what you mean there. I think it is found at page 315 of the report.

MR BUCKLAND: We put a proviso on these measurements in that we needed to take bits of structure where we could identify what the actual thickness, width and diameter was, and then compare that to the actual shell hole, so we needed some structure for which we knew what the measurements were to be able to measure that.

CMDR RUSH: Perhaps if we could look at figure 288 on

page 322. That is a photograph that has been identified as depicting B turret. Can you indicate to us what you did in relation to identification of the 15cm shell hit on B turret?

MR BUCKLAND: On B turret, you will see it identifies PO1FB03. That is the port side.

CMDR RUSH: So that is a hole --

MR BUCKLAND: The hole has been hashed over. You will see the damage around that hole where the plating has been bent into the hole. For that hole size, we've taken a measurement based on the sighting flaps of the gun. We have measured that it is probably 5 inches in diameter, so the possibility is that the weapon didn't totally penetrate in this case.

You will see that further down, next to the barbette, there's a large hole below the barbette and damage to the barbette. Again, we have identified that this would have damaged the ring gear to the barbette and stopped the gun from operating. You will see that that is a very large hole, 6 feet.

CMDR RUSH: If we look at figure 289, this is a hole in the lower deck at number 2 and number 3 lower mess deck?

MR BUCKLAND: You will see that this hole has been measured at 6 feet by 3 feet, so it's a very, very large hole. To the right-hand side of that photograph, is part of a scuttle that has been taken in with the damage. So that is not part of it; that just continues on from the weapon damage. In this case, the weapon would have detonated on contact, but fragments and that hull plating would have been thrown through the ship, causing damage throughout the ship directly behind that hull plate.

THE PRESIDENT: So you have used a CAD system, calibrated against known measurements, and used it to measure the penetrations?

MR BUCKLAND: That's right and because of where the ship is sitting at the moment, these are approximate, but they give us some idea of what the holes are and the sizes.

CMDR RUSH: I'm not going through every one, Mr Buckland,

but each shell hole was identified and a description given. There are a couple that I will take you to. The first is at figure 306. There identified is the lower bridge area of the ship.

MR BUCKLAND: Yes.

CMDR RUSH: What do we see there?

MR BUCKLAND: This is clearly a 6 inch by 6 inch, so you would expect that that was caused by the 15cm shell penetrating directly in there without exploding on contact, and either it contacted inside, or, even if the fusing didn't work, we're talking about shells that are hitting the shell plate at over 400 metres per second, 40kg of shell - there's a lot of secondary damage from the fragments that are being generated just from that striking, going through that plate, so there is a lot of secondary fragmentation, anyway, as it crashes through the ship.

CMDR RUSH: So even if there was no explosion on contact, there would be secondary damage as a consequence of the forces applied by the shell?

MR BUCKLAND: Yes. It would have generated a lot of secondary fragments.

CMDR RUSH: Figure 307 is again, as I understand it, port side damage, this time to the director control tower.

MR BUCKLAND: Yes. And, again, we have identified that as 7 inches, so that would have been another hole that has penetrated directly into the control tower. At this stage, we expect that the director control tower wasn't operational.

CMDR RUSH: May we look at a couple of photographs on starboard side. First, if we look at figure 318, is this on starboard side lower deck?

MR BUCKLAND: Yes. You will see several holes here. The one identified as S2FB06 is clearly a 6 inch hole, and with the larger contact detonation - you will see there is very large, ragged damage in this area that has torn through into that section. Then there are two other fine holes below that which are just identified as maybe fragment damage from that weapon.

CMDR RUSH: The lower mess and upper deck seamen's mess area?

MR BUCKLAND: Yes.

CMDR RUSH: If we look at the next figure, 319?

MR BUCKLAND: This is on the starboard side of the upper bridge area. As you can see in this photo, there is a lot of damage and lots of rusticles, which will be explained later, on the surface of that plate, so if there are any holes underneath that rusty looking area, it's impossible to see them, as you can see. However, on the top, you will just see that there's the edge up there where there has been obviously a ripping away as the shells ripped through and detonated. We will need to go to the video to see more of that image there.

CMDR RUSH: The next figure, 320, is a reconstruction of the Sydney bridge.

MR BUCKLAND: That was the area that you were just looking at. We have tried to put in some reconstructions just to show what areas you are actually looking at, because with the state that the ship is in now, sometimes it is difficult to see. That area that we were just looking at is that (indicating), and the damage is just below the range finder.

We are indicating here that any weapon hit up there would have taken out the personnel in that area.

CMDR RUSH: And in relation to the ship as reconstructed, as we saw yesterday on the video imagery, were you able to use that to work out matters such as you've spoken about - the location of personnel?

MR BUCKLAND: Yes, within our vulnerability code we have positioned crew members around, and using our algorithms we can actually calculate who has been incapacitated and what equipment has been damaged.

CMDR RUSH: Perhaps I might ask Mr de Yong this question: those that have seen the photographs on the Finding Sydney website and looking at these photographs may see a difference in the clarity in the imagery. Can you

explain that difference?

MR de YONG: Yes. With regard to the photos that were supplied to us to work with, we have simply passed the images and the video footage through a red filter. There's a loss, there's an absorption, with depth in terms of the red part of the spectrum that tends to cause images taken underwater to have a bluish colour associated with them, which tends to destroy the clarity and the features of the images. So these images have been processed by passing them through a standard red filter that is in a standard commercial Photoshop package. They bring the clarity and the original colour back into the images.

CMDR RUSH: Mr Buckland, can I ask you to go back to page 159 of the report and figure 134. You mentioned the use of the reconstruction to explain where the damage to the ship was?

MR BUCKLAND: Yes. There is a series of images in the report which show the reconstruction of the Sydney and identify parts of the images from the Finding Sydney Foundation and where they were originally located. As you'll see there, the director control tower on the left-hand side - that is now sitting on the seabed. That is not part of the ship, the main part of the ship, any more.

CMDR RUSH: So what these images are doing is, as I understand it, using the photographs and then the computer-imaged ship to indicate areas of shell hits to the particular structure?

MR BUCKLAND: It is actually showing a confirmation of shell hits, fire damage and just the general state of the ship as it lies at the moment, just to give some idea of the state of the ship as it now sits on the seabed.

CMDR RUSH: So what we're looking at there is the forward superstructure on starboard side?

MR BUCKLAND: That's right.

CMDR RUSH: If we can go through some of these images, firstly figure 135, what do we see there?

MR BUCKLAND: This is the forecastle deck. I'm not sure

how good the resolution is. The upper left-hand photo shows the --

MR JEREMY: It is just forward of the flag deck. It shows the location of one of the 0.5 inch machine guns.

CMDR RUSH: And, again in general terms, you have placed the photographs in a position with arrows showing the general nature of damage to the ship?

MR BUCKLAND: Just so you can locate that photograph and where it is in relation to the ship. It gives you an idea, especially on the right-hand side in those three photographs, of the difficulty on the forecastle deck, even though there are a lot of holes, of identifying any other damage than the ones we have positively identified.

CMDR RUSH: If we look at the photographs on the right-hand side, the upper right-hand photograph and the bottom right-hand photograph show doors are open.

MR BUCKLAND: That's correct.

CMDR RUSH: Is it possible to determine how they were opened or whether that would have been as a consequence of damage or not?

MR BUCKLAND: No. It is almost impossible. We tried to look at the dogging and whatever else, but we have no idea. In the second picture, you will see that there are clearly fragment holes coming from the door. At this point, the fragments would be going inside the door, but it's open, so it has been opened after the action has started.

THE PRESIDENT: Either by man or by blast - you can't tell?

MR BUCKLAND: We can't tell. We would expect that it would be opened by man, in that the fragment holes are going inside and then it has been pulled out, so - unless there was another weapon that did it.

CMDR RUSH: We are looking there at the forward upper and lower decks starboard. Is there evidence of fire damage demonstrated in those photographs?

MR BUCKLAND: Yes, you will see the discolouration of the

blue to what's now a grey colour, and that discolouration is identified as fire damage, just from the internal heat burning the paint off the surface.

CMDR RUSH: With regard to the second photograph on the left, is what we see there in that discolouration what is identified as fire damage?

MR BUCKLAND: That's right.

CMDR RUSH: Again, in the photograph directly under the image, is it your opinion that that also is fire damage?

MR BUCKLAND: That is. I would rather our fire expert answer some of the questions on the fire damage.

CMDR RUSH: Okay. If we go to figure 137, again this is port side now?

MR BUCKLAND: That's right.

CMDR RUSH: It shows the forward superstructure of port side and, again, the arrows pointing to the general areas of the damage?

MR BUCKLAND: The general areas. You will see some secondary damage, which Dr Cannon and Mr Jeremy will talk about later on - some of the sinking damage that has occurred. Again, you will see where there has been some fire damage and weapons damage.

CMDR RUSH: If we go to figure 139, we're looking there at the smith's shop on port side?

MR BUCKLAND: That's right.

CMDR RUSH: We probably won't come back to this, so I'm going to ask for your opinion: is that discolouration, in your opinion, fire damage?

MR BUCKLAND: Yes. You will see there's weapon damage there. Once we get to another photograph, you will see that there are fragment holes in that area.

CMDR RUSH: And figure 141. You are there relating the photographs back to the --

MR BUCKLAND: Back to the damage near the crane area and also near where some of the boats were sitting.

CMDR RUSH: Is that on port side?

MR BUCKLAND: On port side. This is around the midships area.

CMDR RUSH: And in figure 143, you are looking there on starboard side, the aft deck?

MR BUCKLAND: Yes, this is the starboard side, and we start seeing some of the decking in this photograph and also some of the collapsed deck, which I think Dr Cannon will explain a bit later.

CMDR RUSH: In figure 144, again, we have the aft upper decks on port side - the other side to the figure we've just seen?

MR BUCKLAND: That's correct.

CMDR RUSH: Sir, I will come back with other experts to talk about fire damage.

THE PRESIDENT: Yes.

CMDR RUSH: Could we turn, Mr de Yong, to page 171 of the report to consider the ship's boats and Carley floats and look at the potential damage to them. Were there any Carley floats found in wreckage or the debris field?

MR de YONG: There was no evidence of any Carley floats on the seaboard or remaining on board the remnants of the hull.

CMDR RUSH: From the original position that we saw yesterday of the ship's boats as of November 1941, were any in their original position?

MR de YONG: No. There were no boats retained with the main structure of HMAS Sydney. Any boats that we were able to identify were found in the debris field.

CMDR RUSH: Was there anything to identify the cutters?

MR de YONG: There was no evidence of any of the cutters.

We found five boats in the debris field. They were identified as the two whalers, the two motorboats and the pinnace. There was no evidence of any of the cutters being present in the debris field.

CMDR RUSH: And the 16-foot jolly?

MR de YONG: There was no evidence of that, either.

CMDR RUSH: In relation to the boats that were found in the debris field, had there been a deterioration, as a consequence of the effluxion of time, on the construction?

MR de YONG: There was certainly a varying degree of deterioration. Some of the boats had deteriorated significantly. What you see on the screen at the moment is one of the motorboats. It shows a degree of deterioration, but there are two motorboats, and one of the motorboats shows very little deterioration. I'm talking about the exterior of the boat at this stage. In all the boats that we found on the seabed, all the interior had significantly deteriorated, all the equipment, particularly for something like the pinnace, the propulsion system and all those sorts of internal structure, had all disappeared. It had all fallen out presumably during the sinking process.

But there is no question about the fact that some of the boats had deteriorated significantly, some had shown an extreme resilience to deterioration on the seabed, and in fact it is because of the deterioration that it is very difficult to identify with great certainty the degree of fragment damage to the boats, because the fragment damage would have been a point where deterioration would possibly have started. So since the deterioration could have been significant, there is no evidence that the fragment damage was the point of commencement of that deterioration, but it is highly likely that it was.

CMDR RUSH: Was there any difference in deterioration between the boats that were carvel constructed as opposed to boats that were clinker constructed?

MR de YONG: Yes. That was one of the main differentiation processes between the two different types of boats. The carvel boats have a smooth outer planking, whereas the clinker boats have a rough outer planking. The

carvel boats showed significantly less deterioration, as a general statement, than the clinker-built boats.

CMDR RUSH: On the screen at the moment is figure 147, which is the 35-foot motorboat.

MR de YONG: That's correct.

CMDR RUSH: If we go to figure (a), in relation to that damage, what we are seeing there is general deterioration of the boat. Is there anything specific in relation to that, apart from it appearing to be broken in two?

MR de YONG: As you say, you can see the physical deterioration to the outer planking. Although being a carvel-built boat, still part of it is quite intact. The interesting thing about this boat is that the damage that you are seeing there, the significant damage that appears to be in the centre of it, seems quite at odds with what you would expect from a weapons engagement. My opinion is that that damage was not as a consequence of any weapons damage.

Interestingly enough, the ship's catapult is lying almost next to it on the seabed, and my opinion is that during the sinking process, the catapult actually hit this boat and caused that damage.

CMDR RUSH: In photograph (c), you have identified by arrow possible fragment impacts. Is that done with any degree of certainty?

MR de YONG: No. They're possible areas where fragment impact may have occurred. It's very difficult to identify fragment impact, particularly on a boat that has been sitting at the bottom of the ocean for such a long period of time and with such deterioration.

CMDR RUSH: If we could look at figure 148, this is the other motorboat?

MR de YONG: This is the other motorboat. The motorboats were both on the starboard side, so both these boats were from the starboard part of the ship. Again, it's an identical construction, and, interestingly enough, you can see that it's in much better condition. You can see that the insides are missing, as I noted earlier. There are

some remnants of some of the interior engine drive system, but most of it is missing.

The outer planking is in extremely good condition, and there is limited fire damage to this particular boat. There are sections that have rotted out because the ship is lying partially on the seabed, and the silt has caused some rotting, but it's in remarkably good condition.

CMDR RUSH: If we could look at the two images on page 175, which is perhaps figure 149, what are we looking at there, Mr de Yong?

MR de YONG: This is the pinnace and one of the whalers. Since the pinnace was on the port side, my assumption is that this is the port side whaler. The pinnace, again, is in reasonable condition. There are some later images that show some little more detail, but, again, the inside structure has been completely destroyed. Again, I assume a lot of it is a case of the equipment falling out during the sinking process.

As you can see, the whaler has very little of the outer planking intact because it's a clinker-built boat. One would expect the outer planking to deteriorate much faster than that on the carvel-built boat. The interesting thing about the whaler is that there appears to be fairly significant damage where those two arrows are pointing. It doesn't appear that the damage has been due, in my opinion, to some form of physical effect, as we saw earlier with the ship's catapult being proposed to cause the damage; I believe this damage was caused by a weapons hit.

CMDR RUSH: At figure 149, the images there are initially, if we look at (c) at the top --

MR de YONG: Item (c) is the edge of that hole that I believe was caused by weapons hit and you can clearly see that it has caused fire damage to the boat. You can see the blackening of the remaining structure of the boat itself. You can see that on the boat's badge, the paint has been burnt off. If you look at the image, that's correct, in that area there, there's clear evidence of fire damage.

CMDR RUSH: Was the pinnace located on the port side of Sydney?

MR de YONG: Yes, it was.

CMDR RUSH: My recollection is that there was a whaler on each side of Sydney?

MR de YONG: There was a whaler on both sides, that's correct, so I am assuming this is the port whaler.

CMDR RUSH: If we go to figure 150, this is a whaler different from the one we've just looked at on the seabed?

MR de YONG: That's correct. This is the second whaler. Because the other whaler, I believe, was with the pinnace and so therefore was the port whaler, my assumption is that this is the starboard whaler we're looking at here.

CMDR RUSH: The cradles and davits for the boats - we're looking at davits for the cutters and cradles for the other boats. Was there any sign of either in the wreckage?

MR de YONG: The davits for the two cutters - there is no evidence of the davits at all. If we go to figure 151, we will see the starboard davit. These are the davit holders. There is no davit present. You can see extensive shell damage around this area. You can see weapons hits, that's correct, right in those two positions there.

As we've seen previously from Mr Buckland, there was extensive damage around the cutter davit area, and, in my opinion, the davits would have been destroyed, and with the davits being destroyed, the boats would have been blown overboard. That would have happened during the encounter, which means that they would never have been found in the debris field.

CMDR RUSH: Figure 154 is the port side cradle for the gig.

MR de YONG: This is the cradle on the port side for where the gig used to be. There were two Carley floats on top of this support cradle. You can see that there are clear weapons hits to the structure. You can see clear physical tearing apart of the structure here, whether due to blast or secondary fragmentation, or whatever, but it tends to indicate that the Carley floats that would have been sitting directly above this would have been extensively

damaged.

CMDR RUSH: If I can ask you to go back to figure 152, which is referred to as the starboard side end of the 27-foot whaler cradle, again there are pointers there to weapons damage?

MR de YONG: Yes, three significant shell hits to the hull of the ship, which would have, as Mr Buckland has alluded to so far, produced and generated very large numbers of fragments, so the whaler that would have been sitting on that cradle would have been extensively damaged.

CMDR RUSH: Finally, to figure 155, which is the holes around davits for the port cutter?

MR de YONG: This is the forward locating hole for the port cutter. Certainly, the davits are completely gone. There is extensive weapons damage or shell damage at this point here, and there's some potential fire damage as well.

If you go to figure (b), this is the aft davit holder. You can see a very, very large shell hole right there right by the davit. That would have blown the davit off very, very quickly and it would have taken the boat with it.

CMDR RUSH: Sir, if we turn to other structural damage to Sydney and the separation of the bow, I think we're referring to Mr Jeremy and Dr Cannon: was the torpedo responsible for the removal or separation of the bow?

MR JEREMY: Ultimately, yes.

CMDR RUSH: We'll come to it, but your opinion is after sinking?

MR JEREMY: After sinking, yes.

CMDR RUSH: Figure 156. This is the forecastle deck. Could you explain to us what is being referred to there?

MR JEREMY: This shows what is left of the forecastle deck on the ship and the line of the tears in the deck plating. As you can see, most of those tears follow the riveted seams in the plating and, in some cases, are very close to riveted butts as well. This suggests tearing of that structure and the failure of the rivets.

Next to the barbette of A turret, there are a couple of tears which may have occurred a little bit later on, either during the sinking process or when the ship actually hit the bottom.

CMDR RUSH: So if we were to look at a line across the bow of the ship as to the point of separation, is it possible to --

MR JEREMY: Yes. You can see just forward of my red lines there, there is actually the end of the timber planking on the deck, across at that level there (indicating), and that's very close to where the ship actually separated. These tears are fairly accurately located from the remaining fairlead and other deck fittings, which we can see in the photographs, but there is likely to have been a bit of localised tearing around the bow section as well as it descended to the bottom.

CMDR RUSH: And figure 157?

MR JEREMY: This is a piece of shell plating which has been ripped from the ship during the descent to the bottom. It shows two side scuttles, one of which is an original one, and the other one which had been blanked. That was done during the War to reduce the risk of flooding to the ship. The side scuttles in Sydney which were blanked were those below the upper deck, so that's a piece of shell plating - we can't be certain from which side of the ship - between the lower deck and the upper deck.

CMDR RUSH: You spoke earlier about the sinking being a violent process. Is it the sinking itself that has caused that deformation?

MR JEREMY: Very likely, yes.

DR CANNON: There is also a significant amount of the side plating that we haven't been able to identify, so there's the plating that stops on the stern section of the ship, that starts on the bow, and then there's a segment of plates that are in the debris field that we can't identify. So they would have been torn away.

MR JEREMY: There are some significant targets in the sonar image which were not sighted by the Finding Sydney

Foundation, and it's quite possible that some of those are some of these missing sections.

CMDR RUSH: Was there implosion damage to Sydney?

MR JEREMY: Yes, extensive implosion damage. Perhaps if we go to some of the images.

CMDR RUSH: Firstly, figure 159, but before we look at that, can you explain to us what implosion damage is, how it occurs?

MR JEREMY: If you like to think of an aluminium drink can which is empty which you then squeeze from the outside and it crushes, this is a very similar process. As Sydney sank, the evidence suggests that she probably plunged very rapidly by the bows, the stern probably up into the air, and then dived. As she dived through the water, the compartments in the ship which still had a lot of air in them or were completely intact would have been subject to increasing water pressure from outside, and quite rapidly that would have exceeded the strength of the structure to resist crushing. In many instances, of course, they start to flood very quickly from water getting in through air escapes and ventilation trunks or open hatches, but the sinking would be so rapid that the air would not be able to get out fast enough and the structure would collapse inwards, and there's extensive evidence that this has occurred on Sydney.

CMDR RUSH: At figure 159?

MR JEREMY: This is towards the forward end of the major implosion area and it's on the starboard side looking slightly forward, and it is beside the aft deckhouse. You can see a bollard there on the side. There's an awning stanchion bent over just before it. That has probably been bent by debris as the ship sank. You can see just a little bit forward of that, the ship's side is bent in a bit.

If you look at the silt-filled area between there and the deckhouse side, that's about the forward end of the imploded section. You can see that the bollards are bent in a little bit. In actual fact, we think that the whole after deckhouse has slumped a little bit down, but that may have occurred when the ship hit the bottom.

CMDR RUSH: The photo may not depict what your opinion is, but are we just looking at a couple of inches or?

MR JEREMY: No, we are talking about six frame spaces, and the frame spacing is three feet, so we are talking about 18 to 20 feet of the ship there.

CMDR RUSH: That suffered implosion damage?

MR JEREMY: No, the total length of the ship that suffered implosion damage is approximately from the forward end of that photograph right to the stern.

CMDR RUSH: But on that photograph, in relation to what appears to be the downward movement, for want of a better term, caused by implosion damage, are you able to estimate how far down it is?

MR JEREMY: The depth of the implosion? Yes, on the quarterdeck we can. If we look perhaps at figure 160, you can see there that that is the capstan which was sitting on the deck, the quarterdeck, and the deck has been imploded downwards. The ship's side, there on the starboard side where the bollard is, has been bent inwards. The bollards, of course, are quite distorted from their normal location. I would estimate that that has probably dropped about half between-deck height, so it has probably gone down 4 or 5 feet into the next deck down.

CMDR RUSH: What we're looking at in that photograph is the timber decking of the ship in the background?

MR JEREMY: Yes.

CMDR RUSH: At figure 161?

MR JEREMY: This shows the very stern of the ship. There are further examples here of implosion. You can see the side shell plating right at the stern has been forced inwards. Part of that side shell plating there, I think, is a temporary repair which was carried out to some damage which occurred to the ship when coming alongside in Fremantle some time in the previous year, but there is clear evidence there of implosion, and you can see the deck plating is bent right in and the ship's side has been drawn in as well.

CMDR RUSH: Is figure 162 a diagram of the implosion area based on the drawings of the ship?

MR JEREMY: Yes, that is. That shows the approximate extent of the imploded upper deck aft and it also shows the location of two considerable splits in the upper deck right beside Y turret, which may have occurred during the implosion or may also have occurred during the impact with the sea floor.

THE PRESIDENT: Does implosion damage occur when the water pressure exceeds the structural strength of the ship plus the internal air pressure?

MR JEREMY: Yes.

DR CANNON: It's a combination, as John mentioned earlier. There will be intakes that air can either come in or out of, and it's dependent upon the speed at which water can go in. If water goes in at the same time as the load created by the sinking process, then it won't implode. If it's much slower, then it will.

THE PRESIDENT: Thank you.

CMDR RUSH: In general terms, from what we have looked at, Mr Jeremy, earlier in relation to torpedo damage and sustained shell damage forward of the ship, the area of implosion damage was relatively free of battle damage?

MR JEREMY: Yes, it is relatively free, as far as we can tell, yes.

CMDR RUSH: In relation to its ability to maintain watertight integrity, is that, if you like, demonstrated by that diagram?

MR JEREMY: Yes. It suggests that most of the aft section of the ship was probably still full of air when the ship left the surface, so it was probably not subject to any major flooding.

CMDR RUSH: Sir, is that a convenient time?

THE PRESIDENT: Yes, we will take a brief adjournment.

SHORT ADJOURNMENT

CMDR RUSH: At page 187 of the report you deal with the damage sustained by the ship on impact with the seabed.

MR JEREMY: Yes.

CMDR RUSH: That is perhaps demonstrated at figure 164?

MR JEREMY: Yes, it is. Sydney appears to have landed in a sandbank or an area of silt, so some of the interesting areas to look at to judge just how she hit the bottom are hidden. But there is some evidence of impact damage around the stern.

In my opinion, it is quite possible that the first bits of the ship to actually hit the bottom were the rudder and the cut-up where the keel comes up towards the stern, so that has contributed to the damage to the stern.

CMDR RUSH: Perhaps if we go to figure 165?

MR JEREMY: This shows the port inner propeller of Sydney. As you can see, it is partly buried in sand or silt. It looks actually like sand. The A bracket has broken away from the hull.

CMDR RUSH: Could you point to where the A bracket is?

MR JEREMY: That's it there (indicating). The upper arm of the A bracket has fractured. You can see the end of the fracture of the A bracket. It is very hard to see in this image, but you can see the broken end of the A bracket arm on the ship (indicating). As you can see, that propeller shaft has been bent outwards from the hull during the impact. It has also been partly withdrawn, because that propeller should be right up against the A bracket, so it's likely that either the A bracket has moved forward or the propeller shaft has been partly withdrawn during the impact with the sea floor.

CMDR RUSH: And figure 166?

MR JEREMY: This shows a bend in the starboard bilge keel. In this area, there appears to be less sand and it is quite possibly a solid rocky bottom, so the ship has sat down with a significant thump. There is also evidence in this photograph of some collapse of the shell due to implosion.

The next two images show the area affected on the starboard side where the shell has collapsed. It is approximately in that region (indicating) and it appears as if the watertight compartments in that area have collapsed through implosion during the sinking.

CMDR RUSH: So what is demonstrated there is an area of implosion damage?

MR JEREMY: That is an area of implosion damage. The bend in the bilge keel is almost certainly as a result of hitting the bottom.

CMDR RUSH: And at figure 168?

MR JEREMY: Figure 168 is a section through the ship showing that area of implosion, and the spaces just immediately inside that red line are in fact watertight compartments in the double bottom, which would have been completely sealed when the ship left the surface.

CMDR RUSH: And in relation to the forecastle deck, in your opinion did that sustain damage in this process?

MR JEREMY: We think it probably did. The next image perhaps might be appropriate.

CMDR RUSH: Figure 169.

MR JEREMY: This shows the forecastle deck immediately forward of A turret. Up in the top left there, that piece of structure with round holes in it is actually part of the safety firing arc mechanism for A turret. But just below the anemone there on the left, you can see that the deck has split and this section of deck has been bent down.

On the bottom left, we have a mushroom-top ventilator there, which has been damaged possibly by impact by something. Right in the middle of the photograph is a watertight hatch without its lid. On the right of the picture, you can see where there has been a split in the deck along a deck seam, and this flappy piece of plate up forward here - and also the whole deck piece would have been flappy - has possibly ended up in that position partly because of the impact with the sea floor and partly because of the passage through the water on the way down.

CMDR RUSH: Speaking very generally, is it possible to give some idea of the force with which the hull of the ship would have met the sea floor?

MR JEREMY: It would be only very general, I'm afraid. It's quite a heavy hit. There is not much data about how fast ships go when they hit the sea floor, but it could have been perhaps between 10 and 15 knots.

CMDR RUSH: Was there damage to the ship as a consequence of the tearing away or breaking off of the bow section?

MR JEREMY: Yes, there was. Perhaps if we look at figure 170. This shows the fore end of the bridge. The scuttles, which you can see in the forward screen there, are scuttles for the captain's sea cabin and the navigating officer's cabin. Above it, you can see a large area of plating which has collapsed in. That particular section is quite a smooth collapse, but a bit further up it looks as if it has been hit by something. In behind that screen would have been the wheelhouse, and we think that the forward part of the bridge may have been hit by some large piece of wreckage during the sinking process.

CMDR RUSH: Apart from the bow section, is there anything else that would explain that?

MR JEREMY: Well, it could be a piece of ship's side shell or something of that nature, but a fairly large chunk, probably.

If I may just expand, CMDR Rush, we know that this was not damaged before the ship sank, because the bridge roof, which was right over the top of all of this, is sitting quite intact in the debris field leaning up against the director control tower, so it must have left the ship before this happened.

CMDR RUSH: Is the deterioration of the ship that was referred to earlier in evidence, and the formation of rusticles, general throughout the ship?

MR JEREMY: Who is our rusticle expert at this table?

MR BUCKLAND: This is just the general state of the ship. There is rusticle, rust and other deterioration to the ship.

CMDR RUSH: Just to make it clear, if it hasn't been made clear already, figure 171 is indicative of the way the rusticle formations congregate or develop over years?

MR BUCKLAND: The right-hand side image shows a lot of the rust and the rusticles. Those large lumps are called rusticles that form on the side of the ship.

CMDR RUSH: Again, in general, is that consistent with other wrecks that have been discovered in similar positions over years?

MR BUCKLAND: Very similar, yes.

CMDR RUSH: Could we have a look at the timber deck at figure 173. The depiction in that figure shows, in general, photographs of the timber decking and then points to their position on the ship. The report indicates that in relation to the thickness of the decking, there appears to be a reduction in thickness.

MR BUCKLAND: Yes. Large areas of the forecastle and the upper decks were covered with wood planking. At the moment, just from observations, it would appear that the wood has deteriorated. The only other information that we can gather from this is that the caulking between each of those planks is elevated. It would appear that the wood planking has rotted or deteriorated.

CMDR RUSH: Again we'll deal with this a bit later, but in relation to fire damage, does the deck seem to have survived that, the wooden decking?

MR BUCKLAND: It appears to have survived that. It's fairly difficult to see, from the state of the ship.

CMDR RUSH: Can we turn our attention to damage to the weapons systems at page 194 and look at the 6 inch guns and fire control. Firstly, in relation to the wreckage, you have produced a diagram of the final orientation of each of the 6 inch guns?

MR BUCKLAND: That's correct. At figure 174, you will see that for A and B turrets their final resting state is pointing to port. X and Y, on the aft guns, are both pointing to port but aimed forward.

CMDR RUSH: You mentioned before that some of the damage to turrets is indicative of firing from the starboard side. Is that orientation consistent with that?

MR BUCKLAND: If you see the damage to A turret currently, you would expect that all these guns were pointing towards Kormoran at some stage, but on A turret there are large weapon holes on the front face. It's now the front face, but in normal position when that's pointing forward, it would be the starboard face. We would expect that that damage occurred from the Kormoran firing over the bows of the Sydney and hit that face at that stage, so the guns were, by that time, inoperable and pointing to port.

CMDR RUSH: Figure 175, looking at the computer model of the ship, I take it is taken from the photographic imagery and then we get an idea of it sitting there in the reconstruction?

MR BUCKLAND: You get some idea of the way it's pointing, but I wouldn't take too much detail from these, because there has been secondary damage to the gun barrels, so the angle that they're elevated to currently would have been from part of the sinking process.

CMDR RUSH: Figure 178 is a reconstruction of the final orientation of X and Y turrets?

MR BUCKLAND: Correct, and again you will see that they are pointing forward but to port.

CMDR RUSH: Mr Buckland, in relation to the director control, figure 181 shows the director control tower in the debris field.

MR BUCKLAND: Correct.

CMDR RUSH: You have taken us through the damage.

MR BUCKLAND: The director control tower base received several hits, but we predict that the tower stayed with the ship until the sinking process, so this parted on the break-up of the ship through the water.

MR JEREMY: Perhaps, CMDR Rush, I could comment. The photograph, figure 181, also shows the bridge roof lying

against the director control tower. It is substantially intact.

CMDR RUSH: With regard to the 4 inch guns and fire control, Mr Buckland, was it possible to determine the orientation of the guns?

MR BUCKLAND: Again, we have a reconstruction in figure 183 of the current state of the 4 inch guns. You will see that one is missing, presumably as part of the sinking process. Something may have pushed it off. We are assuming that. Again, regarding the direction that these guns are pointing, both in elevation and direction, they could have easily been hit by things as the ship sank.

CMDR RUSH: So three of the guns are still fixed to the mounts?

MR BUCKLAND: Correct. You will see images in figures 183 and 185 showing the guns in the wreckage. You will see there where the decking plate from the base of the gun has been wrapped around that gun, again probably from the sinking process.

CMDR RUSH: And in relation to the plating that was spoken about yesterday around the 4 inch gun deck, was any of that remaining?

MR BUCKLAND: There was one small section. If you look at figure 187, there is one small section, which it is hard to identify from this photograph, but there is a plate there that's protecting - that is the only part of the plate that we can find.

THE PRESIDENT: You are not able to determine if these guns were fired, are you?

MR BUCKLAND: No.

CMDR RUSH: In relation to the fire control system for the 4 inch gun?

MR BUCKLAND: Again, figure 189 shows the base of the control station. You will see that there has been a large impact at the top. That is the base where the tower would have been. That damage would have resulted in the tower collapsing on to the deck. But, again, it didn't totally

part with the ship, because it's in that debris field, so it wasn't lost at the battle site.

CMDR RUSH: The damage to the tower would have impacted on the system in relation to the 4 inch guns, I take it?

MR BUCKLAND: Totally. That is for directing of the guns, and also here there were a lot of fragments flying into other things, such as the aerial.

CMDR RUSH: As far as the quad machine guns are concerned?

MR BUCKLAND: Again, the mountings are shown. We assume that the quad guns have been washed overboard, again through the sinking process. We don't think they were blown off from weapons damage.

CMDR RUSH: Were the port and starboard torpedo tubes found with the ship?

MR BUCKLAND: No. They were found in the debris field. If you look at figure 191, this is where they were mounted. They were mounted on that ring there, so both the port and the starboard weren't with the ship, but they were in the debris field.

If we go to figure 193, this has been identified as the starboard torpedo quad tubes. There are three torpedoes still in their tubes. There has been a large amount of damage. You can see there is one which sustained minor damage, but the other two are largely damaged. We assume that is from one single shot that has come through and hit the tubes from approximately 90 degrees.

CMDR RUSH: So when you are indicating the damage and a single shot, in the background, if you like, at the top of the photograph, we see a torpedo that seems to be largely damaged.

MR BUCKLAND: Correct. On the right-hand side of that, that is where the warhead part of the torpedo is, and on the left-hand side is the air cylinder to run the motor for the torpedo. On the left-hand side of that photograph, you will see the rollers that sit on that mounting that we saw previously.

CMDR RUSH: So the torpedo tubes were, in effect,

inverted?

MR BUCKLAND: Inverted, yes, as sitting on the ship, this is the bottom of the torpedo tube.

CMDR RUSH: I think you said that you think that the damage to those torpedoes has been caused by a single shot?

MR BUCKLAND: A single shot coming from one direction, it is indeterminant as to which direction that shot has come from.

CMDR RUSH: A shell?

MR BUCKLAND: It would have been a large shell hit.

THE PRESIDENT: The propulsion for those torpedoes are those little propellers, I take it?

MR BUCKLAND: No. That is the fusing for the warhead itself.

THE PRESIDENT: It fires outwards to the right as we look at it?

MR BUCKLAND: Exactly.

THE PRESIDENT: And was a fourth torpedo found anywhere nearby?

MR BUCKLAND: There is a torpedo loose in the debris field, but we can't identify whether it is from the port side or the starboard side. If we go to figure 198, this has been identified as the port torpedo quad tubes, and here we have two torpedoes still in their tubes and two missing. Then if we go to figure 200, there is a torpedo in the debris field, so we have identified six torpedoes in total from the debris field. There would be two missing.

CMDR RUSH: You indicated, Mr Buckland, that it was possible to distinguish between the starboard tubes and the port side tubes?

MR BUCKLAND: Yes. If we go to figure 195, we can identify that they're the starboard or port from two means. There is a platform at the top left of that picture, which indicates that it is the starboard quad tube. The

secondary way we worked out that it was the quad tubes is on the end cover plates of each of these tubes, they have a lettering system which indicates the firing order of the tubes for the fire control on board the ship, and these are labelled "Q", "X", "Y", "Z". If we go to figure 196, on the end caps they're actually identified as "Q", "X", "Y", "Z". You need to home in, and if we go to figure 197, it will be easier to see in a minute. In the middle of that circle, there's a letter "Q".

And there's a letter "Z" that's embossed on those cover plates. If we go to figure 199 on the port torpedo tubes, again we can identify from the side plating but also from the embossing on the end covers, and you will see an "E". On the port side quad tubes, they are labelled "F", "I", "R", "E", which is the indication, again, for the firing. So that's how we identified that they were the port and starboard sets of tubes.

CMDR RUSH: Is it then possible to determine whether the torpedo tubes were manned and whether they were pointing outwards from their stowed position?

MR BUCKLAND: No. From the starboard side tubes, from the reconstruction that we did, it was more likely that they were pointed out, when they were hit, than stowed, but we can't give a definite.

CMDR RUSH: What was it about the tubes that led you to think that?

MR BUCKLAND: Because of the direction - if you look at figure 193, it is indicating that possibly it is more likely that the weapon came from the front of the screen to the rear of the screen, so as the damage got worse, that's the direction of the shell that came through, so it clipped tube number 2, took a section out of tube number 3 and then hit number 4 and took a larger section.

In this case, for this side tube, the torpedo that is missing would be the torpedo that was stowed inboard. For that to happen, the shell would have had to come from the port side, but our reconstruction would show that there is a lot of structure in between that tube, so it is more likely that that tube was pointing outwards and then it was hit from one of the shells as it was doing its turn, so the shell has actually come from forward, over the bow, and

then hit those tubes. Again, we can't really make it definite.

CMDR RUSH: So that we get some overall understanding to put the photograph in some context, you have at figure 194 given us a diagram of the 21-inch torpedo. What is the overall length of the torpedo?

MR BUCKLAND: It is 24 feet, so the warhead itself is only a very small section. We might just indicate the head there, and that's where that firing pin that you can see is, around there. Where that weapon damage has occurred is almost between the warhead and the air vessel itself.

CMDR RUSH: Sir, the intention now, subject to your assent, would be to call Dr Neill, who was responsible for the creation of both the computer model that we have seen and the simulation that I showed in opening, to explain how that was done, and then to bring people back together to go through the interpretation of the evidence that has been put before the Commission thus far, and then finally to deal with the operational aspects of Sydney and fire damage.

So, gentlemen, if I could ask you to retire for a short period of time, and I call Dr Neill.

<ROGER ANDREW NEILL, affirmed: [12.16pm]

CMDR RUSH: Dr Neill, could you state your full name to the Commissioner, please?

DR NEILL: Roger Andrew Neill.

CMDR RUSH: And your address?

DR NEILL: [redacted]

CMDR RUSH: And, Dr Neill, your current position?

DR NEILL: I'm head of Unmanned Maritime Systems in the Maritime Platforms Division of DSTO.

CMDR RUSH: Do you have a degree of Bachelor of Science.

DR NEILL: Yes, a physics degree.

CMDR RUSH: And also a doctorate, in what area?

DR NEILL: It's medical physics.

CMDR RUSH: In your work at DSTO, you mentioned that you are in charge of Unmanned Maritime Platforms, but over a period of time have you also, starting off with the discovery of the AE2 submarine, developed an interest in maritime wrecks?

DR NEILL: Yes. Mr Buckland has mentioned many times the remotely operated vehicle imagery of the Sydney. Coming out of my expertise with unmanned maritime systems, I obviously developed an interest in the application of those systems to marine archaeology which was, to some extent, out of my interest, but, nevertheless I became involved with the marine archaeological assessment of the submarine HMAS AE2 and, from that, I believe I developed some expertise in this domain.

CMDR RUSH: And, Dr Neill, in relation to the DSTO work for this report, did you undertake the task of creating a computer-built image of HMAS Sydney?

DR NEILL: Yes. Again arising from the work that I did with AE2, I found that by building a high-fidelity model of that submarine, it very much facilitated the interpretation of the wreck of that submarine in its location on site in Turkey, so it seemed like an obvious and sensible thing to follow a similar process with the Sydney. We have found that by developing high-fidelity computer models, you are able to do a degree of, I use the term forensic visualisation, accurate representations of various scenarios that may be relevant.

CMDR RUSH: What did you use to produce and put together the computer model?

DR NEILL: I started with the original as-built drawings of the Sydney. I then attempted to track the changes and modifications to the ship, obviously working with my colleagues, so by making use of photographs and other sources of information I was able to incorporate changes that we were aware of. Then finally, we cross-correlated the imagery as generated by me with the imagery as seen on the seabed of the wreck of the ship.

CMDR RUSH: Sir, could we bring up DSTO.001.0069? You might take us through it?

DR NEILL: Yes. This illustrates the process that I used in building the computer model. What I have done on the left-hand side image is taken the profile view of some of the sections of the ship and the plan view and then superimposed those in the correct orientation and position. Then I have built a hull through those plans so that they correspond, as best as possible.

The very first thing that you find when you do this is that there are inconsistencies between the drawings, so there is inevitably a little bit of interpretation that has to take place.

Working from that, though, moving to the other side image, I have then, if you like, roughed in, for want of a better term, the major structures of the ship, so you can see the A and B turrets, the breakwater; the superstructure is beginning to be built; and a very early version of, for instance, the director control tower.

Then as I got hold of more information, acquired more information, I was able then to fill in the missing details I believe with quite a high degree of integrity.

CMDR RUSH: Perhaps if we can bring up the next image, which is 0415.

DR NEILL: Yes, no source of information was safe from me, so in the case of the Vickers quad machine guns, obviously we had that one photograph that we had access to, but I discovered that the manufacturer, the company Vickers, actually has a museum and it has photographs of some of the things that it has built, including the quad machine guns. So I was able to access photographs and I was also able to access a drawing of that unit.

Wherever possible, I've done that with all of the major implements on board the ship. When we started the process, I wasn't sure really what fidelity we needed, so I decided to just go for broke and built it as precisely as we could.

CMDR RUSH: The next image?

DR NEILL: As I mentioned a little earlier, we cross-checked the imagery as generated by me in the model against the imagery as evident from the ROV footage, so that is the vicinity of starboard side in the vicinity of the blacksmith's shop, and you'll see things like the grinding wheel that's still in place at the aft end of the blacksmith's shop, the skylight on top of the blacksmith's shop, which has been blown out, and there is the base of the mast sitting just behind the skylight there.

Generally, there is a very high level of correlation between what we built and what is shown on the ship. There are some very slight differences. There appear to be a couple of vertical supports between the upper deck and the foredeck, which I haven't actually shown, because they weren't shown in the plans. Until we got that footage, I had no way of knowing that those struts were there. So some things I haven't actually corrected, due to the pressure of time.

CMDR RUSH: There are one or two more in the next image?

DR NEILL: The next image is really to illustrate the level of fidelity that we generated and the fact that the model is recognisably HMAS Sydney.

CMDR RUSH: That deals with the model. Yesterday, there was also a simulation in relation to port side and starboard side damage and the aggregation of shell hits to the port side of Sydney and also the latter period of time dealing with Sydney and its roll. Firstly, dealing with the shells and the fire, as indicated, can you give us an indication of what you relied upon in bringing that imagery together?

DR NEILL: I worked with the team, so as the team generated the plot of shell hits, in the first instance along the port side of the ship, they very carefully positioned each hit and that was mapped. That made it very easy for me then to take those hits and position them on the model with, I believe, quite a high level of precision.

For instance, we had sidelights in a particular orientation. I was able to position the shell hits using those as reference points, for instance, and relate those to what the team had actually identified, so in that way we were able to build up, I believe, quite a realistic

representation of where each of the hits were.

CMDR RUSH: Perhaps if we do it in sequence, if we could go to the simulation, the first piece of simulation is an aerial view or fly-around of Sydney. It is 0416. Before we look at it, could you tell us what it represents and how it was done?

DR NEILL: Yes. We used a software package called Blender. It is actually an animation software package, but it's one that is able to be used for doing quite precise reconstruction. We used that to build the static representations that have been shown this morning and also to generate the animations that have been done.

With that package, it is an artist's package in that you are able to simulate, for instance, the position of the sun; you are able to simulate forces due to wind and, in that way, later on we were able to generate smoke. We have, we believe, a reasonably realistic representation of where the smoke would have been blowing. You are able to generate sea state type representations. So it is quite a powerful package. However, there is a degree of interpretation required to do what we have done.

CMDR RUSH: Before we show that particular section, you indicated that you worked with a team at DSTO and it was a team effort in relation to bringing together the information that you have attempted to put into the simulation?

DR NEILL: Yes, very much so. I actually attempted to retain a small degree of independence from the rest of the team, in the sense that we cross-checked against each other, so we worked a little bit independently and, in that way, we developed a high level of confidence that if we came up with consistent answers, we had confidence in each other's interpretations. That seemed to be a very healthy way to act, if you like, as an internal referee, and I think in every instance we came to the same conclusion.

CMDR RUSH: Perhaps if we have a look at this.

DR NEILL: With this sequence I was trying to get across four features of the ship which have very much come across in the last day. The first is the fact that, in this generation of ship, the quarterdeck and the foredeck were

very much associated with seakeeping and ship handling, with the exception of the depth charge rails, which are just visible on the stern there, the quarterdeck and the foredeck weren't involved with war fighting.

The evidence has shown that the German crew pretty much ignored those two parts of the ship, and it kind of makes sense when you think of it in that light.

The second thing which I was trying to portray was in highlighting the concentration on this generation of ship of the command and control in one part of the ship, so very much the bridge, the director control tower, the high-angle control station are all in one place. The only exception to that is the aft control position, which as Mr Jeremy pointed out yesterday had quite minimal equipment, in any case.

That is very much shown in that imagery where you have quite a large ship with a very, very centralised, and therefore very vulnerable, control station.

Likewise with the boats, the disposition of all of the ship's boats was really determined by the technology of the day. There was only one crane on board the ship and the boats were very much clustered around that crane in order that it be able to get those boats into the water. Again, that is a point of particular vulnerability for this design of ship, in that you have many of your lifesaving appliances concentrated in one place next to an aircraft which carried very flammable fuel.

CMDR RUSH: This was raised by a member of the public yesterday: is there any significance in the flag that is depicted there?

DR NEILL: The flag caused a great degree of stress, actually. That's the Admiralty Battle Ensign, as I understand it, which is the ensign that was used both in the First World War and the Second World War. Regarding the disposition of the flag, it appears that when the ship was entering and leaving harbour, it was normally deployed off a jackstaff at the stern of the ship, but for practicality purposes whilst she was at sea it was deployed off the mainmast in the location where it is shown.

To be quite honest, my use of the flag was to give an

impression of motion.

CMDR RUSH: The next sequence, Dr Neill, deals with the port side engagement. Firstly, in general terms, counsel assisting provided DSTO with a set of assumptions which appear in the report. Using that as a base, would you indicate what other information you used and how it was that you brought this particular piece of the simulation together?

DR NEILL: Yes. I started obviously using the assumptions as the basis for building the sequence. I attempted to cross-check particularly the timing of the sequence against what potentially was likely to take place, so based on the assumption that the ships were approximately 1,000 metres apart, based on the speed of Second World War German torpedoes, it meant that depending on whether the torpedo was flying at 30 knots or 40 knots, the time of flight through the water for the torpedo was somewhere between 50 and 70 seconds, so that gave me a strong basis to work against in terms of checking against the assumptions.

The gents determined that the likely maximum firing rate of the Kormoran's guns was around about seven salvos per minute, so I've worked off that and determined the total time that it would take to fire the number of salvos which were indicated in the assumptions, and the timing is quite consistent with what you would expect to see.

Essentially, I tried to work through the assumptions and do a reality check on each aspect of them. There are a couple of things which I questioned a little, and you will see that I have addressed them in the animation. For instance, the assumptions state that the bridge and director control tower were struck and then, shortly after, Sydney fired a salvo from all four guns.

If the director control tower had been struck, then in all probability that salvo from Sydney had to be fired under independent initiation from the four guns. So I have shown that in the animation.

Of course, if the order was slightly wrong, Sydney may have fired that salvo shortly before the director control tower was hit. I just worked with the assumptions.

The one other thing which I would say is that

throughout the animation, I have damaged some items on the ship, for instance, the cutters come away from the ship during the engagement, but I haven't damaged other things, and the reason for that is that it wasn't clear from either the assumptions or the evidence that we could see in the wreck field at what point things were damaged. Therefore, I've left them alone.

CMDR RUSH: One aspect of this particular sequence is the distribution of, if you like, the shrapnel fragments from each individual hit. Was that based as shown in the animation on any particular advice that you had been given in relation to that?

DR NEILL: The distribution, the actual spray pattern, is obviously just a visualisation, but it is meant to be representative of what is shown in the report. The radius or diameter of the spray as shown is actually meant to be a representation of the damage blast radius.

As Mr Buckland pointed out earlier, unless shrapnel actually hits something, it would have kept going much further than I have represented. So I have attempted to represent two things with the one visualisation.

CMDR RUSH: Just before we show it, is each individual hit on port side basically taken from the material that Mr Buckland referred to in his evidence this morning?

DR NEILL: Yes. Sorry, the one other thing, though, is that I didn't attempt to differentiate between hits that penetrated the ship and hits that exploded on the surface. The reason for that is that it would be very difficult to represent the scope of the damage of a shell that exploded inside the ship, so I felt that it was really more representative to show it as if it had exploded on the outside.

CMDR RUSH: Thank you.

DR NEILL: This first period, which is the first 10 seconds or so of this representation, corresponds to the period in which the Kormoran would have been decamouflaging. The assumptions state that the Kormoran also fired a ranging shot during this time. I didn't represent that.

The other thing which I didn't point out is that the point of visual reference here is the Kormoran's bridge.

CMDR RUSH: So this is meant to represent us looking at Sydney from Kormoran's bridge?

DR NEILL: From Kormoran's bridge, yes. This is about the time that the torpedo would have been fired. The first hit on the bridge is shown as a three-gun salvo from Kormoran. Our report states that Kormoran, in all probability, didn't have centralised firing, so the guns would have been fired independently. I have chosen to show them as if they were fired centrally, and the reason for that is that it makes it easier to see the sequence of salvos, but the actual contact would have been slightly staggered.

The first salvo, we believe, hit the base of the barbette of the director control tower and the region of the bridge, so the impact of that on the operation of Sydney would have been very dramatic indeed.

Winding back just slightly, I have shown Sydney's response as a slightly staggered four-gun salvo. Again, that's, as I mentioned, because I believe that the gun crews would have very quickly realised that they had to work in local control. They possibly were still using the firing solution, for want of a better term, that was directed by the director shortly before the hit, but they wouldn't have had the benefit of gyro initiation. Therefore, that may be an explanation as to why that shot apparently went high.

What you can see just starting here is a representation of the secondary armament from Kormoran focused on the 4 inch gun deck and the quarterdeck. At that point, I have represented the roof coming off B turret.

The evidence this morning was that the shell that actually hit B turret between the gunsights may not have fully penetrated that turret. Nevertheless, if you work out the kinetic energy of that shell, just the kinetic energy of the shell, regardless of its explosion, is almost equivalent to a tour coach at 100 kilometres an hour running into something. That's the sort of kinetic energy that is involved, and that hitting the front face of the turret in itself may have been sufficient to remove that

roof off that turret.

So the sequence continues. The focus was shifted to the A and B turrets and then shifted back more generally along the midships area. The fire started at this point. I have actually represented one of the hits on the port side davits for the sea cutters. You will see that I have represented a hit on the forward davit and then, a little later on, it represents the hit on the aft davit. The order is inconsequential. Whether it was that order or the other, the end result, as Mr de Yong has mentioned, is that the davit would have gone overboard, and that's shown a little later. So the cutter is actually hanging there on the side of the ship. Then a little later, another hit takes off the remaining davit.

The assumptions state that Sydney was moving backwards a little bit, possibly because she saw the firing of the torpedo, and attempted to slow down. I don't know the answer to that, but the assumptions state that she slowed down and I have attempted to represent that.

This is the torpedo hit. As was mentioned this morning, the ship would have responded by trimming up by the bow initially. Then the gas bubble that was generated by the torpedo actually creates a hole under the bow and she would then drop into that hole. She would then respond by coming back up again, and then as water flooded into the ship, she would trim down by the bow, so that is represented here over about a 20-second time frame. So she goes up, she drops down, up again, and then she starts to trim down by the bow as water rushes into the bow of the ship.

During that period, we didn't show any hits from the Kormoran. That was really a limitation of the computer technology that we had available. What I have represented there are the remaining hits on the port side, and I have represented them as being fairly low down by the waterline. I have no real reason to know that that was the case, but it does make sense that the Kormoran would attempt to breach the waterline as well as that caused by the torpedo hit, and there are hits there.

CMDR RUSH: Is the next image an aggregation of all port side hits as if they occurred all at once?

DR NEILL: Yes. It seemed to be a very effective, I'd say almost chilling, way of representing the impact of those 41 hits on the port side of the ship. Really, what comes across very, very strongly is just how completely and comprehensively that midships section of Sydney was covered by the Kormoran's fire, and this is ignoring the secondary fire from 3.7 and 2cm guns. (Sequence shown).

THE PRESIDENT: That last sequence also excluded the torpedo, did it not?

DR NEILL: Yes. That was meant to exclusively represent the 15cm shell hits.

CMDR RUSH: The next sequence, Dr Neill, is the 15cm shell hits to starboard side, and for this you worked on an assumption that Sydney undertook a turn to the port and crossed astern of Kormoran?

DR NEILL: Yes. That was actually initiated during the last sequence. During the last sequence, I showed the turn up to the point where Sydney was looking directly towards Kormoran. At least based on the assumptions, she continued to turn to port. She then crossed Kormoran's stern and then sailed off, from memory, at 150 degrees bearing and basically sailed away from Kormoran.

The assumptions state that Kormoran kept firing on Sydney until she was about nine and a half kilometres away from Kormoran. Depending on what speed you assume Sydney was doing, that may have been up to 50 minutes. Basically during that period, Kormoran fired reasonably consistently, we believe.

Sorry, there is one other thing that I forgot to mention on the port side engagement, if I could mention that. The assumptions state that Kormoran fired around about 11 salvos. If we assume a maximum of four guns could bear at one time, that is a maximum of 44 15cm hits on Sydney. We have identified 41. So if that assumption of 11 salvos from Kormoran is correct, then the firing during that first sequence was extremely accurate.

CMDR RUSH: The next one is sequence 4, with sound.

DR NEILL: The German account states that they saw the B turret roof fall off the ship. I represented that. It

was during that port turn that the Germans reported that they saw that turret roof fall off, so I have represented that. At this stage, I have also represented the hits on what became the forward face of A turret, which was legitimately at starboard side, but because of its disposition was pointing towards the front of the ship.

At this stage, the fire is very, very well established. There is a lot of smoke. From this point, we have no real knowledge of what order shell strikes would have taken place on Sydney, so I have simply geographically taken the chart that the team generated and I have started at the front of the ship and simply moved back. So that sequence follows.

Sydney is continuing to undertake the turn, and then she steams off at about 150 degree bearing. Based on the numbers of shells that the Kormoran's crew claim to have fired and the number of hits that are evident on board Sydney, they had somewhere around 10 to 15 per cent strike rate as the range increased.

CMDR RUSH: The final animation, Dr Neill, relates to later into the evening and the roll of Sydney. We are yet to get evidence in relation to that, but did you rely on the work that had been done by Terry Turner in relation to the computer modelling that he had done as to the flooding and the effect of the flooding and damage on Sydney?

DR NEILL: Yes. Mr Turner provided me with a time plot of roll versus time. It indicated that Sydney would have been rolling between about 15 degrees and up to 40 degrees, with around about a 10-second time frame per roll.

Here, I attempted to reproduce a section of the time line which Mr Turner provided me with, and I believe it is quite precise. This is sequence 5.

The German crew reported that they could still see the glow from the fires, so I have represented the fires in three principal locations, which we'll also talk about later on this afternoon, I believe. Sydney has listed heavily to port and she's rolling across from about 15 degrees down to about 40 degrees, 42 degrees maximum. I think this one might be 42 degrees.

The sea there is shown as having come up to about sea

state 4, which is about a 2.5 metre sea height, principal sea height.

CMDR RUSH: I think the evidence will be that the roll of Sydney developed from 15 degrees to approximately 45 degrees. Did you attempt to depict any particular degree in that animation?

DR NEILL: Yes. That's ranging between around about 15 and 42 degrees. I would have to look up the notes, but each roll is actually slightly different, because I tried to reproduce part of Terry's sequence. I believe that this particular roll is a 42-degree roll. The most upright position was 15 degrees.

CMDR RUSH: Sir, before lunch, I wonder whether we will take an uninterrupted view of the animation so that we get a complete picture, at 0415.

THE PRESIDENT: Yes.

(Sequences 1, 2, 3, 4 and 5 shown).

CMDR RUSH: Sir, I tender the video animation.

EXHIBIT #107 VIDEO ANIMATION PROVIDED BY DR NEILL

CMDR RUSH: If that is a convenient time, sir?

THE PRESIDENT: Yes. We will adjourn to 2 o'clock.

LUNCHEON ADJOURNMENT

UPON RESUMPTION:

CMDR RUSH: Sir, may we now deal with aspects of the interpretation of the evidence. In relation to that, if Mr John Jeremy, Dr Cannon, Mr Buckland and Mr de Yong could return to the witness desk, at least initially.

Could we deal firstly with the weapons damage and analysis process. We have been over this a little bit, Mr Buckland, but could I just get the process. You refer in the report to using an XVAM analysis to try to interpret the weapons damage to Sydney. Could you give the Commissioner the background of that and how it is used?

MR BUCKLAND: It is a vulnerability assessment simulation program that DSTO has developed over many years and that is based on a large database from real weapons trials, fragmentation of weapons and blast and fragment damage.

The simulation looks at the structure of the ship and calculates, based on the velocity and weight of fragments, how far they will penetrate through various bulkheads. It will also look at damage from blasts onto bulkheads within the ship and it also has a simulation to look at crew incapacitation based on critical failure of levels in the program.

CMDR RUSH: From the perspective of examining the 15cm shellfire to various parts of the ship, what do you do?

MR BUCKLAND: We took the 87 hits that we identified as striking the ship, we took their coordinates and we put them through the simulation to see the relative amount of damage to the ship's structure. For the contact-detonated shots, we detonated them on the surface. For the shots that we identified that penetrated into the structure, based on the velocity of the shell we put a distance into the structure and detonated the shell inside the structure.

CMDR RUSH: The distance that the shell enters into the ship, I take it, is dependent upon the structure --

MR BUCKLAND: The program can calculate the residual velocity of fragments going through from one section, so if there is a 10mm plate and it is hit by a 1,200 metres per second fragment, it will calculate the residual velocity

and mass of that fragment as it penetrates through. With the warhead hitting the hull, once it strikes the hull plate, there will be a residual velocity, and depending on the fuse delay of that warhead, it will travel in a certain distance. In this case, we tried to detonate most at the centre line of the ship, except in cases where we knew that there was a lot of structure in front of that warhead.

CMDR RUSH: Dr Skeen has brought up on the monitor figure 1, which is the XVAM model for Sydney. Would you explain what the model represents?

MR BUCKLAND: We created a representation of the Sydney based on the bulkheads and the hull plating thicknesses. Each of those square rectangular blocks is a representation of a compartment or part of a compartment within the Sydney. This is an output from one of our simulations from a single 15cm shell. The orange compartment is where we have detonated a shell, and you will see that there are 2,600 fragments being generated into that compartment.

In the compartments, as we go out through the structure, this is a representation of the fragments, so then you would move out to a lower number of fragments as you move away from that detonation point out to a point where the dark blue is one or two fragments having penetrated that far.

As part of the code as well, there is another module which calculates pure blast damage. Then they are combined. It is a probability-type calculation, in the end, for what is the likelihood of damage.

CMDR RUSH: Does each one of those sections represent a deck of Sydney?

MR BUCKLAND: Yes.

CMDR RUSH: So where we see the colour, is that the forecastle deck of Sydney?

MR BUCKLAND: That's correct.

CMDR RUSH: The first colour there is blue. What does that represent?

MR BUCKLAND: This is representing a volume that the

fragments are in. Where it is orange, we are calculating that the detonation has occurred there, so there are 2,600 fragments in that space. You will see later how we have put in a vector for those fragments so that we know which way the fragments are travelling.

CMDR RUSH: Does the model take an examination of each of the identified 15cm hits both port and starboard of Sydney?

MR BUCKLAND: Exactly. We will go through where we have combined the whole 87 shots to get a total damage profile on the ship.

CMDR RUSH: In the report, going back to page 215, at the bottom of that page you use the term "blast overpressure" generated from the shell having limited damage potential but the explosion producing more than 2,000 lethal fragments. What is the overpressure?

MR BUCKLAND: We have identified two shells that were used. There is the armour-piercing or the base-fused shell, and that had only 1kg of explosive. The detonating charge, the nose-fuse shell, had approximately 4.5kg of explosive. That explosive, when you detonate it, creates an overpressure into a space, and that overpressure is what does the damage to, in this case, structure, equipment and other things within that space.

CMDR RUSH: We have on the screen figure 201, which is a cross-sectional profile of the German 15cm AP shell.

MR BUCKLAND: That's right.

CMDR RUSH: So the significance of the AP shell is that it is designed to penetrate armour?

MR BUCKLAND: It is designed to penetrate armour, so it will penetrate a long way through the ship's structure, depending on what it will hit. You will see that it has a very heavy steel section at the head.

CMDR RUSH: Is there a delay in the fusing of that shell to promote explosion inside the ship?

MR BUCKLAND: There is a fusing delay that it can be set to, depending on how far they would like that to penetrate through into the ship.

CMDR RUSH: At figure 202, we have the HE shell?

MR BUCKLAND: This is the HE shell. This is really just to demonstrate the less-thick wall. In this case, there is a higher detonating charge within the shell. This shell would generate 4,000 steel fragments. The armour-piercing shell would still generate approximately 2,000 steel fragments.

CMDR RUSH: As to the 20mm and 3.7cm armament of Kormoran, would you refer us to the projectiles that were fired by each of those?

MR BUCKLAND: The 3.7cm shell would have a similar bursting charge, so it would detonate as well and generate fragments. In this case, we haven't put it into our XVAM analysis. We did this purely on the 15cm shells. A lot of the 20mm rounds also had a small bursting charge within them as well, so they would, on contact, also cause other fragments.

CMDR RUSH: You refer at page 216 to the 3.7cm shell having a velocity of 800 metres a second and the 20mm shell having a velocity of 900 metres a second.

MR BUCKLAND: Correct.

CMDR RUSH: Is that velocity of significance in relation to the damage?

MR BUCKLAND: These are the muzzle velocities. The velocity is important because it is giving the kinetic energy to that shell. Depending on the stand-off distance, you will have greater kinetic energy being close before the velocity drops off.

CMDR RUSH: Do those shells also have a fragmentation?

MR BUCKLAND: Yes, correct.

CMDR RUSH: So they create their own shrapnel field?

MR BUCKLAND: For the 20mm, there is only a limited amount. There is a limited bursting charge within them. A lot are tracer rounds, which have a very small charge the 3.7cm HE would generate. The shells in this case are

700 grams, so the actual amount of steel fragments is around that range.

CMDR RUSH: You mentioned before that the steel fragments from the 15cm shell would go around the ship until stopped by something. Is it the same in relation to the 3.7cm gun and the 20mm gun?

MR BUCKLAND: It is, but the velocity of those fragments would be much less than that generated by the 15cm shells, so the 15cm shells would have a greater lethality range.

CMDR RUSH: At page 217, you refer to weapon trajectories and that the elevation required of the 15cm gun for a range of 5,000 metres is only 1.7 degrees.

MR BUCKLAND: Correct.

CMDR RUSH: From there, you say that shots on the Sydney appear to have a shallow impact angle.

MR BUCKLAND: Exactly. It is very difficult to pick up what that angle is, but we have done so from the concentric nature of the shell holes that we've seen. The angle of fall at table 21 in this case is important, apart from the elevation angle of the gun. The angle of fall is the contact angle at which that shell will be landing on the ship or on the hull. Even at 10,000 metres, the angle of fall will be only 8.8 degrees.

CMDR RUSH: What is the significance of the angle of fall, for instance, at 5,000 metres of 2.2 degrees?

MR BUCKLAND: It means that the contact point of the shell onto the surface is basically normal to the hull, so that you have a greater chance that it will penetrate into the hull.

THE PRESIDENT: If we're speaking, as we probably are, of distances between 1,000 metres and 1,500 metres, you would expect that the striking velocity would be greater than 673 metres per second and closer to muzzle velocity and that the angle of fall would be less than 2.2 degrees?

MR BUCKLAND: The striking velocity won't be much more than 673 metres per second. Right up to 5,000 metres, there is not going to be much drop-off. The muzzle

velocity, I think, was 800 metres per second at the start.

THE PRESIDENT: So what is the difference between 5,000 metres and 1,500 metres?

MR BUCKLAND: For the striking velocity, we're probably looking at 700 metres per second.

THE PRESIDENT: And the angle of fall would be marginally less than 2.2 degrees?

MR BUCKLAND: That's at an elevation of 1.7 degrees. You have lost 0.5 degree over that range.

CMDR RUSH: In the bottom paragraph on page 217, you use the word "lethality" of the warheads and you say that they are "extremely lethal over 10,000 metres". Is that accentuated the shorter the range?

MR BUCKLAND: By the striking velocity. In this case, it's not the actual weapon detonating; it is just the striking velocity, so especially for the AP shot, it is likely to go further into the ship. As it crashes through the ship, it is going to do a lot of damage as it goes through the ship, because you will get a lot of secondary damage. As it hits the shell plate, it will create those bits of fragments from the hull that would go through the ship at that velocity as well, and then it will keep hitting subsequent bulkheads.

CMDR RUSH: You refer, by way of two diagrams, to the estimated blast and fragment damage contours. At figure 203, that is for the AP weapon detonation. Can you explain by reference to the colours there what you are referring to?

MR BUCKLAND: Within our simulation, the areas that are in dark red represent a volume-based calculation on the blast overpressure, and everything within that volume will be destroyed within 1.5 metres. The casualty radius there means that any crew who are unprotected by a protected space, a totally enclosed space, would become a casualty within that volume.

On the right-hand side, there is a profile of fragments which will have a greater lethality range, but if that requires them to be unimpeded, they are a

line-of-sight calculation. For the AP shell, you will see that the fragments will be generated from the weapon between 75 degrees and about 125 degrees. The main generation of fragments will come from that perpendicular to the shell, and you will have 2,000 fragments coming out from that spot. You will have a few fragments that will be fired forward of that shell, which is the shell head itself, and then a few other fragments which will be forced backwards.

CMDR RUSH: Then figure 204 shows the contours for the nose-fused 15cm HE shell.

MR BUCKLAND: That's right. Because of the larger detonating explosion, the amount of explosive, the casualty radius is higher. It is up to a 5-metre radius. Obviously, if that shell detonates on one side of a watertight bulkhead, that watertight bulkhead will protect the people on the other side, unless it is within 3.2 metres, and then it will create holes within that bulkhead.

THE PRESIDENT: Do you get a greater number of fragments if the striking velocity is greater?

MR BUCKLAND: You will get more secondary fragments from the missile itself. From the actual shell casing, you will get the same number of fragments that it detonates, but from the armour-piercing shell, if it still has forward velocity before it detonates, you will get that extra velocity from the fragments and you will get an extra lethality from the fragments as it pushes through.

THE PRESIDENT: Created on the way through?

MR BUCKLAND: That's right.

CMDR RUSH: Mr Buckland, you deal with torpedo damage mechanisms. We've discussed today the mechanism, if you like, of the initial tearing of a hole in the hull of the ship and also the penetration through, in this aspect, the starboard side of the ship. Does the bubble that is created also have the consequences of damage and flooding?

MR BUCKLAND: I probably explained this morning that the explosive will blow a hole into the actual hull itself and you will have secondary fragments from that hull material

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.

CMDR RUSH: Is that in relation to the Maritime Platforms Division?

MR GAMBLE: In support of Navy submarines and surface ships.

CMDR RUSH: Could you state your full name and address, please, Ms Suendermann?

MS SUENDERMANN: Brigitta Suendermann, [redacted]

CMDR RUSH: And your qualifications?

MS SUENDERMANN: I have a Bachelor of Applied Science and a Masters of Applied Science.

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

MS SUENDERMANN: Also with the Maritime Platforms Division in fire and damage control research, undergoing analysis of fire risk assessments on ships, mathematical fire modelling and fire trials.

CMDR RUSH: Did you jointly attempt to examine the organisation of the ship, doing so without a watch and station bill?

MR GAMBLE: Yes.

CMDR RUSH: From that examination, did you produce a table - table 14 on page 104 - based on other ships and other Navies, of the likely distribution of personnel through the ship?

MS SUENDERMANN: Yes, we did.

THE PRESIDENT: At Action Stations?

MS SUENDERMANN: At Action Stations, yes.

CMDR RUSH: Just to show that, at page 104, if we go down the column to the fourth, we're dealing with the painter, the plumber, the blacksmith and the joiner. At Action Stations, they are at a damage control station?

MS SUENDERMANN: At a guess, an educated guess. The painter I don't know about. The plumber is obviously quite useful, and the same with the joiner and the blacksmith. They're useful for damage control purposes.

CMDR RUSH: You went to US Navy data and the like to try to establish a pattern in relation to the distribution of men in Sydney?

MS SUENDERMANN: That's correct. We went to the US Damage Control Book of 1945, because information from the British Navy wasn't available to us. That was four years later. The organisation will not have changed significantly. We used this information for where we expected people to be at Action Stations.

CMDR RUSH: From that information and also other material, firstly, did you work out where the damage control sections would be located at Action Stations on Sydney?

MS SUENDERMANN: Yes. Looking at information from HMAS Hobart, which had an incident on torpedo hit a few years later, they detailed three damage control stations, which have been indicated already today.

CMDR RUSH: That's at figure 78.

MS SUENDERMANN: They are the green blobs. They are all on the lower deck. The forward one is underneath, in the mess area, between the two turrets. The central one, DC2, is in the electrical engineer's workshop and predominantly would deal with the engine spaces, which are distributed either side. The aft one is also in a mess area and is fairly close to the wardroom flat. The damage control headquarters is in the lower steering compartment on the platform deck.

CMDR RUSH: So the damage control headquarters is on the platform deck in the forward steering compartment?

MS SUENDERMANN: The lower steering compartment.

CMDR RUSH: Who was the officer in charge of damage control?

MS SUENDERMANN: We have a discussion about that, whether it is actually the executive officer or possibly the senior

engineer on board. There is usually a group of officers involved in damage control with the overseeing of the organisation.

CMDR RUSH: You set out the damage control and examples of damage control at figure 81.

MS SUENDERMANN: Yes.

CMDR RUSH: That is at page 115, which we are just coming to. The splinter boxes and the wood shoring and the like would look, according to the diagram, to be a fairly old-fashioned method of damage control.

MS SUENDERMANN: It is still in current use today.

CMDR RUSH: If we can look at the individual sections in that figure, at (a) we're dealing with a system of plugging using pieces of timber.

MS SUENDERMANN: Correct. If you have a hole in a bulkhead, the more obstacles you can put into that hole the less leakage you are going to have through it. The idea of this method is to stop the ingression of water into your compartment, so if you can jam objects into it, that will slow down the leakage.

They have on board wedges and lumps of wood specifically for blocking holes, and obviously the hammer, but they could use anything on hand to block holes.

CMDR RUSH: Figure (b) shows bracing. What is the purpose of that?

MS SUENDERMANN: You can see that there is a bow in the vertical, which means that there is some pressure on the other side - presumably water - so you can try to brace it; you can try to strengthen that bulkhead. The bracing pieces usually are lengths of wood, four-by-two typically. Again, still carried on board ships today.

CMDR RUSH: Then there is a figure demonstrating a splinter box.

MS SUENDERMANN: A splinter box is made from steel. Some of them, I think, were made on board. They carried them. As the central part of this diagram shows, you put them

over the damaged hull to cover the entire hole, if possible. You would presumably do this to a deck that is still above the waterline. It is a bit hard to do it when you are under the water.

CMDR RUSH: Then the splinter box, as we see, is shored in place.

MS SUENDERMANN: Yes. It has to be held in place. There should be men in place to watch these various types of repair.

CMDR RUSH: Apart from the repair types set out in those figures, are you aware of any other types of damage control for the plugging of holes in ships?

MS SUENDERMANN: There are other forms. These are just examples of how you would use the shoring. You could block them up in various ways. You can shore over hatches; you can brace doors.

MR GAMBLE: There was an example from the Second World War where a split in a bulkhead or a deck was sealed with wads of clothing and then shored in place with timber. That's another method that could be used.

CMDR RUSH: From your examination of the systems that were available, having regard to the damage that we've seen that was sustained by Sydney, have you any view as to the effectiveness of this form of damage control?

MR GAMBLE: There were examples in the Second World War of ships sustaining torpedo damage, both forward and aft. In those examples, bulkheads were shored to be reinforced, to ensure that they didn't collapse under the pressure of floodwater. In the cases where that happened, they were single events, so just a torpedo hit; there weren't subsequent torpedo hits or shell hits to those ships.

CMDR RUSH: Were the damage control parties equipped by number and by resources to cope with the sort of damage that Sydney sustained?

MR GAMBLE: We don't believe so. In addition, casualties from the weapon impacts would have caused a loss of numbers in the damage control organisation, making it more difficult to repair the damage.

CMDR RUSH: You identified the positions on the ship for the various damage control parties. Were they each given responsibility for a particular section of the ship?

MS SUENDERMANN: Yes, they would have been responsible for the areas around where they were located, but if there had been no damage in their area, they would have been called along to other areas to assist.

CMDR RUSH: Mr Gamble, I am going to ask you this generally: have you also examined, to an extent, the electrical circuitry of Hobart?

MR GAMBLE: There is a number of examples of descriptions of electrical systems on British-designed ships in the Second World War, and they give a good overview of how those systems were operated.

CMDR RUSH: In relation to the damage sustained by Sydney from torpedo and shellfire, overall, do you have an opinion as to the impact that that would have had on the electrical systems?

MR GAMBLE: We heard a general description earlier of the electrical distribution system which is known as the ring main. The ring main and the electrical generators, four in total, were all located on the platform deck. Also on the platform deck was the switchboard room, which was the control and monitoring system for the electrical distribution system, and six breaker rooms. Basically, these allowed electrical power to be run from the ring main to individual electrical pieces of equipment.

If we look at the predicted extent of damage plans, at figure 247 --

CMDR RUSH: That is the damage to the platform deck compartment.

MR GAMBLE: Yes. As I said, this is where most of the major components of the electrical generation and distribution system were installed. In the forward section of the ship we can see predicted damage to two complete sections of the ship. That is two sections between watertight bulkheads. So it is quite a large area of damage. Forward of this damage and aft of the torpedo

damage were two of the breaker rooms which distributed power to individual pieces of electrical equipment in the forward section of the ship. Aft of these two sections were another two breaker rooms and the switchboard room.

The switchboard room is also predicted to have suffered damage, and while the loss of the switchboard room wouldn't have rendered the electrical system inoperable, it would have caused delays and difficulty as crew would have to move around the ship, particularly on the platform deck, to operate the breakers which opened and closed supply to various pieces of equipment or circuits.

There is also predicted damage at that level to the forward boiler room and also some to the forward engine room. This is an area where, at the side of the ship, the ring main cables ran, basically.

So all of that predicted damage combined results in a probable loss of the electrical system to the forward section of the ship, and if we go up to the lower deck, in figure 246, in this case the predicted damage is even greater than on the platform deck in the forward section of the ship.

So the branch lines from the breaker rooms would run up to the lower deck and then further up the ship to control the various pieces of equipment - lighting and ventilation, motors for the various pieces of equipment and the like - so it is likely that or most of these branch lines would be damaged as well, rendering the system inoperable in the forward section.

The damage to the aft of the ship is not as severe, and it is possible, particularly on the platform deck, that the ring main in this area and the breakers were intact.

When the ship moved to Action Stations, the crew would have split the ring main into four sections. Two of those sections would have supplied the forward section of the ship and two supplied the aft section of the ship. So it is possible that the aft two sections remained intact.

CMDR RUSH: The electrical system relied upon, I think, two generators to maintain --

MR GAMBLE: There were two steam-powered generators, one

in the forward engine room and one in the aft engine room, and two diesel-powered generators which were outside of the aft boiler room. Each of these would supply ring main cables on either side of the ship, and through the use of emergency cables which the ship would have also carried, the generators could have supplied other sections of the ring main or equipment directly using emergency cables.

CMDR RUSH: Having regard to the damage to the ship and the roll of the ship as depicted, what impact on damage control and personnel involved in damage control do you see that having?

MR GAMBLE: The roll angles described were quite steep. There is a report from HMAS Australia in 1945 when the ship was damaged by Japanese aircraft deliberately hitting the ship. One of those caused flooding and the ship was deliberately listed to 10 degrees to reduce the water pressure on a particular bulkhead. Comments from that damage report say that the ship would have been unworkable at a greater angle, so greater than 10 degrees would have rendered the ship effectively unworkable. So at between I think 15 and 40 degrees it would have been very difficult to undertake any operations on the ship.

CMDR RUSH: Can I ask you to turn to page 170. You there examine fire damage. At figure 145 there are set out examples of fire damage to the ship. You have picked four photographs to depict that damage. Perhaps if we examine the officers' galley on the forecastle deck. What are we looking at there to delineate the fire damage?

MR GAMBLE: Okay. This first example of fire damage, around the outside of the compartment there, along the edges and the corner, we can see paint that has blackened and is damaged from heat, so either from heat transfer from inside that compartment or flames on the exterior of that compartment.

CMDR RUSH: Perhaps if we go across to the adjacent photograph of the captain's sleeping space on the upper deck.

MR GAMBLE: This type of patching pattern, if you like, is typical of heat transfer from inside a compartment to the outside. Generally, we see the centre of the steel plating damaged by fire or by heat, and less damage at the top and

the bottom and in the corners of those compartments, where there is heavier steel structure which takes longer to heat up and can conduct the heat away, so causing less damage.

CMDR RUSH: So as a consequence of the photographic and video imagery, were you able to produce a diagram of the various decks of the ship and indicate where the fire damage was to Sydney, based on that evidence?

MR GAMBLE: We did predict fire damage to the exterior of the ship. We used the damage to the paint as the indicator for this. We disregarded a number of areas where the paint or the metal was degraded. These weren't consistent with fire damage. But large areas of the upper decks were, including from the bridge --

CMDR RUSH: Perhaps if we look at figure 146.

MR GAMBLE: On the port side, we see basically from the bridge extending right down to the lower deck we have fire damage, and on the starboard side from the bridge down to upper deck. Amidships we have the structure below the aircraft catapult. You can see that there were fires there. On the aft upper deck and forecastle decks we also have predicted some fire damage in that area.

CMDR RUSH: The areas that you have just gone to were on both the port and starboard side.

MR GAMBLE: On port and starboard.

CMDR RUSH: Then on the forecastle deck?

MR GAMBLE: The plan images are simply an estimate of the fire internally based on the external damage. While we can't see inside the ship to look at that damage, it is a reasonable prediction of the internal fire spread.

CMDR RUSH: You have indicated areas there both forward and aft on the forecastle deck and, just below that, the upper deck, of fire damage internally.

MR GAMBLE: Yes, internally.

CMDR RUSH: Then on the lower deck, smaller areas of fire damage.

MR GAMBLE: On the port side forward and starboard side aft.

CMDR RUSH: That is what you were able to ascertain from what was shown on the evidence provided from the images of the ship.

MR GAMBLE: Yes, along with the shell impacts, which provide the most probable cause of ignition of combustible materials in those areas.

CMDR RUSH: Would the fires be limited to that, or is there potential for fire inside the ship that just can't be determined.

MR GAMBLE: There is potential for greater areas of fire inside the ship that simply haven't transferred to the exterior paint.

CMDR RUSH: There are just a couple of other matters. At page 233 of the report, in paragraph 7.2.3, there is a statement that the fires would have eventually joined to form a larger conflagration, joined together. What are we talking about there.

MR GAMBLE: Because of the large number of hits to the forward bridge structure and below, there were a lot of hot fragments flying around, so it is possible that a number of small fires were initially ignited and eventually those fires would have spread and formed the large area of fire that we see predicted.

CMDR RUSH: Finally, did you undertake, by looking at the design plans for Sydney, the task of trying to assess, if he was in the forward steering position, how the XO might have got to the after steering position?

MR GAMBLE: Yes. It is assumed that the XO's position at Action Stations would be the lower steering position, which also acted as damage control headquarters. This practice was in place, and is still used in modern Navies, to separate the commanding officer and the executive officer, so that if the commanding officer becomes a casualty, the executive officer can assume command.

In this case, there was predicted damage to the bridge early in the battle, in which case the XO would probably

have to assume command, being the highest-ranking able-bodied officer on the ship. To do this, he would most likely move to the aft control position.

There is a number of possible routes to move to that location. The lower steering position is on the platform deck, so the XO would have to move up to the lower deck. There is only one possible route for this. Then there is a number of routes to move along the lower deck for most of the journey or some of the journey, and then move up to the upper deck and eventually up to the aft control position.

CMDR RUSH: Do all the routes, at one stage or another, have the XO on the upper deck?

MR GAMBLE: Yes. The XO needs to move to the upper deck at some stage. On the route that offers the most protection, the XO stays on the lower deck and moves up through a hatch which is on the starboard side of the ship and some what protected by the aft structure. That would be the route that would offer the most protection from fire from Kormoran.

THE PRESIDENT: That practice of separating the captain from the executive officer occurs only when the ship goes to Action Stations; is that right?

MR GAMBLE: I believe so.

CMDR RUSH: In general terms, the time taken to move from that steering position to the aft steering position is three to four minutes?

MR GAMBLE: Somewhere between two and a half and four minutes, depending on the route chosen. The major difference in time is that if the executive officer stays below deck there are more doors to go through and at Action Stations these would be closed and all the clips or dogs would be in place. So it takes some time to open a door.

CMDR RUSH: What you are saying is, for crew to move from that area of the ship where the XO may be, in general terms, to the aft area of the ship, if the ship be at Action Stations, is quite an intricate and detailed journey?

MR GAMBLE: It is quite a distance from the base of the

area of the bridge to the aft structure of the ship. If we bring up one of the diagrams on page 238, if we move to the bottom, this is the slowest route but that which offers the greatest protection. You will see that the bottom drawing is the platform deck. There is a short movement to a hatch up to the lower deck. There is then movement along the lower deck for quite a distance, going through a number of watertight doors, to a point where movement up through a hatch can be made to the upper deck. Then there is a short movement aft and then up a ladder to the forecastle deck. Then there is another ladder and movement across some open space to the door of the aft control position, which is on the port side of the compartment. This is where, in the case of the loss of the bridge, the ship would be controlled from.

CMDR RUSH: I think they are the matters that I wanted to raise, sir.

THE PRESIDENT: Thank you. Could we bring up figure 82, please, on page 116. This, as I understand it, is an illustration of what any person surviving below after the attack would have to do to try to get to a compartment through a watertight barrier; is that right?

MR GAMBLE: Correct.

THE PRESIDENT: What is involved in going, for instance, from the 4 inch HA magazine up to the sick bay or, alternatively, up above the galley into the upper deck. Would somebody have to walk up or climb up a series of ladders?

MS SUENDERMANN: Yes.

THE PRESIDENT: In that instance that I have mentioned, up through some three or four decks?

MS SUENDERMANN: That's correct. Most of the watertight bulkheads below the lower deck don't have passage across them; there is no doorway, so you need to go up. The exception is the high-angle calculation position. From there you need to traverse a bulkhead at 76 in order to get out of the room. So you go through a series of doors through the transmitting station, through the low power compass room - it actually may not be that room. These rooms are along the centre line. So I'm not sure if the

doors are actually along the centre line, but they are within that section of the ship.

You then need to go up a ladder. If you are at Action Stations, you need to un-dog the hatch at the top of the ladder. You then have to dog it again, because you are still at Action Stations and you still need to maintain watertight integrity in all places. In this case, you then need to go up another ladder, with a hatch again, and you can either go aft to the boiler room or forward through the stokers' mess, and up either a ladder into the galley, or you can go across to the lower mess, again, through a door. The bright red arrows indicate that there is a doorway through the watertight bulkhead. You need to un-dog that door and then re-dog it on the other side.

THE PRESIDENT: The reason I raise it is because it seems to me that the prospect of anyone being able to achieve that --

MS SUENDERMANN: Is remote.

THE PRESIDENT: -- in circumstances where there was no power, so no light, where much of this area had been subject to heavy bombardment and was on fire and smoke-filled, would seem to me to be extremely remote.

MS SUENDERMANN: Correct. There would be a lot of damage blocking access as well.

THE PRESIDENT: It would seem to me that the person seeking to do so also wouldn't know if they were going to a safer or a less-safe place.

MS SUENDERMANN: Correct.

CMDR RUSH: I have no other matters, sir.

THE PRESIDENT: LCDR Katter, do you have any questions?

LCDR KATTER: Nothing further, sir.

THE PRESIDENT: Thank you.

CMDR RUSH: Sir, there are two questions that I have which I think Mr Jeremy may be able to answer. They are very brief. I think as a matter of completeness I would like to

do that.

THE PRESIDENT: Yes, very well.

(Mr Jeremy returned to the witness box.)

CMDR RUSH: Mr Jeremy, the Commission of Inquiry has received some submissions in relation to the wrecks - including Kormoran, but particularly concentrating on Sydney - suggesting that the ship that we have examined over the course of the last two days is not the Sydney. Do you have any comment on that, or any doubt?

MR JEREMY: I have absolutely no doubt whatsoever that that is HMAS Sydney.

CMDR RUSH: The other matter is that in some photographs which don't appear in the report, but it doesn't matter for the purpose of the question, there are leather shoes that have been identified in the debris field near the hull of the ship. Do you have any opinion as to the likelihood of where those shoes came from?

MR JEREMY: I believe it is possible that they may have come from lockers which were located around the upper deck of the ship for the engine room personnel to change their footwear after leaving the machinery spaces so that they didn't track oil through the ship. So it is possible that those shoes and boots have come from those lockers.

CMDR RUSH: Thank you. They are all the matters, sir.

THE PRESIDENT: Thank you very much. Thank you indeed for a very comprehensive report.

I will now adjourn. There will be further hearings of this Inquiry in Sydney, here, on 19 January, and then there will be some further hearings in Perth commencing on 3 February. I will adjourn until 19 January.

AT 5PM THE COMMISSION WAS ADJOURNED
TO MONDAY, 19 JANUARY 2009 AT 10AM