have looked at lifesaving equipment.

Sir, I call Mr John Jeremy, Dr Stuart Cannon, Mr Leo de Yong and Mr Michael Buckland.

<JOHN CHRISTOPHER JEREMY, affirmed: [10.36am]

<STUART MARTIN CANNON, affirmed: [10.36am]

<LEO VINCENT DE YONG, affirmed: [10.36am]

<MICHAEL EDMOND BUCKLAND, affirmed: [10.36am]

CMDR RUSH: Gentlemen, if I can start from my right, Mr Jeremy, could you state your full name and address, please?

MR JEREMY: John Christopher Jeremy [redacted]

CMDR RUSH: And your occupation?

MR JEREMY: Naval architect, retired, as a maritime consultant.

CMDR RUSH: Dr Cannon?

DR CANNON: Stuart Martin Cannon [redacted]

CMDR RUSH: And your occupation?

DR CANNON: Naval architect and a Defence scientist.

CMDR RUSH: Mr Buckland?

MR BUCKLAND: Michael Edmond Buckland [redacted] I'm a Defence scientist.

MR de YONG: Leo Vincent de Yong, [redacted] I am a Defence scientist.

CMDR RUSH: Mr Jeremy, if I can come back to you, are you a graduate in Naval architecture from the University of New South Wales?

MR JEREMY: Yes, I am.

CMDR RUSH: Upon graduation, has most of your career been spent in fact involved in Naval architecture in Australia, in Sydney?

MR JEREMY: Predominantly in shipbuilding and ship repair in Sydney.

CMDR RUSH: In particular, can you give us some idea of what has involved you over what period of time?

MR JEREMY: Yes. I spent 31 or 32 years with Cockatoo Dockyard in Sydney engaged in ship construction from time as an apprentice draftsman through to planning, technical management, general management, and ultimately as managing director and chief executive of the company.

CMDR RUSH: Over the course of that period of time, what was the nature of the construction that was going on at the dockyards?

MR JEREMY: We were building Type 12 frigates, the destroyer tender HMAS Stalwart, the passenger ship Empress of Australia, a number of other smaller vessels, and the last ship we built was the fleet under way replenishment ship, HMAS Success. We also undertook many refits of Naval surface ships, destroyers, frigates, patrol boats, supply ships, and many refits and other dockings and maintenance of the Royal Australian Navy Oberon class submarines.

CMDR RUSH: Are you a past president of the Australian Division of the Royal Institution of Naval Architects?

MR JEREMY: I am.

CMDR RUSH: In addition to that, are you currently Editor-in-Chief of The Australian Naval Architect and Chairman of the Publications Subcommittee of the Australian Division Council?

MR JEREMY: I am.

CMDR RUSH: Dr Cannon, your qualifications?

DR CANNON: I have a Bachelor of Science in Naval architecture, a Master of Science and a PhD in Naval architecture.

CMDR RUSH: You are currently employed with the Defence Science and Technology Organisation and you have described your current employment. What is involved in that employment?

DR CANNON: There are two aspects of my current employment. Firstly, I am responsible for the ship structural research that is done at DSTO. It is structural analysis of the whole fleet of surface ships. The second aspect is that I currently manage all of the surface platform systems research, which can cover fire damage, weapons damage, operational aspects and things like that.

CMDR RUSH: For how long have you been involved in that specific area?

DR CANNON: Currently, I have been employed at DSTO for 11 years. Prior to that, I was working for another research organisation in Australia. I spent four years working for them. Then prior to that, it was in the UK where I was doing my research for my PhD.

CMDR RUSH: Your PhD and research involved what?

DR CANNON: My PhD involved looking at the structural response of ships in extreme seaways and the structural integrity associated with that.

CMDR RUSH: Are you currently the President of the Royal Institution of Naval Architects, the Australian Division?

DR CANNON: Yes, I am.

CMDR RUSH: Would you give the Commissioner some understanding of the Royal Institution of Naval Architects, what it does and what it encompasses?

DR CANNON: The Royal Institution of Naval Architects is a professional organisation which was established in 1860. Its aim is to promote the art and science of ship design. It is a membership organisation that takes qualified Naval architects. It ensures that we maintain our training, our professional development, and enables groups of like-minded people to come together.

CMDR RUSH: Mr Buckland, currently at DSTO, what does your

work involve?

MR BUCKLAND: We design computer simulations of vulnerability studies from weapons effects and design of ship structures to withstand those effects from weapons damage.

CMDR RUSH: When you talk about the vulnerability effects, what are you referring to?

MR BUCKLAND: Against weapons effects, so against blast and fragment damage.

CMDR RUSH: Concerning that, have you been involved both in computer analysis of those effects and also in actual experiments in relation to those effects?

MR BUCKLAND: Yes. I have been with DSTO for over 20 years. Initially, we worked on fragmentation effects for Army projectiles, and that work has gone on to do trials for Navy and weapons against Naval vessels. One of those trials was a full-scale trial for a decommissioned Navy ship.

CMDR RUSH: Perhaps it might be advantageous at this stage if you would explain what that involved?

MR BUCKLAND: We did a series of weapons from 1kg up to 30kg, various weapons, against that ship and to look at the damage to the structure and the progress of fragment and blast damage throughout the structure, and we used that as the basis to validate our codes.

CMDR RUSH: Have you, for the purposes of evidence and report, specifically looked at munition and munition damage to Sydney and Kormoran?

MR BUCKLAND: Yes.

CMDR RUSH: That has involved you, if you like, as the centre of that examination?

MR BUCKLAND: Yes.

CMDR RUSH: Mr de Yong, your background and current position at DSTO involves what?

MR de YONG: I have been with DSTO for over 20 years. My actual background started with DSTO and I was involved for quite a number of years carrying out research into explosives and pyrotechnics. Subsequent to carrying out that research, I moved to another part of DSTO, where I became involved in conducting research on infrared signatures. I currently head up the Electromagnetic Signatures Group within Maritime Platforms Division as well as also heading up the Vulnerability, Damage Control and Recoverability Group within Maritime Platforms Division.

CMDR RUSH: When you talk about vulnerability, damage control and recoverability, what is involved?

MR de YONG: You have just heard from Mr Buckland. Mike heads up the vulnerability side of the group. You will hear from several of the other members of the team looking at aspects associated with the work that we do with respect to damage control and the recoverability side.

The damage control research we do is looking at new technologies for the current and future fleet associated with damage control, and that goes to areas such as novel firefighting systems, damage control procedures, and we're also carrying out a lot of research looking at computer modelling of evacuation to allow better evacuation processes to be developed for current and future RAN fleet.

CMDR RUSH: Just by way of qualifications, do you hold a Bachelor of Applied Science and a Master of Science?

MR de YONG: That's correct.

CMDR RUSH: Would you perhaps, Mr de Yong, explain how it is that RINA and DSTO came together to produce the report?

MR de YONG: DSTO believed that the Royal Institution of Naval Architects was a body that would provide significant expertise to the examination of the sinking of HMAS Sydney. As you have already heard, DSTO has a number of Members of RINA, and also the current President of the Australian Division of RINA is present within DSTO. Therefore, it was thought that DSTO alone should not undertake the task but should utilise the expertise that is available from RINA. Therefore, DSTO and RINA combined to conduct the analysis.

CMDR RUSH: Do you each have in front of you a copy of the

report that has been produced?

Sir, I tender the Report on the Technical Aspects of the Sinking of HMAS Sydney and HSK Kormoran produced by the Defence Science and Technology Organisation, the Maritime Platforms Division and the Royal Institution of Naval Architects, Australian Division, which I think will become exhibit 106.

EXHIBIT #106 REPORT ON TECHNICAL ASPECTS OF THE SINKING OF HMAS SYDNEY AND HSK KORMORAN

CMDR RUSH: Mr Jeremy, I may direct the first area of questioning to you. Sydney, as opened and as detailed in the report, was a Modified Leander class light cruiser. Where did the design originate?

MR JEREMY: The design is a British Admiralty design that arose from a requirement to provide sufficient cruisers for the Royal Navy to meet their worldwide commitments during the 1920s. At that time, the Royal Navy was bound by the limits imposed by the Washington Naval Treaty, which limited the number of ships that they could have of certain capabilities. In particular, and well known to many, was the upper limit of 10,000 tonnes and guns not exceeding 8 inch calibre. Meeting that requirement, the well-known county class cruisers, of which HMAS Australia and HMAS Canberra were two ships, were as a result of that process.

To meet the need for the number of ships, the Royal Navy needed additional smaller vessels to retain within treaty limits. Two smaller 8 inch gunships were built, but further designs of 6 inch gunships were also built, with the result that a cruiser, HMS Leander, was ordered in the 1929 shipbuilding program, and she became the prototype for a class of light cruiser which could be built within treaty limits to meet the needs of the Royal Navy.

CMDR RUSH: Did the RAN take delivery in total of three of this class of ship?

MR JEREMY: Not of the Leander class but of the slightly later class, the Modified Leander class, yes. The first ship that we acquired was HMAS Sydney, which was purchased while she was still under construction in replacement for our old cruiser, HMAS Brisbane, which we needed to dispose

of under the treaty obligations. We later acquired the second two ships in the Modified Leander class, which became HMAS Perth and HMAS Hobart.

CMDR RUSH: Were each of those ships identical or not?

MR JEREMY: They were all built to the same design, but all three were built by different shipbuilders. Whilst they would have been substantially the same, in those days shipbuilders were allowed some latitude in minor details. So where we might see one particular fitting in one place on one ship, it might have been slightly different on the other, but sufficiently the same for our purposes, I believe.

CMDR RUSH: You mentioned the Washington Treaty. Did that create for Naval architects concerns in relation to weight and in relation to cost?

MR JEREMY: Very definitely. One of the great incentives for cost at the time, of course, was the Depression. The Modified Leander class cruisers were being designed between 1930 and 1932 and there were significant impositions on the cost of those ships. But weight was particularly important. If your treaty obligations are that you can have 70 cruisers and you suddenly start building ships which are too heavy, then you might have one fewer ship, so weight was extremely important.

CMDR RUSH: In relation to those, if you like, restrictions of cost and weight, did that have any impact on the Modified Leander class? As a consequence of your analysis and understanding, are you able to say, as to the nature of the ship, whether they were a good warship or whether that impacted upon their capacity?

MR JEREMY: There was a definite impact. In October 1932, during the detailed design and early construction of the Leander class cruisers, the high price of the ships prompted the then Third Sea Lord and Controller of the Navy to order a review of the design, and he proposed himself a number of changes which might be made. This was in order to reduce the cost of the ships and included reducing the gunfire control equipment, with the elimination of magazine cooling and even the reduction of internal telephones.

The changes to the fire control equipment in

particular involved the elimination of an after director control tower, so that the ships were subsequently only fitted with one, the forward one. This was regarded as an acceptable compromise at the time under the circumstances, but it was, I think, the source of some later comments about the ships' capabilities.

As built, the ships were very fine ships. They were built to the highest of British Naval standards and very well built - good modern cruisers.

CMDR RUSH: Could I ask you to go to page 43 of the report.

MR JEREMY: Yes.

CMDR RUSH: We can bring that up on the screens. I am looking at what is entitled "Description of HMAS Sydney" and the particulars as completed.

MR JEREMY: Yes.

CMDR RUSH: I don't want to spend a lot of time on this, but the first four headings there are "Displacement": "Light", "Half Oil", "Full Load" and "Standard". What does displacement mean and what does it depend upon when we're looking at those figures?

MR JEREMY: Displacement is actually the measure of weight of the ship, which is the weight of the water displaced by the ship, hence the term "displacement". The light displacement is the ship without crew, fuel, stores and ammunition. It is just the basic ship. The displacement half oil is, as it says, with half of its stores and oil consumed. Displacement full load is complete in all respects, ready for sea, with ammunition and a full load of fuel. Standard displacement is a measure which was introduced by the Washington Naval Treaty and it is, in effect, full load less the fuel oil and reserve feed water.

CMDR RUSH: Then there are two figures given in relation to length - length overall and length between perpendiculars.

MR JEREMY: The length overall is exactly as it says: it is the length of the ship between the foremost extremity to the aftermost extremity.

The length between perpendiculars is the length between the intersection of the stem and the design waterline, and, in Sydney's case, with the centre line of the rudder stock. The length between perpendiculars used to be the aft end of the rudder post, but in more modern ships it is the centre line of the rudder stock. That is the length between perpendiculars.

CMDR RUSH: What is the purpose of those two lengths?

MR JEREMY: The length between perpendiculars has been around for a long while. If you consider a ship with a straight vertical stem and a stern at which the rudder actually emerges from the water, the length between perpendiculars is very close to the waterline length without taking account of the rudder. The distance that the ship lies forward of the forward perpendicular or aft of the after perpendicular is called the overhang.

As the designs of ships changed, the overhangs tended to increase, so you see a difference in length between the between perpendiculars on Sydney of 530 feet and the length overall of some 32 feet 3 and a bit inches. That is the total length of the overhangs forward of the forward perpendicular and aft of the after perpendicular.

CMDR RUSH: We will come to the boilers and shafts, but there were four of each - four propeller shafts and four boilers?

MR JEREMY: Yes, Sydney was propelled by steam turbines - two turbines in the forward engine room and two turbines in the after engine room. Each set of turbine machinery powered one shaft and one propeller.

CMDR RUSH: Her maximum speed was 32.5 knots?

MR JEREMY: Yes, that was the design maximum speed. She achieved rather more on trials, but one has to be cautious of trials results and look at the displacements at which they are actually run.

CMDR RUSH: And her power?

MR JEREMY: It was 72,000 shaft horsepower as designed.

CMDR RUSH: Where does that put her in relation to warships?

MR JEREMY: Well, she is very typical of the sort of 1930s cruiser design.

CMDR RUSH: Mr Buckland, at page 44 of the report, the basic armament of Sydney is set out. I think I will come back to that when we come to the ship's drawings. That may be more appropriate.

In relation to her 6 inch guns, can you give us some understanding of how the A and B turrets and the X and Y turrets were located on the ship and how the turrets worked in conjunction? Each turret had two 6 inch guns. Did they work together or did they work independently?

MR BUCKLAND: They all operated independently, but if you want me to get into director control, all the guns could be fired together, but they had their own engines and operating systems. Is that the question?

CMDR RUSH: When a turret fired, would the two guns in the turret normally fire independently or would they fire a broadside together?

MR BUCKLAND: They would all try to fire at the same time, mainly because of the difficulty that if you start firing them independently, smoke and noise would interrupt being able to get ranges right.

CMDR RUSH: Could I ask you, gentlemen, to go to page 59, to the general arrangements in relation to HMAS Sydney. It is stated that Sydney was conventionally arranged with superimposed 6 inch mountings, A and B forward of the bridge and X and Y aft. What does "superimposed" mean?

MR JEREMY: One turret above the other, basically.

CMDR RUSH: How many decks did Sydney have, Mr Jeremy?

MR JEREMY: Within the hull, the uppermost deck of the hull was the forecastle deck. This deck was not continuous, but the A turret, for example, was on the forecastle deck. The uppermost continuous deck of the hull was the upper deck, which stretched right through the ship. It might be appropriate, perhaps, if we have the general

arrangement profile and I could use this marvellous little instrument to demonstrate where they are.

CMDR RUSH: Could I ask firstly if we can go to figure 36, which is the figure in relation to the hold of the ship, and we can go through what is contained there. I think we have the profile.

MR JEREMY: The hold is the lowest part of the ship, effectively. It is not, strictly speaking, a deck. It is the inside of the bottom of the ship, although there are decks within the hold. We have some watertight compartments right forward. HMAS Sydney was one of the first ships in the Royal Australian Navy to be fitted with an ASDIC, or a sonar, as we would call it today. That was fitted within the hull there, the directing gear. Further aft, along the centre line of the ship, we have magazines and shell rooms for the forward turrets located in that area there. Outboard, we have some storerooms, and then in this region here we have fuel tanks.

The spaces within these longitudinal bulkheads here and here (indicating) - the shell room for A turret, the magazines, the forward magazine which supplied cordite charges to both turrets, the magazine for B turret, the 4 inch magazine, the ammunition for the 4 inch guns was next aft, followed by very important compartments for the fighting of the ship, the transmitting station and the high-angle control system station here, which were the calculation rooms, effectively, for the gunfire control system. These compartments here were protected by some armour within the ship.

CMDR RUSH: When you say "armour within the ship", was it exterior?

MR JEREMY: It was on the sides and top of those spaces.

CMDR RUSH: You have mentioned the fuel tanks?

MR JEREMY: Yes. There were fuel tanks located here (indicating) and here.

CMDR RUSH: Are they the fuel tanks for the ship?

MR JEREMY: Yes. They are the fuel tanks for the ship. They carry furnace fuel.

CMDR RUSH: Was there an aircraft fuel tank?

MR JEREMY: Yes, up forward here, which carried 1,600 gallons of petrol.

CMDR RUSH: Are the boiler rooms also located in the hold of the ship?

MR JEREMY: Yes. If we move further aft, we have four main machinery spaces, A boiler room, A engine room. This is in the hold here, so we will see this more clearly on the next deck. This is the underneath of B boiler room and B engine room. I think it is better that we look at the next deck to explain the arrangement of machinery space.

As we come further aft again, we have another armoured section of the ship, which contains the magazines and shell rooms for the after turrets. Again, there are more fuel tanks aft in this space here. There are also fuel tanks between here and here, under the machinery spaces and beside the machinery spaces, in the ship's double bottom. The ship had a double bottom structure just slightly forward of the A boiler room to the after bulkhead of B engine room.

CMDR RUSH: Was there also a transmitting station in the hull of the ship?

MR JEREMY: Yes, the transmitting station which was associated with the gunfire control system was located here just forward of the boiler room.

THE PRESIDENT: Could you point out where the torpedo hit? Did it hit at the level of the hold?

MR JEREMY: Yes, more or less. The torpedo hit was about here (indicating).

CMDR RUSH: If you like, working from the bottom, was there a single bottom or a double bottom?

MR JEREMY: There was a double bottom, more or less under the machinery spaces, which extended some way up the side of the ship.

CMDR RUSH: What was the purpose of the double bottom?

MR JEREMY: The double bottom provided several purposes. It was part of the longitudinal strength structure of the ship; it added to the strength of the ship. It also provided space in which fuel oil tanks could be built; it provided space for lubricating oil tanks and things of that nature and a number of watertight compartments, which were simply there as watertight compartments, because the double bottom also provided some degree of protection to the machinery spaces in the event of damage, such as a grounding or something like that. It was important, in the design of these warships' double bottoms, that if you indented a shell in way of them, there was minimum transmission of that damage through to the inner bottom.

CMDR RUSH: Going up, was the next deck the platform deck?

MR JEREMY: The next deck is the platform deck, yes.

CMDR RUSH: That's at page 55, figure 35.

MR JEREMY: I will work from forward aft, so if we could move to the forward end. There are a lot of storerooms up here, but there are some important spaces. We have a compressor room there, which provided compressed air for the ship. But also here we have a pump lobby, which was the location of one of the ship's fire pumps.

CMDR RUSH: Just slow down a little bit. That was a pump lobby?

MR JEREMY: A pump lobby, yes. It has also other very interesting compartments around it, like the band room, for example, which is there. But other spaces in this area - you have flour stores and other storerooms, and there is also, next to the pump room, one of the electrical breaker spaces as well.

CMDR RUSH: The main switchboard room?

MR JEREMY: Yes, the main switchboard room is on this level here, just forward of A boiler room on the port side right there. You have the lower steering position also on this level, which is here on the centre line, a little bit further forward, partly protected by the presence of storerooms outboard. One of the ship's gyrocompasses is located here. There are other spaces like the telephone

exchange and so forth in here. You also have two more breaker rooms with main circuit-breakers for the electrical system.

CMDR RUSH: So the lower steering position there is forward of the boiler, is it?

MR JEREMY: Yes, well forward of A boiler room, pretty well directly under the bridge of the ship.

CMDR RUSH: Are there also the wireless transmission offices?

MR JEREMY: Yes. The second W/T office is located here just forward of A boiler room. There is a low-power switchboard room on this side as well. This area is a pretty vital area for the ship in terms of her fighting, communicating and power supply systems.

CMDR RUSH: Moving to the boiler room --

MR JEREMY: If we move the diagram a little bit, here we have again the machinery spaces. In each machinery space, we have a split system which was introduced into the Leander class in the Modified Leander class. The first ships had three boiler rooms and an engine room. I would have to check the details exactly, but basically they had boiler rooms and then engine rooms, whereas in the Modified Leander class it was split so that you had a boiler room and engine room, followed by another boiler room and engine room, so these two machinery spaces could operate independently. If you lost a boiler room and an engine room, you could still steam the ship. If you lost, for example, A engine room and B boiler room - and assuming the steam pipes were still intact - you could still steam the ship. You had a lot of interchangeability.

You can see here that is A boiler room and A engine room, so there are two sets of turbines in that engine room. The boilers in A boiler room are located side by side. In B boiler room, which is here, they are located one in front of the other, so they are fore and aft. Then B engine room is aft here and B engine room also has two turbine sets.

Outboard of the B boiler room are two longitudinal watertight bulkheads there and there, and outboard of those

spaces, at this level, we have stores in these spaces, but importantly there, just immediately after A engine room and there (indicating) are two diesel generator spaces.

Again, this was a modification in the Modified Leander class. The Leander class ships had only turbine-driven generators. Diesel-driven generators were introduced into the Modified Leander class not so much to give an emergency generating capacity but more, in fact, to enable the ship to shut down her steam plant in port and still be able to power herself. But it would have been convenient and useful in an emergency nonetheless.

CMDR RUSH: Then aft of the second machinery space?

MR JEREMY: Aft of the second machinery space, we again have another pump room located down aft here. There was another hull and fire pump. We have another gyro compass room and many stores. It is mostly stores in this area. There is also an ammunition handling space for Y turret. Moving right aft, we have the steering gear compartment, which also was an armoured space. It was protected on all sides and on the top by a degree of armour plating.

CMDR RUSH: Is there a position on the platform deck or is it the upper deck where the ship could actually be steered?

MR JEREMY: There are two positions on the platform deck from where the ship can be steered. One was the lower steering position forward on the platform deck, which was fitted out with a wheel and engine room telegraphs and communications. The other position, where you had two alternatives for steering the ship, was within the steering gear compartment itself. You could either control the telemotor system from within the steering gear compartment or, if there was a total power failure and you lost the steering pumps, you could actually operate hand pumps to steer the ship from that position.

CMDR RUSH: Perhaps if we could go to the lower deck, which is figure 34.

MR JEREMY: If we may start from forward, here there is a watertight compartment, some battery rooms and stores and then the cable office for the anchor cables. Then, in most of this space aft from that bulkhead right up to the forward bulkhead over the boiler room, there are mess

spaces for the crew. Also on this deck you can see the ammunition handling space for A turret, where the shells and cartridges brought up from the magazines are loaded on to the rotating structure for the turret.

There is A boiler room here. Out at the side of the platform deck level, there is a kit locker space and a wash space. Then over A engine room, there is quite a well-equipped engineer's workshop and other related storerooms, workshops and so forth there.

Outboard of the B boiler room, we have wash places. Then aft, over the engine room, we have some more important compartments. The main wireless offices are here in this area. Then further aft, we have officers' and warrant officers' accommodation. You can see the barbette and the ammunition handling space for X turret. The wardroom and officers' cabins are all located in this area.

CMDR RUSH: From there to the upper deck?

MR JEREMY: This is the uppermost continuous deck of the ship and an important deck from the point of view of the ship's structure. If we again start right forward, in Naval tradition, shall we say, in the location where it is most difficult to get access to, we have the paint room. The capstan machinery compartment and two prison cells are next aft. Despite that being a machinery space, it was used for accommodation.

The Leander class and their successors, the Modified Leander class, were extremely compact ships and were constantly suffering, right from their design stage, for lack of space for the crew, so crew were accommodated in the capstan machinery compartment.

Moving further aft, we have petty officers' and stokers' mess decks in this area here. Then we come to musicians' and seamen's mess deck in here, moving up. In these spaces, again, we have a barbette there for A turret and the ammunition handling space for B turret.

Moving further aft on this deck - and, again, we are physically locating on the ship, we are under the bridge - we have the sick bay and an office of the store on the port side and the sick bay on the starboard side.

When we come further aft from there, we have a bulkhead but then what is substantially an open space, because in the original design, the ship's side stopped a bit further forward than it actually did in Sydney. It was extended after trials in the early ships of the Leander class because of the sea coming on board in that area, which was useful, because that space became available also for hammock sleeping. So some of the crew slept in that space.

Here we have the crew's galley on the midships, on the centre line there, with the canteen and butcher shop over here on the starboard side. On the port side, we have another office and diving gear store, and then abandon ship stores are also located in that space. The space is open at the aft end.

On the centre line, you can see three boats shown there, which are in fact mounted above the upper deck at forecastle deck level. Down the centre, here, you can see we have funnel hatches, which are the uptakes from A boiler room, and vent trunks for the forced draft fans for A boiler room. At the aft end, we have another important space - the ship's bakery.

The round structure on the centre line here is the base for the aircraft catapult. It contained the shipwright's workshop, an aircraft store and an office. Aft of it, you can see again funnel hatches for B boiler room and ventilation intakes, forced draft fan intakes, for B boiler room.

These are the two torpedo tubes, which are on the upper deck in this location here, just aft of the funnel, underneath the 4 inch gun platform, which is over here, and there are four little round structures there, which actually are the supporting structure for the 4 inch guns. There are other things here, like vegetable stores and the potato peeler.

CMDR RUSH: Could you point to that?

MR JEREMY: There are vegetable stores just forward of where the 4 inch gun on the port side is located.

CMDR RUSH: Are they on both starboard and port side?

MR JEREMY: They are on both.

THE PRESIDENT: What about the potato peeler?

MR JEREMY: I believe it was there in the vegetable preparation store just next to the port side 27-foot whaler, which was located there.

THE PRESIDENT: There was some suggestion from some of the German witnesses that they saw people wearing white aprons. One of the witnesses to date has said that it may have been two persons peeling potatoes at the time of the engagement, that being the time when normally on the ship potatoes were peeled preparatory for the evening meal. So the location of the potato-peeling room may be of some importance.

MR JEREMY: It is there. It is on the port side.

THE PRESIDENT: So it would have been visible in the first stages of the engagement?

MR JEREMY: That area of the ship would have been visible, yes.

Moving aft further on the upper deck, we have the aft superstructure. At the forward end of this is the torpedo parting space - a space in which one parts a torpedo, I dare say, to change warheads from practice heads for the real thing.

There are also ventilation trunks here at the forward end of that space, which are the ventilation trunks for B engine room, and there are further of those a little bit further aft in the after deckhouse there, two being supply, two being exhaust.

This deckhouse also includes some officers' cabins. There is an office for the executive officer, the commander, at least a cabin for him, and the engineer officers' cabins. They are on the port side. On the starboard side, that is occupied by the captain's day cabin, the captain's sleeping cabin, the captain's bathroom. You can see the barbette there for X turret, and then further aft on the upper deck of course we now have Y turret.

CMDR RUSH: Before we go to the forecastle deck, I am

wondering if we can bring up figure 54, which is at page 82. Mr Jeremy, just so that we get an understanding, you have been talking about the upper deck. What area of the ship, as we look at that photograph of Sydney, comprises the upper deck?

MR JEREMY: You actually can't see the upper deck in this photograph. The deck that you can see there, on which all the men are standing, is the forecastle deck. The upper deck is the next deck down.

You can see on the ship's side shell plating here, where apparently thick plating turns down to a lower level. Can you see that? There is a strake of plating which seems to dip down and go to a lower level. That is the original break of the forecastle in the original Leander class design. The extension of the forecastle deck after that is the add-in bit which was done later in the design of the ships to enclose a space which was very wet. The upper deck is inside the ship. You can see a boat boom attached to the side of the ship there. That's very close to the level of the upper deck, because you can see some sidelights underneath it.

CMDR RUSH: After the forecastle deck, we're dealing with the superstructure deck?

MR JEREMY: Yes, this is the forward superstructure. You have a superstructure deck and then the decks - the nomenclature today is very much simpler, but in those days, I would just have to check exactly, you have the superstructure deck, which was the deck on which B turret sits. The forward superstructure contains two more decks --

CMDR RUSH: I will come back to that. Perhaps we can turn to figure 32 on page 49, which is the forecastle deck.

MR JEREMY: If we move to the forward end of the ship again and work our way aft. Here you have, of course, the anchor and cable handling equipment right forward. The forward breakwater, which is evident in some photos of the wreck - and then A turret and the forward deckhouse.

The forward deckhouse, forward half of the forward deckhouse, in addition to the barbette for B turret, contains the crew's heads and urinals; a recreation space;

what is referred to as a soda fountain; a little pantry/canteen place, no doubt; another recreation space and storerooms and a sizeable lobby.

Immediately aft of that we have the smith's shop - a little blacksmith's shop on the forecastle deck. The cruisers of the day were quite well equipped with workshops. You would rarely find a smith's workshop on a warship today. We have the fan intakes for the A boiler room, the funnel and then the ship's crane.

Also on this level we have the catapult, if we can move the diagram a little further forward. We have the catapult. The second funnel and the intake there, just beside the funnel, for the forced draft fans for B boiler room.

Outboard of the second funnel we have two of the 4 inch guns, and a little bit further aft we have two more of those 4 inch guns.

We then have another deckhouse, or piece of superstructure, just aft of that deck, and that contains galleys. The practice in those days was to have separate galleys for almost everyone. So the captain has a galley, there is a wardroom galley and a warrant officers' galley located in that space there. Immediately after that we have X turret.

CMDR RUSH: Then if we go to the superstructure deck, at figure 31.

MR JEREMY: Yes. That's perfect. At this level, on the superstructure deck on the forward superstructure, we have B turret. There is the bridge deckhouse here. At this level, this deckhouse contains the captain's sea cabin; the navigating officer's cabin; curiously, the dental surgery; the armament office; and there is a signals office located in that area there. There are two objects in front of the bridge screen, which are paravanes, and two winches aft of the deckhouse which were part of the paravane streaming arrangements, part of her defence against mines. There are two quad machine gun mounts on this level as well, and then the flag deck, the signal deck, with the flag lockers and the semaphore facilities located aft on this deck.

Around the funnel there are two large searchlights,

and you will notice that there are pipes leading forward from the funnel and down into the forward deckhouse there and further down. They, of course, are uptakes from the smithery and the galleys.

If we go further up in the forward superstructure to the lower bridge level, we have right forward, behind the forward screen of the deckhouse, the wheelhouse, which contained one steering position and the engine room telegraphs, and of course compasses and so forth.

Immediately after that we have a plotting office, remote control office and a chart room. There is a silent compartment aft there, which I think must have been associated with the sonar or the ASDIC.

This had open deck around these spaces here. There was some splinter or bullet protection provided to the remote control office and the plotting room, but none to the wheelhouse. There were blast screens - not so much blast screens as splinter screens, which could be folded down, fitted here at the forward end of that open deck space. You could see them in that earlier photograph we were looking at.

CMDR RUSH: Was that structure open or enclosed?

MR JEREMY: The wheelhouse was enclosed but these decks were open around there. Immediately above that we have the upper bridge. There is the compass platform here, which is the centre of operations for the captain and officers of the watch, the navigating officer. There is a pelorus and voice pipes and telephone communications there.

There are the two captain's sights, which are the first stage of the gunfire control system, to enable the captain to designate a particular target. There are two large range finders, which are on pedestals some height above the deck level, and there are also other sites associated with firing torpedos and so forth.

Towards the aft end we have at each side two signalling lanterns for visual signalling purposes and in the centre the director control tower, which is the main control for the 6 inch guns. As I mentioned earlier, there was only one of these in these ships, in the Modified Leanders. Originally the concept had been to have another

one on the aft deckhouse.

Then right aft you have the high-angle control system, which was the control tower for the 4 inch guns.

CMDR RUSH: So we're at the bridge level there?

MR JEREMY: Yes, we're at the upper bridge level there.

CMDR RUSH: Was that open or enclosed?

MR JEREMY: It was partially enclosed. It had windows across the very front and on the two sides there, and there was a partial enclosure. It had what was described as a bulletproof roof, which in fact was only about half an inch of high tensile steel, but it nevertheless gave some protection, albeit fairly small. The aft end of that was completely open.

THE PRESIDENT: What was the method of communication from the bridge level down to the plotting room?

MR JEREMY: I can't tell you, Mr Cole, without actually referring to the details, but much of the primary communication would have been by voice pipe in those days.

CMDR RUSH: I think there will be evidence, sir, that it was via voice pipe.

MR JEREMY: Shall we move aft on this deck?

CMDR RUSH: Yes, thank you.

MR JEREMY: Finally on this deck we have the second funnel with the boiler intakes. Then, on top of the after deckhouse, we have an aft control position, and this was the substitute for the second director control tower, fairly simply fitted out, which had a gunnery sight located within it. There were, as built, four three pounder signalling guns located on this deck, but the evidence seems to suggest that these were removed before the ship was lost, some time earlier in the war.

Then there was a searchlight platform with a searchlight on top of it and on top of the after control position was another one of the quadruple machine guns.

CMDR RUSH: Perhaps attempting to put that in some context, can we go to figure 30, which is a profile of Sydney. If we go back to the lower deck, the hold?

MR JEREMY: Yes.

CMDR RUSH: Just using the pointer, would you indicate --

MR JEREMY: That is the lowest part of the ship, right through here (indicating).

CMDR RUSH: Then going up, the next deck we spoke about was the platform deck?

MR JEREMY: The platform deck, yes, which is approximately around the waterline. So it runs through there (indicating).

CMDR RUSH: And then the lower deck?

MR JEREMY: The lower deck is at that level (indicating).

CMDR RUSH: Is that above the waterline?

MR JEREMY: That is above the waterline. Then the upper deck, which is the uppermost continuous deck from aft right through to the bow (indicating).

THE PRESIDENT: Can you say what the height of the torpedo damage was?

MR JEREMY: The torpedo damage is shown in a later illustration, but it was not much above the level of the lower deck so the hole was located in there (indicating).

CMDR RUSH: Then the forecastle deck?

MR JEREMY: The forecastle deck, which is the upper deck forward here, which comes aft to its break there. Then, of course, the level, the forecastle deck level, continues in the after superstructure and the 4 inch gun platform at the forecastle deck level, but the forecastle deck as people might think of it is the deck from the break in the forecastle there through forward to the stem.

CMDR RUSH: Then going to the superstructure, can you point to the --

MR JEREMY: The superstructure deck, yes. There is the forward superstructure that we talked about with B turret on it, A turret on the forecastle deck there, the bridge structure.

CMDR RUSH: So the lower bridge.

MR JEREMY: The lower bridge is at that level there (indicating).

CMDR RUSH: The bridge?

MR JEREMY: And the upper bridge is right on the top.

CMDR RUSH: The director control tower?

MR JEREMY: The forward director control tower is there mounted on a tower above the upper bridge level, and the high-angle control system director is on a tower further aft.

CMDR RUSH: Just moving aft, you have the forward funnel.

MR JEREMY: We haven't mentioned the masts, of course. There is a foremast there, which is much higher than shown on this plan, and the after mast here. Again, much higher. And the ship's main communications antennas were slung between those masts.

The then crane is there, just aft of the forward funnel. The catapult is on it in central location there, just further aft between the two funnels.

CMDR RUSH: Could you also indicate to us the lower steering position and the after steering position?

MR JEREMY: Certainly. The lower steering position was on the platform deck approximately there directly underneath the bridge (indicating). The wheelhouse, being up there (indicating), at that level, on the lower bridge, and the lower steering position was directly below it on the platform deck.

The after steering position was in the steering gear compartment right aft. So there were two steering positions in the steering gear compartment.

CMDR RUSH: Mr Jeremy, just to complete it, we spoke of, on the platform deck, a wireless transmission office and the main switchboard room. Are you able to indicate where that is?

MR JEREMY: Yes, on the platform deck, the main switchboard room is in this location, just forward of the boiler room, and also, as it happens, just forward of the ship's side armour. There are wireless offices in this region and wireless offices down aft here (indicating).

CMDR RUSH: You also indicated to the Commissioner the vegetable lockers. Where are they located?

MR JEREMY: There, just by the after funnel (indicating).

CMDR RUSH: And the torpedo tubes, you indicated, were below --

MR JEREMY: Below the 4 inch gun deck, just slightly aft of the after funnel on the upper deck.

CMDR RUSH: Just in relation to that general description of Sydney, Mr Jeremy, is there anything else that you think we need to understand before we move on?

MR JEREMY: Not on the general description, I think. I think we are going to cover quite a bit more detail in due course.

THE PRESIDENT: Is that a convenient time?

CMDR RUSH: Yes, it is, sir.

SHORT ADJOURNMENT

CMDR RUSH: Sir, I was wondering if I could go back briefly over a couple of matters. I have been told that with the use of the pointer it is not abundantly clear to people who are sitting in the back of the Inquiry room.

MR JEREMY: Yes, very well.

CMDR RUSH: I understand, Mr Jeremy, that there is a screen in front of you, and you can point to it on the screen so that it will in fact appear. Just going back, if

we go back over the decks, the hold, the platform deck, the lower deck and the upper deck, can you just, again, point to where they are on the profile?

MR JEREMY: We will have to get the profile up, first, CMDR Rush, then we will be in business.

THE COMMISSIONER: It is page 45.

MR JEREMY: Yes. It is a different file, unfortunately. We have to find it.

CMDR RUSH: 0067.

MR JEREMY: Right.

CMDR RUSH: So if we start with the hold. Would you just take us through the decks again?

MR JEREMY: The hold is the bottom part of the ship. We come, moving aft from the stem, which is here. You can see my pointer, actually, which is helpful, I think. That means I don't actually have to mark anything, which will make life a little bit simpler. Moving up, we have watertight compartments immediately after the stem. There is the cable locker, which I mentioned earlier on. There is the aviation spirit compartment - the petrol compartment - where there was a 1600 gallon tank of petrol for the aircraft.

You will notice, if we move just above, out of the hold onto the platform deck above it, you can see the petrol control compartment. That's where the petrol was pumped up to the aircraft.

The pipes from this compartment led up to underneath the forecastle deck, and then aft, and the system was so arranged that if you had finished refuelling an aircraft, you could purge the pipes back into the aviation fuel tanks and keep the piping free of petrol.

Further aft in the hold we have two fresh water tanks, which are the forward fresh water tanks for the ship. Then, immediately aft of that, there is the ASDIC or the sonar directing gear compartment. You can see the dome here in its housed location.

THE PRESIDENT: Just before you leave that, the bottom line there gives the frames?

MR JEREMY: Yes.

THE PRESIDENT: They are the numbers of the frames which are the ribs of the ship, in other words?

MR JEREMY: Yes. Normally, one identifies bulkheads, for example, by the frame number at which they are located.

THE PRESIDENT: Going forward, could you tell me the frame number ahead of which the torpedo struck and indicate it, please?

MR JEREMY: The torpedo struck close to here, between, shall we say, frames 23 to 27; in this vicinity here. Actually, below the waterline, of course, in this area here.

THE PRESIDENT: We will come to this in due course, but that, in essence, put out of operation all of that which was forward of where the torpedo struck?

MR JEREMY: Yes. The damage here would have been quite extensive, both forward and aft. The damage would have included, almost certainly, some penetration of the lower deck at that level as well. It is better if we zoom in, because it is a bit hard to see that. It is easier for everybody, I think, if we can see the writing.

There is a small arms magazine here on the centre line. This is within the armoured area of the ship, right through here, at this level. We're still in the hold. We have tanks underneath, on this level here, beneath these spaces.

There is A shell room, which supplies, via means of hoists, ammunition hoists, shells to the A ammunition lobby here on the lower deck. The magazine, which here extends from watertight bulkhead at frame 35 to watertight bulkhead at frame 53, supplies both A and B turrets - again, by hoists: one at the forward end, which lifts the cordite cartridges up to the A ammunition lobby, and at the aft end here, where they were moved up to the B ammunition lobby there on the upper deck.

Then there is the B shell room in this location, aft of bulkhead 53, where you again have a hoist taking the shells up to the B ammunition lobby.

Moving a bit further aft, as you can see, there is B turret. The bridge is up here. That's your forward bridge superstructure. If we come back into the hold, we have the magazine for the 4 inch guns. Now, it is interesting that it is actually here, because it is a long way from the 4 inch guns. There were ready-use stowages for 4 inch ammunition on the 4 inch gun deck because it is quite a long way to bring the ammunition from the 4 inch magazine up to the upper deck and then aft to the 4 inch gun deck.

CMDR RUSH: Could I just ask you, while we're on that point: there were lockers on the 4 inch gun deck that stowed ammunition for the 4 inch guns.

MR JEREMY: Yes, there were.

CMDR RUSH: And for the taking of ammunition to the 4 inch guns was it basically a manual system, after it had been raised from the 4 inch gun magazine?

MR JEREMY: Yes, it was basically a manual system.

If we can come a little bit further aft on the hold, I mentioned earlier on important elements of the ship's fire control system. There is the high-angle calculating position here on the centre line and the transmitting station there on the centre line. These spaces received data from the director control towers to calculate the direction in which the guns should be fired and the elevation at which the guns should fire, taking into account the speed of the target and the speed of Sydney and the relative bearings of the two ships. So that information was then fed back to the turrets, to the gun mountings.

CMDR RUSH: Could I just stop you there. Was it not fed back to the director control tower?

MR JEREMY: I'm sure it is. I'm not the expert on that area, CMDR Rush. I think it best to ask someone else that question.

On the centre line here we have another important space, the number 1 low-power room and the gyro compass room. The low-power room was fitted out with motor generators to convert the ship's power supply, the high-voltage power supply, to the low-voltage power supply needed for the fire control system and internal communications and the low-voltage power which is required for actually firing the guns.

Shall I continue through the platform deck or move up in this forward part of the ship. What would you like?

CMDR RUSH: Could we perhaps go through the platform deck quickly.

MR JEREMY: Very good. If we move aft we have the forward boiler room here above the double bottom. That space in there is part of the double bottom of the ship. There is the forward boiler room, up to the upper deck.

The forward engine room is in here, again, above the double bottom. That's the double bottom space. There is your forward engine room. Above that you have the engineer's workshop that I mentioned earlier on.

Coming further aft, on the centre line we have the aft boiler room - again, above the double bottom, which is there - and of course outboard of that boiler room we have the diesel generator spaces and other compartments outboard of the longitudinal watertight bulkheads of that boiler room.

If we come further aft we have the aft engine room, which extends up to the lower deck and aft here to watertight bulkhead 151.

Continuing aft in the hold, we have the warhead room for torpedo warheads; the bomb room for bombs for the aircraft; X shell room - the shell room for X gun. Again, we have a very similar arrangement to that which was forward, with a 6 inch magazine supplying cordite charges to both X and Y turrets, and then Y shell room aft here on the centre line of the ship.

Outboard of these spaces, of course, you have the shaft tunnels where the propeller shafts from the main engines come to emerge from the hull and then be supported

by these A brackets here. This propeller shaft is the outer propeller.

CMDR RUSH: So we understand, we're looking at one side of the ship here?

MR JEREMY: Yes, the starboard side.

CMDR RUSH: On the starboard side of the ship there are two propeller shafts?

MR JEREMY: Two propeller shafts. There is the outboard one which is further forward and the after one which is further aft.

CMDR RUSH: That's replicated on the port side?

MR JEREMY: That is replicated on the port side, yes.

There is another storeroom. A different kind of spirit in this case, not aviation spirit. There is a spirit store and an inflammables store, then watertight compartments down aft here, aft of what we call the cut-up, where the flat keel ends and the ship's stern begins to come up. I will come a little bit further aft.

It is really taking us perhaps now to the platform deck, and perhaps we could move forward on the platform deck rather than going right forward and come aft again. Would that be satisfactory?

CMDR RUSH: Yes.

MR JEREMY: Right aft, in the very stern, again, at a point of almost maximum inconvenience, is the officers' baggage room. Immediately forward of it is the steering gear compartment, which extends in that space there.

CMDR RUSH: That's where you indicated earlier in your evidence there is ability to steer via telemotor or manually controlled pumps for steering?

MR JEREMY: Yes. The rudder here which you can see is hung in this position, and attached to the crosshead on the top of the rudder stock are two sets of hydraulic rams, which actually turn the rudder. The hydraulic power to turn the rudder is provided by two electrically driven

variable-delivery hydraulic pumps which are located here in the steering gear compartment.

There are two alternative ways of actually turning the rudder within the steering gear compartment. At the forward end of the steering gear compartment on its starboard side there is what is called a silent compartment - in other words it is an insulated room to keep noise out - which has a steering wheel which is mechanically linked to the telemotor receiver in the steering gear compartment, so that if you lose all forward steering, but you still have the steering motors operating, you can steer the ship quite normally but from that silent compartment.

If you lose electrical power and you lose the ability to steer with the hydraulic system, there is also in this forward part of the compartment a hand-operated hydraulic pump with two big steering wheels on it, which enables two men to actually pump the hydraulic rams by hand to steer the ship. It is a very slow process, and is very definitely only emergency steering, but it does enable you to turn the rudder by hand without any electricity.

If we move a little bit further forward on this deck, we have the after fresh water tanks just forward of the steering gear compartment. Now, I mentioned earlier that the steering gear compartment is armoured. It has fairly light armour around the steering gear compartment. Forward here, of course, it is not. Fresh water tanks. Then there is the Y ammunition lobby, which has some protection, with the shell room directly below it and the magazine directly ahead of it.

The aft compressor room, with air compressors and one of the 50 tonne hull and fire pumps, is located aft here. A second gyro compass is located on this deck aft here.

There are stores and then we are into the after engine room. So we will move forward again to forward of the forward boiler room.

We are again in a very important part of the ship. For reference as to position, we're virtually underneath the foremast, which is here; forward of the forward funnel; directly down and a little bit after the bridge. If we come down here onto the platform deck, we have a wireless office on the centre line, a second wireless office, the

telephone exchange, an auxiliary wireless office and the lower steering position.

CMDR RUSH: Would you just indicate to us the waterline, where we are?

MR JEREMY: The waterline is somewhere around here (indicating). As you can see, the lower steering position is located directly below the bridge. That is where the compass platform is, that is where the captain is. The wheelhouse is underneath it. Then directly below is the lower steering position. Perhaps later we might talk in more detail, CMDR Rush, about the steering gear itself, so I won't talk now about the telemotor systems.

Moving a bit further forward, again on platform deck, we are talking about the centre line here, we have a lobby and chart and chronometer room down at that level. There is a pump lobby. This is where one of the hull and fire pumps is located above the 6 inch magazine. There is a compressor room, storeroom, the petrol control compartment and canvas room and then the cable locker again.

Shall I move up to the next deck?

CMDR RUSH: Thank you.

MR JEREMY: We will move aft again. There is the stem. That conveniently located paint store is right up forward there. I'm not sure what "secondary room" is, I would have to check that, but there is the shipwright's store, the cable locker flat and the first of the forward mess decks.

If we look right down aft on this deck here, on the lower deck, you will see, apart from the ammunition lobby for A turret, we're really talking about mess decks. So these are accommodation spaces which are fitted out with mess tables, kit lockers and hammock stowages because, of course, the crew in Sydney slept in hammocks. Messes continue all the way aft on this deck.

CMDR RUSH: This is the lower deck?

MR JEREMY: This is the lower deck. The stokers, close to their place of work, are on the after end of that lower deck, just forward of the forward boiler room.

We'll take another trip further aft on the same level. We are still on the lower deck. We have here the fan rooms which are supplying air via these inlets into the after engine room. We have cabins on each side and, importantly, here, directly underneath the mainmast, which is there, we have the main W/T office. That's the main comms centre for the ship in that area there.

Then further aft here, apart from, of course, X ammunition lobby, there are mainly officers' and warrant officers' accommodation. So there are cabins along the ship's side and right aft, with the wardroom on the port side, until a bit more machinery intervenes with the machinery which drives the capstan which was located on the quarterdeck, and then warrant officers' cabins right aft.

CMDR RUSH: Then working backwards through the upper deck?

MR JEREMY: I have mentioned the capstan, which was located here, and that's quite evident in many of the photos of the wreck, which no doubt we'll see later on. Coming forward, we have the Y gun mounting here with its barbette, inside which you have the roller bearing path upon which the mounting actually sits, and we may talk about that in more detail later.

In the after deckhouse, we have the senior officers' cabins - the commander, the executive officer, the engineer officer and the captain's accommodation down aft here, then their heads and bathrooms, then the torpedo workshop. The torpedo workshop was also, in effect, the ship's electrical workshop.

This deckhouse leads us directly to the 4 inch gun deck, which is here, which is a structure built above the upper deck at forecastle deck level, and there is your starboard torpedo tube mount located there, in its stowed position.

CMDR RUSH: They are in a stowed position forward and aft?

MR JEREMY: Yes, forward and aft with the warhead at the aft end and the firing bit at the forward end.

If we come further forward from there, there are the vegetable stores, port and starboard, and then the support structure for the catapult. The catapult is there, a

revolving catapult, which would have the aircraft sitting on top of it.

The two 27-foot whalers here are mounted upon a steel structure in their sea-stowed position. They could be slung from davits when in port - davits aft which were portable - but this is where they were normally when they were at sea, stowed in that location. The regulating office and the mail office and the aircraft store and shipwright's workshop are there inside the catapult support deckhouse.

There is the bakery. A good strategic location for the bakery. Good smells on the iron deck there, I'm sure. Drying rooms, near where there is plenty of heat, and, again, a supporting structure for the motorboats, two of which were mounted above.

You can see here the forward funnel and the seaplane crane, which of course, as we've already noted, was used to launch the boats, with the exception of two that we'll come to in a moment.

The big searchlight projectors, the 36 inch light projectors, are mounted on platforms beside the forward funnel. Then we come a little bit further forward on this deck. On the centre line you have the ship's galley, which is in there, and its funnel, because the ship's galley was fitted with oil-fired ranges. It wasn't an electric galley. So the fumes and exhaust from that was taken up and up the forward funnel.

The smith's shop, of course, as I earlier mentioned, was above that and it also discharged up the forward funnel.

Outboard in this enclosed area you had hammock spaces and canteens and so forth, and also some of the abandon ship gear was located in this area here, worth remembering because we will be coming back to it later.

At this level we also see the davits, here and here, (indicating) for the ship's two 32-foot cutters. These were normally the only boats that you would expect to see used at sea. They were designed to be the boats which you launched if you had a man overboard. They were the boats which you launched if you wanted to board another ship or

if you wanted to pick up a dan buoy or some action at sea which required the use of a boat.

CMDR RUSH: Did they require the crane?

MR JEREMY: No, they did not. They would normally be slung out at sea so that they were ready for launching at short notice. In this drawing, they are showed in the stowed position, sitting on deck.

We have a galley a bit further forward. Now we are coming up under the forward superstructure again, which is very important for the future story. We have the sick bay, which is in this area here. There is a large space for the sick bay.

Then there are more mess decks. We are back into mess decks and the B ammunition lobby underneath the B turret.

Moving again further forward, we have the barbette for A turret there on the centre line, and A turret in that position, with chief petty officers' and engine artificers' messes and stokers' messes, petty officers' messes, canteen, staff mess and so forth, then the capstan engine flat up forward here and the two prisons, or the two cells, right forward. Of course, as I mentioned, even though we have machinery space up here it was still occupied by crew and the conveniently located paint room, again, right up forward.

If we come back on the forecastle deck we have, of course, A turret and the forward superstructure containing the crew's heads and recreation spaces in this area in here.

I might just go up, perhaps, CMDR Rush, into the forward superstructure as we're here. We have the navigating officer's cabin and the captain's sea cabin up forward here, and that is, of course, where the captain would live at sea, rather than aft. For reasons which, from a ship-design point of view, I don't quite understand, the dental surgery is also there, and then we have the signalling offices and so forth in here.

Above that is the wheelhouse, which is directly located under the ship's conning position, the compass platform, and there would be direct and convenient voice

pipe communication between there, so that if you wanted to alter the course of the ship or you wanted to alter the ship's speed, you would pass an order from the compass platform via voice pipe to the wheelhouse, where the helmsman would alter the course of the ship, apply the wheel as ordered or, alternatively, orders would be given in terms of "ahead" or "astern" and so many revolutions to the machinery spaces.

There is the plotting office and the remote control office and then the chart house and the silent compartment, which, as I said earlier, was probably associated with the sonar, and then the bridge itself, where we have, as I mentioned, the compass platform, enclosed partly by windows and with the bulletproof roof, which extended from there through to there above it (indicating).

There are the two big range finders - the UK1 range finders - mounted on pedestals in this position, and here is the director control tower. I will just move up a little bit. That is here, which of course is the director for the 6 inch gun, the main armament. The secondary armament, the 4 inch guns, were controlled by this director here.

For signalling purposes, we of course have two signalling projectors here and here. And we have, of course, the foremast, which is supporting signal halyards, operated from the flag deck, and here is the flag locker here. So you have signalmen down at this level ready to hoist flags as ordered by the bridge.

The W/T office is down here. The aerial trunks come from the W/T office up here to the foremast, and from the auxiliary W/T office, which is a little bit further forward, they come up to a position here at the superstructure deck level where the antennas are run to the foremast. They can be seen on a later drawing.

We're coming aft, perhaps, to the after superstructure and we have the galleys. That's the captain's and the warrant officers' and the wardroom galley located here. Here is the after control position, which, with its gun sight, is a secondary gunfire control position, with the 0.5 inch machine guns located on top of it. Then there is the mainmast and the structure which has the big 36 inch searchlight on top of it. Here is the little funnel,

chimney, from the oil-fired ranges in the galleys.

THE PRESIDENT: As you previously said, the masts are much taller than that?

MR JEREMY: Much taller. I'm sure that later on we can call up a drawing which will show that rig perfectly.

On the 4 inch gun deck here we have the four single 4 inch guns with ready-use ammunition lockers here for those guns.

CMDR RUSH: Thank you very much. May I now turn to armament, sir, and direct questions principally to Mr Buckland. We have discussed the 6 inch guns in turrets, Mr Buckland. What was the nature of the shell fired by the 6 inch guns?

MR BUCKLAND: They had a variety of shells, but they had a nose-fuse high-explosive shell and they also had a semi-armour-piercing shell which they could fire.

CMDR RUSH: The weight of the German armament I opened, I think, as being 42 or 43kg. What was the weight of the 6 inch shell?

MR BUCKLAND: Very similar, 112 pounds, which was about 40kg.

CMDR RUSH: What was the approximate range?

MR BUCKLAND: It is over 20,000 metres, 20km. The actual range is in the document; it is 25km.

CMDR RUSH: I am looking at page 60 of the report at paragraph 21.5. You say the range of the gun was 25,480 yards at elevation 45 degrees. Was that the most appropriate elevation for range?

MR BUCKLAND: No. Depending on the elevation at which you are aiming the gun, you are going to get different ranges for the weapon. That is just to obtain the maximum range for the gun.

CMDR RUSH: We've been through with Mr Jeremy the locations of A and B turrets and X and Y turrets. In relation to the loading of the guns, are you able to give

us a general description? Was there hand loading and hand ramming? How did it work.

MR BUCKLAND: They have breech-loaded ammunition. The shells came up through the hoist that John has indicated. It is probably shown on figure 37. The shells are transported up by a hoist system to a tilting tray the shells are then offloaded into --

CMDR RUSH: We might see if we can get figure 37 on the screen. Perhaps for the purposes of your evidence, Mr Buckland, if we use the manual pointer, the laser pointer, and you can take us through this diagram.

MR BUCKLAND: This is the gun house with the barrels of the gun, but this is the actual trunk of the turret housing or the turret (indicating).

CMDR RUSH: Mr Jeremy has referred to the barbette from time to time.

MR BUCKLAND: The barbette is this section underneath.

CMDR RUSH: What is the barbette?

MR BUCKLAND: The barbette is what the gun housing sits on. John might be able to explain that one actually a bit better, just because it is important in relation to where the revolving ring sits.

CMDR RUSH: Can you explain what the barbette does?

MR JEREMY: It is really the gun support structure. I would need to get my pointer machine up on the screen again.

CMDR RUSH: I don't think we can do it just at the moment, Mr Jeremy. I think we will just take some oral evidence, at this stage.

MR JEREMY: Very good.

CMDR RUSH: What is the barbette?

MR JEREMY: It is effectively the supporting structure for the gun turret. It includes the armoured ring that you see directly under the gun turret, which I can show you. It is

the armoured ring there which is directly under the gun turret, which protects the roller bearing path, which is in here.

That roller bearing path is the ring upon which the turret actually rotates. It is what actually supports the whole mounting and all of the rotating structure of the mount, which extends down right into the handling room down here, the ammunition lobby down below here. So that all of that rotates with the turret. The barbette structure really is the supporting ring structure in here, on top of which you have the roller bearing path. That has to be very solid and very accurately built.

CMDR RUSH: What sort of weight are we talking about?

MR JEREMY: The rotating weight of the turret is 95 tonnes.

CMDR RUSH: It rotates on a roller bearing?

MR JEREMY: When the ship is built, the top of that barbette structure has a big thick plate on it, which is then machined, in situ, to be very, very flat, and aligned as closely as possible to the gun rings of each of the turrets, so each of the four turrets. They are not like that, tilted; they have to be as flat as possible, so that when you rotate the turrets they are all pointing in the same way, instead of moving as they rotate.

CMDR RUSH: Was an hydraulic system used for rotation?

MR JEREMY: Just to finish the description, on top of that you then have a roller bearing path which is bolted, and roller bearings, which are right around underneath the gun turret. They actually support the whole of the rotating structure. That's the turret and the rotating structure below the turret. There are hydraulically powered motors, which drive pinions against a big gear wheel, which is built into the roller bearing mechanism, so it is geared to it, so those motors actually rotate the turret.

CMDR RUSH: And that was driven from inside the turret?

MR JEREMY: Yes, it is a self-contained system within each turret which requires external electricity, of course.

CMDR RUSH: And each individual turret had that capacity to rotate as desired?

MR JEREMY: Yes.

CMDR RUSH: For completeness, if the hydraulic system was lost, was there an ability to rotate the turret manually?

MR JEREMY: Yes, there was, but it would be slow. It could be rotated by hand.

CMDR RUSH: How was that done, in very general terms?

MR JEREMY: In very general terms, there were wheels which you wound inside the turret, which could actually turn it. I'm not familiar with the details of that.

CMDR RUSH: If I can come back to Mr Buckland in relation to this, are you familiar with the number of men who were required to operate inside the turret?

MR BUCKLAND: Yes.

CMDR RUSH: For each of the turrets - A and B and X and Y - how many men were involved in the operation, firstly, just of the turret itself?

MR BUCKLAND: There were 20 people in the turret itself. In the lobby there were another 10. Then in the shell room there were four and in the handling room there were another three. So there was a total of 37 all up.

CMDR RUSH: There has been a description of shell and cordite. Can you explain the role of the shell and what would be loaded and the role of the cordite charge and how they came from their magazines and lobby into the turret?

MR BUCKLAND: The shell and the cordite are kept separate. The shell is the warhead itself, so that was loaded first, and then the cordite is actually the firing charge which propels the shell out of the barrel, and that is handled separately up to the breech and loaded separately, but the shell needs to be rammed in and then the cordite firing charge is then rammed.

CMDR RUSH: So what was the mechanism of ramming a shell into the breech and then ramming the cordite into the

breech.

MR BUCKLAND: A manual pole.

CMDR RUSH: From your research into this, once loaded, shell and cordite, was it easy to extract the shell or did the shell have to be fired.

MR BUCKLAND: No, they tried to clear the barrel by firing the weapon off. They wouldn't try to extract the cordite.

CMDR RUSH: We spoke, Mr Buckland, about the range of 25,480 yards. Was that an accurate range?

MR BUCKLAND: As the distance increases, accuracy is dropping off. I'm not quite certain of your question.

CMDR RUSH: Would one expect there to be great accuracy at that range or is that the absolute maximum?

MR BUCKLAND: That's the absolute maximum of the weapon, but the further you go, your accuracy is dropping off.

CMDR RUSH: Did you prepare a table - table 6 at page 61 - as to the total crew numbers that were involved in relation to the 6 inch guns?

MR BUCKLAND: Yes.

CMDR RUSH: You have set out there the numbers that were involved in each aspect of the gun handling to total 156 for the four turrets?

MR BUCKLAND: Yes.

CMDR RUSH: That is including ammunition rooms and the like. Can I briefly ask you to describe the mechanism of bringing the ammunition to the turrets? Was it a mechanical system in part?

MR BUCKLAND: It was both mechanical and manual, in that the shells had to be loaded onto the hoist and then that was hoisted up.

CMDR RUSH: Where were they loaded onto the hoist?

MR BUCKLAND: At the handling room. In the handling room.

CMDR RUSH: How would they then get from the handling room to the turret? What was the process?

MR BUCKLAND: There was a hoist up to the turret and then within the turret there was a shell mechanism where the shell could be loaded towards the breech and then the shell was pushed into the breech or into the barrel.

CMDR RUSH: Could I ask you about the 4 inch guns. I think you refer to these at page 62 of the report. Mr Jeremy has referred to the 4 inch gun deck. What was the nature of the 4 inch guns? What were they principally designed for?

MR BUCKLAND: They were principally anti-aircraft; for firing at aircraft.

CMDR RUSH: In relation to the loading and firing of the guns, was it a manual operation?

MR BUCKLAND: It was a manual operation.

CMDR RUSH: Again, Mr Jeremy has given some evidence, but is it your understanding that the armament was stored in ready-use lockers on the gun deck?

MR BUCKLAND: Yes.

CMDR RUSH: Have you any idea of the weight of the shells?

MR BUCKLAND: Yes. They were in the proximity of 10 to 15kg.

THE PRESIDENT: It is 31 pounds; 14.06kg.

CMDR RUSH: I didn't ask you this, but I will ask it firstly for the 4 inch guns, what was the rate of fire per minute?

MR BUCKLAND: The rate of fire for the 4 inch guns was 10 to 15 rounds per minute.

CMDR RUSH: What about the 6 inch guns?

MR BUCKLAND: They could fire six to eight rounds per barrel. So it was 12 to 16 rounds per turret.

CMDR RUSH: Per minute?

MR BUCKLAND: Per minute.

CMDR RUSH: We have seen where the 4 inch magazine is. Was there any mechanised system for bringing that armament to the 4 inch gun deck.

MR BUCKLAND: I think John explained that before. There was a hoist up to the upper deck then it was manhandled down. You had to manhandle it up to that platform where the 4 inch guns were mounted.

CMDR RUSH: There was also reference to the director control tower and the director control system, and evidence that that applied to the 6 inch guns. What was the role of director control for the 6 inch guns?

MR BUCKLAND: I will just explain. Firing the guns from a ship is very complicated because you need to get the relative range and direction of the enemy and also, because your platform is rotating, pitching and yawing, what the director control initially does is, once they get the sight from the enemy ship, it is directed towards that enemy ship that they are going to fire on and that signal is sent to the turrets and each of those turrets will be then aimed in that direction. But they also take the range and direction, and that is then transmitted down to the transmitter room, where they do the calculations on their table, which they then have to signal back to the guns, to each gun turret, to say which elevation for each of those guns, because each gun will have a slight variation.

CMDR RUSH: In relation to the initial information that is sent down to the table that works out range and bearing for firing, does that come from director control?

MR BUCKLAND: Director control.

CMDR RUSH: Then once that is established, does it go back to director control and does director control send that information to the turrets?

MR BUCKLAND: No, the information goes from the transmitter station. Director control sends some information straight to the turrets for the direction that

the guns are bearing, but most of the information comes from the transmitter station, which then gets transmitted to each of the gun turret housings. Then, once the guns are trained onto the target, that is then signalled back to the transmitter station and once they've got the red lights on from each gun, that will then be put back up to the director control tower, who is then able to fire the guns, because they try to fire all the guns at once.

CMDR RUSH: So once each turret has come in to bear and aim in accordance with the directions it has been given, there is a red light system for each turret that comes back to the transmitter station?

MR BUCKLAND: That's right, and they've loaded the shells.

CMDR RUSH: They have loaded the shells and they are ready to fire - which goes back to director control?

MR BUCKLAND: Yes.

CMDR RUSH: Is the firing done by director control?

MR BUCKLAND: Director control can fire. They can fire from the turrets, but the director control will try to fire all the guns simultaneously.

CMDR RUSH: You mentioned before the yaw and the movement of the ship. Was there a system which allowed for that in relation to the firing?

MR BUCKLAND: Director control could put that into gyro firing so that that could take into account the motion of the ship, so that it would fire at an appropriate time when the guns should be bearing onto the target.

CMDR RUSH: What is the relevance of that in firing onto the target - the pitch, the yaw and the movement?

MR BUCKLAND: There are lots of different types of movement that the ship is going through, so it makes it very difficult. That's why they have the firing table down in transmitter station, where if you have the four guns to bear and there are seas making it rock, of course you have the movement of the guns up and down, so to be able to fire at your target, you have to make certain that it is in line with that roll.

CMDR RUSH: So using the gyro system, is that an attempt to ensure that it is firing as directed?

MR BUCKLAND: That's right, yes. This will depend on the stand off - the range, the relative velocity between the two vessels, other factors with the speed and the angle that you are firing from the guns. So each gun will need a different calculation.

CMDR RUSH: In relation to the 4 inch guns, was there a not dissimilar system that applied to that?

MR BUCKLAND: Yes, very similar, from the HAC tower. That went back to the office next to the transmitter, that John pointed out before.

CMDR RUSH: Is that a HACS or high-angle control system?

MR BUCKLAND: Yes.

CMDR RUSH: We've seen the tower that applies to that.

MR BUCKLAND: That's right. But they, as I understand it, didn't have the firing button at HACS; they fired that from the guns.

CMDR RUSH: Mr Buckland, you also examined the torpedos of Sydney. I think you refer to that at page 63 of the report. The torpedos carried a 750 pound TNT explosive head.

MR BUCKLAND: Yes.

CMDR RUSH: You refer to a range of different ranges depending upon the speed at which the torpedo travelled the distance. For example, you have referred to a range of 10,500 yards at 35 knots, and a little bit further if speed was reduced.

Just in relation to the tubes, how many torpedos were in individual tubes?

MR BUCKLAND: In each tube there is one torpedo, but there are four tubes per port and starboard.

CMDR RUSH: Were the torpedos carried in those tubes at

all times, or all relevant times, if you like.

MR BUCKLAND: At all relevant times they would be stored in the tubes.

CMDR RUSH: The diagram, the profile of the ship that we saw, showed that the tubes were stored forward and aft. To put the torpedos into use, what was required?

MR BUCKLAND: They were rotated out. They were on a mounting system that they could just be angled out, so they had a range between - I'm not quite certain what it was now, but they had a firing range, so they could bear straight out, trying to bear out.

CMDR RUSH: So did that require the torpedo crew to rotate the tubes so that they bore outwards?

MR BUCKLAND: Yes, from the bridge they would give a plot of where they needed to be directed, and it would be communicated down to the torpedo crew to rotate.

CMDR RUSH: This may be a question either for Dr Cannon or Mr Jeremy, but what was the nature of the protection and armour protection for the torpedo crews and the 4 inch gun crews?

MR JEREMY: Essentially, none. There was some splinter protection added at the early stage of World War II to the 4 inch gun deck by putting about half-inch high tensile steel plating around the guardrails outboard of the 4 inch gun mountings, but that was minor - very minor. There was no protection to the torpedo tubes at all.

CMDR RUSH: The guardrail came to approximately what height?

MR JEREMY: About 3 feet high.

CMDR RUSH: Sir, I may turn now to the construction of Sydney and its various subdivisions, and I refer to page 66 of the report. I think Dr Cannon may give some evidence in relation to this.

Dr Cannon, in the report it is stated that the construction of Sydney was of steel, and it was transversely framed. I understand the steel component,

what does "transversely framed" mean?

DR CANNON: The structures that the ships are made of is essentially thin plate, and then there are two strengthening mechanisms for that plate. The frames, if you like, are the ribs that run around the outside of the ship along the hull plating and along the decks.

Then there is a secondary stiffening system, being longitudinal girders that run from the aft end of the ship through to the forward end of the ship.

In a transversely framed ship the transverse frames tend to be closer together, and in Sydney's case, this was typically 3 feet between each frame.

CMDR RUSH: Could I ask you, if we can bring up figure 40, which is described as Sydney's "body plan", in relation to the body frames, are you able to explain how that drawing assists us, or does that drawing assist us in relation to an understanding of the framing?

DR CANNON: I think in this diagram, as we look at it, the after end of the ship is on the left-hand side of the diagram and the forward end of the ship is on the right-hand side of the diagram. Each of those lines show the frame section as we go aft.

The frame shape, if you like, at the very forward end of the ship is highlighted there by John. Then, as we move aft, you can see the frames start to get wider and wider, as the ship's shape becomes a lot fuller, ultimately until we get to the midships region, where we have the extreme there.

A similar thing is occurring on the left-hand side. The midships region is on outer extreme. Then, as we move further aft along the ship, the shape of the frame is shown in that body plan.

CMDR RUSH: Are the frames, as such, girders in the ship?

DR CANNON: Perhaps if we turn over to the next figure, if we may, figure 41 on page 69. This is showing a typical frame, which happens to be at frame 27, the location where the torpedo impacted.

The information that you get from this type of diagram is first of all the hull plating thickness. The hull plating thickness was described in terms of pounds. A 1 inch plate is typically 40 pounds; a half inch plate is 20 pounds. So as we start from the keel, which is just off the bottom of the diagram there, Sydney would have had 30 pound plate on the outside of the hull there, three-quarters of an inch thick. As we move up along the side, where there is a longitudinal bulkhead, the hull plating would be 25 pound plate. Then, as we move further up between the decks, this will reduce in thickness, if you like, to 17 pound plate.

CMDR RUSH: Is there a reason for that reduction?

DR CANNON: As the ship itself bends in the seaway, it is the two extremes that take most of the loading, so the stresses in that location from a seaway are lower.

Right at the sheer strake, the plating again will increase up to about 25 pound plating.

The deck plating, in the uppermost deck there, which is the forecastle deck in this particular region, would be 14 pound plate. In the two decks below, about 12 pound plate, as well as in the lowest deck there. So that's the outer shell plating, if you like.

Then there is the frame that runs around the outside. This is typically about 6 inches long, C section. Then also marked are the longitudinals, particularly on the forecastle deck. At the top there you can see there a number of longitudinals. These would be 6 inches deep C sections with 3 inches across the top, 3 inches across the bottom.

CMDR RUSH: What are they when you say "sections"?

DR CANNON: They are sections of steel, channel bars. They would be riveted on to the main deck.

CMDR RUSH: What is the purpose of those sections?

DR CANNON: To give longitudinal strength to the ship and to prevent buckling of the plating.

CMDR RUSH: You refer in the report to the numbering of

frames going from zero to 208. In looking at those numbers, are we to understand that there are 208 individual frames along the structure of Sydney?

DR CANNON: Yes. Between the perpendiculars. There are a few extra.

CMDR RUSH: How is the numbering of frames undertaken?

DR CANNON: The frames in warships are taken from the forward perpendicular - the area where the waterline crosses the stem, as Mr Jeremy presented earlier. Then with each frame space, as we move along towards the stern of the ship, we increase the numbers.

CMDR RUSH: The design length is mentioned in the report, between the perpendiculars, at 530 feet.

DR CANNON: That's correct.

CMDR RUSH: It was measured at 530 feet and three-eighths of an inch, as constructed. In shipbuilding terms, have they done a good job?

DR CANNON: Three-eighths of an inch, over the length of that ship, from the design to the construction I would say is incredibly good for this particular era.

MR JEREMY: Perhaps, CMDR Rush, if I comment: one measures a ship as built. It is not an easy job to measure a ship actually as built, and three-eighths of an inch is as near as damn it spot on, really.

CMDR RUSH: The construction of the ship you refer to as being riveted construction and welded construction. Where was it riveted and where welded, and in terms of history in relation to Naval architecture, was welding a relatively new phenomenon?

DR CANNON: Yes. I think early on in the report, and Mr Jeremy has given such evidence, we say that weight was critical. At about this time the Admiralty were considering welding as an option for ship design. One of the benefits of welding is that it actually saves weight.

The majority of Sydney was riveted construction. So that is a mechanical fastening joint where rivets, which

are essentially nuts and bolts, are holding the ship's structure together. However, in areas near watertight bulkheads, in order to reduce weight, they have used some welding. It was a number of years later that I think ships became totally welded. John might be able to update me on that.

MR JEREMY: If I may, CMDR Rush, the man responsible for the design of the Leander class and the Modified Leander class cruisers, Charles Lillicrap, was a great proponent of welding, and these ships incorporated, for the time, a very high degree of welding. The first all-welded British ship was actually built a few years later, in the middle of the 1930s, but a lot of decks and bulkheads in Sydney were fully welded.

CMDR RUSH: Does the ship's profile show us the framing system, if we were to look at that?

DR CANNON: Yes. It certainly shows the framing number.

CMDR RUSH: Figure 30.

MR JEREMY: We have a slightly new system operating. We will go right forward.

CMDR RUSH: Does that show the frames numbered from forward at zero through to 208?

DR CANNON: Yes.

MR JEREMY: If I can comment, frame zero is there (indicating) which is the intersection of the stem with the design waterline. This plan does not show every numbered frame, but, for example, that bulkhead is at frame 7. The numbers are a bit faint on this drawing, but then each one is numbered as we go aft. The numbering, of course, in warships being the reverse of merchant ship practice, just for convenience, which tended to number the other way if the ship was British. Until we come right aft here where the frame here is frame 208. You will notice, of course, the frames continue aft in the after overhang.

CMDR RUSH: The other feature, as I understand it, of Sydney, was the design of watertight compartments?

DR CANNON: Yes.

CMDR RUSH: Can you indicate what they were and what their purpose was in design?

DR CANNON: One of the important aspects of ship design is obviously maintaining watertight integrity, and this is done through a number of transverse watertight bulkheads contained within the ship's hull, the ship's envelope. There were some 23 - I think that is the number that is quoted in the report - watertight bulkheads that are marked on this diagram above the frame spaces where it says "watertight bulkhead". So if you look at that first frame that John is identifying at frame 7, there is a watertight bulkhead. There is a total of 23 along the whole length of the ship. All of them went to the platform deck - in other words, more or less where the waterline is; 16 of them went further, up through the lower deck and up to the upper deck.

Because these bulkheads don't contribute to longitudinal strength, they tend to be of a smaller plating thickness, typically about 7 pounds.

CMDR RUSH: In ship's design, what was the purpose of the watertight compartments or bulkheads?

DR CANNON: The purpose of the watertight compartment is essentially, if there is damage in one location, to keep floodwater within that location. It limits the amount of flooding and therefore it limits the amount of sinking of the hull in the water. So its primary aim is to help keep the ship afloat.

CMDR RUSH: Were they longitudinal?

DR CANNON: There are two areas where there were longitudinal bulkheads, in the forward section, from frame 25 through to frame 86. They were highlighted in those deck plans that John showed earlier.

CMDR RUSH: What is the difference between the longitudinal as opposed to transverse watertight compartments? Was one concentrated on, as opposed to the other?

DR CANNON: Yes. They are of similar structure. The primary aim there is to stop some transverse flooding all

the way across the ship. It tended to be very close to the centre line of the ship. John's identifying the forward longitudinal bulkhead there.

It did enable separate compartments, so that if you did have a ship that is heeling over you could flood from one side to the other to keep it up on an even keel. Then there was a second lot of longitudinal bulkheads further aft in the modified engine room design that John is highlighting there, and then a third set further aft from frame 151 through to 191, more longitudinal bulkheads.

CMDR RUSH: So when we talk about those compartments being watertight, in the normal operations of the ship at sea how were they kept watertight?

DR CANNON: They are a solid bulkhead that is physically linked to the side of the ship. Below the waterline, or below the platform deck, there were two large watertight doors in two bulkheads, the first one being up at frame 76, between the transmitting station and the calculating room that John mentioned earlier, and there was a second watertight door further aft at frame 183, again, below the waterline.

CMDR RUSH: And so to get access between the watertight compartments, how did one do that?

DR CANNON: Anybody on board ship, if they were in one compartment, would have to travel vertically upwards until they got to the point where the watertight bulkhead was stopped, along the deck and back down again, apart from at these two locations.

CMDR RUSH: There has been mention of armour plating on Sydney. Could I ask you to look at figure 42 on page 70. What is depicted there in red is described as demonstrating or showing the side armour of Sydney. What was the point of it and what did it mean, as far as protection was concerned?

DR CANNON: In this particular case, because the armour plating is not related to the sea loading, I might direct that question to Mr Buckland, if I may.

MR BUCKLAND: The engine rooms and the boiler rooms were totally enclosed with the armour plating to stop fragments

or smaller projectiles penetrating into those rooms so it gave it greater vulnerability.

CMDR RUSH: So was the armour plating designed specifically to protect those areas?

MR BUCKLAND: There was a requirement, at the time that the ship was constructed, to protect the armour from 6 inch shells from 10,000 yards.

CMDR RUSH: I think that is referred to at page 69 of the report. Looking at the armour and protective plating, the design specification was to protect or make the ship immune to 6 inch shell fire above 10,000 yards?

MR BUCKLAND: Yes.

CMDR RUSH: Just so we understand that, for a 6 inch shell fired from a ship in excess of 10,000 yards away, was the armour plating designed to protect the ship from sustaining entry by that shell into the ship?

MR BUCKLAND: I think there has always been a battle between armour plating and the weapons people. Not all 6 inch shells are the same, so the armour-piercing shell still had a fairly large velocity at that stage, but over 10,000 yards the angle of impact onto that plating would have meant that it wouldn't have penetrated that plating.

CMDR RUSH: There is reference in the report to the ship's side being immune above 10,000 yards and the crowns being immune below 16,000 yards. What are we talking about when we refer to crowns?

MR BUCKLAND: The crowns are basically the deck heads or roofs of those spaces that are being protected.

CMDR RUSH: So when we talking about the bridge, which Mr Jeremy mentioned had a particular thickness, was that what we would refer to as the crown?

MR BUCKLAND: The top of the bridge was protected mainly from aircraft machine gunfire, so there was protection on that bridge roof structure. It also gave some limited protection from fragmenting shells.

CMDR RUSH: From a Naval architect's point of view, what

are the crowns?

MR JEREMY: The top of the compartment, basically. So the crown of the steering gear compartment is the top of the steering gear compartment and the armour on the top does not need to be as thick as that on the sides because a shell, of course, is likely to be coming at a different angle.

CMDR RUSH: Is that a convenient time, sir?

THE PRESIDENT: Yes. I adjourn until 2 o'clock.

LUNCHEON ADJOURNMENT

UPON RESUMPTION:

CMDR RUSH: Mr Jeremy and Dr Cannon, we have already had some evidence in relation to the machinery of Sydney. It is dealt with at page 71 of the report. We have heard about the four boilers and the two engines. Could we have briefly a description of the nature of the boilers and the engines? When we were going through the profile, we looked at the shafts on starboard side, replicated on port side. What I want to ask you is in relation to the boilers and their arrangements. If you go to figure 43, it is set out in some detail.

MR JEREMY: Yes, certainly. Figure 43 shows the arrangement of the forward boiler room and the forward engine room in Sydney. You will notice that in the forward boiler room, there are actually three boilers. There are the two main boilers - A1 on the starboard side and A2 on the port side. In addition, there is an auxiliary boiler, which supplied saturated steam for ship's domestic purposes and saturated steam for use during start-up of the main machinery plant so that you could supply steam to the forced draft fans and other auxiliaries.

The boiler rooms in HMAS Sydney were sealed, pressurised boiler rooms. They were supplied by air from steam-driven forced draft fans, with the air exhausting up through the funnels. A boiler room was slightly different, in that there was an additional fan supplying air to this room to enable early start-up of the auxiliary boilers and running of the auxiliaries.

Steam from A boiler room was supplied into A engine room and via a further connection through into B engine room if necessary. You can see in the illustration that there are two main turbine sets in A engine room, port and starboard. They are both the same but opposite hand and comprise a cruising turbine, a high-pressure turbine and a low-pressure turbine and a single-reduction gearbox linked to, in each case, a propeller shaft.

The engine room also contained one of the ship's turbo generators, a 300kW turbo generator. The machinery was controlled from a manoeuvring platform at the forward end of the engine room.

Shall I move on to B?

THE PRESIDENT: Just before you do, was the air intake into the main boiler room subsequently transferred into the engine room?

MR JEREMY: No. The engine room was separately ventilated, and you can see on this drawing two of the exhaust fans shown. There is one of the exhaust fans here and there is another one there (indicating).

THE PRESIDENT: From where did it draw its fresh air?

MR JEREMY: From the upper deck area, the forecastle deck level of the upper deck.

THE PRESIDENT: So if there was smoke in the upper deck area, the expectation would be that it would have been drawn into these rooms?

MR JEREMY: It would, yes.

CMDR RUSH: Following up that question of the Commissioner, was it possible to operate the boilers without ventilation?

MR JEREMY: No. They required the forced draft for the air to operate. I guess that they would operate for a short while on natural draft, but it would be highly inefficient and you would get a great deal of poor combustion and not much steam. But I'm not a marine engineer, so I can't be certain of that.

CMDR RUSH: Was there any provision for recirculation of the air through boiler rooms and engine rooms?

MR JEREMY: No, none whatsoever. One of the big differences between this kind of boiler room and a post-War boiler room, for example, in a more modern ship, is that a more modern ship would have a boiler room where the forced draft was supplied to a sealed boiler, so that the boiler room could in fact be operated in conditions of nuclear, bacteriological or chemical contamination, but you could not do that with this kind of boiler.

I'll move on to B. The arrangement here is similar, except that B boiler room is quite narrow because it is bounded by these two longitudinal watertight bulkheads,

outboard of which we have two diesel generator compartments - one there and one there (indicating). The boilers are fore and aft, B1 forward and B2 aft. There is no auxiliary boiler in this space, and the only ventilation for this space was the turbine-driven forced draft fans for B boiler room.

The B engine room is very similar to the forward engine room. It has two sets of steam turbines. In this case, they are operating the inboard shafts rather than the outboard shafts. It is manoeuvred in a similar manner. There is also a 300kW turbo generator, and this space also has the ship's evaporators, 1, 2, 3 and 4, which supply distilled feed water for the boilers and fresh water for the ship.

CMDR RUSH: May I turn to the steering gear. You have already referred to the telemotor system for the steering gear, but I want to look at it in a little bit more detail. You refer in the report to Sydney having an electrohydraulic steering gear. Could you explain to us what you mean by that terminology and how it relates specifically to the telemotor system?

MR JEREMY: Yes, certainly. As I mentioned before, the rudder was turned by two sets of hydraulic rams attached to a cross-head on top of the rudder stock. The pressure to operate those hydraulic rams was supplied by two electrically driven variable-delivery hydraulic pumps in the steering gear compartment.

To instruct that system what to do, you had an electrohydraulic telemotor steering system. In each of the two forward steering positions, there was a steering wheel which was attached to a telemotor transmitter, which effectively was a ram inside a tube, which, when you moved the wheel, you moved the piston. You had two pipes leading from that piston aft to the steering gear compartment. The telemotor system was filled with a fluid which was a mix of 50 per cent water and 50 per cent glycerine.

In the steering gear compartment, there was a duplicate, effectively, of the transmitter, called a receiver, so that when you moved the transmitter, you moved the fluid in the system, and that moved the receiver in exactly the same way.

The receiver was connected by a system of levers to a control mechanism which controlled the delivery of hydraulic fluid from the pumps to the rams. Both steering positions were similarly fitted, and from each steering position you had two pipes - the telemotor pipes. From the wheelhouse, the telemotor pipes led down to the lower steering position to a valve panel where you could direct the telemotor transmission from the wheelhouse, for example, down a starboard set of pipes or down a port set of pipes.

Similarly, in the lower steering position, it operated in exactly the same way and the signal was transmitted either side, depending on how you set the valves. You could, for example, set the wheelhouse to transmit via the starboard pipes and the lower steering position via the port pipes.

When the helmsman turned the wheel, of course, a signal was sent via the telemotor system to the steering gear and the rudder turned proportionally to the amount that he turned the wheel.

In order that the system be failsafe and that there be feel in the system so that the helmsman could feel what he was doing, the telemotor receivers incorporated a very powerful spring, so that if you let go of the wheel, the spring would return the telemotor receiver to the neutral or rudder amidships position and the wheel would spin back to the amidships position.

Similarly, if the telemotor system was breached or failed, then the spring would return the receiver to the midships position and the rudder would return amidships.

CMDR RUSH: I think the run of telemotor pipes is illustrated at figure 50.

MR JEREMY: Yes. We don't have drawings for Sydney of the run of telemotor pipes. We weren't able to locate them, but we do for HMAS Hobart, her sister ship.

CMDR RUSH: Page 78.

MR JEREMY: Yes. In HMAS Hobart - and Sydney was probably similar - that is the lower steering position there (indicating). So the pipes from the wheelhouse have come

down to that position from above. Two sets of pipes run aft from the lower steering position to the steering gear compartment. In Hobart - and, as I say, Sydney was probably similar - the starboard set came down in this way, out to the ship's side, down very close to the ship's side, just below the level of the upper deck, then came inboard a little bit at the forward bulkhead of A boiler room, ran down inside the cable space, which was located just inside the armour plating in way of the machinery spaces, and ran aft to the steering gear compartment. We don't have the detail for that here.

On the port side, the pipes ran out straight to the ship's side and then down close to the ship's side just under the lower deck, behind the main switchboard, then back in at the forward bulkhead of A boiler room, and then, in the same way as on the starboard side, through the machinery spaces inboard of the cable passage to the steering gear compartment.

As a result of this, of course, the telemotor pipes were very vulnerable to any damage in way of that shell at that level, so there is, noting the damage which we'll see later on HMAS Sydney, quite a considerable possibility that the telemotor pipes on the port side, and possibly the starboard side also, were disrupted by shellfire.

CMDR RUSH: Just to explain, if the port side telemotor pipes were damaged, then it was possible to run the steering telemotor on the starboard side?

MR JEREMY: Yes, subject to a couple of qualifications. The steering pedestals in Sydney were of an early type which had a single transmitter, so that if the telemotor pipes from that transmitter to the steering gear were breached and you got air into the system and into the transmitter, then switching to another set of pipes would not help you because you would have compressible air in the system. But if you avoided that circumstance, then you could do so.

Later Admiralty practice changed and they put duplex transmitters on the steering pedestals so that you could run one via one set of pipes and one by another set of pipes, which reduced the risk of the loss of the steering because of air in the system rather than the total loss of telemotor pipes.

THE PRESIDENT: If the telemotor system was breached, you would expect to get air in it?

MR JEREMY: The fluid would run out, and depending on where it was breached and how quickly you noticed it was breached, there is a good chance of getting air into it, I would think. But we don't know what Sydney's method of operation of her steering gear might have been. She might have had the lower steering position operating by the starboard pipes and the wheelhouse via the port pipes or vice versa. We don't know.

CMDR RUSH: If that be the position, if the lower steering position, for example, was by port and the wheelhouse by starboard, and the wheelhouse was affected by damage and port side was affected by damage, if it were set up to run in that way, would it necessarily mean air in the opposite side of the telemotor system?

MR JEREMY: Not necessarily, no, not necessarily.

CMDR RUSH: But possibly?

MR JEREMY: Yes, it's possible.

CMDR RUSH: You mentioned that because of the spring mechanism, pretty much automatically the steering would come back so that the course was amidships?

MR JEREMY: Yes.

CMDR RUSH: If the telemotor system be damaged, what is required, then, to steer the ship? For example, here there is some evidence - good evidence, perhaps - that Sydney turned to port. What is required for such a turn?

MR JEREMY: Control of the ship would have had to be transferred to the after steering position and orders given directly to a helmsman in the steering gear compartment, who would then have two options: if there is power, he can steer the ship from the after steering position by directly, with a mechanical linkage, controlling the telemotor receiver.

THE PRESIDENT: On the German account, Sydney turned fairly hard to port and passed astern of Kormoran. Is

there any possibility of that being involuntary?

MR JEREMY: I don't believe so. It is hard to see, from the way the system was constructed, how it would cause an involuntary turn. It is designed really to fail safe, in other words, fail with the rudder amidships. If you had helm on - in other words, you were turning - and the telemotor system was disrupted, then the receiver would lose signal and it would return the rudder amidships.

THE PRESIDENT: And if the evidence discloses, as the Germans seem to suggest, that having passed astern, she made yet another turn, although not nearly as acute, a turn to starboard somewhat, that would indicate that the steering mechanism was to some extent under control?

MR JEREMY: It would.

CMDR RUSH: May I turn to the water services on Sydney, without going into too much detail. You mentioned in earlier evidence the tanks for fresh water, and there was also obviously hot water, with pipes for each running through midships.

MR JEREMY: Perhaps we might have a look at the diagram, shall we?

CMDR RUSH: It is figure 51.

MR JEREMY: Yes, figure 51. It is a bit difficult to see too much detail on these drawings, but I would say that HMAS Sydney was absolutely typical of British cruiser design of the time in the way in which the services were laid out.

In this illustration, the fresh water service is marked in green and, as I mentioned earlier, there were fresh water tanks forward, here, and aft, here. They were not very big fresh water tanks. No doubt the distillers had plenty of work to do.

The salt water service, the main service or firemain, is shown in red throughout the ship leading forward and leading aft, and the main suction is indicated by the blue lines. The main suction is the main pumping main for the ship. This is the means of stripping water out of compartments. As far as I know, in most British cruisers,

it was all run in much the same place, and there you see the main suction line from there.

The main service, the red line, and the main suction, the blue line, could be cross-connected, where necessary, in order that water could be moved around within the ship and you could flood or drain compartments with the use of the main suctions and connections thereto.

CMDR RUSH: There is reference to sluice valves being fitted to the watertight compartments. What is their role?

MR JEREMY: Their role is to isolate damaged sections of the service, so that if, for example, one particular space - we'll just choose any particular space, the main suction, for example - is breached there, you can seal it there (indicating) and you can seal it there (indicating). There was also provision for enabling a cross-connection across the damaged piece of pipe with temporary hoses either on the main suction or on the main service to enable supply to be continued.

CMDR RUSH: If a watertight compartment needed to be flooded, how was that done? Was it done using the pumps or could it be done automatically?

MR JEREMY: It could be done very quickly for compartments down here, like the magazines. They had flooding arrangements directly connected to the sea. CMDR Rush, should I go to figure 53?

CMDR RUSH: When you said "down here"?

MR JEREMY: In the hold. Figure 53 shows us a section through a typical cruiser - and Sydney is just like this - with a magazine, which you can see here. They could be flooded directly through a seacock fitted in the bottom of the ship, and quite a large one. You see it's a 7 inch diameter pipe, so you could flood that magazine very, very quickly.

If you wanted to flood compartments which were, say, watertight compartments not intended to be flooded, then you had to flood those compartments by means of a hose from the main service. They also had to be pumped out by means of a hose, if you had to. Even though you could flood the magazines very quickly, to empty them you actually had to

attach a hose to a standpipe on the main suction and pump them out with a hose. After all, it's the flooding which needs to be quick.

Machinery spaces were differently arranged. Machinery spaces had bilge wells fitted in them which enabled you to pump them out directly via means of the fire and bilge pumps in those spaces. The machinery spaces were also fitted with bilge ejectors, which were run off the steam system, so that you could actually move a great deal of water very quickly out of the machinery spaces by that means.

CMDR RUSH: For the flooding to take place - for instance, magazine flooding - was that done manually?

MR JEREMY: Yes, that was done completely manually, and the valves down here (indicating) were fitted with extended spindles, which ran up, being operated either on each deck or on the upper deck. For example, the flooding valves for the forward magazines and shell rooms were extended up to a box just after the breakwater just forward of A turret, and a similar arrangement aft.

CMDR RUSH: So it could be flooded from various decks on the ship using the arrangements coming up through the ship?

MR JEREMY: Yes.

CMDR RUSH: As I understand it, there were two main pumps in relation to the fit of the ship?

MR JEREMY: There were two pumps outside the machinery spaces. There was one 50-tonne pump forward and one aft. Inside the machinery spaces, there were some more, which I think are detailed later in the report.

CMDR RUSH: What ran those pumps? Was it electricity?

MR JEREMY: Electricity, yes.

CMDR RUSH: We'll come back to that later in the report.

We have had some evidence concerning ventilation. You have used the terms forced supply of ventilation and natural ventilation. The forced supply of ventilation was by fan?

MR JEREMY: Yes. The principle that was employed in Sydney was that compartments which required active ventilation - in other words, ventilation by fans - were supplied with fresh air by fan, forced supply, and normally exhausted naturally. In other words, you had an exhaust system, but the pressure of the air that you are supplying just naturally exhausts the compartment to the open air.

There were exceptions, for example, spaces which might have fumes or gases in them, or heads in bathrooms, for example, where there might be steam or other vapours you want to get rid of. They were also often fitted with fan exhaust.

Unlike a modern ship where fans are often located in separate fan rooms, the fans were scattered throughout Sydney, quite often in the spaces they served. Generally there was not a great deal of movement of ventilation trunks fore and aft, but where they did penetrate watertight boundaries they would have a valve to enable them to be sealed off.

CMDR RUSH: Of what were the ventilation trunks constructed?

MR JEREMY: They were of light alloy steel, very light steel.

CMDR RUSH: Was there any wood or timber used?

MR JEREMY: Yes, timber and wood would have been used mainly in electronic compartments, such as the transmitting station and the W/T offices.

CMDR RUSH: If I can briefly turn to the electrical system at page 84 of the report.

THE PRESIDENT: Before you leave ventilation, the depiction of the damage suffered by Sydney in those graphics earlier today indicated a vast amount of smoke, extending, it would seem, virtually the whole length of the ship, certainly the centre half, anyway. Does the ventilation system you just described result in it being probable that throughout the ship, smoke was ingested by this ventilation system?

MR JEREMY: It certainly could have been, but I expect that the extent to which it was would depend on how quickly fans might have been shut down, because I would expect that because ventilation inlets were on the upper deck, two means of shutting it down were either to close the flap that let the air in or just to turn the fan off, and if the fan hasn't been turned off by damage, I expect someone might well, in those circumstances, actually shut down ventilation to stop the ingress of air.

The way the ventilation was arranged, it did, however, mean that if you did get smoke into the ship, you didn't have any easy means of getting it out, because it was natural exhaust, not fan exhaust. Certainly, there was a distinct possibility, at least initially, of a good deal of smoke being drawn in through the ventilation system.

THE PRESIDENT: So there are three possibilities: one is that damage to the ship may have destroyed the electrical power to service the intake fans, stopping it going in?

MR JEREMY: Yes.

THE PRESIDENT: The second is that someone may have turned it off?

MR JEREMY: Yes.

THE PRESIDENT: And the third circumstance is that, by some means, probably natural means, smoke would have entered, in any event?

MR JEREMY: Yes, locally from fires or through other openings.

THE PRESIDENT: With no prospect of removing it?

MR JEREMY: Very little prospect of removing it, yes.

CMDR RUSH: The high-power electrical system, you indicate at page 84 of the report, was 220 volts.

MR JEREMY: Yes.

CMDR RUSH: The main sources of power in relation to that electrical system were the steam generators?

MR JEREMY: There were four generators. There were the two steam generators, one in each engine room, and the two diesel generators, one each side of B boiler room.

CMDR RUSH: In the report, it is stated that the electrical circuitry was a ring main circuit. What is meant by that term?

MR JEREMY: I am not overly familiar with the electrical system in Sydney. In fact, we could not find any of Sydney's original electrical drawings or information, so we were relying very much on typical drawings of this, and I must confess that I'm not familiar with exactly how this system worked, but I am aware that it was possible to separate the ring main to different sections, and normal practice to do so under certain conditions, for example, at Action Stations, so that the individual generators could supply individual parts of the ring main, and to some extent, the system was protected against total failure by that separation.

CMDR RUSH: In that sense, were there branch breakers, so that that ring main system could be affected in the way you've described?

MR JEREMY: Yes. As I understand it, that was the way it worked.

CMDR RUSH: You refer to the electrical system being capable of being monitored from the switchboard room?

MR JEREMY: Yes, the main switchboard room could monitor the whole electrical system and also control a good deal of it from there, but it could also be controlled directly from the breaker rooms, which were in the various parts of the ship.

CMDR RUSH: Just in relation to the electrical power and what it powered, you referred to the pumps being powered by electricity. Obviously, the lighting was powered by electricity.

MR JEREMY: Yes.

CMDR RUSH: The ship's crane?

MR JEREMY: The ship's crane is electric.

CMDR RUSH: And telephone communication?

MR JEREMY: The telephone system was electric.

CMDR RUSH: And the ventilation?

MR JEREMY: And the ventilation, yes.

CMDR RUSH: In relation to fire control and armament, were there electrical components there?

MR JEREMY: Yes, there were. As I understand it, a lot of the fire control system ran off low power rather than high power, and I believe that we're talking about something like 22 volts DC, except for the firing circuits which were a higher open-circuit voltage. Those supplies were provided by motor generators, where one end was a motor running at 220 volts and the other end was a generator running at the lower voltage, and that system supplied the low-power requirements for the ship.

CMDR RUSH: The ring main system is set out at figure 56. As I understand it, this is a fairly basic drawing of the general design.

MR JEREMY: Yes. It's a typical layout, I believe.

CMDR RUSH: With parts of this being able to be separated from other parts, in essence?

MR JEREMY: Yes, as I understand it, yes.

CMDR RUSH: The Commission has had some evidence in relation to the communication systems. You have given the location of the main wireless transmission office. As far as the aerials from that transmission office are concerned, from the office where did they come out on the deck to get to the mainmast?

MR JEREMY: Perhaps we might look at figure 57. This shows the arrangement of aerials on the ship, the foremast here and the mainmast here, and you can see the main aerial for the ship is stretched between those two masts, with leads down to the after superstructure and then down through a trunk into the main W/T office, which is there (indicating).

Forward, we have the second W/T office and the auxiliary W/T office here, and you can see the trunks being led up through the ship to the base of the foremast, and then up to the top, or, rather, to the secondary antennas, and from the auxiliary W/T office up to the superstructure deck here with the antennas running from there up to the yardarm.

CMDR RUSH: The auxiliary W/T office is?

MR JEREMY: There (indicating).

THE PRESIDENT: The masts, I take it, would not have survived the ship going down 2.5 kilometres below water?

MR JEREMY: No. They would have been amongst the first things to leave the ship during the sinking. This system is vulnerable to a number of things during the action. One is from gunfire which could have affected the aerial risers and feeders, and the other is from possible whipping from the torpedo hit. We have no knowledge as to what happened in Sydney, but we do know that, in other ships, torpedo hits have caused whipping sufficient to bring down those aerials. We have no evidence as to what might or might not have happened in Sydney.

THE PRESIDENT: If the masts were damaged by shellfire, that would disable the communication system, I take it?

MR JEREMY: It would have the potential to do so, yes.

CMDR RUSH: Sir, I intend to move to lifesaving equipment on board HMAS Sydney. Primarily the questioning is to Mr de Yong. Mr de Yong, in the report at pages 88 and 89, there is reference to Carley floats.

THE PRESIDENT: I'm sorry, just before you go on to that, if I may just go back to telecommunications. You speak in the report of types 48, 49, 45 and 43A being the four transmission sets available on Sydney. As I understand the report, each of those four was capable only of transmission by continuous wave?

MR JEREMY: I believe that's correct, sir, yes.

THE PRESIDENT: And that means that they could only send

messages in coded Morse?

MR JEREMY: Correct.

THE PRESIDENT: Thank you.

CMDR RUSH: Mr de Yong, figure 58 gives us two views of the Carley float.

MR de YONG: That's correct.

CMDR RUSH: The Carley float has a tube-like structure. What was the nature of the construction of that tube?

MR de YONG: The Carley float was essentially like a giant life ring, in a way, oval in shape. The outer ring was constructed of thin metal, probably up to about 1mm thick, and most of the Carley floats were manufactured from copper, but we are aware of some potentially being manufactured out of galvanised steel.

As I said, they were very thin in construction, so there were steel bulkheads welded throughout the inside of the Carley floats to give them strength, number one, and also to give them some watertight capability, so that if a breach occurred in one section, it didn't cause the whole float to flood.

Around the outside of the metal construction was then a cork material, again to give a little bit of greater buoyancy. Then there was a canvas material wrapped around the outside, and then there was a rope assembly wrapped around the outer construction.

CMDR RUSH: By the look of the diagram, it had a slatted type of timber floor surface?

MR de YONG: It had a timber floor made of slatted wood. It wasn't permanently - if that's the right choice of word - fixed to the outer ring, but it was held to the outer ring by a series of ropes. The diagram that is up on the screen shows the slatted timber floor in the top screen in the fitted or stowed position. The bottom screen shows it when it's deployed. When a Carley float was deployed, the floor dropped away from the upper float assembly. So what that meant for anybody that was in a Carley float was that they were immersed in water up to waist or above high,

depending upon how tall the individual was, so you weren't in a dry position at any stage. You were immersed in water whilst you were in a Carley float.

THE PRESIDENT: Was that an automatic process or did you have to do something to lower the floor?

MR de YONG: The floor dropped away very easily. It was held very lightly in place, and as soon as it was deployed if any weight was put on it, it would release away.

CMDR RUSH: As far as Sydney is concerned, you have gone to the initial allocation of Carley floats for Sydney at table 9 on page 90 and referred in that table to different pattern numbers. Do the pattern numbers refer to different sizes?

MR de YONG: Yes, they do. The Carley floats were manufactured in a whole range of sizes, but it would appear that RN ships, RAN ships and USN and a few other Navies tended to concentrate on a few sizes - the pattern 17, pattern 18 and pattern 20s. Table 10 gives you the dimensions of each of these Carley floats, the dimensions of the tube, the lifesaving capacity, but probably one of the interesting features is the weight of these devices.

Pattern 18 weighed 406kg, yet these floats were designed to be manhandled off board during an emergency situation. The 406kg is a lot of weight to manhandle around on board a ship.

CMDR RUSH: The lifesaving capacity is set out in the initial allocation. For instance, for a pattern 17, you indicate that the initial allocation was 2 with a lifesaving capacity of 45 for each Carley float.

MR de YONG: That's correct.

CMDR RUSH: So each of the patterns is there set out. Could I just ask you about table 10 where you refer to the details of the Carley float. In the last line, for pattern 20, you give the size of it as "5 by 10" and the weight 175kg, and you refer to the lifesaving capacity as "20 (12 plus 8)". What is the significance of the "12 plus 8"?

MR de YONG: The other feature of the Carley float was

that it was not intended to have its lifesaving capacity within the ring of the Carley float. The lifesaving capacity of the Carley float was the people within the float plus people who would be hanging from ropes around the outside. In the case of the pattern 20 Carley float, which is there, there would be normally 12 people inside the Carley float and 8 hanging from the ropes outside the Carley float.

I haven't been able to find what the consequent numbers are for patterns 17 and 18, so they're not in the table, but certainly the information on the pattern 20 was able to be sourced, and one could do a simple comparison, a ratio, and perhaps calculate the ratios for the other two. But because we had no verifiable evidence, it is not there in the table.

CMDR RUSH: When we look at lifesaving capacity for Carley floats, it involves people being in the Carley float and people hanging on to a rope outside the Carley float, in the water?

MR de YONG: Exactly.

CMDR RUSH: You say in the report that the numbers and locations of the Carley floats seemed to change over the life of Sydney.

MR de YONG: The number and type of Carley floats changed what appears to be fairly significantly during the life of Sydney and also the location of the Carley floats on board Sydney. As table 9 shows, the initial allocation of Carley floats appears to be two number 17s, two number 18s and two number 20s.

If we move down to figure 61, we can see where the disposition of these Carley floats was as initially allocated. There were two Carley floats, one either side of the 4 inch gun deck, between each of the 4 inch guns and just by the ready-use lockers for the 4 inch ammunition, and they were two pattern 17 Carley floats.

CMDR RUSH: So the 4 inch gun deck is --

MR de YONG: Right there. That is the 4 inch gun deck. There are two 4 inch guns either side of the pattern 17 Carley float and there was one either side.

CMDR RUSH: Then we have two pattern 18s?

MR de YONG: Between the 4 inch guns, the two pairs of 4 inch guns, running along the centre line of Sydney there was a structure which was a wood storage rack. We believe it was used for all sorts of things. It may have been used for the storage of wooden shoring, all sorts of things, but there was a fairly significant structure there, and two pattern 18 Carley floats were attached to that, one either side. It was claimed that that combined structure was something like a rudimentary blast shield. The use of Carley floats and the location of Carley floats either side of that wood storage rack was consistent throughout the life of Sydney, from the initial allocation up until when Sydney sank.

CMDR RUSH: Perhaps if I could ask you to look at figure 62, which is a photograph of a number 18 Carley float stowed on the timber stowage rack.

MR de YONG: That is the timber stowage rack amidships between the pairs of 4 inch guns, and there are two large Carley floats there stored either side.

CMDR RUSH: We see the outline, if you like, of the other Carley float to the left of that photograph?

MR de YONG: On the other side. One on the port side and one on the starboard side.

CMDR RUSH: The description of that is as a pattern number 18.

MR de YONG: Yes.

CMDR RUSH: A pattern number 18 is given as having a lifesaving capacity of a total of 67 men.

MR de YONG: That's correct.

CMDR RUSH: So what we're looking at there, with a pattern number 18, with the four sailors in front of it, is what is provided for for lifesaving capacity for 67 sailors?

MR de YONG: As I noted before, the lifesaving capacity is individuals inside the Carley float and individuals

outside. As the size of the Carley float increased, of course the number that you could get outside increased significantly. So a number 18 Carley float would have a large number of people hanging from what they called the becketed ropes on the outside of the Carley float.

CMDR RUSH: One matter I haven't asked about but I know is referred to in the report is a peacetime complement of crew and a wartime complement of crew. Is it your understanding that the numbers of crew increased during wartime to 645 men?

MR de YONG: It certainly did, yes.

CMDR RUSH: Was there an increase from the initial allotment of Carley floats on the ship and a change in the type of Carley floats?

MR de YONG: The initial allocation of Carley floats was six, as I have pointed out earlier - two pattern 17s, two pattern 18s and two pattern 19s. At some stage in late 1940, I believe, early 1941, there was a significant change in that the number of Carley floats increased from six to nine.

The Carley floats shifted around from various positions between the initial allocation and late 1940/early 1941. It would appear that the number 18 Carley floats, the large Carley floats, were shifted to the stern of HMAS Sydney, which was probably a very smart thing because it is a lot easier to get the large Carley floats off from the stern than trying to remove them from something like the wood storage rack.

There appear to have been four Carley floats replacing those two pattern number 18s that went from the wood storage rack to the stern, so therefore you had two moving; you had four replacing them, so that's where you see the numbers increasing. But the Carley floats that replaced them were pattern number 20 Carley floats. They were smaller Carley floats.

The two Carley floats that we saw earlier that were on the 4 inch gun decks were removed completely, and we now see, or we then saw, the emergence of two Carley floats replacing the 30-foot gig that was on the port side of the ship. The gig just seems to have been completely removed.

It doesn't seem to have been relocated.

Therefore, when you look at figure 69, that is the port side of HMAS Sydney looking aft. You can see the 4 inch guns at the rear of the photo, and you can see the two Carley floats there where the 30-foot gig would normally have been. So you have an increase in the number of Carley floats from six to nine, but if you look at the total lifesaving capacity, I think in the report the total lifesaving capacity went from 264 to 274, so the number of Carley floats increased by three but the total lifesaving capacity increased by only ten.

CMDR RUSH: Before we get to that table, if I could ask you to look at figure 67, which is on page 94. We're looking at Carley floats there located on Sydney with what looks like one inside the other?

MR de YONG: That's correct. It would appear that when the two pattern number 18 Carley floats were removed from the wood storage rack and placed on the stern of HMAS Sydney, on the starboard side one pattern number 20 was placed inside one of the pattern number 18s.

CMDR RUSH: Just looking at that, the methodology of getting those Carley floats into the water was by manhandling?

MR de YONG: Yes. It would certainly have been much easier to manhandle them into the water from that position.

CMDR RUSH: Allowing for the manner in which they were meant to provide lifesaving effectiveness for sailors, was any type of provisioning stored in Carley floats?

MR de YONG: There is an indication that the Royal Navy and certainly the US Navy, in their use of these types of lifesaving equipment, actually started to store provisions inside them, mainly water. What appears to have been done was that 4 inch shell cases had an end cap machined for them, water was filled into the 4 inch shell and the 4 inch shell was placed into the Carley float as a water-storage system.

We cannot find any evidence of anything stored inside any of the Carley floats that we have observed photographs of from HMAS Sydney except for one photograph, and that is,

if we turn to figure 63 --

CMDR RUSH: Page 92.

MR de YONG: That's correct. If we look at that photo there, figure 63, the Carley float on the port side, on the right side of that photo, appears to have a long cylindrical object inside it. That may - may - be some form of water storage or provisioning system. That is the only evidence we can find. We have seen a number of figures that have been put up in the last 10 minutes, and none of them have shown any evidence of any lifesaving equipment or anything attached to them.

CMDR RUSH: Mr de Yong, what was the method of storing or ensuring that the Carley floats remained with the ship? How were they attached to the ship?

MR de YONG: They were held down to either the deck or whatever structure they were attached to with rope or wire. If you examine a number of the photos, they were not strongly held down. They were designed to be easily removed. They're an emergency lifesaving piece of equipment, and consequently they were designed and held in such a manner that they could be easily removed by the crew and easily used and moved overboard.

CMDR RUSH: You deal with it at length at some later stage in your evidence, but very briefly I want to ask you about the copper tubing covered with the cork which you have described. What was its susceptibility to fragment damage from, for instance, the 15cm shell?

MR de YONG: It would be highly susceptible.

THE PRESIDENT: If a Carley float entered the water upside-down, would it still work? Would the floor drop down the other way?

MR de YONG: Yes. The floor drops either way. The Carley float doesn't have an up side or a bottom side.

CMDR RUSH: Mr de Yong, at figure 70 there is a diagram of the position of Carley floats in Sydney in November 1941. How did you ascertain or come to decide on the location of the Carley floats?

MR de YONG: The location of the Carley floats was purely based on the photographic evidence that was available to us, and the evaluation of the date at which that photo was taken. We were provided with a number of photos that gave fairly specific dates. Therefore, we were able to ascertain that in the early part of 1941 there was a particular allocation of Carley floats, and we even had one particular photo that was September 1941, August 1941. So a number of the images we had were close to the time when the encounter with Kormoran occurred.

CMDR RUSH: If we can have a look at that diagram, would you take us through from stern to bow, if you like, the positions, as best you can ascertain it in November 1941, of the Carley floats and the pattern numbers?

MR de YONG: As we saw on one of the previous figures, on the stern there were two pattern number 18 Carley floats, two of the large Carley floats, with a third pattern 20 inside one of the pattern number 18s.

CMDR RUSH: So they're situated on the quarterdeck?

MR de YONG: Yes, they certainly are. If we move forward to the 4 inch gun deck and to the wood storage rack, as I outlined earlier, the two large pattern number 18s, which were moved to the stern, were replaced with four pattern number 20s, four of the smaller pattern number 20s. One of the figures shows two on one side, and all the evidence indicates that there were two on other side, so there were two on the starboard and then two on the port side.

On the port side, again, we have a number of photographs that show that the 30-foot gig that was supposed to be beside the motor and sailing pinnace, which is one of the lifeboats, was removed from the ship and was replaced with two pattern number 20 Carley floats.

CMDR RUSH: Looking at the ship's boats, just below that you have set out a table of the initial allocation of boats on Sydney.

MR de YONG: The initial allocation of the boats from Sydney - if we start in the forward position and move aft, the first two boats, both port and starboard, were 32-foot cutters. The cutters were the only boats that were on davits. When at sea, they were swung out from the davit.

When they were in harbour or not at sea, they were swung inboard. I think as Mr Jeremy said earlier, the intent was that they would be used for emergency situations, man overboard, when at sea, and that's why they were swung out.

CMDR RUSH: Perhaps if we can look at figure 73 and then come back to the position of the boats. Looking at figure 73 on page 99, there we see the 32-foot cutter swung out?

MR de YONG: That's correct. This is the port side of Sydney. There is one of the 4 inch guns in the foreground. As we move forward, the first boat you can see there is the 27-foot whaler. We can then see the 32-foot cutter on its davits. You can see the two Carley floats, as I mentioned earlier, that had replaced the 30-foot gig. And just inboard of that, you can just see part of the motor and sailing pinnace.

CMDR RUSH: Just while we are looking at the photograph of the cutter on the davits, are those davits manually operated?

MR de YONG: Yes.

CMDR RUSH: And the cutter weighed, you have indicated, 4.23 tonnes or 4,267kg?

MR de YONG: That's correct.

CMDR RUSH: Each individual cutter was given a lifesaving capacity of 118 men?

MR de YONG: That's correct.

CMDR RUSH: Whilst we're looking at the whaler, there were two whalers, and they were given a lifesaving capacity of 54 men?

MR de YONG: That's correct.

CMDR RUSH: It would appear, having regard to the dimensions, that that would be very tight accommodation, putting it mildly?

MR de YONG: That's correct.

CMDR RUSH: Can I come back to the position of the boats

in the initial allocation on Sydney as completed, at page 96.

MR de YONG: We have seen the two cutters on the davits. We have looked at the port side and seen the two Carley floats where the 30-foot gig should be. We have also seen part of the 36-foot pinnace. Inside the 36-foot pinnace is a small dinghy. It's called a skiff dinghy and there are various other names - a jolly-boat and various other names during the course of its allocation to HMAS Sydney.

In fact, if we look at figure 69, we will see essentially a view looking the other way from the previous view. In the foreground, you can see the cutter. Then you can see the two Carley floats. Next to the two Carley floats or inboard of the two Carley floats is the motor and sailing pinnace, and inside the motor and sailing pinnace you can see the 16-foot dinghy.

So if we go back to figure 71 again, the final boat on the port side is the 27 -foot whaler, and we saw that on one of the previous photographs. The only other smaller boat on the port side is what's known as the balsa or the balsa raft. It supposedly sits on top of the vegetable store, but I have not been able to find any photographic evidence of the existence of the balsa. It may have been initially allocated and removed, but I have no evidence to show its existence.

On the starboard side, we have, again, a 32-foot cutter on davits, just like on the port side. Aft of that are two motorboats. Initially, as allocated, there was a motor pinnace and a motorboat, and the motor pinnace seems to have been replaced by a motorboat, so there were two motorboats, not that there is a lot of difference in them. If you look at the table above, their length is approximately the same, their weight is approximately the same and their lifesaving capacity is approximately the same. But from all the photographic evidence we have, those two boats appear to be identical rather than being two different boats.

Moving aft again, as on the port side, we have a 27-foot whaler.

If we look at figure 74, we can see the boats on the starboard side. You can see the 32-foot cutter, the two

motorboats and the 27-foot whaler. So there were four boats on the starboard side and six boats on the port side, and that was as initially allocated.

CMDR RUSH: The lifesaving capacity of the cutter, in the initial allocation, was set down for 118 men?

MR de YONG: That is two cutters. The two cutters would be 118.

CMDR RUSH: Then in relation to the whaler, it is 54?

MR de YONG: That's correct.

CMDR RUSH: I think we have covered the other boats. As you have indicated, Mr de Yong, over the period of time up until November 1941, there appear to be changes that have been made to ship's boats on Sydney. Did you put together a table at page 98, table 13, in relation to the distribution of boats and lifesaving capacity as of November 1941?

MR de YONG: Yes, that is what we believe the allocation was in November 1941. The major difference here is that the gig is no longer on the list, and we no longer have the balsa listed, because we can find no evidence for it. We certainly know that the gig is missing, because we have seen it removed and replaced by two Carley floats.

CMDR RUSH: The total of the lifesaving capacity there is 342?

MR de YONG: That's correct.

CMDR RUSH: Just in relation to the boats indicated in the table, apart from the cutters, did the other boats require a crane for them to be placed in the water?

MR de YONG: They did, yes. All of them required the crane.

THE PRESIDENT: Mr de Yong, taking the Carley floats as you have indicated and the boats as you have indicated gives a total lifesaving capacity of 616 against a complement of 645. Was that usual in the 1940s?

MR de YONG: I honestly don't know. I don't have enough

knowledge of what the normal lifesaving capacity would be, whether the ship would normally under-cater for the number of ship's crew or not. I would have thought, though, that there would be enough lifesaving capacity on board for the entire ship's complement.

THE PRESIDENT: In some evidence I read somewhere, there was a thing called a Hilken raft - I think it was called a Hilken raft - being a raft named after one of the former officers of Sydney, which was the nailing together with planks of some vegetable tins, I think?

MR de YONG: That's correct.

THE PRESIDENT: But that was removed throughout 1941?

MR de YONG: I think I refer to the Hilken raft. A Mr Ravenscroft proposed that Hilken rafts were used on Sydney during his 1998 submission to the Government Inquiry. I tried a number of sources to find any evidence of these devices and could find no evidence at all that they were allocated or initially employed or used anywhere on HMAS Sydney.

THE PRESIDENT: Thank you.

CMDR RUSH: I think you refer to them, Mr de Yong, under "other lifesaving equipment" at pages 100 to 101. In dealing with the Hilken raft at page 101, you describe them as two sealed-up large food tins sealed into a pine box?

MR de YONG: That's correct, and then they were, somehow or another, attached to two lengths of timber to create some form of rudimentary raft, apparently. But, as I said to the Commissioner, I can find no photographic or written evidence of the existence, other than that reference in the 1998 Government Inquiry.

CMDR RUSH: The other lifesaving equipment included a lifebelt?

MR de YONG: That's correct.

CMDR RUSH: What was the nature of the lifebelt?

MR de YONG: All the crew were issued with a lifebelt that was essentially a rubber belt that was supposed to be worn

over the shoulder. Most of the crew apparently disliked that position and wore it around their waist. The idea was that you would wear it at all times and that just before entering the water, you would inflate it and it would provide you with some form of rudimentary flotation aid once you were in the water.

THE PRESIDENT: You inflated it by blowing into a tube, did you?

MR de YONG: Yes. You inflated it yourself. It wasn't self-inflating.

CMDR RUSH: How was it worn once inflated?

MR de YONG: Around the waist.

CMDR RUSH: From the position of buoyancy or support, what was the nature of that as provided by this type of equipment?

MR de YONG: Most of the documents that I have read indicate that it provided a degree of buoyancy for individuals who were in the water. It didn't provide buoyancy for a long period of time. One of the problems with it was that if the wearer of that particular device happened to fall asleep, which is what happens when people are in the water for a long period of time, it would provide no support to the upper part of the body, and the wearer would tend to turn over and drown.

CMDR RUSH: Was there any type of support for the upper body or the head provided by --

MR de YONG: No, there was no support for the upper body.

CMDR RUSH: What was its capacity to keep a person afloat, in terms of time?

MR de YONG: My estimation from the evidence that I've read suggests that a lifebelt would keep someone alive for hours, and not much longer than that. It was meant to be a very, very short-term lifesaving device.

THE PRESIDENT: And it was standard issue throughout not only Australia but the British fleet?

MR de YONG: The British went away from them and went to more robust lifesaving vests and devices. The USN also had them at one stage and discarded them in favour of, again, larger lifesaving devices and with head support systems built in.

THE PRESIDENT: Do we know when that occurred?

MR de YONG: No. I don't know when that occurred.

CMDR RUSH: On that aspect, were Carley floats also used in US Navy and the Royal Navy?

MR de YONG: Yes, they certainly were. Carley floats were used by a number of Navies.

CMDR RUSH: Is there anything that you have come across to indicate where Carley floats were made?

MR de YONG: The original Carley floats were manufactured in the United States. The original patent for the Carley floats was a US patent. They were manufactured in the UK, Notts Industries. We believe there were Carley floats manufactured in Australia, but from any of the submissions we have read and any of the documentary evidence we've seen, there is nothing to support who actually manufactured them in Australia.

THE PRESIDENT: Some of them bear, I think I read, the name John Lysaght.

MR de YONG: That's correct.

THE PRESIDENT: I know they manufactured them in England as well, but they may have manufactured them here.

MR de YONG: They may have manufactured in Australia, yes, that's correct.

CMDR RUSH: Unless you have any more questions, sir, that would conclude the matters relevant to HMAS Sydney.

THE PRESIDENT: Thank you. CMDR Renwick, do you wish to ask any questions?

CMDR RENWICK: At this stage, sir, I don't have any questions. I may have some tomorrow.

THE PRESIDENT: Thank you.

CMDR RUSH: Sir, I will ask Mr Buckland to stay there, and we will have a change of personnel, Mr Lyon.

<TIMOTHY DAVID LYON, affirmed: [3.18pm]

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

MR LYON: Timothy David Lyon, [redacted]

CMDR RUSH: Are you a qualified Naval architect?

MR LYON: I am.

CMDR RUSH: Could you indicate what your qualifications are?

MR LYON: I have a Bachelor of Engineering degree in Naval Architecture and a Master of Science degree in Mechanical Engineering.

CMDR RUSH: Where was the Master of Science completed?

MR LYON: At the University of Houston, as it turns out.

CMDR RUSH: Mr Lyon, I don't think you do at the moment, but you have spent much of your life practising as a Naval architect?

MR LYON: Yes. I spent 18 years with the Department of Defence as an employee, mostly working in ship design. Some relevant areas - I was Head of the New Construction Group in the Directorate of Naval Ship Design. I was Assistant Design Manager (Hull) for the AOR Project, the Minesweeper Project and the Australian Frigate Project. And I was Design Manager for the ANZAC Ship Project.

Then I spent nine years as a consultant, mostly to the Department of Defence, and relevant in there I was Consultant Naval Architect for the design of the Armidale Class Patrol Boat Project.

CMDR RUSH: And you are a member of the Royal Institution

of Naval Architects and a member of the American Society of Naval Engineers?

MR LYON: Yes.

CMDR RUSH: It was in your capacity as being involved with the Institution that you became involved to look at the design and hull features and other features of HSK Kormoran?

MR LYON: Yes. I'm on the Divisional Council with John and Stuart.

CMDR RUSH: Perhaps if we turn to page 119 of the report, which deals with Kormoran, you set out a diagram at page 119 of the general arrangements of Kormoran.

MR LYON: Yes.

CMDR RUSH: Firstly, in relation to displacement, Kormoran displaced 19,900 tonnes.

MR LYON: That would be its design displacement as a merchant ship. We'll probably never know what it displaced in its warship configuration. But that would have been fully loaded with cargo, which it never was when it was operating as Kormoran.

CMDR RUSH: Its dimensions were 167.5 metres.

MR LYON: Length overall.

CMDR RUSH: In terms, is that a large ship for its time?

MR LYON: As a merchant ship, yes, quite a large merchant ship. It was a cargo liner. It was designed to carry cargo as well as passengers.

CMDR RUSH: Its means of propulsion are set out as four 9-cylinder 4-stroke diesel engines and two propulsion electric motors. How did that work?

MR LYON: It was a diesel-electric ship, so the four diesel engines drove generators and generated electric power, which provided the entire power for the ship. Then a proportion of that power, about 80 per cent, was used for propulsion by two large electric motors - one electric

motor per shaft. It was a two-shaft ship.

CMDR RUSH: In relation to its fuel and fuel capacity, there were 5,200 tonnes of diesel?

MR LYON: Yes.

CMDR RUSH: And, depending on speed, a range of 84,500 miles at 10 knots to 50,000 miles at 17 knots?

MR LYON: Yes. These are fairly large figures for ships at that stage, but of course it stayed at sea for a year, so those sorts of figures are actually needed.

CMDR RUSH: You referred to "protection" and "splinter protection". Kormoran, as you have indicated, initially was built as a cargo liner under the name Steiermark. Did it ever operate as a cargo liner?

MR LYON: No, it never entered service as a cargo ship. It was completed just before the war.

CMDR RUSH: Was there any form of armament or protection given to Kormoran?

MR LYON: Nothing in its original design as a merchant ship. The only reference I could find was to some splinter protection around the chart house, the helm and the engine room. That is a reference by Detmers. I can't verify it, but it wouldn't be relevant to this engagement, anyway.

THE PRESIDENT: Kormoran was, in other words, about the same length as Sydney?

MR LYON: Slightly shorter, yes, but about the same size.

CMDR RUSH: Dealing with the armament of Kormoran, there were six 15cm guns in single mounts?

MR LYON: Yes.

CMDR RUSH: Perhaps if we can look at figure 84 on page 121. By using the pointer, are you able to indicate on the ship where Kormoran's 15cm guns were positioned?

MR LYON: Number 1 and 2 guns were concealed under the forecastle.

CMDR RUSH: Where you have the green arc, is that showing the --

MR LYON: That is showing the arc of fire once it is decamouflaged. Number 3 gun is in the number 2 hold, with a slightly reduced arc of fire.

CMDR RUSH: Was that capable of firing only to port, or could it fire to starboard?

MR LYON: It could fire to starboard as well, but not forward or aft. The number 3 gun was in the number 5 hold - actually, that is the number 4 hold.

CMDR RUSH: Also, could that fire to port and to starboard?

MR LYON: Yes. That is the number 5 gun in the number 4 hold. Then the number 5 and number 6 guns are underneath the quarterdeck, with those designated arcs of fire.

THE PRESIDENT: So she could fire a salvo of four guns --

MR LYON: Yes, a maximum salvo of four guns to each side.

THE PRESIDENT: -- to either port or starboard?

MR LYON: A maximum of two forward and two aft.

CMDR RUSH: There were two 3.7cm anti-aircraft guns?

MR LYON: Yes. Just aft and below the bridge, one on the starboard side and one on the port side.

CMDR RUSH: Again, they were in single mounts?

MR LYON: Single mounts.

CMDR RUSH: And there were five 2cm cannons in single mounts?

MR LYON: Yes, two on the forecastle, two just behind the funnel and one on the quarterdeck.

CMDR RUSH: Kormoran was fitted with torpedo tubes?

MR LYON: Yes, six torpedo tubes, two twin swivelling mounts above the waterline either side of number 2 hold, and below the waterline two single torpedo tubes angled 35 degrees abaft of the beam.

CMDR RUSH: How was the camouflage in relation to the torpedo tubes organised?

MR LYON: The torpedo tubes were inside the hull and had a flap which opened outside the hull, run by counterweights.

CMDR RUSH: Were there also underwater torpedo tubes on Kormoran?

MR LYON: Yes.

CMDR RUSH: Are you able, just by reference to that figure, to indicate where those tubes were?

MR LYON: Yes, the underwater torpedo tubes are there and there (indicating).

CMDR RUSH: Feel free to answer jointly as you see fit, but I want to ask firstly about the armament, the 15cm guns. Mr Buckland, firstly, are you able to give any indication of the rate of firing of those guns?

MR BUCKLAND: Of the 15cm --

MR LYON: I certainly can. It's five to seven rounds per minute, but that's dependent on having a ready supply of ammunition. This ship doesn't have the ammunition hoists that the Sydney had, so when there's ready-use ammunition, it's five to seven rounds per minute. That would fall away as that ammunition was consumed.

CMDR RUSH: As to the guns themselves, Mr Buckland, at figure 85 you have drawn a sketch in relation to the guns as they were fitted to KM Baden.

MR LYON: That is a World War I German battleship, and it carried the same guns.

CMDR RUSH: It is purely to indicate the nature of the gun?

MR LYON: There are two possible candidate guns that could have been fitted. That drawing shows you, if you look at the underwater photographs, that this is the right gun because of the notches in the barrel. The other candidate gun has a smooth barrel.

CMDR RUSH: If I could ask you to turn to page 127, at figure 87 you have a diagram in relation to the number 1 and number 2 guns.

MR LYON: Yes.

CMDR RUSH: As I understand it, these were mounted beneath the forecastle deck of Kormoran?

MR LYON: Yes.

CMDR RUSH: Would explain to us what you are indicating by that diagram as to the camouflaged position of the number 1 gun?

MR LYON: Yes. At the top, that is actually the upper deck, and that is the guardrail on the upper deck, and this is the side of the ship. They have essentially cut across there and across there and taken out a piece of the side of the ship and a piece of the deck and hinged it so that it could swing upwards. In order to effect the swinging upwards, they have attached an arm with a light counterweight on it and secured that with a quick-release pin, so that this becomes a mechanism, which, when you pull the quick-release pin, will automatically swing downwards. The weight swings downwards, the door hatch over here swings upwards, and almost instantaneously the camouflage is removed without any use of physical force, any power or any requirement of that sort.

CMDR RUSH: So the diagram as you have drawn it has the barrel --

MR LYON: And the gun has to be fore and aft at the time that it is camouflaged. It can't be swung out before the camouflage door is lifted.

CMDR RUSH: So as it is there, the gun is fore and aft?

MR LYON: Fore and aft.

CMDR RUSH: The weight mechanism then, in effect, is lifting up a section of deck and hull?

MR LYON: Yes.

CMDR RUSH: From the position of a ship that is training or sighting Kormoran prior to the decamouflage, from your investigation would there be anything to indicate the system and the hull structure that you have identified as being part of the camouflage from 1,000 yards, 1,500 yards or 2,000 yards?

MR LYON: You would have to be within a few metres to detect it. From 1,000 metres away, you wouldn't know it was there. You couldn't possibly see it.

CMDR RUSH: In relation to the decamouflage of those guns, have you done any form of calculation in an attempt to try to ascertain how long it would take to expose the guns, that is, for the deck and the hull section to be lifted up?

MR LYON: Yes, both a technical analysis and a survey of the other available supporting evidence to show that there was evidence to support that this could be done in that time, yes.

CMDR RUSH: What sort of time are we talking about?

MR LYON: For those particular guns under the forecastle, I think that they could be decamouflaged and fire opened in about 15 to 18 seconds.

CMDR RUSH: In relation to the lifting itself, have you any idea --

MR LYON: About 2 seconds.

CMDR RUSH: How do you reach that figure?

MR LYON: I have designed the mechanism, and it is only the time taken for a weight to swing down through that arc, and it would swing at that sort of speed. It's not that scientific, but there's nothing stopping it; the weight is going to swing at that pace. That's how long it's going to take.

THE PRESIDENT: It's called gravity, isn't it?

MR LYON: Yes, gravity. The gun then has to be trained through 90 degrees to bear on the target. I have done some research to find out what the training rate of guns of that era was. I couldn't find this exact gun, but I found a similar German gun, and I have used those training rates and I have been conservative. I have taken a lower rate than that one and a yet further lower rate than that to determine the rates.

CMDR RUSH: For the training rate, you have indicated in your report to us that, in your opinion, it would take some 15 to 18 seconds for the 1 and 2 guns to commence firing?

MR LYON: Yes.

CMDR RUSH: What was the training rate? What was the capacity? You've been conservative. Could you give us an idea of the training rate?

MR LYON: I have a more detailed document here. For the later German gun, which is the one on the Graf Spee, it was capable of training at 8 degrees per second, so I've used 7.5 degrees per second as the most optimistic and 6 degrees per second as the pessimistic, so that's where you get the 15 to 18 seconds.

CMDR RUSH: Mr Buckland, turning to the armament for the 15cm guns, I think we have already discussed this, but the weight of the munition fired by those guns was 45.3kg?

MR BUCKLAND: That's right.

CMDR RUSH: What was the approximate range of the 15cm guns?

MR BUCKLAND: Again, it was approximately 25 kilometres that it could fire.

CMDR RUSH: In relation to the shells fired by Kormoran, were there two different types of shell?

MR BUCKLAND: Yes. There is the armour-piercing type shell with the rear fusing, and the contact-fuse, nose-fuse shells that were high-explosive shells.

CMDR RUSH: What was the difference between the two types

of shell?

MR BUCKLAND: The high-explosive shells, on contact, have about 4kg of bursting charge, so they burst and create approximately 4,000 fragments. The armour-piercing rounds, which have basically only about 1kg of bursting charge, are more for being able to penetrate deep into the ship. There is a bursting charge that detonates and generates probably about 2,000 fragments from that shell. But with the penetration into the ship, you're creating a lot of secondary fragments as it rips through the ship.

CMDR RUSH: Going back to you, Mr Lyon, the numbers 3 and 4 15cm guns were mounted in the centre line of the ship. Maybe you want to explain what is depicted in figure 91, apart from the swimming pool?

MR LYON: That's the number 3 gun, which is inside the hold. Obviously, a hold goes all the way down to the bottom of the ship. The Germans, of course, rebuilt the entire internals of this ship so that it's a warship inside. They could have just filled in the deck inside the hatch combing of that hatch and put the gun on top of that, but then the gun would have appeared above the top of the hatch combing and been visible. So they built a pit inside the hatch combing to lower the gun so that it's below the level of the hatch sides.

They put the hatch sides on hinges and held them up - we can't see all of the evidence, but most likely with a solid rod or a pipe on an angle with a quick-release pin, so that all four segments are independent. They have covered the whole lot with a canvas tarpaulin, which is the purpose of the picture of the swimming pool, because it also has the same canvas tarpaulin over it. In that hatch, not only is there a swimming pool but there is a light motorboat.

So you have a canvas tarpaulin, which you can pull off with a couple of ropes. You then pull four quick-release pins, and the sides of the hatch combings fall down. You pull some more quick-release pins, and the guardrails fall down. If you look at the underwater photograph, you can see the hinges on the guardrails because they are lying flat on the deck. Then you can traverse the gun and commence firing. It is, however, slightly lower than other guns and is more restricted in its field of fire.

CMDR RUSH: For these guns to be decamouflaged, there was removal of a tarpaulin?

MR LYON: Removal of a tarpaulin.

CMDR RUSH: And just pulled off the hatch combing?

MR LYON: Pulled off the hatch combing.

CMDR RUSH: And then collapsible sides?

MR LYON: Pull four pins. Gravity drops the side walls.

CMDR RUSH: Have you undertaken a calculation to form your opinion as to how long it would take to train and fire that gun from the order to open fire?

MR LYON: Yes, that is about the same. It takes slightly longer to decamouflage, but within that hatch, you can have the gun trained 45 degrees to either side while it's still camouflaged, so it reduces the amount of time taken to train it, so it is about the same amount of time to open fire.

CMDR RUSH: You have included at figure 86 a photograph of the 3.7cm anti-aircraft guns.

MR LYON: Yes. They're an Army anti-aircraft gun.

CMDR RUSH: They were capable of firing at what rate?

MR LYON: A theoretical rate of fire of 160 rounds per minute, but they are fed by clips of ammunition and the effective rate of fire was 80 rounds per minute.

CMDR RUSH: You mentioned clips. Were they loaded by a clip of ammunition?

MR LYON: Yes, a five-round clip by hand.

CMDR RUSH: Mr Buckland, the projectile of that armament was what weight?

MR BUCKLAND: The weight was 685 grams. There were various types of shells that could be fired, but it was around 700 grams.

CMDR RUSH: Was there just the one type of shell?

MR BUCKLAND: There were several types of shell, but they were mainly contact-fuse type shells. There was the armour-piercing shell as well. We presume that there were a lot of armour-piercing shells for the 3.7cm.

THE PRESIDENT: This gun was designed as an anti-tank gun, was it not?

MR LYON: No, an anti-aircraft gun. It could be used as an anti-tank gun.

CMDR RUSH: Some authors have referred to this gun as an anti-tank gun. In your opinion, is it likely that this could be so described?

MR LYON: No, because the 37mm PAK, which was the anti-tank gun, had an effective range of only 600 yards. At any range greater than that, it had no system to hit a target. You would have no idea whether you were hitting a target or, indeed, how to hit a target. However, this had an effective range of 4,400 metres and a sophisticated sight.

CMDR RUSH: In relation to the armour-piercing capability of the munition fired by this gun, Mr Buckland, was it possible to locate, from the imagery of Sydney, any damage specifically that you could allocate to this gun?

MR BUCKLAND: We will come to that in a later section, but, no, we couldn't do anything because with the quality of the underwater imaging, we weren't looking for that size damage.

CMDR RUSH: In relation to the munition fired by this gun, from the point of view of the effectiveness of the gun, have you any opinion on that?

MR BUCKLAND: The effectiveness of?

CMDR RUSH: Of this munition fired against a ship such as Sydney.

MR BUCKLAND: From close range, up to 6,000 metres, against exposed personnel, it's lethal. It's a matter of

accuracy, of being able to accurately hit something at that distance, because of the relative movements of the platform itself. But if you are spraying, at 80 rounds per minute, there's a lot of rounds being hit in a short time frame.

CMDR RUSH: Would tracer rounds be used with that munition?

MR BUCKLAND: In the AA type, there would be tracer rounds.

CMDR RUSH: Mr Lyon, from the order to fire to the ability to train and fire that gun as fitted on Kormoran, what sort of timing is involved?

MR LYON: It should be only a few seconds. It was hidden behind light metal screens that were just dropped by gravity, and it is an anti-aircraft weapon, so it tracks and trains extremely rapidly.

CMDR RUSH: The other type of armament fitted to Kormoran is described as the 2cm cannon. I think you have indicated that, in all, there were five fitted to Kormoran?

MR LYON: Yes, of which three could bear on either side.

CMDR RUSH: The 2cm cannon, Mr Lyon, I think fired a 120mm shell or round?

MR LYON: A 20mm shell. I think that is 120 grams of explosive, not the weight of the shell.

CMDR RUSH: And what was the rate of fire?

MR LYON: It had a theoretical rate of fire of 240 rounds per minute, but 20-round magazines had to be put on, so the effective rate of fire was about 100 to 120 rounds per minute.

CMDR RUSH: And the range of the gun?

MR LYON: The range of the gun was about 4,000 metres, 4,400 metres.

CMDR RUSH: In relation to the use of the gun, principally in this type of engagement what was it directed at?

MR LYON: My understanding is that it was directed at the torpedo tubes in the 4 inch gun deck.

MR BUCKLAND: It wouldn't typically be used as an anti-ship weapon.

MR LYON: No, it is an anti-aircraft weapon

MR BUCKLAND: It's an anti-aircraft type gun.

MR LYON: And it would have fired tracer ammunition, so they would have closed the target.

THE PRESIDENT: And an antipersonnel gun?

MR LYON: They're explosive shells, so an effective antipersonnel weapon.

CMDR RUSH: Mr Buckland, what was the explosive or TNT content of the torpedoes carried by Kormoran?

MR BUCKLAND: Call it TNT equivalent. There was 300kg of hexonite, the actual explosive.

CMDR RUSH: And the range of the torpedo?

MR BUCKLAND: We have it here that it was 6,000 metres at 44 knots, but up to 14,000 metres at 30 knots.

CMDR RUSH: Was the firing of those torpedoes conventional in the sense of being fired from the tube itself by torpedo party?

MR BUCKLAND: As I understand it, yes.

MR LYON: Yes. Whereas Sydney could fire its torpedoes from the bridge and in fact the torpedo officer on the bridge of the Sydney could fire the torpedoes, they could only be fired on the Kormoran from the tubes after a telephone order from the torpedo officer.

CMDR RUSH: As to the wreck site and the damage sustained by Kormoran - firstly, Mr Lyon, you have examined the imagery, photographic and video, as it concerns Kormoran?

MR LYON: Yes.

CMDR RUSH: At page 136, you have a diagram in relation to effectively what is left of Kormoran?

MR LYON: Yes.

CMDR RUSH: If I could ask you to go to figure 97, the diagram shows the extent of damage to Kormoran as it lies on the ocean floor. What does the red hatched section represent?

MR LYON: The red hatched section is missing entirely, and I mean entirely, and the unhatched section is what's there.

CMDR RUSH: In relation to length of the ship, approximately how much is left?

MR LYON: About 45 per cent.

CMDR RUSH: From your review of photographic and video imagery, firstly did you satisfy yourself that it was Kormoran?

MR LYON: It is the Kormoran, yes.

CMDR RUSH: What are the features that enable you to say that?

MR LYON: From what we can see, it certainly has the three holds that are listed there. It has the quarterdeck. It has the mast in the right spot. I must admit, there's not a whole hell of a lot else left, but that's what you can see. And, of course, we can see the weapons that are in that section. We can see two 20mm cannons, three of the 5.9 inch guns and the torpedo tube camouflage system. So they all check as well.

CMDR RUSH: In relation to what is left of that bow section, was there any damage that you could pinpoint by gunfire or shellfire to that particular section of the ship?

MR LYON: No. The only damage I found was as a consequence of the sinking.

CMDR RUSH: On page 137, figure 98 shows the 15cm gun, and you say "in the hold"?

MR LYON: Yes, in number 2 hold, yes.

CMDR RUSH: Located where on the ship?

MR LYON: If we go back to the previous diagram, it is in that hold there (indicating).

CMDR RUSH: That is identifiable in the imagery that you have looked at as to that hold and the gun there?

MR LYON: Yes, yes. There are more photographs, of course.

CMDR RUSH: In figure 99, that is the 15cm gun in the number 2 hold?

MR LYON: No, that is the forecastle.

CMDR RUSH: Again, could you take us to where that is on the diagram?

MR LYON: That's that gun there (indicating). This gun is in the forecastle. The one in the hold is that gun there (indicating). You can see that the deck is slightly crushed down. That's presumably due to the sinking. And, of course, the camouflage hatches are missing. They have been torn off. There is no gunfire damage.

CMDR RUSH: I think you are at page 141. If I could ask you to go back to page 139, figure 103. You referred in your evidence to a torpedo or a flap.

MR LYON: Yes. That is the flap behind which the above-water torpedo tubes were concealed.

CMDR RUSH: So the position was that up until the torpedo tubes were trained, that flap would be the camouflage?

MR LYON: No. In fact, you had to open that camouflage flap before you could train the tubes.

CMDR RUSH: But up until the training, that was the camouflage flap?

MR LYON: That would be down, once again counterweighted, and would conceal where the tubes were.

CMDR RUSH: Over the page at figure 105 is the below-water torpedo tube, starboard side?

MR LYON: Yes.

CMDR RUSH: As you indicated in your evidence, the Kormoran was fitted with underwater tubes on port and starboard side?

MR LYON: Yes.

CMDR RUSH: We'll come to it later, but there are two matters I want to ask you about now in relation to the firing of the underwater torpedo. What sort of speed did the ship have to be at before the underwater torpedo could be fired?

MR LYON: Detmers says that it has to be 3 knots or less, and that makes sense in terms of the hydrodynamics, because, as you can imagine, when your ship is sailing along, the water next to the hull is doing the same speed as the ship, say 14 knots if it is doing 14 knots, and the water a little bit away from the hull is doing no speed. So if a torpedo is just exiting the ship's hull, the stern of the torpedo is doing 14 knots being pulled forward, and the bow of the torpedo is in water not moving at all, so the torpedo is being pulled off course. So if you fire the torpedo in anything above about 3 knots, you can't be sure where it's going to go.

CMDR RUSH: Were the underwater torpedo tubes set at any particular angle for firing?

MR LYON: The drawing shows 35 degrees, and that photograph shows a non-circular hole, so that fairly well confirms that they were at an angle of about 35 degrees abaft the beam.

CMDR RUSH: What we have just looked at is starboard side. Figure 106 is a torpedo tube on port side?

MR LYON: Yes.

THE PRESIDENT: You can't tell if torpedoes have been fired from either side?

MR LYON: No. There is something in the hole, but we're

not sure what it is. It is not a torpedo, but it is not an empty hole.

CMDR RUSH: As you have indicated, only the bow section of Kormoran remains. In relation to the stowage of mines on Kormoran, is that indicated at figure 109 on page 142?

MR LYON: Yes. That is based on exhibit 16, which is a drawing of the Kormoran, which shows a mine deck has been built below the main deck from the stern almost to the superstructure.

CMDR RUSH: At figure 110, you have set out the area of damage as a consequence of the mass detonation of mines?

MR LYON: Well, at DSTO direction.

MR BUCKLAND: Yes, that is based on 360 mines.

CMDR RUSH: Is what we've seen of the extant bow of Kormoran, as opposed to what is not there, consistent with that sort of detonation?

MR BUCKLAND: Very consistent, yes. It is very consistent.

CMDR RUSH: If that is a convenient time, sir, I will go to the wreck site of Sydney tomorrow morning.

THE PRESIDENT: Yes, very well. We will adjourn until 10am.

AT 3.55PM THE COMMISSION WAS ADJOURNED TO TUESDAY, 13 JANUARY 2009 AT 10AM