Page 1

Tuesday, 29 January 2013
(10.00 am)
DR NEVILLE ANTHONY ARMSTRONG (on former oath)
THE CHAIRMAN: Good morning, Dr Armstrong. May I remind you that you continue to testify according to your original oath.
A. I'm aware of that, Mr Chairman. Good morning.
THE CHAIRMAN: Mr Shieh?
Examination by MR SHIEH (continued)
MR SHIEH: Good morning, Dr Armstrong.
Yesterday afternoon I think we stopped at the place when you were discussing the various graphs or plots that you had done, at the expert bundle, pages 482 and 483; being appendix IV, items 15 and 16 of your supplemental report.
These plots or graphs are basically based on different assumptions as to what you have described as "choke factors", to take into account the effect of the debris and the various things that could prevent water ingress through the various holes and gashes; correct?
A. Correct.
Q. Could you explain to us perhaps in greater detail the significance of the various choke factors? Because we see 0.3, 0.45 and 0.85. These are numbers, but in real-life terms, what do they denote?

Page 2

A. Yes. Good morning, Mr Shieh.
The holes in Lamma IV were choked with debris from the Sea Smooth, as can be seen in a variety of pictures of the Lamma IV on the hard stand. It is difficult to know how much of the hole was blocked by this debris. Particularly the diagonal gash had quite a lot of debris in it. I put into the calculation the ability to choke the hole, make it essentially -- or reduce the flow through that hole. I kept the size the same. And I estimated what I thought the amount of blockage was, based on looking at the photographs from both the inside and the outside of the hole.
It is a somewhat arbitrary choice of choke factors. For example, the door, the non-watertight access opening, I should say, should have a value of zero because it is not choked. But the reality is that the flow of water through a hole will contract. It has a technical name called a vena contracta, which means that the flow through a hole is actually smaller than the hole size.
Q. So a choke factor of zero means no blockage, no choking?
A. A choke factor of zero means that there is no debris in the opening. So the choke factor you can see there of 0.8 is for the diagonal gash.
Q. This is page 482, the bottom chart, 0.8 choke factor; is

Page 3

that correct? You're referring to that?
A. Yes, correct. It's also shown in the diagram at the top of page 482 and the bottom of page 482.
Q. Yes.
A. So the 0.8 refers to the diagonal gash which had a lot of debris into it, and the 0.4 refers to the opening into the tank room, which appears to me not to have had a lot of debris in it. The 0.2 is referring to the access opening in frame 1/2.
I did look at the exercise of changing the choke factors, of course, to see how much reliance there was on these choke factors in changing the sinking time. I chose some other choke factors which I thought were realistic, based on my experience. And that appears on page 483, where I made some variation. It can be seen that there is not a lot of difference in time to sink: a matter of some seconds, and it is not a matter of minutes. The time to sink is very, very short and clearly it's not enough time for the crew to have organised evacuation in an organised manner. And I think the difference between the choke factors probably is not very material.
Yes, I can be criticised for getting the wrong choke factors, but at the end of the day I don't think it made a lot of difference.

Page 4

THE CHAIRMAN: Didn't make a lot of difference to the speed at which the vessel sank, and therefore the time available to evacuate safely?
A. That is the point I was trying to make, yes, Mr Chairman.
MR SHIEH: Which is I think probably the last point you made yesterday afternoon: that the difference in time caused by these variations in choke factors that you have chosen is probably immaterial for the purpose of deciding whether or not, let's say, more lives could have been saved?
A. Correct. And even if the choke factors had been wrong by a factor of 2, which I think is a very large difference, then it did not make a lot of difference to the overall time to sink.
Q. Thank you. Could I just ascertain the various choke factors. Let's say that the first choke factor, 0.8, represents the diagonal gash, you say --
A. Correct.
Q. -- together with the hole associated with it still in the engine room?
A. Right.
Q. The next one, 0.4, or in the other chart, 0.45, represents the hole in the tank room?
A. Correct.

Page 5

Q. And the last one, 0.2 or 0.3, represents really the access opening?
A. Correct.
Q. That's the hole connecting the tank room and the steering compartment.
A. Correct.
Q. Can we now move on in your main report, your first report, to the section at page 414 on the subject of your opinion on why Lamma IV sank so quickly. In paragraph 34, you said you were asked to examine why the Lamma IV sank so quickly.

At paragraph 35, you made the point that the software that you had used only gave the final static solution. By that I take it that you mean it could only allow you to predict or to work out what the final shape, up to 75 degrees, of the vessel would be, but it would not actually give you an idea as to the timeframe within which that would happen?
A. It is a static calculation, so, yes, time does not come into this calculation.
Q. "To solve this problem a numerical model was generated based on the detailed information contained in the original design drawings ... The results from Maxsurf and Hydromax were useful to compare the output from the dynamic simulation model in terms of the final vessel

Page 6

attitude, and a comparison of the two predictions where the vessel remained afloat is given in Appendix IV, item 7."

Which is page 464, the top part.

Basically the point you were making is that you used something called a numerical simulation model which would allow you to work out even the time factor, and you compare the result of using the numerical simulation model with the result that you get by using the Hydromax software as a cross-check; is that correct?
A. Correct.
Q. Thank you.

"The comparisons are considered to be within the range of anticipated accuracy, particularly as the numerical model used the same hydrostatic particulars as were taken from the vessel stability book and submitted to the Marine Department, whereas Hydromax used some slightly different values that were calculated as an integral part of that software. There are also differences ... the small difference in values would not noticeably alter the predicted time to sink."

Then at paragraph 36 you mentioned measuring the holes in the hull of Lamma IV, and then you set out appendix IV, item 8, which is that diagram which depicts the diagonal gash, the hole at the end and the other

Page 7

hole in the tank compartment, which I don't think we will look at because we are reasonably familiar with that.

We turn over to the next page, at 415. From the size of the holes, we move on to the next page at the top:

"Knowing the depth of water above each of the assumed three holes, on both the inside and outside surface of the hole, together with the area and shape of the holes themselves, it was possible to calculate the rate of inflow of water into the ship using the commonly used Bernoulli equation for each of the holes."

So shape and size of the hole and depth of water, you work out the rate of influx?
A. (Witness nods).
Q. "Different formulations were used to calculate the inflow of water to reflect the different shapes of hole ... This provided a method to calculate the amount of water entering the ship every second ..."

It goes on until the end. Perhaps I could invite you to briefly explain that in common, everyday language. It's common enough in the text, but perhaps hearing it from you would be --
A. Yes, I hoped it was commonly understood in the text.
Q. Yes.

Page 8

A. Do you wish me to explain the Bernoulli equations?
Q. No, no. But perhaps hearing it from you live would be better than me reading out black and white text. The manner in which you would work out the rate of sinking.
A. Yes. The flow of water through a hole is a reasonably common problem and quite a lot of work has been done on that over the years. I think it's fairly easy to grasp that if you have a hole in the side of a surface and a head of water outside, that the depth of water has an important role to play in how much water is coming through the hole. The deeper it is outside, the more water will come through. So certainly the head of water --
Q. Specifically against the pressure?
A. The head of water provides the pressure at the hole. So knowing the pressure at the hole outside the hole, which is a direct function of the head, you know the force that's trying to push the water through the hole. But it becomes a little more complicated when you consider that the water level inside the boat is rising as well. So you have to calculate the pressure inside the hole. It's a little more complicated than that as well, because if there is no water inside, then the water flows out like a jet, a jet of water. If it is flying out like a jet, you get some contraction of that jet.

Page 9

It's not the same size as the hole; it's slightly smaller due to the fact that the water speeds up.

So you have to use one equation for a jet-like flow through a hole, and then as soon as water starts to approach the hole inside the vessel, you change to a different form of equation, because the pressure inside is different and then once the hole inside is submerged, you then have to account for the pressure inside the vessel owing to the depth of water inside.

All of that, of course, is reasonably simple on a fixed structure that's sitting on the ground. But here we have a vessel that when water is coming in, the vessel starts to move because of the weight of the water. So it starts to trim. I did not consider the vessel heeling, because I considered that the vessel was sinking upright by all accounts. But I had to allow the whole vessel, and the compartment being flooded, to trim as a result of the water coming in.

The trimming then of course changed the depth of water outside in way of the hole and therefore changed the pressure outside. So it's quite a complicated calculation, because everything is moving, which is why I treated it as a discrete problem fixed in time, solved it, and then I said, "Well, in one second, how much water has flowed in?" And then checked after one second

Page 10

how much the vessel would have moved because of that water, making allowance for how quickly the water flowed into the compartment. That was reproduced every second.

I did check the accuracy of the model by looking at every half-second, which made for a very much longer calculation, and in fact I even did it for every 0.2 of a second. But there was virtually no difference by getting smaller discrete time intervals. So I ended up with reproducing my spreadsheet done every second. It was still quite an extensive spreadsheet, because of the need to calculate not only the trim of the ship, which caused the pressure outside to change in way of the hole, but also of course changed the water level inside the compartment in way of the hole.

Is that a good explanation?

Q. Yes, thank you.

The one-second interval point is really the point that you make at the end of paragraph 36, although you have kindly indicated that you have actually tested that by using different assumed time intervals.

A. Yes.

Q. Thank you. Paragraph 37:

"The calculation allowed for the additional buoyancy provided by the internal structure and fittings as the water flooded the inside of the vessel, including the

Page 11

volume of the main engines, the fuel tank ..."

So all these matters have been factored into your equation when working out what happened every second?

A. (Witness nods).

Mr Shieh, I just realised I have made an error in something I've said. If we may go back.

Q. Yes. Could you point out which part? You have the transcript in front of you.

A. Talking about the choke factors.

Q. Choke factors? Yes. Do you need the actual diagram or the graph to make your correction?

A. The actual choke factors used, Mr Shieh.

THE CHAIRMAN: 0.8, 0.4, 0.2?

A. You asked me the question which holes did they refer to? I gave an erroneous response. I'm sorry, Mr Chairman.

MR SHIEH: Right. Could you tell us which hole these three choke factors relate to?

A. Correct. The 0.8 refers to the diagonal gash. The 0.4 refers to the small hole in the engine room near the bulkhead. The 0.2 refers to the hole into the tank room. And the open access value is not given. It was a little more than zero. But essentially it was close to zero for when it was open, and if I made it 1, it was equivalent to it being closed.

I'm sorry, it was done some time ago and I had

Page 12

forgotten.

Q. Thank you. So basically zero is as if it's clear; 1 is as if it's watertight. So the value would only be somewhere between zero and 1?

A. Correct.

Q. Thank you. We come back to your first --

THE CHAIRMAN: Just give me a moment, please. Thank you.

MR SHIEH: We move on to paragraph 38 where you set out the dynamic numerical flooding simulation, first with the tank compartment flooded, that is what you call one-compartment damage, which was "intended to replicate the same flooded condition in the builder's damage stability book ... it showed that the vessel remained afloat with this single compartment flooded and with close agreement on the waterline position". This is page 464, appendix IV, item 7.

There's no diagram for this; there is only the result, the numerical result.

A. There appears to be no diagram.

Q. But you refer to appendix IV, item 7. Appendix IV, item 7, there are two conditions: one is engine room only, and one is engine room and tank room. There isn't a set of calculations for tank compartment only.

A. Yes. This paragraph 38-1 refers to appendix IV, item 7, numerical simulation model. And it gives the

Page 13

drafts 1.47 and 1.27.
Q. Yes, but that says "engine room only".
A. And that's engine room only, which is the -- ah.
Q. But paragraph 38-1 says "tank".
A. Correct. I'm not sure if that's not a typographical error and should be "tank room only", perhaps. I would need to --
THE CHAIRMAN: Take your time. Read it through.
A. I cannot be sure, unfortunately, without going back to the original calculations.
THE CHAIRMAN: Do you have them with you?
A. On the computer, Mr Chairman.
MR SHIEH: Perhaps we can do that in the mid-morning break. We'll make a mental note of that, Mr Chairman.
THE CHAIRMAN: Yes.
MR SHIEH: But I believe it is reasonably established that for Lamma IV, to put it very bluntly, if you only flood the tank room, it won't sink. If you only flood the engine room, it won't sink either. Is that the broad recollection or impression that you had, by having done the various calculations?
A. Yes, correct.
Q. So it is simply a matter of --
THE CHAIRMAN: Are you dealing there with the three different periods, 1996, 1998 and 2005?

Page 14

A. At this stage, when I wrote this report, Mr Chairman, I was actually using the 1998 stability book. I made the comment in my first supplemental that I subsequently discovered there was a later stability book dated 2005. So these comments here are related to the 1998 stability book.
I think the comparison, however, in appendix IV, item 7, is against the 2005 stability book.
MR SHIEH: Dr Armstrong, could I remind you that at page 464 you actually referred to the stability book in 2005.
A. Correct. That is in the second supplemental, I think.
Q. No, this is in your first report.
A. Ah. Okay.
MR MOK: Mr Chairman, I think the reference in item 7, where it refers to the stability book 2005, it is a reference to the engine room. The page reference is bundle 4, page 701. On the top left-hand corner there is a figure for draft front perpendicular, which is 1.29, which is the figure used in the table.
THE CHAIRMAN: Yes.
A. Thank you, Mr Mok. You had the advantage of having a stability book, which I did not in front of me. In which case I would suggest that the item under paragraph 38-1 --
MR SHIEH: Should read "engine compartment"?

Page 15

A. -- is incorrect, where it says "as shown in appendix IV, item 7".
THE CHAIRMAN: So paragraph 38-1 does deal with the tank compartment or not?
A. It does deal with the tank compartment.
THE CHAIRMAN: It does. And the reference to appendix IV, item 7 is to be deleted?
A. Should be deleted.
THE CHAIRMAN: The other matter that you adverted to -- was this calculated by reference to the 1998 stability book or to the 2005 book? Do you need to check your calculations?
A. I would like to check to be sure, Mr Chairman.
THE CHAIRMAN: Yes, please do.
A. I certainly started with the 1998 one, but at some stage, when I found the 2005 book, I did change over to that.
THE CHAIRMAN: Thank you.
MR SHIEH: Also, if the reference to appendix IV, item 7, those calculations or those figures, is actually an error, so I presume that there should be equivalent calculations which do refer to the tank compartment?
A. Yes. I'm not so sure it was an error, Mr Shieh, because I looked at a lot of one-compartment damage. I just chose to refer here to the tank room flooded because

Page 16

probably it was a greater draft. There are other calculations which are for the engine room.
Q. I know. Perhaps "error" is probably not the correct word to use, because as Mr Chairman asked, paragraph 38-1 does intend to refer to the scenario of tank compartment flooded.
But you say the reference to appendix IV, item 7 should be deleted because those calculations set out in item 7 related to the engine room. So what I am asking is that there would presumably, in your working papers or in your computer, be a set of calculations which do depict something similar to appendix IV, item 7, but relating to the scenario of tank compartment only flooded.
A. Yes. I can recall now what happened. I did not have a Hydromax solution for the tank room flooded, only for the engine room flooded, and therefore I chose to use the engine room only in appendix IV, item 7 for the comparison purposes.
Q. Right.
A. So the data in appendix IV, item 7 is correct, engine room only. And paragraph 38-1, as we have said, should have not referred to that.
Q. Thank you. Paragraph 38-2:
"With the tank compartment and the engine room

Page 17

flooded (two-compartment damage). This replicated the damage to the craft, but assumed that a watertight door had been fitted to the aft peak bulkhead. The vessel eventually became stable after about 165 seconds ... from the time of collision. The inflow rate of water varied considerably between 0.4-1.4 tonnes/second. The flow rate constantly changes because the water level inside changes as the craft trims and the outside water level also changes with both trim and sinkage."

But for this scenario, the vessel remained "afloat"?

A. Yes, correct.

Q. Thank you. Scenario 3:

"With the tank compartment, engine room ..."

THE CHAIRMAN: Before we go further.

Is this based on the 2005 position, namely the raised lead ballast?

A. No, Mr Chairman, this is based on the 1998, and my first supplemental corrects the information to the 2005 stability book.

THE CHAIRMAN: Thank you. So this is the tank room and the steering gear compartment now have 8.25 tonnes of lead in them, and this is the calculation with the tank room and engine room flooded, but with a watertight bulkhead for the steering compartment?

A. Correct.

Page 18

THE CHAIRMAN: Do I understand it correctly?

A. Correct. With the 8.25 tonnes of ballast, and also the additional weight.

THE CHAIRMAN: Thank you.

MR SHIEH: In fact you mentioned your first supplemental report, when you took into account what one may call the fuller set of stability booklet information, and that can be seen at page 471 of this bundle.

At paragraph 3, you make the point that there were several stability books and damage stability books for the vessel. You discovered a later-approved stability book, which is the 2005 one, in a new format and based on different computer software.

Basically, at pages 471 and 472, in this whole paragraph, you describe the updated work that you did, having taken into account the wider range of information that you had since looked at. Is that a fair way of putting it?

A. Yes, sir.

Q. Thank you. At paragraph 5, you said:

"The above modifications make no difference to the vessel sinking, or the impact of the omission of a watertight door ... They only change the shape of the plot of the vessel angle against time, and add some seconds to the estimated time to resting on the seabed."

Page 19

The revised timeline is given in appendix IV, item 15. It is to that that we now turn. Page 482. That's the diagram we looked at yesterday.

"The time to sink, given in my original report at paragraph 38-3" -- which is the paragraph we were just looking at prior to jumping to your first supplemental report -- "of about 87 seconds from initial contact to the deck at the stern going below the water, has extended to 96 seconds. The time of 102 seconds from the initial contact to assuming a position of 70 degrees to the horizontal, given in my original report at paragraph 40, is amended to 118 seconds."

Which is the result as depicted in the two charts at page 482, and which you explained to us yesterday.

A. Yes.

Q. Page 482, you would say -- perhaps forgive me for my rather layman-like analogy -- is a more microscale for the bottom of page 482. The top chart deals with a microscale, it deals with when the deck is submerged --

A. Yes.

Q. -- whereas page 482, the bottom chart looks at the matter in a more macro way, it looks at whether the vessel actually began to go stern-down and eventually, colloquially, sink?

Page 20

A. Correct.

Q. Because, as you say, the last part of the bottom chart of page 482 involved much more complex interaction of various factors such as water going in and all that?

A. Correct, and is probably a little less accurate because it is so complex.

Q. Thank you. That was I think the effect of what you said yesterday when we first visited these two charts.

Could I now ask you to look at paragraph 39 of your first report at page 416.

"It can be seen from the various photographs that there was a considerable amount of debris remaining in the hole into the engine room ... mainly being the bow structure ... This debris appears to have been firmly embedded, as the photographs show a crane being used to pull it out."

Yesterday we saw a whole series of those photographs of the exercise of trying to extract the debris. So I'm not going to revisit those.

"This embedded structure would have severely restricted the flow of water ..."

This whole paragraph deals with a subject we have looked at, basically the subject of choke factors you have already explained orally; correct? So this deals with the same subject matter; correct?

Page 21

A. Sorry, could you repeat that?
Q. This whole paragraph deals with a subject matter you have already explained to us orally, that is to say the subject of choke factors?
A. Yes.
Q. So we'll skip over that.
Paragraph 40:
"Having simulated the flooding process, a second numerical model was made to simulate the sinking process, based on the output from the flooding model. This was necessary because of the different physics involved in the flow of water ... The sinking simulation illustrated in appendix IV, item 9.2 indicated that the vessel would continue to increase trim by the stern until such time as the transom ... hit the seabed, at which time the vessel would have an approximate attitude of 70 degrees to the horizontal, with the forward part of the vessel remaining above the water as a result of the buoyancy of the forward hull compartments. This is illustrated in appendix IV, item 9.3."
Can we turn to page 466. This is the illustration that you refer to; correct?
A. Correct.
Q. "According to the sinking simulation model the time to reach this position was 102 seconds after the initial

Page 22

collision, and it probably remained at this attitude for some time, say 10-20 minutes."
The figure of 102 seconds has been subsequently modified in your first supplemental report, paragraph 6, to become 118 seconds; correct?
A. Correct.
Q. So we strike "102" and basically insert "118". Would that be the right way of doing it?
A. Correct.
Q. "There is a photograph of the vessel in this condition published by the media, before the incoming tide and local currents appear to have allowed the craft to assume a more vertical attitude ... as the water became deeper, and eventually to have allowed the craft to 'turn over' to an angle of about 110 degrees, which was photographed and circulated by the media."
THE CHAIRMAN: Before we get to that.
Paragraph 40, which of the various permutations are we dealing with there now? Are we dealing with the actual situation, 2005, raised lead, tank room, engine room and aft peak all flooded?
A. Correct.
THE CHAIRMAN: That's what we're dealing with?
A. Correct.
THE CHAIRMAN: Just give me a moment.

Page 23

So reading that in conjunction with paragraph 38-3, which we passed over, this is the actual situation in paragraph 38-3, is it not, and, as you say at about line 5:
"... the main deck at the stern sinking below the water level about 87 seconds from the time of the collision".
A. Paragraph 3 is of course related to the 1998 stability book --
THE CHAIRMAN: Thank you.
A. -- which was corrected in my first supplemental.
THE CHAIRMAN: So what's the time for the deck being submerged in the actual situation? 2005, lead raised by 10 inches, 2.5 compartments flooded?
A. That is given on page 472, Mr Chairman.
THE CHAIRMAN: Thank you.
MR SHIEH: As I understand it, Mr Chairman, page 472, Dr Armstrong at paragraph 6 made two corrections to numbers. One is correcting "87" to "96". That deals with what I call the micro situation, the submersion of the deck. The next correction is to amend "102 seconds" to "118 seconds". That deals with the time that it took to sink, as we call it colloquially.
Is that a correct way of putting it, Dr Armstrong?
A. Correct.

Page 24

THE CHAIRMAN: Thank you.
A. And the attitude given on page 466 would not be affected, in my opinion, by those differences between 1998 and 2005.
MR SHIEH: And the depiction at page 466 remains good, despite the amendment to the time factor; that is correct?
A. Correct.
Q. Because the amendments you've made only relate to the time it would have taken for the deck to submerge and for the vessel to sink; it does not affect the position?
A. That is correct.
Q. Can we come back to this question about the position or the condition of the vessel. You refer to a photograph published in the media. In fact we have seen a good deal of photographs from various media, most of which actually depicted the vessel at an angle of about 110 degrees.
A. Correct.
Q. But from your calculation, and from your software, you came up with a situation as depicted at page 466.
A. (Witness nods).
Q. So one perhaps had to look for contemporaneous evidence and perhaps explanation as to how the situation at page 466 could eventually become the widely publicised

Page 25

photographs of the Lamma IV, as eventually depicted in a wide series of media photographs. So that is the exercise you were embarking upon?
A. Yes. I was trying to justify my conclusions.
Q. And you located a photograph of the vessel in the position at page 466 in the media.
Mr Chairman, it is actually the South China Morning Post. Dr Armstrong had actually -- we have actually scanned a copy of the photograph. Perhaps we should acknowledge that the photograph comes from the South China Morning Post.
Perhaps we can scan that put up the scanned version.
It has just been inserted into the bundle this morning.
How would you comment on this photograph, Dr Armstrong?
A. I do not know at what stage this photograph was taken, but I'm sure somebody can work it out because of the presence of what looks to me like a fireboat in the background, with a red hull, and the obvious rescue that is going on in the foreground. It appears to be of rescuers taking people out through the windows. So I'm sure a time could be put against it.
It is obvious that the vessel is in an attitude similar to that on page 466.

Page 26

Q. We'll turn to page 466.
A. If one looks at the -- if we can go back to the photograph, thank you.
Q. Page 487-1.
A. If one looks at the masts and the radars, from the shadows, it is obviously in a similar attitude to that shown in my diagram. Judging by the water surface, which is quite white in places, there is obviously air escaping from the vessel. Presumably that's because the vessel is still continuing to settle a bit further in the water. In that regard, if we can go back to the diagram on page 466, there is a compartment forward of the engine room which is a crew compartment, nominally a crew compartment --
Q. That's what you -- you have marked it "Buoyant compartment"?
A. Yes, it is actually marked there as "Buoyant compartment". I have assumed that at this stage it was buoyant. In fact there was an access opening down into that compartment and eventually water would have found its way down --
Q. Access opening down from the deck?
A. Down from the deck, from inside. There was no access from outside of the deckhouse, but there was an access down from inside the deckhouse. So eventually water

Page 27

would have started to fill that compartment and the vessel would have continued to sink further, if the seabed allowed it. But I had no means of knowing how much water was coming into that buoyant compartment, so I stopped by investigation at that point. But I thought there was very good correlation between that and the photograph.
Q. Thank you, Dr Armstrong.
Could we now look at your first supplemental report. We have looked at paragraph 6, which is at page 472. Paragraph 6, you have set out the corrections that you have made, which we have looked at.
Paragraph 7 deals with the point that we have touched on, namely the effect of using different assumed choke factors. We'll skip over that.
Now, we get to the question of the final attitude of Lamma IV. You say at paragraph 8:
"There are various representations of the final attitude of Lamma IV after sinking and before salvage, and an explanation of these attitudes is offered to avoid possible confusion."
That is the point I mentioned earlier, because different media have actually shown pictures depicting different angles and different attitudes.
A. Yes, sir.

Page 28

Q. So you set out these various phases to assist us in understanding the various stages that the vessel had gone through.
A. That was the intention, yes.
Q. Thank you.
"Phase 1: Consequent to the flooding, Lamma IV sank by the stern until the deck edge on the transom went below the waterline. When this happened there was no further reserve of buoyancy and the vessel could only sink further. The trim angle at this point was a little more than 6.5 degrees, and this occurred at about 97 seconds after the collision."
Could I ask you to look at page 484 in the same bundle.
The paragraph you just looked at is depicted in the second diagram here, "End of Phase 1"; correct?
A. Correct, and that is for the vessel using the 2005 stability book.
Q. 2005 figures, all three compartments flooded?
A. Correct, yes.
Q. "Transom immersed at 6.5 degrees".
Could we turn back to page 482. If we try to check that against the chart or the graph at the top, "Transom immersed", so the trim angle of 6.5 -- if we look at 6.5 trim angle, move horizontally to where 6.5 hits the

Page 29

red line, and we pull it down, it's actually 100-odd seconds rather than the 97 seconds that you mentioned in the text.
A. Mm.
Q. Is there any --
A. Yes, I notice that.
Q. Sorry?
A. I notice that.
Q. Yes. Could there be any explanation? Because you mentioned 97 seconds, but when I tried to check it against the graph, it's 100-odd seconds.
A. I may have taken the figure, when writing the report, from the next page, appendix IV, item 16.
Q. Yes. That would yield a time of 90-odd seconds, based on a different set of assumed choke values.
A. Correct.
Q. Thank you. Phase 2 -- or if we actually look at the chart at page 482. If we had used the chart at page 482 instead, for the vessel to achieve a trim angle of 6.5 degrees, it would have taken about, what, 105 seconds, 106 seconds?
A. Something like that, yes.
Q. Around about that?
A. Yes.
Q. So the difference could well be less than 10 seconds,

Page 30

depending on which chart you use.
We move on to phase 2 at page 473:
"The vessel continued to rotate by the stern until the transom hit the seabed at approximately 118 seconds at an angle of 62 degrees. There are two witnesses who comment about a heel to starboard during the descent. This may have been the result of hydrodynamic forces generated around the hull whilst sinking, or from the rudders which were most likely positioned to one side, or even from the initial contact with soft mud."
That is the phase 2 diagram at page 484, left-hand side, bottom. Is that so, Dr Armstrong? "End of Phase 2"?
Is that so, Dr Armstrong? Phase 2 corresponds to the bottom left-hand diagram?
A. Correct.
Q. "Phase 2a: The vessel settled in the mud to some unknown extent, but I have estimated this as initially 70 degrees based on the depth of water and an assumption as to the depth of mud, supported by the attitude of the vessel illustrated in a photograph owned by the South China Morning Post ..."
Which is the one we saw just now; correct?
A. Correct. Could I also draw your attention to the photograph on page 954, which is my second supplemental

Page 31

report, which is a view of the after end of the vessel.
Q. Yes.
A. I mention that because, to me, there's not a lot of damage there, and I suspect the seabed in that region is probably quite soft mud rather than hard mud or indeed rocks. I could see no obvious -- I mean, the handrail, for example, is still intact. So I think the bottom was probably not an obvious bottom. It may have slowly gone from water to mud in a rather amorphous fashion.
THE CHAIRMAN: There was a layer of mud, was there not, on the open area, mud and shells?
A. A considerable amount of mud on the open area, sir, and also in the steering gear compartment and some other areas. But I have no means of knowing whether that mud came -- I suspect it came from when the vessel was in this attitude. But it could, I suppose, have also come from when the vessel was on the shore, I think on Lamma Island somewhere, where it rested for a while after the rescue.
THE CHAIRMAN: Yes.
MR SHIEH: Then we move on to phase 3:
"The vessel further settled in the mud, assisted by the effects of the current and the incoming tide, and assumed an attitude of 90 degrees, as illustrated by the Fire Services Department during the rescue."

Page 32

At footnote 6 you refer to an exhibit in the witness statement of Yau Wai-keung, which is FSD bundle 3, page 652.
THE CHAIRMAN: Has this witness given oral testimony?
MR SHIEH: Yes, Yau Wai-keung did.
Mr Chairman, in relation to the other two witnesses who Dr Armstrong refers to in footnotes 3 and 4, Wong Tai-wah did give evidence and Leung Yuk-chuen I understood did not. I understood Mr Chairman had some directions as to the manner in which witnesses whose statements have been referred to --
THE CHAIRMAN: That's correct, because the way we're proceeding is to deal with everything publicly, openly, transparently. We've gathered together a huge volume of material. The material that we've used so far, as far as witnesses are concerned, has always involved the witness giving oral testimony and adopting the out-of-hearing-room statement.
So that everyone understands what it is the Commission is having regard to when it makes its findings, it is that which has been advanced openly in this hearing.
MR SHIEH: And therefore, insofar as Dr Armstrong might have referred to statements of witnesses who have not testified live, it is proposed that at the appropriate

Page 33

juncture, perhaps after Dr Armstrong has completed his testimony, I will read out the relevant parts of the non-testifying witnesses, subject to --

THE CHAIRMAN: Certainly that's one way of dealing with it. Another way of dealing with it, dealing with the witnesses we came across yesterday, and there are six of them to whom he refers, and the issue there was witnesses who spoke to the vessel accelerating prior to collision.

MR SHIEH: Yes.

THE CHAIRMAN: In fact only two of them speak to that, of the six that are nominated there. But that was a general issue that was dealt with by other witnesses, so --

MR SHIEH: Who have testified.

THE CHAIRMAN: Who have testified. But there is one witness, and he is Tang Ying-kit, who speaks about the change in the wake of the vessel, the white water he noticed. He speaks about the vessel accelerating twice. He's a witness we wish to hear from.

MR SHIEH: Yes. I have the relevant reference to his statement, so perhaps as an appropriate juncture, maybe not now so as not to break up the flow of Dr Armstrong's evidence --

THE CHAIRMAN: No.

Page 34

MR SHIEH: -- I will read out the relevant parts of Tang Ying-kit's --

THE CHAIRMAN: We wish to hear from Mr Tang. I think this is an issue that is relevant to Lamma IV and to the coxswain's account.

MR SHIEH: So we will make arrangements for the live testimony.

THE CHAIRMAN: From him only. The others, for our part, seem to fall into the general pattern, subject to any submissions that counsel have to make. But he seems to fit into a different category, and potentially of assistance to the coxswain of Lamma IV.

MR SHIEH: Thank you. So the way the matter will proceed is the Commission would like, subject to hearing submissions, Tang Ying-kit to be called live, whereas the others --

THE CHAIRMAN: The others I don't think we need to trouble with, frankly. If counsel want their statements read out, we'll consider that. But they seem to be subsumed in the general testimony.

MR SHIEH: And the same would go for the two footnoted witnesses? One is Wong Tai-wah, who has in fact testified --

THE CHAIRMAN: If Mr Wong has testified, that deals with that concern. If the other witness simply says the same

Page 35

thing, then again we don't need to hear from him.

MR SHIEH: Perhaps we could check whether or not the statement of the other witness actually adds anything, because if not, then we probably need not trouble ourselves with reading it out.

THE CHAIRMAN: That's the way in which I invite you to approach the issue.

MR SHIEH: Thank you.

Dr Armstrong, coming back to phase 3. That also vertical, 90-degree attitude is what you have in mind as being phase 3?

A. No, sir. I was really referring to I think a slightly -- yes, correct.

Q. That is exhibit 3 to Mr Yau's witness statement?

A. Correct.

Q. So that is phase 3, a 90-degree attitude?

A. Yes.

THE CHAIRMAN: Before we go further -- I was distracted there for a moment. This is the overview provided by the senior fire officer, is it?

MR SHIEH: Yes.

THE CHAIRMAN: Yes. Thank you.

MR SHIEH: Lastly, phase 4, at page 474 of the bundle:

"Pushed by the current and with a receding tide, the vessel was trapped at an angle of greater than

Page 36

90 degrees, estimated from photographs as approximately 110-115 degrees. This attitude is widely presented in the media, but by this time I believe that all practical rescues of passengers had been completed. It is not known how much of the vessel was supported by the mud at this time, as the inside of the cabin has little obvious mud within it when it was inspected and there was little damage in the cabin area and upper deck from lying at the bottom. I can only assume that the vessel had dug a hole in the mud during the previous hours whilst it lay at lesser angles."

Now, phase 4 is depicted at page 485. That is phase 4 that you referred to?

A. Yes.

Q. In the text of your discussion, page 474, you refer to there being "little damage in the cabin area and upper deck from lying at the bottom".

That is the point that you made just now by directing our attention to the expert bundle, the picture at page 954?

A. That was the intention, yes. I was a little puzzled by the attitude of the vessel and the given depth of water. If it had been much deeper, I could accept that would be the attitude of the vessel. So it had either dug a hole in the mud, or somehow moved into deeper water.

Page 37

Q. Thank you. When you say "This attitude is widely presented in the media" -- could I ask you to look at marine bundle 1, page 124.
This is, I believe, the picture that is widely reported in the media that you have in mind?
A. It was certainly reproduced in a lot of newspapers in Australia.
Q. Thank you, Dr Armstrong.
THE CHAIRMAN: Can you help me as to what time that evening the tide turned and ebbed?
A. Mr Chairman, I can't be 100 per cent sure now, but the information is certainly in the file. I think it was close to midnight, about 20 past midnight or something like that.
THE CHAIRMAN: Thank you.
MR SHIEH: We're trying to check whatever available information there is about tide that evening.
Mr Chairman, the tide, according to our information, turned at around 22:10.
THE CHAIRMAN: Is that at Quarry Bay?
MR SHIEH: Yes.
THE CHAIRMAN: Thank you.
MR SHIEH: Dr Armstrong, we have looked at questions concerning the sinking of Lamma IV, and we have looked at various charts and diagrams depicting the attitude

Page 38

and also the time it took to sink.
Could I now turn to a different topic, concerning the general structural condition of Lamma IV. For that, could I ask you to turn to your first report, paragraph 23, in the first expert bundle, page 410.
At paragraph 23, you start off:
"During the inspection of damage to Lamma IV, the opportunity was taken to make a general survey of the condition of the structure of the vessel. I found that it was generally of sound construction, with little evidence of corrosion or weakening of the plating or stiffening components. Brackets were generally well aligned without obvious buckling from excessive sea loads.
There were two locations where there had been very localised severe corrosion in the aftermost corners of the main deck where a stainless steel pillar supported the deck above. The deck immediately under each pillar has corroded completely through creating a small hole about 100 mm squared. However at some stage in the past it has been sealed with a filling compound and the pillar put back in place to cover it. I consider the corrosion was caused by an electrolytic action of the two different metals at this point, namely aluminium and the stainless steel of unknown properties. This hole

Page 39

played no part in the sinking of Lamma IV and is only noted as part of the general condition of the ship."
But generally speaking, you would agree that aluminium would undergo corrosion when placed in contact with a foreign metal, a different kind of metal? As a general observation?
A. As a general observation, I must first of all comment that there is almost no use whatsoever in the Marine Department industry of aluminium per se. It should really refer to "aluminium alloy", and it is a common -- I do it myself. It is a common mistake to just refer to "aluminium". There are many different grades for aluminium alloy. This particular vessel, Lamma IV, was built of a very common marine grade of aluminium alloy called 5083, and even 5083 comes in different tempers, different strengths.
5083 is a very stable material which does not generally corrode. However, when placed close to some other materials, particularly things like copper, it will corrode extremely quickly. In this case, it appeared -- it was under a pillar, which was of some unknown stainless steel material. Stainless steel also comes in many different grades and types. So it is difficult for me to say generally that there will be corrosion between stainless steel and aluminium.

Page 40

If I'm pressed to say, is there corrosion between stainless steel and aluminium, I would say yes. One of the biggest problems with aluminium vessels, high-speed vessels, is where they use water jets which have jets made from stainless steel, and we see corrosion in those areas.
So I believe that this was very definitely because of the quality of the stainless steel that had been used. It was a local issue. It had been addressed. I don't believe it had anything to do with the sinking of Lamma IV. But it was noticed by the police photographer and there are some photographs of the hole in the police files. I also noticed it and took some photographs. But I don't really think it's relevant, sir.
THE CHAIRMAN: What are the main components of that aluminium alloy, 5083?
A. I should know the exact percentages, but --
THE CHAIRMAN: Perhaps you'd like to come back to us later on that.
A. They're essentially silicon, magnesium and manganese. But the exact percentages, given the pressure of the occasion, I don't want to quote.
THE CHAIRMAN: No. Thank you.
MR SHIEH: Now we move on to paragraph 25, when you deal

Page 41

with the question of the thickness of aluminium plating. You say:

"On two separate occasions the plating thickness of the side plating of Lamma IV has been checked by ultrasound. This was done at the request of Mardep as a condition of survey in June 2005 and again in May 2011. The survey results show an average thickness of the side plating as 4.5 mm in July 2005, with a slight decrease to 4.4 mm average in May 2011. From my inspection of the plating, which is protected by paint on both sides and in good condition, I am of the opinion that there was no measurable reduction of thickness over the past 6 years; rather the 0.1 mm discrepancy was more likely caused by differences in the accuracy of the instrumentation and the measurement process used at the time.

The drawings approved by Mardep show that the side plating should have been 5.0 mm thickness. Given the protective paint scheme on both the outside and inside of Lamma IV hull plates, I am of the opinion that it is most likely that the vessel was constructed with side plating of 4.5 mm thickness, as measured in June 2005, despite the drawings showing 5.0 mm thickness. The thinner plating size on Lamma IV may have contributed to the extent of the damage that was experienced, as

Page 42

plating of a greater thickness would have reduced the damaged hole size, which in turn might have provided marginally more time for escape before the vessel sank."

At paragraph 26, you say:

"The hull construction for Lamma IV was subcontracted to Wuzhou Shipyard in Guangxi, China, and the hull survey was conducted by China Classification Society, under an arrangement with Mardep. The survey report makes no specific reference to the thickness of materials that were used.

The bottom plating thickness also appears to be undersized, although this played no part in the sinking. According to the ultrasound results at survey in 2005, the bottom plating thickness was 5.5 mm with some variations in the 2011 measurements of up to 5.8 mm. The drawings approved by Mardep show a minimum thickness of 6 mm."

Dr Armstrong, since giving your first report, the Commission received witness statements from I believe Cheoy Lee, producing certain documentation concerning placing orders for the relevant aluminium alloy.

A. I have seen that, yes.

Q. You've seen that. Could I ask you to look at --

THE CHAIRMAN: We've also had Mr Lo's evidence.

MR SHIEH: Mr Lo, giving -- testifying.

Page 43

THE CHAIRMAN: Have you had access to the transcript of his evidence?

A. I have, yes.

MR SHIEH: Could I first of all take this witness to the Wilkinson & Grist bundle.

THE CHAIRMAN: Yes.

MR SHIEH: May I ask the witness to turn to page 1. This is the witness statement of Mr Lo, Ken Lo, from Cheoy Lee Shipyard. The relevant part is actually paragraph 40, which is page 9 of this bundle. Paragraph 41, Mr Lo refers to the evidence of Wong Wing-chuen, senior surveyor of ships of Mardep, having explained in his witness statement that the Blue Book did not stipulate any construction standard or guideline regarding plate thickness.

"... however, if the applicable rules and regulations of the Lloyd's Register was applied, then the plating required for a vessel of this type would only be 3.5 mm."

Dr Armstrong, you have considered the Blue Book as to whether or not it stipulated any construction standard or guideline or particular numerical requirement for thickness.

A. There are no requirements in the Blue Book.

Q. There are no requirements in the Blue Book. Thank you.

Page 44

Mr Ken Lo refers here to the relevant rules and regulations of the Lloyd's Register in saying that "the plating required for a vessel of this type would only be 3.5 mm". What do you have to say about that?

A. There are many different sets of rules and regulations, and without seeing this particular set of rules, I find it hard to comment. Also, of course, it depends on what grade of aluminium is being considered. So one can't take it out of context and say, "Aluminium shall be 3.5".

Q. If I can show you marine bundle 11, because that is what Mr Ken Lo has referred to. Marine bundle 11, page 3943. This is where the relevant witness, Mr Wong Wing-chuen, at paragraph 48 of his witness statement, refers to the Lloyd's Register requirement coming down to 3.5 mm.

Are you able to offer any specific comment on that?

A. It could be an appropriate standard for this vessel, yes.

Q. Thank you. Then at paragraph 43 of his statement, Mr Ken Lo refers to ordering the aluminium plates from a company in Florida in December 1994, and he actually produced the relevant order form or purchase order, which we can find at page 17 of this bundle. Item 4, we can see:

"5 mm x 72 inch x 388-inch alloy 5083 ..."

Page 45

So that corresponds with your understanding as to the grade of aluminium alloy used on the vessel?
A. Correct.
Q. At paragraph 44, he says:
"The materials were supplied with American Bureau of Shipping certificates and these had been shown to the China Classification Society surveyor, a mandatory requirement."
Then paragraph 45:
""Apparently, upon receipt of the ABS certificates, it was noticed that the thickness of the 5.0 mm plates were supplied in the imperial management of 0.19 inches, which was equivalent to only 4.83 mm. Cheoy Lee advised Mardep of this discrepancy by its letter of 4 April 1995 and received no objection from Mardep in their reply letter ..."
Then he said:
"It is customary practice ..."
THE CHAIRMAN: Could we see that letter again, please.
MR SHIEH: It's marine bundle 2, page 206. This is a letter that attracted no specific comment from Mardep on this issue.
THE CHAIRMAN: Well, it was ignored in the reply letter of about 10 days later.
MR SHIEH: Yes. I should say the Mardep replied to the

Page 46

letter, but not commenting on this particular point.
THE CHAIRMAN: No. Correct. This subject wasn't touched upon.
MR SHIEH: Page 206. Dr Armstrong, you can look at the manner in which the matter was raised with Mardep:
"We would also like to advise of the following changes:
1. 0.19 inch (4.83 mm) plating in place of 5 mm plating."
So this particular point was raised with Mardep, but Mardep had not specifically commented or accepted or rejected this point.
A. Indeed, Mardep did produce drawings approving 5 mm.
Q. 5, yes.
A. I would say I missed this particular paragraph when I was looking through the documentation, because it is headed "Fin Construction", "Bulwark Construction" and "FO Tank". So I assumed the 5 mm comment was referring to one or other of those items, subsequently being drawn to my attention that none of these drawings do have 5 mm plating in them, but I did not read it that way originally.
THE CHAIRMAN: Before you move on.
What in your opinion ought to have happened, given that the Marine Department are being told about this

Page 47

change in the plating, and given that the size now being provided for for the vessel is not that which is stipulated on the drawings? What should have happened, as far as the drawings are concerned?
A. I would have expected a letter stating that that was acceptable, and the drawings may have been left as they were.
MR SHIEH: Dr Armstrong, paragraph 46, Mr Lo says:
"It is customary practice accepted by all leading marine classification societies to accept tolerance for plate thickness and in this particular size of aluminium plate, 0.2 mm is the acceptable limit."
Then he refers to attachment 6, which is page 29 of this bundle. Can I ask you to look at page 29 of this bundle. You see that is Lloyd's Register Rules, the relevant rules for Lloyd's Register. Then at the bottom:
"Dimensional tolerances.
1.4.1. Underthickness tolerances for rolled products for marine construction are given in table 8.1.1."
Then in the table, I think the relevant entry is the second one. The tolerance is given as 0.2 mm. What comment do you have on this?
A. May I first of all explain, for the understanding of the

Page 48

Commission, that when aluminium plate is manufactured, it is rolled between two heavy rollers. In doing that, you lose a little control of how thick it may be. So this is a table that explains the allowable variations in the thickness. So when you order a 5 mm plate, it may end up at 4.8 or even a little bit more than 5. It is quite common practice to hope that it's slightly less than the 5, because that way you pay less for it because it's sold by weight.
0.2 I believe is a very common standard, and in fact I produced rules from another class society, Det Norske Veritas, which appear in my supplemental report on page 952, which also states 0.2 mm.
Q. It's table A4 at page 952.
A. Correct. For thicknesses between 4 and 8, the second line down of table A4, 0.2 mm. And 0.2 mm is what would expect. So I agree with Mr Lo.
Q. In fact there is also produced in Chinese the relevant rules for China Classification Society, in the Wilkinson & Grist bundle, page 40-51.
It's in Chinese, but we can see where the arrow is pointing at. There's a translation at the back, yes. Page 40-52, "Underthickness tolerances for rolled products", and you can see 0.2. It follows a similar format as the Lloyd's table.

Page 49

A. (Witness nods).
Although it's not specifically stated, this is understood by reading the rest of the chapter to apply to 5083 aluminium plate.
THE CHAIRMAN: 5083 ...?
A. Aluminium plate. Aluminium alloy.
THE CHAIRMAN: Thank you.
MR SHIEH: Can we now come back to Mr Ken Lo's statement.
"CCS was engaged by Cheoy Lee through Guangxi Wuzhou Shipyard to ensure that the hull was constructed to drawings approved by Mardep and this procedure was approved ...
Upon completion of the requisite inspections of the completed hull, CCS surveyor signed and stamped the Mardep survey items list and issued a survey report ... confirming the hull was constructed in accordance with the drawings approved by Mardep.
Mr Wong Wing-chuen has again very clearly explained in paragraph 51 of his statement ... that there would be wear and tear on the plating of a vessel that has been in service for 14 years and that the reduction in thickness of the plating, which is less than 10 per cent was considered acceptable."
Then he refers to marine bundle 11, which is the text of Mr Wong Wing-chuen's witness statement.

Page 50

I believe you have actually dealt with the subject of corrosion, aluminium corrosion, in your first supplemental report; is that correct, Dr Armstrong?
A. Correct, yes.
Q. Perhaps taking it in stages, I will direct your attention to what Mr Wong Wing-chuen said first.
Mr Chairman, this is going to lead to a chain of looking at one document leading to another, so perhaps it might be an appropriate moment.
THE CHAIRMAN: Very well, if you think that's a convenient break, we'll take the morning break now.
Dr Armstrong, we'll take 20 minutes and therefore resume at 11.45. Thank you.
(11.25 am)
(A short break)
(11.45 am)
MR SHIEH: Dr Armstrong, I was about to take you to the evidence of Mr Wong Wing-chuen, to whom Mr Ken Lo referred. Marine bundle 11, page 3944. Paragraph 51:
"Further, there was no ultrasonic testing of Lamma IV's hull plating in May 2011 as alleged. According to Mardep's records, hull gauging was carried out in the periodic survey of Lamma IV on 16 June 2005 and 14 August 2009 respectively. Presumably Dr Armstrong was referring to those tests. In any

Page 51

event, even though the test recorded the side and bottom plate thickness to be 4.4 mm and 5.8 mm respectively ..."
I think we can disregard 5.8, right, Dr Armstrong, because it relates to the bottom and, as you said, the bottom thickness has nothing to do with the sinking?
A. Correct, yes.
Q. So let's focus on 4.4:
"... such reduction in thickness (about 0.4 mm and 0.2 mm respectively, less than 10 per cent of original thickness) was regarded as the result of wear and tear in Lamma IV's 14 years of operation, and was considered to be acceptable by Mardep.
Accordingly, Mardep is unable to agree with Dr Armstrong's opinion that there was incompliance [he means "non-compliance'] with the applicable requirements in the design and construction of the hull shell plates."
That is what Mr Wong Wing-chuen said.
First of all, he took issue with what you said about ultrasound, ultrasonic testing in 2011.
Have you had a chance of reviewing what you noted and do you agree with him that it should actually be 2009?
A. Thank you for that. Could I refer you to police

Page 52

bundle Q, I think it is, page 4870. This is hull thickness measurement record.
Q. Yes, thank you.
A. The date is in the top right. It's May 2011.
Q. Yes. That is the one that you had in mind when you wrote your report referring to 2011?
A. Correct. So I do not understand Mr Wong's comment.
Q. Right. But in any event, you have seen what this -- perhaps you can also look at what the witness actually refers to by way of marine bundle 4, to see the two documents that he has referred to. Marine bundle 4, pages 848 and 854.
First of all, page 848, "Inspection Record". "Quadrennial Survey". This is the one conducted in 2005, you can see in the top left-hand corner.
The next one is page 854, which is the one conducted in 2009.
So these are the two documents which the witness Mr Wong referred to as showing that there were inspections in 2005 and 2009, but you yourself refer to that document in the police bundle as indicating that there had been inspection of the hull thickness in 2011?
A. Correct. And I see no indication in 2009 on page 854 of what the thicknesses were.
Q. No indication, no. But in any event, the witness's main

Page 53

point is whether or not it's 4.4, as you indicated in your report, such reduction was regarded as the result of wear and tear. So you see the point he's making, and Mr Ken Lo adopted that. So you see the point they are getting at, Dr Armstrong?
A. I see the point; I don't agree with it, but I see the point.
Q. Right. I think we'll take it step by step, because Mr Ken Lo actually testified in this hearing.
My next step is going to be to take you to the remaining part of his witness statement to complete this part, and then take you to the oral evidence to see how he developed the theme in this relevant part of his witness statement.
A. Right.
Q. So let's do it in stages. I don't want to jump between statement and transcript, so let's finish his statement first.
THE CHAIRMAN: Let's just understand the issue. The issue is the circumstances in which the plate thickness reduces to 4.4; is that the issue?
A. Perhaps, Mr Chairman. Or maybe it didn't reduce., it was built at 4.4.
THE CHAIRMAN: Well, yes. I take your point. One starting point is the drawings say 5 mm. We've had a letter

Page 54

explaining that they never were going to be 5 mm, it was 4.83 mm, being 0.19 inches.
A. Correct.
THE CHAIRMAN: So if one then starts from 4.83, one issue is how does 4.83 in 1995 become 4.4 -- is that the right figure? -- in 2011?
A. Correct.
THE CHAIRMAN: One possibility is it started off life at 4.4.
A. It's a possibility.
MR SHIEH: Because if it started off life at 4.4, the question is not really one of corrosion or whatever; it would simply be a case where actually they were short-charged from day one. But if it did start off life as 4.8-something, the question of why it then diminished to 4.4 then becomes relevant.
THE CHAIRMAN: Thank you. So that's the journey we're now going to embark on.
MR SHIEH: Yes.
Could I ask you to look at the Wilkinson & Grist bundle, page 11. This is a continuation of Mr Ken Lo's witness statement. We stopped at paragraph 49, where Mr Lo referred to Wong Wing-chuen's witness statement, which is the one we have just looked at, Dr Armstrong.
A. (Witness nods).

Page 55

Q. Now we continue to look at what Mr Ken Lo had to say. He said:
"I do not believe that I need to dwell further on the subject of normal wear and tear of a vessel.
51. I should nevertheless mention that according to annex M of the Code of Practice -- Safety Standard for Classes I, II and III Vessels issued under ... [the Ordinance] ... a vessel will still be considered seaworthy even if the planting of the hull has no more than 30 per cent corrosion. It means that the hull of a vessel would only be cropped and renewed if the thickness of the hull decreases by 30 per cent from its original thickness. In other words, Lamma IV would still be considered as seaworthy even if the plating of its hull was 3.5 mm."
He then refers to attachment 7, which is the annex M that he has referred to in the text of that paragraph. You can see under the section "Hull":
"Repairing of Corroded Hull and Structural Member.
The thickness reduction of hull plating and structural members caused by corrosion should not be more than the specified percentage of the original thickness as shown in the following table."
Then for "Decks, shell, structural member", corrosion limit was stated to be 30 per cent. Do you

Page 56

see that?
A. I see that, yes.
Q. That is the point relied upon by Mr Ken Lo.
Paragraph 52 at page 12 of the bundle:
"The reduction in thickness of the plating of a vessel can also be caused by the ultrasound test conducted to check its thickness. For such a test to be performed, paint will have to be removed from various spots of the hull plating and each spot will have to be flat so as to give the touch pad of the ultrasonic device a proper contact. Otherwise, erroneous reading will be recorded. It is this paint removal and mild sanding down process that will also reduce the thickness of the plating slightly."
Do you see that, Dr Armstrong?
A. I see that.
Q. I see you actually referred to it in a later stage in your second supplemental report, but let's pave the groundwork first.
I now take you to the transcript of the evidence of Mr Lo. We travel to Day 19, which is last Monday, 21 January. The relevant part of this transcript starts at page 20. You may have actually read this already, but I think we should project that so you can actually refresh your memory.

Page 57

At the top of page 20. "No, definitely not" refers to a previous topic, so let's disregard that.

Mr Beresford, my learned junior, asked him:

"Question: You then go on to say that the vessel had been in service for 14 years, and that there may have been a reduction in thickness ...

Answer: Yes.

Question: But isn't it right that on aluminium plating over a period of 14 years, there wouldn't normally be much in the way of wear and tear?

Answer: It depends on whether there is any corrosion, erosion. There's a lot of electrolysis. ...

Question: But corrosion is something you associate normally with steel ...

Answer: No, no, no. There is. They're a dissimilar metal. Aluminium is very sensitive to other materials, like steel, for instance. If there is a steel in contact with aluminium, the aluminium will be wasted first.

Question: And is there any steel in contact with the aluminium in this case?

Answer: Well, not when we built it."

Then Mr Chairman interposed whether Dr Armstrong has made some observations about that in his report.

I think in your original report and also I think in

Page 58

your second supplemental report, you came back to revisit this question of corrosion.

A. Yes.

Q. As I said, I'm paving the groundwork for you to develop your opinion. So this is what was said:

"Answer: Must have. This is very common knowledge.

Question: I think we can anticipate that Dr Armstrong will say that he would not anticipate any substantial reduction in the side plating assuming a 5083 grade of aluminium was used.

Answer: I can only tell you that in all classification rules, there is allowance for aluminium wastage. When we get to the next paragraph, I will show you further rules from ABS and from -- this one is from Bureau Veritas, showing the same thing. ...

Question: Actually, you say ..."

Then he referred to the bit about annex M -- I won't read that out in full.

Line 19:

"Question: I think you mean the 'plating of the hull', do you not?

Answer: Yes.

Question: '... has no more than 30 per cent corrosion.'"

Then he continues to read on until the end of that

Page 59

paragraph.

Over the page at page 22, line 4. He refers to attachment 7. Attachment 7 was annex M, Dr Armstrong, you remember; we've just seen that?

A. Yes.

Q. We move on to line 15:

"Question: But is this not a guidance document for steel hull plating?

Answer: It does not say whether it's steel or aluminium, so it is assumed that all material applies. That's why I mentioned earlier, I do have other classification rules in my hand, one from ABS dated 2004, and one from ABS, 2013, plus Bureau Veritas, all talking about aluminium wastage.

Question: Perhaps we can just come to those in a moment.

Answer: Yes.

Question: But just while we're on annex M to the code of practice, I believe Dr Armstrong will say that this refers to steel-hulled plating which corrodes easily and is not suitable for marine-grade aluminium. He says that because steel corrodes or rusts, the original thicknesses for steel material are usually calculated by classification societies with an additional thickness to allow for corrosion, so that

Page 60

even with a 30 per cent reduction in thickness over the years, the material would still retain sufficient strength to absorb the design loads.

Answer: Well, that is Dr Armstrong's view.

Question: Do you agree or disagree with it?

Answer: I have no comment ..."

Line 16:

"Mr Chairman: But you interpret this guidance as applying to aluminium?

Answer: Yes. Because aluminium also, you know, can have corrosion.

Mr Beresford: Now, you wanted to refer to some other classification society materials, I believe?

Answer: Yes."

Then there are some additional documents being mentioned, two pages from ABS and some from Bureau Veritas, and then the question of copying them. Then there's some discussion with Mr Pao.

Then further down the page, there's a reference to the China Classification table. Dr Armstrong, we've looked at that. It basically dealt with the 0.2 mm tolerance. So we'll skip through that.

At page 25:

"Question: Mr Lo, you did say, I think, that there were no materials present in the Lamma IV, at least as

Page 61

built, that would cause the aluminium to corrode more easily.

If we look at attachment 4 to your statement, which is the packing list, you've already drawn our attention to the aluminium plate ...

Answer: Yes.

Question: I'm told that Dr Armstrong will say that this hull plate was built with some 6061-T5 and -56 stiffeners, and 5083-H321 components.

Answer: Yes.

Question: Do you agree with that?

Answer: Yes.

Question: He will say that these are all acceptable marine-grade aluminium materials which in combination should not corrode.

Answer: That definitely would not corrode. This is all aluminium.

Question: You agree with that?

Answer: Yes.

Mr Chairman: The corrosion problem comes about, as I understand your evidence, when you have two different metals that are in contact?

Answer: There are other issues. No doubt seawater -- there are a lot of factors affecting a ship's hull.

Mr Chairman: Yes, but one of them is two different

Page 62

metals in proximity?

Answer: That is the worst, yes.

Mr Chairman: Yes.

Answer: I mean, for instance if you have a steel nut in the bilge of your ship and nobody recognises it, they will put a hole into the hull eventually.

Mr Chairman: Yes."

Then the question about what Cheoy Lee was doing by way of maintenance, et cetera, was raised. We'll skip through that.

At page 27 of the same transcript -- this is about paint. Line 20:

"Then you go on in paragraph 52 of your statement to say:

'The reduction in thickness of the plating of a vessel can be caused by the ultrasound test that is conducted to check its thickness. For such a test to be performed, paint will have to be removed from various spots ...'"

This is basically reading out the last bit of the witness statement.

Over the page, page 28, Mr Beresford asks:

"But I suggest to you that sanding down the paint and then removing the oxide layer on the aluminium should only remove hundredths of a millimetre, which is

Page 63

not significant.

Answer: That could be a case, yes.

Question: And you agree --

Answer: Probably not significant if you are careful, yes."

Then there's a reference to the China Classification rules, and further down the page there is the arrow.

Over the page, page 29, they move on to damage stability calculation, which is beyond the topic that we're now looking at.

So that's what Mr Ken Lo elaborated or testified to in the witness box on this subject of wear and tear, corrosion, and whether the stripping of paint could have any impact on thickness. So you've seen all that.

Could I now come to what you say on the topic. First of all, back to your first report, page 411. We have looked at paragraph 27 already. This is about bottom plate thickness, and we have already touched on the point that this has nothing to do with the sinking.

So we move on to your paragraph 28 of your first report:

"It is further noted that according to [what we call the 1995 Instructions] the minimum thickness of side plating for a launch of less than 30 metres in length is specified as 5.0 mm. This dimension is for a hull built

Page 64

of steel with a stiffener spacing of 600 mm."

Would you like to take a look at the 1995 Instructions, Dr Armstrong? Can I just track down the reference for that. It's marine bundle 8, page 1820. I think the relevant part should be page 1821.

Dr Armstrong, you refer to these 1995 Instructions; correct? 3.2.

A. Correct.

Q. Bottom of page 1820:

"In no case the thickness of any part of the shell and deck plating of any steel vessel is less than the minimum standard as stipulated in the following table."

So we look at the table over the page. Which of these items do you have in mind, Dr Armstrong?

A. Side plate.

Q. Side plate, yes.

A. For a vessel with a length between 15 and 30 metres: 5 mm.

Q. So it says "Minimum thickness: 5 mm". The cursor can perhaps point to that. Yes.

So that's what you have in mind. This dimension is for a hull built of steel, with a stiffener spacing of 600 mm, because that is the built-in premise in 3.2 on the previous page at 1820; correct?

A. Correct.

Page 65

Q. Then at page 411, you go on to say:
"It is permitted to adjust the allowable thickness for other frame spacings, and Lamma IV was designed with a frame spacing of 350 mm."
Does it mean that you can actually do adjustments and calculate the minimum thickness on the basis of some other, different frame spacing as being used?
A. Indeed. For a trained naval architect, it is a relatively simple exercise based on a very simple formulation.
THE CHAIRMAN: So this provision is based on a frame spacing of 600 mm?
A. The table is based on 600. It is relatively simple to change that to 350, which is the spacing on Lamma IV. It's also possible, using the same equation, to change the material to aluminium rather than steel, and I've done that. I regret I haven't put it in evidence, but I can do so.
MR SHIEH: Mr Chairman, at this juncture there is one point concerning how various what I may call loose ends may be tidied up. Yesterday Mr Grossman put in one expert report and one supplemental expert report, which concerned the subject matter of Dr Armstrong's testimony. Overnight other documentation has come in. One is a supplemental report by Dr Peter Cheng, put in

Page 66

by the Department of Justice.
THE CHAIRMAN: Yes.
MR SHIEH: Probably the Commission has not had the time to go through it in any great detail.
THE CHAIRMAN: No. If I've seen it, it is only because it's in a bundle of material that's dumped on my desk every morning.
MR SHIEH: To which no particular attention has been drawn.
THE CHAIRMAN: No, I deliberately don't give it attention because when things come in late, they don't deserve attention.
MR SHIEH: One subject matter dealt with by Dr Peter Cheng's supplemental report -- and obviously Mr Mok may well make the necessary application at some stage -- Dr Peter Cheng, as I understand it, performed that type of calculation that Dr Armstrong had alluded to.
THE CHAIRMAN: Yes.
MR SHIEH: If Dr Armstrong actually said that he has in fact done some similar calculation and he would be prepared to put it in writing, then obviously, subject to the direction of the Commission, it may well be that if Dr Cheng's report is in, or even if it is not in, if Dr Armstrong is prepared to assist the Commission by performing the calculation by using, first of all, different material, and, two, different stiffener

Page 67

spacing, then there may well have to be a short break after the completion of Dr Armstrong's evidence for us to really gather our thoughts and make sure the paperwork is in order.
THE CHAIRMAN: Yes. The only issue that we're addressing is providing what should be the plating thickness for aluminium at 350 mm spacing.
A. (Witness nods).
THE CHAIRMAN: It's as simple as that, is it not?
A. I believe it's very simple, yes.
MR SHIEH: Yes. And Dr Cheng --
THE CHAIRMAN: How long does it make to calculate that?
A. Well, I already have that. It took me 10 minutes.
THE CHAIRMAN: Yes. And where do you have the calculations? In a computer?
A. I thought I had it here and I was looking for it during the break, but I couldn't put my hands on it, sir.
THE CHAIRMAN: Is it in a computer?
A. No, it's a handwritten calculation. It's so simple I just did it by hand.
THE CHAIRMAN: So it's a 10-minute calculation?
A. Something like that.
THE CHAIRMAN: No doubt we can do it during the course of the day.
MR SHIEH: Yes. With or without a break, or maybe for me to

Page 68

familiarise myself with it, or maybe he could be led cold, but it may well be that it may be better for me to actually understand it before leading it.
THE CHAIRMAN: Do you remember what the result is?
A. I do indeed, sir.
THE CHAIRMAN: What is the result?
A. 5.22.
THE CHAIRMAN: So with aluminium of this grade -- does grade come into it?
A. It does indeed.
THE CHAIRMAN: Aluminium of this grade, with 350 mm spacing, as in Lamma IV, the plating should be 5.22?
A. According to my calculation, correct.
MR SHIEH: And the actual numbers will come after Dr Armstrong has had a chance of perhaps digging out the handwriting calculation or perhaps redoing it, which would take perhaps 10 minutes.
THE CHAIRMAN: Thank you very much.
So, just so I understand it, this is the required minimum of the thickness of the plating; is that it?
A. It clearly states "required minimum shall not be less than".
THE CHAIRMAN: And we're dealing with side plating?
A. Only with side plating.
MR SHIEH: Dr Armstrong, parking the issue of producing the

Page 69

actual numbers by which you get to the figure of 5.22 mm, perhaps I'll read on your paragraph 28.
A. Please.
Q. You said:
"However, Lamma IV was built from aluminium, not steel, and my opinion is that a stiffener spacing of 350 mm ... is approximately equivalent to 600 mm stiffener spacing for steel, for a similar bending strength. My conclusion is that the side plating in aluminium should have been 5.00 mm in accordance with the instructions ..."
In fact, according to what you have just told us, converted by reference to changing it to aluminium and changing the spacing, you get even more than 5 mm?
A. I came up with 5.22. I subtracted 0.2 for over-rolling and came up with 5 in the report.
THE CHAIRMAN: So that's the tolerance you've allowed already in that calculation?
A. Correct.
I have now actually located, or someone has located for me, my handwritten calculation, sir. It is available.
MR SHIEH: Perhaps, if you think that it is in a form that you can talk us through, this can be produced for the secretariat to copy and scan.

Page 70

A. It is handwritten, so it might be better if it's --
Q. You may wish to do it over the lunch adjournment to make it --
THE CHAIRMAN: It's entirely up to you. Do you think we can read it?
A. I believe I have excellent handwriting, Mr Chairman.
THE CHAIRMAN: Then let's scan it now. (Handed).
You do.
A. Thank you.
MR SHIEH: Could I read on in the meantime, Dr Armstrong. I stopped at the word "instructions":
"... and this is reflected on the drawings approved by Mardep. The side plating as built, in my opinion, was 0.5 mm undersized."
This assumes the side plating as built was already 4.5 mm.
A. (Witness nods).
Q. But if, for example, side plating as built was 4.8 mm, then there would be 0.3 mm unaccounted for?
A. (Witness nods).
Q. "The Instructions for the Survey of Class I and Class II Launches and Ferry Vessels ... permit lesser thickness of side plating if the vessel is classed with a recognised classification society. However these instructions also make clear that if it is not

Page 71

maintained in class with the classification society, then the operating licence will be withdrawn and the requirements of the minimum thickness in the Instructions shall be complied with in full. Lamma IV had been designed to the rules of a recognised classification society, but it had never been classed by them, and so should have complied in full with the thickness requirements given in the 1995 Instructions."
When you say "Lamma IV had been designed to the rules of a recognised classification society", which one do you have in mind?
A. Det Norske Veritas.
Q. Yes, but it has never been classed by DNV?
A. Correct.
Q. Therefore, what one may call the default position, namely the requirement of the 1995 Instructions, should apply; correct?
A. Yes.
Q. But that is assuming that the applicable regulations or instructions at the time were the 1995 Instructions?
A. It is -- based on that assumption, based on the evidence in front of me, that was my interpretation of which instructions applied. I will leave it to the Commission to decide which ones are the actual ones.
Q. Yes. You mentioned that the Blue Book, which is the

Page 72

version of the instructions prior to the 1995 Instructions, did not have specific stipulation on minimum thickness.
THE CHAIRMAN: Where is that mentioned?
MR SHIEH: I asked him orally this morning.
THE CHAIRMAN: Thank you.
MR SHIEH: I will actually be asking him to look at the equivalent provision in the Blue Book, just to make good the point that the equivalent part in the Blue Book concerning construction standard did not actually stipulate any minimum thickness.
Dr Armstrong, can I ask you to look at marine bundle 8.
Thank you for the calculation, Dr Armstrong, but perhaps I will deal with this question about the absence of stipulation in the Blue Book, about minimum thickness, before moving to the calculation.
THE CHAIRMAN: Please do.
MR SHIEH: Dr Armstrong, marine bundle 8, page 1768.
Could we first of all look at 1820, which is the 1995 regulations. This is chapter II. The heading is "Requirements and construction of hull -- new vessels". Do you see that, Dr Armstrong?
A. Yes.
Q. Then we see various headings: "First Survey",

Page 73

"Registered or Identification Dimensions", and then we have "Construction Standard".

Then the minimum thickness provision is contained in that section headed "Construction Standard". You can see that, yes?

A. I see.

Q. Then over the page at page 1821 we have things following on, like "Coamings", "Bulkheads", matters of that nature.

When I tried to track down the existence of equivalent standards I turned to the equivalent chapter in the Blue Book, which is in page 1768.

This is the Blue Book equivalent. You can see, Blue Book, "Chapter II. Requirements and Construction of Hull"; you can see that?

A. I see that.

Q. "First Survey", "Construction", "Registered or Identification Dimensions", "Coamings", and then over the page, "Bulkheads".

So if one were trying to locate similar stipulations in the Blue Book, this would be the chapter that one would turn to, Dr Armstrong; is that the way you would approach instructions of this nature?

A. Yes, sir.

Q. So under "Construction", paragraph 9 at page 1768:

Page 74

"In the case of new vessels, the surveyor or inspector will examine the construction so as to ensure that the approved plans are adhered to in respect of the vessel's dimensions, materials, scantlings, fastenings, et cetera, and no material departure from any approved plan will be allowed without the concurrence of the senior surveyor ..."

This would seem to be the only stipulation about construction that we could find in this chapter.

A. It's the only one I'm aware of, yes.

Q. Of course we would obviously have to address what instructions Mardep applied at the time, because Mardep now says, according to its evidence, that they only began to apply the 1995 standard as from a particular point in time onwards.

Leaving that issue to one side, simply commenting on what you can see by way of 9, what do you say about a standard or an instruction or a requirement which is worded in this particular way, without any express stipulation as to any kind of standard or safety or numerical limits?

A. I cannot obviously answer for how the Marine Department may interpret that. My own personal opinion would be that I would use some standard such as a classification society, Lloyd's Small Craft, for example, which was one

Page 75

of the few available at that time. Alternatively, there are other regulations in other countries that are commonly used for this type of vessel. But I do not know how Marine Department would interpret that.

Q. Because on the face of it, if we simply look at it, as far as construction is concerned, it simply says, "you shall not allow departure from approved plans without concurrence of various people", and the only thing that the person administering these instructions is supposed to do is to ensure that approved plans are adhered to.

A. It's left to the skills of the Marine Department, yes.

Q. And it's left to the question of how the relevant plans have been approved and what standards have been adopted when approving those plans, because once those plans have been approved, under this regulation they become the yardstick by reference to which Marine Department is to scrutinise the question of construction.

A. Yes.

Q. Can we now look at the calculation you have done, which is now in front of us. I hope it has been scanned. Yes, it has.

In due course it will be given a page number, but for the time being, let's look at it in its present form.

Could you talk us through it, Dr Armstrong.

Page 76

A. I will attempt to.

The formulation relating material properties, material geometry and the stress or strength of the material is basically shown by equation 3, which is indicated by a circle with a "3" in it on the right-hand side. That formulation will be extremely familiar to anybody working in the area of mechanical engineering. In fact, I'm sure you've probably all seen it yourselves. It basically says bending moment over stress is equal to the inertia of the section divided by the depth of the section: BM/sigma is I/Y.

Using that formulation, we can take the stated properties in the table for steel. It says that the steel material -- thank you. If we go down. That's fine.

The steel material is 600 mm wide, and it is greater than 5 mm thick. Based on the 600 mm by 500 mm we can simply work out the inertia, which is the value of "I", for the standard steel material in the instructions.

"I" is given by the length of material, that is 600; times the depth of the material, 5 mm cubed; divided by 12. That's in millimetres to the power of 4. And divided by half the thickness of material, which is the 5/2 factor: 2.5 mm.

So I/Y for the steel material in the standard is

Page 77

usually given by formula 5.
Q. That is 600 times?
A. 600 times 5 cubed, divided by 12, divided by 2.5.
Q. Yes.
A. So we know the right-hand side of equation 3 for steel in the standards book, in the book giving the standard.
If we now look at equation 3, you'll notice it has a Greek symbol sigma, which is the stress of the material. If we stroll up a little bit, according to Lloyd's Rules and Regulations for the Classifications of Yachts and Small Craft, published in 1983, the yield strength for steel is 235 newtons per square millimetre.
So we know immediately three of the unknowns in equation 3. We can work out the bending moment, because we know the right-hand side of the equation and we know the maximum allowable stress.
I should have added that the value in equation 1, the steel yield strength is equal to the maximum allowable stress that you are permitted to use.
Knowing the bending moment, that is essentially the load that the structure is seeing created by the sea and other loads. So I am saying that the bending moment for a steel boat would be identical to the bending moment for an aluminium boat or a boat of any material; basically the loads imposed on that boat by being in the

Page 78

ocean.
So if we work out the bending moment for steel by the method I've just explained, we can then say it's the same as the aluminium section.
Are we okay so far, or am I going too quickly?
Q. No, it's okay.
A. We know the bending moment for aluminium, the left-hand side of equation 3. We know the stress for aluminium, which is given in equation 2, according to Lloyd's Rules -- "maximum allowable aluminium alloy", that should say. It's measured in a slightly different way, so it's called 0.2 per cent proof stress. This is 125 newtons per square millimetre.
We also know the sectional inertia in terms of the width being 350 for Lamma IV. We don't, of course, know the thickness. That is what we're trying to find. And we don't know the depth of the section. That's also related to the thickness, what we're trying to find.
So if you scroll down a little further, there's a little diagram there of the aluminium alloy being 350 wide and thickness, "t". We know the I/Y value is the function of "t" given in equation 7. We know the stress. The equation is reproduced just below equation 7. That is the bending moment -- 350 square times 1.632, divided by the allowable stress of 125,

Page 79

equals the I/Y value in equation 7: 350 divided by 6 times "t" squared, which gives a thickness of 5.22 for an aluminium alloy with a spacing of 350.
Q. Can I try to summarise it in extremely layman terms.
The aim of the exercise is to find out the equivalent of "t" in the case of aluminium?
A. Correct.
Q. And "t" is embedded as part of the definition of "I" in your equation 3?
A. Correct.
Q. Everything else would be known, either by looking at the books or various other sources. So once you plug everything in, "t" for aluminium follows as a matter of course?
A. Very succinctly put, yes. I should have been a lawyer.
Q. So that's your calculation, Dr Armstrong, in coming up to 5.22 mm for aluminium --
A. Yes.
Q. -- with 350 stiffener spacing. Thank you.
Could we now then come back to your report. We have looked at what you have said in paragraph 28, and your point that although rules of a classification society can be used instead of the stipulation in the 1995 Instructions, that presupposes a vessel is in class with that classification society, which is not our case;

Page 80

correct?
A. Correct.
Q. Can we now then look at what you say in your second supplemental expert report, expert bundle 2, page 932. Paragraph 23 onwards:
"During investigation of the damage to the hull of Lamma IV I noted that the thickness of the hull plating appeared to be thinner ... Approximate measurements with a tape measure suggested that the plating was a little over 4 mm."
So that is actually measured at a damage location, at an opening?
A. Yes.
Q. That's why you can actually measure the thickness?
A. Yes.
Q. But that may not actually represent the thickness in an undamaged location?
A. Correct.
Q. How would that differ?
A. I would expect it to have been thinner if the plate had been stretched.
Q. Or, say, if it's next to a hole?
A. Yes.
Q. "I assumed initially that the plating may have been stretched as a result of the collision and thus reduced

Page 81

in thickness, but I also examined the inside of the engine room for evidence of the general upkeep of the aluminium structure and whether the thickness of the engine room plating may have suffered a reduction in thickness owing to corrosion. I found that the hull plating in the engine room and tank room were in generally excellent condition, as stated in my initial report at paragraph 23. I then purposefully looked for the results of the thickness gauging carried out during the survey process as reported in paragraph 25 of my report.

Whilst my opinion of the structural condition of Lamma IV in the engine room and tank room was that it was in excellent condition, I did not look at the whole structure, only isolated parts ...

I note that the generally accepted tolerances for marine grade aluminium plating of this size are 0.2 mm, for example as given by the classification society regulations of Det Norske Veritas."

That's page 952 of this bundle, to which you had earlier drawn our attention.

A. Correct, yes.

Q. That is page 952, and the table at A4 we looked at. Do you have table A4, Dr Armstrong?

A. Yes.

Page 82

Q. Returning to the text, paragraph 26:

"I have been involved in the design and manufacture of aluminium craft since 1989, almost all of them using 5083 grade marine aluminium plate with 6061 grade extrusions."

We have seen 5083 grade marine aluminium plate in the order form placed with the American firm, in the order form that we saw earlier this morning, Dr Armstrong.

A. (Witness nods).

Q. But 6061 grade, you confirm that this was also the case in Lamma IV?

A. Correct, according to the bill of materials provided by Cheoy Lee, yes.

Q. Thank you.

"I have also assisted with maintenance of various craft and provided expert technical advice on corrosion issues that have affected several aluminium fast ferries and luxury yachts. The great majority of problems with corrosion that I have witnessed have related to the areas around stainless steel materials in way of waterjet inlets ..."

That is a point that you mentioned earlier?

A. Yes.

Q. And that is the same point?

Page 83

A. Yes.

Q. "... and the remainder have related to galvanic action caused by dissimilar metals on the vessel and/or on the wharf. In all of these cases the corrosion has been below the waterline external to the craft and involved other materials.

Aluminium alloy oxidises extremely rapidly when the surface is scratched or abraded, to form aluminium oxide. Whilst aluminium might generally be considered to be a soft material, in fact aluminium oxide" -- and you highlighted that -- "is one of the hardest substances known to mankind. It is also called corundum, an extremely abrasive material, and in other crystalline arrangements is known as ruby and also sapphire. When formed on bare aluminium it is extremely thin (about 4 nanometres), but nevertheless it forms a highly effective boundary to corrosion."

So you mean, usually, in a layman's eyes, oxidation is a bad thing; if iron oxidises, it rusts?

A. Yes.

Q. But here you are saying that for aluminium alloy, if it oxidises it actually makes it stronger?

A. Yes. Well, I wouldn't say it made it stronger, sir. It makes it -- because it is so thin, it just provides a very strong boundary against corrosion.

Page 84

THE CHAIRMAN: So it protects the underlying material?

A. It protects the underlying material.

MR SHIEH: I'll move on. Paragraph 28:

"Because the corrosion properties of marine grade aluminium are so good, a large number of high-speed craft have been built in 5083 marine grade aluminium without being painted, particularly on the interior, and on the outside of catamarans between the hulls. Paint is only generally applied to these craft to provide an identity of the owner. An example of a 2006 design for which I was responsible and which was built in aluminium and which has not been painted is given in appendix IV, item 22."

That's page 953. That's the USS Independence. Is that an American warship?

A. It is a warship built in the US. Two of these vessels have now been built. There is another eight under construction. I was responsible for the concept design of this vessel. As you can see, it is unpainted, apart from below the waterline. There was a rigorous five-year testing period during which we had to prove that aluminium was a suitable material, which included proving that it would survive for a 30-year design lifespan.

Q. 5083 marine grade aluminium with 6061 grade stiffener,

Page 85

same as for the Lamma IV?
A. Correct.
Q. Paragraph 29:
"I doubt whether the reduction in thickness of the side plating from 4.83 mm to 4.4 mm could have been caused by corrosion. I also find it difficult to comprehend how this could have happened in the first nine years ... and then there was no further significant corrosion over the next six years ... as suggested by the thickness gauging reports. However, I note that Lamma IV has been operating in tropical areas with high temperatures and high humidity, and it is possible that condensation on the inside surfaces may have been acidic and caused some corrosion. I have been involved in several military vessels operating in the Western Pacific, in conditions of high temperatures and high humidity, and these have not exhibited corrosion of the plating. These craft however have not been operating in areas with atmospheric pollution such as are sometimes experienced in Hong Kong."
In this paragraph, Dr Armstrong, you are really highlighting perhaps that one peculiar feature in Hong Kong that is not shared by the Western Pacific locations that you have referred to, and that is atmospheric pollution.

Page 86

A. Yes, atmospheric pollution and condensation can cause acidity, and that would not be good for corrosion of aluminium.
Q. Yes, but in terms of high temperatures and high humidity, and the potential causative effect that these may have about acidic conditions, you have mentioned that even for military vessels in the Western Pacific, where these conditions -- high humidity and high temperature -- existed, they have not exhibited corrosion of the plating.
A. Correct.
Q. Then you went on to identify one situation peculiar to Hong Kong that was perhaps not shared by the Western Pacific location --
A. Correct.
Q. -- and that is atmospheric pollution?
A. Correct.
Q. So would it be fair to say that you are saying if indeed there was corrosion, would you say that it is possibly because of atmospheric pollution?
A. I'm raising the possibility. It's getting a little outside my knowledge area, but I'm saying it is a distinct scientific possibility. There was one other item that did come to --
Q. That is to say, if indeed there was corrosion.

Page 87

A. If there was corrosion. There was another thought came to mind this morning: that I have no knowledge of what paint was applied. If the incorrect paint was applied to the inside of aluminium, that could also be the source of corrosion. I have no reason to say that the wrong paint has been applied, but I think it's fairly obvious that if, for example, a lead-based paint had been put on, there would have been quite extensive corrosion. But I'm not suggesting for a minute that was the case. I'm just saying that there are some potential causes of corrosion of which I have no expert knowledge at this stage.
Q. Thank you. Paragraph 30:
"Classification society regulations do permit lesser scantlings than the 5.0 mm minimum required by the 1995 Instructions. I understand that the designer has commented that the scantlings would be satisfactory even at 4.4 mm thickness. However I also note that the 1995 Instructions permit scantlings to be set by classification societies, but if so then the vessel must remain in class with that society."
When you say, "I understand that the designer has commented that scantlings would be satisfactory even at 4.4 mm", are you referring to the evidence of a particular witness that you have seen?

Page 88

A. Yes, I'm referring to some particular evidence. I'm sorry, I don't have a note of where it is.
Q. Perhaps Mr Lo, who commented ...
A. It could well have been. But it was certainly in writing. It wasn't oral evidence.
THE CHAIRMAN: The designer was Mr Lim. We don't have a written statement from Mr Lim.
MR SHIEH: Mr Lim has not been questioned on this aspect, because he was only questioned about the watertight bulkhead and the like. So that's why I asked, because it mentions "the designer".
THE CHAIRMAN: Yes.
MR SHIEH: But the general thrust of your point, really, Dr Armstrong, is that insofar as people try to rely on classification society regulations allowing perhaps some lesser thickness, it presupposes the vessel being in class with that classification society; correct?
A. Correct. There was --
Q. Which provides some assurance of --
A. There was some documentation came in this morning, I think from Dr Cheng, quoting a number of classification society calculations, all coming up with different values.
So my point is, as you say, that according to the 1995 Instructions, it should not have been permitted to

Page 89

use class society calculations.
Q. Because it was not in class --
A. Because it was not in class.
Q. -- with that society?
A. (Witness nods).
Q. Thank you. That, Dr Armstrong, completes the evidence on this question about aluminium.
Perhaps I will now move on in your report to a different topic, and that is to say the topic of seat failures. Please turn to page 417, paragraph 42:
"Following flooding, Lamma IV assumed a severe stern trim. This attitude caused the failure of all of the fastenings connecting the seats to the upper deck ..."
I think this sets out the general outlook of the vessel following the collision, with which we are reasonably familiar.
Paragraph 43, you describe the structure of the upper deck: 2.1 mm woven rovings, 25 mm of foam, 2.1 mm of woven rovings at the bottom.
Over the page:
"This type of construction is typical for a vessel deck, where the foam is essentially used to separate the two outer skins to provide good bending strength."
Dr Armstrong, as I understand it, the thrust of this paragraph is that the woven roving may have strength in

Page 90

certain dimensions, in two dimensions, but it has limited strength perpendicular to the deck and therefore may not be a good material to hold the screws. That's the general thrust of this paragraph, is it, Dr Armstrong? Or perhaps you can develop your point first.
A. Could you just bear with me one second, please.
The original point of the paragraph was to point out that the combined structure -- that is, the woven rovings and the foam and the woven rovings underneath -- do not have good strength in the perpendicular direction. However, you're right when you say that the woven rovings itself also have very different properties in different directions. Perpendicular is weaker than in the directions along the material.
It's a complicated answer because the material is not homogeneous -- I apologise to the translators. By "homogeneous", I mean the material is not the same, it's not consistent throughout. It consists of strands of glass, which is a very strong material, laid in different directions, and it is very strong along those strands of glass, embedded in a plastic resin, I think polyester in this particular case -- it might have been epoxy, I can't remember -- but anyway, a plastic resin, and therefore has very different properties from one

Page 91

point to another.
It's also made at the same time as the structure is being manufactured. Why is that significant? It means that you have limited control over how much glass and how much plastic is actually at a particular point. It is theoretically possible that you just happen to have no glass somewhere and a lot of resin.
Now, that depends a lot on the skill of the manufacturer, and the manufacturing process. And there is no question in my mind that Cheoy Lee is one of the best at making fibreglass materials. But nevertheless, it's difficult to control the mix.
THE CHAIRMAN: Can you just help me with this aspect of things. We know that the superstructure of the vessel was subcontracted to a New Zealand contractor.
A. Yes.
THE CHAIRMAN: The hull was built in the mainland. The two came together in Hong Kong and appear to have been joined together, from a layman's point of view. Would you expect the superstructure made in New Zealand to have the upper deck floor already in place or not?
A. I'm not familiar with exactly who did what, Mr Chairman. I know High Modulus in New Zealand --
THE CHAIRMAN: That's the company.
A. Yes. They are recognised as about the best there are in

Page 92

the business in terms of design. I have no knowledge of the capability of who built it or how they built it.
THE CHAIRMAN: So High Modulus would be designers rather than manufacturers?
A. That was my understanding, but I would stand corrected.
THE CHAIRMAN: But coming back to my question, would you expect it to arrive with the upper deck floor, which is the main deck ceiling, already in place or not?
A. I would assume that, yes.
THE CHAIRMAN: Yes.
Mr Pao, are you able to help us? That's a line of enquiry we raised with you yesterday. Have we got any further with that?
MR PAO: I believe I've seen some documents. They're collating it. Because if they produce the whole file, there is irrelevant material in there.
THE CHAIRMAN: Yes.
MR PAO: They would like to just simply supply the Commission with the relevant --
THE CHAIRMAN: But that's under way?
MR PAO: It's under way.
THE CHAIRMAN: Thank you.
I'm sorry, I interrupted you, Dr Armstrong. You were explaining the non-homogeneous nature of the glass fibre substance.

Page 93

A. When considering a little local detail like a screw, it is very hard to say whether that particular screw would be embedded in lots of glass or in lots of resin. To further complicate the issue, the deck is not quite as simple as I have described it on the previous page, on page 417, because it also has some internal what are called shear webs, which I refer to in the words --

MR SHIEH: Could I pause you here and draw your attention to your first supplemental report, page 475, when you commented on Dr Cheng Yuk-ki's report -- the shear webs, which is what I'm actually going to refer you to. Page 475.

A. Thank you.

Q. This is the 100 mm times 100 mm boxes concept.

A. Yes. I think the box sizes are probably smaller than I've quoted there.

Q. Can I ask you to explain this. This is a different feature from the feature you told us earlier, about the non-homogeneous nature of that top and bottom layer?

A. It is a different subject, yes. But considering the local structure in way of a screw thread, I think you have to consider all of these issues because the material you're screwing into is just not consistent. It's non-homogeneous. Maybe I've wandered off the point.

Page 94

Q. You were about to talk about -- you said to make things more complicated, there is this concept of shear webs. I was reminding you that this is the subject matter of what you have written at page 475, at the top.

A. Yes. I think overall I can say is, yes, there's limited strength in the perpendicular direction to the deck, but it can vary quite a lot depending on the local arrangement of the material such as where the shear webs are.

Q. But what's the significance of these shear webs? I mean, they are a particular dimension by a particular dimension. So how would the existence or internal arrangement or compartmentalisation of the foam core into these boxes affect how strongly they can hold onto a screw?

A. The only relationship there is if the screw happened to coincide with a shear web, and therefore some of the threads were engaged in fibreglass that was essentially in a vertical direction as opposed to a horizontal direction. The chances of that, of course, are quite small, but I only mention it because there's a large variation.

Q. If they coincide with fibreglass in a vertical direction, then it would be held firmer or not so firm?

A. The threads are in contact with more stronger material, so therefore it will be stronger embedded and therefore would be a stronger connection. But the odds of a screw actually being on a shear web are quite small. The majority of the material is not shear web.

Page 95

MR SHIEH: Would this be an appropriate moment, Mr Chairman? I'm moving on to a different topic.

THE CHAIRMAN: Yes, if we're moving on, certainly. Dr Armstrong, we'll take our lunch break now and we'll resume this afternoon at 2.30.

A. Thank you.

(12.56 pm)

(The luncheon adjournment)

(2.30 pm)

MR PAO: Mr Chairman, I wish to inform the Commission that Dr Armstrong's impression about the New Zealand firm being only the designer and not the manufacturer of the superstructure is correct. I've just confirmed with my client that in fact Cheoy Lee was the manufacturer of the superstructure in Hong Kong.

THE CHAIRMAN: Right. Thank you for that confirmation. Then moving to the next step, we had asked for information relating to the contract or the order placed with New Zealand, but also then we ought to add that we seek information as to the construction of the superstructure by Cheoy Lee in Hong Kong.

Page 96

MR PAO: Yes. I'll see to that.

THE CHAIRMAN: Thank you.

MR SHIEH: Mr Chairman, before we proceed with Dr Armstrong's evidence, there is a point about the remaining witnesses for these couple of days that perhaps I should raise with the Commission, because Mr Chairman will recall raising the question about calling Mr Tang Ying-kit, one of the factual witnesses, the passengers on Lamma IV.

THE CHAIRMAN: Yes.

MR SHIEH: Enquiries have been made with Mr Tang. He is available tomorrow. He is also available on Friday. But he will not be available on Thursday. So if he is to be called, I think in fairness he ought to be told when so he can make his plans accordingly, especially if, say for argument's sake, he is required tomorrow. I'm not saying that he will be required tomorrow.

THE CHAIRMAN: Yes.

MR SHIEH: And there are other issues which may arise turning on the sequence of witnesses.

After finishing Dr Armstrong, we would have to decide whether or not we need Dr Cheng.

THE CHAIRMAN: Yes.

MR SHIEH: There are one or two aspects of Dr Cheng's evidence that Dr Armstrong has some issues with and we

Page 97

have yet to obtain a more detailed indication, but the initial inclination is that there are a few areas which Dr Armstrong has some comments on. But we bear in mind Dr Cheng's availability in the sense that he has to leave on the morning of the 31st, which is Thursday.
THE CHAIRMAN: Yes. I'm mindful of that.
MR SHIEH: So if there is any chance of him coming in tomorrow and then not finishing, then obviously that is something to be factored in, whether we do call him tomorrow or whether we leave him until after the New Year break. That's one consideration.
THE CHAIRMAN: Yes.
MR SHIEH: Also, there is my learned friend Mr Dominic Yeung's, acting for the China Classification Society, application to recall witnesses. That issue is left outstanding.
THE CHAIRMAN: It's certainly not urgent, is it?
MR SHIEH: Well, not urgent in the sense that it has to be dealt with before we move on. But on the other hand, the plan as we see it is that Captain Pryke may be available either the end of this week or early next week.
THE CHAIRMAN: It's next week that I had envisaged that he would be recalled for examination or questioning in respect of the first issue; that is, the collision.

Page 98

MR SHIEH: Yes. Primarily, I gather, by Mr Sussex and Mr Zimmern.
THE CHAIRMAN: Yes.
MR SHIEH: Then it would be followed next by the crew members. Now, it may well --
THE CHAIRMAN: Well, no.
MR SHIEH: Sorry?
THE CHAIRMAN: We're getting involved in quite a discussion in the middle of Dr Armstrong's evidence. But I take on board what you're saying. Can we not revisit this at 4.30?
MR SHIEH: Yes. The only reason I'm raising it is if there is a quick solution to whether Mr Tang Ying-kit --
THE CHAIRMAN: Mr Tang we can say Friday.
MR SHIEH: Friday. Thank you.
Dr Armstrong, welcome back. Before the lunch break I was looking at page 475 of expert bundle 1, in particular your discussion about the internal shear webs, the foam core of the structure compartmentalised into roughly 100 mm by 100 mm boxes. Let me recap. The non-homogeneous nature of the material is a separate point that you addressed earlier on in your main report as being a special feature of the material, which may lead to, how shall I put it, the not-so-firm hold on the screw?

Page 99

A. A variation in their strength capability.
Q. Yes. Put in layman's terms, it's because of the non-homogeneous make-up of the material. They may not be equally dense or the material would not be equally packed at all places, so that a screw, if it were to be driven into it, could well strike into a rather loose area and therefore the material would be unable to firmly grip the screw. Is that the idea?
A. I put it slightly differently. It could go into certain areas where it would have additional strength rather than say it would have less strength. But in the majority of locations where they would be driven, I do consider they would have very little strength because there would be so little thread engaged with the 2.1-mm-thick woven rovings.
Q. But in respect of the shear web point that we are looking at in this paragraph --
A. Then it would have additional strength if it were to strike a shear web.
Q. If it struck a shear web. But can you help us visualise this idea of a shear web? When you say "if it goes into a shear web", what do you mean?
THE CHAIRMAN: This is where the fibre is pointing vertically, not horizontally, is it not, and the chances of hitting it are pretty low?

Page 100

A. Well, simply put, yes, sir. In fact, "vertically" is not quite right, because the woven rovings have two dimensions to them. They are vertical and horizontal. That's probably a quibble. But there is just more material for the screw to engage with.
MR SHIEH: If it happens to strike into a shear web, do you say?
A. I think the odds of it striking a shear web are very small, but if it did, then it would have more screw threads engaged into the glass fibre as opposed to the resin itself, and therefore it would have greater pull-out strength.
Q. Could I now turn back to your main report and continue with your discussion about the seats. Page 418.
The discussion as to the characteristics of the woven rovings is at paragraph 43.
At paragraph 44 you discuss the actual deck construction, and you have a photograph, in fact two photographs showing the actual deck construction and also a sketch of the arrangement. Page 467. The top photograph there shows a hole. Can you explain to us the circumstances where you came across this hole? This is not a hole that you made, right? This is a hole that was there?
A. No, this was not a hole that I made. This was a hole

Page 101

pointed out to me by Senior Inspector Tang of the Marine Police. It was where a ventilation fitting had passed through the deck, and it was a hole that was manufactured during the construction of the vessel and would have had a circular vent fitting running through it, which has been displaced as a result of the accident.

In order to help understand it, there is a cable outside, a steel cable by the look of it, running outside, and there's also a red hose, which are irrelevant. What we're looking at is a circular section through the deck, and you can see some green colour, which is the foam, and some vertical white partitions which are in fact the shear webs. Then above and below that are the upper and lower surfaces of the deck, made out of 2.1-mm-thick woven rovings.

Q. So the white things we see are actually the shear webs?

A. Correct.

Q. The bottom sketch on the same page shows the layers of the wafer, if I can put it this way, viewed sideways?

A. Correct. Those screws are actually taken from the deck of Lamma IV, with the permission of the police. What I've not shown in the sketch is that there are some vinyl tiles sitting on the floor of --

Q. Above the woven rovings?

Page 102

A. Above the woven rovings, between the seat support and the woven rovings. But I had allowed for those in the thickness of the base plate of the seat support.

I don't know how thick they are, but I would guess about 1.2mm, 1.3 mm. So I think the amount of thread of the screws inside the plastic foam is very close to reality.

Q. Thank you.

A. The plastic foam itself is quite hard to describe. I'm not sure of the material of this particular one. It's probably a polyurethane foam or some other chemical composition. Typically -- well, on this particular boat, I did have a sample and it is easily crushed in your hand and made into a powder. I would describe it in layman's terms as having the strength of toast, and about similar strength characteristics when it has a screw put into it.

Q. Not very suitable for holding screws, or having a grip, having a firm grip?

A. In my opinion, no. But I did note the comment by Mr Lo that their practice was to put some bedding compound in, and if this was an epoxy type of material, that would have strengthened the hole where the screw was.

Q. Thank you. Paragraph 45, page 418:

"Most of the self-tapping screws which were used to attach the seats are 25 mm long, but were only embedded

Page 103

into woven rovings of 2.1 mm thickness. The remaining 20.9 mm of the screws were embedded in the soft foam core and the vinyl floor tiles, which provided no strength to the self-tapping screws."

I'm sure it's entirely my fault. Could you work out the math with me. Woven rovings of 2.1 mm thickness -- so it's 2.1 on top?

A. Yes. One has to allow for the thickness of the seat foundation as well in the mathematics --

Q. Yes.

A. -- which are 2 mm thick, approximately.

Q. Right. Thank you.

THE CHAIRMAN: That's with the vinyl?

A. I believe so, yes, sir.

THE CHAIRMAN: Thank you.

MR SHIEH: Thickness of the support?

A. No, that is not with the vinyl, Mr Chairman, I'm sorry. Because I say 20.9 were embedded in the soft foam core and the vinyl floor tiles.

Q. Thank you.

"It is an engineering 'rule of thumb' that self-tapping screws in metal should be sized such that the thickness of material equals at least two-and-a-half threads of a screw. The majority of screws used on Lamma IV did not even have one full thread of the screw

Page 104

engaged with the woven rovings, which would have needed to be at least 5 mm thick to comply with the 2.5 times 'rule of thumb'."

Because each thread was about, what, 2 mm?

A. If I can refer you to the sketch on page 467, at the bottom.

Q. Yes.

A. The thickness of the black line is approximately one thread.

Q. Right.

A. So, yes, you're correct: about 2 mm would be one thread. The thickness, the black line, being the woven rovings, is engaging with about one thread.

Q. "In any case, fibreglass construction cannot take a large screw load because it is not a homogeneous material and resin will not hold for a large load. Furthermore, screw holes in a fibreglass deck permit water on the deck to penetrate to the foam at the core which causes it to deteriorate with age, and which may have further contributed in a small way to the seat foundation failure."

When you say "causes it to deteriorate", you mean the foam?

A. I mean the foam, yes. And we did hear from Mr Lo that they were aware of it and had put some bedding compound

Page 105

in.
Q. Maybe epoxy?
A. Yes, maybe epoxy.
Q. "The seat connections on the upper deck should have been through-bolted, meaning a bolt should have been used that had a nut under the deck with a washer sufficiently large to spread the load so as not to crush the foam. The seat foundations on the lower deck did not fail, because all of them were screwed through the aluminium metal deck, with about 2.5 threads engaged. Viewed from below, as shown in appendix IV, item 12, the screws have remained undisturbed."
That is page 468.
This shows the seat foundation screws in the aluminium main deck, but this picture is taken from below the main deck, so from one of the compartments?
A. It's taken from below the main deck, and there were many such pairs of screws, as you might anticipate, under each of the seats. I looked at all of them and I could not tell that anything had happened up above. The paint was intact, there were no cracks or any other evidence of strain.
Q. But this is not an example of them being bolted; this is simply an example where the screws were driven in through a metal deck with 2.5 threads engaged?

Page 106

A. Yes, although oddly there were occasions where there were bolts through and I just assumed at some stage the seats had either been taken out or changed or moved. There were some nuts underneath as well. But I think it was just, as I say, because of some later change.
THE CHAIRMAN: Do you have a photograph of that, of the through-bolt going through the main deck aluminium floor?
A. I think not, Mr Chairman. I did take many pictures down below, so there may be a picture somewhere I can look for just in case I captured it.
THE CHAIRMAN: Thank you.
MR SHIEH: There is a picture of a bolted arrangement taken by Dr Cheng, but with the bolt being visible, viewed from the top, which may be one type of arrangement which would have ensured a firmer attachment. Could I ask you to look at page 390. Do you see that, Dr Armstrong?
A. I see that. I also saw that the seat which ran forward and aft on the centreline on the open deck, which remained attached or perhaps had been reattached, I'm not sure, but when I inspected the vessel, those five seats were attached to the deck and had remained, in my opinion, intact and had bolts fitted. I do have a picture of that.
THE CHAIRMAN: We had some evidence in relation to the seats

Page 107

in the middle of the open area deck, where I think it was the port aft fitting had lifted from the deck.
A. Yes.
THE CHAIRMAN: As had, I think, the middle of the attachments.
A. They are the seats I was referring to, yes.
THE CHAIRMAN: They remained attached in some places but not in all, is the point I'm making. Perhaps we could see those photographs.
MR SHIEH: Yes. Could I just have a moment to locate them.
THE CHAIRMAN: Yes, of course.
MR SHIEH: Page 398-2, produced by Dr Cheng during the course of his evidence.
The pictures at the top left-hand corner and the bottom right-hand corner show two mountings which have become detached. They form part of that pair of long white benches on the weather deck. Is that the mountings that you observed, in the picture?
A. Yes, the benches seen in the bottom left of the screen are the benches I was referring to. They are not shown on the General Arrangement plan in that location, so I presume they were moved at some stage. I notice that at least one of the foundations, and it could have been the one shown in the right-hand photograph on the left-hand side, had bolts, through-deck bolts on it, and

Page 108

were still intact. Although it appears to have lifted in that picture.
I do have the photographs with me, and maybe at a suitable interval I can try and find those.
Q. You do not have it now nearby, but you can locate them?
A. It is on a computer.
Q. Right. But let's address this question of the screws and the bolts in a bit greater detail, because you mentioned -- first of all, you produced the photographs at page 468 as being an example where screws were screwed through aluminium metal deck with 2.5 threads engaged, which did not fail. Now, this mechanism did not involve the using of bolts; this simply utilises the thickness of the metal through which the screw was driven. Correct?
A. Correct.
Q. And because the surface that the screw was driven through is not the structure that we have seen with foam in the middle, but is actually metal --
A. Correct.
Q. -- that's the 2.5-thread point, this enabled a firm grip on the screw?
A. Correct.
THE CHAIRMAN: What is the thickness of the metal deck that we're looking at there?

Page 109

A. I believe it's 4 mm, Mr Chairman.
MR SHIEH: Now, that is the metal -- let me see. That is what deck? That is the lower deck?
A. That is the lower deck, yes. The main deck.
Q. Which is called the main deck?
A. Yes.
Q. Right. And the screws penetrated the metal and you had to go to one of the compartments to take a picture looking upwards?
A. Correct. That was inside the tank room, I think.
Q. Right. Dr Cheng's photograph of the bolt at page 390 shows another way whereby seats could be securely mounted. You saw some examples of this manner of securing the seats during your visit?
A. I saw one.
Q. You saw one?
A. I saw one.
Q. According to Dr Cheng, this was taken on the main deck cabin. But I think you have different terminologies, because what Dr Cheng referred to as the main deck I believe means the upper deck; right?
THE CHAIRMAN: No, I think this is the floor of the main deck, is what Dr Cheng was telling us. So he was looking down onto the floor of the main deck.
MR SHIEH: Yes.

Page 110

THE CHAIRMAN: The photograph we've just looked at was a photograph from underneath, looking up.
MR SHIEH: Yes.
THE CHAIRMAN: If we call it the floor, perhaps that might work.
MR SHIEH: Yes, but I thought there was a point Dr Cheng mentioned, that he perhaps might have used rather different terminology in describing this deck.
But this way of attaching the seats would require driving in the screw from below the deck and putting the bolt from above?
A. I think it will be more likely to be done the other way: putting the bolt in from the top and the nut underneath.
Q. Oh, right.
THE CHAIRMAN: So this is the bolt head that we're looking at?
A. Yes.
THE CHAIRMAN: The nut and washer would be down beneath?
A. Underneath, yes.
MR SHIEH: Right. Thank you.
So that is the other way of ensuring a firm grip?
A. (Witness nods).
Q. But the detached seats, in your opinion, would not have been secured by either of these methods?
A. When you say "either of these methods" --

Page 111

Q. Either with a bolt, or being tapped in, or being penetrated with at least 2.5 threads.
A. Correct.
Q. Thank you.
Paragraph 47, you refer to the 1995 Instructions which said:
"Where seats are provided for passengers, their form, design and attachments ... should be adequate ..."
Then you make the point that it's all up to the experience of the individual inspector or surveyor.
Paragraph 48, you say:
"It is noted from the annual survey items that the seats generally appear to have performed adequately since 1995. There is evidence that some of the seat foundations became loose in service, and photographs taken after the accident of one seat foundation suggest that at one stage some of the seat screws have pulled out and could not be replaced, and consequently a small steel plate was connected to the deck with four new screws and to which the seat was then attached."
Could I ask you to look at police album VIII, page 421, to see whether or not that is what you have in mind.
Is that what you have in mind, Dr Armstrong?
A. I cannot say that with certainty because I noticed the

Page 112

four holes and I cannot say that that was the same four holes that is shown in this particular drawing.
I understand from what I've heard recently and read in the transcripts that this may have been the plate in which some pop rivets were used.
THE CHAIRMAN: That's what Dr Cheng told us.
A. I only saw the four holes in the deck. I think it's quite an interesting photograph, because this actually uses four screws which are generally associated with roofing and are a much finer thread. It's possible that if this type of screw had been used in fibreglass, then there would have been 2.5 threads in contact. But of course, these screws were not generally used. So I cannot say with certainty it's the same four holes.
MR SHIEH: But further down at the same paragraph, you mention:
"In other examples the screws appear to have pulled out at some stage and have been put back very close to the previous hole."
Could I have police album VII, page 357. Is that the feature?
A. That's the exact photograph I had in mind, yes.
Q. Thank you. Now, there have been suggestions that the detachment of the seats on the Lamma IV could well have been related to the deceleration of the vessel. What

Page 113

would you say about that suggestion?
A. The deceleration during the collision?
Q. Yes.
A. I did do a quick calculation when that was raised, and according to my calculation, the deceleration averaged something around about 0.2 G. Of course it would have been variable. I think there would have been an initial higher impact deceleration. But it would have been --
Q. Sorry, when you say "0.2 G", "G" would be --
A. Acceleration due to gravity.
Q. 9.8?
A. 9.8065, yes.
Q. Gravitational acceleration?
A. Yes. 0.2 G. There would have been an impact load for a very short duration higher than that, but it would not have affected the seats.
Q. You mentioned that you actually made a calculation at the time when the matter was raised.
A. (Witness nods).
Q. I believe it was actually raised during the questioning, I believe, of Dr Cheng.
A. You may well be right, yes.
Q. Is it possible for you to write out the calculation for us?
A. Yes, of course it is possible.

Page 114

Q. Will it take a long time, or is it possible that you actually write it out --
A. I've got the original somewhere.
Q. Right. I suppose those at the back may well help dig out the piece of paper.
A. It may well be at Lo & Lo. I also calculated the accelerations owing to operation in a seaway, and noted that 0.2, 0.25 G would be typical of the loads you would experience in a 1.5-metre sea when rolling. So my conclusion was that it was not an abnormal load for the seats, if one can assume a 1.2-metre sea occurs in Hong Kong, and I think it does in places because of the wash of vessels.
Q. Therefore your conclusion was that the force caused by either the acceleration or the deceleration would not have had any significant contribution?
A. That was my conclusion, that it was not an abnormal load.
Q. At page 419, paragraph 48, after referring to the photograph at page 357, you continued to say:
"It was only in the abnormal condition where the vessel had excessive stern trim and the weight of the seated person generated an abnormal tipping force that the foundations finally failed. Nevertheless the arrangement of screwing seats into GRP foam sandwich in

Page 115

my opinion could not be considered as adequate."
So that still represents your conclusion? You've heard Dr Cheng give evidence, and you have seen --
A. I still stand by that.
Q. -- the result of his test about the amount of force that was needed. Could I remind you of your first supplemental report, where you dealt with that. The same bundle, page 475. This is where you discussed the shear webs. It is in the wider context of commenting on Dr Cheng's experiment. So you would confirm that view?
A. I'm still of the same view as I was when I wrote the first report.
Q. We now move on to deal with the question of the applicable regulations at the time of construction of Lamma IV. In a way, one can say it's either a question of law, whether or not the statute, properly understood, applied to the Lamma IV; or it could well be a matter of fact, namely which set of rules Mardep chose in fact to apply.
A. (Witness nods).
Q. But I would simply wish to get your opinion as an expert shipbuilder to look at the text of the relevant regulations and see what would have been your reaction upon seeing the wording of those texts, which may be of assistance to the Commission.

Page 116

A. Right.
Q. Paragraph 49:
"Lamma IV was constructed in 1995. According to the evidence available to me, the keel was laid on 30 June 1995, and it is the date of keel-laying that is used in Hong Kong, as elsewhere, for the purposes of defining the application of regulations."
Over the page:
"The Hong Kong Marine Department surveyors and inspectors used guidance documents published by the Director of Marine for the purposes of survey. The document titled 'Instructions for the Survey of Class I and Class 2 Launches and Ferry Vessels ...' contain survey requirements for 'new vessels' where new vessels are defined as, inter alia, '(a) a vessel the keel of which is laid ... on or after 1 January 1995'. My conclusion is that these instructions were the correct ones to be used for Lamma IV, for which the keel had been laid in June 1995."
So your impression or your own interpretation, looking at the text of the rule, is that by force of the text of these instructions, they apply to ships the keel of which was laid on or after 1 January 1995, which was the case of Lamma IV?
A. That was my personal interpretation, lacking any further

Page 117

evidence, yes.
THE CHAIRMAN: Could we have that definition on the screen. Page 1817.
MR SHIEH: Yes. It's marine bundle 8.
"'New vessel' means
(a) a vessel the keel of which is laid, or which is at a similar stage of construction ... on or after 1 January 1995."
That's the definition you had in mind, Dr Armstrong?
A. Yes.
Q. Thank you. Then in the next paragraph, you pointed out:
"Prior to 1995, there were guidance documents titled 'Instructions for the Survey of Launches ..."
That's the Blue Book; correct?
A. Correct.
Q. You say:
"At the time of construction of Lamma IV there appears to be some confusion as to which of the two books of Instructions were applicable, probably because the surveyors and inspectors were familiar with the Blue Book, but the new Instructions were less familiar. At the time there would also have been craft building to both sets of instructions because their respective dates of keel-laying fell either side of 1 January 1995."
Could I show you the stance taken by the Marine

Page 118

Department. I think it is actually covered by a host of different Mardep witnesses, but the witness statement I am going to show you comes from Mr Wong Wing-chuen, who actually has not testified, but it just comes in handy because I don't believe there is any material difference between Mr Wong's explanation and other Mardep witnesses. It is marine bundle 11, page 3932. The bottom of the page, paragraph 16:
"At that time there were statutory requirements to regulate the construction and survey of ocean-going vessels set out in ... (Cap 369AM), but no statutory requirements had been prescribed for the construction and survey of local vessels.
Instead, guidelines as to Mardep's practice concerning local vessels were set out in a booklet called 'Instructions for the Survey of Launches and Ferry Vessels' (which were updated from time to time), commonly referred to as the 'Blue Book' and its subsequent replacement [being the 1995 Instructions] ..."
Then paragraph 18:
"The survey of Lamma IV was conducted by reference to the Blue Book, since the 1995 Instructions only came into effect on 19 January 1996, by which lime Lamma IV ... had already been keel laid (in June 1995).

Page 119

There is now produced and shown to me marked 'WCW-1' copy of Marine Department Notice No. 7 of 1996 issued on 19 January 1996, which announced the coming into effect of the 1995 Instructions. See also the exchange between the shipbuilder, Cheoy Lee and Mardep ... and Mardep's file note ... which show that the Blue Book as opposed to the 1995 Instructions applied to the approval and initial survey of Lamma IV."
Marine Department Notice No. 7 is at WCW-1, which is in the same bundle, page 3947.
"Owners, operators and shipbuilders of launches and ferry vessels are hereby informed that certain chapters of the existing Instructions have been amended and updated ... separate standard for vessels carrying not more than 60 passengers now termed as class II vessels ..."
It sets out the various chapters.
"The contents of chapter V 'Fire-Fighting Appliances' and chapter VI ... have not been changed but are presented in table form.
3. Chapter X 'Local Certificate of Competency' is amended ..."
Chapter X, certificate of competency, and then it goes on.
Paragraph 6:

Page 120

"The amended Instructions, endorsed by the Provisional Local Vessel Advisory Committee, will supersede the existing Instructions and will come into effect from the date of issue of this Notice."
Being January 1996.
So this is what Mardep says to the way it handled things. It issued a notice in January, and they say the 1995 Instructions came into effect in the sense of Mardep beginning to apply them, as from January 1996.
A. (Witness nods).
Q. That's the way Mardep puts it. Now, as an expert shipbuilder, obviously you have to deal with interpretation of regulations. In an ordinary court of law, this may or may not be material, but since we are an inquiry I simply wish to have your opinion on this point. The text of the 1995 Instructions in terms says it applies to vessels keel laid -- you know, "new vessel" definition -- after 30 June 1995. Do you remember that definition?
A. Yes, sir.
Q. So in terms, the applicability depends on the keel-laid date; correct?
A. Correct.
Q. So what do you say, what is your comment about what I would call a conundrum? Mardep says 1 January 1996,

Page 121

come into operation; but somebody who looks at the rule book in, let's say, January 1996 would see the definition of "new vessel" being keel laid after 30 June.

If you were the person administering these rules, how would you have dealt with a vessel like the Lamma IV, keel laid after 30 June 1995 but before what's called the date of this notice, where under Mardep's understanding the instructions came into effect?

A. I understand your dilemma, Mr Shieh. It's not clear. Nevertheless, no matter what date the letter was issued saying that these new instructions are in force, the new instructions do make it quite clear that a new vessel, for which there are regulations under the chapter of "new vessel", is one that is built after 1 January 1995.

So my initial reaction would be, this is somewhat retrospective legislation that requires me to comply with something that was written previously. By and large IMO do not grandfather their clauses so that they bring in regulations for existing ships or ones for which the keel had been laid previously. It does happen, but it's a little unusual.

I think the reaction would normally be to make contact with the Marine Department for clarification. But the way that I read this when I first saw it, and

Page 122

before the statement from Mr Wong, was that it's quite clear in my mind that even though it had come into effect on 19 January 1996, the definition was still that a new vessel was one built after 1 January 1995. So I would have to comply with that.

Q. Could I put it this way. You mention retroactive legislation, but obviously these are not laws: these simply represent guidelines which Mardep, in their wisdom, decided to impose upon let's say their staff in inspecting vessels and in ensuring vessel safety.

As one would expect, as rules and guidelines mature, they should represent an improvement over a previous set of instructions. Would you agree that by and large, that would be the way in which guidelines and instructions gradually develop?

A. Indeed.

Q. So one might be forgiven for proceeding on the basis, rather than to be backward-looking and say, "Ah, if there's a doubt, let's keep to the old regime. Here we have a new set of rules, improved set of rules which in terms define 'new vessel' as being a vessel keel laid after 30 June. So in case of doubt, apply what is supposed to be the more mature set of rules". Is there anything to be said of that sort of thinking?

A. I think a professional approach like that is something

Page 123

many people would do, yes, and certainly something that I would look very closely at if I was involved in designing a vessel.

Q. But in any event, you make the point at paragraph 53:

"Essentially it does not matter too much as to which were the correct regulations, because it is clear that both sets of Instructions were guidance documents for the surveyor and were not mandatory, with much being left up to the discretion of the surveyor or inspector ... Also, both sets of instructions are reasonably similar."

Of course, we are seen specific aspects where the 1995 Instructions were more specific, in particular the bit about construction, with the minimum requirement of 5 mm.

But in the table below, in paragraph 54, you set out the main requirements by way of comparison; correct?

A. Correct.

Q. 3.2, for example -- that's the point we have just touched on -- "Minimum thickness of shell plating, 5 mm"; whereas under the Blue Book, "No requirement". But in terms of watertight bulkhead, collision bulkhead forward, both sets of rules required that; correct?

A. Correct.

Q. "Watertight bulkheads at each end of engine room", both

Page 124

sets of rules required that; correct?

A. Correct.

Q. "Peak bulkheads at both ends", maximum distance 40 per cent ship length; both sets have that?

A. Yes.

Q. "Any access opening in a watertight bulkhead is to have an efficient watertight closing appliance."

Both sets have it; correct?

A. Correct.

Q. And the reference to regulation 5 in the Blue Book has been corrected to regulation 6 in the 1995 Instructions. I shouldn't say "corrected" because I think the underlying regulations are different. But anyway, they both refer to the equivalent of the same regulation.

A. Correct, yes.

Q. Then "stability information booklets ... shall be submitted for approval" under 1995 Instructions, whereas under the Blue Book, "No requirement for approval".

Then over the page, again, in particular about seats, "Where seats are provided for, their ... attachments to the deck should be adequate for their intended service", that's 1995, but then for Blue Book it says "properly secured".

Do you see any material difference between these two in terms of seats? The requirement of "attachments ...

Page 125

should be adequate" on the one hand, and "properly secured" on the other?
A. No, I see no material difference.
Q. Thank you. Then further down this section, you began discussing this question of 0.1L, schedule 3 and all that, which we touched on yesterday, which I will not revisit for the time being.
I now come to the next main heading, "Openings in the aft peak bulkhead".
Dr Armstrong, I have now with me a typed-up note -- in fact it probably emanates from you -- setting out the result of your calculation which those at Lo & Lo have identified. In fact I was looking at a copy myself, except that it actually refers to your calculation. Perhaps your manuscript calculation is not there, but your subsequent description of the result of your calculation is depicted in this note which you have typed up?
A. Correct.
Q. Before I come to the openings in the aft peak bulkhead, this document has been located at an opportune moment for me to ask you to perhaps explain the calculations that you have done.
This goes to the issue about the effect of deceleration on the detachment of the seats,

Page 126

Mr Chairman.
THE CHAIRMAN: Yes.
MR SHIEH: Perhaps, Dr Armstrong, you can talk us through this, about this being a simple calculation based on velocity before and velocity afterwards?
A. Surely. It's based on a very simple formulation, that the velocity after an event is equal to the velocity before an event, plus the acceleration times the distance travelled. The formulation that I used is actually V squared equals U squared plus 2FS, which means the velocity before the acceleration -- I'll start again.
The velocity after the deceleration is zero, having come to a stop, is equal to the velocity beforehand, which I assume to be 11 knots, times 2 times the deceleration times the distance travelled. I was able to measure the distance travelled from the damage on Lamma IV and by putting 11 knots, 0 knots, and the distance travelled, I was able to work out what the deceleration was, which was, on average, 0.24 G.
Q. So you say it was nothing exceptional?
Could you give us the numerical value "G" again?
A. 9.8065 metres per second squared. Roughly 32 feet per second squared.
Q. Thank you.

Page 127

We now come to openings of the aft peak bulkhead, page 425 of the expert bundle.
You have expressed your view that the vessel sank in the way it did because of a combination of various things, first of all the hole, the gash and the hole in the engine room and the hole in the tank room, but more importantly the absence of a watertight door between the tank room and the steering gear compartment.
A. Yes, all of those were factors.
Q. Had there been a watertight door at frame 1/2, the vessel would not have sunk in the way it did; it would actually have remained afloat in the manner that you have depicted, I think in your first supplemental report. I'm sorry, I've lost the reference. Could you just bear with me, Dr Armstrong.
Page 463. This shows the effect of the watertight door between the tank room and the steering gear compartment in the middle of that page.
A. Correct. It would have stayed afloat, but fairly marginal.
Q. Yes. This section, page 425 of your first report, addresses the issue of the openings in the aft peak bulkhead.
"The drawings provided by the shipbuilder showing the ships structure for Lamma IV were originally

Page 128

submitted to the Hong Kong Marine Department by letter of 5 January 1995. There were four structural drawings, which have dates in December 1994 ... Two of these drawings were relevant to the aft peak bulkhead (frame 1/2)."
Could we turn up marine bundle 2, which is where we found the various drawings.
Profile and Deck is where you first referred to, footnote 76. Could I ask you to look at bundle 2192. That's the one you have in mind, Dr Armstrong? Profile and Deck?
THE CHAIRMAN: The page number again?
MR SHIEH: I'm sorry. My mistake. It's page 204.
THE CHAIRMAN: Yes. They begin at page 172, don't they, and then we go to pages 202, 203, 204 and 205. At all events, you want page 202?
MR SHIEH: Yes, because that's Profile and Deck.
MR BERESFORD: That's page 204.
MR SHIEH: I'm sorry, page 204. Profile and Deck.
THE CHAIRMAN: Would it help you, Dr Armstrong, to have the Cheoy Lee original version, the big ones?
A. No, I think I can remember, thank you very much.
THE CHAIRMAN: You're happy with that.
MR SHIEH: You say:
"[This] shows four views of the proposed structure.

Page 129

The top view (side shell profile) shows the words 'WT BHD' ... The second view (centreline profile) shows the words 'Corrugated WT BHD'... the bottom view (bottom plan) shows 'WT BHD' at frame 1/2. The appropriate line representing the bulkhead is also shown on all four views. The term WT is generally understood to mean 'Water Tight'. It is obvious that the bulkhead at frame 1/2 was intended to be watertight, as was required by the Regulations and Instructions ..."

So you place emphasis on the reference to "WT"; correct?

A. Correct.

Q. You say:

"The appropriate line representing the bulkhead is also shown on all four views."

In your experience, solid lines denote a watertight bulkhead?

A. Generally, yes. Sometimes it may be shown as in the upper view, the profile, as a more solid dotted line.

Q. Yes.

A. Indeed there is a convention with a solid dotted line with two -- with a dotted line with two solid lines on either side, but that is not shown here.

Q. Yes. We have looked at these drawings at some length, so I'm not going to ask you to identify the individual

Page 130

lines representing the bulkheads. We are reasonably familiar with that.

Over the page, you refer to drawing 391-5. I think that's Sections and Bulkheads, which is page 205.

The relevant one is the one at the bottom left-hand corner. You say:

"It is a solid corrugated bulkhead with an opening located ... and marked 'Access Opening 1,200 x 600 W/50R at Corner (Port Only)."

That's the drawing you intended to refer to?

A. Yes, correct.

Q. "To those knowledgeable in the art, this means that there is an opening in the otherwise solid bulkhead, located on the port side of the vessel, with a size of 1,200 mm high and with a width of 600 mm. The corners of the opening are rounded with a 50 mm radius. Dimensions are also given for the exact location of this opening both vertically and horizontally. Someone at some stage has marked both of the above structural drawings as 'superseded'."

Dr Armstrong, the reason why the word "superseded" does not appear in this version drawings is because -- you know there has been a series of these drawings and the version that you made express reference to in your report is actually at a different page, at page 193.

Page 131

A. Correct, yes.

Q. That one has a handwritten notation of "superseded". But the one that we have looked at at page 205 has a Marine Department "approval" chop, 3 May.

A. Correct. There is also one other occurrence on this drawing which I should draw your attention to, which is in the top right-hand corner, where it also refers to watertight bulkhead.

Q. Section B-B.

A. Section B-B.

Q. Yes. Which expressly refers to "WT Bulkhead"?

A. Correct.

Q. Thank you. Then at paragraph 63:

"On 10 March 1995, the shipbuilder sent a letter to Mardep seeking expedited approval of the drawings sent on 5 January 1995, and in an effort to speed up approval also enclosed copies of the drawings for a sister ship which had been built in China some 3 years previously."

That letter that you referred to is marine bundle 2, page 195, which is the sister ship letter, enclosing some drawings of the sister ship. 10 March 1995.

I think for present purposes, in this paragraph, I don't think I need to actually take you to those parts of the sister ship drawing which are the same as the drawings for Lamma IV, but you have identified one part

Page 132

where they are not the same, and that is the fifth line from the bottom of this paragraph:

"The sectional view at frame 1/2, shown on the drawing called Sections and Bulkheads shows the same opening details as the previous submitted drawing but the words 'Access Opening' have been replaced with the words "WT Door'. All of the drawings for the sister ship have been marked as 'For record purposes only' and there is no evidence that I can see that they were used for approval purposes for Lamma IV."

The relevant drawing is page 198. Dr Armstrong, this is Sections and Bulkheads drawing for the sister ship, which is for material purposes the same as the Sections and Bulkheads drawings of the Lamma IV, save and except the bottom left-hand corner; correct?

A. Correct.

Q. If we home in and close up, instead of "access opening" it says "watertight door".

At the bottom, paragraph 64:

"On 21 March 1995, the builder submitted a new set of drawings with the comment that they have discovered and corrected some minor errors. These are the drawings which were used for approval, and the file copies were accordingly marked as 'approved'."

This set of drawings is actually a set of drawings

Page 133

that I've asked you to look at earlier, because I've skipped over the earlier set of drawings that you referred to. But I think for material purposes, the point sought to be illustrated is the same, namely the consistent references to "watertight bulkheads".
A. Mr Shieh, could I draw your attention to the drawing of the sister ship that we've just had?
Q. Yes. Page 198. Which particular --
A. The bottom left diagram. It actually says "Bulkhead at frame 1.5", rather than frame 1/2.
Q. Yes.
A. However, when I read that I assumed that was a typographical error because in the Profile and Deck, it's still shown as frame 1/2.
Q. Profile and Deck on the previous page at 197?
A. 197, perhaps.
Q. Yes.
A. I believe the reason for this is that the frame numbering system was different; that instead of starting with zero partway forward, they actually started with zero behind the boat. So also the boat was the same, the frame numbering system was different.
I think you can see on that drawing there's a zero on the very left-hand side of the drawing.
Q. Are you referring to the Profile and Deck?

Page 134

A. I'm referring to the Profile and Deck, and we're looking at the deck on the screen at the moment. There is a zero on the very left-hand side.
A. Yes. On Lamma IV, the zero is about 1 metre further forward than that, or a bit more than 1 metre. So I think the frame numbering designation changed between the sister ship and this ship, Lamma IV. I just wanted to clarify that calling it "bulkhead 1.5" did not actually make any substantial difference; it was just the name that was different.
Q. But if you look at page 197, which is Profile and Deck for the sister ship, if you look at the centreline profile, for example, on the far left there is a zero --
A. Yes. A good example. And the bulkhead is at 1.5.
Q. Yes.
A. But on Lamma IV, if you look carefully, the numbers have all been moved along one.
Q. Yes. So it's the same position, except that it is called 1.5 here?
A. Correct.
Q. Thank you.
A. I only mention that in case somebody thinks the bulkhead has been moved because it says 1.5.
Q. In case someone thinks it has been moved further to the fore?

Page 135

A. Yes. It has not been moved.
Q. Thank you.
Coming back to paragraph 64, you drew attention to several drawings, but the notations there are the same as the drawings that you had alluded to at paragraph 62 and therefore I'm not going to compare these various drawings. In fact, I have asked you to look at this set of approved drawings when I took you to the underlying documents.
But in the middle of page 427, you say:
"The use of the words 'Access Opening' is not helpful, as it does not signify the presence or absence of a watertight door. It is noted that the Instructions for Survey states 'where any access opening is fitted in a watertight bulkhead, it is to have an efficient closing appliance'."
In fact this feature is common between the Blue Book and the 1995 Instructions?
A. It is, yes.
Q. So for this, it doesn't actually matter which is the applicable set of instructions; correct?
A. Correct.
THE CHAIRMAN: And what is that provision in the 1995 rules?
MR SHIEH: Mr Chairman, it is at page 421 of the expert bundle, where Dr Armstrong helpfully set out the

Page 136

paragraph number in the comparative table.
A. Chapter II, 5.4.
Q. In 1995, it's chapter II, 5.4; in the Blue Book, it's chapter 12(v).
THE CHAIRMAN: Thank you.
MR SHIEH: I'll read further from the middle of page 427:
"This would suggest to me that the use of the term 'access opening' on a structural drawing of a watertight bulkhead is valid terminology, at least with regard to use with the Instructions to which it was being built. Under those same Instructions it still needs to have an efficient watertight closing appliance."
As I understand it, Dr Armstrong, what you are really saying is the drawings consistently refer to the existence of a watertight bulkhead at frame 1/2, but in the one single drawing -- I think it's Sections and Bulkheads drawing, bottom left-hand corner -- there is that rectangle which says "access opening", but read in context you would rationalise all the drawings as meaning that bulkhead is intended to be a watertight bulkhead, but there is to be an access opening there. But with this access opening, what you then do is to comply with the requirements of the Blue Book or the 1995 Instructions to have an efficient closing appliance, so that it can both have an access opening,

Page 137

and yet, on the other hand, be watertight, if you want it to be watertight?
A. That is correct. All the information I had available to me suggested it should have been watertight. All of the structural drawings, backed up by the damage stability book, which is a de facto watertight subdivision approach requiring or showing that there were watertight bulkheads there, as well as the specification which talked about five watertight bulkheads at six compartments, all of the information I had available to me indicated that those bulkheads would be watertight. The fact that there was an access opening was, I thought, satisfactory because of the clause in the instructions which said that access openings had to have a watertight door.
Q. Thank you. At paragraph 65, you refer to the actual access opening. I don't think it is controversial, because you describe in some detail what you have seen. I think it is now accepted on all fronts that in fact the access opening had no efficient closing appliance; there simply was no door. You say over the page at paragraph 66:
"It is possible that the access opening and door could have been moved at some stage, although there is no obvious evidence of this."

Page 138

But, Dr Armstrong, I think hearing the matter in this hearing, you have not heard any evidence that there ever was affixed any door to that opening?
A. Yes, I agree.
THE CHAIRMAN: If someone had decided after the drawings had been drawn that they weren't going to put a watertight door there, what ought to have been done as far as the drawings were concerned?
A. What ought to have been done? Insofar as the drawings are approved by Marine Department, certainly the Marine Department should have been made aware of such a major change. That would have resulted in either agreement or disagreement. If there was disagreement, it would have then been necessary to modify the vessel in some way. I believe fitting a watertight door could have been done relatively easily, and I understand at a reasonable cost.
We have heard that the vessel as built did meet the -- or appears to have met the watertight subdivision requirements. It is unfortunate, of course, that later on when weight was added that it did not. I can see that there could have been an argument in 1995 when the vessel was built that because we didn't have a door, some arrangement was made with the surveyors that it wasn't necessary, but I have no evidence of that in the

Page 139

information put in front of me.
THE CHAIRMAN: But if it had been determined to proceed without a door, should any revised drawing have been sought or the drawing amended to show it had been changed?
A. It is standard practice in the industry in which I'm involved to produce what are called as-built drawings, but maybe not for a small vessel that was being used locally. But certainly in all the contracts I've been involved in, they've required as-built drawings so that the owner knows exactly what he has or has not got. It's usually specified in the contract, and I'm unaware of this contract giving such detail.
MR SHIEH: We have heard evidence that the cost of actually adding a door is only going to be in the region of a few thousand dollars. You are aware of that evidence?
A. Yes, I was aware of that.
Q. I'm not sure whether we have evidence about the cost implications of various things, or whether or not that has actually been taken into account, but what would have been your estimate as to the relative cost of actually amending the drawings or producing a set of as-built drawings showing actually no door? Would you be able to comment on that?
A. I cannot comment on the cost of buying in a door.

Page 140

I would have thought that was a reasonably priced item, and I've no reason to disagree with the figure put forward by Mr Lo.
The changes to the vessel would have been a small change to the depth of the flat bar running around the opening, to make it a slightly bigger structure to avoid the corrugations, because the opening was fitted in a corrugated bulkhead, so you needed to get clear of those corrugations.
I think the minimal cost -- changing the drawings, almost minimal because all you need to do is rub out "access opening" and type in "watertight door", so nugatory there, I think.
Q. No, but what if the idea was to say, "We are now determined not to have a watertight door", and therefore the plans needed to be redrawn to actually make it explicitly clear that it's not watertight?
THE CHAIRMAN: Not a watertight bulkhead now.
MR SHIEH: Not a watertight bulkhead.
Would the costs have been equally minimal in that case?
A. Equally minimal.
Q. Dr Armstrong, in respect of the hypothetical question, because the evidence we have heard is that at the time when the vessel was "passed" -- because obviously when

Page 141

Lamma IV was being constructed, inspections and surveys were done stage by stage. You were here or at least you have seen the transcript of the various Mardep inspectors testifying.

A. Yes.

Q. We have heard that for various reasons, the fact that there was no watertight door at frame 1/2 has not been spotted and correlated with the various drawings that we have seen, which would have prompted the hypothetical question of, what if the point had indeed been spotted at the material time during one of the several opportunities when the lack of a watertight door might or could have been spotted? What ought Mardep to have done or what would Mardep have done?

A. I'm not sure I can answer that question on behalf of Mardep, Mr Shieh.

Q. I know. But could I ask you to comment on certain evidence that has been given by Mardep. Could I ask you to look at the evidence of Wong Chi-kin. Marine bundle 11, page 3880.

THE CHAIRMAN: You're looking at the witness statement, are you?

MR SHIEH: The witness statement, yes.

"Effect of the Approved Plans".

This is Wong Chi-kin, Marine Department inspector,

Page 142

who actually approved the Profile and Deck and the Sections and Bulkheads drawings. Paragraph 49 explains his thinking as a result of what he now knows to be the case:

"In respect of Lamma IV, I approved the plans entitled 'Profile & Deck', 'Sections & Bulkheads' ... on 3 May 1995 ..."

Dr Armstrong, we've seen those drawings and we've actually seen the chop, "3 May 1995".

"... and the plans entitled 'Shell Expansion' and 'Midship Section' on 17 May 1995 ... The owner/builder of vessel is expected to build the vessel in accordance with the approved plans. However, this does not mean that if there is any aspect of the vessel which departs from the approved plans, a certificate of survey must necessarily be denied."

Whether any departure from the approved plans would be accepted by the Section would depend on the importance of the particular aspect of the vessel which does not adhere to the plans. For example, if a bulkhead which is shown to be watertight on the approved plans turns out not to be watertight, such alteration will be disallowed unless the absence of the watertight nature of the bulkhead would in no way compromise the safety of the vessel. This could be determined by

Page 143

examining the shipyard's submission of its calculation of floodable length or damage stability.

In the present case, I understand that Cheoy Lee did not install a watertight door at the access opening in frame 1/2. This was a departure from the approved plans. If I had been involved in the decision whether or not to issue a certificate of survey, I would certainly have examined the 'Damage Stability Information' booklet submitted initially by Cheoy Lee on 6 March 1996. If, after examining such calculation, I came to the view that the safety of the vessel would not be jeopardised, I would consider issuing such certificate notwithstanding the departure from the approved plans.

At around the time when the booklet was submitted by Cheoy Lee, I was being transferred out of Section to the Government New Construction Section located at the Government Dockyard. The responsibility for examining the booklet therefore lay with my successor, Mr Leung Wai-hok, who was also a surveyor of ships.

I now have an opportunity to examine the calculation set out in the booklet. As stated in paragraph 47 above, I agree with Dr Armstrong both the steering gear compartment and the tank room should be investigated as being flooded. In other words, the calculation should

Page 144

have been undertaken on the basis that the steering gear and the tank room in fact constituted one compartment instead of two. This is because, as I have explained above, since the length of the former was less than 0.1L, the bulkhead between the two compartments at frame 1/2 should not be regarded as forming part of the subdivision of Lamma IV.

However, as a matter of fact, the booklet did not contain such calculation. Faced with such a situation, a surveyor of ships could respond in a number of ways. He could have asked the shipbuilder to resubmit a revised booklet ... Alternatively, he could instruct a ship inspector working under him to perform such calculation, or he might make a professional judgment on the basis of the information already contained in the booklet to determine whether it was likely that the calculation of damage stability based on a flooding of both compartments would or would not meet the criteria for attaining damage stability.

I can illustrate the last point in this way. In respect of Lamma IV, it is possible to accurately estimate the effect of flooding of both the steering gear compartment and the tank room without performing a full calculation. This is because if I compared the volume of the adjacent engine room with the combined

Page 145

volume of the steering gear compartment and tank room, I would find that the combined volume is smaller than the volume of the engine room. As the booklet shows, the criteria for attaining damage stability would be complied with if the engine room were flooded. It could, based on the surveyor's professional judgment and experiences, be reasonably concluded that such criteria would likewise be complied with if the steering gear compartment and tank room ... were both flooded.

Accordingly, if I had been remained in the position of surveyor of ships ... I might well have decided to issue a certificate of survey for this vessel even though the booklet did not contain the calculation based on the combined volume in accordance with the one-compartment flooding standard as I explained above."

Dr Armstrong, have you seen this evidence before?

A. I have read this before, yes.

Q. You have read this before. But now your memory has been refreshed.

A. Yes. Thank you.

Q. I understand that during the hearing, a point has arisen as to whether or not this -- which is effectively an ex post facto explanation of how this witness would have dealt with the matter had it been the subject of a discussion --

Page 146

THE CHAIRMAN: That was established in his oral testimony. This is his pre-oral testimony statement, but this was expanded in oral testimony.

MR SHIEH: Yes.

Yes, because I understand that there has been a certain exchange during the course of this witness's testimony as to whether or not this evidence is to be received. But be that as it may, because the purpose of my reading it out is actually for Dr Armstrong to actually comment on an ex post facto argument of this nature. So probably we don't have to revisit whether or not this evidence has formally been received, because Mr Beresford seems to recall that this particular part of Wong Chi-kin's evidence might not have been received by the Commission.

THE CHAIRMAN: I don't recall it in those terms, but as I recall the evidence, it was apparent that the witness was addressing things with the benefit of hindsight.

MR SHIEH: Correct. Ex post facto rationalisation as to what he would have done.

THE CHAIRMAN: Yes. It's certainly relevant for Dr Armstrong to tell us what should have been done if this had been discovered.

MR SHIEH: Or to comment on this line of thinking.

THE CHAIRMAN: Yes.

Page 147

MR SHIEH: That's the reason I'm reading it to Dr Armstrong.

THE CHAIRMAN: Yes.

MR SHIEH: Dr Armstrong, you have seen this witness. He was responsible for approving the plans. He was not responsible for ultimately signing off the ship, if I can put it this way, because Mr Leung Wai-hok was responsible for doing that. He gave his explanation as to what he might well have done had he noticed that the actual ship as built departed from the drawings that he had approved. Particularly at paragraph 56, he referred to this thinking, that because the combined volume of steering gear compartment and tank compartment, which is very near the aft, was smaller than the volume of the engine room. So he reasoned, if the vessel could pass the test for engine room flooding, which is of a larger volume, the vessel should pass whatever test is prescribed for tank room plus steering gear flooding, which totally took up less volume than the engine room.

That's the purport of his paragraph 56. Do you have any comment on that mode of thinking?

A. I have a difficulty with the paragraphs you've just explained in terms of timeline, which -- let me explain.

Q. Yes, please.

A. The vessel got approved plans on roughly mid-May 1995. If the builder then went ahead and built the vessels in

Page 148

accordance with the approved plans, everything would have progressed along and eventually the damage stability information would have been brought together and seen, and a certificate issued. Now, the damage stability information cannot be completed until the vessel is complete and an inclining experiment is conducted, in order to ascertain the weight of the vessel, and also its drafts and trim.

However, if the builder at some stage decides that he is going to build not in accordance with the drawings, but make some alteration, the builder is by and large taking a large risk that he will end up with a boat which will not pass certification.

I ask myself what builder would take that risk? The obvious thing to do is to raise it with the Marine Department or the authority involved, and say, "Am I okay to do this?" If you were to leave a door off, I would have thought you would have asked the Marine Department, "What is the effect of leaving this door off?" If that indeed happened, where is the calculation that showed that it was done and was satisfactory? I've seen no evidence of that at all.

So I find the risk that was taken to be far larger than certainly I would be willing to take as a shipbuilder.

Page 149

The second comment I'd like to make is in regards to paragraph 56, suggesting that some surveyors' professional judgment and experience be used when you're dealing with the safety of 200-300 people I find to be quite extraordinary. I would expect an inspector or surveyor to want to do a full calculation. It's not difficult to do, especially with software. Indeed, it was one for the purposes of producing the Damage Stability Book. So we know such software existed and was relatively easy to use. So I cannot see how you could use professional judgment. I wouldn't want to do that, with so many people's lives at risk.

We're not talking about a situation where someone may be injured: we're talking about risk to 300 people's lives here. So I would have thought "professional judgment" was not satisfactory.

I would have thought that if they decided not to go ahead with approved plans, that they would discuss it with the surveyor. The surveyor should have then documented it and if necessary, talked to his manager, his superior back at Mardep, and the decision then be made as to whether to approve it or not. And those sorts of decisions go on in shipbuilding all the time. It's quite correct to say that sometimes, for whatever reason, you cannot build in accordance with the approved

Page 150

plans. It happens on every contract I've been involved in.

In that case you go back to the surveyor, you explain why, you produce the calculations, if necessary, to show that what you are proposing is equally if not stronger, and it is then agreed, you usually get a letter saying, "Yes, this is allowed"; you don't necessarily change the drawings but you have documentation. Then you proceed to build a ship and it becomes certified at the end of the day. Then it's a matter of the contract as to whether you produce as-built drawings or not.

Q. How about this line of reasoning which this inspector adopted ex post facto by -- he didn't even actually perform the calculation, he simply took the view that the combined volume of tank and steering room compartment was actually smaller than the engine room, for which calculations had been done. So he took the view, "Ah, should be fine", and it would have passed any test, so he did not actually perform any calculation.

On that front, what comments do you have? Because during the course of the evidence, in examining the Mardep witnesses, they actually accepted that even though the volume might be similar, or even the combined volume may be even smaller than the engine room, the

Page 151

resulting moment would not be the same because of the location.

A. I think that's rather a sad approach, to expect a professional person just to add two volumes together and say it will be satisfactory. As you've just alluded, if he had taken the volume and the lever to create a moment, he would have got a better indication. But even so, it would have been a crude approximation, even taking a moment. I would have wanted to have done it much more accurately than that.

There are a number of factors in play. To do it in accordance, for example, with schedule 3, it's not clear to me what would happen to the margin line with heel on the vessel, and that can't be done simply. That would have to be done using the software that they had available to them. The moment method would give you a crude indication of schedule 1 requirements, but would give you no indication at all, in my opinion, of schedule 3 requirements.

THE CHAIRMAN: So we understand your evidence, you regard it as quite extraordinary that this should have been done on the basis of experience being prayed in aid rather than doing calculations?

A. I do, yes.

THE CHAIRMAN: Thank you.

Page 152

MR SHIEH: Dr Armstrong, allow me to perhaps test you a bit, playing devil's advocate.

You have since conducted calculations on the basis of Lamma IV as built in 1996?

A. Yes.

Q. In particular, seeing whether or not the margin line test would have been passed, based on various compartment flooding scenarios; correct? I think that we can see in expert bundle 2. That's your latest expert report. Can I ask you to look at expert evidence bundle 2, page 928.

The relevant standards required testing of flooding of one compartment only at the time; correct, Dr Armstrong?

A. Yes.

Q. One compartment. We could perhaps leave to one side the flooding scenario of engine room only, because I think flooding of engine room only passed the margin line test --

A. Yes.

Q. -- and we have no issue with that.

A. Correct.

Q. Here you deal with "tank room only" flooding; correct, Dr Armstrong?

A. Yes.

Page 153

Q. Page 928: condition as of 1998 as constructed.
A. 1996?
Q. 1996, as constructed. "With watertight door". In other words, "With watertight door", that is "tank room only" does mean "tank room only?
A. Correct.
Q. Satisfactory. Margin line not submerged. Yes?
A. Yes.
Q. "No watertight door", that is to say, you assume that if tank room is flooded, steering gets flooded as well?
A. Correct.
Q. Which incidentally would have been the requisite approach if you were to look at steering compartment, because steering compartment can't be reviewed as one compartment because it is less than 0.1L.
A. Exactly.
Q. So you have to test one-compartment flooding by looking at tank room plus steering; correct?
A. Correct.
Q. Which would be similar to a case whereby tank room flooded without watertight door; correct?
A. Correct, yes.
Q. Let's say a hypothetical Marine inspector were to say to himself, "Let me do the calculations. I am aware of this 0.1L concept, so I won't look at steering

Page 154

compartment flooding on its own, because that is less than 0.1L. I will have to think of a compartment which is longer than 0.1L", which in the case of Lamma IV would be steering compartment plus tank room; correct?
A. Correct.
Q. That would have yielded a "pass" result, because that would be no watertight door: passed. So this hypothetical Marine inspector, had he done the requisite calculation, would still have reached a "pass" result. So he might well have said to himself, "Right. Although I now know there is no watertight door, having done the calculation, treating the two as one, I'll pass it."
What do you say to this suggested approach of the hypothetical Marine inspector who has actually done the calculation and come up with the result that we can see as built in 1996?
A. Then the vessel could proceed with certification, because it met the requirements of schedule 1 in this particular case.
Q. Could it then have been suggested that the non-spotting of the absence of the watertight door had no impact on let's say the satisfaction of the margin line test, and therefore it made no difference to whether or not the vessel could have been passed, in the sense that even if it had been spotted, the calculations would still show

Page 155

that a vessel with no watertight door would still pass the test?
A. At that time, yes. However, it left a trail through the Damage Stability Book which indicated that it had certain characteristics which it did not, because the bulkhead was not watertight. That may have had an impact further down the track.
Q. In 1998 and 2005?
A. Correct.
Q. I will explore that in a bit more detail when we come to 2005 and 1998, when actually the margin line test would have failed after the adding of ballast.
Perhaps still staying at 1996. Irrespective of this idea about damage stability calculation, submersion of margin line, would a hypothetical Marine inspector have taken into account things apart from these numerical matters? Do you remember we've discussed this concept of the aft peak bulkhead, of the requirement in the Blue Book that the ship should have peak bulkheads at both ends?
A. (Witness nods).
Q. So would this hypothetical Marine inspector say to himself, "Irrespective of the satisfaction of these calculations, where is the aft peak bulkhead?", and, if so, what would have been the response of this

Page 156

hypothetical Marine inspector asking himself, "Was the Blue Book complied with insofar as a peak bulkhead at the aft end is concerned?"
A. The hypothetical Inspector, I would have thought, would have documented all of this information. If he had made a decision that it did not need a watertight aft peak bulkhead, he should have documented that, left a trail behind.
Q. Let's say this hypothetical Marine inspector left a note behind and said, "I have taken the view that frame 1/2 need not be watertight because I don't take that as the aft peak bulkhead. The aft peak bulkhead, or the peak bulkhead on the aft required by the Blue Book, the role of that is played by the watertight bulkhead as between the engine room and the tank room."
Now, what would you say to that sort of approach?
A. I think the Director of Marine -- I'm sorry, I don't understand the effect of legislation in this area, but I hypothesise myself that the Director of Marine had the power for his inspectors to make such decisions that they did not want to comply with certain parts of what we've heard are non-mandatory instructions, but even so I would expect him to give reasons for it and make the office aware of his decisions.
Q. Coming back to the point in question, in your opinion,

Page 157

ought this hypothetical Marine inspector regard frame 1/2 with an access opening as the requisite aft peak bulkhead?
A. My personal opinion is, no, it wasn't a satisfactory approach. All of the indications were there should be an aft peak bulkhead and it should be watertight. So personally, if I had been approving the vessel, I would not have accepted that. But that's my personal opinion.
Q. Yesterday you talked about SOLAS, the SOLAS requirements, and you mentioned that SOLAS actually required an aft peak bulkhead.
A. It does.
Q. I think we have since located the relevant page of SOLAS. I hope it has now been inserted in expert bundle 2.
Item 12D, page 956-5. Regulation 10:
"A fore peak or collision bulkhead shall be fitted which shall be watertight up to the bulkhead deck."
A. It's subregulation 7, Mr Shieh, under Regulation 10.
Q. So we'll move on to the next page. Yes, of course.
"An after peak bulkhead, and bulkheads dividing the machinery space, as defined in regulation 2, from the cargo and passenger spaces forward and aft, shall also be fitted and made watertight up to the bulkhead deck. The after peak bulkhead may, however, be stepped below

Page 158

the bulkhead deck, provided the degree of safety of the ship as regards subdivision is not thereby diminished."
So that is the SOLAS stipulation --
A. Correct.
Q. -- as to the need for a watertight after peak bulkhead.
A. Correct.
Q. Of course, this does not actually tell you in numerical terms how far away the requisite aft peak bulkhead is required to be from the stern. But yesterday I think you gave some evidence on the positioning of the aft peak bulkhead.
A. Yes, sir, and there is no definition in SOLAS of what an aft peak bulkhead is, and I believe that is because it is a very commonly used and accepted term in the industry.
Q. I know it may be a rather difficult question. You have made a comment that a bulkhead which is halfway between midship and the transom could not qualify as an aft peak bulkhead because it is too far away from the aft. You made a comment on that, because that was Mr Beresford's question of Mr Lo, that a bulkhead which is 57 per cent of the space between midship and transom could not be regarded as the relevant aft peak bulkhead, and Mr Lo gave his opinion, and I think you disagreed with him.
A. I disagreed with him, yes.

Page 159

Q. As I said, it may be a difficult question. But how close to the stern would you say a bulkhead needs to be?
A. Within 10 per cent of the length, I would have said. That is based on the fact that collision bulkhead should be between 5 per cent and 7 per cent.
Q. Collision bulkhead, that would be at the fore?
A. At the forward end, yes.
Q. In fact, within the definition of regulation 7 it actually says:
"An after peak bulkhead, and bulkheads dividing the machinery space ... shall also be fitted ..."
It seems to suggest that an after peak bulkhead is something separate and distinct from a bulkhead which separates machinery space. What do you say about that suggestion?
A. Could you give me that quote again, please?
Q. It's within the definition of regulation 7:
"An after peak bulkhead, and bulkheads dividing the machinery space ..."
In other words, it could well be argued or suggested that an aft peak bulkhead is something separate and distinct from, you know, the type of bulkheads which separate machinery space, such as the bulkhead between tank and engine.
A. I understand. In fact, the bulkheads dividing the

Page 160

machinery space from the cargo or the machinery space from the passengers is also a requirement in the Instructions, which says, "There shall be bulkheads at the forward and after end of the machinery space".
So those bulkheads are there not necessarily for watertight subdivision, as you are indicating, but also to prevent all sorts of other events, such as the spread of fire or to avoid flooding of the machinery space, or to stop noxious gases and the like escaping from the machinery space.
The same sort of argument could be applied to the aft peak bulkhead, although I wouldn't suggest that's a source of fire. But as I mentioned yesterday, there is a source of water leakage through something like the shafting for the propeller or the shafting for the rudders.
So both of them in the same paragraph, I believe, are there because there is a need to delineate between the use of the space and the risk of the space from the cargo spaces and the passenger spaces.
Q. Thank you. And in the case of the Lamma IV, you mentioned yesterday, in terms of breaches of the ship's structure, even though the propeller doesn't actually go into the steering gear compartment -- I think you said it went into the engine room.

Page 161

A. Comes through the engine room floor, yes.
Q. The rudder does come through the steering gear compartment?
A. There are two rudders and they both come through, yes.
Q. Steering gear compartment?
A. Yes.
THE CHAIRMAN: It's the rudder stock that comes through?
A. It's the rudder stock that comes through.
MR SHIEH: So this question about potential breaching of the structure is not an immaterial one; it is the one that applies to Lamma IV because the rudder certainly --
A. It is a risk because it depends on a mechanical seal, and mechanical seals can fail, and do fail.
Q. But can it be said -- again, I'm playing the devil's advocate -- that, "Oh, it doesn't matter because even if the rudder pokes a hole in the steering gear compartment -- let's say the whole steering gear compartment is flooded, it doesn't matter because there is this damage stability calculation requirement which actually requires you to assume steering gear compartment and tank room to be both flooded. So as long as that is passed, margin line not immersed, so it's okay. No point making that frame 1/2 watertight."
A. Yes, you're correct.
Q. What would you say about that sort of argument, which

Page 162

more or less eliminates the need for an aft peak bulkhead?
A. Well, the aft peak bulkheads I suggested should be at least 10 per cent away because of that extent of damage. However, it's a different criteria. The 10 per cent only refers to the situation of a collision. If you put an aft peak bulkhead at, say, 5 per cent, then it still provides that separation of water flooding in through rudder stocks. It's not unusual for vessels to accidentally touch the bottom, and in touching the bottom, bending the rudder. Many vessels have lost their rudder; water comes in through the hole. It does matter then where the aft peak bulkhead is. It's immaterial whether it's 10 per cent or 2 per cent; it still protects the rest of the boat from flooding. The 10 per cent only applies in case of accident.
THE CHAIRMAN: In case of collision?
A. In case of collision. Sorry, yes. I understand. In case of collision.
MR SHIEH: Could I then move on to the situation in 1998, because this, as you said, could be where the carried-over effect of the failure to spot the error in 1996 would be felt. Could I ask you to look at your calculation in expert bundle 2. I think it is the same table, page 928.

Page 163

A. These are the results of a calculation rather than the calculation itself.
Q. Yes, these are the results of a calculation.
As of 1998 we know that ballast had been added. In such a case --
THE CHAIRMAN: And I think there's a separate factor that you reminded us of earlier: that the weight of the vessel has been increased as well, in addition to the ballast?
A. Correct, yes, by about 6.25 tonnes, if I remember rightly.
MR SHIEH: But then this calculation -- well, the result of the calculation here took that into account as well?
A. Yes.
Q. So a vessel -- the Lamma IV as of 1998, with watertight door, in other words tank room flooding does mean tank room flooding only, would have passed the margin line submersion test?
A. Correct.
Q. But without watertight door, it would have failed the margin line test?
A. Correct.
Q. But this is where, again, I would like to test you a bit. Passing or non-passing of the margin line test depends on the result of conducting the relevant

Page 164

calculations, one-compartment flooding, and then proceeding on the basis of which is the relevant compartment; correct?
A. (Witness nods).
Q. Again, could it be said, "Oh, it doesn't matter because" -- now, this is perhaps a little bit long and if you want some time to consider it, perhaps tell us because we're near 4.30. Could it be said, "Oh, it doesn't matter whether or not in fact the absence or presence of a door in frame 1/2 was spotted or not", because in 1998, let's say the hypothetical conscientious Marine inspector realised the 0.1L problem, in other words he realises that the steering gear compartment cannot be treated as an individual compartment for the purpose of calculation of one-compartment flooding. This conscientious Marine inspector would then say to himself, "Ah, for the purpose of one-compartment flooding, I should treat steering gear compartment and tank room merged as one and I will calculate the relevant margin line test, and it would have failed the margin line test." But that would have been the case whether or not there is or is not a watertight door, because for the purpose of calculating the one-compartment flooding scenario, door or no door, you just merge the two as one, because this

Page 165

would be the way people do the one-compartment flooding calculation.

And the Marine inspector, the hypothetical conscientious Marine inspector, upon spotting the failure of the margin line test in 1998, would have sent Cheoy Lee or Hongkong Electric back and said, "You failed. Can you sort it out, try to find a way out?"

Upon being asked to do this, the problem about failing the margin line test would not and could not have been solved by adding a door.

A. Adding a door, mm'hm.

Q. So could it then be said that door or no door has no bearing on the passing or failure of the margin line test in 1998, even if a conscientious Marine inspector had spotted the need to merge steering compartment and tank compartment for the purpose of one-compartment flooding? Do you follow the line I'm getting at?

A. I follow exactly your line of argument, yes. And I believe you are right, that certainly if this conscientious Marine inspector had indeed seen that there was a problem with the two compartments flooded, or, if you like, the steering gear compartment flooded and therefore the space forward also flooded, fitting a door would not have solved the problem. So there would have needed to have been another solution. In

Page 166

that regard, the door is immaterial.

THE CHAIRMAN: The problem at this stage is the added lead.

A. The problem at this stage is the added weight of the vessel.

THE CHAIRMAN: Yes. Lead plus the extra weight of the vessel.

A. Correct.

THE CHAIRMAN: And it appears, does it not, that the trail not having been left as perhaps it ought to have been, as you said earlier, formed the basis of the miscalculations?

A. I believe so.

MR SHIEH: I wonder whether that would be an appropriate moment, because I will go on to test the same line by reference to 2005.

THE CHAIRMAN: Yes, certainly.

It's been a long day for you already, Dr Armstrong. For your purposes, we'll call it the end of the day. But we have some other things I want to deal with now. We will resume with your evidence tomorrow at 10 o'clock, but you're free to leave the witness box now.

A. Yes, sir.

(The witness stood down)

THE CHAIRMAN: Mr Yeung, your matter.

Page 167

MR YEUNG: Yes, Mr Chairman.

THE CHAIRMAN: The matter I think we can deal with at this stage is your request for the provision of documentation from Cheoy Lee. What is it that you are seeking?

MR YEUNG: Yes, sir. As indicated in the letter submitted yesterday, we ask for all communication between Cheoy Lee and the Wuzhou Shipyard in respect of the construction survey inspection of Lamma IV; the covering letter from Cheoy Lee to the Hong Kong Marine Department enclosing the survey items list; the survey report signed by our client; and lastly, the certificates of the hull plates for construction of Lamma IV issued by the American Bureau of Shipping.

THE CHAIRMAN: Yes.

MR YEUNG: Of course, I'm fully aware of the reply made by Wilkinson & Grist, saying in effect that there are only two items that are still in their custody, and that is a fax dated 7 April from Vanzon, which was the agent of the Wuzhou Shipyard, to their client, and there's another fax dated 5 September from Vanzon again to their client, enclosing the CCS survey report dated 6 September 1995.

THE CHAIRMAN: Yes. So in the upshot, what is it you seek?

MR YEUNG: At least the two documents that are listed in the letter of 28 January by Wilkinson & Grist.

Page 168

THE CHAIRMAN: Yes. We have the CCS survey report, do we not, Mr Pao?

MR PAO: Yes, we do.

THE CHAIRMAN: So what's missing is the fax enclosing it; is that right?

MR PAO: Yes.

THE CHAIRMAN: And that's in your possession?

MR PAO: I believe so, yes.

THE CHAIRMAN: That can be provided to the Commission, can it not?

MR PAO: Yes.

THE CHAIRMAN: What's the other matter, Mr Yeung?

MR YEUNG: The first fax, dated 7 April 1995, from Vanzon enclosing a draft contract.

THE CHAIRMAN: Yes. And you've got that, Mr Pao?

MR PAO: Yes, we do.

THE CHAIRMAN: And you can provide that to the Commission?

MR PAO: Yes, we can.

THE CHAIRMAN: Thank you.

Now, Mr Yeung, is there anything else we can deal with at this stage?

MR YEUNG: Yes. We apply, as I indicated yesterday, for the recall of two witnesses.

THE CHAIRMAN: That's a separate issue. We don't need to deal with that now. We don't have anything from you

Page 169

yet, do we?
MR YEUNG: Actually, we have provided a witness statement, but it's in Chinese, to all parties. The English translation is being finalised, and those instructing me are aiming to send the translation out later today or tonight.
THE CHAIRMAN: Right. When was this material provided?
MR YEUNG: Just after lunch.
THE CHAIRMAN: Right. It certainly hasn't reached me.
MR YEUNG: Mr Secretary has a copy, but it's in Chinese.
THE CHAIRMAN: Yes. I have a Chinese-reading co-Commissioner; this is not a problem. But it hasn't reached us.
So we'll deal with your application when we've got your material.
MR YEUNG: Thank you. I'm grateful.
THE CHAIRMAN: Mr Zimmern, Mr Sussex intimated yesterday that you would be in the final stages, as I understood it, of dealing with an expert report that would be provided to the Commission which is relevant to the questioning of Captain Pryke. Where are we on that?
MR ZIMMERN: My understanding, Chairman, is that that report we anticipate will be ready during the course of tomorrow.
THE CHAIRMAN: Tomorrow?

Page 170

MR ZIMMERN: Yes.
THE CHAIRMAN: Thank you. Any other matters arising?
MR GROSSMAN: I'm sorry, perhaps something I should ask my learned friend, but we really would like to know who the next witnesses are. I think you still have to make a decision on whether or not Dr Peter Cheng is to be called.
THE CHAIRMAN: Well, that's going to be partly in the hands of counsel. I've no idea how long it is such questions as you might be permitted to ask will take.
All of you, not just you, Mr Grossman.
MR GROSSMAN: Well, I can tell you immediately: no time at all.
THE CHAIRMAN: Well, that is a matter for counsel, and I leave it to you to discuss it amongst yourselves.
10 o'clock.
(4.38 pm)
(The hearing adjourned until 10 am on the following day)

Page 171

I N D E X

DR NEVILLE ANTHONY ARMSTRONG (on former oath) 1
Examination by MR SHIEH (continued) 1
(The witness stood down) 166