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Thursday, 31 January 2013
(10.00 am)
DR NEVILLE ANTHONY ARMSTRONG (on former oath)
THE CHAIRMAN: May I remind you again that you continue to testify according to your original oath.
A. Thank you.
Good morning, Mr Chairman and Mr Commissioner.
Examination by MR SHIEH (continued)
MR SHIEH: Dr Armstrong, yesterday we stopped at a point when we were trying to locate the 1996 equivalent of a document that you managed to look up on the internet, which was the 2011 version.
Let me just sort out the documents that have come in overnight and found their way into the expert bundle.
Could I ask you to look at expert bundle 2. I think these documents have been put in at the end. First of all, I hope the Commission's bundle has been updated as well.
Page 956-31. This, I understand, is part 3 chapter 3 of the Rules of Classification, DNV, July 1996. Do you see that, Dr Armstrong?
A. Yes.
Q. This was supplied by the Department of Justice yesterday. Have you had a chance of looking at this document, Dr Armstrong?

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A. I am familiar with the document.
Q. Is this the document that you were trying to lay your hands on yesterday?
A. I believe -- well, I was not trying to locate this particular one, Mr Shieh. I had a copy of the 2011 one. I think the Department of Justice provided this particular document.
Q. Right. But you are content to express your views based on --
A. It is essentially the same document.
Q. Right. So, chapter 3, 1996. This is the whole document supplied by DoJ.
But as I understand it, you yourself have also located two documents that you wish to place before the Commission to assist the Commission in understanding this question --
A. Correct.
Q. -- between 215 on the one hand, and I think the other value is 125.
A. Correct.
Q. Page 956-64 is the first document that you have located overnight. Before we go into the details of this document, could you just explain or identify for us the nature of this document?
A. Yes. Thank you, sir. Page 956-64 is a document from

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an aluminium supplier. I think this particular one comes from --
Q. Alcan.
A. -- Alcan.
Q. We can see on the bottom right-hand corner, immediately above the blue box, "63", which is the internal page numbering, above that we see "Alcan Marine"; correct?
A. Correct.
Q. That is basically a brand, a supplier of aluminium alloy?
A. Correct. And in particular, this brochure is trying to promote the capabilities of one of their specific products called Sealium which can be ignored, but you'll notice quite a lot of reference to that.
Q. We'll go into the details of this document later.
The other document that you have identified and located overnight is at page 956-84.
A. Correct. Which is a manufacturer's brochure from Alcoa.
Q. Alcoa, which is basically another what I would call brand name?
A. Another brand name. I believe they may now be the same company, but at that time they were separate companies.
Q. Right. Let's pull the threads together. The origin of this current excursion, if I can put it this way, was from the appendix 8 in Dr Peter Cheng's second

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supplemental report, which is at page 922-29. This is DNV Rules, and we can see "NV-5083". For H116, we have 215. That is the value Dr Peter Cheng picked for the purpose of his calculation.
A. Correct.
Q. And you are trying to assist us as to your rationale in picking what one may call a lower yield strength for that particular aluminium alloy?
A. Correct.
Q. Now, with these documents -- and I've looked at them but I think you are in a much better position to explain to us in whatever order you wish to. We have now the 1996 document, chapter 3, the DNV Rules, and we now have the two manufacturers' brochures. Can you take us through them in whatever way you feel appropriate, to identify the salient features and explain to us your thinking.
A. Yes. Thank you.
May I refer you to the Alcoa brochure, page 956-84.
Q. Yes.
A. The background to what I would like to explain to you refers to the properties of aluminium alloy. Aluminium alloy is a mixture, as I'm sure you're aware, of various materials, which is given elsewhere in this bundle, principally a magnesium, and in a way it is similar to steel being an alloy of iron, and most people appreciate

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that steel is much stronger than iron. So I only mention that by way of comparison. You can make aluminium alloy much stronger aluminium.

My experience in designing and using aluminium alloy for ships is by coincidence illustrated on page 956-85, which is the next page. I would stress this boat was not made from aluminium provided by Alcoa. They just chose a picture because they thought it looked good. But the picture at the bottom of this page is one that I was intimately involved in, and this was the world's longest aluminium high-speed craft.

Q. The Benchijigua Express?

A. The Benchijigua Express operates in the Atlantic Ocean between the islands of the Canary Islands. It carries 1,000 passengers and does 42 knots. But we're not here for the purposes of that vessel. I'm just trying to comment that I have a lot of experience of aluminium design.

The mechanical properties for the material that was used for Lamma IV are indicated on page 956-88. At the bottom of the page you will see "EN AW" -- which is immaterial; that's the manufacturer's designation -- "5083", and then the lower part of that, "Temper: H116". You'll see in one of the middle columns it gives a value of 215.

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Q. Yes.

A. I won't trouble you with what the value means, but I think we understand that is the design stress level.

Q. Yes.

A. I need to point out that this is the capability of the material. This is the mechanical strength of the material as supplied by the manufacturer, Alcoa.

Unfortunately when you weld aluminium, you change the granular structure due to the heat and this can lead to cracking, does lead to cracking, and can also and does reduce the strength substantially. Welding of aluminium is quite a difficult procedure to do correctly, and there are, to my knowledge, only between 20 and 30 shipyards in the world who are regularly building in aluminium.

Aluminium is used by other shipyards to make superstructures, and in that case quite often the superstructures are riveted together, not welded. There is a reason for that, to do with the bending of the ship. As the ship bends, the strongest points need to be the deck and the bottom of the ship, because they're like the top and the bottom part of a girder, the ship being considered to be a girder resting on one large wave.

If you put an aluminium deckhouse on top of this

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structure, the aluminium will try to take all the load, rather than the steel. So it's common to design the aluminium deckhouse so it does not take a load, and the way to do that is to rivet it together, so the rivets allow it to give a little. This is by the by on Lamma IV, which of course was fully welded.

But it does mean that you need to know two properties. One is the property of aluminium where you may use it for a riveted construction, in which case you are not heating it in any way, and you may use 215. But as soon as you start welding aluminium, you change the properties of aluminium. Therefore, if we can turn the page to 956-90, you'll see at the bottom of that page properties for aluminium when it is welded. 5083, temper 116, is shown there on the right-hand side as 125.

If I might then very quickly refer you to the other manufacturer's brochure, which is on page 956-69.

Q. The other brochure being the Alcan brochure?

A. Thank you, yes. Page 956-69. At the top of that page, you will see 5083 156 in sheet form, that is the top line, given as non-welded metal, 215; and then as welded metal, 125.

Q. Yes.

A. These are the same figures, by coincidence, as used by

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myself, 125, and Dr Cheng, 215. I don't know Dr Cheng's experience but in my mind, he is associated with quite large ships so I expect Dr Cheng's expert knowledge refers to aluminium used on large vessels, where quite often these would be non-welded metals which would be riveted together.

On the right-hand side, I draw to your attention the column headed "Coefficient f1", and that is simply the value of 125 divided by 215. I mention that because that same coefficient appears in the DNV Rules, which I would now like to turn to.

THE CHAIRMAN: Just give me a moment to follow this, please.

MR SHIEH: The coefficient f1 is 0.6?

A. Correct.

THE CHAIRMAN: Thank you.

A. If we can turn to page 956-35, which is one of the first pages in section 1 of the DNV Rules, you'll see on the right-hand side --

THE CHAIRMAN: Just a moment, please.

Thank you.

A. On the right-hand side, in paragraph A202, under the heading "Aluminium alloys", you will see a little formulation there: f1 equals the yield stress divided by 240. 240 is what DNV choose to take as the nominal strength of aluminium alloy no matter what grade it is.

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I'd also like to stress that different formulations appear amongst the different classification societies, and there is so real commonality between their rules, which is something I mentioned yesterday. You have to take classification society rules in their entirety, and not really take parts of them out of context. So we have to be a little careful.

But for the purposes of explaining the difference between 215 and 125, I think it's reasonably valid.

I now need to find, Mr Shieh, the other reference --

MR SHIEH: When you say "different formulations", different formulations of what?

A. For example, the formula that gives you the thickness required for side plating, which we are not going to look at in this particular example.

Q. Thank you. So we've looked at the definition of the factor f1, being the yield strength divided by 240. Is that a universally accepted definition?

A. No, this is DNV's own definition.

Q. This is DNV's own rule?

A. Yes. I merely illustrate it for the purpose of showing you that f1 does appear in the DNV regulations, and I showed it to you in the Alcoa brochure which was the welded divided by the unwelded.

Q. Yes. But I think it's the Alcan brochure where the f1

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coefficient appeared. Did Alcan also use the same definition, the denominator --

A. They do not mention f1.

Q. Anyway, don't let me break up your train of reasoning. You've taken us to page 956-35.

A. I appreciated the little break because it allowed me to find the correct page. I've only received these documents this morning.

On page 956-40, you will see on the left-hand side at the bottom table B4.

Q. Yes.

A. Table B4 has a designation NV-5083, with temper H116, which agrees with Lamma IV.

Q. Yes.

A. And on the right-hand side, it gives two values of f1.

Q. Yes.

A. These two values are given because the properties of the welded metal depend also on the properties of the filler wire. Let me explain. When you weld aluminium using the various processes, you usually use a wire which is for the purposes of introducing an electrical current into the gap between the aluminiums you're trying to join. The electrical discharge between this element and the base metal creates a lot of heat, which melts the filler wire and melts the parent metal, and thereby

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allows it to cool down and join one solid mass.

There are two values in the column headed "f1", dependent on the properties of the filler wires you are using. And in this case, DNV have specified two particular filler wires, namely 5356 and 5183. 5183 is quite similar to 5083, but a little different. If you use 5183 filler wire, then the f1 value is 0.6, according to DNV, and that factor f1 is a ratio between the welded property and the property of the base material that you bought from the manufacturer.

Q. So in other words, if you want to work backwards from the f1 figure of 0.6 to find out the yield strength of this particular alloy as welded, you simply multiply 240 by 0.6, approximately. Would that be the way to do it?

A. Approximately, yes. Sorry, I do not have in front of me what that value is. I think it's 129, from memory, which is close to the 125 used by other people. So I used 125 because I believed this is a welded structure and it's the correct value to use for a welded structure. I think Dr Cheng has used the unwelded value, because he is more used to using aluminium in an unwelded condition.

Q. You mentioned the concept of tempering yesterday, of aluminium.

A. Unfortunately the welding process destroys locally

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the -- let me explain a little bit more, perhaps. When you weld two pieces of aluminium together, the heat is quite intense but is quite local. By "local", I mean approximately 50 cm on either side of the weld, and that is called a heat-affected zone, and you will find reference in all of these articles that I've drawn to your attention, including the DNV Rules, talking about the heat-affected zone. In that heat-affected zone, the properties of the aluminium change. The tempering is lost because of the heating process. It can be brought back by retempering the whole boat, the whole welded vessel, or by mechanically trying to recreate the tempering process. If you go along with a little hammer and hit it for a long period of time, you can actually bring the temper back. But nobody does that.

So in that heat-affected zone, you have lost the original properties. Away from the heat-affected zone, you still have the 215 capability, but you have to consider the whole piece of plating, and the lowest properties really drive it all. That heat-affected zone also causes shrinkage and distortion, and that is why aluminium is difficult to build with. You need certain skills in building aluminium ships.

To give you some example, the large vessel I showed you at the beginning, you actually had to design it

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200 mm longer than it needed to be because the whole boat shrank by 200 mm due to the welding process. So it's quite a convoluted and difficult process to weld aluminium, not so much of course at Lamma IV size, because you could afford for it to shrink a few millimetres.

Q. If we pause here for a second and look at page 956-40, it caters for the use of two different specifications of fillers. One is 5183, and the other is 5356. You have just shown us the example of using 5183 which, used in combination with H116, would give an f1 figure of 0.6, which translates to something like 129-something, or 129. In a way, if you had used the other filler, the value would actually be smaller than 129, wouldn't it, because the coefficient is actually smaller than 0.6?

A. In my head, Mr Shieh, about 114, something like that.

Q. Yes. So in fact, of those two fillers, you have actually adopted the filler model or spec which would give a higher coefficient and therefore a higher yield strength?

A. Correct, Mr Shieh. But I would again stress that the DNV Rules have to be read in their total context, and I'm only using this for illustrative purposes, to show that the welded value is less than the unwelded value. Other authorities use this simple 125 value as --

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Q. In other words, there's no magic in the f1 figure? The f1 formulation is simply by choice of the relevant classification society?

A. Correct.

Q. What you really want is to look at the yield strength itself and not to try to work backwards by this process?

A. Yes. The difference between 119 and 125 is very small, but the difference between 215 and 125 is very large.

I'll give you an example. If you look at the rule in DNV, which may be in the papers provided, for the thickness of material for a vessel build in accordance with -- it is indeed, on page 956-46.

Q. Yes.

A. There is the rule there for how thick the side plating may be. It's paragraph B101. Sorry, you'll need to go up a little. On the right-hand side.

Q. "Minimum thicknesses"?

A. B101:

"The [minimum] thickness of structures is in general not to be less than ..."

It contains a value t0.

If you scroll down a short distance, you will see table B1, and for side shell plating t1 is 3.5. But by the time you insert 3.5 back into the formula B101, and insert all the other values, which I did yesterday, you

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will find that the thickness can be 3.0.

So DNV allow you much thinner plating than, for example, was written into the Instructions to Surveyors saying 5 mm. That's because there are many other things taken into considerations in the DNV regulations, and you would have to design the whole boat to DNV to qualify to use this formula. You can't take it out of context.

Q. Thank you. Thank you, Dr Armstrong.

Is there anything else in the DNV Rules chapter 3, and the Alcan and Alcoa pamphlets or brochures that you wish to draw our attention to in order to deal with the point, the difference between 125 on the one hand and 215 on the other?

A. One other small subject, sir, is to comment that aluminium is subject to fatigue cracking. By that I mean that if you take aluminium and bend it a number of times, you can introduce cracks. A somewhat common example is you may have at some stage got hold of an aluminium can, such as a Coke or beer can, and oscillated it backwards and forwards and broken it into two component parts. That's an example of fatigue of aluminium. You can break it quite easily.

You have to design for fatigue, and indeed DNV Rules have strict requirements on fatigue. The heat-affected

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zone also affects fatigue, which is another reason why you have to carefully design to the lower strength level.

MR SHIEH: Thank you.

On that note, Dr Armstrong, I think we have dealt with this point raised by Dr Cheng about the appropriate yield strength that ought to be slotted into the relevant formula for the purpose of converting the 5 mm thickness requirement for steel, with a particular stiffener value, into aluminium.

Unless the Commission has any further questions, I have no further questions for Dr Armstrong.

THE CHAIRMAN: Thank you.

Just dealing with the consequence of your evidence in terms of the plating, can I ask that you be reminded of what you say in your first report, paragraph 25, page 410. The bottom of that paragraph, the penultimate line:

"The thinner plating size on Lamma IV may have contributed to the extent of the damage that was experienced, as 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."

You've couched that opinion in cautious, conditional

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language. Do I take it that you haven't attempted to do any empirical study as to the effect of the difference of plating size?
A. I have done no such studies, Mr Chairman.
THE CHAIRMAN: Thank you.
A. I merely wanted to draw it to the attention of the Inquiry.
THE CHAIRMAN: Yes, Mr Grossman. Do you have an application?
MR GROSSMAN: I do have an application, Mr Chairman. I would like to ask a few questions, and I emphasise "few", on a number of issues. First of all, I want to go through the relationship of the various persons involved in the planning, the construction and the survey, to deal with various responsibilities.
THE CHAIRMAN: Yes.
MR GROSSMAN: Secondly, I would like to ask questions on the effect of the collision on the loosening of the seats.
THE CHAIRMAN: Yes.
MR GROSSMAN: Thirdly, I want to explore quickly how long Lamma IV was afloat before it started tilting.
THE CHAIRMAN: Yes.
MR GROSSMAN: Fourthly, I want to ask a few questions about the damage to the Sea Smooth.
THE CHAIRMAN: Yes.

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MR GROSSMAN: And lastly, a couple of questions about the whistle.
THE CHAIRMAN: Yes, very well. Please proceed.

Examination by MR GROSSMAN

MR GROSSMAN: Good morning, Dr Armstrong.
A. Good morning, Mr Grossman.
Q. I think you understand I represent Hongkong Electric.
A. I do.
Q. This morning we presented a document I'd like you to have a look at. You may not have seen it before. It's in the Reed Smith Richards Butler bundle at page 1322.
Mr Chairman, this was done overnight, and we've had it served and scanned this morning.
THE CHAIRMAN: Yes.
MR GROSSMAN: Have you had an opportunity to have a look at this?
A. I have, sir, yes.
Q. What we've done, as best we can, is just to see quickly where everything was done. So it can be perhaps a helpful way of showing what took place. Perhaps we can look at it very quickly.
First of all, Hongkong Electric give a tender, a contract to Cheoy Lee Shipyard. If we look then on the right-hand side, there's a contract for the design of the aluminium hull that goes to Naval-Consult in

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Singapore. Then there are drawings of the hull, which go back to Cheoy Lee Shipyard.
A. Mm'hm.
Q. Cheoy Lee send the drawings to the Marine Department, and the Marine Department approve it, send it back to Cheoy Lee. There's a contract for the supply of the aluminium plate which goes to a company in Florida. That's accepted, and it goes to the Wuzhou Shipyard in the People's Republic, who construct the hull. And that is sent back to Cheoy Lee Shipyard.
Am I right so far?
A. I understand, yes.
Q. Yes. Then on the left-hand side, if we can go to the bottom part, there's a contract for the design and the construction of the superstructure that goes to a company called High Modulus in New Zealand. This is what you dealt with yesterday afternoon.
A. Mr Grossman, I thought that was only a design. I thought it was fabricated by Cheoy Lee.
Q. Yes, very well. Thank you.
THE CHAIRMAN: So we can strike that out. It's "Design of superstructure"?
MR GROSSMAN: Design of the superstructure, that goes back to Cheoy Lee. And then Cheoy Lee make an application for survey to China Classification Society and the

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Marine Department, and there's a survey item list. Everything is surveyed, sent back to Cheoy Lee Shipyard.
A. (Witness nods).
Q. And that goes back to, eventually, the customer; am I right?
A. I believe so, yes.
Q. During the course of your evidence you have, if I may say so, very diplomatically highlighted various errors, discrepancies, inherent weaknesses, design defects that took place. I wonder if on this chart you could indicate where they took place. Basically we're talking about design, we're talking about the thickness of the hull, we're talking about the seating, et cetera.
Is it possible for you to do that?
A. May I enquire, Mr Chairman, whether that would come under part 2 of the Inquiry?
Q. Well, let me put it another way.
THE CHAIRMAN: Yes, it might well do.
MR GROSSMAN: Let me put it another way, then.
With all these different companies involved, with all the surveys that are done, wherever blame might be apportioned, and it's not my business to look at that, would you accept that a lay customer such as Hongkong Electric could hardly be blamed for accepting this vessel as delivered?

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THE CHAIRMAN: Is this within your field of expertise? If it is, please answer the question.
A. I'm certainly not able to lay any blame; it's not my purpose to apportion blame at all.
MR GROSSMAN: No.
A. I merely try to state the facts as I see them.
Q. Yes. Yes, very well.
A. I think that's very difficult to answer on the spur of the moment, sir, because as you have mentioned, there are quite a number of areas. So I think they'd all need to be considered. It will be something I'd be willing to comment on in part 2 if that is thought to be appropriate.
MR GROSSMAN: I'll leave that, leave it for the Commission, Mr Chairman, if you think that's appropriate, to ask that.
THE CHAIRMAN: Very well.
MR GROSSMAN: I want to deal with the aspects of the survey, if I may. First of all, if I can ask you this. Put yourself in the position of a surveyor or inspector who looks at the various matters that you have highlighted. First of all, would a surveyor in the course of his duties look to see whether the bulkheads were watertight in terms of the drawings?
A. Can I just explain that there are surveyors and there

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are inspectors, and I think you mean both.
Q. Yes, both.
A. Yes. Yes, I would say that was definitely one of the duties that I would expect of a surveyor or inspector.
Q. Yes. A surveyor would check that against the plans?
A. Very important.
Q. What about the measurement of the thickness of the hull?
A. It was a little complex in this particular case because it was built elsewhere, at Wuzhou Shipyard, and some reliance is therefore placed on the skills of the CCS survey. There seems to have been some understanding between Mardep and CCS that I don't fully understand, as to what they accepted and what they did not accept. But my understanding of what I've read is that Mardep would accept survey of the structure and would not therefore check it again. And CCS are a recognised and competent organisation, so they would not need to do so, I would suggest.
Q. Very well. What about the testing of the seats: how would the seats be tested?
A. I don't think the seats would be tested at all. I think the surveyor would -- if I was the surveyor, which is your original question, I would want to satisfy myself by looking at drawings, and, perhaps a verbal explanation as to how they were attached, that they were

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adequate. I wouldn't necessarily expect to see a complex calculation. I think any competent engineer could tell whether they were adequately supported or not.
Q. And in this case, you say they were not adequately supported?
A. In my opinion, they were not adequately supported.
Q. As far as the life jackets are concerned, you've been a little critical of the ones that were on board, and for that matter the ones that Hongkong Electric plan, or planned, to use on their new vessels.
A. I wasn't intending to be critical of the new ones. I merely tried to point out that there are a number of factors that need careful consideration.
Q. Yes.
A. I'd need to know more about the ones that are currently proposed.
Q. Very well. As far as the number of life jackets are concerned, and the quality of the life jackets, to see whether they meet regulations, would this be something you would expect the surveyor and the inspector to check?
A. Absolutely, yes.
Q. Yes. While we're dealing with life jackets, I think you were asked yesterday, I think it was, about how the

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number of life jackets can be calculated according to the number of people on board, and my learned friend Mr Shieh went through with you the suggestion that there should be just -- there could be two per lifebuoy, four, et cetera, for the life raft, and you were critical of that.
A. I was, yes.
Q. Yes. This would be something, of course, that the Marine Department would be aware of, no doubt?
A. I'm sure they would be, yes.
Q. And the Marine Department would indicate whether the way in which it was calculated -- life jackets, life-saving equipment was calculated -- they would be aware of this and say either yea or nay?
A. I'm sure they would be, yes.
Q. So unlike a headline in the South China Morning Post this morning, this would be something that the Marine Department would determine, rather than Hongkong Electric themselves?
A. It would be something that the Marine Department would specify, and I believe there were requirements. I know there are requirements in the instructions, and I'm sure they were complied with.
Q. Would you have a look, please, at your report at page 420, paragraph 52. Here you've dealt with

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different views that different inspectors and surveyors had of which instructions were in use for Lamma IV. May I take it you would not expect a lay customer to involve himself in this type of debate?
A. Certainly not.
Q. Thank you. I want to turn now to the question of the effect of the collision on the seats. Is it possible to in any way quantify the effect, the kinetic effect of this collision on the seats, on the security of the seats?
A. There possibly is.
Q. Thank you. Let me put it from this point of view. You've indicated very graphically how the collision happened, and may I take it that you accept, I think, that the decks would have buckled or flexed?
A. Yes.
Q. Certainly. And the buckling or flexing effect would have had a major effect on the seating, the security of the seats?
A. By and large, sir, I cannot agree with the use of the words "large effect". There would have been an impact initially of very short duration which would have put a high acceleration value on everything on Lamma IV, which would have been of very short duration.
Q. Yes.

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A. And the difficulty in calculating that effect is to try and understand what the duration might have been.
Q. The reason I ask this is because in your evidence, you indicated that, first of all, the pillars are intrinsic to the integrity of the reduced weight on the ship.
A. (Witness nods).
Q. I think you said, "If the pillar is displaced" -- no, let me say you didn't say this.
Can I ask you this. If the pillar is displaced, as it was here, presumably the integrity of the deck --
THE CHAIRMAN: Which pillar are we talking about?
MR GROSSMAN: We saw a picture of a pillar.
THE CHAIRMAN: Can you remind me at least, so I can follow your questioning.
MR GROSSMAN: Give me a moment. I'm just trying to find it.
A. Perhaps the pillar on frame 5 on the main deck.
Q. That's correct, on the main deck.
A. Which was moved through 15 degrees or so.
Q. Yes. Is that not an indication of quite severe buckling on the deck?
A. It seems to me, by looking at that pillar and from the marks on it, that it was hit by the cross-deck structure of Sea Smooth near the top of the pillar, and detached from the deck above. As I mentioned in evidence, the upper structure of that upper deck was also severely

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damaged, and there are photographs which show that to be the case.
Q. Yes.
A. Above that particular pillar, though, is an open deck area. There are no seats above that pillar.
Q. Yes. It's the displacement of the pillar, the force that must have been utilised, used to displace that pillar that makes me ask whether the deck itself would have been quite severely buckled.
A. The deck -- may I understand you mean the main deck?
Q. Yes.
THE CHAIRMAN: The main deck being the aluminium deck?
A. The main deck being, in my opinion, the aluminium deck, yes.
THE CHAIRMAN: Is that the one you're asking the witness about?
MR GROSSMAN: Yes, it is.
I think probably the best illustration is at page 455.
A. At the top of the page.
Q. Yes.
A. Mr Grossman, I also mentioned that the Sea Smooth moved on shortly after that and struck the toilet block at the after end.
Q. Indeed, yes.

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A. I would be of the opinion that striking the toilet block was a greater impact than striking this pillar. From memory the pillar is only attached by four quite small bolts, which would have sheared off reasonably easily when struck in that direction. So, yes, there were a number of events during the collision at which the accelerations would have peaked. So, for example, when the Sea Smooth first struck the fender of Lamma IV, there would have been a high acceleration for a short duration.
Q. Yes.
A. When it then struck the toilet block, you would have had a similar high peak. I did mention in evidence that the average deceleration was approximately 0.24 G, from memory.
Q. Yes.
A. But that was an average. There were higher peaks than that for very short durations.
Q. I understand. that.
At page 419 you deal with this to some extent, at paragraph 48. In the second-last sentence, four lines from the end, you 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

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the foundations finally failed."
Do I understand from that what you're saying is that if there hadn't been an accident, the seats were adequately secured?
A. No, sir, I do not believe the seats were adequately secured.
Q. Sorry, that was wrong. There would have been no collapse at all, other than the fact that there was an accident? After all, it had been going for some years without a problem.
A. I'm not sure I can agree there is no problem. There is evidence which I mention in paragraph 48, that some of the seat foundations became loose in service, and there was also comment made by the engineer on Lamma IV that the seats were generally loose, I think was how he put it. Whether that was dangerous or not is an interesting question, and perhaps not, because the person sitting on a seat provides a force on the legs of the chair which tend to keep it in contact with the deck. Of course, it's a different situation when the boat is operating in waves, and I do not have any knowledge about the waves around Lamma Island. That's not quite true, because I have sailed around there, but usually on quite calm days. But there are large vessels going past and the wake of those vessels I would have thought would have

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provided a wave which would have caused the Lamma IV to roll, and that could potentially have been dangerous.
Q. Yes. Please continue. I beg your pardon.
A. I was only going to comment that there was no question that the vessel lying at the angle it was was an abnormal condition, which is why I used the word.
Q. Yes, thank you. I've been using the word "buckle" when talking of the condition of the deck after the accident. Would it perhaps be better to use the word "flex"? Would the decks have flexed?
A. Yes. I'm sorry, I was using -- my interpretation of the word "buckle" is a very technical interpretation, because engineers understand what buckling it. It's a particular phenomenon due to compression of the decks. If you're talking about flexure of the decks, there would have been some flexing of the decks, there would have been some shockwave passing through the decks. It possibly could have had some effect on the screws which were inadequately holding the chairs down. That would be hard to put some measure on. It could be done, but it could best be done by doing some experimentation.
Q. In that regard, can I refer you to a calculation you did which appears on page 956-13. You start off there saying:
"I calculated the deceleration of Lamma IV, in

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response to the line of questioning of Dr Cheng on Friday about whether this could have weakened the seat foundations."
Do you see that?
A. I'm aware of this, yes.
Q. You then do a calculation in relation to deceleration. But your last sentence says:
"So I don't accept that the seat foundations were weakened by the collision."
Would it be more correct to say "were weakened by the deceleration"?
A. Yes, I could accept that correction.
Q. Thank you. Lastly, or almost lastly, on the question of the seats, the type of screws that were used you've been critical of. Would you accept that this is a design fault?
A. There were a number of screws used, of course. The majority of them I do feel was a design issue.
Q. Thank you.
A. Although whether the fault lay in the design office or not, I do not know. But I suspect that it did not. I suspect it was probably more of what I would call a production issue, in that that is how seats were attached, so that is how the person on the shop floor attached them. I don't believe there were any design

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drawings showing the seats' attachment.
Q. It's more a construction fault than a design fault?
A. Correct.
Q. Yes. Thank you.
Would you turn to page 467, please, of your report. Appendix IV, number 10. I want to ask you a question about that.
I believe you said, and by all means correct me if I misunderstood it, that this hole was specifically created. Or did you mean this was the part of the damage after the collision?
THE CHAIRMAN: I think the witness said it was a ventilation hole.
MR GROSSMAN: I see.
THE CHAIRMAN: Am I right?
A. Correct. If it would help explain it, I can refer you to a photograph.
MR GROSSMAN: By all means.
A. It's photograph 185 in police album -- it's in one of the police albums, and it's photograph 185.
I thought this photograph showed on the right-hand side -- can we scroll slightly to the right? Thank you. Just to the right of the person in blue, you can see a white mushroom shape, which is a vent opening, and on the left-hand side of the picture there is a hole in the

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deck where the vent trunking has been knocked over.
Q. I see. Thank you. No, I understand that.
I'll turn to another point. If you could look at page 473, please, of your report. Here you go into detail about the final attitude of Lamma IV. Could you just explain to me, if it's possible, how soon after the collision would it have become apparent to anyone watching, I don't mean on the Lamma IV, but to anyone watching, that it was beginning to tilt?
A. I think if we reference my timeline, the latest timeline on page 482, I think you would notice perhaps 1 degree of tilt, but we'll accept, say, 2 degrees of tilt would be quite noticeable.
2 degrees of tilt is roughly 35 seconds, Mr Grossman, according to this graph.
Q. Yes.
A. Somewhere between 15 and 35 seconds, depending on how experienced you were.
Q. Yes. All right, thank you.
Now, I want to ask you just a little about the damage to the Sea Smooth that you've mentioned. Was there any aspect of the integrity of the Sea Smooth after the collision that would have prevented it stopping?
A. With hindsight, Mr Grossman, no, I don't believe there

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was any structural reason that it could not have stayed to assist, if that's the question you are asking me.
Q. Yes. I well understand there may be other reasons, but from a structural point of view?
A. From a structural point of view, and from a possible watertight integrity point of view. But it's not for me to judge whether other people saw it sinking.
Q. I quite understand. I understand. I just wanted to clear that particular point.
Finally, I want to ask you a couple of questions about the whistle, which you deal with in paragraph 68. First of all, let me ask you this. You've said that the whistle, if indeed it was sounded, would have been heard on the upper deck of the Lamma IV. Would it have been heard, or should it have been heard, by those on the Sea Smooth?
A. Indeed you would expect it to be, sir. It's designed for that very purpose.
Q. Thank you. Would you have a look, please, at page 469. I think there's a better picture on page 469. You pointed out the corrosion that you saw on the whistle.
A. On page 468, the corrosion. Yes.
Q. Sorry, page 468, you pointed out the corrosion.
The vessel, as we know, and the wheelhouse had been underwater for a while.

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A. Yes.
Q. You made your inspection sometime in the second week of December?
A. Correct.
Q. Bearing in mind that the vessel and the electrical components had been exposed first of all to seawater and then to the elements, sea air, et cetera, would you not expect to find corrosion?
A. It's a good question, Mr Grossman, that I should have addressed. I would point out that the adjacent item, the adjacent switch, shows rust on the terminals. That's in the middle of the picture. I would expect to see rust in that particular case, from the fact that it was immersed in water. Or perhaps it was not immersed; I'm not 100 per cent sure.
But the point I wish to make is that the blue-colour corrosion on the horn button contacts suggest to me that it is a copper deposit, without doing a chemical analysis, and it is typical of corrosion you would get if there was an electrical supply to that particular unit.
We know the electrical supply failed on Lamma IV, so I personally am of the opinion that the corrosion you see on the horn button was not caused after the electrical supply had been disconnected.

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MR GROSSMAN: Thank you very much.
A. Thank you.
THE CHAIRMAN: Yes.
MR ZIMMERN: Thank you, Mr Chairman. Might we be permitted to ask a question about the navigation lights, in relation particularly to the failure of the power supply?
THE CHAIRMAN: Yes, please do.
Examination by MR ZIMMERN
MR ZIMMERN: Good morning, Dr Armstrong.
A. Good morning, Mr Zimmern.
Q. Your last answer was that the electrical supply failed on the Lamma IV, and I think that's consistent with the evidence you gave on the first day, that the generator failed about 18 seconds after collision, based on your flooding model.
A. Based on my flooding model, yes.
Q. I'd like to ask some questions in relation to the power supply to the navigation lights. If the sole source of power to the navigation lights was the generator, it would be natural that those lights would likewise fail?
A. Correct.
Q. However, we're given to understand -- and this is where we'll need some assistance from you -- from Cheoy Lee that there was a back-up battery, as one would expect,

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and that this battery was located in the engine room on the port side.
A. (Witness nods).
Q. Unfortunately we don't have any direct evidence as to this, so if the secretariat could turn up marine bundle 2 at page 316.
This is a letter from Cheoy Lee enclosing some drawings, in particular the electrical equipment arrangements and some schematics, and I'm hoping if you'd be able to assist us through looking at these documents, whether you can determine where this battery may or may not have been placed.
A. I believe so, Mr Zimmern. I'm familiar with the drawings.
Q. I'm grateful.
THE CHAIRMAN: Are you able to help us from your own inspection of the vessel?
A. In some small way, that I stood on the battery at one particular stage when I was inspected the side damage and looked down and noticed that they were two batteries close together, and I thought at that stage, "Surely, they are not the emergency power supply." Unfortunately I did not take a photograph of them, but I was aware that they were on the port side of the engine room.
MR ZIMMERN: I'm not sure whether this would assist. From

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the schematics, would one be able to discern where the emergency battery or reserve battery would be located?
A. From the schematic, no, sir. A schematic does not give locations.
Q. If I could then see if this might assist. If we could turn to marine bundle 1, page 151. This is a photo, from what I can see, that looks towards the genset, or generator, and on the right we can see the gash on the port side. Is it possible within this photo to see where the batteries you happened to step on are?
A. Unfortunately not, Mr Zimmern. I believe the photographer was standing on the batteries when he took this picture.
THE CHAIRMAN: But this is a matter that could be enquired into now, could it not?
A. It could be, by looking at the ship.
May I refer you to drawing 317.
MR ZIMMERN: Yes. In marine bundle 2?
A. In marine bundle 2. You asked me about whether the schematic could tell you where the batteries were. This is not a schematic; it's a layout of the electrical system.
Q. This is the arrangement plan for the electrical system?
A. Arrangement plan for the electrical system.
THE CHAIRMAN: I think we're at cross-purposes here. Which

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document do you want on the screen?
A. Page 317. It is a rather poor copy, but the larger version is somewhat clearer. If you can zoom in on the lower plan -- that's the one -- and zoom in as close as you can in the engine room. Maybe a little closer, if you can. Excellent. And to the left little. Thank you.
This is a layout of the engine room. In the bottom left-hand corner, near the centreline, you might see a rectangle marked "genset". Just below that, there's a little box which on the larger scale can be seen to be the 12-volt batteries which are used to start the genset. So that's one set of batteries.
MR ZIMMERN: Yes.
A. On the starboard side of the engine room, you can see a roughly rectangular box called "Caterpillar 3412". Below that, there is another box which, if you read on the better copy, says "24-volt" -- and then it's got an amperage, I think. That is the starting battery for the starboard main engine.
Q. Yes.
A. That's the second set of batteries. On the other side of the vessel, the port side, you've got a corresponding set of batteries for starting the port main engine, and alongside that, another box which I believe to be the

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emergency back-up batteries. Having said all of that, the back-up batteries were charged by -- could be charged by either the generator or from, as I understand it, the starboard engine, which had its own alternator set on it. It could also be -- no, it was charged by the port engine generator or the starboard engine generator. The separate genset was not used to charge the back-up batteries.
I found that a little unusual, because I would not expect the emergency source of power to be in the same compartment as the main source of power. It means if you have a fire in the engine room, you've lost all electrical power.
Q. Likewise, if the engine room was submerged, you might likely lose all electrical power?
A. You would lose all electrical power.
Q. That just leads me to the next point, Dr Armstrong. Had the battery been submerged, it's likely that there would be no power to the navigation lights?
A. I'm not expert enough to be able to answer that question.
Q. I'm grateful. But when you did notice the batteries, they were on the ground?
A. Correct. But when I saw the engine room, there had been a lot of clearing up done and I cannot be certain that

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they were in the correct location.
Q. At that particular time?
A. At that particular time.
Q. Just generally, with a reserve battery, would you expect it to be attached to the floor or to the wall of the compartment?
A. They were in a glass fibre battery box secured to the floor of the compartment, from memory.
MR ZIMMERN: I'm grateful. Thank you very much, Dr Armstrong.
A. Thank you.
MR PAO: Mr Chairman, might I have leave to ask Dr Armstrong on several issues. First, the thickness of the plating; the effect of the epoxy bedding material used for fixing the self-tapping screw; the so-called missing door at frame 1/2. I would also invite Dr Armstrong to look at the preliminary stability book produced by Naval-Consult, and I would also like to clarify with Dr Armstrong his previous work experience, whether he has had any opportunity of working with Cheoy Lee.
THE CHAIRMAN: Yes, please do.
Examination by MR PAO
MR PAO: Dr Armstrong, we notice that in the late 1970s you were employed as a ship surveyor in the Marine Department in the New Construction Section?

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A. I was, yes.
Q. During that period of time, have you had any opportunity of working with Cheoy Lee?
A. I have, yes.
Q. After you moved on to greener pastures, have you also had an opportunity of working --
A. Sadly not, that I can recall. Would you like me to explain my experience with Cheoy Lee in the first place?
Q. Please do.
A. I was involved as a surveyor to oversee the construction of some fibreglass diving platforms, I think for the Public Works Department. There may have been three of these, one of which was eventually moored off Repulse Bay and used for people to dive off, another one at Shek O, I seem to remember, but I can't remember where the third one was. It was a simple construction. It was not a ship.
Q. After you moved on, in the latter years of your career, have you also had the opportunity of working with Cheoy Lee?
A. I cannot recall any opportunity at all.
Q. Right. Because I seem to have seen drawings --
THE CHAIRMAN: Just a moment, Mr Pao. I'm going to ask that the microphone be repositioned so that we can hear the conversation you're having with Dr Armstrong.

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MR PAO: I just want to make sure that your answers to questions put to you would not be affected by your experience working with Cheoy Lee?
A. Of course, yes. Of course.
Q. That's what I --
A. I did once survey a yacht on behalf of Australian Customs Service that was being imported into Australia that had been built by Cheoy Lee. That vessel was accepted and there were no problems.
I had one other experience where I -- my hobby used to be radio, and I picked up an SOS from some Americans at sea between Hong Kong and Guam who were sailing a new vessel built by Cheoy Lee and got caught in a typhoon, and I was able to assist in the rescue of those people.
Other than that, which is very tenuous, I can think of no other connection with Cheoy Lee.
I knew Mr CY Cheung, the engineer, and Ken Lo.
Q. During that time when you have had these experiences working with Cheoy Lee, were you able to form an opinion as regards Cheoy Lee as a shipbuilder?
A. I was, although they were principally at that stage involved in building yachts, and I have the highest regard for Cheoy Lee.
Q. In your evidence I believe on Monday, you said that -- may I just find the reference to that page first.

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I can't find it at the moment.
You said in your evidence to the effect that a shipbuilder would not take the risk of building a ship that would end up not being certified as seaworthy, and that would be a risk that you as a shipbuilder would never take.
THE CHAIRMAN: That was in the context, was it not, of taking a risk from building a vessel that didn't accord with the drawing?
MR PAO: Yes.
THE CHAIRMAN: That's the context.
MR PAO: Yes, that's the context. Not building to the plan approved, and risk the ship not being certified as seaworthy.
A. Correct, yes.
Q. So in your view, would Cheoy Lee take such a risk?
THE CHAIRMAN: Are you in a position to answer that?
MR PAO: If you're not in a position to answer that, then say so.
THE CHAIRMAN: I can't imagine how you can be in a position to answer that.
A. Well --
THE CHAIRMAN: You're asking how somebody else would conduct themselves. That's not within the witness's expertise.
MR PAO: No, in his experience with working with Cheoy Lee.

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THE CHAIRMAN: I can't see how anybody can answer that. That's for Cheoy Lee to answer.
A. My experience with Cheoy Lee was 35 years ago as well.
MR PAO: That's fair enough.
Dr Armstrong, you have read the evidence of Mr Lo. Have you read the evidence of Mr Lim of Naval-Consult?
A. Probably. I'm not 100 per cent sure.
THE CHAIRMAN: If it helps you, he was the witness who gave evidence from Singapore via videolink.
A. Unfortunately at the time, sir, I was away from here.
MR PAO: I would like you to have a look at the Preliminary Trim & Stability Booklet that Mr Lim produced.
I'm just looking up the page reference for that particular document, Mr Chairman.
THE CHAIRMAN: Yes.
MR PAO: It's in the miscellaneous bundle, starting from page 111.
Move further on to page 26 or so of this document. Can we scroll down. "Damage stability". And then further up. Stay on that page, please.
This is a preliminary stability calculation done by Naval-Consult.
A. May I ask you if you know the date of this document?
Q. Yes, we do. It's late 1994.
THE CHAIRMAN: Where do we see that?

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MR PAO: It's over the page, where the graphs appear. Further on. At the top left-hand corner.
THE CHAIRMAN: Page number?
MR PAO: Page 143, I believe.
So it's 1994, 23 December.
THE CHAIRMAN: It's a fax transmission imprint, is it not?
MR PAO: No, it's not. We've confirmed with Mr Lim that --
THE CHAIRMAN: "21:37"?
MR PAO: No, "21:37" is the time when this document was printed out, presumably.
THE CHAIRMAN: I see.
MR PAO: We've in fact confirmed with Mr Lim that this report was done between the period of late 1994 to mid-1995, and it was after the drawings were completed but before the vessel was constructed.
Could we go back to that previous page, 141, I think. Yes.
This is a damage stability calculation prepared by Naval-Consult on the basis of "full loaded departure with 200 passengers, damage condition, steering & tank room damage with passenger crowding".
This is in fact the calculation you were looking for, for one-compartment flooding of the vessel Lamma IV, that you say that someone in Cheoy Lee's office should have done?

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A. Mm. (Witness nods).
THE CHAIRMAN: Do you agree with that?
MR PAO: I think Dr Armstrong nodded.
A. I do agree with that.
THE CHAIRMAN: Thank you.
MR PAO: In your view, had the design office in Cheoy Lee prepared their own damage stability calculations following what has been done by Naval-Consult, then all the rest of the errors down the line would not have occurred. Would you agree with that?
A. No, Mr Pao, I would not agree with that because of the alterations that were subsequently done that increased the weight of --
Q. I'm concentrating on 1996 at the moment, sorry. I haven't made myself clear.
A. Okay.
Q. So had they prepared their damage stability report following the line that Naval-Consult has undertaken in their calculation, in 1996, then there would have been no problem; the error would not have occurred?
A. Well, it would have complied with the damage stability requirements but maybe would not have complied with the requirements that there be an aft peak bulkhead.
Q. Yes. I agree with you on that score. But you also said that there was a serious disconnect between the office

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staff and the engineer on the ground.
A. The surveyors on the ground.
Q. The surveyor or engineer on the ground, in relation to these calculations and what actually was on the ground, on the vessel?
A. I think I said it seemed to me that there was a serious disconnect, yes.
Q. If that happened within your company, there's this kind of serious breakdown in communication between the design staff and the engineer down on the ground, what would you have done?
A. I think you need a programme of continuous professional development whereby people are continuously trained to understand why they do things and what the risks involved are, and to understand the basis of why they're doing what they're doing. So I think it's largely --
Q. What they have been doing wrong in the past?
A. It's largely a question of training.
Q. Yes. And that, I understood, has been put in place in Cheoy Lee.
THE CHAIRMAN: Well, if that is to be dealt with in evidence, then it will be put in by evidence, not by statements by counsel.
MR PAO: Yes. No, no. I fully appreciate that, Mr Chairman.

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Coming to the thickness of the aluminium plating. You have done all the calculations, and there are some handwritten calculations you have prepared, and you arrived at the figure of 5.22 mm.
A. (Witness nods).
Q. Forgive my ignorance, but it appears that the corrosion characteristics of the respective metal, being steel and aluminium, has not been factored in. Would that be the case? Or you don't need to factor in the corrosion characteristics for that calculation?
A. If we're referring to the calculation that is in -- well, it's not a calculation, it's a table in the Instructions to Surveyors 1995, there is no specific mention that I can recall on corrosion. It merely says, "The thickness shall not be less than 5 mm". Your question, as I understand it, is should I have allowed for the fact that some class societies require you to have 0.4 of a metre thickness to allow for corrosion on steel, and not for aluminium? I could accept that argument.
Q. So 5.22 mm could be thinner, taking into consideration your evidence that aluminium alloy does not corrode that much?
A. Yes, it could be marginally thinner, yes.
Q. Could be marginally thinner?

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A. Yes.
Q. Because when we're talking about 0.23 and 0.24 of a millimetre, we're basically talking about the thickness of an average fingernail, are we not?
A. Yes, but when it says "not less than", "not less than" is quite specific. It's not a range.
THE CHAIRMAN: The "not less than" refers to 5 mm?
A. 5 mm, yes, sir.
MR PAO: That was in the 1995 Instructions.
A. Correct. There was nothing in the Blue Book.
Q. Yes. I have explored this with other witnesses in that when the ultrasonic gauging test was done, spots of paint needed to be removed from the hull plating before the touchpad of the ultrasonic device could be put on it to get an accurate reading.
A. Yes.
Q. I was thinking of a scenario where a heavy-handed worker with an electric grinder, pushing it against the paint to remove it, would that marginally reduce the thickness of the plate?
A. In my opinion, no, sir. Because once the paint is removed, the grinder then meets the aluminium oxide. The grinder is probably made of aluminium oxide. So I think there would be some heat generated, but not a lot of material removed.

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Q. You're saying that underneath the paint, there will be a layer of aluminium oxide?
A. Oh, yes.
Q. Always?
A. Because it's formed before the paint is put on. It forms very rapidly.
Q. I see. When it comes into contact with the atmosphere, it would then be formed?
A. With the atmosphere, yes. Within a second or two.
Q. You know that the Lamma IV has been in service for 16 years. During that time, it would be repainted?
A. (Witness nods).
Q. Maybe annually, biannually?
A. Yes, it had been well-maintained.
Q. During that process of repainting or stripping down of the old paint and then priming and repainting it, would that reduce the thickness of the aluminium plating?
A. I don't believe it would have reduced it by a measurable amount, sir. There is in existence -- I'm sorry, there was in existence until very recently a vessel called the Sacal Boracino which was a roll-on, roll-off vessel operating in South America which was almost 50 years old, built from aluminium, and had been repainted a number of times, and was still in class. If it was still in class, then the thickness could not have

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reduced by a substantial amount, otherwise it would no longer have been in class. The vessel has now been scrapped, but it was the oldest aluminium craft that I was aware of. And 50 years is a lot longer than steel vessels that have managed to survive.
Q. I see. So the thickness hasn't been reduced significantly?
A. I have no knowledge of the thickness of Sacal Boracino. I do know it was still in class.
Q. Would you say that it's a possibility that during the painting and repainting over the years, that paint stripping exercise would reduce the thickness? Or it's not a possibility that you would entertain at all?
A. Mr Pao, it would reduce in thickness by a very small amount. I would find it hard to say by how much, but I would think less than 0.1 of a mm.
Q. Less than 0.1 of a millimetre?
A. My opinion.
Q. Yes. You've seen the documents of the material purchased by Cheoy Lee for the construction of this vehicle being certified by the American Bureau of Shipping as 4.83 mm?
A. Yes.
THE CHAIRMAN: Mr Pao, we don't have those certifications, do we?

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A. No, we don't, unfortunately.
THE CHAIRMAN: No.
MR PAO: But they ordered 5 mm and they were supplied with that, and they immediately informed the Marine Department that -- I think that's --
THE CHAIRMAN: But it's a missing document, as far as we're concerned, the certification?
MR PAO: It is, unfortunately, yes.
But if it is indeed certified by the American Bureau of Shipping, 4.83 mm, do you still maintain your --
THE CHAIRMAN: Is it likely to have been certified in metric or by imperial measure?
MR PAO: Imperial measure, I believe, sir.
THE CHAIRMAN: 0.19 inches, yes.
MR PAO: Yes.
If it has indeed been certified by the American Bureau of Shipping as 0.19 inches, do you still maintain your view that the hull of the Lamma IV was probably built with 4.5 mm or 4.4 mm aluminium alloy plating?
A. My conclusion was that in my opinion, Lamma IV was built undersized, and by that I was referring to less than 5 mm.
Q. Less than 5 mm?
A. That was because I believed the 1995 Instructions were relevant, and the 1995 Instructions clearly state that

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you should not use classification society rules --
Q. Unless you are in the class?
A. -- unless you are maintained in class. And the reasons go back to what I have said before today, that you need to be in class using the rules in their entirety.
If you want me to answer the question about whether 4.8 was satisfactory, I would say no, because the minimum size is 5. And the certified drawings, the approved drawings, showed 5.
Q. That should have been after that letter informing Mardep that it was in fact 0.19 inches -- they should have some sort of confirmation that --
A. I've not seen any --
Q. We haven't seen any either. The subject was ignored, as Mr Chairman has observed. We'll leave it to that.
Coming to another subject.
THE CHAIRMAN: If you're moving to another topic, perhaps if it's not inconvenient to you, we'll take our mid-morning break.
Dr Armstrong, we'll take a break for 20 minutes.
(11.35 am)
(A short break)
(11.55 am)
THE CHAIRMAN: Yes, Mr Pao.
MR PAO: Dr Armstrong, just before the break we were talking

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about the evidence of Mr Lim of Naval-Consult. Do you remember that?
A. Yes.
Q. I was slightly concerned that you don't seem to be fully aware of what Mr Lim has said, so may I invite you to look at one document, which is marine bundle 11, page 4027.
THE CHAIRMAN: Frankly, Mr Pao, I don't think an interchange of emails between Cheoy Lee and Mr Lim is a terribly helpful way to go about this.
MR PAO: No, this is Mr Lim answering the questions of the Marine Department investigator.
THE CHAIRMAN: Yes. We've had Mr Lim give evidence. Is that not the primary material before the Commission?
MR PAO: Yes, it is. But I just want Dr Armstrong to know the background of this, because in this email Mr Lim told the investigator, Mr Ho of the Marine Department, that Lamma IV was designed to the one-compartment flooding criteria, the single-compartment flooding criteria, and in the answer to question 2, when the investigator asked Mr Lim:
"Was there a mistake of the draftsman to decide the bulkhead 1/2 as watertight in some of the drawings?"
And Mr Lim has said:
"In this instance, I would say yes. This could be

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the result of him modifying existing drawings from a previously built vessel (MV Eastern District No. 1)."
So in Mr Lim's evidence, it was a mistake in not rubbing out the "watertight" notations in the other drawings, rather than making that bulkhead at frame 1/2 a watertight bulkhead.
Dr Armstrong, you said that even if the floodable length criteria is satisfied by a recalculation of damage stability by the Cheoy Lee design office, it still would not have passed, in your view, the requirement of watertight aft peak criteria. Is that correct?
A. Correct, yes.
Q. In 1996, that is?
A. Correct.
Q. Now the question turns to how long can that aft peak compartment be, and I believe my learned friend Mr Mok will deal with that with you in due course.
THE CHAIRMAN: Mr Pao, may I enjoin you as much as I possibly can to speak into a microphone. It's very difficult to hear what you're saying.
MR PAO: Yes.
On the question of the passenger seats, you have read the evidence of Dr Cheng for the Government forensic unit?

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A. I have, yes.
Q. Dr Cheng gave evidence that the force of the impact would not dislodge the seats from the upper deck?
A. Yes.
Q. Is that evidence consistent with your calculation that the G-force of 0.24 G -- is it consistent with that calculation that you have done at page 956-13?
A. Yes. As I indicate in that calculation, that's about the level you would expect to see with the vessel rolling in a sea, and you would not expect the seats to become -- in fact, you would not want the seats to become dislodged when operating in a seaway. So I agree with Dr Cheng in that regard.
Q. So the impact force would not dislodge the seats? It's only when the ship started tilting and the passenger weight was on the back of the seat, that dislodged it?
A. That's my opinion, yes.
Q. Thank you. Coming back to the missing door. Your evidence is that in 2005, when the ballast was moved 10 inches higher, the damage stability calculations would show that even if you fix a watertight door at bulkhead 1/2, it still would not have passed that criteria of one-compartment flooding? When the ballast was raised 10 inches, and then your evidence is that fixing a watertight door at bulkhead 1/2 is not the

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solution.
A. Correct.
Q. You either reduce the weight of the ballast, or you fix a buoyancy tank at the transom?
A. Correct.
Q. So, in your view, that should have been recommended or if the calculations were done properly, then a solution would be found along those lines?
A. The problem would have been identified and then a solution needed to be found, yes.
THE CHAIRMAN: If the calculation had been done properly?
MR PAO: Yes. That's --
A. That's what I said, yes.
Q. That is in fact the basis of my question: if the calculations were done properly, along the lines that Naval-Consult had done in 1994.
A. Correct.
Q. Yes.
A. From what I have seen of these calculations in 1994, they are done correctly.
Q. I'm coming to the end of my questioning. After all these number-crunching exercises -- if I may invite you to take one step back and look at the picture, say -- would you consider that the passenger weight on the upper deck towards the stern of the boat was a very

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significant factor that caused the Lamma IV to sink as quickly as it did?
A. No, sir, I would not think that was the case.
Q. You would not. Okay.
Take another step back. Considering the velocity of the impact during the accident, and the grave injury that was caused to the hull of the Lamma IV, would you say that it really doesn't matter whether there's a watertight door at the bulkhead 1/2; that Lamma IV would not survive the accident in any event?
A. According to my calculations, Mr Pao, if the door had been there, the vessel would have floated, despite the injury.
MR PAO: Thank you, Dr Armstrong. I have no further questions.
A. Thank you.
THE CHAIRMAN: Yes, Mr Mok.
MR MOK: Mr Chairman, Commissioner Tang, I would like to explore with this witness several areas about the hull, the plating thickness; about the seating arrangements; and also a bit about flooding, and the plans.
THE CHAIRMAN: Yes.
MR MOK: I would also like to ask Dr Armstrong to clarify one small matter.
THE CHAIRMAN: That being?

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MR MOK: It's a small matter concerning the choke factors.
THE CHAIRMAN: Thank you. Please proceed.
Examination by MR MOK
MR MOK: Good morning, Dr Armstrong.
A. Good morning to you, Mr Mok.
Q. I would like to explore with you the several areas that I mentioned, and the first one is, may I seek a clarification in relation to the choke factor just so that I do not understand your evidence incorrectly.
This is a reference in your report on page 416 of the bundle, paragraph 39. This is about five lines from the bottom of paragraph 39. It states:
"The finally selected values were 0.2 for the engine room hole (diagonal slot), 0.4 for the rectangular hole in the engine room near the aft bulkhead, and 0.80 for the rectangular hole into the tank compartment."
I know you have revised these figures in the supplemental report, but for the time being this is a reference to the graph at page 465; correct?
A. Correct.
Q. Am I wrong in understanding -- just for clarification, in fact the number should be altered a little bit so that 0.2 should be exchanged for 0.8 in this sentence?
A. I see your dilemma. Just one minute, please.
THE CHAIRMAN: Yes. Take your time. You did make

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a correction in your evidence.
MR MOK: Yes.
THE CHAIRMAN: As I understood it, it was -- I better look at my notes.
MR MOK: Mr Chairman, my understanding is it's the other way round, so that the gash, which is diagonal slot, should be 0.8; and the hole in the tank compartment should be 0.2. I just want to make sure that I have not misunderstood this.
THE CHAIRMAN: Yes.
A. Could I possibly refer you to page 489-18.
MR MOK: That's the supplemental?
A. This is in expert bundle 1. Page 489-18 is showing part of the calculation. In this case it is the tank room. You'll see the yellow box shows the choke factor as being "0.8" for the tank room. Then on page 489-22 it gives a choke factor of "0.4" for the engine room. I think maybe page 489-32 -- page 489-12 shows a value of "1", which is the assumption that there is a complete opening there; there is no choke factor. There is no choking. It is a little confusing, because if there is no choking at a value of 1 -- so I think the words are correct, Mr Mok.
THE CHAIRMAN: So no choking between the tank room through the access room to the steering compartment; is that the

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point?
A. The box on page 489-12 allows you to enter "0" for "closed", which is, if you like, fully choked, Mr Chairman. Or you can put in "1", which means it's fully open.
THE CHAIRMAN: But the place that we're considering is the access opening between the steering compartment and the tank room?
A. In that particular case, yes, sir.
THE CHAIRMAN: Yes.
MR MOK: To put it simply, the lower the number, then there would be more choking; right?
A. The more choking, correct.
Q. Therefore, in that sequence -- 0.2, 0.4, 0.8 -- it would actually represent the directions from the engine room to the tank room, as you've indicated in the sentence?
A. Yes. And the graph you referred to on page 465 is also correct, but the choke factors have appeared in the reverse order.
Q. Yes. Yes, because when I was listening to your oral evidence, I got the impression that it was the other way round. So it's probably my mistake.
A. Possibly mine, because it's a bit of a pressure sitting here. I don't profess to be perfect.
Q. No, of course. It's understandable.

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Now, the second matter I wish to take up with you concerns the plate thickness. The first document I invite you to look at, which you have no doubt seen, is the purchase order of Cheoy Lee. This I think is in the W&G bundle at page 17.
A. Yes, I have seen this before.
Q. Yes. Now, am I correct in understanding that you prepared your first report, you had not had the opportunity of seeing this particular document?
A. That is correct, yes.
Q. What this document shows, Dr Armstrong, in item 4 is that when the side plating was ordered, they were ordered to the standard of 5 mm?
A. Yes, I see that.
Q. Just while you are on this series of documents, you will see that there was also a packing list on page 23, and at page 25, item 20, you see the same item, being the packing list of the materials which was sent to the Wuzhou Shipyard.
A. Yes, I have seen that.
Q. Now, in relation to this or -- before I go to the question, can you go to page 18. You will also remember that one of the requirements of Cheoy Lee from this Florida firm is that the ABS inspection certificates were required.

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A. I noted that, yes.
Q. In relation to the manufacturing process, you had given a very helpful explanation. So if I may direct your attention to that now. Day 25, page 48, starting from line 1.
Can we go to the end of page 47 first.
Can I read this to you. It says:
"Answer: May I first of all explain, for the understanding of the 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."
That's a very helpful explanation. Is it because of the inherent difficulty of the manufacturing process to keep the thickness at precisely the thickness that was ordered? Is it an inherent difficulty in the process?
A. It is, yes. Yes.
Q. And therefore would it be correct to say that it is common practice, as you said, in the industry that when a shipbuilder orders, say, a particular thickness, say

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5 mm, and the actual plate that is delivered is, say, 4.8, then under industry practice, the shipbuilder has an obligation to accept the plate that has this particular under-thickness? Is that the practice?
A. Mr Mok, no. I said it is common practice to hope.
Q. To hope?
A. I didn't say it was common practice to organise it or to --
Q. No, no. I don't mean organise. What I mean is, because it is so common -- I'll put it another way -- the shipbuilder is not entitled to reject it on that ground?
A. Correct.
Q. And when it is eventually delivered, say with an under-thickness of, as you put it here, 0.2 mm, for example, does that mean that the shipbuilder would have to pay less because the eventual delivery was lighter than what was originally ordered?
A. In this particular case, Mr Mok, I do not know, is the answer to that question. But in my experience elsewhere, usually it would be paid for by weight so if it came in undersized, you would pay less for it. That may not have been the case in this contract.
Q. I understand. So that would mean, would it not, that there must be some sort of certification at the end of the manufacturing process to gauge precisely what was

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the thickness of the eventual product, so that the shipbuilder and the plate supplier would know exactly what the price should be?
A. Normally that would just be by weighing it.
Q. By weighing it. Where you have a certification such as the ABS certificate, would you also normally expect that the thickness be stated there?
A. Yes, I would expect that.
THE CHAIRMAN: Just give me a moment, please. Thank you.
MR MOK: The next document which is relevant in this series is the familiar letter that is at page 206 of marine bundle 2, tab 6.
THE CHAIRMAN: Just whilst we're on this American Bureau of -- is it "Shipping" -- ABS?
MR MOK: "Of Shipping".
THE CHAIRMAN: Since that document, insofar as it's relevant to us, appears to be missing --
MR MOK: It appears so.
THE CHAIRMAN: Are there any other versions of a survey relevant in this process that would help us understand what information ought to have been supplied, if the document existed?
MR MOK: Well, in terms of what appears in the bundles --
THE CHAIRMAN: No, I don't think we'll find it there. Perhaps this is a question I should be addressing to

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Mr Pao.
Mr Pao, can you help us so that at least we can understand what might have been on the missing document, by providing us with another one that deals with this issue?
MR PAO: I will have to take instructions on that.
THE CHAIRMAN: Thank you.
MR PAO: But I think the CCS evidence might be useful, because they were given sight of the documents.
THE CHAIRMAN: That was, on your evidence, provided through Cheoy Lee to them?
MR PAO: Yes.
THE CHAIRMAN: Yes. What I'm asking for is a precedent so that we can see the nature of the document.
MR PAO: More recent documents, or --
THE CHAIRMAN: Anything that gives us an idea of what is likely to have been on the document.
MR PAO: I see. I'll take instructions on that, Mr Chairman.
THE CHAIRMAN: Thank you.
MR MOK: Thank you, Mr Chairman. That would be very helpful indeed.
The document I'm referring to, which by now you may have seen several times, is at page 206.
A. Yes.

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Q. Again, my understanding is that you did have this document with you when you prepared your first report?
A. In fact I did have access to it, and I had read it, but I did not read the middle paragraph as referring to the shell plating.
Q. Yes, that's my understanding from your earlier evidence. If we go to the middle of this letter, where it refers to:
"We would also like to advise of the following changes: 1. 0.19 inches (4.83 mm) plating in place of 5 mm plating."
Pausing there. Reading this letter as a very experienced professional, would you understand this to mean that although the original intended thickness was 5 mm, but what was delivered was less than that, so it would be 4.83 mm instead of 5 mm, that was the information Cheoy Lee was giving Mardep at that time?
A. Mr Mok, in my experience in shipbuilding, there are always practical things that come up and it is common practice to go back to the approving authority and say, "I'm sorry, but this has changed. Can we please have your permission to go ahead with something different?" I think the 4.83 would have been a good example where you could have gone back to the certifying authority and said, "Sorry, it's not 5; it's 4.83", and I would have

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expected that to have been approved in this particular case. Even though I have not seen any approval letter, I still have a small difficulty with the fact that the regulations, as I read them, do say "shall not be less than 5 mm".

Q. Dr Armstrong, we will come to that point later. For the time being, may I ask you to confirm this. On the basis that this letter is correct, in other words that the plating was 4.83 mm instead of 5 mm, would you agree that this under-thickness is perfectly in line and consistent with the industry practice regarding the difficulty of plate manufacturing of which you just informed us?

A. Yes, I would agree with that.

Q. You will also see in the next paragraph that the letter says:

"Our designer advised changes are acceptable and remain within applicable DNV rules."

May I invite you to look at one particular document which we have in the bundle. If you can just give me a minute. I believe this document --

MR SHIEH: Does my learned friend have in mind expert bundle 2, page 952? That's a document produced by Dr Armstrong himself, I think.

MR MOK: I may be looking at a slightly different document.

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Can I have a minute, Mr Chairman.

THE CHAIRMAN: Yes. Take your time.

MR MOK: I'm looking at page 4048. I don't know which bundle this is. Is it marine bundle? Yes, this is the document.

Dr Armstrong, these are the DNV Rules. There is a collection of them referred to on this page, 4048. But the one that we're interested in is at page 4049, for metallic materials, the date of which was January 1993.

If you go over the page to 4050 and look at the table -- before we look at the table, you see there's a paragraph 401. Do you see that?

A. Yes.

Q. It states:

"The surveyor does not inspect dimensions or surface condition of each single plate, section, et cetera. It is the aluminium producer's responsibility that the requirements for dimensional tolerances are satisfied."

Do you see that?

A. Yes, I accept that. It's the process that is approved, not the individual plates.

Q. So if I understand correctly, table B1 sets out what is commonly called the under-thickness tolerance of plates; correct?

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A. Correct.

Q. Say, for example, in relation to a nominal thickness of 4-10 mm, and in relation to plate size, the relevant one being the middle one, I believe, 1,500-2,000 mm, the tolerance would be 6 per cent; correct?

A. I can see that, yes, sir.

Q. So in the present case, the nominal thickness being 5 mm, then the tolerance should be 0.3 mm; correct?

A. Yes, sir.

Q. So what this means, and reading this in the light of paragraph 401, is that the plate supplier -- that is, the Florida company -- had the responsibility to make sure that the plate that was produced by them should not exceed the tolerance of 0.3 mm, so it cannot be, for example, in relation to the order of 5 mm, less than 4.7 mm?

A. I think it's important to recognise that we have looked at a number of different standards with different values in them, and it gets back to the problem of taking something out of context. This is a set of rules from DNV which may incorporate elsewhere in their regulations some allowance for this thinner plate, perhaps. These are rules for ocean-going ships that you are quoting from. They are the main DNV Ships Rules. We have seen in other tables there are values of 0.2 mm for small

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ships and light craft, and also I think from ABS, 0.2. So there are variations between the class societies.

Q. Yes, we have indeed, and in your evidence, you say that 0.2 mm is an acceptable tolerance?

A. Correct.

Q. I understand your point about different rules and about the context. But whatever rule you apply, I think you agree that you've got to give a tolerance to the manufacturer because it is inherently almost impossible for the manufacturer to produce precisely the thickness that has been ordered?

A. Yes, I agree, and it's usually, as it stated here in table B1, a minus tolerance. Some specifications say there should be no positive tolerance. So you should not end up with it thicker.

Q. Right. Thank you for that. Really, the point that I'm exploring with you, Dr Armstrong, is not so much what rules should apply, rather what was the thickness of the plate which was actually delivered to Cheoy Lee. That's the point that I'm at.

A. Understood.

Q. I believe you said, and you've confirmed it this morning, that Cheoy Lee is a well-respected, highly regarded, reputable shipbuilder in the industry; right?

A. I have said that.

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Q. Those are the various descriptions you have used.
A. I have said that, and I believe that.
Q. Yes. Now, do you agree that if what is stated in this letter, being 0.19 inches or 4.83 mm, were not true -- in other words, if the plating, for example, was in fact 4.5 mm instead of 4.83 mm -- would you regard that as a very serious misrepresentation in this letter?
THE CHAIRMAN: By whom?
MR MOK: By Cheoy Lee.
THE CHAIRMAN: If it was known to Cheoy Lee that it was 4.5?
MR MOK: Yes.
A. If it was known to Cheoy Lee, yes, it would be a misrepresentation.
Q. And it is likely, would you say, that the fact that Cheoy Lee was able to state 4.83 mm in relation to thickness of this plating was because they have seen from the ABS certificate that that was so certified?
THE CHAIRMAN: I don't think Dr Armstrong can answer that. Someone from Cheoy Lee can tell us that.
MR MOK: Right.
THE CHAIRMAN: Or perhaps someone from the China Classification Society.
MR MOK: Right.
Perhaps if I can put the question this way. Based on the requirement that there was an ABS certificate,

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based on the industry practice as you have explained to us, would it be correct to say that what is stated in this letter constitutes fairly good evidence of what in fact the thickness of the plate was as delivered?
THE CHAIRMAN: I think what constitutes good evidence is a matter for the Commission, not Dr Armstrong.
MR MOK: Thank you.
Perhaps I'll put it in yet another way.
Dr Armstrong, have you seen any other evidence throughout this case that goes to contradict the fact that perhaps -- not "perhaps" -- to contradict the fact that the plating thickness as delivered was 4.83 mm? Have you seen any evidence?
A. I have not seen any evidence that suggests it was anything other than 4.83.
Q. Right. In that case, can I --
A. But sorry, if I might just say, there is some evidence that it should have been 5, as you have just shown me, that it was ordered as 5.
Q. Yes. Again, I said that's a different question. I'm only at the point of determining the actual thickness of these plates.
Can I invite you, with that, to look at paragraph 25 of your first report, please. It's at page 410.
May I ask you to go to five lines from the bottom of

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the page, starting with:
"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 ..."
Do you see that?
A. I see that, yes.
Q. Would you be prepared, given all the evidence that you have seen, given the inherent difficulty with the construction or manufacturing process, given the letter that we have seen, given the fact that there was an ABS certificate which we have not seen, but apparently seen by both Cheoy Lee and the China Classification Society, that the likelihood was that the side plating was 4.83 and not 4.5? Would you be prepared to accept that?
A. I would be prepared to accept that, yes, bearing in mind that I had not seen or understood the letter at page 206 when my opinion was given.
Q. Thank you. Because if you are prepared to accept that, then it may be totally unnecessary for us to go to the question of the corrosion, because as I understand it, all this evidence and the opinion about corrosion is to enable one to arrive at the actual thickness of the plate as delivered. Would that be correct?

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A. Yes, I agree.
Q. With that, Dr Armstrong, can we dispense with any further discussion -- can we dispense with the actual evidence concerning corrosion? Or does it serve any remaining purpose?
A. I'm not sure it's up to me to decide whether it can be dispensed with completely.
Q. I understand.
A. I merely provided facts of what I saw in order for the Commission to decide.
Q. If I may put the question in a slightly longer way, which is this. As I understand your evidence, you noticed that in 2005 the thickness was, on the average, 4.5 mm.
A. (Witness nods).
Q. You also noticed that in 2011, it dropped slightly, according to the report, to 4.4 mm.
A. (Witness nods).
Q. Your view was that the 4.4 may have been an error, and in fact it should -- or perhaps given that error, it should still have been 4.5 mm. So far, am I correct?
A. I merely said that it could be within the tolerances of the machine.
Q. Yes. And further, you are saying that because aluminium alloy is a very hard substance, therefore it was

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unlikely that there could be such a deterioration in terms of thickness during that period of time, from the time that it was built?
A. For 5083 material, yes.
Q. Further, you said that it is unlikely that there should be a deterioration from either 5 or 4.83, to 4.5, in the first nine years -- that is, up to 2005 -- and yet there was no corrosion, or almost none, between the six years between 2005 and 2011. That you find also is an odd feature?
A. Yes.
Q. Right. Also, of course, there is the protective painting which would have shielded the vessel from corrosion in the first place?
A. (Witness nods).
Q. So based on all this reasoning, you came to the conclusion that you did in paragraph 25, that it is most likely that the vessel was constructed with a side plating of 4.5 mm to start with.
Would that be a correct summary of that line of reasoning?
A. Yes.
Q. So that is why I said that if you are prepared to accept that the original plating was most likely to be 4.83 instead of 4.5, then all this discussion and reasoning

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concerning corrosion will become unnecessary. Would you agree with that?
A. I can accept that line of argument, yes.
THE CHAIRMAN: Let me understand what the issue is.
If the plate, as you've accepted I think now is likely, was 4.83, is it possible that it was corrosion that resulted in it being measured as 4.5 in 2005?
A. It could have been a certain degree of corrosion. It could have been the level of accuracy of the measurement device. It's more corrosion than I would have expected, sir, but it is possible.
THE CHAIRMAN: So it could have been corrosion, or the accuracy of the device used to measure?
A. Yes.
THE CHAIRMAN: Thank you.
MR SHIEH: Mr Chairman, I wonder whether I may assist here. This being an Inquiry, I don't think we need or should really be saving things up one's sleeve and say it's a matter for you, because Mr Mok seems to be asking this witness for his opinion on a certain line of reasoning so as to decide whether or not another line of questioning, namely about corrosion, is or is not to be pursued.
But ultimately, whether or not the thickness of the aluminium plating as delivered was 4.8 or 4.5 ultimately

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remains a matter for the Commission. Now, Dr Armstrong gave his opinion based on the matters Mr Mok shown him. But ultimately, there could well -- and I'm putting it no higher than that -- be an argument that all the evidence should be looked at in its totality.
One possibility, and again I put it no higher than that, is that given the measured thickness in 2005 being 4.4/4.5, and given that the documentation is not quite complete, and even if the ABS certificate says 4.8, one may not actually know how they derived that figure, there remains -- again, I put it no higher than this -- a possibility that this Commission may well find that the thickness as delivered was actually contrary to the ABS certificate or contrary to the letter, indeed only 4.5. In which case, the competing possibility of "Oh, no, it's actually 4.8 to begin with, but subsequently corroded to 4.5" would have to be addressed as part of that argument. Because Dr Armstrong did express his view that it's unlikely for that sort of corrosion to have occurred.
THE CHAIRMAN: Which is why I've asked him the question I did, which was, was it possible. I understand he's agreed with that. Possible on the basis of corrosion, and the inaccuracy of the measuring instrument.
MR SHIEH: Yes, but I'm just raising this possibility of the

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measurement, the 4.5 mm as measured, being factored back into the Commission's fact-finding exercise as to the true thickness as delivered, and therefore the significance of the 4.5 mm as measured, whether it was indeed due to corrosion, could well be a live issue.
I'll leave it to Mr Mok. I don't want it to be said eventually, when this submission is made, that Mr Mok says, "Look, Dr Armstrong has said don't worry about corrosion."
THE CHAIRMAN: Thank you.
MR MOK: Mr Chairman, I was hoping that -- because the only issue here that I'm exploring is the actual thickness of the plate. I was hoping that if the witness is able to assist us by his direct evidence, we can do away with a number of further questions that I may have to put to the witness. But if Mr Shieh is saying that at the end of the day, he may still submit to the Commission that there is a possibility that it was 4.5 mm, then I'm afraid I have to put a few more questions along this line to explore the question of corrosion, which I hoped I could have saved time by not doing.
THE CHAIRMAN: Well, you've heard what he said. It's up to you what you do.
MR MOK: Then I am obliged.
I'm sorry, Dr Armstrong. I am put in the position

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of having to ask a few more questions, if I may. Please forgive me for that.
A. I think I did respond that I thought it was possible, but unlikely.
Q. Let's deal with this question of corrosion now. First of all, I think we refer to a survey in June 2005. For that may I ask you to look at page 653 of marine bundle 4.
You will see that this is the inspection record of an inspection which took place on 16 June 2005.
THE CHAIRMAN: Just give me a moment, please. Thank you.
MR MOK: The actual figures we see from pages 654 and 655. We have already heard evidence about this particular thickness measurement exercise. Do you remember that?
A. Yes, sir.
Q. I think, based on these figures, you came to the view that the average thickness of the side plate at that point in time was 4.5 mm?
A. Correct.
Q. Then you compare that with the hull report which was dated, I believe, in 2011. That is at police bundle P or Q, I'm not sure which, page 4870.
I think this was a measurement carried out by Cheoy Lee but not being inspected on this particular occasion, but it doesn't really matter. On pages 4870 and 4871,

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you see some figures on the side plate, most of the figures being 4.3, 4.4 or 4.5; do you see that?
A. Yes.
Q. Your view looking at this was that the average thickness of the side plate was at that point in time recorded, and I say this because of your evidence about accuracy, as 4.4 mm; right?
A. Correct.
Q. But you also reason that because of the inherent lack of accuracy of these measurements, you can't take these figures to be 100 per cent correct?
A. That is correct, yes.
Q. And on this occasion, I think you're allowing a margin of error, if I may say, of maybe plus or minus 0.1 mm?
A. Something of that magnitude, yes, sir.
Q. Just out of interest here, what is the normal margin of error of using an instrument of this kind? Is it 0.1 mm or a little bit more than that?
A. I cannot answer that with any first-hand knowledge, but I am aware that you need to prepare the surface, and if there are impurities on the surface when you're measuring, then you can get a spurious answer.
Q. Right. So at least on this particular occasion, you are prepared to recognise a margin of error of, say, 0.1 mm?
A. Yes, sir.

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Q. Can I explore with you this question. As I understand, between these two measurements in 2005 and 2011, you acted on the assumption that there was an error in 2011 but there was no error in 2005, in your report?
A. I'm sorry, I did not mean to imply that.
Q. Well, you said that in 2005, it was 4.5 mm; in 2011, it was 4.4 mm. But in your view, that drop of 0.1 mm could have been due to an error in measurement.
A. Yes, I did. I was not trying to imply that it was in 2005; I thought it could have been equally in 2004.
Q. No. If I can come back to this. You said that in 2005, it was 4.5.
A. (Witness nods).
Q. In 2011, it was 4.4. Now, that drop of 0.1 mm, according to you, was likely to have been a measurement error.
A. Yes, but I don't say at which stage it was a measurement error. I say that the discrepancy was more likely caused by differences in the accuracy of the instrumentation used at the time. I don't say which time, which year.
THE CHAIRMAN: By that you mean that in 2005, the average of 4.5 could have been an error of 0.1; it could have been 4.4? So that's where the error could have been?
A. Correct, yes.

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THE CHAIRMAN: Or it could have been an error in 2011?
A. Correct.
MR MOK: So let's take this alternative basis, a different assumption. Because of the 0.1 mm margin of error, it could be possible that there was an error in 2005, and in fact the actual thickness was 4.6 mm, and it is equally possible that there was no error, say, in 2011, so that it would be 4.4 mm. Would that be equally possible?
A. Yes, it would be equally possible.
Q. Right. Now, judging from the timeframe, let's say if there was -- let's assume for the time being that the plate was 4.83 to start with in 1996. After nine years, let's say it dropped to 4.6, so there was corrosion of 0.23 mm; that's during the nine-year period. And also then you look at the subsequent period, between 2005 and 2011; assuming there is no inaccuracy in 2011, then there would be a further drop from 4.6 to 4.4 during the six-year period of time. Do you follow me?
A. Yes, I follow your line of reasoning.
Q. So that scenario is perfectly -- there is nothing extraordinary about that, because that degree of deterioration is quite proportionate between the first period and the second period; right?
A. I understand what you're saying.

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Q. Do you agree that is an equally possible scenario from the scenario of, say, a decrease from 4.83 to 4.5 in the first period and no deterioration in the second period? Those two scenarios, because we're operating under certain assumptions, they're equally possible based on this reasoning?
A. Yes.
Q. Let's say, for example, that the plate originally was 4.83, and let's say in 2005, it became -- sorry. I'll start again.
It's 4.83 in 1996, and then it became, say, 4.6, given the margin of error, in 2005. So the deterioration was 0.23 mm. Let's work with this scenario.
You've informed us that there are several factors which might have caused corrosion, although you are not that sure. If I may invite you to your second supplemental report, page 933, paragraph 29.
If I may just read to you, starting from the words "However, I note that". Or maybe I should read from the start:
"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

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nine years ... and then there was no further significant corrosion over the next six years (2005-2011) as suggested by the thickness gauging reports."
It is this sentence that I was addressing in my discussion with you just now; right?
A. Yes.
Q. I think you've accepted that the equally likely scenario or possible scenario is that there should be a deterioration, say, of 0.23 in the first nine years, and 0.2 in the second six years; correct?
A. Understood, yes.
Q. So would this difficulty go away if we posed the equally possible scenario like this?
A. Thank you for clarifying. Yes.
Q. I come to the next bit. It says:
"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."
Do you see that?
A. Yes.
Q. So that would be one possible cause of corrosion, say, in a place like Hong Kong, sometimes with high temperatures and high humidity?

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A. (Witness nods).
Q. Do you agree?
A. Yes, I agree.
Q. Thank you. Then you said:
"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."
So this is the other end of the scale, where no corrosion was noted in those places.
Then you qualify that by saying:
"These craft however have not been operating in areas with atmospheric pollution such as are sometimes experienced in Hong Kong."
A. (Witness nods).
Q. So atmospheric pollution, on top of high temperatures and high humidity, could also in your view be a cause of corrosion in Hong Kong; right?
A. Almost certainly atmospheric pollution and condensation create an acidic moisture on the surface, which is one of the reasons why the aluminium should be painted, because the paint then provides a barrier. If it's not painted, then that acidic liquid will dissolve the aluminium oxide that I spoke about earlier.
Q. Yes.

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A. But I would have expected the paint, if it had been properly painted, to have prevented that. However, I have only investigated the craft on one occasion, when the paint was in good condition, and of course the vessel has no doubt been painted a number of times. So there could have been a time in its life when it was incorrectly painted or insufficiently painted, when that acidic moisture could have attacked it.
Q. Thank you for that, Dr Armstrong.
Am I correct in saying that in your view, you may not have conducted or seen any studies as to what exactly would be the reduction in thickness given a particular atmospheric pollution condition or certain temperature or humidity? You've not gone into this area or have seen any studies of this kind?
A. I have seen some studies. I do not have them available to me, but there have been studies done, I know, on various acidic solutions.
Q. Right. That's very helpful. So can I ask you this. Given these factors which operate in Hong Kong, would it be so out of the ordinary, given these factors, that there could be corrosion of plating over a period of, say, nine years to the degree of, say, 0.23 mm? Would that be so out of the ordinary, or would it be quite possible?

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A. Given a certain set of circumstances such as lack of paint at some times, yes, I believe it will be possible. It is higher than I would have thought, but it is possible.
Q. Okay. Then the final question I have on this is that again, given the same conditions and factors that we have seen, would it be so out of the ordinary for the plate to have deteriorated or been corroded over a period of 15 years, from 4.83 to 4.4; that is about 0.43 mm over a period of 15 years.
A. Or indeed it may have been 4.5.
Q. Thank you for that.
A. Yes, it is possible. I was about to say, I think the point really has to be made that according to the drawings, it should have been 5, and I successfully identified that in fact it was less than 5 when it was built.
Q. Yes. I understand that point. Perhaps we can come to that point in the afternoon.
But my one final question on this line is that, given our discussion just now on corrosion, would you agree that there is nothing in relation to corrosion or evidence concerning corrosion that may contradict the prima facie evidence that in fact the original plating as delivered or as built in Lamma IV was in fact 4.83?

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There's no evidence or reasoning which plainly contradicts that conclusion?
THE CHAIRMAN: I'm sorry, was there an answer?
MR MOK: Not yet.
Do you want me to repeat the question?
A. Would you do that, please? Thank you.
Q. Yes, of course.
Given the discussion that we had just now concerning corrosion, are you prepared to agree that there is in fact no evidence, either concerning corrosion or anything else, which plainly contradicts what may prima facie appear to be the case, namely that the plating when it was delivered in 1995 was in fact 4.83 mm in thickness?
THE CHAIRMAN: The real question is the plate used to build the vessel of 4.83.
MR MOK: Thank you, Mr Chairman.
A. I can agree with your comment, yes.
MR MOK: Thank you very much.
Mr Chairman, is this an appropriate time?
THE CHAIRMAN: Yes, certainly.
Dr Armstrong, we'll take our lunch adjournment now and we'll resume at 2.30. Thank you.
(1.01 pm)
(The luncheon adjournment)

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(2.30 pm)
THE CHAIRMAN: Mr Mok.
MR MOK: Thank you, Mr Chairman.
Good afternoon, Dr Armstrong.
A. Good afternoon.
Q. I next wish to refer to the 1995 Instructions. I think you fairly said that the interpretation of the Rules or Instructions is a matter for the Commission. You said that?
A. Correct, yes.
Q. But you were also asked earlier for your own reading of those rules.
A. Yes.
Q. Your own understanding of those rules.
Let's see if I fairly summarise it correctly.
I think you accept or you have no question, no reason to doubt, the evidence that these instructions only came into effect in January of 1996, but --
THE CHAIRMAN: They were promulgated on 19 January.
MR MOK: Yes. Thank you.
THE CHAIRMAN: It's a moot point as to when they came into effect.
MR MOK: Yes. But you say there may be some retrospective effect in relation in particular to the building of new vessels. Is that your understanding?

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A. At the time I wrote my report, Mr Mok, I was unaware of the existence of the -- I think it was a letter that said they came into effect, sorry, were promulgated in January. My opinion on reading the 1995 Instructions was that a "new vessel" was one built after 1 January 1995.
Q. Yes, and therefore according to the definition which you saw in the 1995 Instructions, your reading was that perhaps those rules should also be applied to the construction of Lamma IV as a new vessel?
A. Correct, and even after discovering that there were rules promulgated in 1996, I was still under the impression that Lamma IV was a new vessel.
Q. Yes. Thank you. Now, can I ask you to look at some documents concerning the history of the vessel. First of all, may I ask you to go to marine bundle 2, tab 1. This is a letter from --
THE CHAIRMAN: We don't have a page yet.
MR MOK: I'm sorry. Page 171.
THE CHAIRMAN: Thank you very much.
MR MOK: The date is 24 November 1994, from Cheoy Lee to the Director of Marine, saying:
"We have the pleasure of informing that we have won a contract for the construction of [Lamma IV, in short].
We are building the vessel for use in Hong Kong

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waters ..."
Then they attach the General Arrangement drawings.
A. Yes.
Q. So that triggered the entire process of plan approval within the Marine Department?
A. I don't believe it would trigger that process until the drawings were received, sir.
Q. Thank you. Then we can go to page 195. I believe this letter is where they submitted some drawings, not of Lamma IV but what they call the sister vessel, which we now know is the Eastern District. Do you see that?
A. I see that, yes.
Q. So the date there was March 1995. Even before that, if I may invite you to page 175, please, there's an error of the date. The date should have been 5 January 1995. This is where they submitted the six sets of drawings we see on this page.
A. Yes, sir.
Q. Would that trigger the plan approval process?
A. I think the letter dated 10 March 1995, shown on page 195, would have had no effect whatsoever and can be disregarded.
Q. Thank you.
A. It was not for the Lamma IV.
Q. What about the January letter?

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A. Yes, that would have triggered, in my opinion, the survey process.
Q. Thank you. Then at page 201, you will see another letter from Cheoy Lee making some amendments to the plans, the four sets of plans which are enclosed; right?
A. Yes. This is the letter referring to some minor errors being corrected.
Q. Right. Now, in relation to the plate thickness you will see on page 202 the Shell Expansion plan, where you see on the diagram there that -- you see the number "5" throughout, and therefore that represents, does it not, that the plate was intended to be 5 mm?
A. It does represent 5 mm thickness, yes.
Q. So what Mardep at that stage was asked to approve were these plans, including the intended thickness of 5 mm for the side plating?
A. Yes, I believe so.
Q. Then we came to the letter of 4 April, which we have seen, at page 206 where that thickness was said to be 4.83 instead of 5 mm; right?
A. Yes.
Q. So would you agree that, when Mardep was asked to approve these plans and the amended versions of these plans, they would approve them under the practice that was in effect at that particular time? And here we are

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talking about the period between January and April of 1995.
A. I do not know the answer to that, Mr Mok, I'm sorry.
Q. You do not know the answer? Right.
But we know that the plans were approved in May, or some of -- the main plans were approved in May of 1995?
A. Yes, sir. But we do not know how much discussion was going on within the Marine Department formulating these regulations.
Q. No, we do not, indeed. But on the basis -- let's say for the time being, on the basis that the approval was given under the practice of the Marine Department before the 1995 Instructions were being promulgated later, would you expect that after the approval and after the promulgation of the 1995 Instructions, Mardep would then go back to Cheoy Lee and say, "Ah, now we have the new instructions and let's scrutinise to see whether or not the vessel satisfies these new instructions"? Would you expect that to happen?
A. I cannot guess what they may have done, but I would think that would be probably unlikely. But again, I would point out "new vessel" does not refer to when the drawings were received or indeed when the drawings were approved. It refers to four particular trigger events. The one which is relevant, I think, is the keel

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being laid.
Q. Yes, I understand your point. That is a definition that would be applied after the instruction came into force?
A. Yes, correct. The keel being laid on or after 1 January 1995.
Q. I understand that. And the point that I'm making, which I hope is clear, is that if plans had been approved under the old practice and then there was a change, let's say months later, and then -- what I'm putting to you, that it would be grossly unfair and unlikely that Mardep would come back to Cheoy Lee and say, "We need to scrutinise everything again under the new rules".
A. I just, unfortunately, do not know how much of the practice embodied in the 1995 Instructions were in fact being applied at that time.
Q. Do you see any evidence, though, from all the papers that you have read, that there was any indication that Mardep ever applied the 1995 Instructions before the time they were being promulgated?
A. I do, sir. I wrote about this in my first report, about some confusion amongst the surveyors/inspectors in the Marine Department as to which sets of instructions applied at the time.
Q. Yes. But what I'm talking about is in relation to the papers concerning the approval process and all the

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inspections, was there any evidence that you can point to to show that in fact Mardep was applying the 1995 Instructions at a time before they were being promulgated in January of 1996?
A. I just ask for a bit of time, if possible, to think about that.
Q. Of course.
THE CHAIRMAN: We have seen, have we not -- I think it was in respect of some provision for an engine shut-off, it was a machinery part, where at one level someone applied the 1995 Rules --
MR MOK: Yes.
THE CHAIRMAN: -- and then somebody else, I think a Mr Lee, said, "No, it's not those rules; it's the other rules." Perhaps that would help Dr Armstrong.
MR MOK: Yes, it's the non-return valve, and that's an issue which was resolved in March of 1996. Can we come to that in due course?
THE CHAIRMAN: Yes.
MR MOK: At the moment -- I realise this matter and I will take you to those references, but they were in March of 1996. So I'm talking about a time let's say before January of 1996.
A. I'm unable to be specific because of the broad range of the subject. For example, it covers the whole range of

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not only construction but also things like life-saving and fire-fighting and so on, which are outfit items and probably would have occurred later anyway. But I can think of nothing specific immediately.
Q. Right. Now, I wish to take you briefly, if I may, to the approval or the inspection process. For that, may we turn to marine bundle 4, tab 165, at page 831.
At page 831, we do have a bit of a timeline in relation to the inspection of the various parts of the vessel. If you look at the first date, which is 13 November 1995, what is stated there is:
"Hull construction (internal) inspected with approved [diagrams] ..."
But some outstanding matters were set out in numbered paragraphs (1) to (7). Do you see that?
A. Yes.
Q. That, as I understand it, was an actual inspection of so much of the vessel that was being built at that time in relation to the hull portion.
A. Yes.
Q. Is that your understanding?
A. That's my understanding.
Q. Right. So by that time -- that is, again, before the promulgation of the new instructions -- a lot of work had already been done in the building of the vessel;

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would you agree?
A. Some work, yes, sir.
Q. Well, we see, for example, if you go down this table to the date -- for example, 11 December 1995. There was the inspection of the superstructure construction, and then also valves and so on, and a number of outstanding matters were then set out. Do you see that?
A. I see that, yes. But it's still not a ship; it's components of a ship.
Q. Of course.
A. Am I permitted to comment on your previous question?
Q. Of course. Please.
A. I note that the drawings did show a minimum size of 5 mm plating on the side, which may or may not refer to the requirements of the 1995 Instructions. I also note the requirement that the stability book be approved, which again appear in the 1995 Instructions but not in the Blue Book.
Q. Oh, I see what you mean.
THE CHAIRMAN: Where do you note this?
A. I'd have to find the item, Mr Chairman.
THE CHAIRMAN: Yes.
A. There is a letter from Marine Department requesting that the stability book and damage stability book be submitted for approval.

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MR MOK: Yes. You're thinking of the General Arrangement plan, are you?
A. Yes, that's correct. It's some notes on the General Arrangement plan. Thank you.
Q. Yes. Dr Armstrong, we have heard evidence from some officers, which you may recall, that although the requirement -- it appears from, I think, instruction 15 of the Blue Book -- was as to schedule 1, which deals with floodable length, but as a matter of practice they may, in their discretion, accept either a floodable length calculation or a damage stability calculation. Have you --
A. I agree, which was subsequently included in the 1995 Instructions.
Q. Correct.
A. So this was possibly something that was being discussed at the time for inclusion in the 1995 Instructions.
Q. But that is a speculation on your part?
A. Indeed, yes.
Q. I think just to finish up this point, what I'm suggesting is that perhaps this point -- that is, whether or not floodable length calculation or damage stability calculation is accepted -- perhaps is not a very good indication that the 1995 Instructions did apply at the construction phase of this vessel? Do you

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agree; it's not a very good indication?
A. You asked me for an indication, and that was my response.
Q. Sorry, I didn't catch that?
A. You asked me for an indication, and that was all I could think of on the spur of the moment.
Q. Thank you very much.
Let's get back to page 831. The point there I wish to -- and then let's go over the page a little bit. You will see the date of 2 January 1996, where some tests were being witnessed. This is called "Materials B+T test". Can you tell us briefly what this test is about?
A. I believe this is a test of the mechanical properties of the shafting that was used to drive the propeller around. There is some requirement for a particular strength of that item.
Q. Right. And then if we look down this page at page 832, you will see at the bottom, for example, a number of items were being inspected or witnessed: rudder plate, and items 1, 3, 4, 6, 7, et cetera. So quite a number of items were inspected on 11 January 1996. Do you see that?
A. Yes. These were all components of a ship.
Q. Then over the page. By 31 January 1996, the inclining experiment was carried out; right?

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A. (Witness nods).
Q. I believe it was your evidence that the inclining experiment could only take place after the vessel had been completed?
A. Correct, yes.
Q. So at the latest by 31 January 1996, the vessel had already been completed?
A. To all intents and purposes, yes.
Q. Yes.
A. There may have been some small outstanding items, irrelevant.
Q. Yes. And we know, as Mr Chairman reminded us, that the promulgation date of the 1995 Instructions was 19 January 1996. That was, if I may say, shortly before the inclining experiment date; right?
A. I agree.
Q. So may I just put to you simply this. Notwithstanding the definition of "new vessel" in the 1995 Instructions, but if as a matter of fact the entire ship had been built under the practice of Mardep before the 1995 Instructions had been promulgated, there is no question that after it had been promulgated, that any part of those rules should be applied retrospectively in respect of the building or the construction of this ship prior to that time. Do you agree with that?

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A. No, Mr Mok, I do not agree.
Q. Can you inform us of your reasons?
A. I question why the paragraph is in the 1995 Instructions that a new vessel is a vessel of which the keel is laid on or after 1 January 1995. And when you question whether there would then be a requirement to change anything that had been required under the latest set of rules and not under what was approved on the plans, I would answer that that could have been the subject of a negotiation between the inspectors and the shipyard.
Q. Sorry, what is a matter of negotiation?
A. Anything that was found to be non-compliant with the 1995 Instructions.
Q. Why do you say that is there?
A. Because you suggested it, Mr Mok: that if there was something that was wrong, would the shipyard be asked to go and change it? And I'm saying they wouldn't necessarily be asked to go and change it, but they could be asked to -- or they could be negotiated to address the matter in some way or other. I have no evidence of that. I can only go on what I read in the Instructions.
Q. Would it be correct to say that you have no evidence that in fact the whole process of plan approval, inspection, and the witnessing of experiments and so on, in fact took place by reference to any of the rules that

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were promulgated in January 1995? Have you seen any evidence of that?
A. I have the evidence of the rules themselves, and a belief that the requisite bodies would have followed the rules.
Q. Thank you very much.
May I come now to the matter which Mr Chairman reminded us of. This is in the same bundle at page 834. You will see the date of 7 March 1996, and the item there says:
"Outstanding items of final survey dated 15 February 1996 were inspected afloat. Item no. 2, 3, 4, 5 & 6 were found in order, but item no. 1 was not so complied with the requirement of new 'Instructions for The Survey of Launches & Ferry Vessels' of 1995 edition. I consulted with surveyor of ship, Mr Norman T Lee, and he agreed that the vessel had to follow the previous instructions as she had been built before that new edition took place in 1996."
Then therefore I think a short-term --
A. Certificate.
Q. Certificate, thank you -- for three months was then issued; do you see that?
A. I see that.
Q. To understand this item, one needs to refer to two

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letters, one of which is found in marine bundle 2, item 51.

If I may just read this very quickly. The date was 2 February 1996, from Cheoy Lee to the Marine Department.

THE CHAIRMAN: Sorry, what are we looking at?

MR MOK: It's a letter, Mr Chairman, of 2 February.

THE CHAIRMAN: That's not what is on the screen.

MR MOK: I'm sorry. Let me just double-check. This is the page I wanted: page 296 of bundle 2.

THE CHAIRMAN: Thank you.

MR MOK: The date is 2 February 1996. It says:

"We refer to the bilge piping inspection carried out by your Mr Wong yesterday ..."

THE CHAIRMAN: Could we see more of the page so that we know between whom the letter is passing?

MR MOK: Yes. It's to the Marine Department, Local Craft Safety Section, attention Mr WS Ho.

THE CHAIRMAN: Thank you.

MR MOK: The first paragraph says:

"We refer to the bilge piping inspection carried out by your Mr Wong yesterday and would like to thank you for expediting the approval of the relevant drawing, and make the inspection possible.

On the approved drawing there is a comment which

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advises that the bilge lines should have 'a screw-down non-return valve at the suction end of each branch bilge pipe'. This is a requirement of the new rules and since the rest of the drawings were assessed following the old rules, it would be expected that this drawing should also be evaluated by the old rules."

Just pausing there, Dr Armstrong. It appears, at least from the face of this letter, that the drawings had been assessed under the old rules. Have you seen anything which is contrary to that?

A. This is a letter from a manufacturer, it's not from the Marine Department, so I do not know the circumstances in which they felt qualified to say how the drawings had been approved.

Q. Well, we don't know, but at the same time this manufacturer is a very experienced one. So I think at the very least one can suppose that they had a lot of dealings, as you said.

THE CHAIRMAN: Well, it's an assertion in any event. Whether or not it's true, it's an assertion.

MR MOK: It is an assertion, and the question I'm asking Dr Armstrong is whether or not he has seen any evidence which contradicts this assertion.

THE CHAIRMAN: As to this particular point?

MR MOK: As to the point that the drawing, or the rest of

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the drawings were assessed following the old rules.

THE CHAIRMAN: Well, the letter is specific, is it not? "On the approved drawing there is a comment". Do we have that drawing?

MR MOK: I'm sure we do.

Mr Chairman, can we come back to the drawing once we've located it? I don't have --

THE CHAIRMAN: You're asking Dr Armstrong if he's seen anything that suggests whether or not it was being done other than other the old rules --

MR MOK: In relation to the other drawings.

THE CHAIRMAN: No, this is specific. It's not plural, it's singular: "On the approved drawing there is a comment which advises". I think it would help Dr Armstrong to see that first.

MR MOK: Of course. If I may have a moment.

Page 288, I'm told.

THE CHAIRMAN: Thank you. "Bilge Piping Diagrammatic", is that it?

MR MOK: Yes, that's the one I'm told may be relevant.

THE CHAIRMAN: That's approved on 31 January 1996?

MR MOK: The second comment:

"Pipe diameters shown on drawing are [normal] diameters."

THE CHAIRMAN: "Nominal", I think.

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MR MOK: I'm sorry.

On the left:

"Suction end of each branch bilge pipe to fit with [non-return valve]."

Do you see that?

A. Yes.

Q. That appears to be the drawing which was being referred to in this letter?

A. I believe you're right, yes.

Q. So what the letter says is that this is a requirement of the new rules, "and since the rest of the drawings" -- which I take to mean other drawings, other than the one relating to this particular bilge piping --

A. I question that, in fact.

Q. You question that?

A. I do not know what is meant by "the rest of the drawings".

Q. All right.

A. Particularly the reference to Mr Norman T Lee, who is an engineering surveyor, or was, I understand. And this is an engineering matter. I'm really not sure whether this is referring to all the drawings or just to the engineering-type drawings, which are dealt with differently to the structural drawings.

Q. Right. No matter what he was referring to, what I'm

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trying to say is that these "other drawings" were other drawings than the drawing relating to the bilge piping; would you agree with that?
A. Yes.
Q. Thank you. So what he was asking is whether or not -- and then it goes on to say:
"However, if you insist that this drawing is to be adhere to the new regulations, since it was checked in 1996, we would like to point out that although having a non-return valve at the suction end of each bilge line is common practice, it does not appear practical, nor safe, to have a screw-down non-return valve at the bottom of the bilges. Therefore we were wondering whether the 'screw-down' valve requirement, at the suction end, is an item that was inadvertently introduced to the rules, since there is already one of these valves at the bilge manifold."
Do you see that discussion?
A. I do see that discussion, yes.
Q. Then the reply is in tab 53, page 312.
MR SHIEH: I'm sorry to interject here, Mr Chairman. Maybe I'm being slow. But Mr Mok was questioning the witness on the basis of the drawing at marine bundle 2, page 288, and on the basis that this is the drawing referred to in that letter. But that letter actually

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put in quotation marks the requirement -- could I have the letter -- "a screw-down non-return valve at the suction end of each branch bilge pipe", in quotation marks, so it suggests that on the approved drawing we should be looking at there should be this comment verbatim.
But the drawing Mr Mok has been showing Dr Armstrong, at marine bundle 2, page 206, although there's a reference to "suction end at each branch bilge pipe", et cetera, I don't seem to be able to locate that comment in inverted commas.
Maybe it's there and it's just my eyes that couldn't find it.
THE CHAIRMAN: Yes. We can all have a look.
Can you see that anywhere, Dr Armstrong?
A. I had noticed that the letters "SD" had been scrubbed out. "SDNR" is usually recognised as being screw-down non-return valve, but the "SD" has been scrubbed out and some initials alongside, which might be similar to the person signing the approval -- I'm not sure.
THE CHAIRMAN: Thank you.
MR MOK: The term "screw-down" is actually highlighted in the previous letter of 2 February. You see the question there was "whether the 'screw-down' valve requirement ... is an item that was inadvertently introduced to the

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rules". You see that highlighting of the "screw-down" part?
A. I'm sorry, I do not see that. Which document?
Q. Could you go back to 296, please. At the end of the long paragraph, there's a question wondering whether the "screw-down" valve requirement was inadvertently introduced.
A. Yes.
Q. So as you said, the "screw-down" part was a reference to the "NS" which was crossed out in the plan?
A. Yes. But does not this letter highlight the fact that they were applying the 1995 Regulations?
Q. Yes, that's what I'm exploring with you, Dr Armstrong.
Can we go back to page 312. That's a reply to Cheoy Lee from the Director of Marine.
"Thank you for your fax of 2 February 1996 regarding the requirement of screw-down non-return valves for the open-end bilge suction pipe.
As you aware, such a requirement had been made under the new Instructions for the Survey of Launches & Ferry Vessels which stipulated the fitting of screw-down non-return valves in both bilge manifold and suction end of each branch bilge pipe.
I do not concur with your view that the fitting of SDNR valve will be an impractical and unsafe feature;

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nevertheless, your view had been passed to 'Local Craft Review' for their scrutiny. Meantime, for the captioned vessel, I am prepared to accept non-return valve instead of screw-down non-return valve in the locations as stated in 2) of HKMD's comment on the returned 'Bilge Piping Diagrammatic' drawing ..."
Signed Norman T Lee for the Director of Marine. Do you see that?
A. Yes, I read that.
Q. So that takes us back to the notation or the note in the inspection file on page 834 of marine bundle 4.
Apparently what happened was that Mr Fung, who was the surveyor whose name appears on the last column, consulted with Mr Norman Lee on this issue and Mr Norman Lee agreed that the vessel had to follow the previous instructions as she had been built before that new edition took effect in 1996; right?
A. Yes.
Q. Do you agree that this note, also together with the letters that we have seen, does provide evidence to show that at least the processing or the approval of the ship had been processed under the old practice or the old rules?
A. No. It suggests to me, Mr Mok, that it was a process under both sets of rules, and with some negotiation

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going on.
Q. Well, the reason why this issue came up was because this matter arose after the new rule had been promulgated. That was 19 January 1996.
A. This note is signed by a surveyor, not by a necessarily senior person in the organisation.
Q. It may not be. But the point is this, that before the promulgation on 19 January 1996, what I suggest to you is that this note, together with the letters, does provide some evidence that in fact the previous vetting of the ship before the promulgation of those rules had taken place under the old rules.
THE CHAIRMAN: I think you've put that question once before, and he didn't agree with you. He said that it appeared that both sets were being applied, and there was an element of negotiation going on.
A. Thank you.
MR MOK: Yes. Now, let's assume for the time being that it is the old rules that apply; that is, under the Blue Book.
A. (Witness nods).
Q. I think you have observed that under the Blue Book, there was no requirement or no specific requirement concerning the thickness of plates.
A. Correct.

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Q. I think you also said that in those circumstances, maybe one has to refer to rules, for example promulgated by one or the other of the classification societies?
A. I'm not sure I said that, Mr Mok, but it is an obvious way to do it, yes.
Q. I think you did say this, that the Lloyd's Register is one of the few or was one of the few at that time which had specific rules dealing with small vessels or small craft?
A. I did say that.
Q. Yes. Thank you.
A. DNV was another.
Q. Yes. May I invite you now to look at those rules very briefly.
The reference here is to marine bundle 11, page 3953-3. You will see at page 3953-1, the reference it is to "Rules and Regulations for the Classification of Yachts and Small Craft". The date was May of 1983. Do you agree that would be an appropriate set of rules to apply at that relevant time?
A. Yes, I do. Very appropriate.
Q. If we go to page 3953-3, under the heading "Side shell", you will see:
"The thickness of the side shell plating is to comply with the requirements of table 3.5.1 or 3.5.2."

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Would you agree that that would be an appropriate rule to apply?
A. I have seen that, yes, sir.
Q. Under table 3.5.1 -- let's look at the first column in terms of length -- the closest one to ours, is it 26 or some other?
A. Between 26 and 28.
Q. Let's take 26. Then the basic stiffener spacing, theirs is 480 and ours is --
THE CHAIRMAN: Before we proceed, I thought this vessel was 28 metres. Why are we taking 26?
A. It's a complicated matter in terms of length of ship, Mr Chairman. There are so many different ways of describing a length of a ship.
THE CHAIRMAN: Length overall, length waterline.
A. Indeed.
THE CHAIRMAN: What is this referring to?
A. Under the Blue Book, the length is the registered length, which is very close to the length overall but not quite. Under Lloyd's, I do not know. We would have to look it up in the opening paragraphs. I think it would possibly be something quite obscure like 96 per cent of the length on the -- sorry, the length on the waterline at 96 per cent of the depth of the ship, measured to the rudder stock.

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THE CHAIRMAN: Ought we not to establish this before we embark upon this adventure, as to what is the correct basic starting point?
A. I think Mr Mok's aim, without wishing to pre-judge you, is to suggest that in any case it's less than 5, whether we take 26 or 28, sir.
THE CHAIRMAN: Very well. Then it may not matter. In which case, why not take the higher value, if it's going to be proved in that way?
MR MOK: Because, Mr Chairman, my understanding is that it is, as Dr Armstrong says, between 26 and 28. So --
THE CHAIRMAN: Is there any difficulty in establishing what the actual figure is?
MR MOK: Yes, at this moment. I think we can do that maybe a bit later but not immediately, Mr Chairman.
THE CHAIRMAN: Very well.
MR MOK: Let's take, for example, 26 first, Dr Armstrong. There are a number of different columns there. I believe the formula set out there is velocity over the waterline length -- or the square root of the waterline length is less or equal to the various numbers set out in those various columns. That's the formula.
A. You're correct, Mr Mok. But now I have a difficulty with what is the length on the waterline. I think that would be worthwhile looking up.

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Q. That would be worthwhile looking up?
A. I believe so.
Q. Would that appear in the Damage Stability Booklet?
A. No, Lloyd's would have their own definition, sir.
Q. I see. So we have to look at that definition rather than --
A. I'm sorry, I think that's essential, yes.
Q. All right. Can you give us a range, though? If we look at the Stability Booklet. Say, for example, page 322 of marine bundle 2.
A. Somewhere between 23 and 25.5.
THE CHAIRMAN: As being the waterline?
A. As a range of waterline length, yes.
THE CHAIRMAN: And how do you choose that range?
A. I chose it, sir, because I believe the length on waterline of 24.89 in accordance with the Stability Book is what you and I may regard as the real length on the waterline, from the forward end to the after end.
THE CHAIRMAN: Yes.
A. But I do not know where it is measured to in Lloyd's. It is very possibly to the centreline of rudder stock. I'm assuming the rudder stock is about 0.75 metres forward of the transom, which would bring it down to 24. So I think it needs to be ascertained.
MR MOK: All right. Thank you very much.

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Perhaps for the matter of the calculation, we can take this further once we've got the values.
THE CHAIRMAN: Very well.
MR SHIEH: Mr Chairman, could I just pause here to raise a housekeeping matter. I understand Mr Tang Wan-on, the Hongkong Electric officer, next to testify, is on one hour's notice on standby.
THE CHAIRMAN: Yes.
MR SHIEH: I raise it with my learned friend. If there is not any likelihood that he will finish in good time for there to be any meaningful evidence of Mr Tang Wan-on, then we'll simply not trouble Mr Tang to be constantly on the alert.
THE CHAIRMAN: I follow.
Mr Mok, can you help us?
MR MOK: Yes, of course. I think I indicated to my learned friend that we are unlikely to be requiring Mr Tang this afternoon.
THE CHAIRMAN: Thank you.
MR SHIEH: I think Mr Grossman can let his instructing solicitors know.
THE CHAIRMAN: Yes.
MR GROSSMAN: Thank you.
MR MOK: Dr Armstrong, would you be able to assist us, even at this stage, looking at these rules and this table,

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what approximately do you think would be the plate thickness according to the workings indicated in these rules and tables, or a range of it? Would it be, say, for example, less than 5 mm?
A. I apologise, but I think that would be too hard to just guess. I think you need to --
Q. That's fair enough.
A. I say that because it's somewhere close to 5.
Q. Sorry?
A. I say that because it looks to me like it would be somewhere close to 5, but I cannot say whether it is above or below 5 mm thickness.
Q. Right. Okay. So let's say for example it is close to 5, or even 5. You would agree also that under the Lloyd's Register, there is also allowance for tolerance. I think you said maybe it's 0.2 mm for 5?
A. Indeed I did.
Q. There is also reference to the rules at W&G bundle, tab 1, page 29. Can we have a quick look at that. Does that table assist?
A. Yes, table 8.1.1 indicates 0.2.
Q. 0.2, right. So if the calculation derived from the Lloyd's Register table is going to be 5 or close to 5, would you agree that the plate that is used or was used, if the plate was, say, 4.83, that would be within the

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tolerance range under the Lloyd's Register Rules?
A. Yes, I would agree to that. I thought we had already agreed that 4.83 was satisfactory.
Q. Thank you. If that was satisfactory, is there anything else that would indicate that the plating was unsatisfactory in terms of thickness, of Lamma IV?
A. I think I've already expressed my opinion that it could have corroded to the sizes we have seen. But I felt that it was unlikely. But nevertheless, it's possible.
Q. I see. If I may summarise your view to see if I am correct.
If one applies the Lloyd's Rules and the 0.2 mm of tolerance, then the thickness of 4.83 would be satisfactory, subject to the corrosion point. Is that a fair summary of your view?
A. Yes.
Q. On tolerance, of course there are other rules and different percentages to apply. If I may just invite you to look at one of those rules that we do have in evidence and ask for your comments. The ABS wastage rules, which have been supplied to us -- can we have a look at them at W&G bundle, page 40-53. This table indicates the various allowances under these rules, and we can see there are different allowances relating to steel as opposed to aluminium. Generally, maybe the

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wastage, you would agree, for aluminium would be less than steel; is that correct?
A. Yes.
Q. Here it indicates 20 per cent to be the allowable level in relation to conventional vessels of under 90 metres built to ABS class.
Can you tell us, Dr Armstrong, would 20 per cent be generally accepted as a corrosion or wastage allowance for an aluminium vessel of that size?
A. Mr Mok, you'd have to advise me on the background to this table, to what grade of aluminium is it referring to, and to what year was it produced.
Q. But can you assist us, let's say in 1996 or 1995, in relation generally to aluminium wastage or corrosion, what would be the allowance for such a vessel?
A. For aluminium, as it was in America, possibly as large as values quoted here. But for aluminium alloy, I would say 5083, considerably lesser values.
Q. The concept of allowance, Dr Armstrong, is this, isn't it, that given that the ship in water may be subject to a certain degree of wear and tear, and that the idea is that you won't, for example, require a vessel to maintain the same kind of thickness as at the time when it was built. Is that the concept?
A. For steel that is the case, sir, and Lloyd's typically

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would add 0.4 of a millimetre for corrosion allowance.
However, aluminium, as I said yesterday, certainly with DNV has no allowance whatsoever for corrosion, and in my experience ships don't corrode, and I showed an example of a vessel in which there was not even any paint, designed for a 30-year life, with no corrosion.
Q. Dr Armstrong, I do understand your point on that. But at the moment, we're talking about the corrosion allowance that a vessel is allowed to deteriorate to without any requirement for, say, the hull to be revamped or rebuilt.
A. Which is why I asked you, sir, about the origins of this table, because a lot of aluminium craft are built in order to be lightweight, and thereby gain either speed or reduced power because they are lightweight. And when trying to design a lightweight vessel, you don't want to have to build in a wastage allowance. So the class societies, for example, for high-speed craft do not have a wastage allowance in them because they know that aluminium does not corrode, of a certain grade. And I think we need to establish what grade this table refers to before I can comment about the wastage being realistic or not. I would maintain there is no aluminium wastage allowance in most classification society rules that were around at that time.

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Q. Let's say that a vessel such as Lamma IV had been subject to some wastage or corrosion over the years. What would one expect them to do? Let's say if there is a corrosion of, say, 0.2 mm, what does one expect the shipbuilder or the owner to do?
A. I have some experience of vessels that have experienced localised corrosion. It's usually, as I said in one of my reports, owing to dissimilar metals, and in one case, I can recall, due to some chemical being spilt on the surface. In that case, there was local pitting and these sorts of issues are usually addressed by using some proprietary compound which is spread on, not unlike a paint, but it's a lot harder than a paint. It's a ceramic-based mix that goes on as a liquid and settles to a hard compound. However, none of those were what I would call general corrosion. It was not over a large surface. They were just local issues. I've never come across wastage over a large area on aluminium at all.
Q. Well, let's say there was. Let's say there was a wastage, a general wastage of, say, 0.2 mm in relation to aluminium. Then what would one expect the ship owner to do?
A. That's a matter of the classification society, Mr Mok. I'm not qualified to answer. I don't know what they would do.

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Q. You don't know what they would do?
A. It's not a circumstance I've come across before.
Q. Right. Thank you.
A. I know table 3 refers to "conventional vessels", and I'm sure if we look through this particular document in more detail, you would find that this was not at all 5083 but some much lesser grade of plating. Because 5083 is quite expensive.
Q. Let me ask you one matter further in relation to this. 5083, as you said, is a very high grade of marine aluminium alloy. A very high grade.
A. Yes.
Q. In other words, it is of a much better quality than what you would call the conventional grade, which is less expensive --
A. Correct.
Q. -- and less high quality.
So if we look at the wastage as a question of safety for the vessel, in other words it should not go below a certain percentage so that the vessel becomes less safe than it ought to be, would it make sense to say that if a high grade of aluminium is being used, then the ship would not be compromised any more than a vessel of a lesser grade when the corrosion has occurred to the same degree?

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A. That's a rather tricky question. Could you just repeat that for me?
Q. Of course. What I'm saying is that if a conventional vessel using a lesser grade of material is allowed to have a wastage allowance of, say, 20 per cent, compare that with a vessel with a higher grade of material and therefore harder and more enduring in nature. What I am suggesting is that where that vessel has a corrosion to the same degree, let's say 20 per cent, it would not perform any less or worse off than a vessel with a lesser grade of material?
A. I think if it had a zero wastage, it must be better off over a number of years. Have I answered your question?
Q. Well, a zero wastage is of course better off. But here we are comparing two vessels, one with a high grade, one with an ordinary grade of materials --
A. The higher grade of which has zero or close to zero wastage.
Q. No. The question is, if we allow the vessel with the lower grade a corrosion percentage of, say, 20 per cent, and at the same time we allow a wastage allowance for the vessel with the higher grade -- what I am suggesting to you is that the performance of the higher-grade vessel would be no worse off or no less than the vessel with a lower grade of material.

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A. Okay.
Q. That's the comparison.
A. Performance in terms of wastage or -- I'm wondering how you measure performance.
THE CHAIRMAN: Do you mean safety?
MR MOK: Yes, so far as safety is concerned.
A. Yes, I agree with you. I'm sorry, I was misinterpreting because the stronger material would be a lighter vessel, and therefore it would have better performance in terms of speed and power and so on.
Q. Right.
A. I may be able to help you a little bit, Mr Mok, in that I've remembered that there were some problems with a variation of 5083 material that was incorrectly manufactured in the USA in the early 2000s, maybe 2001. It was actually material I think called 5383, which is a slight improvement on 5083, a slightly different chemical mix. There were some seven, maybe eight vessels built with that material, which ultimately proved itself subject to very high corrosion due to some incorrect procedures that were carried out. It was a strange sort of wastage which is called exfoliation, because the aluminium came off like leaves, hence the name "exfoliation". It was deemed to be unsatisfactory because the wastage was evident, whereas it should not

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have had any wastage. All of those vessels all had to be scrapped. So the classification society's approach in that state was: "Not satisfactory. Build it again."
Q. Thank you. Now we're going into the 1995 Instructions, and those Instructions, if I may just go to them now, are in marine bundle 8, tab 2. The relevant one is at page 1820. I think your reference there is to point 3.2; right?
A. Yes.
Q. It says there:
"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. The tabulated figures for minimum thickness are based on frame spacing of 600 mm. The minimum thickness of hull plating for other frame spacing can be obtained by direct proportion, but in no case the thickness of any part of hull plating is less than 3.5 mm ..."
Then the table over the page sets out the various parameters and the minimum thickness corresponding to them.
A. Yes.
Q. I think you would agree, Dr Armstrong, that this table is intended to apply to steel vessels?
A. It states that quite clearly, yes.

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Q. Yes. And there is in fact no table, as we can see, for aluminium vessels?
A. Correct.
Q. From your understanding of the case, would it be because at that particular time -- that is, around 1996 -- aluminium vessels were not that popular as they are these days, so there would be fewer vessels built of that material in those days? Is that the impression you get?
A. Less popular than steel vessels?
Q. There are fewer in terms of aluminium vessels being built in Hong Kong in that particular time.
A. Relatively few vessels built in aluminium at that time, yes. In the rest of the world, 1996 was the heyday of the building of aluminium vessels. But still small in terms of how many steel vessels were being built.
Q. Right.
A. Of course, there were a lot of aluminium vessels operating in Hong Kong at that stage, built in aluminium, mainly hydrofoils and jetfoils and so on.
Q. Right. So with that background, Dr Armstrong, would it be correct to say that in fact in this book, at least as we have seen, there are really no rules or intended rules concerning hull thickness to be applied to aluminium vessels?

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A. That is the case, yes.
Q. So what you have tried to do to assist the Commission is, assuming that the table also applied to aluminium vessels, what that value should have been in relation to a vessel with a stiffener spacing of 350 mm?
A. Correct.
Q. That's the exercise that we are assisted with?
A. Yes.
Q. But that exercise would only be valid on the assumption that those rules should also be applied to aluminium vessels, albeit with some sort of conversion which is not stated; right?
A. Correct, yes.
Q. Let's now come to the other assumption, which is not apparent from these rules; that is, that you could do the conversion exercise as you have done and see what the result should be.
Assuming that we have a thickness or a ship which has been approved for 5 mm, such as Lamma IV, at the time when it was approved, assuming that all your calculation is correct, then the plans could have been approved, right, even under this particular rule? That is, using your formula --
A. Yes.
Q. -- and converting it to aluminium. It would have been

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approved, even under this rule?
A. I believe so, yes.
Q. The only thing that occurred in this particular case is that after it had been approved, and when the aluminium was actually delivered, it had an under-thickness so that it was not 5, but 4.83. And as you said, it could be expected because that is the difficulty with aluminium manufacturing in general.
Now, in those circumstances, would it not be right that if Mardep were to apply the tolerance rule and accepted that, that would be perfectly within anyone's understanding of these rules?
A. I thought we had already discussed that and accepted it.
Q. Thank you. So even if the 1995 Rules were to apply, would you agree that there would be no compliance -- non-compliance at the time when the ship was being built?
A. Yes, I would.
THE CHAIRMAN: That's on the basis that it was being built with 4.83 mm plating?
A. That's on the basis that I calculated 5.22 in my calculation, and 0.2 of a per cent for under-rolling brings you down to approximately 5.0, and then some negotiation with the certification authority would allow 0.1-odd of a millimetre.

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It's my assumption.
MR MOK: Thank you. I think subject to any matters that we need to return to in relation to Lloyd's -- I'll think about it overnight whether or not we need to return to it -- those are my questions relating to the plate thickness.
May we now turn to the question of the seats.
The first matter that I would like to refer to is your calculation at expert bundle page 956-13. I think we looked at that this morning.
A. It was mentioned this morning, yes.
Q. May I just quickly summarise what you are saying there, to see if I'm correct. What you are doing there is to equate the impact of the collision in terms of the impact on the seat foundation of the vessel, with a normal load when Lamma IV was being operated in its normal course of service.
A. Not quite the words I would have used, Mr Mok. I was trying to equate the acceleration experienced during the collision with the accelerations that would be experienced in service in a sea state, with a 1.2-metre-high beam sea.
Q. Acceleration?
A. Acceleration.
Q. How would such acceleration have an impact on the seat

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foundation?
A. Well, an acceleration can be equated to a load. In fact under DNV Rules, for example, for aluminium craft, the boat is designed to an acceleration, not to a loading. It's designed to an acceleration.
Q. Right. So the reasoning here is that the acceleration or the impact from the acceleration at the time of the collision would be no more than the impact of a collision where Lamma IV was being operated at the conditions that you set out here, at 11 knots, at 1.2-metre-high beam sea, which as I understand it is the normal operation environment for Lamma IV.
A. I don't know if that is normal or not, Mr Mok. It was an example derived from the 0.24 G.
Q. Right.
A. But I thought it was realistic. If the Lamma IV was to go close to the wash of a big vessel, for example, it may be 1.2 metres high.
Q. As high as that?
A. Possible.
Q. So that would be the condition where Lamma IV, travelling at a speed of 11 knots in Hong Kong waters, but maybe near to a bigger vessel which may have created a wave which affects the vessel; that's the condition we're talking about?

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A. Yes. Can I stress that I used the words "averaged 0.24 G".
Q. Yes. 0.24 G. And the point that you make there is that 0.24 G is insufficient to have any significant impact on the seat foundation. Is that the point being made there?
A. Yes.
Q. Right.
A. I was trying to make the point that I did not think the collision weakened the seat foundations any more than they were weakened by operation in a 1.2-metre-high beam sea.
Q. Right. Thank you. That force of 0.24 G, according to you here, is not sufficient even to significantly affect seat the seat foundation, let alone detaching the seats from the floor. Would that be a fair way of putting it?
A. No, I can't agree, Mr Mok, because one has to put repeat events into this and think about fatigue and continuous operation like that. Whereas the accident was a one-off event, and I was trying to comment I think on a question from Mr Grossman about whether the foundations had been weakened by the single event, the collision. I think 0.24 G is not something you'd want to be happening all the time, for the seats to stay attached.
Q. No, I understand that. But we are taking Lamma IV at

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the condition that it was in at the time of the collision, are we not?
A. Yes.
Q. So whatever wear and tear in relation to the seat foundation, it would have occurred by that time, right, as a result of the years of operations?
A. Yes.
Q. So your point is, with the condition of the vessel at that time, 0.24 G would be insufficient to significantly affect the seat foundation, let alone to detach the seats from the floor. Would that be a correct statement?
A. Yes. I think this is the same point I was trying to make: the collision could not have done it.
Q. So by the same token, with 0.24 G, if instead of being created by the collision, let's say it was created by a vessel, a large ocean-going vessel creating a wave of 1.2 metres nearby, that force, again because it was 0.24 G, would be insufficient to affect significantly the seat foundation, let alone to detach any seats from the floor?
A. Unless it was a repeat event. But one-off, I agree.
Q. Again, Dr Armstrong, we are talking about the condition of Lamma IV at the time of the collision. I'm not talking about any other time. Do you understand what

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I mean?
A. No.
Q. That question is posed at the same time as the time of collision. So in the same way that a collision would not cause that effect, what I am suggesting is that an ocean-going vessel creating a wave of 1.2 metres high at that point in time would also not create that effect. Do you understand what I mean?
A. I agree with you. If it had gone past many vessels many times, the answer would have been different.
Q. I know.
A. Okay.
Q. But as you said, we're talking about one point in time only.
So does it follow that the seating, whatever defect it may have, was adequate at that point in time to withstand, say, a wave coming at it of 1.2 metres, created by a nearby ocean-going vessel?
A. Yes, I believe so.
Q. Also, I think in the body of your report, there are indications which are also consistent with that. May I ask you, please, to look at paragraph 48 of your first report, page 419. You say in the last four lines of paragraph 48:
"It was only in the abnormal condition where the

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vessel had excessive stern trim and the weight of the seated person generated an abnormal tipping force that the foundations finally failed."
Do you see that?
A. Yes. I carefully chose those words.
Q. Yes. So it goes to support the point that in its normal condition -- that is, where the description here would not occur -- the seats would not have the effect of them being detached and the foundation would not have the effect of failing, as you describe in this sentence? In the normal condition, not the one that you are describing in this sentence.
A. When considering one-off events, yes.
Q. There is also another indication in paragraph 78, I believe. You say in paragraph:
"The passenger seats on Lamma IV collapsed because they were insufficiently attached to the plastic deck to withstand the abnormal load, being only screwed to the deck structure without apparent consideration of the make-up of the internal structure of the deck."
Do you see that?
A. Yes.
Q. So what clearly you are saying, Dr Armstrong, is that the seating or the attachment of the seating was clearly inadequate when it ran into that sort of abnormal load

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or abnormal event?
A. Yes.
Q. Would you agree that it does not imply from that that where there is a normal load, in normal circumstances, including the circumstance where you have an ocean-going vessel travelling fairly near, it doesn't imply that the seats are inadequately being attached during those normal conditions?
A. It does not imply that, no.
Q. Right. So when we talk about adequacy or inadequacy, do you agree that one has to first of all pose the question "adequate for what purpose"?
A. Very important, yes.
Q. We see in relation to the new code of conduct governing high-speed vessel, for example, there are additional requirements which may cater for even abnormal events. Can we take a look at that.
I believe it's in bundle 11, the code of conduct -- the code of practice. I keep saying "code of conduct". Page 3527. I think its paragraph 4.3, and this applies to high-speed craft:
"Seats and their attachments, and the structure in the proximity of the seats, should be of a form and design, and so arranged, such as to minimise the possibility of injury and to avoid trapping of the

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passengers after the assumed damage in the collision design condition. Dangerous projections and hard edges should be eliminated or padded."
Do you see that?
A. I do. That's very similar to chapter 4 of the high-speed craft code of IMO.
Q. I think you can assist us here. That obviously is a very specifical requirement because it draws attention to the assumed damage in collision design condition.
A. Yes.
Q. Is that, in your experience and understanding, a unique requirement for high-speed craft? Or do you see also that sort of wording being applied to, say, a small craft which is not a high-speed craft?
A. It was specific wording put together for the high-speed craft code, and I have to admit I was involved in writing it. It has been adopted by some other authorities for certain types of vessel. I'm aware that it's just been written into part of the Australian regulations. I don't believe that it would apply to most conventional ferries, because the problem here is collision at high speed. That's not usually the case of most ferries. I think we'd need to define "high speed" though. I'm not sure if Sea Smooth was classed as a high-speed vessel or not.

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Q. Let's leave that question aside for the time being. Can you assist us in understanding what is the rationale for prescribing such a requirement in relation to high-speed craft? What is the thinking behind it? I think you can assist us because you were the --
A. This particular clause came about, Mr Mok, because of a specific accident to a vessel called the Seacat in Norway in 1989, give or take 12 months -- I'm not sure -- where a small 30-metre catamaran turned to port in the dark in order to enter a fjord and missed the fjord entrance and hit the cliff, a vertical wall. Unfortunately the vessel was travelling at 33 knots and therefore the craft stopped, but unfortunately the people inside continued at 33 knots with some awful injuries. One of the problems was that everybody ended up on the forward bulkhead, and all the seats as well, in rather the opposite manner to happened unfortunately to Lamma IV.
It was then decided that high-speed craft doing these sorts of speeds needed to have some better protection, and one of the outcomes was in chapter 4 to specify where the collision bulkheads should be, and how to design for what was colloquially called a crumple zone. This was some part of the aluminium structure at the bow that could deform, and whilst it deformed,

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slowed the boat down sufficiently that people could survive it.
It then also regulated seat design, and that was discussed over a period of years because at that stage, there were no known seats that could comply with what IMO needed, and there was no known testing mechanism either.
That was finally agreed and inserted into the high-speed craft code. So it was specifically aimed at small craft running into a vertical cliff which would cause almost instantaneous stoppage.
Q. Right. So as a result of that particular accident, eventually there were discussions that finally gave rise to this particular form of drafting?
A. Very similar to this. High-speed craft code, chapter 4.
Q. Can you assist us. Let's assume that the upper deck of Lamma IV were the upper deck of a high-speed craft, with a fibreglass flooring and with the sort of embedded foam of the type that you describe in your evidence. Assuming that to be a high-speed craft, what kind of seating arrangement should be put in place in order to comply with this particular rule?
A. The normal way to do that would be to fit a track along the deck. This is a track that's specifically designed by the seat manufacturers. The track, of course, has to

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be sufficiently and rigidly attached to the deck. And then to fit the seats to that track. I believe a similar arrangement was indeed fitted to Sea Smooth, which I noticed during my inspection.

Q. How would the tracks be fitted into the fibreglass floor? What would be the safe way, in order to comply with this particular requirement?

A. The high-speed craft code actually has requirements for seats and the loads they're required to take, which don't follow through here, I appreciate. I'm not qualified to be exactly specific how that could be done, because I've never seen it myself in detail on a fibreglass high-speed craft.

Fibreglass is a somewhat unusual material for a high-speed craft because of the fire regulations. It's not very common. It's difficult to meet the requirements, because of fire and smoke and toxicity. So there aren't that many of them. But I would suggest certainly that through-bolting in some way would be essential.

Q. Right. Let's look at through-bolting as one possibility. I think you explained to us that the material inside the floor, the foam part which is the thicker part of the flooring, it's very soft?

A. Yes, sir.

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Q. And it could crumble like toast, I think someone --

THE CHAIRMAN: That was Dr Armstrong's illustration: it had the strength of toast.

A. Yes.

THE CHAIRMAN: Whilst we're on the question of foam, do we have an answer as to what the thickness on Lamma IV was?

A. I've had difficulty finding my particular notes, Mr Chairman. But could I, in lieu of doing that, refer you to a photograph which I think may assist.

THE CHAIRMAN: That's the photograph with the tape measure in front of it?

A. Yes, sir.

THE CHAIRMAN: Yes.

A. It can be seen I think in expert bundle 2, the London Offshore Company witness statement on page 975.

I am very sure this is the same hole, Mr Chairman. I know of no other holes in the deck that were circular.

THE CHAIRMAN: Yes. Thank you for that. But nevertheless I think, whether it's done by you, Dr Armstrong, or anyone else, we ought to have evidence of an expect measurement of the foam that was actually used on Lamma IV's upper deck.

A. I did send an email to Lo & Lo at some stage about this very issue, and I quoted some details in it. But I would strongly recommend it be checked again,

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Mr Chairman.

This photograph to me indicates only 20 mm thickness, when I scale it carefully. And my own notes suggest 25. I'm a little unsure.

THE CHAIRMAN: Obviously the vessel is still there. It can be done again.

But I think, Mr Shieh, we must have that.

MR SHIEH: Yes. We can ask Lo & Lo to make enquiries with the police and Mardep and make sure somebody does it.

THE CHAIRMAN: Thank you.

MR SHIEH: It may or may not require Dr Armstrong to be physically --

THE CHAIRMAN: No, it doesn't have to be Dr Armstrong, but it's the information we require.

I interrupted you, Mr Mok.

MR MOK: That's quite all right.

Dr Armstrong, with a material of that kind, let's say you put bolts through that particular material. Because of the soft nature, wouldn't there be some giving along the bolt, because, given some pressure, whether horizontal or any other way, it may eventually make the foam even more malleable? I don't know whether I'm making myself clear.

A. You are.

Q. But the difficulty of using a bolt through that kind of

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material, would that cause difficulty?

A. The fault for confusion is not yours, it's probably mine, Mr Mok, in that I have tried to simplify matters by saying "a bolt", but in reality it's more complex because you'd want to put a sleeve through there in order to provide some compression load for the bolt to pull against. So it is not simply a question of drilling a hole and putting a bolt through.

Q. Right. Because I got the impression that that's what you may be doing.

A. I apologise. No, you would have to put an insert in there and probably bed that in with some resin compound as well to make a clean -- say, aluminium, maybe steel insert, tube, through which the bolt could pass, and then a washer and nut underneath.

Q. Right.

A. In case of obstruction underneath due to structure, one could fit an insert into the foam locally, perhaps with some hard wood, perhaps a metal type of insert.

Q. Right. Earlier on you mentioned some stiffener problems because it may depend on where you have those bolts. Would that cause any difficulty for this particular method, the stiffeners?

A. I'm suggesting something locally could be done in that case to put an insert in, instead of the foam.

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Q. If one were to adopt that particular --
A. However, Mr Mok, with track, of course one doesn't have to put the track bolt-holding-down system exactly where you want the seats. Track can be put and fastened down clear of stiffeners, with bolts in between, for example, and then the seats can be positioned anywhere you require on that track, such as was done with Sea Smooth.
Q. So here we are talking about perhaps two different levels of security, the first one being using bolts on the individual chairs without the track; that's one way?
A. (Witness nods).
Q. The other way is to put a track in, as on the Sea Smooth and other high-speed craft, using that method and then put the seat on top of the track?
A. Yes.
Q. These are two variations?
A. Yes.
Q. With either of these variations, it would seem that this would be quite a major operation in terms of the construction, as opposed to, say, the sort of self-tapping screws that are being used in this case. It's a much more major kind of construction?
A. Yes.
Q. So in your view, if one were to do that, with or without the track, that may be sufficient to satisfy the

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requirement in paragraph 4.3?
A. 4.3 of which document?
Q. Of the code of practice. Have you got that? Page 3527.
A. I have that. Yes, it could be sufficient to satisfy the requirements, either of those.
THE CHAIRMAN: That is for high-speed craft? That's what these requirements are for?
A. Depending on how the collision design condition is defined in this document.
MR MOK: Right. What about the IMO, that you are more familiar with? Would that satisfy, the equivalent requirement there?
A. I can't answer that, Mr Mok, because the IMO does not allow such a structural arrangement.
Q. I see.
A. It doesn't allow you to use fibreglass as a structural material --
Q. In the first place.
A. -- in the first place, because of smoke and toxicity issues, in case of fire.
Q. Would it be correct to say that whatever arrangement you have so far as seating is concerned under this rule, that is really catered for the impact of a collision and to minimise the damage that may be caused by that, and that it is not catered for a situation where you have

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the vessel standing vertical, as in the case of Lamma IV? That rule that we are discussing is not there to address that situation, right, but to address the situation of --
A. Well, it is, but I think it would more than adequately address the situation that Lamma IV found itself in.
Q. I think you've already indicated this, but let's be clear. You have not found these particular rules to be applied to crafts other than high-speed craft, or very rarely would it be applied?
A. I have no experience of high-speed craft built out of a composite material. There are some built in Norway, out of carbon fibre, but I do not know how they address this issue.
Q. Maybe I'll put it in another way. I think this may go into the second part of the Inquiry a little bit, but it's relevant here. As an expert in this area, would you advise that this kind of set-up, this kind of arrangement or this kind of wording be applied also to vessels other than high-speed craft in Hong Kong?
A. I think that needs some further consideration, Mr Mok. It's certainly worthy of consideration I think under part 2 or something like that.
Q. We don't know whether and when your assistance is required on that, but on that, can you help us with just

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one point further. What are some of the factors you may take into account in deciding whether or not this requirement should be applied, say, to a vessel like Lamma IV?
A. I'd want to look at the formulations again of how the collision accelerations are worked out, and try and equate that against such things as the number of passengers and the weight of the craft.
Q. Do you agree that the sort of elaborate arrangement -- the through-bolt and the special tube and so on -- is not an arrangement that is generally required, let's say, in relation to a vessel like Lamma IV?
A. Not generally required?
THE CHAIRMAN: Is your question restricted to Hong Kong or around the world?
MR MOK: Let's say around the world, or the jurisdictions that Dr Armstrong is familiar with.
A. I was struck when I went on board Lamma IV with what I saw remaining, that I thought the attachments were inadequate, and I have never thought that before on any other vessel I have been on.
Q. I understand. And whilst that is clearly an impression you have, based on your very extensive experience, what I would like to ask you is whether there are any objective rules, regulations, practices which may be

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referred to to say that the seating arrangement of Lamma IV is inadequate in the normal service or normal operation of that vessel? Are there any such rules or practices that we can refer to?
A. I only know of one possible source.
Q. Yes?
A. My own jurisdiction, Australia, has recently completed and issued a comprehensive set of regulations for domestic commercial craft. I cannot give you details of the seats, because I don't recall them. But there are some regulations there for seats that may be worthwhile looking at.
Q. Thank you. Other than that, is there anything else that we can refer to?
A. Not that I'm aware of, no.
Q. Just one detail which I would like some clarification of, if I may. If we look at the diagram on page 467, the bottom one. What this shows is self-tapping screws being placed, inserted inside two layers, one is the woven roving which you've described to us before, and also the plastic foam. I think you've measured the woven roving to be 2.1 mm.
A. Correct.
Q. There is also I think a vinyl layer on top which is also around 2 mm?

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A. I think a little less, from memory.
Q. Can you give us the figure?
A. According to my measurements on board, which was not necessarily all that accurate, sir, because I was using a tape measure, 1.5 mm.
Q. Right. That layer of vinyl surface would be glued onto the woven rovings so that they actually become one continuous piece of material; is that how it's done?
A. The vinyl tiles were approximately 9 inches by 9 inches, from memory. So not continuous.
Q. All right. Sorry for using that word.
What I mean is, are they stuck together to become part of the woven roving?
A. I do not know that.
Q. You don't?
A. I would assume so from the fact that many of the tiles were still there after the accident. So there was probably some adhesive.
Q. Right. So if we add in our imagination one extra layer on top of the woven roving, the vinyl tiles of 1.5 mm thick, would that assist in the adhesive or the security of the screws that are screwed through these three layers of materials?
A. No, sir. I don't believe so. Although the vinyl flooring is not shown, the thicknesses are actually

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correct. The vinyl flooring should have gone above the woven roving and below the seat support.
Q. Right.
A. You'll see that the screws are sitting up a little proud of the seat support. They're sitting up because I didn't put the vinyl flooring in, which was my error. But the relative positions are correct and the dimensions that I believe I give somewhere are correct, with 20.9, I think it was, being inserted into the foam.
Q. Maybe I'm not so clear about my question. I think --
THE CHAIRMAN: I think your question is this: does the vinyl add anything to the security of the screw in the deck?
MR MOK: Yes.
THE CHAIRMAN: I think you answered that to start with.
A. I think I answered that at the beginning. It's "no".
MR MOK: Yes, you did say that. I asked that because you mentioned this rule of thumb, that should there should be at least --
A. 2.5 threads.
THE CHAIRMAN: That's in metal, is it not?
A. That's in metal, correct.
MR MOK: So your answer is that it won't help even if part of the threads go through the vinyl tile; it doesn't help at all.
A. Not at all.

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Q. Is that because of the quality of the material, of the vinyl?
A. Yes, indeed.
Q. It doesn't help to --
A. It's a weak, flexible material.
Q. Thank you. Now, assuming that -- I mean, this is a small point -- we do have enough material, that is enough of the woven roving to enable the 2.5 threads to go through it, assuming that to be the case, that, of course, would not have prevented the seats from being detached in an accident such as that that occurred in Lamma IV? Even that, if you were to comply with that, may not prevent the seat from being detached?
A. The rule of thumb of 2.5 threads in metal is not quite the same as 2.5 threads in woven rovings. I think you'd need more.
Q. Right. In other words, that rule of thumb doesn't really apply to this particular kind of material?
A. No, it was given as an example.
Q. I see.
A. I did do a web search of pull-out strengths of screws in woven rovings, and it's not quite such an obscure subject because there are a lot of yachts made out of woven rovings, and I found a lot of people complaining and asking the same question that I was looking for

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an answer for, because they'd had problems with screws pulling out. But I did not resolve the question.
Q. You did not, sorry?
A. I did not find an answer to the question. Everybody seemed to think that you would have to put an insert in, or bolt straight through.
Q. Would it be correct to say one simply doesn't know how much force it is necessary to pull the seat from the floor, which has been attached by this particular method? There isn't any figure or any indication that one can give?
A. I think that could be done, but what is questionable is what is the pull-out force of a self-tapping screw into a depth of fibreglass, because as I said yesterday, the properties of fibreglass are variable. So you would expect to get a range of answers. You may then take the worst answer, I suppose, as a guideline. But you could work out what force -- you could agree a design force for a seat.
Q. So the answer is it can be done, although it hasn't been done in this particular case?
A. Correct.
Q. So it seems that the bottom line is this. Those screws and the way they are attached are clearly inadequate when one comes to an accident such as what happened to

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Lamma IV. But on the other hand, they seem to be adequate for the normal service and operation of the vessel, even if it was sailing near an ocean-going vessel. And there doesn't seem to have been any report of any incident of seat detaching throughout the 15 or 16 years of service.
A. Mr Mok, there are references to problems with seats.
Q. Yes, we do know that and we also know that some of the seats have been rescrewed or reinserted and --
A. We do not know why or under what circumstances though.
Q. We don't.
A. No.
Q. But clearly, those are attempts to fix a problem which had been noticed at the time.
A. Yes.
Q. And after fixing it, or throughout the many years in which the vessel was being maintained, there hasn't been, as far as we know, any reported incidents of any seats detaching under whatever condition the vessel was being operated in in Hong Kong waters.
A. If you say so, yes.
Q. Thank you. Can I now ask you to please go to your paragraph 48 again at page 419. The last sentence of paragraph 48 is:
"Nevertheless the arrangement of screwing seats into

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GRP foam sandwich in my opinion could not be considered as adequate."
Right? I think it would be a fair question to ask, adequate for what purpose? What purpose are you referring to in that sentence?
A. I'm referring to the attachment of a seat to the deck on the ferry which is designed to operate in a seaway.
Q. And why would that be inadequate?
A. Because mechanically, a screw into fibreglass is just not an adequate connection. It's going to come loose.
Q. Yes. In a way, that is one way of looking at adequacy. But if one looks at the purpose for which adequacy is being discussed, can you be more specific as to what purpose it is not adequate for?
A. I think it's fairly obvious that the seat has to be attached to the deck at all times, particularly when the boat is moving around. So the screw has to be adequate to maintain contact between the seat and the deck, with a certain amount of force, a certain amount of loading, to make sure that it does not shift or come loose over a period of time. And I still believe it to be an inadequate connection to screw a self-tapping screw into 2.1 mm of woven rovings.
Q. I see. So am I correct in summarising this, that your view of adequacy is that the seats must be so attached

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that they do not become loosened over the course of time? Is that your view of "adequacy"?
A. There are other, of course, requirements. They should also not collapse under the weight of a person and so on. But, yes, broadly that's what I'm saying.
Q. I see. So you wouldn't use, for example, a looser standard, that it would be adequate so that the seats would not become detached or otherwise cause danger to the passengers during the normal operation of the vessel? You would not, say, use this, if I may put it, more liberal standard?
A. You might then have to define such things as "danger" and what you were expressly referring to.
Q. Well, "danger" meaning that the seats would move or detach in such a way that it may crush people or it may collapse in the course of voyage. Dangers such as those. You would not adopt that standard of adequacy; you would adopt a higher standard so that they cannot be loosened at all?
A. I think when specifying what you require, it should be done in a way that can be proven or disproven, and the use of words like "adequate" is inadequate.
Q. Is inadequate.
A. Nevertheless, putting screws into GRP foam sandwich by any definition is inadequate because they're going to

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come out, whether it's a seat, a shelf, or a battery box; whatever.
Q. But what if those seats are constantly being maintained so that, for example, if you have a loosened screw, you fix it? I'm not saying that necessarily on Lamma IV everything is fixed very well, but wouldn't it be a solution to the issue that you're posing?
A. No, it would represent an even greater problem to me, Mr Mok, because you constantly have people going around trying to tighten up screws and one of the problems now is you're going to over-tighten the screws and pull up the glass. You can see that in the some of the photographs of the failure, where the screw has been pulled out of the glass due to excessive forces, which you're going to run the risk of doing if you keep tightening screws up.
Q. Then maybe finally, if I may invite you to look at the rules. The Blue Book first. That's in bundle 8, tab 1, page 1773. Paragraph 26 says:
"Seats should always be properly secured."
A. Yes.
Q. We now turn to the 1995 equivalent of that rule. I think it's page 1835 of the same bundle. 4.1 says:
"Where seats are provided for passengers, their form, design and attachments to the deck should be

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adequate for the intended service."
Now, the "intended service", if one understands that to be the normal day-to-day service of the vessel, would you agree that the attachments of the seats in Lamma IV were adequate in the sense that they're not liable to be detached or otherwise cause danger because of the movement of the seats during the normal course of Lamma IV's voyages?
A. No, I would not agree because I think they were inadequate because they were liable to become detached.
Q. During voyage?
A. During a normal voyage, yes. Over a period of time.
Q. So you think that as at the time, for example, in 2012, the evidence that you have seen in this vessel is such that your view is that the seats are liable or were liable to be detached during the normal course of voyage at that time? Is that your opinion?
A. That's my opinion. And by "detached", maybe I can just explain that I mean not necessarily fall over, but become loose, which allows the seat to then become detached from the deck in some circumstances.
Q. So we are back to the same point; that is, the standard that you would apply? In other words, if your standard is that "adequacy" means that it cannot be loosened, but without reaching the extent of causing actual danger,

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you would still find that to be inadequate?
A. Yes, sir.
MR MOK: Thank you very much.
Mr Chairman, I think I have finished that line. I am going on to a different topic.
THE CHAIRMAN: Very well. How long, if you're able to estimate, do you anticipate being tomorrow morning?
MR MOK: I would expect about an hour.
THE CHAIRMAN: Thank you.
MR SHIEH: Mr Chairman, there is one point of perhaps order, because Mr Tang Ying-kit, a lay witness coming talk about what he observed by way of waves and wake, is scheduled to come tomorrow morning. Because of potential uncertainty -- I know Mr Mok is doing it to the best of his intent, but if we are not entirely sure how long Mr Mok may be with Dr Armstrong, and I may have some questions to ask Dr Armstrong, I simply suggest that maybe we interpose Mr Tang Ying-kit, because he might be reasonably short, rather than keep him in a abeyance while the questioning of Dr Armstrong continues.
THE CHAIRMAN: From what Mr Mok has said we can probably tell Mr Tang to come not before the morning break.
MR SHIEH: Very well. We shall do so.
THE CHAIRMAN: Now, Mr Shieh, there was an issue as to who

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it was that was re-screwing the seats back to the deck of Lamma IV, and I think we've received some material. I think on the one hand -- Mr Pao, correct me if I'm mistaken -- Cheoy Lee say they weren't doing this kind of work.
MR PAO: No, they weren't.
THE CHAIRMAN: Is that right?
MR PAO: Yes.
THE CHAIRMAN: So the issue is who is doing that, and I'd ask you to consider that. This is what appears to be, for example, putting in the rivet into the four-screw platform.
MR SHIEH: Or removing a mounting plate and then --
THE CHAIRMAN: And repositioning it.
MR SHIEH: -- repositioning the parallel set of holes.
THE CHAIRMAN: Thank you.
MR GROSSMAN: I think we'll be able to assist Mr Shieh with that.
THE CHAIRMAN: Thank you very much.
Yes, there was another matter. Dr Armstrong, can I just invite you to have a look at material that has been put in by Reed Smith Richards Butler, accompanying, I think, a second statement of Tang Wan-on. It's at page 774-11.
Can we put that up on the screen.

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That's the form of tender, but it's what it refers to in the body, in relation to the batteries, that I'd invite you to have a look at and see if you can help us. Because this is an issue that has to be addressed at some stage; that is to say, where the alternative power source was and the circumstances in which the emergency would also fail.
A. Understood.
THE CHAIRMAN: So could we come to page 774-43. There is provision here for a DC system, 24-volt. Item L8:
"The batteries should be maintenance-free type, not less than 200 ampere-hour and suitable for marine use. A total of six 12-volt batteries in 3 banks of 24-volt, two banks for starting the main engines and one for the emergency lighting system and 24-volt instruments and electronic equipment. All batteries to be housed in GRP boxes positioned to the engine room floor."
That seems to accord with the description you were giving us today?
A. Yes, sir.
THE CHAIRMAN: If we come then to the tender specifications, page 774-71. The DC system is addressed again, and the switchboard itself is then described at item B:
"The master emergency lighting controls also to be on this panel ..."

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That's a panel adjacent to the main AC board.
"... with local control in wheelhouse."
Now, we have photos of the wheelhouse. The Commission would like assistance as to where the local control was in the wheelhouse for emergency power.
A. There's an emergency switchboard, Mr Chairman, on the port side aft bulkhead.
THE CHAIRMAN: Thank you. We'll come to this tomorrow, if you can help us with that tomorrow.
A. Yes.
THE CHAIRMAN: Then over the page at 774-72, the actual emergency lighting system described:
"An adequate number of lighting fittings to be provided in wheelhouse, passenger cabins, toilets, aft deck, crew quarters, engine room and steering flat. 24-volt operation with master controls on main DC panel and automatic changeover in the event of main failure."
So that's where we need help. We also need help as to whether this automatic system operated the navigation lights.
A. I can do that, sir.
THE CHAIRMAN: Thank you very much for that.
We'll adjourn now until 10 o'clock tomorrow.
I'm sorry, there is one other matter. The American Bureau of Survey. Can we ask you for your help again.

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We are missing some survey certificates that apparently testified to the 5083-H116 tempered 4.83 mm plate. In your experience, how long is it likely that a survey organisation would keep its copy of such documentation? Can you help us? Do you have any information about that?
A. No, sir.
THE CHAIRMAN: If a vessel is to be built and last for the 50 years that you've described of the vessel that recently retired, would you expect the classification or the bureau certifying parts of it to maintain those records?
A. In my experience, the classification societies have always kept every piece of paper that related to the approval of a ship, but I have no first-hand experience of the American Bureau of Shipping in that regard. I can only comment on Lloyd's and DNV and Germanischer Lloyd. But it could well be that they would have them. One would have to ask in which department and in which office. I think the Singapore office is their major office in region.
THE CHAIRMAN: What we're trying to track is aluminium that came from Florida, I think.
Mr Shieh, could I ask you to look at that?
MR SHIEH: Yes, sir.

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THE CHAIRMAN: 10 o'clock tomorrow.
(4.39 pm)
(The hearing adjourned until 10 am on the following day)

I N D E X

DR NEVILLE ANTHONY ARMSTRONG (on former oath) 1

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