

Page 1	Page 3
<p>1 Thursday, 26 September 2019</p> <p>2 (1.35 pm)</p> <p>3 DR BARRIE TREVOR WELLS (on former affirmation)</p> <p>4 MR SHIEH: Mr Chairman and Mr Commissioner, before we</p> <p>5 proceed further with Dr Wells' cross-examination, I have</p> <p>6 one request to make.</p> <p>7 Overnight, I think this morning, the Department of</p> <p>8 Justice responded to a request for information made by</p> <p>9 Messrs Lo & Lo concerning the sampling process,</p> <p>10 specifically relating to panels in area A, because the</p> <p>11 Commission may remember, in the course of examination of</p> <p>12 one of the MTR witnesses -- I think it's Mr Yeung -- he</p> <p>13 mentioned the fact that because of some boundary</p> <p>14 conditions of some panels in area A, this fact was</p> <p>15 communicated to those responsible for the sampling</p> <p>16 process, and Lo & Lo requested the government to explain</p> <p>17 whether this boundary condition, or lack of</p> <p>18 accessibility to certain panels in area A, had been</p> <p>19 taken into account in the sampling.</p> <p>20 The government gave a response this morning which on</p> <p>21 the face of it suggested that yes, because of boundary</p> <p>22 or accessibility problems, some panels in area A were in</p> <p>23 fact excluded from the sampling process.</p> <p>24 Now, ordinarily, I would have wished to explore this</p> <p>25 with my statistics expert, Dr Wells, before he went into</p>	<p>1 (2.07 pm)</p> <p>2 MR SHIEH: I'm grateful for the indulgence. I've had</p> <p>3 a chance of speaking to Dr Wells and we can continue,</p> <p>4 Chairman.</p> <p>5 CHAIRMAN: Thank you.</p> <p>6 Cross-examination by MR CHOW (continued)</p> <p>7 MR CHOW: Good morning, Dr Wells.</p> <p>8 A. Good morning.</p> <p>9 Q. So we now continue with our discussion from yesterday.</p> <p>10 Dr Wells, yesterday just before we adjourned, we</p> <p>11 were talking about the question of whether it is</p> <p>12 necessary to look at the actual sampling process in</p> <p>13 order to determine the question of randomness. Do you</p> <p>14 remember that?</p> <p>15 A. I do, yes.</p> <p>16 Q. I think you agreed at one point that this is something</p> <p>17 that we should look at, that is to say the actual</p> <p>18 sampling process; right?</p> <p>19 A. I think what I said -- I can't actually remember; you</p> <p>20 presumably have transcripts -- but my meaning would have</p> <p>21 been, from a statistical point of view, it is normal</p> <p>22 practice, having undertaken a random sampling exercise,</p> <p>23 to look at the results and see whether they confirm or</p> <p>24 possibly conflict with the assumptions that were made</p> <p>25 originally. I can quite clearly remember saying</p>
Page 2	Page 4
<p>1 the witness box, to see whether it has any statistical</p> <p>2 implication. I'm not saying it has; it may or may not.</p> <p>3 But I just wish to explore this new item of evidence</p> <p>4 with him before we go on. I don't know whether any</p> <p>5 question will be asked of him by the government. It may</p> <p>6 or may not be. But I'm just saying that I should be</p> <p>7 able to at least understand what my expert's view is on</p> <p>8 that additional piece of information.</p> <p>9 So perhaps my request is to ask for maybe five to</p> <p>10 ten minutes to explore this fact alone with my expert.</p> <p>11 CHAIRMAN: Yes, of course.</p> <p>12 Yes, Mr Chow.</p> <p>13 MR CHOW: Mr Chairman, we have no objection to that, save</p> <p>14 and except that in my following questioning, at the</p> <p>15 moment I don't plan to go back to this question about</p> <p>16 the number of samples drawn from area A. But if my</p> <p>17 learned friend Mr Shieh would like to nevertheless talk</p> <p>18 to Dr Wells for five to ten minutes, I have no</p> <p>19 particular objection to that.</p> <p>20 CHAIRMAN: All right. Good.</p> <p>21 Would you let us know, Mr Shieh, when you are ready?</p> <p>22 MR SHIEH: Yes.</p> <p>23 CHAIRMAN: Thank you. Court is adjourned.</p> <p>24 (1.37 pm)</p> <p>25 (A short adjournment)</p>	<p>1 yesterday that statistics never prove anything, so you</p> <p>2 cannot prove whether what you've done is random or is</p> <p>3 not random, but statistics does give you some very good</p> <p>4 indicators, and in particular it can help guide future</p> <p>5 decisions.</p> <p>6 So, having undertaken a random sampling exercise, it</p> <p>7 would be normal practice to undertake a very simple</p> <p>8 check to see whether the data appear to be random.</p> <p>9 Now, you made the point yesterday that it is</p> <p>10 possible, sometimes, to get an extreme event, just at</p> <p>11 random; highly unlikely, and if you do then it is more</p> <p>12 likely that the sampling process was at fault. It</p> <p>13 doesn't guarantee it, it doesn't prove it, but it makes</p> <p>14 it more likely and makes it sensible to at least look</p> <p>15 back over the steps and see whether or not a mistake had</p> <p>16 been made.</p> <p>17 Q. Let me see whether I really fully understand your</p> <p>18 answer. Are you suggesting that even if one cannot</p> <p>19 criticise the sampling process, if one looks at the</p> <p>20 result, and the result suggests that it is unlikely to</p> <p>21 come up, then it still suggests that the process of</p> <p>22 sampling is defective or somehow makes it not random?</p> <p>23 Is that your point?</p> <p>24 A. No. My point is it cannot say it is not random. It can</p> <p>25 make alarm bells ring, that the statistical tests for</p>

Page 5	Page 7
<p>1 randomness, if they show, for instance, that somebody</p> <p>2 just flipped a coin ten times, and every time you came</p> <p>3 with heads upwards, then you cannot prove from</p> <p>4 statistics that that is a biased coin. But it is</p> <p>5 evidence which I think we would be foolish to ignore,</p> <p>6 and one might ask an engineer to have a look at the coin</p> <p>7 and determine whether or not somebody had applied</p> <p>8 weights to it, to make it disproportionately comes up</p> <p>9 heads.</p> <p>10 So statistics doesn't prove anything. The engineers</p> <p>11 prove things. But the statistics can be helpful to the</p> <p>12 engineers in coming to their decisions.</p> <p>13 Q. So are you saying that you don't need to -- well, how</p> <p>14 Prof Yin performs his sampling exercise is not something</p> <p>15 that you need to be concerned with in forming a view as</p> <p>16 to whether the process was proper or not; right?</p> <p>17 A. I think that if I was criticising the process, then the</p> <p>18 parts of the process that I would criticise was that no</p> <p>19 test was done; that it would seem to me to be remiss not</p> <p>20 to just spend five minutes checking with pencil and</p> <p>21 paper that the results are what we expected, having</p> <p>22 spent so much time and effort having collected results.</p> <p>23 So I'm not trying to say that I think the process</p> <p>24 was itself faulty, except inasmuch as, at the end of it,</p> <p>25 I would have thought that it would have been worthwhile</p>	<p>1 started to describe his sampling process starts from</p> <p>2 paragraph 2.1 at page 7.</p> <p>3 A. Right.</p> <p>4 Q. Have you read those paragraphs before?</p> <p>5 A. Yes, I have.</p> <p>6 Q. Can you still recall the details how Prof Yin carried</p> <p>7 out the sampling exercise?</p> <p>8 A. Yes. When you said "details", sorry, I must have been</p> <p>9 getting confused, because in the document that I read</p> <p>10 yesterday, that I received very late the previous night</p> <p>11 and hadn't had a proper chance to look at, which was</p> <p>12 discussed by yourselves yesterday as to whether or not</p> <p>13 it should be admitted, that document, I think it's</p> <p>14 called "Response to Wells' expert report" -- that has</p> <p>15 considerably more detail, so when you referred to</p> <p>16 details, I was assuming you meant those more details.</p> <p>17 Sorry, I didn't realise you were referring to this.</p> <p>18 Q. At the moment, I am referring to details of the sampling</p> <p>19 process described by Prof Yin in his original report,</p> <p>20 starting from paragraph 2.1 up to paragraph 2.3.15.</p> <p>21 A. Okay.</p> <p>22 Q. Have you read this before?</p> <p>23 A. Yes. This is the one where he starts off by saying that</p> <p>24 he's going to take 84 random samples, but actually</p> <p>25 doesn't, he actually takes 28 random samples and then</p>
Page 6	Page 8
<p>1 spending just a few minutes doing the statistical test,</p> <p>2 and I think the fact that no statistical test was done</p> <p>3 is interesting.</p> <p>4 Q. Dr Wells, now you have had a chance to look at Dr Yin's</p> <p>5 report, in which there's a section in which he set out</p> <p>6 in detail how he carried out the sampling process. Can</p> <p>7 I assume that you have read that part of his original</p> <p>8 report?</p> <p>9 A. Yes, I have.</p> <p>10 Q. Is there any step involved in his sampling process which</p> <p>11 appears to you to be faulty?</p> <p>12 A. First of all, can I just clarify -- you said have I read</p> <p>13 the original report -- it wasn't described in detail in</p> <p>14 the original report. It was described in detail in his</p> <p>15 response to my expert report. Am I right?</p> <p>16 Q. No. Perhaps I can identify the relevant paragraphs for</p> <p>17 you, starting from paragraph 2.1 of his original report,</p> <p>18 up to 2.3.15. That is from page 7 to page 13.</p> <p>19 Do you have a copy of Prof Yin's report in front of</p> <p>20 you?</p> <p>21 A. I can see it on your screen.</p> <p>22 Q. Okay. So do you need to take time to read it again?</p> <p>23 A. You said 2.3.15. I'm not looking on the screen at</p> <p>24 2.3.15.</p> <p>25 Q. 2.3.15 is the last paragraph. Actually, where he</p>	<p>1 three random samples of each one of those 28, and</p> <p>2 multiplies by 28 to get 84. They are not actually the</p> <p>3 same thing, but I was glossing over that, sorry.</p> <p>4 Q. All right. As I understand it, he provided details as</p> <p>5 to the two phases of his sampling process. The first</p> <p>6 phase is to select a location of the group of samples of</p> <p>7 three, and then the second phase is to determine the</p> <p>8 layers, at which layers that those samples are to be</p> <p>9 taken.</p> <p>10 So I go back to my original question. By looking at</p> <p>11 the way Prof Yin did his sampling exercise, can you find</p> <p>12 any part of it being faulty, if I may use the term that</p> <p>13 you have just mentioned?</p> <p>14 A. Well, other than what I just said, from a purely</p> <p>15 statistical point of view, it's faulty in that he</p> <p>16 assumes or states that he is taking 84 random samples</p> <p>17 but then he proceeds to do something different. He</p> <p>18 proceeds to take 28 random locations and three samples</p> <p>19 at each of those locations. Statistically, they are</p> <p>20 different things, and the justification he has used for</p> <p>21 84 does not apply to the 28 times 3.</p> <p>22 But it's a minor point of statistics that I wasn't</p> <p>23 going to raise because I don't think it's really all</p> <p>24 that important. It's just a little detail that is</p> <p>25 technically incorrect.</p>

Page 9	<p>1 But as for the rest, I do not feel that I am</p> <p>2 competent to comment on the details because I am not</p> <p>3 familiar with the layout of the structure, I don't know</p> <p>4 how much effort would have to be put into identifying</p> <p>5 which locations are truly representative, how different</p> <p>6 the different locations are, whether there are</p> <p>7 systematic variations within a location. There's a lot</p> <p>8 of engineering involved in that, and I confess I do not</p> <p>9 know enough to be able to comment.</p> <p>10 My comment was that in a normal sampling exercise,</p> <p>11 it would be routine to, at the end, undertake a very</p> <p>12 simple statistical test. That is what was missing as</p> <p>13 far as I was concerned. I was merely commenting on the</p> <p>14 statistics, not the engineering.</p> <p>15 Q. All right. I will then move on to another topic.</p> <p>16 Can I refer you to paragraph 4.7 of your first -- of</p> <p>17 your report in the Original Inquiry, about the clusters</p> <p>18 point.</p> <p>19 In paragraph 4.7, you said:</p> <p>20 "Another important question to ask is: Are the</p> <p>21 samples truly independent? The statistical technique</p> <p>22 used ... assumes independence. If, as is stated in</p> <p>23 section 3.3.27 of the holistic report, a major reason</p> <p>24 for defects is poor workmanship, then defectives will</p> <p>25 probably be in clusters, and therefore not independent."</p>	Page 11	<p>1 areas.</p> <p>2 Q. I see.</p> <p>3 A. Have I misread? Sorry if I have.</p> <p>4 Q. Right. I want to know is the basis on which you make</p> <p>5 that assumption.</p> <p>6 A. The assumption -- because the report says that the</p> <p>7 defective workmanship is mostly in local areas --</p> <p>8 Q. All right.</p> <p>9 A. -- so I assumed it's mostly localised in particular</p> <p>10 areas. I'm having difficulty working out what it is you</p> <p>11 are asking.</p> <p>12 Q. All right. Thank you.</p> <p>13 Can I ask you to look at -- well, perhaps I should</p> <p>14 deal with it this way. Do you agree that in fact if the</p> <p>15 defective couplers are in clusters, the sampling and</p> <p>16 testing process performed would tend to underestimate</p> <p>17 the actual defective rate, not overestimate the</p> <p>18 defective rate as you suggest; do you agree?</p> <p>19 A. No, I don't agree, and if you could possibly go back to</p> <p>20 what I said about this -- are we now happy that what</p> <p>21 I've said is correct or do I have to withdraw? Because</p> <p>22 the report saying that they are mostly in local areas</p> <p>23 doesn't imply that it's localised. Are you -- I'm</p> <p>24 sorry, I'm not sure how far we've got on this.</p> <p>25 Q. It's not --</p>
Page 10	<p>1 Now, my question is what is your basis for saying</p> <p>2 this, that the defective couplers are in clusters?</p> <p>3 A. The basis for my saying it was reading the holistic</p> <p>4 report, section 3.3.27.</p> <p>5 Q. Right. 3.3.27 can be found at bundle OU5, page 3256,</p> <p>6 please.</p> <p>7 Now, 3.3.27, all that it says in this paragraph is:</p> <p>8 "The results of improper coupler connections</p> <p>9 including unconnected and/or cut rebar in both the EWL</p> <p>10 and NSL slabs are considered to be due to workmanship</p> <p>11 issues during installation, misaligned or damaged</p> <p>12 couplers and local areas of rebar congestion."</p> <p>13 Now, it does not suggest that they are somehow</p> <p>14 located in clusters -- are they?</p> <p>15 A. Sorry, maybe we are reading different paragraphs.</p> <p>16 "Local areas". Does "local areas" and "clusters" not</p> <p>17 mean the same thing? Sorry, but don't they tend to</p> <p>18 imply that to you?</p> <p>19 If, for instance, you were told that throughout</p> <p>20 Britain, trees tended to occur in local areas that we</p> <p>21 happen to call woods or forests, then wouldn't that mean</p> <p>22 that the trees were mostly in clusters, clustered</p> <p>23 together in woods and forests? I thought that -- sorry,</p> <p>24 maybe I've misread it. I read that to mean that the</p> <p>25 mostly defective couplers are likely to be in local</p>	Page 12	<p>1 CHAIRMAN: Sorry to interrupt. The word "local" there,</p> <p>2 Doctor, would it perhaps, on an ordinary reading, refer</p> <p>3 simply to rebar congestion, or would it have a wider</p> <p>4 reading?</p> <p>5 A. If it refers specifically to rebar congestion and it is</p> <p>6 (indicating the screen) -- sorry, there's a message on</p> <p>7 the screen. Sorry, where were we?</p> <p>8 So "The results of improper coupler connections</p> <p>9 including unconnected and/or cut rebar", so basically</p> <p>10 that's saying defectives. So defectives "are considered</p> <p>11 to be due to", then there's a number of reasons which</p> <p>12 might be influencing the occurrence of defectives. One</p> <p>13 of those reasons is rebar congestion. Rebar congestion,</p> <p>14 it's saying, is localised, local areas of rebar</p> <p>15 congestion.</p> <p>16 So, working backwards, we now have localisation of</p> <p>17 rebars, so in other words little clusters of rebar</p> <p>18 congestion are causing defectives.</p> <p>19 CHAIRMAN: That's right, yes.</p> <p>20 A. So that sentence is saying that defectives are in</p> <p>21 clusters.</p> <p>22 MR CHOW: Okay. Thank you, Dr Wells.</p> <p>23 A. I need to check that, because otherwise, when we go back</p> <p>24 to my report, I wasn't sure whether I had got it wrong,</p> <p>25 but we are all happy that that paragraph does say that</p>

Page 13	Page 15
<p>1 defectives are in clusters, yes.</p> <p>2 COMMISSIONER HANSFORD: I think what it is saying is some of</p> <p>3 it is in local areas.</p> <p>4 A. Yes. So there can be clustering. Sorry, I didn't mean</p> <p>5 to imply that it's all in clusters. Going back to my</p> <p>6 example of the trees, for instance, I do have trees in</p> <p>7 my garden but that's not a forest. So when I say</p> <p>8 cluster, it doesn't mean that everything is in clumps.</p> <p>9 It means there was a tendency for things to be not</p> <p>10 distributed evenly throughout.</p> <p>11 COMMISSIONER HANSFORD: I think that's what it says.</p> <p>12 CHAIRMAN: Yes.</p> <p>13 MR CHOW: Dr Wells, thank you. Your answer is fine.</p> <p>14 Then can I ask a following-on question: have you</p> <p>15 made any enquiry to confirm that the defective couplers</p> <p>16 appear in clusters?</p> <p>17 A. Can we go back to what I said? We put 3.3.27 up on the</p> <p>18 screen because it was referencing what I said. Can</p> <p>19 I remind myself of what I said?</p> <p>20 So my 4.7 was a question. It is:</p> <p>21 "Another important question to ask is: Are the</p> <p>22 samples truly independent?"</p> <p>23 I was merely trying to indicate areas which could be</p> <p>24 addressed or could be investigated, in order to see</p> <p>25 whether or not there were some assumptions which might</p>	<p>1 all of it and have read through and absorbed it all</p> <p>2 would be untrue.</p> <p>3 Q. So if I refer to paragraph 14 of Prof Yin's responses,</p> <p>4 where he provides his explanation. In paragraph 14 he</p> <p>5 says:</p> <p>6 "For example, suppose we have a sample of size 100</p> <p>7 and the data are clustered" --</p> <p>8 MR SHIEH: Mr Chairman, this is precisely the kind of vice</p> <p>9 that we anticipated yesterday. I can now see why the</p> <p>10 government was so keen to put it in as some kind of</p> <p>11 a file document. It's an aide-memoire for Dr Wells to</p> <p>12 look at, insofar as he could, and to prepare for any</p> <p>13 questions that might be put to him.</p> <p>14 I have no problem if my learned friend understands</p> <p>15 the point and puts it in his own words, but to put it on</p> <p>16 the screen as if it has some kind of a filed status is</p> <p>17 precisely the kind of thing I had wanted to avoid.</p> <p>18 By all means, if my learned friend wants to read out</p> <p>19 something and put it in his notes, I'm fine, but this</p> <p>20 seems to give the document some kind of a status more</p> <p>21 than it deserves; can I just put it this way?</p> <p>22 CHAIRMAN: All right. I recognise the objection.</p> <p>23 MR CHOW: Very well.</p> <p>24 Dr Wells, please don't look at the response. I'm</p> <p>25 going to explain it to you.</p>
Page 14	Page 16
<p>1 have been overlooked, because given the overwhelming</p> <p>2 statistical evidence that this random sampling exercise</p> <p>3 was flawed, I would expect to go back through all the</p> <p>4 steps and examine each one and try to find out whether</p> <p>5 or not it's contributed to that.</p> <p>6 As I said, it is possible that we got an unusual</p> <p>7 result just at random, but it behooves us to go back</p> <p>8 through the process and check -- and I'm just suggesting</p> <p>9 that this is one of the places that could be checked.</p> <p>10 I do not have sufficient knowledge of the works to</p> <p>11 answer the question. I was posing the question, hoping</p> <p>12 that somebody else might be able to answer it.</p> <p>13 So the answer to your question is no.</p> <p>14 Q. All right. Thank you, Dr Wells.</p> <p>15 A. I was merely posing a question.</p> <p>16 Q. Yes. Thank you.</p> <p>17 Now, if we take one step further. Assuming that the</p> <p>18 defectives are in clusters -- now, Prof Yin's view is</p> <p>19 that instead of overestimating the defective rate, this</p> <p>20 effect actually underestimates the defective rate.</p> <p>21 Prof Yin provided his reasoning in paragraph 14 of his</p> <p>22 reply.</p> <p>23 Have you had a chance to read his responses</p> <p>24 yesterday?</p> <p>25 A. I've been through it. To say that I fully understand</p>	<p>1 Prof Yin provides a reasoning for his opinion, being</p> <p>2 that even if the defective couplers are in clusters, the</p> <p>3 result would be the defective rate would actually be</p> <p>4 underestimated; right?</p> <p>5 Suppose we have a sample of a size of 100, and the</p> <p>6 data are clustered, and that is they are not</p> <p>7 independent, in that sense, the sample size of 100 in</p> <p>8 fact is equivalent to a sample size of, say for example,</p> <p>9 80, 80 independent data; right? And why 80 is because</p> <p>10 some of them are correlated, some of the data are</p> <p>11 correlated, because they are not independent.</p> <p>12 Do you follow me?</p> <p>13 A. Yes. Thank you.</p> <p>14 Q. So, by treating the clusters, ie the correlated sample</p> <p>15 size of 100, as if they were independent data, one would</p> <p>16 overly use or inflate the information; do you follow?</p> <p>17 A. I'm following. I don't necessarily mean I agree but</p> <p>18 yes, I'm following. Thank you.</p> <p>19 Q. Well, perhaps: do you agree with that proposition?</p> <p>20 A. No, I don't, because you have a larger difference</p> <p>21 between the clusters. So, yes, you do have smaller</p> <p>22 variation within clusters, but you have larger</p> <p>23 variations between clusters.</p> <p>24 I think it's a rather unreasonable statement,</p> <p>25 because it doesn't give any information about what --</p>

Page 17	<p>1 where those data are within the 100 and how the</p> <p>2 clustering occurs. If it clusters at the end point,</p> <p>3 then you will now get larger differences between the end</p> <p>4 points, which will more than compensate for the lower</p> <p>5 differences within the clusters.</p> <p>6 And the point that we have here is that we only have</p> <p>7 end point because it's binary: it's either defective or</p> <p>8 not defective. Then we're only looking at maximum</p> <p>9 differences.</p> <p>10 So I would not necessarily say that what is stated</p> <p>11 is self-evident. It may have some validity. I would</p> <p>12 like time to look at it. But it certainly is not, in my</p> <p>13 opinion, self-evident that that's the case.</p> <p>14 Q. Let me try this. If the effective sample size of 80 is</p> <p>15 mistaken as the sample size of 100, the estimated</p> <p>16 variance would be smaller than it should be; do you</p> <p>17 agree with this proposition?</p> <p>18 A. No. Sorry, I thought I'd already explained what I'd</p> <p>19 done. What I thought I had already explained is that</p> <p>20 you have a higher between-clusters variance.</p> <p>21 Q. Right. Okay. So obviously you won't agree that because</p> <p>22 of the underestimation of the variance, it would lead to</p> <p>23 an underestimation of the defective rate?</p> <p>24 A. Can I say that I neither agree nor disagree. At this</p> <p>25 point I don't think it is important. My 4.7 was,</p>	Page 19	<p>1 of threads exposed is not more than two, it doesn't</p> <p>2 necessarily mean that the actual engagement length</p> <p>3 inside the coupler was adequate, be it 37mm or 32mm? Do</p> <p>4 you agree?</p> <p>5 A. I think this is a simple point of maths, isn't it? That</p> <p>6 if you have something that's divided into two parts, and</p> <p>7 you can measure the two parts, you would expect the sums</p> <p>8 of the measurements of the two parts to represent the</p> <p>9 whole. So if I could measure -- let me think of</p> <p>10 an example -- I'm sitting in front of a desk at the</p> <p>11 moment which has a split down the middle. If I could</p> <p>12 measure up to the split, and then measure from the split</p> <p>13 to the other end, I would expect the two to sum to the</p> <p>14 total length of the desk.</p> <p>15 Now, as I understand it -- please correct me if I'm</p> <p>16 wrong -- there is a thread on a rebar, and part of it</p> <p>17 can be seen and part of it cannot be seen. So I would</p> <p>18 expect, from a layman's point of view, that the part</p> <p>19 that can be seen, added together with the part that</p> <p>20 can't be seen, would sum to the whole. And my</p> <p>21 understanding -- again, please correct me if I'm</p> <p>22 wrong -- is that the engagement length is the part that</p> <p>23 we can't see, and the exposed threads is the part that</p> <p>24 we can see.</p> <p>25 I would expect the part that we can see, the number</p>
Page 18	<p>1 "Another important question [is] to ask", and in my view</p> <p>2 that question had not been asked. My point is that the</p> <p>3 process was incomplete; that there were several</p> <p>4 important questions that had not been asked. I was not</p> <p>5 trying to get into abstruse points of statistics based</p> <p>6 on the fact that, "We failed to answer the question so</p> <p>7 let's now try to find a valid reason as to why we can</p> <p>8 wriggle out of it." I was saying that the question</p> <p>9 should have been asked.</p> <p>10 Q. Dr Wells, let's move on to another topic then.</p> <p>11 Paragraph 4.10, please, of your report. In</p> <p>12 paragraphs 4.10 to 4.12, you are making the missing</p> <p>13 value approach point; right?</p> <p>14 A. Yes, correct.</p> <p>15 Q. As I understand it, it is your opinion that it is not</p> <p>16 right to simply discard a sample because no measurement</p> <p>17 can be taken when such samples may have passed visual</p> <p>18 inspection, because --</p> <p>19 A. That I correct. Basically, what is happening here is</p> <p>20 that we are only discarding potential "not defectives".</p> <p>21 We are not discarding any potential "defectives". So it</p> <p>22 is clearly biased sampling.</p> <p>23 Q. Right.</p> <p>24 Do you agree that having passed -- for a sample that</p> <p>25 passed the visual inspection, that is to say the number</p>	Page 20	<p>1 of threads, plus the part that we can't see, the</p> <p>2 engagement length, would equal the total threaded length</p> <p>3 of the rebar.</p> <p>4 I'm not sure that this is actually where I'm</p> <p>5 addressing this point, but you asked it so I seem to</p> <p>6 have wandered into it. I think my point was that in</p> <p>7 a very large number of the measurements which were given</p> <p>8 in table B3, the two sums are not the same.</p> <p>9 Now, when I say "not the same" -- obviously, you've</p> <p>10 got to allow a little bit of leeway in this, that the</p> <p>11 PAUT measurement is only accurate to within</p> <p>12 3 millimetres, so we don't expect them to sum exactly,</p> <p>13 we only expect them to sum to within 3 millimetres, but</p> <p>14 those sums I would expect to be the same.</p> <p>15 Q. Dr Wells, sorry to interrupt you. I believe that what</p> <p>16 you are talking about relates to another point, another</p> <p>17 topic that I intend to explore with you in a while. But</p> <p>18 let me finish this topic first. This topic relates to</p> <p>19 the missing values approach; right? This is what</p> <p>20 I would like to explore with you.</p> <p>21 A. Yes.</p> <p>22 Q. What you suggest is that instead of discarding those</p> <p>23 data where no PAUT measurement can be taken, one should</p> <p>24 substitute it with the mean value of the other data. Is</p> <p>25 that the point that you are making; right?</p>

Page 21	Page 23
<p>1 A. I'm simply repeating what's normal practice in 2 situations like this, yes.</p> <p>3 Q. Now, Prof Yin actually holds a different view, and he 4 said that what you have -- the method you have 5 suggested, the missing value approach, actually would 6 have an effect of imputing a mean to a missing data, 7 which is problematic because it fails to account for the 8 variance amongst the missing data, because you assume 9 all the missing data has the same value, which you take 10 as the mean value of the remaining samples. So this is 11 the first problem.</p> <p>12 And the second problem is that, by doing so, you 13 unnecessarily and artificially increase the sample size, 14 because instead of discarding those invalid data, you 15 assume and you simply adopt a mean value, so the total 16 number of sample size that you take into consideration 17 is more than the actual number of sample size.</p> <p>18 So these are the two main problems involved in 19 adopting the so-called missing value approach. Do you 20 recognise this?</p> <p>21 A. Sorry, how do you mean, "recognise"? Do you mean 22 recognise as in have I read that --</p> <p>23 CHAIRMAN: Do you agree?</p> <p>24 MR CHOW: Thank you, sir.</p> <p>25 Do you agree with that proposition of Prof Yin?</p>	<p>1 I wasn't trying to create calculations that could 2 actually be used to construct a building. I was showing 3 how the original approach was quite clearly incorrect.</p> <p>4 The second point -- sorry, could you remind me, 5 I had "unnecessarily and [something else] increase the 6 sample size". I missed the second word.</p> <p>7 Q. The second point is that you would inflate the sample 8 size or the population -- or perhaps this is not 9 an exact word. It's the size of the sample, the total 10 size of the sample.</p> <p>11 A. The size of the sample was given to us. I didn't change 12 it. The size of the sample was changed by deliberately 13 taking some out of one pile and not taking any out of 14 the other pile. I used the sample size as it had been 15 collected. So I didn't change the sample size. It was 16 the holistic report that changed the sample size. The 17 holistic report said, "We have these two piles, we are 18 going to take some out of this pile and discard them." 19 So I don't feel that's a reasonable statement, to say 20 that I changed the sample size. I used the sample size 21 as given.</p> <p>22 Q. As I understand it, Prof Yin is of the opinion that it 23 is proper, in this particular case, to discard those 24 missing data because those missing data also occur at 25 random. And for this reason, the remaining items is</p>
Page 22	Page 24
<p>1 A. No. Do you want me to explain why?</p> <p>2 MR PENNICOTT: Yes!</p> <p>3 A. Sorry, I said no. Do you want me to explain why?</p> <p>4 MR CHOW: Please go ahead.</p> <p>5 A. The method I've suggested is imputing a mean to 6 a missing data, because -- well, I'm not actually 7 imputing anything. What I'm saying is that these are 8 actual samples. They have been taken out of one pile 9 differentially, and therefore reduced that pile without 10 having any effect on the other pile. That makes 11 a significant difference to the relative numbers in the 12 two piles.</p> <p>13 Yes, it does also change the variance; that's 14 a second-level issue. The main thing is it changes the 15 numbers in the piles, and to say that it's quite 16 reasonable to start deliberately interfering with the 17 numbers of data in each piles, simply because we can't 18 then correct for the variance, is simple manipulation of 19 the data to get a particular result.</p> <p>20 In fact, you can allow for the variance, there are 21 statistical techniques that do this. I didn't, 22 I confess, in mine. I simply used the variance as it 23 had been previously calculated.</p> <p>24 It is possible to allow for it. It's a second-level 25 effect. What I was trying to do was illustrate;</p>	<p>1 a good representation of the actual position in the 2 population.</p> <p>3 A. Okay. Can I give an example? In the UK, we have 4 a driving test which consists of two parts. There's 5 a written part and a practical part, and you have to 6 pass both parts in order to get a driving licence, and 7 if you fail the written part, you don't take the 8 practical part. So the written part comes first. Only 9 those people who have taken the written part get to take 10 the practical part.</p> <p>11 That is exactly equivalent to what is happening 12 here, that we have an initial visual inspection. Only 13 those samples that pass the initial visual inspection go 14 on to take the practical part of measuring the 15 engagement length and counting the threads. So --</p> <p>16 Q. Sorry, Dr Wells, can I just pause you here. I don't 17 think this is right factually. What happened is even if 18 a sample failed to pass the visual test, PAUT 19 measurement was also taken. So perhaps your example is 20 not quite appropriate to reflect the situation here.</p> <p>21 A. I'm sorry, I was only going on what is in the holistic 22 report. You must have more information than me. Can 23 you explain to me where you got that information so 24 I can look at it?</p> <p>25 Q. As far as I understand, when we talk about passing the</p>

Page 25	<p>1 visual inspection, only for those couplers which, on</p> <p>2 visual inspection, shows that they were not connected at</p> <p>3 all -- in other words, we see a gap between the couplers</p> <p>4 and the threaded bar -- then no one took the measurement</p> <p>5 by PAUT, for obvious reasons, because we can see a gap</p> <p>6 between the couplers and threaded bars.</p> <p>7 But insofar as we see there is connection between</p> <p>8 the threaded bar and the couplers, even if the number of</p> <p>9 threads exposed is more than two, PAUT measurement was</p> <p>10 taken for those samples. I believe that that is pretty</p> <p>11 obvious from your table B3.2 and B3.3, where we set out</p> <p>12 the data of more than 90 samples.</p> <p>13 A. I think I now understand how I managed to get into my</p> <p>14 digression earlier about the threads and PAUT</p> <p>15 measurements. You're confusing the visual inspection</p> <p>16 with the count of the threads. The count of the</p> <p>17 threads, you are right, is a visual inspection, but it</p> <p>18 isn't actually referred to as a visual inspection in the</p> <p>19 report. I was referring to the visual inspection in the</p> <p>20 same way as it's referred to in the holistic report.</p> <p>21 So the process that we go through -- you actually</p> <p>22 said it yourself just now but I will just recap -- that</p> <p>23 first of all, there was a visual inspection to see</p> <p>24 whether or not it is actually attached; okay? So that's</p> <p>25 why you say we look and see whether or not there's</p>	Page 27	<p>1 saying, "I'm only going to discard things which are</p> <p>2 potentially not defective. I'm not going to discard</p> <p>3 anything which is clearly defective." Hence my example</p> <p>4 of the two-part driving test. The first part, the</p> <p>5 theoretical test, in the driving test, corresponds to,</p> <p>6 "Let's look at it and see whether or not it's even</p> <p>7 worthwhile measuring and counting the threads." That's</p> <p>8 what I mean by visual inspection. I'm sorry if I misled</p> <p>9 you by using the words "visual inspection" to mean</p> <p>10 counting the threads. That wasn't my intention.</p> <p>11 Q. Sorry, Dr Wells. Perhaps I haven't been myself entirely</p> <p>12 clear. My understanding is when one observes the number</p> <p>13 of exposed threads, irrespective of the number being</p> <p>14 smaller than two or larger than two, PAUT measurement</p> <p>15 would be taken. So we are not discarding -- we are not</p> <p>16 only just discarding samples that -- well, the reason</p> <p>17 why we discard a data is because, for some reason, the</p> <p>18 measurement by PAUT was not possible, and the</p> <p>19 probability of this occurring to couplers with exposed</p> <p>20 threads more than two or less than two are the same.</p> <p>21 They are, to that extent, also random -- isn't it?</p> <p>22 Do you see my --</p> <p>23 A. Right. "Random" means we basically close our eyes,</p> <p>24 stick our hands into a bucket and pull things out</p> <p>25 (demonstrating) and we pick one. What you have done</p>
Page 26	<p>1 a gap. So we have now a bifurcation, we have did it or</p> <p>2 did it not pass the visual inspection? If it did not</p> <p>3 pass the visual inspection, it is defective and it goes</p> <p>4 into the "defectives" pile. That "defectives" pile is</p> <p>5 now immutable; we can't take things out of it.</p> <p>6 We now have a pile left which we can see that there</p> <p>7 is some connection so it is worthwhile taking</p> <p>8 a measurement, it is worthwhile counting the threads.</p> <p>9 There was no point in counting the threads previously;</p> <p>10 they simply weren't connected. But if they are</p> <p>11 connected, visual inspection now passes them, they are</p> <p>12 now in this pile ready to be tested for PAUT and counted</p> <p>13 threads.</p> <p>14 If we can't take a PAUT measurement, we discard it.</p> <p>15 Do you see now my point about we are only discarding</p> <p>16 from this pile of potential "effectives", potential "not</p> <p>17 defectives"? We are not discarding from the other pile.</p> <p>18 It is only when it has already passed the first part of</p> <p>19 the multi-part test, the multi-part test being visual</p> <p>20 inspection, is it even worthwhile taking a measurement,</p> <p>21 part 1; part 2, count the threads; part 3, PAUT</p> <p>22 measurement and/or direct measurement. Okay?</p> <p>23 So it's only when it has already passed the</p> <p>24 potential "not defective", the first test, that we even</p> <p>25 consider discarding it. That is not random. That is</p>	Page 28	<p>1 here is looked in the bucket first, found ones which</p> <p>2 meet a certain criteria, let's say red ones, taken all</p> <p>3 of those out, put them to one side; said, "These ones</p> <p>4 are ones which we can see it's not even worthwhile</p> <p>5 taking a measurement for or counting the threads because</p> <p>6 the coupler isn't connected." We've taken those ones</p> <p>7 now out of the bucket, and what is left in the bucket</p> <p>8 are the ones that we can now potentially count threads,</p> <p>9 take the PAUT measurement, do anything else we want.</p> <p>10 Okay?</p> <p>11 So we are now putting our hand into the bucket and</p> <p>12 taking out from a subset, not from the entire</p> <p>13 population. Can we agree that that is not random, that</p> <p>14 there has been a pre-process, some things have been</p> <p>15 taken out of the bucket before I close my eyes and pick</p> <p>16 one?</p> <p>17 Q. For the sake of discussion, assuming what you have said</p> <p>18 is right, then by replacing those data with the mean</p> <p>19 value, how would it improve the accuracy of the outcome?</p> <p>20 A. I was actually suggesting it would include the fairness</p> <p>21 of the outcome. I don't think there is a concept here</p> <p>22 of accuracy. I think there is a concept here of trying</p> <p>23 to understand what is actually happening in the</p> <p>24 structure, and if we are trying to understand what is</p> <p>25 happening in the structure then arbitrarily changing the</p>

Page 29	Page 31
<p>1 basis for picking samples by taking things out of the</p> <p>2 bucket before we make our random selection, does not</p> <p>3 help us understand what is going on in the structure.</p> <p>4 All I was trying to do was make a suggestion to say</p> <p>5 what you have done doesn't help you understand what is</p> <p>6 going on in the structure, and I was trying to suggest</p> <p>7 a better way of helping you understand what is going on</p> <p>8 in the structure. I'm not talking about accuracy. I'm</p> <p>9 simply saying what you've done is wrong; there is</p> <p>10 a better way of doing it.</p> <p>11 Q. My difficulty is to appreciate what you said as your</p> <p>12 method is a better way. Please help me. If you don't</p> <p>13 know the actual value for those missing items, by</p> <p>14 substituting those values with a mean, how would you get</p> <p>15 a better understanding of what happened in the</p> <p>16 structure?</p> <p>17 A. Because, of what is left in the bucket, we can calculate</p> <p>18 an average of all the things in the bucket, and</p> <p>19 therefore, if we are now forced to discard some of those</p> <p>20 things in the bucket, we can say, well, probably the</p> <p>21 most likely value that those discarded things have is</p> <p>22 the average or mean of their cohort, things of their</p> <p>23 kind, things that passed the first pass test. It is not</p> <p>24 perfect. Like I said, it hasn't taken account of the</p> <p>25 reduced variance. You can take account of the reduced</p>	<p>1 okay?</p> <p>2 MR CHOW: Yes.</p> <p>3 CHAIRMAN: But you've only got between zero and one thread</p> <p>4 showing.</p> <p>5 So, if I reduce it down to my simple level of</p> <p>6 a screwdriver and a screw, you've actually screwed the</p> <p>7 screw in out of a whole lot of samples that are all</p> <p>8 there, they should be the same length, and you've done</p> <p>9 it as far as you probably can. You've got between --</p> <p>10 you've got half a thread showing, effectively, but</p> <p>11 that's still defective.</p> <p>12 Okay, so what you are taking into account then is</p> <p>13 the possibility of a variance in the length of the</p> <p>14 threads that would not in any way have anything to do</p> <p>15 with workmanship. That must be right, mustn't it?</p> <p>16 MR CHOW: I totally agree, Mr Chairman. That's why --</p> <p>17 CHAIRMAN: So it becomes a difficult issue if we are looking</p> <p>18 at workmanship?</p> <p>19 MR CHOW: Because there is also an issue of cutting, cut</p> <p>20 bars as well, and actually my next topic that I would</p> <p>21 like to explore with him is on the actual threaded</p> <p>22 length, but this is something that is going to follow.</p> <p>23 Hopefully by then, Mr Chairman will have a better</p> <p>24 understanding of the --</p> <p>25 CHAIRMAN: All right. I'm just trying to, while I'm</p>
Page 30	Page 32
<p>1 variance; it's not impossible. But it is so much better</p> <p>2 than saying, "Well, let's just discard them because we</p> <p>3 can't take a measurement."</p> <p>4 It's at least fair and therefore likely to tell you</p> <p>5 what is happening in the structure -- the variance is</p> <p>6 only a second-level effect. The only reason we want the</p> <p>7 variance is so that we can calculate a tolerance level.</p> <p>8 What we really want to do is understand what is the most</p> <p>9 likely strength of the structure, and the way it has</p> <p>10 been done in the holistic report does not do that. It</p> <p>11 does something else. It calculates the strength of</p> <p>12 a hypothetical structure, had certain conditions applied</p> <p>13 which don't apply. What I've done is shown you how you</p> <p>14 actually can find the most likely expected value of the</p> <p>15 strength of the structure.</p> <p>16 Q. Dr Wells, perhaps it's easier for me simply to put</p> <p>17 a position to you to see whether you agree with it and</p> <p>18 then I will move on.</p> <p>19 CHAIRMAN: Sorry, just on this a second -- looking</p> <p>20 collaterally -- we are looking at coupler engagement</p> <p>21 lengths, and if, for example, I go to item number 42,</p> <p>22 which is "defective", it has -- sorry, appendix B3,</p> <p>23 sheet 7 of 11; this is a question, not a statement --</p> <p>24 but if we go to 42, we've got an enhanced length of</p> <p>25 35.7, which I understand is less than it should be;</p>	<p>1 listening to the statistical issues, I'm trying to keep</p> <p>2 them sort of embedded into some sort of common-sense,</p> <p>3 real approach that I can look at.</p> <p>4 So you are saying there it would have to be</p> <p>5 an assumption that it had been cut?</p> <p>6 COMMISSIONER HANSFORD: I don't think that can be the case,</p> <p>7 can it?</p> <p>8 CHAIRMAN: Cut by how much?</p> <p>9 COMMISSIONER HANSFORD: If you've got 35.7 embedded, and</p> <p>10 you've got nought to one exposed, you can't have cut</p> <p>11 anything. It's impossible to cut it.</p> <p>12 CHAIRMAN: Or else you are deciding to undertake improper</p> <p>13 work in order to trim, you know, the width of somebody's</p> <p>14 fingernail off it.</p> <p>15 COMMISSIONER HANSFORD: Or less.</p> <p>16 CHAIRMAN: It's ridiculous.</p> <p>17 MR CHOW: Mr Chairman, I don't necessarily refer to that</p> <p>18 particular sample. The point I'm trying to make is if</p> <p>19 you look at all the results in the table, it only</p> <p>20 suggests that we can't assume a constant thread length</p> <p>21 from looking at a sample.</p> <p>22 CHAIRMAN: I appreciate that.</p> <p>23 MR CHOW: Yes, and also there's some record that some of the</p> <p>24 threaded bars can be seen as having been cut.</p> <p>25 CHAIRMAN: Yes.</p>

Page 33	Page 35
<p>1 MR CHOW: This is the point I'm trying to make.</p> <p>2 COMMISSIONER HANSFORD: Yes. I think it's quite</p> <p>3 an extension of the argument, Mr Chow, to suggest that</p> <p>4 anything like that can have been cut.</p> <p>5 MR CHOW: Not for that particular sample, yes.</p> <p>6 COMMISSIONER HANSFORD: Well, I think for very few. I can't</p> <p>7 immediately see any where that jumps out to me as it</p> <p>8 must have been cut, but maybe there are some. Maybe</p> <p>9 there are.</p> <p>10 MR CHOW: There are not many.</p> <p>11 CHAIRMAN: Which takes me on a little bit further -- and</p> <p>12 forgive me, Dr Wells, if I'm straying off the point --</p> <p>13 but we are then saying, "Okay, fine, it's defective."</p> <p>14 What does defective mean? What I understand is:</p> <p>15 "Defective" means it doesn't meet your measurements.</p> <p>16 But not meeting your measurements, what does that mean?</p> <p>17 And do we just go around in circles on this? Do you see</p> <p>18 the point --</p> <p>19 MR SHIEH: We are in binomial, multinomial and continuous</p> <p>20 scale territory, I might say.</p> <p>21 CHAIRMAN: Yes. I may be wrong here but I will need some</p> <p>22 assistance at a later stage.</p> <p>23 MR CHOW: As I understand it, a sample is considered to be</p> <p>24 defective if the number of exposed threads is more than</p> <p>25 three --</p>	<p>1 So the actual parameters of this thing also tend to</p> <p>2 be important.</p> <p>3 MR CHOW: At the moment, Mr Chairman, the acceptance</p> <p>4 criteria was -- the one that apparently MTRC and the</p> <p>5 government have adopted is exactly the same as what is</p> <p>6 recommended by BOSA. The government's position so far,</p> <p>7 and actually all along is that the government was open</p> <p>8 to receive any proof that different acceptance criteria</p> <p>9 could be accepted, but so far, up to the present moment,</p> <p>10 all that the government received is the acceptance</p> <p>11 criteria from the supplier. So this is what BOSA</p> <p>12 specified.</p> <p>13 CHAIRMAN: All right. I'm going to need some help there</p> <p>14 too, because the fallibility of memory is such that</p> <p>15 I don't recall BOSA, through any of its qualified</p> <p>16 employees and/or agents, giving any evidence to this</p> <p>17 Commission as how to their recommended measurements for</p> <p>18 insertion were tied into issues of lack of structural</p> <p>19 safety or otherwise.</p> <p>20 I appreciate you may say, "Well, what else are they</p> <p>21 going to be tied into?", but it's a bit like saying, "We</p> <p>22 recommend you stand 25 feet away before you set off the</p> <p>23 fireworks." It may be it's just a very, very cautious</p> <p>24 thing to avoid insurance claims. Do you see what</p> <p>25 I mean?</p>
Page 34	Page 36
<p>1 CHAIRMAN: Yes.</p> <p>2 MR CHOW: -- because we leave a certain margin between two</p> <p>3 and three --</p> <p>4 CHAIRMAN: Yes.</p> <p>5 MR CHOW: -- and if the measured PAUT value is less than</p> <p>6 37 millimetres.</p> <p>7 CHAIRMAN: I appreciate that. Yes.</p> <p>8 MR CHOW: This is how it is categorised in the table.</p> <p>9 CHAIRMAN: Right. But then we come back, do we not, to --</p> <p>10 COMMISSIONER HANSFORD: Sorry, Mr Chow, did you say "and" or</p> <p>11 did you say "or"?</p> <p>12 MR CHOW: "And". This is the acceptance criteria adopted.</p> <p>13 COMMISSIONER HANSFORD: For both?</p> <p>14 MR CHOW: Yes.</p> <p>15 CHAIRMAN: All right. But then we come back, do we not, to</p> <p>16 that issue -- again, I will need some help here, because</p> <p>17 I appreciate I am probably tramping through the</p> <p>18 undergrowth with size 20 boots as opposed to ballet</p> <p>19 shoes -- and it's like deciding on how many people are</p> <p>20 going to pass the accountancy exam in the United Kingdom</p> <p>21 each year. You move the pass mark up to 75, you are</p> <p>22 going to get less people, so a lot would depend on why</p> <p>23 those measurements have been set as they have been set,</p> <p>24 because I understand Arup suggested lower measurements.</p> <p>25 I may be wrong there.</p>	<p>1 So I don't at the moment have anything definitive as</p> <p>2 to why we have these figures for "defective" or</p> <p>3 "non-defective".</p> <p>4 I apologise, Dr Wells. I'm just trying to</p> <p>5 understand all your evidence in light of what we</p> <p>6 actually have to focus on. Apologies if I'm being</p> <p>7 a little slow with you.</p> <p>8 Okay. Please continue.</p> <p>9 MR CHOW: Dr Wells, just now I said I was going to state our</p> <p>10 position and see whether you agree with our stance.</p> <p>11 (Tribunal conferring)</p> <p>12 CHAIRMAN: Sorry. Myself and the Commissioner, Dr Wells --</p> <p>13 would it be correct to say that what I've been talking</p> <p>14 about, insofar as you've been listening, and there's no</p> <p>15 reason for you to have listened, but the one informs the</p> <p>16 other? In other words, those original measurements as</p> <p>17 to what amounts to defective or not defective, that</p> <p>18 itself is a matter one has to look at, and then once</p> <p>19 you've determined those set of figures, then you move</p> <p>20 into what I might call your territory, of statistics, to</p> <p>21 determine their randomness and all the other matters</p> <p>22 that we've looked at -- effectively, the one informs the</p> <p>23 other?</p> <p>24 A. I agree, and this is where I had strayed earlier into</p> <p>25 the same territory as you were just discussing, that the</p>

Page 37	Page 39
<p>1 measurements are sometimes mutually contradictory. And</p> <p>2 there was a question just now, a request for</p> <p>3 clarification on the use of "and" or "or", and my</p> <p>4 understanding is that the "defective" criteria is that</p> <p>5 it has to pass everything to be "not defective".</p> <p>6 So, for instance, item 2, which we are looking at on</p> <p>7 the screen at the moment, passes on the number of</p> <p>8 threads. It passes on the visual inspection of "is it</p> <p>9 connected", but then it's discarded because it can't</p> <p>10 jump the final hurdle of having PAUT result obtained.</p> <p>11 So that, to my mind, is introducing bias. It's one</p> <p>12 which almost certainly would have passed. The number of</p> <p>13 composed threads, nought to one, implies that the PAUT</p> <p>14 would have passed. So we have a probable "pass" being</p> <p>15 discarded. There are no probable "fails" being</p> <p>16 discarded.</p> <p>17 So my point that I think I'm being asked on</p> <p>18 specifically at the moment is why am I disputing the</p> <p>19 classification of "discarded"? It is because it</p> <p>20 introduces noticeable bias and therefore does not tell</p> <p>21 us whether or not the structure is sound. It's wrong,</p> <p>22 and it can be improved quite easily without having to go</p> <p>23 back and collect -- look at more samples.</p> <p>24 CHAIRMAN: Yes. Thank you.</p> <p>25 MR CHOW: Dr Wells, I have one question that follows on from</p>	<p>1 almost got into the "not defective" pile, then you are</p> <p>2 decreasing the size of the "not defective" pile while</p> <p>3 keeping the "defective" pile the same size, so that if</p> <p>4 you decrease one and keep the other one the same, then</p> <p>5 the relative proportions change; the ratio between them</p> <p>6 changes. So that what you are reporting then is a much</p> <p>7 higher ratio of "defectives" to "not defectives", simply</p> <p>8 by having discarded the ones which ran the entire race</p> <p>9 and then were pulled off just before the finish line.</p> <p>10 Q. Dr Wells, I really want to finish off this topic. Can</p> <p>11 I just put our position to see whether you agree with</p> <p>12 me.</p> <p>13 Our position is this: discarding samples is a valid</p> <p>14 statistical -- sorry.</p> <p>15 CHAIRMAN: I'm sorry. I'm just still dragging behind here,</p> <p>16 so please help me.</p> <p>17 What you are saying, as a basis for all this</p> <p>18 discussion, is BOSA's recommendation -- in other words,</p> <p>19 these are the manufacturer's recommendations for</p> <p>20 insertion of couplers and rebars into couplers; right?</p> <p>21 Now, that raises a number of questions. Does it mean</p> <p>22 that if, in each individual instance, you are not</p> <p>23 meeting the manufacturer's recommended measurements for</p> <p>24 insertion, that you are going against any form of</p> <p>25 building code? Or does it mean that it's unsafe?</p>
Page 38	Page 40
<p>1 what you have just said. When you refer to item 2,</p> <p>2 which you said would probably pass but nevertheless</p> <p>3 discarded and because of that it biased the result --</p> <p>4 right?</p> <p>5 A. Yes.</p> <p>6 Q. But you make that statement -- it must be on the</p> <p>7 assumption that the threaded part of the bar has not</p> <p>8 been cut; right?</p> <p>9 A. This isn't my assumption. This is the report</p> <p>10 specifically notes all the bars which were cut. By</p> <p>11 specifically noting all the bars which were cut, then</p> <p>12 the ones which are not noted as having been cut are,</p> <p>13 I think, not just my assumption but by universal</p> <p>14 assumption, therefore not cut.</p> <p>15 So item 2 is not cut. That's what the table is</p> <p>16 telling us. So you have a bar which is not cut and it</p> <p>17 has nought to one threads exposed, and it is visually</p> <p>18 seen to be coupled, it's almost crossed the line. All</p> <p>19 we've got to do is confirm this with the PAUT</p> <p>20 measurements and it will go into the "not defective"</p> <p>21 pile. Then somebody comes along and says, "No,</p> <p>22 technicality, throw it away; can't include that one."</p> <p>23 Now, that only applies to the "not defective" pile. It</p> <p>24 doesn't apply to the "defective" pile.</p> <p>25 So my point is that by taking out specimens which</p>	<p>1 Because at the moment there seem to be two issues. I'm</p> <p>2 just sending up a warning signal so you can come back to</p> <p>3 me and explain to me where it is.</p> <p>4 You see, because you start off on the basis the</p> <p>5 manufacturer's recommendations may actually be prudent</p> <p>6 but actually don't really go to anything at all, other</p> <p>7 than prudence. Do you see what I mean? You know, it's</p> <p>8 like toothpaste manufacturers. A recent country I was</p> <p>9 in was recommending don't brush your teeth more than</p> <p>10 once a day because it's got some whitener in it or</p> <p>11 something, so it probably was not going to do any harm</p> <p>12 to anybody if you brushed your teeth ten times a day,</p> <p>13 but somebody there sued somebody and they decided they</p> <p>14 had better put that on the label.</p> <p>15 So what I'm saying is we would have to look firstly</p> <p>16 at BOSA's recommendations, what is the basis of them,</p> <p>17 how did they come to those recommendations -- that's</p> <p>18 number one -- and what do they amount to? Do they</p> <p>19 amount to breaching the building code in any way?</p> <p>20 Do you see? I don't want to get too deep here,</p> <p>21 because Dr Wells has very kindly got up at the crack of</p> <p>22 dawn this morning. But I just want people to</p> <p>23 understand, I'm going to need some assistance, as we</p> <p>24 move along, as to the statistics. I begin to understand</p> <p>25 better and better but I still need some foundation work.</p>

Page 41

1 All right?

2 MR CHOW: Sir, perhaps just a very quick response, doing my

3 best to assist the Commission. At the moment, the only

4 reliable acceptance criteria is the recommendation from

5 BOSA, and the couplers is a proprietary product and

6 that's the reason why, as I understand it, their

7 recommendation was adopted. On the question of --

8 CHAIRMAN: But, I mean, we don't know the basis of that

9 recommendation -- that's all I'm saying; I don't know

10 the basis of it. It may be that a BOSA witness will

11 come in and it will take exactly ten seconds to convince

12 me you're 100 per cent right. On the other hand, they

13 may come in and say, "We have come to these

14 recommendations after discussing matters with our

15 insurers, after discussing matters with a number of

16 other people, and we prefer to give a wide margin here."

17 MR CHOW: Sir, from my recollection, the factual evidence

18 that we have received so far, including those under the

19 first round of our Inquiry, relevant to this question,

20 is evidence from BOSA explaining their acceptance

21 criteria, the butt-to-butt point and also the length of

22 the threaded part of the rebar.

23 But other than that, I don't recall any evidence as

24 to the explanation why they would need that requirement

25 to ensure the proper working of the coupler connection.

Page 42

1 If I'm wrong, I'm sure someone will correct me.

2 CHAIRMAN: All right. It's just that -- if you go to 42,

3 and then I'll stop so we can move on with the

4 evidence -- but I'm thinking of the poor old bar bender

5 down there working, trying to do an honest day's work.

6 I'm thinking of the engineer from Leightons who's told

7 to go out and inspect it. And he takes a rebar which

8 appears to be exactly the right length, the threads

9 appear to be pretty much the same as everybody else's

10 threads, and he inserts it, and he ends up with one

11 thread showing, which shows he's done a pretty good job,

12 but it so happens that it's 35.7 millimetres internally,

13 which he can't check.

14 And so although the workmanship has been good and

15 everything's gone in by 35.7, which is still almost

16 there in terms of when you count up thousands of these

17 things, it's defective.

18 I'm not saying you are wrong. I'm just saying, if

19 one's looking at workmanship, for example, what do you

20 do? And then I say to myself: maybe BOSA is at fault

21 for not giving some safety measure for having

22 a situation where you can have one thread showing and

23 you can put all your muscle into this rebar insertion,

24 you can have the brightest young engineer with 20/20

25 vision bounce up and measure it and come to exactly the

Page 43

1 same conclusion, which is only one showing, and both of

2 you are at fault.

3 COMMISSIONER HANSFORD: Or the other possibility is that the

4 measurement is incorrect.

5 MR CHOW: In fact, this is similar to our earlier exchange,

6 when I did my opening, on the points that someone has to

7 draw a line, and, sir, you sort of reacted saying,

8 "Perhaps it's not just one line; it can be more than one

9 line." So this goes back to the same question.

10 CHAIRMAN: All right.

11 MR CHOW: But at the moment we don't have more than one

12 reliable line. That is really the point.

13 CHAIRMAN: All right. We will leave it here, just so long

14 as you've got my note of caution --

15 MR CHOW: Yes, I do.

16 CHAIRMAN: -- you know, as to the very basis of all of this,

17 why are we doing this and what are the actual real

18 results as opposed to the mathematical results?

19 Yes. Thank you very much.

20 MR CHOW: Dr Wells, can I just put it to you that -- well,

21 I'm still on the missing value point -- our position is

22 that discarding samples is a valid statistical approach

23 which will not result in any bias, and because in this

24 particular instance the PAUT results were unobtainable

25 for reasons unrelated to the potential outcome, that is

Page 44

1 the engagement length.

2 Do you agree?

3 A. Sorry, you haven't lost contact. I'm thinking and it's

4 not making any noise.

5 Okay. Sorry, the reason I'm having difficulty is

6 that the two parts of your sentence each individually

7 makes perfect sense and I can't disagree with it. It's

8 the juxtaposition that's the problem. It's a bit --

9 I won't try to make an analogy.

10 The point is the discarding of samples is not

11 a valid statistical approach because it is not applied

12 equally. It is only applied to sample specimens --

13 Q. Yes. I understand --

14 A. -- which have already been partially passed. So it's

15 a three-pass process. First of all, we'll take a look;

16 is it coupled? Secondly, we'll count the threads.

17 Thirdly, we'll measure a PAUT. So it passes the first,

18 it passes the second, and it doesn't fail the third;

19 it's just that we cannot undertake the third, so we

20 discard it.

21 But there is no concept of discarding ones which

22 have not passed the first two parts. So we are only

23 discarding ones which are potentially effective. We are

24 never discarding ones which are potentially defective.

25 So I go back to my bucket example, that it's not

Page 45	Page 47
<p>1 random because we are not taking out of the whole 2 bucket. Somebody has come along to the bucket before we 3 get blindfolded and stick our hand in and has taken out, 4 not at random but has taken out specific ones which then 5 bias our choice, so that our choice can now not be 6 random, there is no possibility, because the odds have 7 been stacked against us. 8 Q. Dr Wells -- 9 A. If you are to take a card out of a deck of 52 cards, and 10 somebody comes along and takes out half of the spades 11 and then says, "Pick a card at random", what's the 12 chances of your getting a spade? It's not the same as 13 if you were given a complete unadulterated, unaltered 14 deck. 15 Q. Dr Wells, I don't intend to go into more detailed 16 discussing with you on this topic. Just for the purpose 17 of the record, I am told that on [draft] page 43, 18 line 24, what I said just now is "the discarding sample 19 is a valid statistical approach" instead of "invalid". 20 But I understand that, Dr Wells, you don't agree 21 with this statement; right? 22 A. Yes, it isn't true. 23 MR CHOW: If I may then move on to the next topic, about the 24 threaded length. 25 Sir, I see that it is 3.25. I wonder whether you</p>	<p>1 adequate or not. In other words, those data which has 2 been discarded could well be defective couplers assembly 3 or could well be one which is perfectly okay. So, to 4 that extent, by discarding those values, it would not 5 have any impact on the overall result; would you agree? 6 A. No. 7 Q. All right. Very well. Let's move on. 8 A. Can I just point out, please, that by replacing the 9 discarded values with the average of the remaining 10 values, some of those remaining values are actually 11 fails on the PAUT measurement. So we are averaging the 12 failed or defective PAUTs as well, and including that in 13 the average. That has been taken account of. That is 14 already included. We are not just averaging the passes. 15 We are averaging the fails, the defectives, as well. So 16 we are replacing the discards with genuinely 17 representative examples, which includes both fails and 18 defectives. 19 The reason that your statement -- I've had more time 20 to think about it over tea -- our position is discarding 21 samples is a valid statistical approach which will not 22 result in bias because the reasons for not being able to 23 take PAUT measurement are not related. It isn't the 24 fact that not being able to take PAUT measurement is not 25 related, it's the fact that the ones on which you are</p>
Page 46	Page 48
<p>1 would prefer a short break at this point? 2 COMMISSIONER HANSFORD: What time is it in the UK? 3 CHAIRMAN: What time is it where you are, Dr Wells? 4 WITNESS: 8.20. 5 CHAIRMAN: Okay. Would you like a cup of tea? 6 WITNESS: I would love a cup of tea! 7 CHAIRMAN: In which case, we'll have a break here in 8 Hong Kong. We'll just make it ten minutes. Would that 9 be all right? 10 WITNESS: Plenty. Thank you. 11 CHAIRMAN: Thank you very much. Ten minutes. 12 (3.24 pm) 13 (A short adjournment) 14 (3.49 pm) 15 CHAIRMAN: Thank you, Dr Wells. We're ready to proceed 16 again. 17 WITNESS: Okay. 18 CHAIRMAN: Mr Chow. 19 MR CHOW: Dr Wells, before I move on to the new topic about 20 the compatibility of the two acceptance criteria, 21 I would like to ask one more question on the mean value 22 approach. 23 My understanding is the reason for not being able to 24 take any PAUT measurement is an engineering problem, 25 it's not related to whether the engagement length was</p>	<p>1 going to even try to take PAUT measurement have already 2 been pre-selected. You are not trying to do this on 3 a random selection. You are doing it on a pre-selected, 4 already biased data set. 5 Q. All right. I would prefer to move on, if I may. 6 Yesterday, you told us that the two acceptance 7 criteria, namely exposed threads not more than two and 8 engagement length of 40mm, are not compatible with each 9 other. Do you recall that? 10 A. Yes, I do. 11 Q. My understanding is this. You take that position on 12 your understanding that the length of the thread is 13 44mm; is that correct? 14 A. Yes. 15 Q. So, on the basis that one thread measures 4mm, if two 16 threads exposed is allowed, then obviously the 17 engagement length has to be less than 40mm, it would be 18 around 36mm, so that is your point; right? 19 A. My point is actually very similar, I think, to the 20 Chairman's point, where he looked at item 42 and said 21 that it has number of threads exposed nought to one and 22 yet was defective on the grounds of the PAUT 23 measurement, and I think that I'm simply making the same 24 point as the Chairman made, that this doesn't appear, on 25 the surface of it, to be correct. And all I did was to</p>

Page 49	Page 51
<p>1 formalise that slightly by going through all of the</p> <p>2 items, checking each one in turn to say if I assume that</p> <p>3 the thread length is 44, and I can see a part of it and</p> <p>4 I can't see a part of it, then is the total thread</p> <p>5 compatible with the two measurements separately of the</p> <p>6 part that I can see and the part that I can't see? And</p> <p>7 given that the acceptance criteria is that both have to</p> <p>8 be true, I was pointing out that it's logically</p> <p>9 impossible for some of them to actually pass. The cards</p> <p>10 are stacked against them because the numbers indicate</p> <p>11 that they can't both be correct -- or, rather, all three</p> <p>12 can't be correct. So it's equally possible that the</p> <p>13 total length of thread is wrong.</p> <p>14 But if you say that C is made up of A and B, and</p> <p>15 then you add A and B together and they don't make C,</p> <p>16 then something has gone wrong. I'm not saying what's</p> <p>17 gone wrong. I'm not competent to say what's going</p> <p>18 wrong. I'm really an arithmetician at this point, you</p> <p>19 could argue that this is simple arithmetic, I have</p> <p>20 simply applied a few reasonable assumptions, so I've</p> <p>21 said they don't have to match exactly. Obviously</p> <p>22 there's a margin of error. So, for instance, we have</p> <p>23 nought to one threads or one to two threads, so I have</p> <p>24 said could it be that it would be match if it was one,</p> <p>25 could it be that it would be match if it was two, and if</p>	<p>1 is part of the QSP in which we can see some of the</p> <p>2 requirements.</p> <p>3 You see, on top of this page, we have a table; do</p> <p>4 you see that? The first column sets out the various</p> <p>5 diameters of the bar.</p> <p>6 MR SHIEH: I hasten to rise here. Obviously it will be</p> <p>7 a matter for the Commission to decide how best to deal</p> <p>8 with this matter. The Commission may remember, during</p> <p>9 what we call part 1 of the Commission of Inquiry, there</p> <p>10 has been a good deal of evidence concerning how much you</p> <p>11 need to be embedded and how many threads can permissibly</p> <p>12 be exposed before it can be called safe. We have all</p> <p>13 this evidence about what BOSA said in the brochure. We</p> <p>14 have all the BOSA pull tests, we have the CASTCO test,</p> <p>15 we have 26, we have 28, and all the rest of it, and</p> <p>16 those were contested issues calling for evaluation by</p> <p>17 the Commission.</p> <p>18 What I don't wish to happen is for the government to</p> <p>19 put its preferred version of the evidence to Dr Wells</p> <p>20 and, in a way, ask Dr Wells to interpret the evidence</p> <p>21 and express his view on one assumption of what one may</p> <p>22 call the safety embedded length, and for other people to</p> <p>23 then say, "Well, if you actually put in evidence to</p> <p>24 Dr Wells about this, I'm going to rehearse everything</p> <p>25 that has been rehearsed in part 1", which actually is</p>
Page 50	Page 52
<p>1 it can't match on either extreme then it's incompatible.</p> <p>2 And similarly, with the measurement of what we can't</p> <p>3 see, this has got a margin of error on it as well</p> <p>4 because we know that the PAUT measurement is only</p> <p>5 accurate to within 3 millimetres.</p> <p>6 So, if we apply those, then we can say that</p> <p>7 a certain percentage -- and I don't have the figures in</p> <p>8 front of me -- of the items simply couldn't have passed.</p> <p>9 They have the laws of 1 plus 1 equals 2 stacked against</p> <p>10 them.</p> <p>11 That's just the extreme. It could well be that</p> <p>12 there are more but I have only used the extremes.</p> <p>13 Q. Dr Wells, I fully appreciate the point that you have</p> <p>14 made. I also appreciate that for the purpose of</p> <p>15 preparing your statistical report, you may not have</p> <p>16 looked at all the factual evidence in relation to the</p> <p>17 length of the threaded part of the rebar.</p> <p>18 Now, to clarify the position, I would like to take</p> <p>19 you quickly to some of the relevant evidence. The first</p> <p>20 part of the factual evidence I would like to take you to</p> <p>21 is the quality supervision plan, at bundle H9,</p> <p>22 page 4280.</p> <p>23 This is a document, on the face of it, jointly</p> <p>24 prepared by Leighton, the main contractor of the</p> <p>25 project, and the supplier of the couplers, BOSA. This</p>	<p>1 a matter for the Commission to evaluate, to Dr Wells,</p> <p>2 and say, "What if you read Dr Glover's opinion? He says</p> <p>3 it's 20 and how do you say?" We then get deja vu of</p> <p>4 January this year, when the experts went in.</p> <p>5 It may not be helpful, if this is the path my</p> <p>6 learned friend is going to put in, because the status of</p> <p>7 this document itself is in dispute, as was observed by</p> <p>8 Mr Chairman just now.</p> <p>9 So if it is an intention to actually get Dr Wells to</p> <p>10 somehow form a view as to whether this is actually the</p> <p>11 requisite safety standard or whatever, that could lead</p> <p>12 to some wastage of time and may not be entirely helpful.</p> <p>13 MR CHOW: Mr Chairman, Dr Wells, when he prepared this</p> <p>14 expert opinion on statistical matters, he acted on</p> <p>15 a certain understanding of fact. For example, in</p> <p>16 subparagraph 4.17(a), he set out that his understanding</p> <p>17 is that the threaded length of type A rebar is 44mm, and</p> <p>18 acting on this understanding he then developed his</p> <p>19 argument and then came to a conclusion that the two</p> <p>20 acceptance criteria are not compatible.</p> <p>21 I am entitled -- it is quite reasonable for me to</p> <p>22 expect that Dr Wells did not have an opportunity to</p> <p>23 consider all the relevant factual evidence. I am</p> <p>24 entitled to put to him other factual evidence, but at</p> <p>25 the end I will not ask him to form a view as to which</p>

Page 53	Page 55
<p>1 version of the factual evidence is more reliable and 2 should be adopted. I would only ask him, in the light 3 of the other evidence, how would it -- if the other 4 evidence is accepted, how would the other evidence have 5 impacted on his opinion expressed in his report. 6 Mr Chairman, in my respectful submission, given that 7 the expert acts on a certain understanding of the 8 factual evidence and then starts to give opinions and 9 come to conclusions, the government is perfectly 10 entitled -- 11 CHAIRMAN: Yes, I appreciate the point you make. It seems 12 to me to be a legitimate ... 13 COMMISSIONER HANSFORD: I should just point out that you 14 took us, Mr Chow, to subparagraph 4.17(a) of Dr Wells' 15 report, and in his footnote 5, he's taken that from the 16 holistic report. 17 MR CHOW: Yes. I am aware of that. 18 COMMISSIONER HANSFORD: Okay. 19 MR CHOW: I will also mention to him. 20 COMMISSIONER HANSFORD: Thank you. 21 MR CHOW: Dr Wells, if we may proceed. I understand that in 22 subparagraph 4.17(a), you set out what your 23 understanding was at the time when you prepared the 24 report, and that is that the threaded length of type A 25 rebar is typically 44mm. You also provide a reference.</p>	<p>1 Q. If I may then now -- 2 A. Sorry, may I please ask for some expert guidance? What 3 do you mean -- what do you understand it means by 4 tolerance of 4 millimetres? 5 Q. I'm going to show you other documents which explains 6 what it is about. 7 A. Okay, please. 8 COMMISSIONER HANSFORD: Sorry, there is a note in a box at 9 the bottom. I don't know if that assists, Dr Wells. 10 MR CHOW: "The tolerance established in the table above 11 provides a lower limit on the permissible variation of 12 the length of the threaded bar." 13 A. Okay. So can I just check that I fully understand this? 14 This is the first time I've seen this and I may not be 15 understanding it. But if 4 millimetres is the lower 16 limit on the permissible variation, then the permissible 17 variation has no upper limit and it can vary as much as 18 it likes; is that correct? 19 Q. I'm afraid I'm not in a position to answer your 20 question, but this is what it says. But perhaps what 21 would assist us is the actual evidence given by 22 Mr Paulino, the representative of BOSA. I think he has 23 explained what actually happened. 24 If I may now refer you to Mr Paulino's evidence, the 25 transcript at Day 36 of the first part of the Inquiry.</p>
Page 54	Page 56
<p>1 The reference that you provide actually is part of 2 the holistic report, in which it says that the threaded 3 length is typically 44mm; correct? 4 A. Yes, I think so. 5 Sorry, you were coming in and out of the range of 6 the microphone there, but I think I caught everything. 7 Q. Yes. I would like you to take a look at the part of the 8 quality supervision plan that I've just referred to you: 9 bundle H9, page 4280. The table on top, the first 10 column sets out all the different bar diameters. The 11 one that's relevant is the one with the bar diameter of 12 40mm, which is the second item from the bottom. Do you 13 see that? 14 A. Yes. 15 Q. If we move to the right, under "Coupler dimensions", 16 "L", which as I understand it represents the length of 17 the coupler, which is 88mm; do you see that? 18 A. Yes. 19 Q. So half of it is 44mm. 20 The next column, to its right, provides the value of 21 the tolerance; do you see that? 22 A. Yes. 23 Q. So, for the bar diameter of 40mm, there is an extra 24 tolerance of 4 millimetres; do you see that? 25 A. Yes.</p>	<p>1 Day 36, page 98, please. It is part of the exchange 2 between Mr Paulino and Prof Hansford. 3 If we start with line 22, when Prof Hansford said, 4 "I'm still" -- do you see that? 5 A. Yes, thank you. 6 Q. "... I'm still a bit confused by your answer to a 7 previous question where you referred to butt-to-butt. 8 Now, I know what butt-to-butt means, but I thought you 9 were allowed to have one or two threads exposed after 10 the coupler is connected. 11 If the threads are exposed, how can it be 12 butt-to-butt? 13 Answer: That's a very good question." 14 That's the answer. 15 "If you refer back to page [we don't need to worry 16 about this at the moment] -- in our design, when we are 17 manufacturing threads, we always programme our machine 18 to produce an extra 1 to 2mm on the actual length of our 19 thread. We just wanted to make sure that when the two 20 ends abut inside, connected inside of a coupler and 21 tighten, [then] they are actually butt-to-butt. 22 So if in a worst case scenario we were to have both 23 ends with a maximum tolerance -- for example the 24 diameter 40 rebar which says tolerance of 4mm, the 4mm 25 basically is one thread, equal to one thread, so if both</p>

Page 57	<p>1 ends has a maximum tolerance of one thread, after you</p> <p>2 have connected the two ends together, you will have a</p> <p>3 chance of seeing two threads exposed.</p> <p>4 Commissioner Hansford: I understand that, but in</p> <p>5 that bottom of those three diagrams, you show the</p> <p>6 coupler being of length 2T, and the threads being T?</p> <p>7 Answer: Yes.</p> <p>8 Commissioner Hansford: Are you saying the threads</p> <p>9 are actually T plus one thread?</p> <p>10 Answer: Yes, tolerance. T plus tolerance.</p> <p>11 Commissioner Hansford: T plus tolerance, and the</p> <p>12 tolerance is one thread."</p> <p>13 The answer is clear: one thread.</p> <p>14 So, basically, if we look at the evidence from the</p> <p>15 supplier of the couplers, Mr Paulino, and if you recall</p> <p>16 what it says in the table, what actually happens is</p> <p>17 a typical threaded bar is T, which is 44mm, plus one</p> <p>18 thread, which is the tolerance.</p> <p>19 Now, if we then go to look at a written confirmation</p> <p>20 from BOSA, at bundle H26, page 45640. It's a letter</p> <p>21 from BOSA in answer to enquiry made by the Building</p> <p>22 Authority in Hong Kong, dated 7 January 2019. Starting</p> <p>23 from the third paragraph, "In response to</p> <p>24 paragraph 2(a)(i) of your letter", BOSA was referring to</p> <p>25 an enquiry --</p>	Page 59	<p>1 undercurrents such as, okay, it may be what it says as</p> <p>2 a matter of black and white, but we now recall that</p> <p>3 perhaps a qualifier has been put on how much weight one</p> <p>4 is entitled to put on a document like this. These are</p> <p>5 nuances which vexed us for some time during COI 1 and</p> <p>6 these are now shown to Dr Wells in a black-and-white,</p> <p>7 cold, calculated manner. That is the point I was</p> <p>8 making.</p> <p>9 But if the matter is to be pushed on in</p> <p>10 an expeditious manner, then perhaps what I say is to be</p> <p>11 regarded as only a marker. I don't wish it to hold up</p> <p>12 the matter.</p> <p>13 MR CHOW: Mr Chairman, I don't want to waste time on arguing</p> <p>14 this, because all these letters serve just to confirm</p> <p>15 Mr Paulino's oral evidence.</p> <p>16 CHAIRMAN: You just go with how you feel it's best,</p> <p>17 recognising the objection or the comments by Mr Shieh.</p> <p>18 MR CHOW: I will then move on to Mr Neil Ng's evidence that</p> <p>19 we received on Tuesday. Can I have the transcript for</p> <p>20 Tuesday? I think it's Day 17 for the second round of</p> <p>21 Inquiry, page 62.</p> <p>22 Sorry, it should be Day 2 of --</p> <p>23 MR PENNICOTT: I think we started at Day 1 again so it's</p> <p>24 Day 2.</p> <p>25 MR CHOW: Day 2. Sorry.</p>
Page 58	<p>1 CHAIRMAN: Sorry, was this a letter that we took objection</p> <p>2 to?</p> <p>3 MR PENNICOTT: Sir, I was hesitating to get up because --</p> <p>4 I was just trying to think myself before I stood up and</p> <p>5 said anything about it. I hesitate to say it is and</p> <p>6 I hesitate to say it isn't. I just, I'm afraid, cannot</p> <p>7 remember.</p> <p>8 MR BOULDING: My recollection, sir, is that I cross-examined</p> <p>9 one of the government's technical witnesses on this.</p> <p>10 I've got a feeling it was Prof Au. And he sought to</p> <p>11 rely upon this, even though it was dated January 2019,</p> <p>12 well after the works were carried out. It sticks in my</p> <p>13 mind that you suggested it might be a self-serving</p> <p>14 letter.</p> <p>15 CHAIRMAN: That's right.</p> <p>16 MR CHOW: Sir, this also coincides with my recollection as</p> <p>17 well, but I'm not sure that is an objection from the</p> <p>18 Commission. But if it is then I will just move on;</p> <p>19 I would not refer him to it.</p> <p>20 CHAIRMAN: If you are going to make a more broad point,</p> <p>21 I don't want to stop you.</p> <p>22 MR CHOW: All right.</p> <p>23 MR SHIEH: This is the invidious nature of the exercise,</p> <p>24 because a lot of these nuances are thrown at Dr Wells,</p> <p>25 who is seeing it for the first time, but a lot of these</p>	Page 60	<p>1 Dr Wells, what you are looking at is the verbal</p> <p>2 evidence of Mr Neil Ng.</p> <p>3 MR PENNICOTT: Not yet. What page?</p> <p>4 MR CHOW: Sorry, page 62, starting from line 20. This is</p> <p>5 the evidence of Mr Neil Ng. The question posed was:</p> <p>6 "But if it's ten threads engaged, that would be 40</p> <p>7 inside; there would not be two threads outside?"</p> <p>8 And Mr Ng's answer was:</p> <p>9 "That is correct. Or it could be, depending on the</p> <p>10 threaded bar, some threaded bars are 11 threads, some</p> <p>11 threaded bars we have seen 12 threads. So even if you</p> <p>12 have a situation where you have 10 threads engaged, you</p> <p>13 still might be able to see one to two threads exposed,</p> <p>14 depending on the threading of the bar by the</p> <p>15 technician."</p> <p>16 So this is the latest evidence from Mr Neil Ng.</p> <p>17 On the basis of this factual evidence, if -- "if" --</p> <p>18 the threaded length is 48mm, that is T plus one thread,</p> <p>19 instead of 44, would you agree that the two acceptance</p> <p>20 criteria, namely not more than two threads exposed and</p> <p>21 the minimum engagement length of 40mm, would be</p> <p>22 compatible?</p> <p>23 A. Sorry, can I just recap on what I'm being asked to agree</p> <p>24 to? As I understand it, we started with a document from</p> <p>25 BOSA. Could we go back to that one? I think you showed</p>

Page 61	Page 63
<p>1 me five documents and each one builds on the previous</p> <p>2 one so that the ultimate question depends on everything</p> <p>3 that went before it. Is that correct?</p> <p>4 Q. If you want to go back to that question --</p> <p>5 A. What I understand you've done here, and correct me if</p> <p>6 I'm wrong -- what I understand you've done here is</p> <p>7 you've shown me five documents and said starting with</p> <p>8 this one, then that one, then that one, then that one,</p> <p>9 then that one, now do I agree? So I just want to</p> <p>10 retrace the steps, if I may, because it was quite</p> <p>11 a complicated process and I want to be sure that when</p> <p>12 I say I either agree or I don't agree or I don't</p> <p>13 understand, that I'm doing so in the best of my</p> <p>14 understanding of what you've asked me.</p> <p>15 Q. Dr Wells, to save time, perhaps if I can put it another</p> <p>16 way around.</p> <p>17 The documents I have showed you are something that</p> <p>18 I referred to to suggest that perhaps the threaded</p> <p>19 length of the bar is 48, not 44. For the purpose of</p> <p>20 answering my question, if -- you don't have to commit</p> <p>21 yourself but just in case where the threaded length is</p> <p>22 48mm instead of 44 that you have assumed, am I right</p> <p>23 that the two acceptance criteria, namely not more than</p> <p>24 two threads exposed and a minimum engagement length of</p> <p>25 40mm, these two acceptance criteria would be compatible</p>	<p>1 13 -- I had to write that down because I don't remember</p> <p>2 things -- so if in a worst-case scenario we were to have</p> <p>3 both ends with a maximum tolerance; right? We just</p> <p>4 established that there is no such thing as a maximum</p> <p>5 tolerance, so this whole thing is hypothetical. We have</p> <p>6 started with -- you showed me document 1 and said,</p> <p>7 given 1, then 2, then 3, then 4, then 5, do I agree with</p> <p>8 the statement you made. I cannot either agree or</p> <p>9 disagree because the first two things you showed me are</p> <p>10 nonsensical and don't make sense and are mutually</p> <p>11 incompatible.</p> <p>12 So I do not feel I am in a position to answer</p> <p>13 a question which is hypothetically posed at the end of</p> <p>14 a logically inconsistent argument.</p> <p>15 I apologise if this comes across as being</p> <p>16 obstructive in any way but it seems to me that if you're</p> <p>17 asking me a question which says what do I make of</p> <p>18 a maximum tolerance, when there is no such thing as</p> <p>19 a maximum tolerance, then I cannot answer, can I?</p> <p>20 Q. Dr Wells, I thought my question is simple arithmetic.</p> <p>21 My question was: if the threaded length is 48mm, then it</p> <p>22 is possible that while having two threads exposed, which</p> <p>23 is 8mm, we still can provide a 40mm engagement length.</p> <p>24 I thought this is simple arithmetic -- is it not?</p> <p>25 A. Yes. If 1 plus 1 equals 3, then we can prove almost</p>
Page 62	Page 64
<p>1 with each other, in other words physically possible?</p> <p>2 A. I'm very sorry but, as a mathematician, I'm not often</p> <p>3 asked to answer hypothetical questions, and if somebody</p> <p>4 said to me, "Hypothetically, if 1 plus 1 equals 3, then</p> <p>5 how would that change your maths?", I would find that</p> <p>6 very difficult to answer. I would much prefer to try to</p> <p>7 understand the question you've asked me, and if we go</p> <p>8 back to the BOSA Technology (Hong Kong) Ltd, I asked</p> <p>9 what the tolerance was and I was referred to the box at</p> <p>10 the bottom which says:</p> <p>11 "The tolerance established in the table above</p> <p>12 provides a lower limit ..."</p> <p>13 Can we all see that?</p> <p>14 Q. Yes.</p> <p>15 A. At the time I said: so actually, there is no upper</p> <p>16 limit, there is no maximum specified. So we start with</p> <p>17 this first document -- please forgive me, I am</p> <p>18 a mathematician, I tend to argue logically from first</p> <p>19 principles, and this was the first thing you showed me</p> <p>20 so this is the first principle -- and this principle</p> <p>21 states that there is no maximum tolerance. Is that</p> <p>22 reasonable?</p> <p>23 So then we go on to the second document you showed</p> <p>24 me, please, which is the evidence given by the company</p> <p>25 that wrote that document, and if we look at lines 12 and</p>	<p>1 anything we like. That is basically your question. You</p> <p>2 are asking me what would happen if I were to assume that</p> <p>3 there is no such thing as a maximum tolerance, but the</p> <p>4 maximum tolerance is nevertheless a number. That's what</p> <p>5 you've asked me.</p> <p>6 Q. I don't think this is my question, but anyway --</p> <p>7 A. It is.</p> <p>8 Q. -- I would prefer to move on.</p> <p>9 CHAIRMAN: But if it's a basic question of mathematics, it's</p> <p>10 a statement more than it is a question, is it not?</p> <p>11 MR CHOW: Sir, it is quite true that I don't necessarily</p> <p>12 need to ask that question. I thought it is really</p> <p>13 obvious and it would not take much time and I am</p> <p>14 actually surprised that it has taken so long to get</p> <p>15 an answer from Dr Wells.</p> <p>16 Actually, to save time, I would prefer to move on to</p> <p>17 a new topic. I think I've got enough on that one.</p> <p>18 CHAIRMAN: Certainly, yes.</p> <p>19 MR CHOW: Dr Wells, I would like to move on to another</p> <p>20 subject, regarding the binary, discrete analysis or</p> <p>21 continuous analysis. Do you recall that?</p> <p>22 Paragraph 4.20 of your report.</p> <p>23 A. Yes, I recall.</p> <p>24 Q. In paragraph 4.20, you criticise the adoption of</p> <p>25 a discrete method instead of a continuous method. But,</p>

Page 65	<p>1 as you rightly point out, this assessment is not</p> <p>2 a statistical issue; it is an engineering and management</p> <p>3 issue. Do you agree? Is that your position?</p> <p>4 A. Yes. Yes.</p> <p>5 Q. Do you agree that if we -- had MTRC adopted a continuous</p> <p>6 method, it would have to open up a lot more areas in</p> <p>7 order to get a lot more samples for the statistical</p> <p>8 analysis?</p> <p>9 A. No, I do not agree.</p> <p>10 Q. Okay.</p> <p>11 COMMISSIONER HANSFORD: Can we understand why Dr Wells</p> <p>12 doesn't agree? Is that relevant to this?</p> <p>13 MR CHOW: Yes.</p> <p>14 Can you assist the tribunal as to why you don't</p> <p>15 agree to my proposition?</p> <p>16 A. Well, for various technical reasons. So, for instance,</p> <p>17 the arguments in the holistic report rely on some</p> <p>18 approximations which are necessary because of a binary</p> <p>19 approach was taken. For instance, in the calculation of</p> <p>20 the strength reduction factor in the capping beam</p> <p>21 calculation, there is reliance on the Delta method in</p> <p>22 order to calculate a variance, and the need for this is</p> <p>23 because, with discrete samples, you don't have</p> <p>24 an obvious measure of variance. With numbers, it's very</p> <p>25 easy. You just add the numbers together, find the mean</p>	Page 67	<p>1 You can work with numbers when you've only got quite</p> <p>2 small samples. It is much easier to work with numbers</p> <p>3 in a mathematical sense than it is to work with discrete</p> <p>4 things like red/green/blue or defective/not defective.</p> <p>5 Q. Dr Wells, it is possible that I misunderstood what you</p> <p>6 meant by "continuous". My understanding -- correct me</p> <p>7 if I'm wrong -- by "continuous variable", you are</p> <p>8 saying, instead of considering a coupler connection as</p> <p>9 either pass or fail, we can have partially, like partial</p> <p>10 engagement kind of situation, so we can accept certain</p> <p>11 partial engagement couplers. So, instead of pass or</p> <p>12 fail, we can have partially pass and fail. Is that what</p> <p>13 you are trying to say by "continuous method"?</p> <p>14 A. No, because there is no concept of partially pass. What</p> <p>15 I'm saying is that if you say that a rebar with</p> <p>16 a coupler measured to be 39.999 millimetres is a fail,</p> <p>17 then you are saying that it has absolutely no</p> <p>18 contribution to the structure. If you were to use</p> <p>19 a continuous variable, you could say that an engagement</p> <p>20 length of 39.999 is some percentage less than the</p> <p>21 engagement length of 40.</p> <p>22 I am not competent to say what that percentage less</p> <p>23 is. It might be a very high percentage less. All I'm</p> <p>24 suggesting is that it probably would be easier to use</p> <p>25 a percentage rather than simply say: as soon as it drops</p>
Page 66	<p>1 and then find out how much on average each one is</p> <p>2 distant from the mean. It's very, very, very simple.</p> <p>3 But if you have something such as you throw a dice</p> <p>4 and you have the numbers 1, 2, 3, 4, 5, 6, then there is</p> <p>5 some doubt as to how different 1 is from 2. Obviously,</p> <p>6 I know that 2 minus 1 is 1, that's the difference, if</p> <p>7 you think of them as continuous numbers. But if they</p> <p>8 are simply faces on the dice, then they could be, for</p> <p>9 instance, like a Rubik's Cube, where you have one face</p> <p>10 is red, one is green and one is white. How different is</p> <p>11 red from white? How different is green from red?</p> <p>12 So you have this fundamental problem with discrete</p> <p>13 methods where you don't have an obvious measure of</p> <p>14 variability, of how different things are. With</p> <p>15 continuous measurement, it's simple, it's easy.</p> <p>16 So, with the binary methods, you have to adopt some</p> <p>17 approximations to try to make it look as if you've got</p> <p>18 continuous data, and these approximations actually only</p> <p>19 work when you have quite a large amount of data. For</p> <p>20 instance, the approximation, the Delta method which was</p> <p>21 used on a sample size of seven is actually only valid</p> <p>22 with a sample size of 30. So the method used was just</p> <p>23 not valid, whereas you don't get any of those problems</p> <p>24 with continuous methods. You don't have to have a large</p> <p>25 sample in order to be able to make an approximation.</p>	Page 68	<p>1 below 40, it has absolutely no effect. And I'm saying</p> <p>2 that not from an engineering point of view. It is up to</p> <p>3 somebody else to say whether 39.999 millimetres'</p> <p>4 engagement length is still providing some strength to</p> <p>5 the structure, no matter how little.</p> <p>6 I am saying, from a statistical point of view, it</p> <p>7 would make the analysis an awful lot easier and would</p> <p>8 have bypassed a lot of the mistakes which were actually</p> <p>9 made in the analysis such as the one I just mentioned</p> <p>10 about the Delta method.</p> <p>11 COMMISSIONER HANSFORD: Just to follow up on that,</p> <p>12 Dr Wells -- and you are also saying that that can be</p> <p>13 done with the same sample size or less? It doesn't need</p> <p>14 a larger number of samples; is that correct?</p> <p>15 A. That is correct, yes. I am saying that.</p> <p>16 COMMISSIONER HANSFORD: All right. Thank you.</p> <p>17 MR CHOW: So apparently I have not misunderstood what you</p> <p>18 meant. The only difference between me, the government's</p> <p>19 position, and your position, is that in such</p> <p>20 circumstances the government's position is that instead</p> <p>21 of using a binomial analysis, we need to adopt</p> <p>22 a multinomial analysis, and by doing so, to provide the</p> <p>23 same confidence level of 95 per cent, one would need</p> <p>24 a lot more samples to be obtained, instead of 84.</p> <p>25 So I would assume that you don't agree with this</p>

Page 69

1 proposition; right?

2 A. I do not disagree with that proposition. I was simply

3 not suggesting a multinomial approach. I was suggesting

4 a continuous approach.

5 So I am not disagreeing with a statement which

6 doesn't disagree with anything I've said. Is that okay?

7 Q. All right.

8 COMMISSIONER HANSFORD: Well, hang on. Sorry, I need to

9 understand that now. Because I think your answer -- or

10 Mr Chow's question was: "by doing so, to provide the

11 same confidence level of 90 per cent, one would need

12 a lot more samples to be obtained, instead of 84."

13 That is different to the answer you gave to me,

14 Dr Wells, is it not?

15 A. Sorry, no. It's a slight technical distinction, that

16 you asked me the question, "Would a continuous approach

17 require more samples?", and I said, "No, it wouldn't."

18 COMMISSIONER HANSFORD: Yes.

19 A. I was then asked do I disagree with the statement that a

20 multinomial analysis would require more, and I said no,

21 I don't disagree with that.

22 COMMISSIONER HANSFORD: So the distinction here is between

23 multinomial and continuous?

24 A. Yes. Multinomial would be if you said, "I've got lots

25 of classes, I've got a pass, I've got a nearly pass,

Page 70

1 I've got a not-quite pass, I've got a complete fail",

2 there we go, four classes, multinomial --

3 COMMISSIONER HANSFORD: I understand.

4 A. -- as opposed to binary, two classes.

5 That is not what I have ever suggested. So to say

6 that approach requires more samples is true, but it

7 isn't something I've ever suggested, so I don't see that

8 it's relevant.

9 MR CHOW: Right, okay.

10 MR SHIEH: Instead of taking the SAT, you are taking the

11 A levels. I'm not sure whether it's a good analogy.

12 A levels, you get A, B, C, D, E, F, G; SAT you get

13 a range of marks without gradation.

14 COMMISSIONER HANSFORD: I understand. International

15 Baccalaureate.

16 MR CHOW: I don't propose to go any further than that, not

17 that I'm capable to do so. I will just move on then.

18 Dr Wells, can I ask you to go to paragraph 4.34 of

19 your report.

20 The second column from the left of table 2a, under

21 paragraph 4.34 -- if we look at the bottom row,

22 "Combined", and if you look at those figures under the

23 second column, "Strength reduction factor adopted by the

24 holistic report", my understanding is the first figure,

25 0.366, corresponds to the strength reduction factor for

Page 71

1 EWL slab, and the next figure, 0.332, corresponds to NSL

2 slab; right?

3 A. Yes.

4 Q. And the last figure, the figure at the bottom, is

5 somehow a combination process that you have performed to

6 arrive at a combined strength reduction factor for the

7 two slabs, EWL and NSL slab; right?

8 A. Correct.

9 Q. I observe that the combined value is somewhere in

10 between those figures for EWL and NSL; correct?

11 A. Sorry, you observe that it's between? I observe that it

12 isn't. It's outside. The two above are 354 and 331 and

13 then the last row is 317. Is that what you're referring

14 to?

15 Q. No. I'm referring to the second column from the left,

16 which is the corresponding strength reduction factor set

17 out in the holistic report.

18 A. Sorry. My mistake.

19 Q. Perhaps it's mine.

20 A. I was discounting the first column because it's only --

21 yes, right. So the first column. Yes, it goes 366, 332

22 and then 350, so it's in between, yes.

23 Q. You have spotted what happened in the next column and

24 this is really my question. Am I right to expect that

25 when you combine the figures which correspond to two

Page 72

1 different slabs, you would expect that the combined

2 figures would be somewhere in between? But I notice

3 that under the column that you have calculated, the

4 third column from the left, somehow the combined value

5 is outside the two different figures on top. Is it

6 normal?

7 A. Sorry, on what basis are you expecting the final row to

8 be between the first two, may I ask?

9 Q. I am not sure, honestly. It is just my gut feeling.

10 Because if I look at the first column, the combined

11 figure is in between the first two figures. If the same

12 mathematical operation is being carried out, then

13 I would expect that for the third column, the bottom

14 figure should be somewhere in between the first two.

15 A. It's interesting how gut feeling can sometimes take you

16 along the wrong path. I could give you a very simple

17 example. If you've got a pencil and paper handy,

18 I could give you an example as to how the last row could

19 actually be outside the first two. I could run through

20 it quickly provided I don't make mistakes.

21 Q. Perhaps, Dr Wells, it is easier if I tell you what has

22 been done in the holistic report. Basically, the

23 combined value is the average between the first two --

24 the above two items. Just to make sure, 0.366 ... it's

25 approximately the average of the two separate items.

Page 73	Page 75
<p>1 A. Sorry, are we looking at approximations now? Why have 2 we given three figures of decimals and then said it's 3 roughly the average? 4 Q. Dr Wells, I am informed that actually, in the holistic 5 report, there exists no figures for the combined value. 6 Was it calculated by you? The combined value of 0.35 7 under the second column, was it calculated by you? 8 A. No, I think I read it out of the report, didn't I? 9 Apologise if I've made a mistake here, but I thought 10 I had. 11 Q. Dr Wells, on page 8 of your verification report ... 12 Dr Wells, can I refer you to your original report, 13 the footnote on page 8. You, under note 9, put: 14 "The verification report adopts a strength reduction 15 factor of 35 per cent. As stated in my report for the 16 Extended Inquiry, it appears that the figure of 17 35 per cent is based on the combined samples of the EWL 18 and NSL [slabs]." 19 Does this footnote have something to do with the 20 bottom figures under table 1? 21 A. I confess I cannot recall everything right now. I don't 22 have access to any of my notes. But what I thought 23 I had done here is copied the figures of 366, 332 and 24 350 from the holistic report. Presumably you have 25 a copy and you can check that, but that's what I had</p>	<p>1 basis for either an initial construction or suitable 2 measures on an extant instruction. 3 So that's my first point. The numbers are roughly 4 right. That shouldn't be good enough. I'm 5 a mathematician. I apologise. 6 My main point is that there is actually no 7 theoretical reason why the third row should be between 8 the first and second rows. I can illustrate that very 9 easily. If, for instance, you have the numbers 1, 2 and 10 3 at EWL -- only three measurements because I'm going to 11 do this in my head, without the aid of mechanical 12 devices -- so, if you only had three numbers, three 13 measurements, 1, 2, 3, whatever they are, whether they 14 are millimetres or megapascals or whatever, numbers 1, 2 15 and 3 at the EWL, and if at the NSL you had the numbers 16 5.9, 6 and 6.1, then you would very quickly establish 17 that the mean at EWL is 2 and the mean at NSL is 6. You 18 would then establish that the standard deviation at EWL 19 is 1 -- that's the sample standard deviation, for the 20 record -- and then NSL, the standard deviation is 0.01. 21 So that if you were to create two standard 22 deviations up and down from this, which is effectively 23 what these numbers are, they are upper bounds, the upper 24 bound is the mean plus two standard deviations. So at 25 EWL you would have the number 2 plus 1 is 3, and at NSL</p>
Page 74	Page 76
<p>1 thought I'd done. If it's not, I apologise if I've 2 misled anybody, but that's what I thought I'd done. 3 Q. Okay. In that case, can I trouble you to explain to 4 us -- if I may ask you to go back to your original 5 report then, the table 2a that we have been looking at. 6 Can I trouble you to explain to us how did you calculate 7 the 0.317 from the two figures corresponding to the two 8 slabs individually? 9 A. By redoing analysis with all the numbers put into it. 10 Can I say two things here? One is I actually think 11 I've made a mistake here. I've probably made several 12 mistakes; I was working under huge time pressure to 13 produce this, and I was redoing the calculations as more 14 and more information was made available to me, and 15 occasionally I probably transcribed some numbers 16 incorrectly. Certainly the last column should actually 17 be less than the second-to-last column and it isn't. 18 I notice that now and I apologise. That must be 19 a mistake. 20 On this score, I would simply say that I have been 21 trying throughout this to illustrate alternative ways of 22 doing the analysis and to try to point people in the 23 direction of how I believe the holistic report should 24 have taken the analysis. I've not been as rigorous as 25 I would be if I were presenting these figures as the</p>	<p>1 you would have the number 6 plus 0.1 is 6.1. Then, if 2 you combine the two data sets, you have the number 1, 2 3 and 3, 5.9, 6 and 6.1, and now the average is 4 and the 4 standard deviation is 2, roughly, 2.25. So the mean, 4, 5 plus twice the standard deviation, twice 2.25 is 4.5. 6 4 plus 4.5 is 8.5. 7 So the rows would now read, for this situation, 2, 8 6, 8.5, and I think it's obvious to everybody that 8.5 9 is not between 6 and 2. 10 So hopefully I've established with very simple 11 arithmetic that there is no logical reason why the third 12 row should be between the first and the second, and to 13 criticise it on that basis is a simple failure in 14 statistics, which I don't blame you for because you're 15 not a statistician. That's why I've taken a lot of 16 trouble to try to explain to you why that assumption, 17 that gut feeling of yours, doesn't work. Gut feelings 18 don't always help us. Statistics is there to try to 19 smooth out the in-built biases that we have. 20 Now, in this particular case, yes, I should have 21 looked at that and said, "Yeah, I know theoretically it 22 doesn't have to lie between", but then if you look at my 23 example, I deliberately chose EWL and NSL to be very, 24 very different, and that's the only way my example 25 worked. If you assume that EWL and NSL are very</p>

Page 77	Page 79
<p>1 similar, then your gut feeling now is correct and it 2 should be between those two.</p> <p>3 So your gut feeling is making the assumption that 4 EWL and NSL are very similar. Perhaps we could remember 5 that gut feeling for later, when we come to the issue of 6 are the EWL and NSL actually similar? We've established 7 that your gut feeling is that yes, they are. I think we 8 will find that the government actually says no, they're 9 not, but we'll come back to that presumably in due 10 course.</p> <p>11 In the meantime, yes, you are correct, that number 12 is almost certainly wrong. I apologise for that. And 13 if somebody spends a long time trying to reproduce it, 14 then I apologise for the waste of their time. But, as 15 I said, I was trying to be illustrative, I was trying to 16 get lots of numbers done. What I've presented here is 17 a very, very small subset of all the different 18 calculations that I actually did, in part because the 19 information was arriving in a bit of a drip-feed.</p> <p>20 Is that sufficient to answer?</p> <p>21 Q. Dr Wells, I am not able to enter into a detailed 22 discussion with you on the calculation and I will simply 23 put it to you that when one calculates the combined -- 24 the figure -- to calculate the combined figures, one is 25 actually mixing the data, the two sets of data, one for</p>	<p>1 is a mean plus a measure of how different we might 2 expect the figures to be from the mean. That's what 3 these upper bounds are. These strength reduction 4 factors are not what we expect. They are upper bounds 5 on what we might reasonably, possibly see, and it's this 6 upper bound bit which allows the combined result to be 7 between the first two.</p> <p>8 The expected value, the beam, should, yes, be 9 between the first two. But if one of them has 10 significantly high variation, then you could get 11 a combined result which is different, which is outside 12 the first two.</p> <p>13 COMMISSIONER HANSFORD: Thank you. Yes, I understand. 14 MR CHOW: Dr Wells, I will move on. 15 Paragraphs 4.35 to 4.37, about the sampling size. 16 Under paragraph 4.36, you said Prof Yin has to have 17 "knowledge of the population size and variance or 18 an estimate based on a known sample". Do you see that? 19 A. Yes. 20 Q. You also -- 21 COMMISSIONER HANSFORD: Sorry, where are we looking? 22 MR CHOW: Paragraph 4.36 of Dr Wells' report. 23 COMMISSIONER HANSFORD: His first report? 24 MR CHOW: The first report, yes. 25 COMMISSIONER HANSFORD: Okay. Thank you.</p>
Page 78	Page 80
<p>1 EWL and the other set for NSL, together for the 2 analysis, and then one should obtain a combined value 3 which is in between the two other figures. Am I right 4 that you disagree?</p> <p>5 A. I thought I had just established that there is no 6 theoretical reason why you should. I thought, with at 7 least some very simple arithmetic, I just established 8 that no, it doesn't have to lie between the two --</p> <p>9 CHAIRMAN: But if the numbers are close, then in fact the 10 gut reaction may be correct, in this instance? Would 11 that be right?</p> <p>12 A. The gut reaction is correct if you assume that EWL and 13 NSL are very similar in nature, yes. This is 14 an assumption that I think we are going to come on to 15 later.</p> <p>16 Theoretically, there is absolutely no reason why it 17 should be between those two.</p> <p>18 COMMISSIONER HANSFORD: Just so I can understand, Dr Wells, 19 the simple illustration you gave us, where you gave us 20 some numbers and you did the calculation in your head, 21 was an example of how the combined number could be 22 outside the range of the previous two?</p> <p>23 A. Yes, that's correct.</p> <p>24 COMMISSIONER HANSFORD: Thank you.</p> <p>25 A. It's because what we are looking at here in this table</p>	<p>1 MR CHOW: You also suggest that Prof Yin, in his analysis, 2 has adopted a worst-case scenario, and if he had adopted 3 an appropriate methodology then fewer coupler 4 connections could have been tested to provide the same 5 result. Is that your position?</p> <p>6 A. Yes. Sorry, can I -- I don't wish to pick nits here, 7 but you say is that my position. Please remember that 8 I wrote this when all I had to go on was the holistic 9 report. There are no details in the holistic report as 10 to actually how the calculation was done. I reproduced 11 the calculation on the basis that I have given in 4.36. 12 I reproduced the numbers and reproduced the calculation, 13 and that was the basis for my writing 4.36.</p> <p>14 My basic conclusion is not changed, but I have since 15 then seen considerably more information on how the 16 actual calculation was undertaken, and I would certainly 17 write that paragraph differently now, now that I have 18 seen more information.</p> <p>19 My fundamental conclusion remains.</p> <p>20 Q. Right. So, in other words, having seen how Prof Yin 21 carried out his calculation, you now accept that for 22 Prof Yin, he did not have to have the knowledge of the 23 population size or the variance; correct?</p> <p>24 A. Prof Yin's calculation results in an envelope, an upper 25 and lower bound, around an expected number. This is</p>

Page 81	Page 83
<p>1 a graph where the horizontal axis is, from memory -- the</p> <p>2 horizontal axis or the vertical axis is the variance --</p> <p>3 Q. Dr Wells, perhaps I can direct you to the relevant part</p> <p>4 of Prof Yin's report. Prof Yin's first report,</p> <p>5 paragraph 1.4.1, page 6.</p> <p>6 Yes, this is the formula. It's called "exact</p> <p>7 binomial probability formula". You are familiar with</p> <p>8 this formula?</p> <p>9 A. Yes.</p> <p>10 Q. Do you accept that for someone who adopts this formula</p> <p>11 for the statistical analysis, he doesn't have to know</p> <p>12 the population size or the variance of the population?</p> <p>13 A. Let me see now. The variance is $n, p, 1$ minus p, and</p> <p>14 what we have there is a first term which is</p> <p>15 combinatorial with n, times p, times 1 minus p. So it</p> <p>16 does look suspiciously like a variance to me.</p> <p>17 My point here is that that formula creates a series</p> <p>18 of numbers. So k equals nought to y, so you do it for y</p> <p>19 equals 0 and you get one number; you do it for y equals</p> <p>20 2 and you get another number; you do it for y equals 3</p> <p>21 and you get another number.</p> <p>22 "... y is the observed number of defective coupler</p> <p>23 connections in the sample."</p> <p>24 So before you have started you don't know what y is.</p> <p>25 You have to do this for every possible number of</p>	<p>1 statistics, that you need to be prepared to change your</p> <p>2 mind. You start off with a hypothesis, with an idea,</p> <p>3 and then, as you get real data, that has to change.</p> <p>4 All I'm saying here is that if you just do the</p> <p>5 calculation upfront and then walk away and let people</p> <p>6 get on with it, then it is my opinion that you have not</p> <p>7 done as good a job as if you actually watched the</p> <p>8 process, monitored it as each one comes in and said,</p> <p>9 "Okay, we might actually be able to refine our estimate</p> <p>10 as we go along."</p> <p>11 That's the only point I was making. I wasn't saying</p> <p>12 that this is unsound. I was just saying, if you'd done</p> <p>13 it slightly differently, then you would probably have</p> <p>14 ended up with a smaller number of samples for the same</p> <p>15 confidence level.</p> <p>16 Q. Dr Wells, I'm not sure you've answered my question. My</p> <p>17 question is simple. For Prof Yin to adopt this formula,</p> <p>18 to work out the sample size of 84, he did not need to</p> <p>19 know the population size or the variance of the</p> <p>20 population. Do you agree?</p> <p>21 A. Okay, in that case I will disagree, because if you don't</p> <p>22 know what the population size is, for instance, then you</p> <p>23 do not know what the upper limit is on this summation.</p> <p>24 Are you going to it for k equals 0 to 0? Are you going</p> <p>25 to it for k equals 0 to 1, k equals 0 to 2? What if</p>
Page 82	Page 84
<p>1 potential defective coupler connections in the sample.</p> <p>2 So you've got a sample size of -- well, total population</p> <p>3 size of 273, so your sample size could go up to 273.</p> <p>4 You don't know yet. So you do this calculation for all</p> <p>5 273 cases, to give you one each for each of the</p> <p>6 variances, and then you plot that as a curve. This is</p> <p>7 why I was saying it's a graph where one of the axes is</p> <p>8 the variance.</p> <p>9 So now you start opening up and as you go through</p> <p>10 you get an estimate of the variance. So an awful lot of</p> <p>11 this graph is now irrelevant, but it can't happen</p> <p>12 because you have actually seen some examples as you go.</p> <p>13 You have a calculation of the variance as you've got it.</p> <p>14 So that if you've already seen two defectives, then the</p> <p>15 case zero defectives and the case one defective are no</p> <p>16 longer possible because you've actually seen two, so</p> <p>17 you've ruled those out.</p> <p>18 So my point is that you can do this calculation at</p> <p>19 the beginning and say, "Right, I've done my calculation.</p> <p>20 Now let's just go in and dig up some concrete"; or you</p> <p>21 can say, "I'm actually going to monitor this as I go</p> <p>22 along and try and adapt my best estimate of the number</p> <p>23 we need as we proceed. As data comes in, I'm prepared</p> <p>24 to change my mind."</p> <p>25 I think this is one of the key things about</p>	<p>1 your population size was 10 and you did it from k equals</p> <p>2 0 to 20? What if your population size was 20 and you</p> <p>3 only did it for k equals 0 to 10? You must have at</p> <p>4 least an expectation to know how far up you need to go.</p> <p>5 Q. Thank you, Dr Wells. I have registered your</p> <p>6 disagreement and I would prefer to move on. Thank you.</p> <p>7 Can I now ask you to look at paragraph 4.41 of your</p> <p>8 report.</p> <p>9 CHAIRMAN: Mr Chow, could I just ask -- I appreciate these</p> <p>10 discussions are not the easiest -- how are you</p> <p>11 progressing, because I have to keep an eye on time?</p> <p>12 MR CHOW: At the moment, I anticipate perhaps I will need at</p> <p>13 least an hour to finish all the questions.</p> <p>14 CHAIRMAN: That will take us to 6.00.</p> <p>15 Is there anybody else? Mr Boulding, do you intend</p> <p>16 to ask any questions?</p> <p>17 MR BOULDING: I have a few questions, sir. 20 or</p> <p>18 30 minutes.</p> <p>19 CHAIRMAN: Okay.</p> <p>20 MR PENNICOTT: Sir, depending on the rest of the questions,</p> <p>21 I only have one little area I want to cover, a few</p> <p>22 questions, no more than five minutes, I hope.</p> <p>23 CHAIRMAN: Mr Shieh?</p> <p>24 MR SHIEH: I have one question to ask him, one topic in</p> <p>25 re-examination.</p>

Page 85	Page 87
<p>1 CHAIRMAN: So we're looking at about an hour and a half. 2 6.30. Is that okay for everybody? 3 (Nodding of heads) 4 Good. 5 Will that be all right for you, Dr Wells, 6.30, or 6 whatever the time is there? Another hour and a half? 7 WITNESS: That's fine. Thank you. Yes. 8 CHAIRMAN: 11.30. That should be fine. 9 Good. Thank you very much, Mr Chow. 10 MR CHOW: Thank you. 11 COURT REPORTER: May I be so bold as to ask for 12 a five-minute break if we are going an extra hour and 13 a half? 14 CHAIRMAN: My apologies. We have worked together on lots of 15 occasions and I hope you know I really am aware of the 16 hard work you do and we certainly will have a break. 17 Would you like to indicate when you feel it's best? 18 COURT REPORTER: Whenever it's appropriate. 19 CHAIRMAN: Yes. 20 MR CHOW: Sir, perhaps it's a convenient moment now, because 21 I'm going to move on to a different area. 22 CHAIRMAN: We thought maybe give it another half-hour so 23 that ... 24 MR CHOW: Sorry, Dr Wells, just now I said paragraph 4.41. 25 In fact it should be 4.42 and table 4.</p>	<p>1 bootstrap method, so he used the bootstrap method which 2 is a way of estimating the variance for small samples. 3 So all he's done is re-estimated the variance. He 4 hasn't taken account of the variation across the two 5 sides of the wall, which is what I was trying to do. 6 This is the difficult bit. This is the bit which 7 the maths in everything I have seen so far presented is 8 different and everybody uses different names either for 9 the same thing or for different things, and obviously 10 it's difficult because nobody seemed to be able to agree 11 on how it was done. It's also the bit where I say it's 12 fundamentally flawed because you can't use the Delta 13 method on a sample size as small as seven. 14 So the idea of trying to say that a rebar, 15 a strengthener, is only effective if it is coupled at 16 both ends, that's the bit which is difficult to do, and 17 I've said why not then use the Monte Carlo method to try 18 to establish whether it is connected at both ends, give 19 them the data you've got on whether the probability -- 20 sorry, the probability of whether it is connected one 21 side and the probability of whether it's connected the 22 other side -- instead of trying to derive it using 23 theoretical statistics, because as we have demonstrated 24 the theoretical statistics is wrong, why not instead try 25 to derive it using a non-theoretical or practical</p>
Page 86	Page 88
<p>1 In table 4, as I understand it, you recalculate the 2 95 per cent confidence upper bound by the Monte Carlo 3 method and you arrive at a value of 0.467, which is 4 about 30 per cent lower than the 68.3 per cent defective 5 rate determined in the holistic report. Is that right? 6 A. Yes. 7 Q. As you may be aware by looking at Prof Yin's responses 8 yesterday, Prof Yin has also recalculated, with the use 9 of Monte Carlo method, and in particular the bootstrap 10 resampling method, which we say is the most commonly use 11 for variance estimation, and he reproduced a table 12 similar to your table 4. 13 However, he found that the result from the Monte 14 Carlo method that he himself performed actually arrived 15 at a very similar figure as determined in the holistic 16 report, which is 0.683 as compared with 0.688. So very 17 close. 18 With two different methods, he arrives at 19 a defective rate which is very close. 20 Obviously, it is far away from your figure of 0.467. 21 Would you be able to explain why? 22 A. I think so. Don't forget I've only had a little time to 23 read Prof Yin's report, but my understanding is that 24 what he did is completely different. He seems to have 25 interpreted the Monte Carlo method as meaning the</p>	<p>1 statistical approach, a Monte Carlo approach? 2 I did it just for illustration. I'm not suggesting 3 that that number should be used in order to construct 4 a building or design suitable measures or anything else. 5 I'm saying, in my opinion, doing it this way bypasses 6 all the theoretical traps and slip-ups that people fell 7 into when they tried to do it theoretically. 8 So, rather than say, "I think I'm a better 9 statistician, I'll be able to do it whereas they 10 couldn't", I said, "Look, let's just bypass the whole 11 thing and use a different approach, Monte Carlo." That 12 is not what Prof Yin did, so obviously I would not 13 expect him to come up with the same answer as me. 14 Q. Okay. I'm trying to simplify the matter. So what you 15 are saying is you know how Prof Yin did by his bootstrap 16 method, and what he did is different from the 17 Monte Carlo method that you have adopted; is that right? 18 A. It's not just different. It's asking a different 19 question. It's a method which is used for a completely 20 different purpose. What he's done is taken one small 21 step of this process and said, "Let's use the bootstrap 22 method in that part of the process." What I've done is 23 said the whole process is really rather difficult; let's 24 do it a different way. 25 Q. Perhaps let me ask this. Having looked at what Prof Yin</p>

Page 89	Page 91
<p>1 did, do you find any part of his calculation which is 2 wrong? 3 A. Sorry, when I look at Prof Yin did -- is this in the 4 totality of everything he has done in the holistic 5 report, the verification report, answers and everything, 6 or are you being more specific? 7 Q. I'm referring to the so-called Monte Carlo -- 8 A. Okay. 9 Q. -- but in particular the bootstrap resampling method. 10 A. Yes, that's fine. Sorry, no, he hasn't done anything 11 wrong. As far as I can tell from what he's presented 12 he's used the bootstrap method, and the bootstrap method 13 is a very respectable method. It's a good way of trying 14 to account for the inaccuracies in the variance in small 15 samples. 16 Q. Okay. So your view is that what he did is nothing 17 wrong, and nevertheless this may give rise to a figure 18 which is very different from your calculation. Can you 19 explain why? 20 A. Yes, because he is asked a completely different question 21 and tried to solve a completely different problem. 22 I wouldn't expect him to come up with the same answer. 23 If I add 1 and 1 and get 2; and you add 2 and 2 and get 24 4, neither of us is wrong; we have just done different 25 things.</p>	<p>1 mathematical statistics. 2 What we can do is put numbers on the level of our 3 uncertainty. So we quite frequently use the term 4 "uncertain". We try not to use the term "certain". We 5 might make mistakes but we try not to. 6 So, given that, we've now got two separate issues, 7 and in my introduction yesterday I showed a graph, 8 because I anticipated that it might be useful to refer 9 back to it. But we have two different concepts. One is 10 effectively an interval within which we expect most of 11 our results to lie. Now -- 12 COMMISSIONER HANSFORD: Sorry, Dr Wells, forgive me 13 interrupting again. Would it be useful if we put your 14 slide up and you can talk to that slide? 15 A. Yes, please. Thank you. 16 COMMISSIONER HANSFORD: So it's the slide which has got the 17 normal distribution and the Wilson distribution; is that 18 correct? 19 A. That's correct, yes. 20 COMMISSIONER HANSFORD: Thank you. That would be helpful. 21 Forgive me for interrupting. Please carry on where 22 you were. 23 A. Thank you. 24 So, as you asked yesterday, what do I mean by 25 Wilson -- well, the problem with the binomial is that it</p>
Page 90	Page 92
<p>1 Q. All right. 2 Thank you, Dr Wells. I would like to move on to the 3 next topic, about confidence level. This is a subject 4 that apparently is rather important too, because it may 5 affect the defective rate. So, in your report, you also 6 mention about perhaps acceptable to adopt a confidence 7 level of 90 per cent instead of 95 per cent. Do you 8 remember that? 9 A. Yes, I do. 10 Q. First of all, let me try to understand the concept of 11 confidence level. Am I right in thinking that 12 confidence level is used to describe certainty in the 13 result, and in layman terms, when you say there is 14 a 95 per cent confidence level, that means you are 15 95 per cent sure of the result? Is that the proper way 16 to understand the meaning of the term? 17 A. No, I'm afraid it isn't. There are two issues there. 18 One is you started off by saying, "Does it describe the 19 certainty?" I've tried to say many times statistics 20 doesn't deal in certainties. Statistics gives you 21 an idea of what is likely to happen. If I toss a coin, 22 I cannot be certain that it will come down heads. 23 I can't even be certain it will come down heads or 24 tails; it might land on its side. We don't have 25 certainties as soon as we enter the realm of</p>	<p>1 is simply discrete; it's difficult to draw a continuous 2 line, or you've got a discrete set of observations. 3 Wilson is simply a convenient way of drawing 4 a continuous binomial. 5 So given a population, a notional population in the 6 centre there, I've got underneath -- I thought it was 7 a red line but it looks reddish-blue from here -- 8 COMMISSIONER HANSFORD: It's red. 9 A. -- extending from the left side to the right side. 10 COMMISSIONER HANSFORD: Yes. 11 A. And what this graph is trying to show is that that is 12 an interval within which most of the observations that 13 we will make should lie. The most likely is the one in 14 the middle. Actually, the ones either side, if you add 15 them together, are probably more likely together than 16 the one in the middle is. 17 So we look at the whole thing and we say there's 18 tails at the left-hand end and the right-hand end, and 19 they are quite small tails; they're very low in terms of 20 the height of the curve and hence how often we expect 21 things to occur. 22 We can then set the interval where we like. There 23 is no theory to help us. So if, for instance, I was 24 designing an aircraft engine, I might want that interval 25 to be very, very large indeed. I do not want this to</p>

Page 93	Page 95
<p>1 fail. It would be catastrophic if it did. If I were</p> <p>2 measuring the strength of a rebar coupler, then</p> <p>3 obviously I don't want the building to fail but I know</p> <p>4 that if one rebar fails, it's got ones either side that</p> <p>5 can do the job.</p> <p>6 So the decision as to where to put that interval is</p> <p>7 an engineering one, combined with a public safety one.</p> <p>8 It is not a statistical one. A statistician doesn't</p> <p>9 really have much to add to that.</p> <p>10 Now let's look at the other graph, the Wilson one,</p> <p>11 the slightly more pointy one and, critically, the</p> <p>12 asymmetric one. This is very much a matter of</p> <p>13 statistics. This is -- we can say that once you've told</p> <p>14 me you want to be, let's say, 90 per cent confident,</p> <p>15 I can now start doing some analysis on how much data do</p> <p>16 you need to collect in order to make that confidence</p> <p>17 level sufficiently reliable?</p> <p>18 So again it can't be certain. Again it's just</p> <p>19 a confidence. But this is much more statistical as</p> <p>20 opposed to engineering.</p> <p>21 So we've got these two different concepts. Now,</p> <p>22 what we've been looking at in the holistic report, when</p> <p>23 we talk about 95 per cent confidence, is generally, as</p> <p>24 I understand it, the reddish-blue line, that we're</p> <p>25 saying that we want most of our couplers to be</p>	<p>1 explain. The two are different. They are the</p> <p>2 reddish-blue line and the green line on the diagram I've</p> <p>3 just drawn.</p> <p>4 Q. I see. So you are not advocating that under CS2,</p> <p>5 90 per cent confidence level would be sufficient?</p> <p>6 A. I am not advocating, I don't think. If I did in my</p> <p>7 expert submission report, then I can only apologise.</p> <p>8 I am trying to illustrate points, and the point I was</p> <p>9 illustrating here is that throughout the holistic</p> <p>10 report, 95 per cent has been used. When figures are</p> <p>11 mentioned in the standard, they are either 90 or 90 or</p> <p>12 95.</p> <p>13 Now, in the one case, whether it's the green line or</p> <p>14 the reddish-blue line, for one of them, regardless of</p> <p>15 which way around we interpret those, one of them is</p> <p>16 always going to be 90, as far as the CS2 standards are</p> <p>17 concerned. The other one could be 90 or 95. So if we</p> <p>18 were to treat this as being a sort of heads and tails</p> <p>19 problem, then effectively we've now got three 90s and</p> <p>20 one 95. And to therefore assume 95 throughout the</p> <p>21 holistic report, without ever, as far as I could see --</p> <p>22 and I might have missed it -- without ever actually</p> <p>23 addressing the reason as to why 95 had been chosen,</p> <p>24 I felt was an omission; that the standards are using 90</p> <p>25 far more often than 95. I am not in a position to say</p>
Page 94	Page 96
<p>1 effective. We want a certain number of them not to be</p> <p>2 defective in order for the building not to fall down.</p> <p>3 So that is the engineering part of it. That's where the</p> <p>4 engineers say, "Well, it could be 85 per cent, it could</p> <p>5 be 90 per cent, it could be 95 per cent", and it all</p> <p>6 depends on how much redundancy there is in the</p> <p>7 structure, how many rebars you put in.</p> <p>8 This is where I have referred back to the ISO</p> <p>9 standard, where there are tables, table after table of</p> <p>10 suggestions for how much confidence you should apply</p> <p>11 given a sample size, and so on. And the Standing</p> <p>12 Committee have obviously come up with a figure of</p> <p>13 90 per cent, I think, and then 95 per cent or</p> <p>14 90 per cent -- they are not sure; no, that's not fair.</p> <p>15 There are options depending on where you are in the</p> <p>16 standard for 90 or 95 per cent in the green line on the</p> <p>17 right.</p> <p>18 MR CHOW: On that point, Prof Yin points out that you</p> <p>19 have -- when you refer to CS2, that 90 per cent</p> <p>20 requirement, instead of 95, Prof Yin points out that you</p> <p>21 have misinterpreted the meaning of the term used in the</p> <p>22 CS2. His position is "confidence level" is not the same</p> <p>23 as "statistical tolerance interval" referred to in CS2.</p> <p>24 Do you have anything to say in response to that?</p> <p>25 A. I think what he said is what I have just tried to</p>	<p>1 which is right. I'm not an engineer. I'm a mere</p> <p>2 statistician. All we can do is tell people what the</p> <p>3 effects of their decisions are. The decision on 90 or</p> <p>4 95 is an engineering one, based on considerations of</p> <p>5 redundancy, safety factors and so on. I was merely</p> <p>6 commenting that I thought it was strange that 95 had</p> <p>7 been used throughout, without any apparent justification</p> <p>8 or reference to theory.</p> <p>9 In Prof Yin's response to my expert report,</p> <p>10 I noticed that he refers to 95 per cent as the gold</p> <p>11 standard and that's why he's chosen 95 rather than 90,</p> <p>12 because 95 is the gold standard. Well, I would argue</p> <p>13 that 99 is more like a gold standard, or 99.9 or 99.999</p> <p>14 is a gold standard. I think simply saying, "This is the</p> <p>15 gold standard and that's why we've used it" is perhaps</p> <p>16 missing the point of how we choose confidence levels and</p> <p>17 confidence intervals.</p> <p>18 Q. Dr Wells, I believe that Prof Yin says more than that.</p> <p>19 He is not suggesting 95 per cent is his golden ratio.</p> <p>20 He is actually saying in conducting statistical</p> <p>21 analysis, the general practice is to adopt a confidence</p> <p>22 level of 95. Do you agree or --</p> <p>23 A. No.</p> <p>24 Q. Okay.</p> <p>25 A. I thought I'd tried to explain this. There is no such</p>

Page 97	<p>1 thing as generality in this. If I'm designing</p> <p>2 an aircraft engine, then 95 per cent is nowhere near</p> <p>3 good enough, and so to say, "We've designed these</p> <p>4 aircraft engines, they're 95 per cent reliable, that's</p> <p>5 because 95 is the gold standard and it's generally</p> <p>6 accepted". Now, 95 per cent means 5 per cent of the</p> <p>7 time it's not going to work, so that means one in 20</p> <p>8 trips from Hong Kong to London, we are going to expect</p> <p>9 an engine to fail.</p> <p>10 If this was a two-engine plane and one engine was</p> <p>11 failing once in every 20 trips, I think I would take the</p> <p>12 train, personally.</p> <p>13 So I don't feel there is any concept to the</p> <p>14 statement, "It's generally accepted in statistics that</p> <p>15 we use 95 per cent." That just, to me, is a meaningless</p> <p>16 statement.</p> <p>17 Q. But actually Prof Yin refers to a specific guidance,</p> <p>18 guidelines, the US FDA guidance on "Multiple Endpoints</p> <p>19 in Clinical Trials guidance for Industry". He provides</p> <p>20 the reference under paragraph 33 of his responses.</p> <p>21 Are you aware of that guidance, guidance document?</p> <p>22 A. No, I'm not. Probably the reason I'm not aware is that</p> <p>23 I don't work in clinical trials. The reason that</p> <p>24 Prof Yin probably is aware is that he does work in</p> <p>25 clinical trials. And it may well be that when doing</p>	Page 99	<p>1 rates of couplers in the structure with a confidence</p> <p>2 level of 95 per cent, and the details are set out in</p> <p>3 Prof Yin's report as well as, I believe, in the holistic</p> <p>4 report as well.</p> <p>5 In your report, I am not aware that you have ever</p> <p>6 said that this is not the position. Am I right?</p> <p>7 A. If I've not said it, then probably I don't believe it.</p> <p>8 Why? Am I being questioned on things I've not said?</p> <p>9 Q. I thought you agreed that with 84 sets of samples, one</p> <p>10 would have enough number of samples to do an evaluation</p> <p>11 of the condition of the coupler connections in the</p> <p>12 structure with a confidence level of 95 per cent.</p> <p>13 I would have thought this is a very important part of</p> <p>14 the whole study and if you disagreed with that, you</p> <p>15 would have spotted that and put it in your report.</p> <p>16 A. My report was mostly trying to deal with how can you</p> <p>17 analyse the data you have already got. You can always</p> <p>18 go out and get more data and try to be more confident,</p> <p>19 but I had understood that we now have data and we are</p> <p>20 trying to analyse it, and my report concentrated on</p> <p>21 that.</p> <p>22 It is possible that there are some aspects of the</p> <p>23 statistics that I have not commented on, and it is</p> <p>24 possible that some of those aspects I agree with, and it</p> <p>25 is possible that some of them I disagree with. I'm</p>
Page 98	<p>1 drug trials, there is a generally accepted standard of</p> <p>2 95 per cent, but I would respectfully submit that this</p> <p>3 is not a drug trial.</p> <p>4 Q. Dr Wells, I would like to ask you a few more general</p> <p>5 questions.</p> <p>6 Perhaps, first of all, I would ask: do you accept</p> <p>7 that at the moment MTRC has taken 84 samples from the</p> <p>8 project in various locations, and that number of samples</p> <p>9 would enable an estimation of the defective rate in the</p> <p>10 population with a confidence level of 95 per cent? Do</p> <p>11 you accept that?</p> <p>12 A. Sorry, I need notice of the question. A sample size of</p> <p>13 84 will give 95 per cent confidence at a certain</p> <p>14 defective rate, I think. I don't think it covers every</p> <p>15 defective rate.</p> <p>16 Sorry, I would need to think a little bit more about</p> <p>17 it, but I don't think that it is a statement that makes</p> <p>18 sense on its own. I think that the 95 per cent</p> <p>19 confidence and the number of 84 is actually read off the</p> <p>20 graph that I was referring to earlier, at a specific</p> <p>21 variance point, hence the number of defectives, I think.</p> <p>22 Q. Dr Wells, the fundamental basis of the holistic proposal</p> <p>23 and the holistic report is that the parties are</p> <p>24 satisfied, so far, that by taking 84 samples, one would</p> <p>25 be able to make an assessment of the actual defective</p>	Page 100	<p>1 really not sure, to be honest. It's been a long --</p> <p>2 Q. All right. Conceptually, assuming that we have enough</p> <p>3 samples to provide us -- to estimate an actual failure</p> <p>4 rate with a confidence level of 95 per cent, there is no</p> <p>5 reason for us to go for a lower level of confidence</p> <p>6 rate, say 95 per cent; do you agree?</p> <p>7 A. I'm sorry, what do you mean by "there is no reason to go</p> <p>8 for"?</p> <p>9 Q. Well, if we have enough samples to enable us to do</p> <p>10 an estimate or projection of the actual defective rate</p> <p>11 with a confidence level of 95, with the same set of</p> <p>12 samples available for the analysis, one would not adopt</p> <p>13 a lower level of confidence in order to get a different</p> <p>14 projection of the defective rate?</p> <p>15 A. Okay. Thanks. I'm sorry. It took me a while to</p> <p>16 understand what you are saying. I do apologise.</p> <p>17 So you are referring to the green line, that the 95</p> <p>18 gives us that green-line confidence. What I'm</p> <p>19 suggesting is that the red line doesn't necessarily need</p> <p>20 to be 95. It could be 90. It could be 99. I'm not</p> <p>21 saying. I don't know. I keep saying I'm not competent</p> <p>22 to say. I'm merely saying that I find it surprising</p> <p>23 that there was no justification of this anywhere in the</p> <p>24 report.</p> <p>25 Let's not dispute the green line. Let's just take</p>

Page 101	Page 103
<p>1 that as accepted. That's 95 per cent, you've got enough</p> <p>2 data. Yes, we are happy that's 95 per cent.</p> <p>3 Sorry, I thought we were going back to the question</p> <p>4 of how did the 84 get derived. But regardless of how it</p> <p>5 was derived, the green line, 95 per cent, great.</p> <p>6 Now, how are we going to do that? How are we going</p> <p>7 to use that information we've already got? We've got</p> <p>8 some information. We need to calculate a strength</p> <p>9 reduction factor. That means we want to be able to say</p> <p>10 that we expect all of the not sampled, not measured</p> <p>11 couplers, the ones which weren't opened up, the ones</p> <p>12 that are still in there and still supporting the</p> <p>13 structure, what can we say about those based on this</p> <p>14 sample that we've already got?</p> <p>15 Now, do we want to be 90 per cent confident in that,</p> <p>16 do we want to be 95, do we want to be 99, do we want to</p> <p>17 be 99.9? I feel that this is a legitimate question that</p> <p>18 should have been asked quite early on, that the</p> <p>19 engineers would be the ones who would come up with the</p> <p>20 answer, and the fact that there was no consideration at</p> <p>21 all of that in their holistic report struck me as being</p> <p>22 an omission, really.</p> <p>23 And hence I decided to recalculate based on</p> <p>24 90 per cent instead of 95 per cent. I'm not suggesting</p> <p>25 that should be used. I was simply trying to illustrate</p>	<p>1 opinion is that I'm not, but my opinion is that you are.</p> <p>2 Q. Dr Wells, actually, I have moved on to another subject</p> <p>3 already. My question is on a theoretical level, about</p> <p>4 level of confidence and the result.</p> <p>5 My understanding -- correct me if I'm wrong -- is</p> <p>6 that on the basis of the same set of samples and the</p> <p>7 corresponding result, if one adopts a confidence level</p> <p>8 of 95 per cent, and correspondingly we have</p> <p>9 an estimation of the defective rate -- for example, X --</p> <p>10 with the same set of test results and the same number of</p> <p>11 samples, 84, if one adopts a lower level of confidence,</p> <p>12 say 90 per cent, the corresponding estimation of the</p> <p>13 defective rate would be lower than X. Would you agree</p> <p>14 with that as a general proposition?</p> <p>15 A. I'm probably going to have to ask you to repeat it,</p> <p>16 because it went a little bit over my head. But I think</p> <p>17 I might be able to cut through a lot of this and explain</p> <p>18 why your questions are not meaningful.</p> <p>19 If we were to look at, for instance, the value of</p> <p>20 0.366 in the holistic report for the strength reduction</p> <p>21 factor in the EWL slab, the value of 0.366, where does</p> <p>22 that come from? Any of those values would do; it</p> <p>23 doesn't really matter. There we go, EWL, 366. What</p> <p>24 does that number actually mean? That number is the</p> <p>25 expected value plus an allowance for the possibility</p>
Page 102	Page 104
<p>1 this point, that the omission of ever having justified</p> <p>2 the 95 was important. It's a different 95 to the one</p> <p>3 which is derived to give you the 84 sample size. That's</p> <p>4 a different thing. That's the green line. I'm now</p> <p>5 talking about the reddish-blue line.</p> <p>6 Q. I'm sorry, Dr Wells. I'm not sure I'm referring to the</p> <p>7 green or blue line, but I'm only thinking about</p> <p>8 the level of confidence. My understanding is that to be</p> <p>9 able to provide a reliable result with a confidence</p> <p>10 level of 95 per cent, one would need to have at least 84</p> <p>11 samples.</p> <p>12 Now, conceptually, given that we have already got 84</p> <p>13 samples available for the analysis, I would not go for</p> <p>14 a lower level of confidence in order to come up with</p> <p>15 a lower defective rate.</p> <p>16 Have I made any mistakes in that statement?</p> <p>17 A. Well, what you've effectively said is, "Looking at my</p> <p>18 diagram, based on the length of the green line, I want</p> <p>19 the red line to be a particular length." Okay? This is</p> <p>20 a bit like saying, "Based on the fact that it rained</p> <p>21 yesterday, I'm now going to have apples for my lunch."</p> <p>22 We're talking about different things. If I can</p> <p>23 refer you back to what you just quoted to me from</p> <p>24 Prof Yin's response. He said that I was, in his</p> <p>25 opinion, apparently confusing these two. Well, my</p>	<p>1 that the expected number might be wrong.</p> <p>2 For instance, if I were to toss a coin 100 times,</p> <p>3 I would expect to get 50 heads and 50 tails. In</p> <p>4 practice, the chances of actually getting 50/50 are</p> <p>5 quite small. I'm quite likely to get 49/51 or 51/49 or</p> <p>6 48/52. There is an amount of variance in it, and we can</p> <p>7 calculate that variance, and we can say 50 per cent of</p> <p>8 the time I would expect to get between, let's say, 45</p> <p>9 and 55 heads and hence 55 and 45 tails. I can put</p> <p>10 a confidence level on the number of heads and number of</p> <p>11 tails I would expect to get.</p> <p>12 That value there, 0.366, is the expected value plus</p> <p>13 a margin for the probable variation. How big should</p> <p>14 that margin be? That margin was chosen to be</p> <p>15 95 per cent. 95 per cent of what? Well, that's</p> <p>16 a statistical matter. Let's gloss over that just for</p> <p>17 a minute --</p> <p>18 Q. Sorry, Dr Wells. Sorry to interrupt you. Perhaps it is</p> <p>19 easier for me to illustrate a point by referring to your</p> <p>20 own report. Your own report, in paragraph 4.34, under</p> <p>21 table 2a -- do you see that? Now, the second column</p> <p>22 from the left, you set out the strength reduction factor</p> <p>23 adopted for the holistic report: 0.366, 0.332, and the</p> <p>24 combined value, 0.350. Do you see that?</p> <p>25 A. Yes.</p>

Page 105	Page 107
<p>1 Q. Now please turn to page 13 of the same report, under 2 paragraph 4.49, where you recalculate, on the basis of 3 the same set of data, but adopting a 95 per cent 4 confidence level. Do you see that? 5 A. Yes. 6 Q. By doing so, you set out, under table 5, the second 7 column, the corresponding figures which reflect the 8 defective rate. 9 Now, the original 0.366 in table 2a for EWL slab 10 becomes 0.338 under table 5, so there's a reduction; 11 right? 12 A. Yes. 13 Q. A lowering of the defective rate -- 14 A. Yes. 15 Q. -- because of the change of the confidence level. 16 Now, for NSL slab, the original 0.332 is now reduced 17 to 0.305; do you see that? 18 A. Yes. 19 Q. So, actually, the question I have just asked is hoping 20 to get you to confirm that by adjusting or lowering the 21 level of confidence, generally you would expect to come 22 up with a result -- with a reduced defective rate. Can 23 you confirm that? 24 A. Yes. 25 Q. Thank you.</p>	<p>1 Now, how are we going to use them? That number, 2 0.366, is a mean plus a number of standard deviations, 3 plus a measure of the amount of uncertainty that we are 4 prepared to allow in our estimation of what all the 5 other untested couplers are contributing to the 6 structure. So that 0.366 is mean plus 1.645 times the 7 standard deviation. 8 Where does that number of 1.645 come from? It has 9 absolutely nothing to do with the 95 per cent, 84 sample 10 size, the shoe size of the person who did the drilling 11 out, whether it was raining on the day or anything else. 12 That is derived from a decision by the engineers as to 13 how much confidence they want to have in the structure, 14 how much redundancy is there. If one of those rebars 15 were to fail, does it matter? On an aircraft, if one of 16 the engines fails, it matters a lot more than if one of 17 the rebars fails in a structure. 18 So those numbers there are derived completely 19 independently from the 95 per cent which is the 20 confidence in our sample size. It is now, as Prof Yin 21 has explained to you, a completely different usage of 22 the word "confidence", and I'm saying that that usage of 23 the word is not addressed anywhere in the holistic 24 report. And the fact that it's not addressed anywhere 25 is, in my view, an opinion, and therefore I was</p>
Page 106	Page 108
<p>1 A. And I'm trying to explain to you that you have used the 2 word "confidence" in two completely different ways, and 3 so there is no relationship at all between the numbers 4 that we are looking at on that screen at the moment and 5 the figure of 95 per cent which is used to derive the 6 size of 84. They are completely different things. 7 You have basically asked me will I please confirm 8 that today is Thursday, and you have then said, "Right, 9 well, based on having confirmed that today is Thursday, 10 you are saying, it will rain on Sunday." These are 11 different things. 12 As Prof Yin has explained in what you read out to 13 the Commission, there are two different meanings of 14 "confidence", and you are asking me to say that based on 15 one meaning of "confidence", do I agree with that? "Now 16 does this apply to this other situation?" No, of course 17 it doesn't. It's a completely different meaning of 18 "confidence". 19 Before you interrupted, I was trying to explain 20 where those numbers of 366, 332 and 338 and so on come 21 from, and they have absolutely no relationship at all to 22 the 84 sample size, 95 per cent confidence in the sample 23 size. That is irrelevant. Once that's been done, once 24 that analysis has been done, we've collected that data, 25 we now have the numbers.</p>	<p>1 calculating table 5 to illustrate what might have 2 happened had that actually been taken account of in the 3 holistic report and a decision come to use the value 4 which is perhaps preferred by the Standing Committee. 5 Q. Thank you, Dr Wells. I really want -- 6 CHAIRMAN: We will have a five or six-minute break now. 7 Thank you very much. 8 (5.44 pm) 9 (A short adjournment) 10 (5.56 pm) 11 CHAIRMAN: Yes. 12 MR CHOW: Thank you. 13 Dr Wells, I would move on to my last topic that 14 I intended to explore with you. That is in relation to 15 one of the ISO documents that you refer to. The related 16 part is actually your second report, when you talk about 17 the overarching spirit or principle under various 18 international standards. 19 Can I refer you to paragraph 3.4 of your second 20 report, please. In paragraph 3.4, you said: 21 "This is stating that the long-term goal of CS2 ... 22 is to reach the situation extant in most other 23 countries, where the national standards do not require 24 purchasers' testing provided manufacturers' testing is 25 deemed adequate. This is in line with the ISO</p>

Page 109	Page 111
<p>1 overarching standard ISO 3951-2:2013, which states that</p> <p>2 standards should allow for a reduction in</p> <p>3 testing/inspections in order '... to reduce inspection</p> <p>4 costs (by means of a switch to a smaller sample size)</p> <p>5 should consistently good quality be achieved'."</p> <p>6 Then you go on to say because of what is stated in</p> <p>7 this ISO, it actually means or "advocates a flexible</p> <p>8 approach for quality assurance when applying standards,</p> <p>9 rather than dogmatic adherence to rules".</p> <p>10 Do you remember that?</p> <p>11 A. Yes, indeed.</p> <p>12 Q. My reading of your whole report, your second report, is</p> <p>13 that you first of all refer to the international</p> <p>14 standard for quality assurance, and from that you draw</p> <p>15 an overarching spirit to the effect that if consistently</p> <p>16 positive test result is achieved, then further tests may</p> <p>17 not be required. Is that the whole idea of your</p> <p>18 approach?</p> <p>19 A. Depending on how you use the term "further", yes.</p> <p>20 Q. You refer to this specific ISO 3951-2. Can I assume</p> <p>21 that you are pretty familiar with that ISO?</p> <p>22 A. It's not my bedtime reading but I refer to it from time</p> <p>23 to time, yes.</p> <p>24 Q. Fair enough.</p> <p>25 Now, a few days ago, the government requested</p>	<p>1 the following:</p> <p>2 (a) automatic protection to the consumer (by means</p> <p>3 of a switch to tightened inspection or discontinuation</p> <p>4 of sampling inspection) should a deterioration in</p> <p>5 quality be detected;</p> <p>6 (b) an incentive (at the discretion of the</p> <p>7 responsible authority) to reduce inspection costs (by</p> <p>8 means of a switch to a smaller sample size) should</p> <p>9 consistently good quality be achieved."</p> <p>10 In fact this part (b) is the part you have referred</p> <p>11 to in your report.</p> <p>12 But the following paragraph says this:</p> <p>13 "In this part of ISO 3951, the acceptability of</p> <p>14 a lot is either implicitly or explicitly determined from</p> <p>15 an estimate of the percentage of non-conforming items in</p> <p>16 the process, based on a random sample of items from the</p> <p>17 lot."</p> <p>18 Then it is the following paragraph that I would like</p> <p>19 to highlight. It says:</p> <p>20 "This part of ISO 3951 is intended for application</p> <p>21 to a continuing series of lots of discrete products all</p> <p>22 supplied by one producer using one production process.</p> <p>23 If there are different producers or production</p> <p>24 processes, this part of ISO 3951 is applied to each one</p> <p>25 separately."</p>
Page 110	Page 112
<p>1 Leighton to provide copies of the various standards that</p> <p>2 you relied on, and we did receive some extracts of the</p> <p>3 relevant part.</p> <p>4 The one that I would like to discuss with you is</p> <p>5 this particular standard. We have managed to obtain</p> <p>6 certain other parts of this standard. Maybe first</p> <p>7 I will distribute copies of this standard, and for your</p> <p>8 benefit I will read out the relevant part of it.</p> <p>9 (Handed).</p> <p>10 Mr Chairman and Prof Hansford, what you have got is</p> <p>11 only two pages of the standard, this standard.</p> <p>12 Dr Wells, what I have shown to the Commission and</p> <p>13 the other parties in this room is only the introduction</p> <p>14 part and also the first page of part 2.</p> <p>15 Now, the introduction part of this ISO says:</p> <p>16 "This part of ISO 3951 specifies an acceptance</p> <p>17 sampling system of single sampling plans for inspection</p> <p>18 by variables."</p> <p>19 Then the second paragraph says:</p> <p>20 "The objectives of the methods laid down in this</p> <p>21 part of ISO 3951 are to ensure that lots of</p> <p>22 an acceptable quality have a high probability of</p> <p>23 acceptance and that the probability of not accepting</p> <p>24 inferior lots is as high as practicable. This is</p> <p>25 achieved by means of the switching rules, which provide</p>	<p>1 If I may then go to the first page of part 2. Now,</p> <p>2 part 2, the title is "General Specification for single</p> <p>3 sampling plan indexed by acceptance quality limit for</p> <p>4 lot-by-lot inspection of independent quality</p> <p>5 characteristics". Under paragraph 1, "Scope":</p> <p>6 "This part of ISO 3951 is primarily designed for use</p> <p>7 under the following conditions:</p> <p>8 (a) where the inspection procedure is to be applied</p> <p>9 to a continuing series of lots of discrete products all</p> <p>10 supplied by one producer using one production process.</p> <p>11 If there are different producers or production</p> <p>12 processes, this part of ISO 3951 shall be applied to</p> <p>13 each one separately".</p> <p>14 So the way I read, as a layman, the express term or</p> <p>15 the caution put down in this ISO is that even the</p> <p>16 so-called overarching spirit that you refer to only</p> <p>17 applies to product from one producer from the same</p> <p>18 process.</p> <p>19 We understand that the untested batches of rebar</p> <p>20 that are in question, they were not from the same</p> <p>21 supplier. They were not from the same country. So</p> <p>22 am I right, if one was to apply the overarching spirit</p> <p>23 stated in the ISO 3951, one cannot mix up all the</p> <p>24 previous test results from various different producers,</p> <p>25 different sources, and say that because the previous</p>

Page 113	<p>1 test results provide positive results we don't need to</p> <p>2 test certain batches of rebar which were delivered at</p> <p>3 a later stage?</p> <p>4 A. Sorry, was that the end of the question? "You cannot</p> <p>5 mix up" was the start of the question; yes?</p> <p>6 Q. Yes.</p> <p>7 A. I totally agree with that, yes. I'm in complete</p> <p>8 agreement.</p> <p>9 COMMISSIONER HANSFORD: Mr Chow, without taking up time now</p> <p>10 can you give us the references for where you say the</p> <p>11 material comes from different suppliers and indeed</p> <p>12 different countries --</p> <p>13 MR CHOW: Yes.</p> <p>14 COMMISSIONER HANSFORD: -- because that wasn't something</p> <p>15 I was completely aware of?</p> <p>16 MR CHOW: As far as I understand, that is already in the</p> <p>17 hearing bundles.</p> <p>18 COMMISSIONER HANSFORD: Is it?</p> <p>19 MR CHOW: I think Prof Yin also briefly mentioned it in his</p> <p>20 report too. I can certainly identify the bundle</p> <p>21 references for the benefit of the tribunal.</p> <p>22 COMMISSIONER HANSFORD: That would be useful. Thank you.</p> <p>23 MR CHOW: I will do that.</p> <p>24 A. So you did read out the relevant part of the ISO</p> <p>25 standard, and then your question to me was on part of</p>	Page 115	<p>1 CHAIRMAN: Thank you.</p> <p>2 MR CHOW: Mr Chairman and Prof Hansford, I have no more</p> <p>3 questions for Dr Wells.</p> <p>4 CHAIRMAN: Thank you.</p> <p>5 MR BOULDING: Good afternoon, Chairman. Can I ask my</p> <p>6 questions sitting down so that I can see the good doctor</p> <p>7 on the monitor?</p> <p>8 CHAIRMAN: Of course.</p> <p>9 MR BOULDING: Thank you very much.</p> <p>10 Cross-examination by MR BOULDING</p> <p>11 Q. Good morning, Dr Wells.</p> <p>12 A. Good morning.</p> <p>13 Q. My name is Philip Boulding and I'm representing the MTR</p> <p>14 in this particular matter. I've got one or two matters</p> <p>15 that I would like to discuss with you, if I may.</p> <p>16 I would like to start with the matter of clusters that</p> <p>17 you discussed briefly with my learned friend Mr Anthony</p> <p>18 Chow. Do you remember that?</p> <p>19 A. Yes.</p> <p>20 Q. If we could look, please, at your report, in particular</p> <p>21 paragraph 4.7. The report, I'm told, is ER1, tab 10.</p> <p>22 Thank you.</p> <p>23 You will there see your paragraph 4.7, and it's in</p> <p>24 the section which starts on page 3, under the heading</p> <p>25 "Analysis. Point 1. Sampling prior to testing</p>
Page 114	<p>1 what you read out. If I may read back to you what you</p> <p>2 read, the last part was "shall be applied to each one</p> <p>3 separately", and that is precisely what I did when I was</p> <p>4 doing my analysis. I applied it to each one separately.</p> <p>5 So yes, I totally agree with you that we should not</p> <p>6 mix them up, and that is why I did not mix them up,</p> <p>7 because I agree with you that you should not mix them</p> <p>8 up. I did exactly what the ISO standard states and</p> <p>9 I applied it to each one separately. Not just to each</p> <p>10 one separately but to each one specifically, so as to</p> <p>11 look at which suppliers from which countries had</p> <p>12 supplied the rebar which was not tested and only use</p> <p>13 those manufacturers' mill tests in order to inform</p> <p>14 a decision as to whether or not we had reached the</p> <p>15 accepted level.</p> <p>16 MR CHOW: Thank you, Dr Wells. I have no more questions for</p> <p>17 you.</p> <p>18 Sir, my colleague has identified the bundle</p> <p>19 references.</p> <p>20 COMMISSIONER HANSFORD: Yes.</p> <p>21 MR CHOW: Actually, it is referred to by Prof Yin at page 23</p> <p>22 of his second report, under footnote 4. The bundle</p> <p>23 reference is CC11/7252 to 7282, and also the document in</p> <p>24 item 332 in bundle CC11.</p> <p>25 COMMISSIONER HANSFORD: Thank you.</p>	Page 116	<p>1 couplers"; do you see that?</p> <p>2 A. Yes, I do.</p> <p>3 Q. In your paragraph 4.7, starting at the very end of</p> <p>4 page 4:</p> <p>5 "If, as is stated in section 3.3.27 of the holistic</p> <p>6 report, a major reason for defects is poor workmanship,</p> <p>7 then defectives will probably be in clusters, and</p> <p>8 therefore not independent."</p> <p>9 Do you see that?</p> <p>10 A. Yes.</p> <p>11 Q. Then you go on to say that so far as you are concerned:</p> <p>12 "This will lead to higher rates of defectives in the</p> <p>13 sample than in the population and hence any results</p> <p>14 (eg of strength reduction factors) will necessarily be</p> <p>15 more conservative than should be the case."</p> <p>16 A. Yes.</p> <p>17 Q. Now, it's right, is it not, that you have not been able</p> <p>18 to refer to any evidence which has been put before this</p> <p>19 Inquiry for the proposition that defectives -- that's</p> <p>20 your term -- will probably be in clusters; that's right,</p> <p>21 is it not?</p> <p>22 A. I think what I've said in 4.7 is:</p> <p>23 "If, as is stated in section 3.3.27 of the holistic</p> <p>24 report, a major reason for defects is ..."</p> <p>25 So I am not making any statement. I am saying, "If</p>

Page 117	Page 119
<p>1 that is true, then ..." So all I have to rely on is</p> <p>2 a statement in the holistic report. I'm saying that if</p> <p>3 that is true, as we discussed earlier today, this means</p> <p>4 we have localised areas of defects.</p> <p>5 Q. Right. So basically --</p> <p>6 A. Defects would likely occur in local areas. What I was</p> <p>7 then saying was that in a statistical sense, if things</p> <p>8 tend to occur in local areas, we call that clustering,</p> <p>9 and clustering leads to conditions under which the</p> <p>10 binomial assumption is incorrect.</p> <p>11 All my statements here are purely statistical</p> <p>12 statements. I'm not purporting to know anything at all</p> <p>13 about the structural engineering or the workmanship or</p> <p>14 any other issues. I'm merely making statistical points.</p> <p>15 Q. I'm glad about that. So it seems to me that the answer</p> <p>16 to my question is, "Mr Boulding, yes, I'm not aware of</p> <p>17 any factual evidence that's been put before the</p> <p>18 Commission to support this particular proposition";</p> <p>19 that's right, is it not, Dr Wells?</p> <p>20 A. I'm sorry, I thought 3.3.27 did -- didn't it?</p> <p>21 Q. No. 3.3.27 I think is the reference that you drew to</p> <p>22 Mr Chow's attention to local areas of rebar congestion.</p> <p>23 That's all it says, isn't it?</p> <p>24 A. Sorry, I must be misremembering. I thought that it said</p> <p>25 that poor workmanship was associated with local areas of</p>	<p>1 distributed. It's related to specific local areas.</p> <p>2 That's what we mean by "clustering". It means things</p> <p>3 cluster together in small local areas rather than being</p> <p>4 evenly distributed, evenly across the entire area.</p> <p>5 That's what "clustering" means.</p> <p>6 That paragraph is stating that workmanship is</p> <p>7 clustered. I didn't make any assumptions. I simply</p> <p>8 used what was in the holistic report.</p> <p>9 Q. Well, we've all got our own views as to what that means</p> <p>10 but thank you very much for clarifying that, Dr Wells.</p> <p>11 Could you look at Prof Yin's report, please. ER1,</p> <p>12 tab 12, page 16. I assume this is a report you have</p> <p>13 read. I think in fact you told the learned</p> <p>14 Commissioners earlier that you read this report, did you</p> <p>15 not?</p> <p>16 A. Sorry, I'm not looking at anything at the moment --</p> <p>17 am I? Oh, here.</p> <p>18 Q. Yes, you are.</p> <p>19 A. Yes, okay. Right, yes, I'm looking at it.</p> <p>20 Q. And do you see that he there refers to "Statistical</p> <p>21 analysis of the PAUT results obtained from the</p> <p>22 opening-up investigation"; do you see that? The</p> <p>23 heading.</p> <p>24 A. What paragraph am I reading?</p> <p>25 Q. I'm reading from the heading, Dr Wells.</p>
Page 118	Page 120
<p>1 rebar congestion. I was not commenting on the rebar</p> <p>2 congestion. I was commenting on the local areas of</p> <p>3 workmanship, poor workmanship.</p> <p>4 Q. So that's the only matter you relied upon, is it,</p> <p>5 Dr Wells?</p> <p>6 A. Again, I might have misremembered, I'm sorry, in which</p> <p>7 case I apologise, you are correct. But if we could have</p> <p>8 a look -- and again it's only my reading of it. Are we</p> <p>9 looking at ...</p> <p>10 Q. It's OU3256, if you want to have a look at that, and</p> <p>11 I think it's page 24, and it's that paragraph that you</p> <p>12 took Mr Chow to, 3.3.27:</p> <p>13 "The results of improper coupler connections</p> <p>14 including unconnected and/or cut rebar in both the EWL</p> <p>15 and NSL slabs are considered to be due to workmanship</p> <p>16 issues during installation, misaligned or damaged</p> <p>17 couplers and local areas of rebar congestion."</p> <p>18 A. Now, my reading of that is that workmanship is related</p> <p>19 to local areas of rebar congestion; yes?</p> <p>20 Q. But that's all you can rely upon, is it not, Dr Wells?</p> <p>21 A. It is indeed. That is all I need to rely on to say that</p> <p>22 that report is stating that workmanship is potentially</p> <p>23 related -- no, in fact, I don't think it even says</p> <p>24 "potentially" -- that workmanship is related to local</p> <p>25 areas; in other words, clustering. It's not evenly</p>	<p>1 A. The opening-up exercise -- so it's:</p> <p>2 "Statistical analysis of the PAUT results obtained</p> <p>3 from the opening-up investigation.</p> <p>4 Verification of defective rates.</p> <p>5 The opening up exercise took place from December</p> <p>6 2018 to April 2019. Throughout the period, I noted that</p> <p>7 the opening up and PAUT results were published and</p> <p>8 regularly updated on the Highways Department's website."</p> <p>9 Do I really need to read from the top?</p> <p>10 "After all the PAUT results became available, I was</p> <p>11 invited to verify the accuracy of the estimated</p> <p>12 defective rate calculated on the basis of the PAUT</p> <p>13 results provided by MTRCL."</p> <p>14 Q. That's all very interesting, Dr Wells, but I had in mind</p> <p>15 3.1.3 --</p> <p>16 A. Which is why I asked you which paragraph. Thank you.</p> <p>17 Q. -- and there Prof Yin tells us what happened and says:</p> <p>18 "The target sample size in each slab was at least 84</p> <p>19 as suggested. MTR provided 90 valid PAUT results for</p> <p>20 EWL slab of which 25 were found to be defective, and 93</p> <p>21 valid PAUT results for NSL slab of which 23 were found</p> <p>22 to be defective. I reviewed the opening up results, and</p> <p>23 found no strong statistical evidence of clustering in</p> <p>24 the sample."</p> <p>25 So far as Prof Yin expresses that view in the last</p>

Page 121	Page 123
<p>1 sentence, you are not, are you, in a position to</p> <p>2 disagree with it?</p> <p>3 A. When I wrote my report, I was not in a position to</p> <p>4 either agree or disagree because I am not a mind reader</p> <p>5 and I had not been able to read Prof Yin's mind where he</p> <p>6 knew in his mind but had never written down that he had</p> <p>7 undertaken a review of the opening-up results and found</p> <p>8 no strong statistical evidence of clustering in the</p> <p>9 sample.</p> <p>10 So, when I wrote my expert report, I was going on</p> <p>11 the information I had, which was the holistic report.</p> <p>12 The holistic report does not mention anywhere any</p> <p>13 statistical analysis of the evidence. Therefore,</p> <p>14 I thought it was a reasonable point on my part to raise</p> <p>15 it as a potential issue. I have never said that my</p> <p>16 report is either proving or disproving anything. I'm</p> <p>17 trying to raise issues which I think might have been</p> <p>18 missed.</p> <p>19 Now, if they weren't missed, they were simply hidden</p> <p>20 away in a drawer and nobody had told anybody about them,</p> <p>21 that's fine, at least now we know, but I didn't know</p> <p>22 that at the time I wrote my report.</p> <p>23 I would also say that I can neither agree nor</p> <p>24 disagree with the statement in 3.1.3 because it is</p> <p>25 meaningless. "I found no strong statistical</p>	<p>1 their own view as to what is "strong". It's</p> <p>2 a meaningless statement, therefore I cannot refute it.</p> <p>3 I have no basis to refute it. Nobody has any basis to</p> <p>4 refute it. It is a non-refutable statement because it</p> <p>5 is meaningless.</p> <p>6 Q. Let me ask you this: have you reviewed the PAUT results</p> <p>7 and found any statistical evidence of clustering?</p> <p>8 A. No.</p> <p>9 Q. Thank you.</p> <p>10 Now, in your report at paragraph 4.7, you say -- and</p> <p>11 I think we've been here once before -- that clustering</p> <p>12 "will lead to higher rates of defectives in the sample</p> <p>13 than in the population and hence any results will</p> <p>14 necessarily be more conservative than should be the</p> <p>15 case".</p> <p>16 Can I suggest this, Dr Wells, that that's not</p> <p>17 necessarily the case, is it? Because clustering may</p> <p>18 also lead to lower rates of defective; that's correct as</p> <p>19 a proposition, isn't it?</p> <p>20 A. It is correct as a proposition. It is not what I said.</p> <p>21 May I read it to you, please:</p> <p>22 "Another important question to ask is: Are the</p> <p>23 samples truly independent? The statistical technique</p> <p>24 used (ie binomial distribution) assumes independence.</p> <p>25 If, as is stated in section 3.3.27 of the holistic</p>
Page 122	Page 124
<p>1 evidence" -- what does he mean by "strong"? I have no</p> <p>2 idea. I don't know what Prof Yin means by "strong".</p> <p>3 It's probably different to something that you would mean</p> <p>4 by the word "strong", or if you took a straw poll</p> <p>5 through all the people in your room, you would probably</p> <p>6 get lots of different answers as to what is meant by</p> <p>7 "strong".</p> <p>8 So I have no basis, even now that I have read that,</p> <p>9 to either agree or disagree. But my main point is that</p> <p>10 at the time I wrote my expert report, all I had to go on</p> <p>11 was the material I had been given, which was the</p> <p>12 holistic report, and at that time I felt it was my duty</p> <p>13 to raise this point, that because clustering does</p> <p>14 invalidate the assumptions of the binomial assumption,</p> <p>15 then I thought that it was not at all unreasonable that</p> <p>16 some clustering analysis had been undertaken.</p> <p>17 Q. That's a very, very long speech, Dr Wells, if I may say</p> <p>18 so, to what I thought was a very simple question. I'll</p> <p>19 put it again. I've got to suggest that you have no</p> <p>20 reason to refute what Prof Yin says there, and of course</p> <p>21 he's coming along to give evidence on oath tomorrow.</p> <p>22 You have no reason to refute that, have you?</p> <p>23 A. I have no basis to refute it --</p> <p>24 Q. Thank you.</p> <p>25 A. -- because it is a meaningless statement. Everybody has</p>	<p>1 report, a major reason for defects is poor workmanship,</p> <p>2 then defectives will probably be in clusters, and</p> <p>3 therefore not independent."</p> <p>4 Right? So the last word in that sentence is</p> <p>5 "independent". So when it then says "This", it refers</p> <p>6 to the last word in the sentence, which is</p> <p>7 "independent", not independence will lead to higher</p> <p>8 rates of defectives, not clustering will;</p> <p>9 non-independence will.</p> <p>10 All I'm saying in this paragraph is that I think</p> <p>11 there should have been an analysis. Since the holistic</p> <p>12 report raised the point that there probably was</p> <p>13 clustering, in fact it didn't even say "probably"; the</p> <p>14 holistic report stated there is clustering, therefore,</p> <p>15 I thought it was incumbent on the statisticians to check</p> <p>16 for clustering.</p> <p>17 I have now been told, I stand corrected, that it was</p> <p>18 actually done. It's just that when I wrote this,</p> <p>19 I didn't know it had been done, so I thought it might be</p> <p>20 helpful to the Commission if I raised it as a possible</p> <p>21 point.</p> <p>22 Q. Well, I hear what you say, but I need to put to you that</p> <p>23 clustering may lead to lower rates of what you refer to</p> <p>24 as the defectives on the basis that random samples can</p> <p>25 be obtained from areas where there's no defect</p>

Page 125	Page 127
<p>1 clustering. That's right as a general proposition, 2 isn't it, Dr Wells? 3 A. As a general proposition, what you have just said is 4 correct. 5 Q. Thank you. 6 A. It is not related to my 4.7. You can probably make lots 7 of points which are correct but not related to things 8 I've stated in my report. 9 Q. Well, you are here to help the Commissioners, Dr Wells, 10 and part of our job is to ask you questions that we 11 think may well assist them. So if you just concentrate 12 on my questions, please, and answer them to the best of 13 your ability. Thank you. 14 Now, if we could move on, please, to page 6 of your 15 report. Here you helpfully deal with acceptance and 16 rejection; do you see that? 17 A. Yes, I do. 18 Q. Thank you. 19 Then various facts and matters are set out in 20 paragraphs 4.14 to 4.17, but I don't need to trouble you 21 with those, but I'd like to look, please, if I may, at 22 paragraph 4.18 of your report. You say: 23 "In light of these facts, it is my opinion that the 24 coupler connections referred to in appendix B3 should be 25 graded as 'not defective' if they satisfy the 'number of</p>	<p>1 Q. Thank you. 2 A. Sorry, you did say you were inviting my comment as well 3 as asking a question. Am I allowed to comment? 4 Q. I'm very happy with your answer that that's correct. 5 That suffices for my reason. 6 A. Sorry, you did specifically state you were inviting me 7 to comment. I apologise. I'm merely stating back to 8 you what you said. 9 Q. I was going to ask you to comment "did you agree" and 10 you said "yes". 11 A. That is a question, not a comment. 12 My comment is that the question doesn't make sense 13 out of context. I was working on the basis of the 14 information I was given in the holistic report. The 15 holistic report states where rebars were cut. What 16 I was referring to here was only those rebars which the 17 holistic report says were not cut. 18 So your question I agree with. If you don't know 19 whether or not it's cut, then yes, you can't judge by 20 threads alone. I was simply reading the report, using 21 the information that I was given, and saying, okay, 22 given that those ones have been excluded because they 23 have been cut, now, of the rest, would it not be 24 reasonable, as the Chairman suggested earlier today, to 25 say that if there's only one thread exposed, then</p>
Page 126	Page 128
<p>1 threads exposed' criterion. These facts also cast doubt 2 on whether the 'engagement length' criterion should 3 be ... at 37 millimetres." 4 Now, we know, do we not, that the purpose of the 5 holistic proposal and the holistic report was to verify 6 the as-constructed conditions and workmanship quality of 7 the Hung Hom Extension, in the light of, amongst other 8 things, an allegation that threaded steel bars were 9 being cut during the steel fixing works? You know that, 10 don't you, Dr Wells? 11 A. I do. 12 Q. Can I suggest that in the light of the complaint that 13 threaded bars were indeed being cut, can I suggest that 14 the number of exposed threads alone is not a suitable 15 criterion? 16 The reason I suggest that, Dr Wells, and I would 17 invite your comment on it, is that, for example, there 18 may just be one exposed thread, but if it's a cut bar 19 situation the engagement, which we know has got to be at 20 least 40 millimetres but there's a tolerance of 21 3 millimetres to allow for the testing equipment, so 22 that gives 37 millimetres -- if the bar was cut, one 23 wouldn't know whether that other requirement had been 24 achieved, would one? 25 A. That is correct.</p>	<p>1 probably the rest of the thread is inside, because it 2 wasn't cut, so where else did it go? 3 Q. I've got to suggest to you, Dr Wells, that the holistic 4 report, contrary to what you have just told the Chairman 5 and the Commissioner, does not in fact state where the 6 rebars were cut. And that's what I suggest to you. 7 A. Okay. I suggest to you that it does. 8 Q. No doubt Mr Shieh will draw that to your attention in 9 re-examination if you are correct. 10 A. Thank you. 11 Q. Now, moving on to 4.27 of your report. This is on 12 page 8. Here, you have a heading, "Analysis of appendix 13 B3: Adopting 28 millimetres engagement length". Do you 14 see that heading there, Dr Wells? 15 A. I do. 16 Q. Splendid. Then in paragraph 4.27 you tell us what 17 you've done. You say: 18 "I have conducted an analysis of the results in 19 appendix B3 by adopting an engagement length of 20 28 millimetres (rather than 37 millimetres). This 21 analysis is presented in table 1 below." 22 Then we see that table under paragraph 4.28. Just 23 to read you in, if I may: 24 "The expert evidence from the structural engineers 25 indicates that the threshold engagement length for</p>

Page 129	Page 131
<p>1 structural integrity should be no more than 2 28 millimetres. If this threshold is adopted instead of 3 37 millimetres, the defective rates of coupler 4 connections reduce significantly from those stated in 5 the holistic report." 6 Now, it's right, is it not, that you would accept 7 that the correct engagement length as an acceptance 8 criterion may be at different levels for different 9 purposes? That's something you would accept as 10 a proposition, would you not? 11 A. I would say that as a statistical expert, not 12 an engineer, I'm not competent to comment on that. 13 Q. That was going to be my next question, namely, that is 14 not a statistical question at all, is it? 15 A. It's interesting. If we look at the etymology of 16 "statistics", the word actually means the arithmetic 17 manipulation of numbers. To me, "statistics" means 18 presenting the information in an easily digestible form. 19 Now, that could be drawing pictures, it could be adding 20 them up and dividing by the number of them there are, it 21 could be something really complicated like doing 22 a hypothesis test. 23 Q. Yes. 24 A. What I have done here is I have added the numbers up in 25 a slightly different way because I thought it might be</p>	<p>1 report, and there you deal with the matter of applying 2 one criterion. Do you see that, about halfway down the 3 page? 4 A. Yes, I do. 5 Q. Thank you. And you say: 6 "I have conducted a separate analysis of the results 7 in appendix B3 by adopting either one of the two 8 criterion used in the holistic report, namely: (i) the 9 'engagement length' criterion (at least 37 millimetres); 10 or (ii) the 'number of threads exposed' criterion 11 (maximum of 2 full threads exposed)." 12 Then you helpfully tell us: 13 "This analysis is presented in table 2a below." 14 Looking at that table, which I think Mr Chow asked 15 a few questions about, the column almost on the far 16 left, we can read, can we not, that's entitled, 17 "Strength reduction factor adopted by the holistic 18 report"? Do you see that? 19 A. I do. 20 Q. And 0.366 is the figure for the EWL, and 0.332 is the 21 figure for the NSL; correct? 22 A. Correct. 23 Q. We know, do we not, that these figures do not result in 24 the need for any suitable measures? 25 A. Sorry --</p>
Page 130	Page 132
<p>1 useful. That is all. So I added the numbers up and 2 presented them as: if a 28 millimetre cut-off was used, 3 then this would be the result. I'm not saying it should 4 be 28 millimetres. I'm not saying it should be 5 37 millimetres. I'm not competent to say. But I am 6 competent to add numbers up and present them. 7 So I was trying to illustrate the amount of change 8 that could occur if a different engagement length was 9 chosen. It's an illustration. It is not intended to be 10 the basis for making decisions on suitable measures for 11 whether or not the structure is sound. I'm trying to 12 illustrate and thereby help people understand the 13 figures as they've been given. I felt that the simple 14 number of 0.366 did not completely capture all of the 15 information which was available in tables B3.1 and 3.2. 16 Q. We do appreciate your assistance, Dr Wells, and you will 17 know, having studied it, that the holistic report deals 18 not only with structural integrity but also the matter 19 of code and contractual compliance. That's something 20 you've read, is it not? 21 That was a question. 22 A. Sorry, I answered. I apologise if you didn't hear. 23 I said, "It is." 24 Q. Thank you very much. 25 Then if we could look, please, at page 9 of your</p>	<p>1 Q. That's something we know, isn't it? 2 A. Is it? Yes, I think you're right. I think that's in 3 the report. 4 Sorry, there are parts of the holistic report which 5 I paid slightly less attention to than others. So, for 6 instance, if it simply says, "This does not result in 7 suitable measures", that's engineering and I'm not 8 particularly -- not that I'm not interested but I felt 9 it was outside my remit. I was really trying to look at 10 the numbers and not simply try to pick numbers that do 11 result in suitable measures and then try to massage 12 them. I was simply trying to provide a helpful analysis 13 of the data. And with this data I did feel that there 14 were other potential ways to analyse it. 15 Q. Again, we're grateful for your assistance, but obviously 16 one can't look at a statistical analysis in a vacuum. 17 You've actually got to have some regard to the facts as 18 well, have you not, Dr Wells? 19 A. That is what I did, yes. That's correct. 20 Q. Good. And proceeding on the basis that the strength 21 reduction factor adopted by the holistic report, 0.366 22 and 0.332, do not require any suitable measures -- 23 I think I've lost him. He's obviously got fed up of me. 24 A. I can still hear you. 25 Q. I can see you again, Dr Wells. Thank you.</p>

Page 133	Page 135
<p>1 Dr Wells, can you still hear me?</p> <p>2 A. Yes, I can.</p> <p>3 Q. Splendid. Bearing in mind what we've just discussed, if</p> <p>4 we go to the next column in from the left, "Strength</p> <p>5 reduction factor based on 'engagement length cut-off</p> <p>6 37 millimetres' alone", and we can see for the EWL that</p> <p>7 the strength reduction factor is 0.354; correct?</p> <p>8 A. Correct.</p> <p>9 Q. And as a matter of fact, I would suggest that that is</p> <p>10 not a significant difference at all, is it, from the</p> <p>11 figure of 0.366?</p> <p>12 A. It's not particularly different, no, you are right, yes,</p> <p>13 I agree.</p> <p>14 Q. Then if one looks at the next figure, 0.331, and compare</p> <p>15 that to the figure in the column on the left, 0.332,</p> <p>16 again you'd agree with me that that is not a significant</p> <p>17 difference at all, is it? I think it's a second decimal</p> <p>18 point; correct?</p> <p>19 A. Yes.</p> <p>20 Q. It would follow from that, would it not -- I know you're</p> <p>21 not an engineer, but it would follow from that, would it</p> <p>22 not, that neither of those figures, 0.354, 0.331, would</p> <p>23 require suitable measures either?</p> <p>24 A. I presume so, yes.</p> <p>25 Q. Going on to your third column, "Strength reduction</p>	<p>1 Q. May I just enquire whether or not in London -- Dr Wells,</p> <p>2 you will have parts of the transcript of yesterday shown</p> <p>3 to you. It is page 73.</p> <p>4 CHAIRMAN: Gentlemen, I'm told that if we want the screen</p> <p>5 back with assuredness, we could take some time to</p> <p>6 reboot.</p> <p>7 MR PENNICOTT: Dr Wells can hear.</p> <p>8 MR SHIEH: Dr Wells can hear us.</p> <p>9 CHAIRMAN: And he can see at least the documents.</p> <p>10 MR SHIEH: Yes.</p> <p>11 Now, Dr Wells, it's been a long day for you or a</p> <p>12 long half-day for you. We've been told that if we want</p> <p>13 the image of you back on our side, we need to reboot,</p> <p>14 but I'm going to suggest, subject to the Commission's</p> <p>15 direction, that we proceed without having to reboot and</p> <p>16 bring up the image again.</p> <p>17 CHAIRMAN: Yes.</p> <p>18 MR SHIEH: Because otherwise it would take a lot of time and</p> <p>19 it's been a long day.</p> <p>20 So can I ask you to look at the transcript of</p> <p>21 yesterday, page 73.</p> <p>22 A. I see it.</p> <p>23 Q. Now, from line 15 onwards -- actually, can we move up to</p> <p>24 the top of that page -- sorry, middle, line 15 -- this</p> <p>25 is Mr Chow asking you:</p>
Page 134	Page 136
<p>1 factor based on 'number of exposed threads ...' alone",</p> <p>2 we've discussed that already so I don't think we need to</p> <p>3 say any more about that.</p> <p>4 Then my recollection is that you owned up to</p> <p>5 a mistake so far as the fourth column was concerned,</p> <p>6 "Strength reduction factor if both criteria are needed</p> <p>7 for a 'fail'?"</p> <p>8 A. I did indeed own up, I confess. I'm sorry.</p> <p>9 MR BOULDING: Thank you very, very much indeed, Dr Wells,</p> <p>10 particularly for coming in early so we can finish your</p> <p>11 evidence today. Thank you very much. No further</p> <p>12 questions.</p> <p>13 WITNESS: Thank you.</p> <p>14 MR PENNICOTT: I'm going to resist asking any more</p> <p>15 questions. I don't think I need to.</p> <p>16 CHAIRMAN: Are you sure?</p> <p>17 MR PENNICOTT: Yes, I am sure.</p> <p>18 CHAIRMAN: Mr Shieh?</p> <p>19 Re-examination by MR SHIEH</p> <p>20 MR SHIEH: Dr Wells, two areas to explore with you only in</p> <p>21 re-examination. First of all, can I ask you to look at</p> <p>22 the transcript of yesterday. I don't know whether you</p> <p>23 have the transcript bundle in front of you in London.</p> <p>24 Now we've lost you on our screen.</p> <p>25 A. Okay.</p>	<p>1 "... just now you said you don't have the number of</p> <p>2 couplers in the diaphragm wall panels. Now, when you</p> <p>3 talk about one population, 175 panels without capping</p> <p>4 beams and 62 panels with capping beams, the ratio you</p> <p>5 determined -- if you simply compare 175 with 62, you</p> <p>6 have 26 per cent, but if you compare the total number of</p> <p>7 couplers within this group of 175 panels, with the total</p> <p>8 number of couplers within another group of 62 panels</p> <p>9 with capping beams, you may not have the same</p> <p>10 percentage ... because the number of couplers in each</p> <p>11 panel are different. Do you agree?"</p> <p>12 And can we look at the next page. You said:</p> <p>13 "I can neither agree nor disagree. All I can do is</p> <p>14 tell you that if what you say is correct, then it</p> <p>15 completely pulls the rug out from underneath all of the</p> <p>16 mathematical analysis that followed on from this,</p> <p>17 because everything that followed on from this then</p> <p>18 assumes that you could multiply these numbers up by</p> <p>19 assuming a ratio of 175 to 62.</p> <p>20 So, if you can't assume the ratio of 175 to 62 is</p> <p>21 actually the ratio in population, then yes, you are</p> <p>22 right that my subsequent analysis in 4.4/4.5 might need</p> <p>23 to be revisited, but unfortunately everything in the</p> <p>24 holistic report then gets thrown out as well."</p> <p>25 Do you see that?</p>

Page 137	Page 139
<p>1 A. Yes.</p> <p>2 Q. So, to summarise, what is being suggested to you, maybe</p> <p>3 implicitly, is that you can't assume all the panels are</p> <p>4 similar in width or contain the same number of couplers.</p> <p>5 That's what your understanding is to be the thrust of</p> <p>6 the question. Is that a fair way of putting it?</p> <p>7 A. I think so, yes.</p> <p>8 Q. Now, can I show you something in Prof Yin's report as to</p> <p>9 the actual methodology used in picking specimens out of</p> <p>10 the panels. But before I do that, let me cut to the</p> <p>11 thrust of the matter. If I tell you that under the</p> <p>12 methodology adopted for picking specimens out of</p> <p>13 a population, however wide or however narrow a panel is,</p> <p>14 once that panel is picked then a fixed number of three</p> <p>15 couplers will be picked from that panel. It doesn't</p> <p>16 matter how wide it is, it doesn't matter how many</p> <p>17 couplers are in fact in that panel, but if a panel is</p> <p>18 picked randomly, then three couplers are going to be</p> <p>19 picked from that panel.</p> <p>20 Do you follow what I'm saying? If I tell you that</p> <p>21 this was in fact the methodology adopted --</p> <p>22 A. Yes.</p> <p>23 Q. -- would you still say that the entire calculation you</p> <p>24 have done would have the rug pulled from underneath?</p> <p>25 A. Well, the point you have just raised is that the</p>	<p>1 Let me put it again. The comment you made about</p> <p>2 randomness in your report assumes that there is a linear</p> <p>3 correlation between the number of panels, the proportion</p> <p>4 between the number of panels and the proportion between</p> <p>5 the specimens picked. Is that a fair way of putting it?</p> <p>6 So if the panels without capping beam and with capping</p> <p>7 beam bears a ratio of 3 to 1, for example, roughly</p> <p>8 speaking, then you would expect that the specimens drawn</p> <p>9 from the panels roughly or should be more likely to bear</p> <p>10 a similar proportion; is that a fair way of putting it,</p> <p>11 in a rather layman-like, crude way?</p> <p>12 A. Yes. If the sampling procedure is truly random, then</p> <p>13 the ratio 26 per cent and the ratio -- what was it,</p> <p>14 8 per cent, should be very close.</p> <p>15 Now, it is possible, just by chance, that you might</p> <p>16 get an odd result -- like I say, you can toss a coin ten</p> <p>17 times and get ten heads. It won't happen very often,</p> <p>18 and when it does probably the first thing you will do is</p> <p>19 say, "Is that coin weighted?"</p> <p>20 So I was really raising the point that if I had seen</p> <p>21 8 per cent where I was expecting 26 per cent, the first</p> <p>22 thing I would have done would have been to have gone</p> <p>23 back and done a statistical analysis of the results and</p> <p>24 tried to see what the probability is, and it might be</p> <p>25 that actually the difference between 8 and 26 is</p>
Page 138	Page 140
<p>1 two-pass sampling of 28 locations, then three from each</p> <p>2 sample, is faulty because the three should actually vary</p> <p>3 depending on how much of the population it is being</p> <p>4 asked to represent. So that if some panels are bigger</p> <p>5 than others and have more support within them, then</p> <p>6 those ones should have a disproportionate number of</p> <p>7 specimens taken from them.</p> <p>8 Now, I understand that Prof Yin took that into</p> <p>9 account in his 28 but didn't take it into account in his</p> <p>10 three. So, yes, I agree, you have picked up a point</p> <p>11 there that I didn't, so if you are looking for</p> <p>12 an alternative career then you might decide to become</p> <p>13 a statistician.</p> <p>14 Now --</p> <p>15 Q. Dr Wells, can I pause you here. That's not my point.</p> <p>16 Maybe it's really been a long day. Maybe I will just</p> <p>17 ask you to read -- because I'm not asking you to comment</p> <p>18 on the faultiness or otherwise of the design. I'm just</p> <p>19 testing an underlying premise of your acceptance of</p> <p>20 Mr Chow's question to you yesterday.</p> <p>21 Can I ask you to actually look at the report by</p> <p>22 Prof Yin, because in an attempt to take a short-cut to</p> <p>23 the matter I might have actually inadvertently prolonged</p> <p>24 it. Can I ask you to look at Prof Yin's report for the</p> <p>25 purpose of the holistic report, paragraph 2.2.2.</p>	<p>1 statistically not all that significant, but I worked out</p> <p>2 that it was significant, and the result -- doing that</p> <p>3 calculation takes so little time that actually I think</p> <p>4 Prof Yin probably spent longer on explaining why he</p> <p>5 didn't do it than it would have taken him to do it, and</p> <p>6 I just think that it's an omission not to; that simply</p> <p>7 saying, "My sampling technique must be right because</p> <p>8 I have devised it perfectly, therefore it has to be</p> <p>9 right", I don't think is sufficient. I think it is</p> <p>10 incumbent on us, as statisticians, to go back and make</p> <p>11 a check on the actual numbers.</p> <p>12 Q. But can I draw your attention back to what Mr Chow put</p> <p>13 to you yesterday. The scenario he put to you yesterday,</p> <p>14 encapsulated by the exchange that I read to you just now</p> <p>15 on the transcript was that, "Aha, hang on a second. Not</p> <p>16 all the panels contain the same number of couplers and</p> <p>17 therefore you can't necessarily infer or assume that the</p> <p>18 actual number of couplers with or without capping beams</p> <p>19 bear the same proportion to the number of panels with or</p> <p>20 without capping beams." That was your understanding of</p> <p>21 the point put to you by Mr Chow yesterday; is that</p> <p>22 a fair way of putting it?</p> <p>23 A. Yes, that's a fair way of putting it --</p> <p>24 Q. And you were saying that, ah, well, if the number of</p> <p>25 couplers potentially open to be picked from the bag</p>

Page 141	Page 143
<p>1 doesn't bear the same proportion to the number of</p> <p>2 panels, then you can't draw any conclusion out of the</p> <p>3 proportion of the specimens actually drawn? That's</p> <p>4 really what you are accepting; correct?</p> <p>5 A. That is true, yes. I think you have cut to the nub of</p> <p>6 it, yes.</p> <p>7 Q. But if I now tell you that in fact your original</p> <p>8 assumption was correct, that the number of couplers</p> <p>9 potentially open to be picked out of the bag does bear</p> <p>10 a proportion to the number of panels with or without</p> <p>11 capping beams, then your acceptance of Mr Chow's</p> <p>12 proposition falls away? That must be so, as a matter of</p> <p>13 logic; correct?</p> <p>14 A. Okay. Yes.</p> <p>15 Q. Now I'm going to show you how exactly the specimens were</p> <p>16 picked out of a bag. Can you look at Prof Yin's report</p> <p>17 at point 2.2.2. He said:</p> <p>18 "D-wall panels available for selecting sampling</p> <p>19 units at EWL and NSL slabs."</p> <p>20 Do you see that?</p> <p>21 A. Okay. Yes.</p> <p>22 Q. "The EWL slab is connected to East D-wall and West</p> <p>23 D-wall ... These D-wall ... connections can be divided</p> <p>24 into four groups ..."</p> <p>25 Then at 2.2.2, Prof Yin says:</p>	<p>1 locations of sampling units on plan, while phase 2</p> <p>2 sampling selection was to determine the layer of coupler</p> <p>3 connections to be exposed for workmanship verification</p> <p>4 at locations selected in phase 1."</p> <p>5 So 2.3.3 talks about phase 1, because -- so phase 2</p> <p>6 means which layer you pick, phase 1 means which location</p> <p>7 you pick. Having picked the location, you then decide</p> <p>8 which of several layers you pick. Do you follow that,</p> <p>9 Dr Wells?</p> <p>10 A. Yes. Thank you.</p> <p>11 Q. Now, 2.3.3 talks about "Phase 1 sampling selection":</p> <p>12 "As described ... the government and MTR ...</p> <p>13 identified 232 and 189 D-wall panel locations at EWL and</p> <p>14 NSL ... respectively, which are physically</p> <p>15 accessible ... Based on the prior decision made, 28</p> <p>16 sampling units, each yielding 3 coupler connections,</p> <p>17 would be selected from each of EWL slab and NSL slab.</p> <p>18 For EWL slab, the top connections available for</p> <p>19 sampling were significantly fewer ..."</p> <p>20 I think we can skip that. Let's go to 2.3.6:</p> <p>21 "In order to select D-wall panels on a random basis,</p> <p>22 a number with 5 decimal places was randomly generated</p> <p>23 from a uniform distribution ranging from 0 to 1 and</p> <p>24 assigned to each D-wall panel in the group. D-wall</p> <p>25 panels available for selection in each group were then</p>
Page 142	Page 144
<p>1 "Before conducting random selection of coupler</p> <p>2 connection samples for verification, the government and</p> <p>3 MTR, after going through the relevant construction</p> <p>4 records, reached general consensus on the identification</p> <p>5 of D-wall panels with or suspected to have coupler</p> <p>6 connections among the 4 groups of connections. The</p> <p>7 number of D-wall panels identified to have coupler</p> <p>8 connections are summarised below".</p> <p>9 Then there are four sectors, totalling 232. Then</p> <p>10 similar for NSL slab:</p> <p>11 "Similar to EWL slab, the NSL slab is connected to</p> <p>12 East D-wall and West D-wall ..."</p> <p>13 2.2.4:</p> <p>14 "The government and MTR had gone through the</p> <p>15 relevant construction records before the random</p> <p>16 selection [process] ..."</p> <p>17 And he talked about certain locations not being</p> <p>18 accessible, but let's skip that for present purposes.</p> <p>19 Let's then go to 2.3.3, "Phase 1 sampling</p> <p>20 selection". Now, to understand the meaning of phase 1</p> <p>21 and phase 2, can I ask you to look at 2.3.2:</p> <p>22 "A two-phase cluster sampling scheme was adopted in</p> <p>23 the selection of sampling units, each opening-up site</p> <p>24 (or sampling unit) yielding three coupler connections.</p> <p>25 Phase 1 sampling selection was to determine the</p>	<p>1 sorted in a descending order based on the assigned</p> <p>2 random number ... The D-wall panels listed after the</p> <p>3 required number of selected D-wall panels formed the</p> <p>4 'waiting list' and served as backup replacement</p> <p>5 locations in case difficulties were encountered during</p> <p>6 opening up of the coupler connections ... For instance,</p> <p>7 for EWL East D-wall top connection where 3 sampling</p> <p>8 units were to be selected, the top 3 D-wall panels</p> <p>9 sorted out of 27 panels according to the values of the</p> <p>10 randomly generated numbers would be chosen as the panels</p> <p>11 to be opened up, and the 4th D-wall panel in the sorted</p> <p>12 list would replace any one of the top 3 originally</p> <p>13 selected D-wall panels ..."</p> <p>14 Then 2.3.7:</p> <p>15 "While the lengths of panels range from 2.8 metres</p> <p>16 to 7.2 metres and that the size of the opening up area</p> <p>17 was about 400 millimetres width for yielding 3 coupler</p> <p>18 connections in the same layer, it was necessary to</p> <p>19 determine the exact location of the opening up area on</p> <p>20 plan at each of the D-wall panels selected as described</p> <p>21 above. To achieve this, another random number with 5</p> <p>22 decimal places valued from 0 to 1 was generated from</p> <p>23 a uniform distribution ..."</p> <p>24 Then if you look over the page at figure 1, you see</p> <p>25 illustration for determining the "reference point". So,</p>

Page 145	Page 147
<p>1 if there's a long D-wall, then if they need to pick</p> <p>2 a particular width within that D-wall to choose their</p> <p>3 three coupler connections, then this is the way they go</p> <p>4 about doing it.</p> <p>5 Then phase 2 talks about deciding which layer. But</p> <p>6 let's gloss through all that. The effect of all this --</p> <p>7 we can all read it -- seems to be that you pick a panel,</p> <p>8 and within that panel, if it's a wide one, then you pick</p> <p>9 a particular width within that panel, but however wide</p> <p>10 or however narrow, for each panel chosen, you only</p> <p>11 choose three coupler connections, irrespective of the</p> <p>12 different number of couplers between different panels.</p> <p>13 Do you see what I mean?</p> <p>14 A. Yes.</p> <p>15 Q. Right. Now, do not criticise this sampling technique.</p> <p>16 This was in fact what happened; all right? So does it</p> <p>17 or does it not appear to you that your original</p> <p>18 assumption or your original premise that you can expect</p> <p>19 a higher -- you should be able to expect a higher</p> <p>20 probability of correlation between the number of panels</p> <p>21 and the number of specimens chosen holds good?</p> <p>22 Is it too long a question?</p> <p>23 A. Sorry, does the question state or ask would we expect</p> <p>24 what we see to match the population we were led to</p> <p>25 believe of 175 to 63? Is that --</p>	<p>1 bias your sampling towards the ones which are most</p> <p>2 accessible, because you are not discarding randomly; you</p> <p>3 are discarding based on a criteria which is how</p> <p>4 accessible are they, so you will necessarily have seen</p> <p>5 a lot more specimens which are easily accessible in your</p> <p>6 sample.</p> <p>7 So what you've just been through has highlighted</p> <p>8 I think several additional points about the reasons why</p> <p>9 this might not actually be a correct sampling procedure.</p> <p>10 But I don't think anything in there would -- other than</p> <p>11 that I think it's not a good sampling procedure, I don't</p> <p>12 think there's anything that would necessarily tell us</p> <p>13 that we should be getting a different result so that the</p> <p>14 26 per cent and the 8 per cent should still be the same,</p> <p>15 and the fact that they are not is then asking us to go</p> <p>16 back and look at some of these other points, such as</p> <p>17 maybe if we had correctly applied the weighting then we</p> <p>18 would have got a more representative sample, and</p> <p>19 I really ought to be using the word "representative",</p> <p>20 not "random" here. We are asking, is it representative</p> <p>21 of the population, and quite clearly 8 per cent is not</p> <p>22 representative of a population with 26 per cent.</p> <p>23 As I said yesterday -- I was asked about oranges and</p> <p>24 apples -- if the greengrocer has 175 oranges and 63</p> <p>25 apples and you go in and pick them at random and you</p>
Page 146	Page 148
<p>1 Q. Yes.</p> <p>2 A. Okay. Right. There are a lot of considerations in</p> <p>3 there. This is a lot more detail than I've seen before,</p> <p>4 and I think you are raising points, as I said, if you</p> <p>5 want to have a second career -- you are raising points</p> <p>6 that I probably should have raised, although, as I say,</p> <p>7 I've only just seen all of this.</p> <p>8 To randomly select from panels of different sizes,</p> <p>9 we would first of all need to weight the randomness</p> <p>10 according to the size of the panel, or according to the</p> <p>11 engineering records which tell us how many specimens</p> <p>12 there are in a panel, because the specimens may not be</p> <p>13 evenly distributed through panels. So we would need to</p> <p>14 go back through that exercise and decide whether or not</p> <p>15 we need to weight them.</p> <p>16 I didn't see a mention of weighting as you went</p> <p>17 through this. Maybe it was done; maybe it wasn't.</p> <p>18 I don't know.</p> <p>19 The next point that I noted, as you were going</p> <p>20 through this, is that if -- makes the same mistake as</p> <p>21 I was pointing out yesterday -- no, earlier today --</p> <p>22 about discards, that with this phase 1/phase 2, when you</p> <p>23 get into phase 2, you try the first three on the list</p> <p>24 and if one of them is not accessible for some reason,</p> <p>25 then you try the fourth. That is obviously going to</p>	<p>1 come out with 83 oranges and only seven apples, then</p> <p>2 there is some evidence, not proof, that the greengrocer</p> <p>3 was stacking the oranges in a more easily accessible</p> <p>4 place because, for some reason, the oranges are perhaps</p> <p>5 about to go out of date and they need to get rid of them</p> <p>6 quickly.</p> <p>7 So once you see a significantly different proportion</p> <p>8 in your sample than you were expecting from the</p> <p>9 population, you go back to your sampling technique and</p> <p>10 ask, "Why might this be? It isn't what I expected."</p> <p>11 There may not be a reason for it, it might be purely</p> <p>12 random, but you at least go back and look. And here you</p> <p>13 have I think highlighted several places where you could</p> <p>14 usefully look. So, for instance, there's this phase 2</p> <p>15 part, that the three is clearly biased because it's</p> <p>16 discarding specimens that can't easily be reached.</p> <p>17 Phase 1 appears to be faulty because the panels are of</p> <p>18 different sizes and may or may not have different</p> <p>19 numbers of couplers in them, and I didn't see</p> <p>20 a weighting factor in there but you went through it</p> <p>21 quite quickly and I might have missed it.</p> <p>22 Q. Dr Wells, thank you. As I said, I wasn't asking you to</p> <p>23 criticise or comment on the soundness of the procedure.</p> <p>24 I was just asking you whether or not the point you made</p> <p>25 about the proportion would remain good, having seen the</p>

Page 149	Page 151
<p>1 way it's done.</p> <p>2 Can I just clarify with you what you meant by</p> <p>3 a certain sentence in the answer you had given. You</p> <p>4 probably don't have the transcript in front of you as to</p> <p>5 what you have just said. What you have just said is</p> <p>6 this:</p> <p>7 "... I don't think there's anything that would</p> <p>8 necessarily tell us that we should be getting a</p> <p>9 different result so that the 26 per cent and the 8 per</p> <p>10 cent should still be the same ..."</p> <p>11 I'm trying to understand what you mean by that. Are</p> <p>12 you suggesting that your point about the disparity</p> <p>13 between the 26 per cent in the population and the</p> <p>14 8 per cent in the specimen would still hold good? Is</p> <p>15 that the point you are trying to make?</p> <p>16 A. Sorry, yes, the disparity still holds good. I cannot</p> <p>17 see from that a reason why we should a priori expect</p> <p>18 a different proportion in the sample to the proportion</p> <p>19 in the population.</p> <p>20 So, having seen a difference, we should now go back</p> <p>21 and look. Now, the minutiae say, "Yes, here are some</p> <p>22 places I could look", and those were the ones I just</p> <p>23 mentioned, the phase 1 bias by discarding the not easily</p> <p>24 accessible and the phase 1 possibly needing some</p> <p>25 weighting factors in there. So these are possible</p>	<p>1 said the holistic report explicitly mentioned when they</p> <p>2 saw rebars had been cut?</p> <p>3 A. Yes, it is.</p> <p>4 Q. Can I then take you to appendix B3, the actual results.</p> <p>5 Let me see. I might have lost the reference. If</p> <p>6 you look at 3310, item 19, for example, you would see:</p> <p>7 "Exposed rebar is unconnected to the coupler and</p> <p>8 thread cut."</p> <p>9 Do you see that?</p> <p>10 A. Yes.</p> <p>11 Q. Then item 20, again, there's a reference to "thread</p> <p>12 cut"; do you see that?</p> <p>13 A. Yes.</p> <p>14 Q. Are these the examples which you had in your mind when</p> <p>15 you said, in your evidence just now, that the holistic</p> <p>16 report in fact mentioned the cutting of bars, if they</p> <p>17 saw it?</p> <p>18 A. Yes, it is. The two pieces of information together --</p> <p>19 one says there were five that were cut and then this</p> <p>20 table explicitly references which five they are -- led</p> <p>21 me to believe that the others were not cut, and that</p> <p>22 therefore the ones that were cut could not be relied</p> <p>23 upon to have a number of exposed threads which was in</p> <p>24 any way compatible with the amount of thread not</p> <p>25 visible. Whereas if it hasn't been cut, I thought it</p>
Page 150	Page 152
<p>1 places to look. But they are not a priori evidence of</p> <p>2 a difference. They are merely possibilities for why the</p> <p>3 difference, a difference, might have occurred.</p> <p>4 But from that I would still say they should -- the</p> <p>5 population and the sample should still match, and if</p> <p>6 they don't it rings an alarm bell, that's all.</p> <p>7 Q. Thank you.</p> <p>8 A. At the very least it's worthwhile spending five minutes</p> <p>9 on doing the calculation to see what that confidence is.</p> <p>10 Q. Thank you very much.</p> <p>11 I'm going to lastly pick up Mr Boulding's invitation</p> <p>12 to take you to the holistic report and see where it</p> <p>13 explicitly refers to cutting. First of all, can I ask</p> <p>14 you to look at the opening-up bundle at page -- let me</p> <p>15 see. Let's look at the text of the holistic report at</p> <p>16 paragraph 3.3.25, and that is to be found at page 3256.</p> <p>17 This is 3.3.25 of the holistic report. It says:</p> <p>18 "There are a total of 48 defective samples in the</p> <p>19 EWL and NSL slabs under the purpose (ii) opening-up,</p> <p>20 including eight cases where the main reinforcement bars</p> <p>21 were not connected to the couplers, and five cases where</p> <p>22 the rebar would appear to have been cut."</p> <p>23 Dr Wells, do you see that?</p> <p>24 A. Yes, I do.</p> <p>25 Q. Is that an occasion which you had in your mind when you</p>	<p>1 was quite reasonable to assume that the amount of</p> <p>2 exposed thread and the amount of unexposed thread are</p> <p>3 added to make the total amount of thread.</p> <p>4 MR SHIEH: Thank you very much, Dr Wells. I have no further</p> <p>5 questions for you, subject to anything arising which the</p> <p>6 Chairman and the Commissioner may want to ask you.</p> <p>7 COMMISSIONER HANSFORD: No. Nothing from me.</p> <p>8 CHAIRMAN: Anything at all, gentlemen?</p> <p>9 Dr Wells, thank you very much. We appreciate the</p> <p>10 fact that you came in so early and that you've stayed</p> <p>11 with us for an extended period of time. Thank you very</p> <p>12 much indeed. Your evidence is now concluded. Thank</p> <p>13 you.</p> <p>14 WITNESS: Thank you.</p> <p>15 (The witness was released)</p> <p>16 CHAIRMAN: Good. All right. We will, tomorrow morning,</p> <p>17 start at what time?</p> <p>18 MR PENNICOTT: 10 o'clock, sir.</p> <p>19 CHAIRMAN: 10 o'clock tomorrow morning. Thank you all very</p> <p>20 much.</p> <p>21 (7.11 pm)</p> <p>22 (The hearing adjourned until 10.00 am the following day)</p> <p>23</p> <p>24</p> <p>25</p>

	INDEX	PAGE
1		
2		
2		
3	DR BARRIE TREVOR WELLS (on former affirmation)	1
3		
4	Cross-examination by MR CHOW (continued)	3
4		
5	Cross-examination by MR BOULDING	115
5		
6	Re-examination by MR SHIEH	134
6		
7	(The witness was released)	152
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		