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1   Thursday, 26 September 2019
2   (1.35 pm)
3   DR BARRIE TREVOR WELLS (on former affirmation)
4   MR SHIEH: Mr Chairman and Mr Commissioner, before we
5   proceed further with Dr Wells' cross-examination, I have
6   one request to make.
7   Overnight, I think this morning, the Department of
8   Justice responded to a request for information made by
9   Messrs Lo & Lo concerning the sampling process,
10   specifically relating to panels in area A, because the
11   Commission may remember, in the course of examination of
12   one of the MTR witnesses -- I think it's Mr Yeung -- he
13   mentioned the fact that because of some boundary
14   conditions of some panels in area A, this fact was
15   communicated to those responsible for the sampling
16   process, and Lo & Lo requested the government to explain
17   whether this boundary condition, or lack of
18   accessibility to certain panels in area A, had been
19   taken into account in the sampling.
20   The government gave a response this morning which on
21   the face of it suggested that yes, because of boundary
22   or accessibility problems, some panels in area A were in
23   fact excluded from the sampling process.
24   Now, ordinarily, I would have wished to explore this
25   with my statistics expert, Dr Wells, before he went into

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1   the witness box, to see whether it has any statistical
2   implication. I'm not saying it has; it may or may not.
3   But I just wish to explore this new item of evidence
4   with him before we go on. I don't know whether any
5   question will be asked of him by the government. It may
6   or may not be. But I'm just saying that I should be
7   able to at least understand what my expert's view is on
8   that additional piece of information.
9   So perhaps my request is to ask for maybe five to
10   ten minutes to explore this fact alone with my expert.
11   CHAIRMAN: Yes, of course.
12   Yes, Mr Chow.
13   MR CHOW: Mr Chairman, we have no objection to that, save
14   and except that in my following questioning, at the
15   moment I don't plan to go back to this question about
16   the number of samples drawn from area A. But if my
17   learned friend Mr Shieh would like to nevertheless talk
18   to Dr Wells for five to ten minutes, I have no
19   particular objection to that.
20   CHAIRMAN: All right. Good.
21   Would you let us know, Mr Shieh, when you are ready?
22   MR SHIEH: Yes.
23   CHAIRMAN: Thank you. Court is adjourned.
24   (1.37 pm)
25   (A short adjournment)

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1   (2.07 pm)
2   MR SHIEH: I'm grateful for the indulgence. I've had
3   a chance of speaking to Dr Wells and we can continue,
4   Chairman.
5   CHAIRMAN: Thank you.
6   Cross-examination by MR CHOW (continued)
7   MR CHOW: Good morning, Dr Wells.
8   A. Good morning.
9   Q. So we now continue with our discussion from yesterday.
10   Dr Wells, yesterday just before we adjourned, we
11   were talking about the question of whether it is
12   necessary to look at the actual sampling process in
13   order to determine the question of randomness. Do you
14   remember that?
15   A. I do, yes.
16   Q. I think you agreed at one point that this is something
17   that we should look at, that is to say the actual
18   sampling process; right?
19   A. I think what I said -- I can't actually remember; you
20   presumably have transcripts -- but my meaning would have
21   been, from a statistical point of view, it is normal
22   practice, having undertaken a random sampling exercise,
23   to look at the results and see whether they confirm or
24   possibly conflict with the assumptions that were made
25   originally. I can quite clearly remember saying

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1   yesterday that statistics never prove anything, so you
2   cannot prove whether what you've done is random or is
3   not random, but statistics does give you some very good
4   indicators, and in particular it can help guide future
5   decisions.
6   So, having undertaken a random sampling exercise, it
7   would be normal practice to undertake a very simple
8   check to see whether the data appear to be random.
9   Now, you made the point yesterday that it is
10   possible, sometimes, to get an extreme event, just at
11   random; highly unlikely, and if you do then it is more
12   likely that the sampling process was at fault. It
13   doesn't guarantee it, it doesn't prove it, but it makes
14   it more likely and makes it sensible to at least look
15   back over the steps and see whether or not a mistake had
16   been made.
17   Q. Let me see whether I really fully understand your
18   answer. Are you suggesting that even if one cannot
19   criticise the sampling process, if one looks at the
20   result, and the result suggests that it is unlikely to
21   come up, then it still suggests that the process of
22   sampling is defective or somehow makes it not random?
23   Is that your point?
24   A. No. My point is it cannot say it is not random. It can
25   make alarm bells ring, that the statistical tests for

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1   randomness, if they show, for instance, that somebody
2   just flipped a coin ten times, and every time you came
3   with heads upwards, then you cannot prove from
4   statistics that that is a biased coin. But it is
5   evidence which I think we would be foolish to ignore,
6   and one might ask an engineer to have a look at the coin
7   and determine whether or not somebody had applied
8   weights to it, to make it disproportionally comes up
9   heads.
10   So statistics doesn't prove anything. The engineers
11   prove things. But the statistics can be helpful to the
12   engineers in coming to their decisions.
13   Q. So are you saying that you don't need to -- well, how
14   Prof Yin performs his sampling exercise is not something
15   that you need to be concerned with in forming a view as
16   to whether the process was proper or not; right?
17   A. I think that if I was criticising the process, then the
18   parts of the process that I would criticise was that no
19   test was done; that it would seem to me to be remiss not
20   to just spend five minutes checking with pencil and
21   paper that the results are what we expected, having
22   spent so much time and effort having collected results.
23   So I'm not trying to say that I think the process
24   was itself faulty, except inasmuch as, at the end of it,
25   I would have thought that it would have been worthwhile

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1   spending just a few minutes doing the statistical test,
2   and I think the fact that no statistical test was done
3   is interesting.
4   Q. Dr Wells, now you have had a chance to look at Dr Yin's
5   report, in which there's a section in which he set out
6   in detail how he carried out the sampling process. Can
7   I assume that you have read that part of his original
8   report?
9   A. Yes, I have.
10   Q. Is there any step involved in his sampling process which
11   appears to you to be faulty?
12   A. First of all, can I just clarify -- you said have I read
13   the original report -- it wasn't described in detail in
14   the original report. It was described in detail in his
15   response to my expert report. Am I right?
16   Q. No. Perhaps I can identify the relevant paragraphs for
17   you, starting from paragraph 2.1 of his original report,
18   up to 2.3.15. That is from page 7 to page 13.
19   Do you have a copy of Prof Yin's report in front of
20   you?
21   A. I can see it on your screen.
22   Q. Okay. So do you need to take time to read it again?
23   A. You said 2.3.15. I'm not looking on the screen at
24   2.3.15.
25   Q. 2.3.15 is the last paragraph. Actually, where he

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1   started to describe his sampling process starts from
2   paragraph 2.1 at page 7.
3   A. Right.
4   Q. Have you read those paragraphs before?
5   A. Yes, I have.
6   Q. Can you still recall the details how Prof Yin carried
7   out the sampling exercise?
8   A. Yes. When you said "details", sorry, I must have been
9   getting confused, because in the document that I read
10   yesterday, that I received very late the previous night
11   and hadn't had a proper chance to look at, which was
12   discussed by yourselves yesterday as to whether or not
13   it should be admitted, that document, I think it's
14   called "Response to Wells' expert report" -- that has
15   considerably more detail, so when you referred to
16   details, I was assuming you meant those more details.
17   Sorry, I didn't realise you were referring to this.
18   Q. At the moment, I am referring to details of the sampling
19   process described by Prof Yin in his original report,
20   starting from paragraph 2.1 up to paragraph 2.3.15.
21   A. Okay.
22   Q. Have you read this before?
23   A. Yes. This is the one where he starts off by saying that
24   he's going to take 84 random samples, but actually
25   doesn't, he actually takes 28 random samples and then

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1   three random samples of each one of those 28, and
2   multiplies by 28 to get 84. They are not actually the
3   same thing, but I was glossing over that, sorry.
4   Q. All right. As I understand it, he provided details as
5   to the two phases of his sampling process. The first
6   phase is to select a location of the group of samples of
7   three, and then the second phase is to determine the
8   layers, at which layers that those samples are to be
9   taken.
10   So I go back to my original question. By looking at
11   the way Prof Yin did his sampling exercise, can you find
12   any part of it being faulty, if I may use the term that
13   you have just mentioned?
14   A. Well, other than what I just said, from a purely
15   statistical point of view, it's faulty in that he
16   assumes or states that he is taking 84 random samples
17   but then he proceeds to do something different. He
18   proceeds to take 28 random locations and three samples
19   at each of those locations. Statistically, they are
20   different things, and the justification he has used for
21   84 does not apply to the 28 times 3.
22   But it's a minor point of statistics that I wasn't
23   going to raise because I don't think it's really all
24   that important. It's just a little detail that is
25   technically incorrect.

A Court Reporting Transcript by Epiq

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1   But as for the rest, I do not feel that I am
2   competent to comment on the details because I am not
3   familiar with the layout of the structure, I don't know
4   how much effort would have to be put into identifying
5   which locations are truly representative, how different
6   the different locations are, whether there are
7   systematic variations within a location. There's a lot
8   of engineering involved in that, and I confess I do not
9   know enough to be able to comment.
10   My comment was that in a normal sampling exercise,
11 it would be routine to, at the end, undertake a very
12 simple statistical test. That is what was missing as
13 far as I was concerned. I was merely commenting on the
14 statistics, not the engineering.
15 Q. All right. I will then move on to another topic.
16   Can I refer you to paragraph 4.7 of your first -- of
17 your report in the Original Inquiry, about the clusters
18 point.
19   In paragraph 4.7, you said:
20   "Another important question to ask is: Are the
21 samples truly independent? The statistical technique
22 used ... assumes independence. If, as is stated in
23 section 3.3.27 of the holistic report, a major reason
24 for defects is poor workmanship, then defectives will
25 probably be in clusters, and therefore not independent."

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1   Now, my question is what is your basis for saying
2   this, that the defective couplers are in clusters?
3   A. The basis for my saying it was reading the holistic
4   report, section 3.3.27.
5   Q. Right. 3.3.27 can be found at bundle OU5, page 3256,
6   please.
7   Now, 3.3.27, all that it says in this paragraph is:
8   "The results of improper coupler connections
9   including unconnected and/or cut rebar in both the EWL
10 and NSL slabs are considered to be due to workmanship
11 issues during installation, misaligned or damaged
12 couplers and local areas of rebar congestion."
13   Now, it does not suggest that they are somehow
14 located in clusters -- are they?
15 A. Sorry, maybe we are reading different paragraphs.
16 "Local areas". Does "local areas" and "clusters" not
17 mean the same thing? Sorry, but don't they tend to
18 imply that to you?
19   If, for instance, you were told that throughout
20 Britain, trees tended to occur in local areas that we
21 happen to call woods or forests, then wouldn't that mean
22 that the trees were mostly in clusters, clustered
23 together in woods and forests? I thought that -- sorry,
24 maybe I've misread it. I read that to mean that the
25 mostly defective couplers are likely to be in local

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1   areas.
2   Q. I see.
3   A. Have I misread? Sorry if I have.
4   Q. Right. I want to know is the basis on which you make
5   that assumption.
6   A. The assumption -- because the report says that the
7   defective workmanship is mostly in local areas --
8   Q. All right.
9   A. -- so I assumed it's mostly localised in particular
10   areas. I'm having difficulty working out what it is you
11   are asking.
12 Q. All right. Thank you.
13   Can I ask you to look at -- well, perhaps I should
14   deal with it this way. Do you agree that in fact if the
15   defective couplers are in clusters, the sampling and
16   testing process performed would tend to underestimate
17   the actual defective rate, not overestimate the
18   defective rate as you suggest; do you agree?
19 A. No, I don't agree, and if you could possibly go back to
20   what I said about this -- are we now happy that what
21   I've said is correct or do I have to withdraw? Because
22   the report saying that they are mostly in local areas
23   doesn't imply that it's localised. Are you -- I'm
24   sorry, I'm not sure how far we've got on this.
25 Q. It's not --

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1   CHAIRMAN: Sorry to interrupt. The word "local" there,
2   Doctor, would it perhaps, on an ordinary reading, refer
3   simply to rebar congestion, or would it have a wider
4   reading?
5   A. If it refers specifically to rebar congestion and it is
6   (indicating the screen) -- sorry, there's a message on
7   the screen. Sorry, where were we?
8   So "The results of improper coupler connections
9   including unconnected and/or cut rebar", so basically
10   that's saying defectives. So defectives "are considered
11   to be due to", then there's a number of reasons which
12   might be influencing the occurrence of defectives. One
13   of those reasons is rebar congestion. Rebar congestion,
14   it's saying, is localised, local areas of rebar
15   congestion.
16   So, working backwards, we now have localisation of
17   rebars, so in other words little clusters of rebar
18   congestion are causing defectives.
19 CHAIRMAN: That's right, yes.
20 A. So that sentence is saying that defectives are in
21   clusters.
22 MR CHOW: Okay. Thank you, Dr Wells.
23 A. I need to check that, because otherwise, when we go back
24   to my report, I wasn't sure whether I had got it wrong,
25   but we are all happy that that paragraph does say that

3 (Pages 9 to 12)

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1   defectives are in clusters, yes.
2   COMMISSIONER HANSFORD: I think what it is saying is some of
3   it is in local areas.
4   A. Yes. So there can be clustering. Sorry, I didn't mean
5   to imply that it's all in clusters. Going back to my
6   example of the trees, for instance, I do have trees in
7   my garden but that's not a forest. So when I say
8   cluster, it doesn't mean that everything is in clumps.
9   It means there was a tendency for things to be not
10   distributed evenly throughout.
11   COMMISSIONER HANSFORD: I think that's what it says.
12   CHAIRMAN: Yes.
13   MR CHOW: Dr Wells, thank you. Your answer is fine.
14   Then can I ask a following-on question: have you
15   made any enquiry to confirm that the defective couplers
16   appear in clusters?
17   A. Can we go back to what I said? We put 3.3.27 up on the
18   screen because it was referencing what I said. Can
19   I remind myself of what I said?
20   So my 4.7 was a question. It is:
21   "Another important question to ask is: Are the
22   samples truly independent?"
23   I was merely trying to indicate areas which could be
24   addressed or could be investigated, in order to see
25   whether or not there were some assumptions which might

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1   have been overlooked, because given the overwhelming
2   statistical evidence that this random sampling exercise
3   was flawed, I would expect to go back through all the
4   steps and examine each one and try to find out whether
5   or not it's contributed to that.
6   As I said, it is possible that we got an unusual
7   result just at random, but it behooves us to go back
8   through the process and check -- and I'm just suggesting
9   that this is one of the places that could be checked.
10   I do not have sufficient knowledge of the works to
11   answer the question. I was posing the question, hoping
12   that somebody else might be able to answer it.
13   So the answer to your question is no.
14   Q. All right. Thank you, Dr Wells.
15   A. I was merely posing a question.
16   Q. Yes. Thank you.
17   Now, if we take one step further. Assuming that the
18   defectives are in clusters -- now, Prof Yin's view is
19   that instead of overestimating the defective rate, this
20   effect actually underestimates the defective rate.
21   Prof Yin provided his reasoning in paragraph 14 of his
22   reply.
23   Have you had a chance to read his responses
24   yesterday?
25   A. I've been through it. To say that I fully understand

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1   all of it and have read through and absorbed it all
2   would be untrue.
3   Q. So if I refer to paragraph 14 of Prof Yin's responses,
4   where he provides his explanation. In paragraph 14 he
5   says:
6   "For example, suppose we have a sample of size 100
7   and the data are clustered" --
8   MR SHIEH: Mr Chairman, this is precisely the kind of vice
9   that we anticipated yesterday. I can now see why the
10   government was so keen to put it in as some kind of
11   a file document. It's an aide-memoire for Dr Wells to
12   look at, insofar as he could, and to prepare for any
13   questions that might be put to him.
14   I have no problem if my learned friend understands
15   the point and puts it in his own words, but to put it on
16   the screen as if it has some kind of a filed status is
17   precisely the kind of thing I had wanted to avoid.
18   By all means, if my learned friend wants to read out
19   something and put it in his notes, I'm fine, but this
20   seems to give the document some kind of a status more
21   than it deserves; can I just put it this way?
22   CHAIRMAN: All right. I recognise the objection.
23   MR CHOW: Very well.
24   Dr Wells, please don't look at the response. I'm
25   going to explain it to you.

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1   Prof Yin provides a reasoning for his opinion, being
2   that even if the defective couplers are in clusters, the
3   result would be the defective rate would actually be
4   underestimated; right?
5   Suppose we have a sample of a size of 100, and the
6   data are clustered, and that is they are not
7   independent, in that sense, the sample size of 100 in
8   fact is equivalent to a sample size of, say for example,
9   80, 80 independent data; right? And why 80 is because
10   some of them are correlated, some of the data are
11   correlated, because they are not independent.
12   Do you follow me?
13   A. Yes. Thank you.
14   Q. So, by treating the clusters, ie the correlated sample
15   size of 100, as if they were independent data, one would
16   overly use or inflate the information; do you follow?
17   A. I'm following. I don't necessarily mean I agree but
18   yes, I'm following. Thank you.
19   Q. Well, perhaps: do you agree with that proposition?
20   A. No, I don't, because you have a larger difference
21   between the clusters. So, yes, you do have smaller
22   variation within clusters, but you have larger
23   variations between clusters.
24   I think it's a rather unreasonable statement,
25   because it doesn't give any information about what --

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1   where those data are within the 100 and how the
2   clustering occurs. If it clusters at the end point,
3   then you will now get larger differences between the end
4   points, which will more than compensate for the lower
5   differences within the clusters.
6   And the point that we have here is that we only have
7   end point because it's binary: it's either defective or
8   not defective. Then we're only looking at maximum
9   differences.
10   So I would not necessarily say that what is stated
11 is self-evident. It may have some validity. I would
12 like time to look at it. But it certainly is not, in my
13 opinion, self-evident that that's the case.
14 Q. Let me try this. If the effective sample size of 80 is
15   mistaken as the sample size of 100, the estimated
16   variance would be smaller than it should be; do you
17   agree with this proposition?
18 A. No. Sorry, I thought I'd already explained what I'd
19   done. What I thought I had already explained is that
20   you have a higher between-clusters variance.
21 Q. Right. Okay. So obviously you won't agree that because
22   of the underestimation of the variance, it would lead to
23   an underestimation of the defective rate?
24 A. Can I say that I neither agree nor disagree. At this
25   point I don't think it is important. My 4.7 was,

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1   "Another important question [is] to ask", and in my view
2   that question had not been asked. My point is that the
3   process was incomplete; that there were several
4   important questions that had not been asked. I was not
5   trying to get into abstruse points of statistics based
6   on the fact that, "We failed to answer the question so
7   let's now try to find a valid reason as to why we can
8   wriggle out of it." I was saying that the question
9   should have been asked.
10 Q. Dr Wells, let's move on to another topic then.
11   Paragraph 4.10, please, of your report. In
12   paragraphs 4.10 to 4.12, you are making the missing
13   value approach point; right?
14 A. Yes, correct.
15 Q. As I understand it, it is your opinion that it is not
16   right to simply discard a sample because no measurement
17   can be taken when such samples may have passed visual
18   inspection, because --
19 A. That I correct. Basically, what is happening here is
20   that we are only discarding potential "not defectives".
21   We are not discarding any potential "defectives". So it
22   is clearly biased sampling.
23 Q. Right.
24   Do you agree that having passed -- for a sample that
25   passed the visual inspection, that is to say the number

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1   of threads exposed is not more than two, it doesn't
2   necessarily mean that the actual engagement length
3   inside the coupler was adequate, be it 37mm or 32mm? Do
4   you agree?
5   A. I think this is a simple point of maths, isn't it? That
6   if you have something that's divided into two parts, and
7   you can measure the two parts, you would expect the sums
8   of the measurements of the two parts to represent the
9   whole. So if I could measure -- let me think of
10   an example -- I'm sitting in front of a desk at the
11   moment which has a split down the middle. If I could
12   measure up to the split, and then measure from the split
13   to the other end, I would expect the two to sum to the
14   total length of the desk.
15   Now, as I understand it -- please correct me if I'm
16   wrong -- there is a thread on a rebar, and part of it
17   can be seen and part of it cannot be seen. So I would
18   expect, from a layman's point of view, that the part
19   that can be seen, added together with the part that
20   can't be seen, would sum to the whole. And my
21   understanding -- again, please correct me if I'm
22   wrong -- is that the engagement length is the part that
23   we can't see, and the exposed threads is the part that
24   we can see.
25   I would expect the part that we can see, the number

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1   of threads, plus the part that we can't see, the
2   engagement length, would equal the total threaded length
3   of the rebar.
4   I'm not sure that this is actually where I'm
5   addressing this point, but you asked it so I seem to
6   have wandered into it. I think my point was that in
7   a very large number of the measurements which were given
8   in table B3, the two sums are not the same.
9   Now, when I say "not the same" -- obviously, you've
10 got to allow a little bit of leeway in this, that the
11 PAUT measurement is only accurate to within
12 3 millimetres, so we don't expect them to sum exactly,
13 we only expect them to sum to within 3 millimetres, but
14 those sums I would expect to be the same.
15 Q. Dr Wells, sorry to interrupt you. I believe that what
16   you are talking about relates to another point, another
17   topic that I intend to explore with you in a while. But
18   let me finish this topic first. This topic relates to
19   the missing values approach; right? This is what
20   I would like to explore with you.
21 A. Yes.
22 Q. What you suggest is that instead of discarding those
23   data where no PAUT measurement can be taken, one should
24   substitute it with the mean value of the other data. Is
25   that the point that you are making; right?

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1 A. I'm simply repeating what's normal practice in
2   situations like this, yes.
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.
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.
18   So these are the two main problems involved in
19   adopting the so-called missing value approach. Do you
20   recognise this?
21 A. Sorry, how do you mean, "recognise"? Do you mean
22   recognise as in have I read that --
23 CHAIRMAN: Do you agree?
24 MR CHOW: Thank you, sir.
25   Do you agree with that proposition of Prof Yin?

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1 A. No. Do you want me to explain why?
2 MR PENNICOTT: Yes!
3 A. Sorry, I said no. Do you want me to explain why?
4 MR CHOW: Please go ahead.
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.
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.
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.
24   It is possible to allow for it. It's a second-level
25   effect. What I was trying to do was illustrate;

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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.
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.
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.
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.
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

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1   a good representation of the actual position in the
2   population.
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.
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 --
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.
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?
25 Q. As far as I understand, when we talk about passing the

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1   visual inspection, only for those couplers which, on
2   visual inspection, shows that they were not connected at
3   all -- in other words, we see a gap between the couplers
4   and the threaded bar -- then no one took the measurement
5   by PAUT, for obvious reasons, because we can see a gap
6   between the couplers and threaded bars.
7   But insofar as we see there is connection between
8   the threaded bar and the couplers, even if the number of
9   threads exposed is more than two, PAUT measurement was
10   taken for those samples. I believe that that is pretty
11   obvious from your table B3.2 and B3.3, where we set out
12   the data of more than 90 samples.
13 A. I think I now understand how I managed to get into my
14   digression earlier about the threads and PAUT
15   measurements. You're confusing the visual inspection
16   with the count of the threads. The count of the
17   threads, you are right, is a visual inspection, but it
18   isn't actually referred to as a visual inspection in the
19   report. I was referring to the visual inspection in the
20   same way as it's referred to in the holistic report.
21   So the process that we go through -- you actually
22   said it yourself just now but I will just recap -- that
23   first of all, there was a visual inspection to see
24   whether or not it is actually attached; okay? So that's
25   why you say we look and see whether or not there's

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1   a gap. So we have now a bifurcation, we have did it or
2   did it not pass the visual inspection? If it did not
3   pass the visual inspection, it is defective and it goes
4   into the "defectives" pile. That "defectives" pile is
5   now immutable; we can't take things out of it.
6   We now have a pile left which we can see that there
7   is some connection so it is worthwhile taking
8   a measurement, it is worthwhile counting the threads.
9   There was no point in counting the threads previously;
10   they simply weren't connected. But if they are
11   connected, visual inspection now passes them, they are
12   now in this pile ready to be tested for PAUT and counted
13   threads.
14   If we can't take a PAUT measurement, we discard it.
15   Do you see now my point about we are only discarding
16   from this pile of potential "effectives", potential "not
17   defectives"? We are not discarding from the other pile.
18   It is only when it has already passed the first part of
19   the multi-part test, the multi-part test being visual
20   inspection, is it even worthwhile taking a measurement,
21   part 1; part 2, count the threads; part 3, PAUT
22   measurement and/or direct measurement. Okay?
23   So it's only when it has already passed the
24   potential "not defective", the first test, that we even
25   consider discarding it. That is not random. That is

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1   saying, "I'm only going to discard things which are
2   potentially not defective. I'm not going to discard
3   anything which is clearly defective." Hence my example
4   of the two-part driving test. The first part, the
5   theoretical test, in the driving test, corresponds to,
6   "Let's look at it and see whether or not it's even
7   worthwhile measuring and counting the threads." That's
8   what I mean by visual inspection. I'm sorry if I misled
9   you by using the words "visual inspection" to mean
10   counting the threads. That wasn't my intention.
11 Q. Sorry, Dr Wells. Perhaps I haven't been myself entirely
12   clear. My understanding is when one observes the number
13   of exposed threads, irrespective of the number being
14   smaller than two or larger than two, PAUT measurement
15   would be taken. So we are not discarding -- we are not
16   only just discarding samples that -- well, the reason
17   why we discard a data is because, for some reason, the
18   measurement by PAUT was not possible, and the
19   probability of this occurring to couplers with exposed
20   threads more than two or less than two are the same.
21   They are, to that extent, also random -- isn't it?
22   Do you see my --
23 A. Right. "Random" means we basically close our eyes,
24   stick our hands into a bucket and pull things out
25   (demonstrating) and we pick one. What you have done

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1   here is looked in the bucket first, found ones which
2   meet a certain criteria, let's say red ones, taken all
3   of those out, put them to one side; said, "These ones
4   are ones which we can see it's not even worthwhile
5   taking a measurement for or counting the threads because
6   the coupler isn't connected." We've taken those ones
7   now out of the bucket, and what is left in the bucket
8   are the ones that we can now potentially count threads,
9   take the PAUT measurement, do anything else we want.
10   Okay?
11   So we are now putting our hand into the bucket and
12   taking out from a subset, not from the entire
13   population. Can we agree that that is not random, that
14   there has been a pre-process, some things have been
15   taken out of the bucket before I close my eyes and pick
16   one?
17 Q. For the sake of discussion, assuming what you have said
18   is right, then by replacing those data with the mean
19   value, how would it improve the accuracy of the outcome?
20 A. I was actually suggesting it would include the fairness
21   of the outcome. I don't think there is a concept here
22   of accuracy. I think there is a concept here of trying
23   to understand what is actually happening in the
24   structure, and if we are trying to understand what is
25   happening in the structure then arbitrarily changing the

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1   basis for picking samples by taking things out of the
2   bucket before we make our random selection, does not
3   help us understand what is going on in the structure.
4   All I was trying to do was make a suggestion to say
5   what you have done doesn't help you understand what is
6   going on in the structure, and I was trying to suggest
7   a better way of helping you understand what is going on
8   in the structure. I'm not talking about accuracy. I'm
9   simply saying what you've done is wrong; there is
10   a better way of doing it.
11 Q. My difficulty is to appreciate what you said as your
12   method is a better way. Please help me. If you don't
13   know the actual value for those missing items, by
14   substituting those values with a mean, how would you get
15   a better understanding of what happened in the
16   structure?
17 A. Because, of what is left in the bucket, we can calculate
18   an average of all the things in the bucket, and
19   therefore, if we are now forced to discard some of those
20   things in the bucket, we can say, well, probably the
21   most likely value that those discarded things have is
22   the average or mean of their cohort, things of their
23   kind, things that passed the first pass test. It is not
24   perfect. Like I said, it hasn't taken account of the
25   reduced variance. You can take account of the reduced

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1   variance; it's not impossible. But it is so much better
2   than saying, "Well, let's just discard them because we
3   can't take a measurement."
4   It's at least fair and therefore likely to tell you
5   what is happening in the structure -- the variance is
6   only a second-level effect. The only reason we want the
7   variance is so that we can calculate a tolerance level.
8   What we really want to do is understand what is the most
9   likely strength of the structure, and the way it has
10   been done in the holistic report does not do that. It
11   does something else. It calculates the strength of
12   a hypothetical structure, had certain conditions applied
13   which don't apply. What I've done is shown you how you
14   actually can find the most likely expected value of the
15   strength of the structure.
16 Q. Dr Wells, perhaps it's easier for me simply to put
17   a position to you to see whether you agree with it and
18   then I will move on.
19 CHAIRMAN: Sorry, just on this a second -- looking
20   collaterally -- we are looking at coupler engagement
21   lengths, and if, for example, I go to item number 42,
22   which is "defective", it has -- sorry, appendix B3,
23   sheet 7 of 11; this is a question, not a statement --
24   but if we go to 42, we've got an enhanced length of
25   35.7, which I understand is less than it should be;

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1   okay?
2 MR CHOW: Yes.
3 CHAIRMAN: But you've only got between zero and one thread
4   showing.
5   So, if I reduce it down to my simple level of
6   a screwdriver and a screw, you've actually screwed the
7   screw in out of a whole lot of samples that are all
8   there, they should be the same length, and you've done
9   it as far as you probably can. You've got between --
10   you've got half a thread showing, effectively, but
11   that's still defective.
12   Okay, so what you are taking into account then is
13   the possibility of a variance in the length of the
14   threads that would not in any way have anything to do
15   with workmanship. That must be right, mustn't it?
16 MR CHOW: I totally agree, Mr Chairman. That's why --
17 CHAIRMAN: So it becomes a difficult issue if we are looking
18   at workmanship?
19 MR CHOW: Because there is also an issue of cutting, cut
20   bars as well, and actually my next topic that I would
21   like to explore with him is on the actual threaded
22   length, but this is something that is going to follow.
23   Hopefully by then, Mr Chairman will have a better
24   understanding of the --
25 CHAIRMAN: All right. I'm just trying to, while I'm

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1   listening to the statistical issues, I'm trying to keep
2   them sort of embedded into some sort of common-sense,
3   real approach that I can look at.
4   So you are saying there it would have to be
5   an assumption that it had been cut?
6 COMMISSIONER HANSFORD: I don't think that can be the case,
7   can it?
8 CHAIRMAN: Cut by how much?
9 COMMISSIONER HANSFORD: If you've got 35.7 embedded, and
10   you've got nought to one exposed, you can't have cut
11   anything. It's impossible to cut it.
12 CHAIRMAN: Or else you are deciding to undertake improper
13   work in order to trim, you know, the width of somebody's
14   fingernail off it.
15 COMMISSIONER HANSFORD: Or less.
16 CHAIRMAN: It's ridiculous.
17 MR CHOW: Mr Chairman, I don't necessarily refer to that
18   particular sample. The point I'm trying to make is if
19   you look at all the results in the table, it only
20   suggests that we can't assume a constant thread length
21   from looking at a sample.
22 CHAIRMAN: I appreciate that.
23 MR CHOW: Yes, and also there's some record that some of the
24   threaded bars can be seen as having been cut.
25 CHAIRMAN: Yes.

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1   MR CHOW: This is the point I'm trying to make.
2   COMMISSIONER HANSFORD: Yes. I think it's quite
3   an extension of the argument, Mr Chow, to suggest that
4   anything like that can have been cut.
5   MR CHOW: Not for that particular sample, yes.
6   COMMISSIONER HANSFORD: Well, I think for very few. I can't
7   immediately see any where that jumps out to me as it
8   must have been cut, but maybe there are some. Maybe
9   there are.
10   MR CHOW: There are not many.
11   CHAIRMAN: Which takes me on a little bit further -- and
12   forgive me, Dr Wells, if I'm straying off the point --
13   but we are then saying, "Okay, fine, it's defective."
14   What does defective mean? What I understand is:
15   "Defective" means it doesn't meet your measurements.
16   But not meeting your measurements, what does that mean?
17   And do we just go around in circles on this? Do you see
18   the point --
19   MR SHIEH: We are in binomial, multinomial and continuous
20   scale territory, I might say.
21   CHAIRMAN: Yes. I may be wrong here but I will need some
22   assistance at a later stage.
23   MR CHOW: As I understand it, a sample is considered to be
24   defective if the number of exposed threads is more than
25   three --

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1   CHAIRMAN: Yes.
2   MR CHOW: -- because we leave a certain margin between two
3   and three --
4   CHAIRMAN: Yes.
5   MR CHOW: -- and if the measured PAUT value is less than
6   37 millimetres.
7   CHAIRMAN: I appreciate that. Yes.
8   MR CHOW: This is how it is categorised in the table.
9   CHAIRMAN: Right. But then we come back, do we not, to --
10   COMMISSIONER HANSFORD: Sorry, Mr Chow, did you say "and" or
11   did you say "or"?
12   MR CHOW: "And". This is the acceptance criteria adopted.
13   COMMISSIONER HANSFORD: For both?
14   MR CHOW: Yes.
15   CHAIRMAN: All right. But then we come back, do we not, to
16   that issue -- again, I will need some help here, because
17   I appreciate I am probably tramping through the
18   undergrowth with size 20 boots as opposed to ballet
19   shoes -- and it's like deciding on how many people are
20   going to pass the accountancy exam in the United Kingdom
21   each year. You move the pass mark up to 75, you are
22   going to get less people, so a lot would depend on why
23   those measurements have been set as they have been set,
24   because I understand Arup suggested lower measurements.
25   I may be wrong there.

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1   So the actual parameters of this thing also tend to
2   be important.
3   MR CHOW: At the moment, Mr Chairman, the acceptance
4   criteria was -- the one that apparently MTRC and the
5   government have adopted is exactly the same as what is
6   recommended by BOSA. The government's position so far,
7   and actually all along is that the government was open
8   to receive any proof that different acceptance criteria
9   could be accepted, but so far, up to the present moment,
10   all that the government received is the acceptance
11   criteria from the supplier. So this is what BOSA
12   specified.
13   CHAIRMAN: All right. I'm going to need some help there
14   too, because the fallibility of memory is such that
15   I don't recall BOSA, through any of its qualified
16   employees and/or agents, giving any evidence to this
17   Commission as how to their recommended measurements for
18   insertion were tied into issues of lack of structural
19   safety or otherwise.
20   I appreciate you may say, "Well, what else are they
21   going to be tied into?", but it's a bit like saying, "We
22   recommend you stand 25 feet away before you set off the
23   fireworks." It may be it's just a very, very cautious
24   thing to avoid insurance claims. Do you see what
25   I mean?

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1   So I don't at the moment have anything definitive as
2   to why we have these figures for "defective" or
3   "non-defective".
4   I apologise, Dr Wells. I'm just trying to
5   understand all your evidence in light of what we
6   actually have to focus on. Apologies if I'm being
7   a little slow with you.
8   Okay. Please continue.
9   MR CHOW: Dr Wells, just now I said I was going to state our
10   position and see whether you agree with our stance.
11   (Tribunal conferring)
12   CHAIRMAN: Sorry. Myself and the Commissioner, Dr Wells --
13   would it be correct to say that what I've been talking
14   about, insofar as you've been listening, and there's no
15   reason for you to have listened, but the one informs the
16   other? In other words, those original measurements as
17   to what amounts to defective or not defective, that
18   itself is a matter one has to look at, and then once
19   you've determined those set of figures, then you move
20   into what I might call your territory, of statistics, to
21   determine their randomness and all the other matters
22   that we've looked at -- effectively, the one informs the
23   other?
24   A. I agree, and this is where I had strayed earlier into
25   the same territory as you were just discussing, that the

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1   measurements are sometimes mutually contradictory. And
2   there was a question just now, a request for
3   clarification on the use of "and" or "or", and my
4   understanding is that the "defective" criteria is that
5   it has to pass everything to be "not defective".
6   So, for instance, item 2, which we are looking at on
7   the screen at the moment, passes on the number of
8   threads. It passes on the visual inspection of "is it
9   connected", but then it's discarded because it can't
10   jump the final hurdle of having PAUT result obtained.
11   So that, to my mind, is introducing bias. It's one
12   which almost certainly would have passed. The number of
13   composed threads, nought to one, implies that the PAUT
14   would have passed. So we have a probable "pass" being
15   discarded. There are no probable "fails" being
16   discarded.
17   So my point that I think I'm being asked on
18   specifically at the moment is why am I disputing the
19   classification of "discarded"? It is because it
20   introduces noticeable bias and therefore does not tell
21   us whether or not the structure is sound. It's wrong,
22   and it can be improved quite easily without having to go
23   back and collect -- look at more samples.
24   CHAIRMAN: Yes. Thank you.
25   MR CHOW: Dr Wells, I have one question that follows on from

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1   what you have just said. When you refer to item 2,
2   which you said would probably pass but nevertheless
3   discarded and because of that it biased the result --
4   right?
5   A. Yes.
6   Q. But you make that statement -- it must be on the
7   assumption that the threaded part of the bar has not
8   been cut; right?
9   A. This isn't my assumption. This is the report
10   specifically notes all the bars which were cut. By
11   specifically noting all the bars which were cut, then
12   the ones which are not noted as having been cut are,
13   I think, not just my assumption but by universal
14   assumption, therefore not cut.
15   So item 2 is not cut. That's what the table is
16   telling us. So you have a bar which is not cut and it
17   has nought to one threads exposed, and it is visually
18   seen to be coupled, it's almost crossed the line. All
19   we've got to do is confirm this with the PAUT
20   measurements and it will go into the "not defective"
21   pile. Then somebody comes along and says, "No,
22   technicality, throw it away; can't include that one."
23   Now, that only applies to the "not defective" pile. It
24   doesn't apply to the "defective" pile.
25   So my point is that by taking out specimens which

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1   almost got into the "not defective" pile, then you are
2   decreasing the size of the "not defective" pile while
3   keeping the "defective" pile the same size, so that if
4   you decrease one and keep the other one the same, then
5   the relative proportions change; the ratio between them
6   changes. So that what you are reporting then is a much
7   higher ratio of "defectives" to "not defectives", simply
8   by having discarded the ones which ran the entire race
9   and then were pulled off just before the finish line.
10   Q. Dr Wells, I really want to finish off this topic. Can
11   I just put our position to see whether you agree with
12   me.
13   Our position is this: discarding samples is a valid
14   statistical -- sorry.
15   CHAIRMAN: I'm sorry. I'm just still dragging behind here,
16   so please help me.
17   What you are saying, as a basis for all this
18   discussion, is BOSA's recommendation -- in other words,
19   these are the manufacturer's recommendations for
20   insertion of couplers and rebars into couplers; right?
21   Now, that raises a number of questions. Does it mean
22   that if, in each individual instance, you are not
23   meeting the manufacturer's recommended measurements for
24   insertion, that you are going against any form of
25   building code? Or does it mean that it's unsafe?

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1   Because at the moment there seem to be two issues. I'm
2   just sending up a warning signal so you can come back to
3   me and explain to me where it is.
4   You see, because you start off on the basis the
5   manufacturer's recommendations may actually be prudent
6   but actually don't really go to anything at all, other
7   than prudence. Do you see what I mean? You know, it's
8   like toothpaste manufacturers. A recent country I was
9   in was recommending don't brush your teeth more than
10   once a day because it's got some whitener in it or
11   something, so it probably was not going to do any harm
12   to anybody if you brushed your teeth ten times a day,
13   but somebody there sued somebody and they decided they
14   had better put that on the label.
15   So what I'm saying is we would have to look firstly
16   at BOSA's recommendations, what is the basis of them,
17   how did they come to those recommendations -- that's
18   number one -- and what do they amount to? Do they
19   amount to breaching the building code in any way?
20   Do you see? I don't want to get too deep here,
21   because Dr Wells has very kindly got up at the crack of
22   dawn this morning. But I just want people to
23   understand, I'm going to need some assistance, as we
24   move along, as to the statistics. I begin to understand
25   better and better but I still need some foundation work.

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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.

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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

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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

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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

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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

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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

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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

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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

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1   formalise that slightly by going through all of the
2   items, checking each one in turn to say if I assume that
3   the thread length is 44, and I can see a part of it and
4   I can't see a part of it, then is the total thread
5   compatible with the two measurements separately of the
6   part that I can see and the part that I can't see? And
7   given that the acceptance criteria is that both have to
8   be true, I was pointing out that it's logically
9   impossible for some of them to actually pass. The cards
10   are stacked against them because the numbers indicate
11   that they can't both be correct -- or, rather, all three
12   can't be correct. So it's equally possible that the
13   total length of thread is wrong.
14   But if you say that C is made up of A and B, and
15   then you add A and B together and they don't make C,
16   then something has gone wrong. I'm not saying what's
17   gone wrong. I'm not competent to say what's going
18   wrong. I'm really an arithmetician at this point, you
19   could argue that this is simple arithmetic, I have
20   simply applied a few reasonable assumptions, so I've
21   said they don't have to match exactly. Obviously
22   there's a margin of error. So, for instance, we have
23   nought to one threads or one to two threads, so I have
24   said could it be that it would be match if it was one,
25   could it be that it would be match if it was two, and if

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1   it can't match on either extreme then it's incompatible.
2   And similarly, with the measurement of what we can't
3   see, this has got a margin of error on it as well
4   because we know that the PAUT measurement is only
5   accurate to within 3 millimetres.
6   So, if we apply those, then we can say that
7   a certain percentage -- and I don't have the figures in
8   front of me -- of the items simply couldn't have passed.
9   They have the laws of 1 plus 1 equals 2 stacked against
10   them.
11   That's just the extreme. It could well be that
12   there are more but I have only used the extremes.
13 Q. Dr Wells, I fully appreciate the point that you have
14   made. I also appreciate that for the purpose of
15   preparing your statistical report, you may not have
16   looked at all the factual evidence in relation to the
17   length of the threaded part of the rebar.
18   Now, to clarify the position, I would like to take
19   you quickly to some of the relevant evidence. The first
20   part of the factual evidence I would like to take you to
21   is the quality supervision plan, at bundle H9,
22   page 4280.
23   This is a document, on the face of it, jointly
24   prepared by Leighton, the main contractor of the
25   project, and the supplier of the couplers, BOSA. This

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1   is part of the QSP in which we can see some of the
2   requirements.
3   You see, on top of this page, we have a table; do
4   you see that? The first column sets out the various
5   diameters of the bar.
6   MR SHIEH: I hasten to rise here. Obviously it will be
7   a matter for the Commission to decide how best to deal
8   with this matter. The Commission may remember, during
9   what we call part 1 of the Commission of Inquiry, there
10   has been a good deal of evidence concerning how much you
11   need to be embedded and how many threads can permissibly
12   be exposed before it can be called safe. We have all
13   this evidence about what BOSA said in the brochure. We
14   have all the BOSA pull tests, we have the CASTCO test,
15   we have 26, we have 28, and all the rest of it, and
16   those were contested issues calling for evaluation by
17   the Commission.
18   What I don't wish to happen is for the government to
19   put its preferred version of the evidence to Dr Wells
20   and, in a way, ask Dr Wells to interpret the evidence
21   and express his view on one assumption of what one may
22   call the safety embedded length, and for other people to
23   then say, "Well, if you actually put in evidence to
24   Dr Wells about this, I'm going to rehearse everything
25   that has been rehearsed in part 1", which actually is

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1   a matter for the Commission to evaluate, to Dr Wells,
2   and say, "What if you read Dr Glover's opinion? He says
3   it's 20 and how do you say?" We then get deja vu of
4   January this year, when the experts went in.
5   It may not be helpful, if this is the path my
6   learned friend is going to put in, because the status of
7   this document itself is in dispute, as was observed by
8   Mr Chairman just now.
9   So if it is an intention to actually get Dr Wells to
10   somehow form a view as to whether this is actually the
11   requisite safety standard or whatever, that could lead
12   to some wastage of time and may not be entirely helpful.
13 MR CHOW: Mr Chairman, Dr Wells, when he prepared this
14   expert opinion on statistical matters, he acted on
15   a certain understanding of fact. For example, in
16   subparagraph 4.17(a), he set out that his understanding
17   is that the threaded length of type A rebar is 44mm, and
18   acting on this understanding he then developed his
19   argument and then came to a conclusion that the two
20   acceptance criteria are not compatible.
21   I am entitled -- it is quite reasonable for me to
22   expect that Dr Wells did not have an opportunity to
23   consider all the relevant factual evidence. I am
24   entitled to put to him other factual evidence, but at
25   the end I will not ask him to form a view as to which

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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.

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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.

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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.

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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

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1   ends has a maximum tolerance of one thread, after you
2   have connected the two ends together, you will have a
3   chance of seeing two threads exposed.
4   Commissioner Hansford: I understand that, but in
5   that bottom of those three diagrams, you show the
6   coupler being of length 2T, and the threads being T?
7   Answer: Yes.
8   Commissioner Hansford: Are you saying the threads
9   are actually T plus one thread?
10   Answer: Yes, tolerance. T plus tolerance.
11   Commissioner Hansford: T plus tolerance, and the
12   tolerance is one thread."
13   The answer is clear: one thread.
14   So, basically, if we look at the evidence from the
15   supplier of the couplers, Mr Paulino, and if you recall
16   what it says in the table, what actually happens is
17   a typical threaded bar is T, which is 44mm, plus one
18   thread, which is the tolerance.
19   Now, if we then go to look at a written confirmation
20   from BOSA, at bundle H26, page 45640. It's a letter
21   from BOSA in answer to enquiry made by the Building
22   Authority in Hong Kong, dated 7 January 2019. Starting
23   from the third paragraph, "In response to
24   paragraph 2(a)(i) of your letter", BOSA was referring to
25   an enquiry --

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1   CHAIRMAN: Sorry, was this a letter that we took objection
2   to?
3   MR PENNICOTT: Sir, I was hesitating to get up because --
4   I was just trying to think myself before I stood up and
5   said anything about it. I hesitate to say it is and
6   I hesitate to say it isn't. I just, I'm afraid, cannot
7   remember.
8   MR BOULDING: My recollection, sir, is that I cross-examined
9   one of the government's technical witnesses on this.
10   I've got a feeling it was Prof Au. And he sought to
11   rely upon this, even though it was dated January 2019,
12   well after the works were carried out. It sticks in my
13   mind that you suggested it might be a self-serving
14   letter.
15   CHAIRMAN: That's right.
16   MR CHOW: Sir, this also coincides with my recollection as
17   well, but I'm not sure that is an objection from the
18   Commission. But if it is then I will just move on;
19   I would not refer him to it.
20   CHAIRMAN: If you are going to make a more broad point,
21   I don't want to stop you.
22   MR CHOW: All right.
23   MR SHIEH: This is the invidious nature of the exercise,
24   because a lot of these nuances are thrown at Dr Wells,
25   who is seeing it for the first time, but a lot of these

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1   undercurrents such as, okay, it may be what it says as
2   a matter of black and white, but we now recall that
3   perhaps a qualifier has been put on how much weight one
4   is entitled to put on a document like this. These are
5   nuances which vexed us for some time during COI 1 and
6   these are now shown to Dr Wells in a black-and-white,
7   cold, calculated manner. That is the point I was
8   making.
9   But if the matter is to be pushed on in
10   an expeditious manner, then perhaps what I say is to be
11   regarded as only a marker. I don't wish it to hold up
12   the matter.
13   MR CHOW: Mr Chairman, I don't want to waste time on arguing
14   this, because all these letters serve just to confirm
15   Mr Paulino's oral evidence.
16   CHAIRMAN: You just go with how you feel it's best,
17   recognising the objection or the comments by Mr Shieh.
18   MR CHOW: I will then move on to Mr Neil Ng's evidence that
19   we received on Tuesday. Can I have the transcript for
20   Tuesday? I think it's Day 17 for the second round of
21   Inquiry, page 62.
22   Sorry, it should be Day 2 of --
23   MR PENNICOTT: I think we started at Day 1 again so it's
24   Day 2.
25   MR CHOW: Day 2. Sorry.

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1   Dr Wells, what you are looking at is the verbal
2   evidence of Mr Neil Ng.
3   MR PENNICOTT: Not yet. What page?
4   MR CHOW: Sorry, page 62, starting from line 20. This is
5   the evidence of Mr Neil Ng. The question posed was:
6   "But if it's ten threads engaged, that would be 40
7   inside; there would not be two threads outside?"
8   And Mr Ng's answer was:
9   "That is correct. Or it could be, depending on the
10   threaded bar, some threaded bars are 11 threads, some
11   threaded bars we have seen 12 threads. So even if you
12   have a situation where you have 10 threads engaged, you
13   still might be able to see one to two threads exposed,
14   depending on the threading of the bar by the
15   technician."
16   So this is the latest evidence from Mr Neil Ng.
17   On the basis of this factual evidence, if -- "if" --
18   the threaded length is 48mm, that is T plus one thread,
19   instead of 44, would you agree that the two acceptance
20   criteria, namely not more than two threads exposed and
21   the minimum engagement length of 40mm, would be
22   compatible?
23   A. Sorry, can I just recap on what I'm being asked to agree
24   to? As I understand it, we started with a document from
25   BOSA. Could we go back to that one? I think you showed

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1   me five documents and each one builds on the previous
2   one so that the ultimate question depends on everything
3   that went before it. Is that correct?
4 Q. If you want to go back to that question --
5 A. What I understand you've done here, and correct me if
6   I'm wrong -- what I understand you've done here is
7   you've shown me five documents and said starting with
8   this one, then that one, then that one, then that one,
9   then that one, now do I agree? So I just want to
10   retrace the steps, if I may, because it was quite
11   a complicated process and I want to be sure that when
12   I say I either agree or I don't agree or I don't
13   understand, that I'm doing so in the best of my
14   understanding of what you've asked me.
15 Q. Dr Wells, to save time, perhaps if I can put it another
16   way around.
17   The documents I have showed you are something that
18   I referred to to suggest that perhaps the threaded
19   length of the bar is 48, not 44. For the purpose of
20   answering my question, if -- you don't have to commit
21   yourself but just in case where the threaded length is
22   48mm instead of 44 that you have assumed, am I right
23   that the two acceptance criteria, namely not more than
24   two threads exposed and a minimum engagement length of
25   40mm, these two acceptance criteria would be compatible

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1   with each other, in other words physically possible?
2 A. I'm very sorry but, as a mathematician, I'm not often
3   asked to answer hypothetical questions, and if somebody
4   said to me, "Hypothetically, if 1 plus 1 equals 3, then
5   how would that change your maths?", I would find that
6   very difficult to answer. I would much prefer to try to
7   understand the question you've asked me, and if we go
8   back to the BOSA Technology (Hong Kong) Ltd, I asked
9   what the tolerance was and I was referred to the box at
10   the bottom which says:
11   "The tolerance established in the table above
12   provides a lower limit ..."
13   Can we all see that?
14 Q. Yes.
15 A. At the time I said: so actually, there is no upper
16   limit, there is no maximum specified. So we start with
17   this first document -- please forgive me, I am
18   a mathematician, I tend to argue logically from first
19   principles, and this was the first thing you showed me
20   so this is the first principle -- and this principle
21   states that there is no maximum tolerance. Is that
22   reasonable?
23   So then we go on to the second document you showed
24   me, please, which is the evidence given by the company
25   that wrote that document, and if we look at lines 12 and

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1   13 -- I had to write that down because I don't remember
2   things -- so if in a worst-case scenario we were to have
3   both ends with a maximum tolerance; right? We just
4   established that there is no such thing as a maximum
5   tolerance, so this whole thing is hypothetical. We have
6   started with -- you showed me document 1 and said,
7   given 1, then 2, then 3, then 4, then 5, do I agree with
8   the statement you made. I cannot either agree or
9   disagree because the first two things you showed me are
10   nonsensical and don't make sense and are mutually
11   incompatible.
12   So I do not feel I am in a position to answer
13   a question which is hypothetically posed at the end of
14   a logically inconsistent argument.
15   I apologise if this comes across as being
16   obstructive in any way but it seems to me that if you're
17   asking me a question which says what do I make of
18   a maximum tolerance, when there is no such thing as
19   a maximum tolerance, then I cannot answer, can I?
20 Q. Dr Wells, I thought my question is simple arithmetic.
21   My question was: if the threaded length is 48mm, then it
22   is possible that while having two threads exposed, which
23   is 8mm, we still can provide a 40mm engagement length.
24   I thought this is simple arithmetic -- is it not?
25 A. Yes. If 1 plus 1 equals 3, then we can prove almost

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1   anything we like. That is basically your question. You
2   are asking me what would happen if I were to assume that
3   there is no such thing as a maximum tolerance, but the
4   maximum tolerance is nevertheless a number. That's what
5   you've asked me.
6 Q. I don't think this is my question, but anyway --
7 A. It is.
8 Q. -- I would prefer to move on.
9 CHAIRMAN: But if it's a basic question of mathematics, it's
10   a statement more than it is a question, is it not?
11 MR CHOW: Sir, it is quite true that I don't necessarily
12   need to ask that question. I thought it is really
13   obvious and it would not take much time and I am
14   actually surprised that it has taken so long to get
15   an answer from Dr Wells.
16   Actually, to save time, I would prefer to move on to
17   a new topic. I think I've got enough on that one.
18 CHAIRMAN: Certainly, yes.
19 MR CHOW: Dr Wells, I would like to move on to another
20   subject, regarding the binary, discrete analysis or
21   continuous analysis. Do you recall that?
22   Paragraph 4.20 of your report.
23 A. Yes, I recall.
24 Q. In paragraph 4.20, you criticise the adoption of
25   a discrete method instead of a continuous method. But,

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1   as you rightly point out, this assessment is not
2   a statistical issue; it is an engineering and management
3   issue. Do you agree? Is that your position?
4   A. Yes. Yes.
5   Q. Do you agree that if we -- had MTRC adopted a continuous
6   method, it would have to open up a lot more areas in
7   order to get a lot more samples for the statistical
8   analysis?
9   A. No, I do not agree.
10   Q. Okay.
11   COMMISSIONER HANSFORD: Can we understand why Dr Wells
12   doesn't agree? Is that relevant to this?
13   MR CHOW: Yes.
14   Can you assist the tribunal as to why you don't
15   agree to my proposition?
16   A. Well, for various technical reasons. So, for instance,
17   the arguments in the holistic report rely on some
18   approximations which are necessary because of a binary
19   approach was taken. For instance, in the calculation of
20   the strength reduction factor in the capping beam
21   calculation, there is reliance on the Delta method in
22   order to calculate a variance, and the need for this is
23   because, with discrete samples, you don't have
24   an obvious measure of variance. With numbers, it's very
25   easy. You just add the numbers together, find the mean

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1   and then find out how much on average each one is
2   distant from the mean. It's very, very, very simple.
3   But if you have something such as you throw a dice
4   and you have the numbers 1, 2, 3, 4, 5, 6, then there is
5   some doubt as to how different 1 is from 2. Obviously,
6   I know that 2 minus 1 is 1, that's the difference, if
7   you think of them as continuous numbers. But if they
8   are simply faces on the dice, then they could be, for
9   instance, like a Rubik's Cube, where you have one face
10   is red, one is green and one is white. How different is
11   red from white? How different is green from red?
12   So you have this fundamental problem with discrete
13   methods where you don't have an obvious measure of
14   variability, of how different things are. With
15   continuous measurement, it's simple, it's easy.
16   So, with the binary methods, you have to adopt some
17   approximations to try to make it look as if you've got
18   continuous data, and these approximations actually only
19   work when you have quite a large amount of data. For
20   instance, the approximation, the Delta method which was
21   used on a sample size of seven is actually only valid
22   with a sample size of 30. So the method used was just
23   not valid, whereas you don't get any of those problems
24   with continuous methods. You don't have to have a large
25   sample in order to be able to make an approximation.

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1   You can work with numbers when you've only got quite
2   small samples. It is much easier to work with numbers
3   in a mathematical sense than it is to work with discrete
4   things like red/green/blue or defective/not defective.
5   Q. Dr Wells, it is possible that I misunderstood what you
6   meant by "continuous". My understanding -- correct me
7   if I'm wrong -- by "continuous variable", you are
8   saying, instead of considering a coupler connection as
9   either pass or fail, we can have partially, like partial
10   engagement kind of situation, so we can accept certain
11   partial engagement couplers. So, instead of pass or
12   fail, we can have partially pass and fail. Is that what
13   you are trying to say by "continuous method"?
14   A. No, because there is no concept of partially pass. What
15   I'm saying is that if you say that a rebar with
16   a coupler measured to be 39.999 millimetres is a fail,
17   then you are saying that it has absolutely no
18   contribution to the structure. If you were to use
19   a continuous variable, you could say that an engagement
20   length of 39.999 is some percentage less than the
21   engagement length of 40.
22   I am not competent to say what that percentage less
23   is. It might be a very high percentage less. All I'm
24   suggesting is that it probably would be easier to use
25   a percentage rather than simply say: as soon as it drops

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1   below 40, it has absolutely no effect. And I'm saying
2   that not from an engineering point of view. It is up to
3   somebody else to say whether 39.999 millimetres'
4   engagement length is still providing some strength to
5   the structure, no matter how little.
6   I am saying, from a statistical point of view, it
7   would make the analysis an awful lot easier and would
8   have bypassed a lot of the mistakes which were actually
9   made in the analysis such as the one I just mentioned
10   about the Delta method.
11   COMMISSIONER HANSFORD: Just to follow up on that,
12   Dr Wells -- and you are also saying that that can be
13   done with the same sample size or less? It doesn't need
14   a larger number of samples; is that correct?
15   A. That is correct, yes. I am saying that.
16   COMMISSIONER HANSFORD: All right. Thank you.
17   MR CHOW: So apparently I have not misunderstood what you
18   meant. The only difference between me, the government's
19   position, and your position, is that in such
20   circumstances the government's position is that instead
21   of using a binomial analysis, we need to adopt
22   a multinomial analysis, and by doing so, to provide the
23   same confidence level of 95 per cent, one would need
24   a lot more samples to be obtained, instead of 84.
25   So I would assume that you don't agree with this

17 (Pages 65 to 68)

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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,

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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

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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

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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.

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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

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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

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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

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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

19 (Pages 73 to 76)

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1   similar, then your gut feeling now is correct and it
2   should be between those two.
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.
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.
20   Is that sufficient to answer?
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

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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?
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 --
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?
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.
16   Theoretically, there is absolutely no reason why it
17   should be between those two.
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?
23 A. Yes, that's correct.
24 COMMISSIONER HANSFORD: Thank you.
25 A. It's because what we are looking at here in this table

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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.
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.
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.

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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?
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.
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.
19   My fundamental conclusion remains.
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?
24 A. Prof Yin's calculation results in an envelope, an upper
25   and lower bound, around an expected number. This is

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1　a graph where the horizontal axis is, from memory -- the
2　horizontal axis or the vertical axis is the variance --
3　Q. Dr Wells, perhaps I can direct you to the relevant part
4　of Prof Yin's report. Prof Yin's first report,
5　paragraph 1.4.1, page 6.
6　　Yes, this is the formula. It's called "exact
7　binomial probability formula". You are familiar with
8　this formula?
9　A. Yes.
10　Q. Do you accept that for someone who adopts this formula
11　for the statistical analysis, he doesn't have to know
12　the population size or the variance of the population?
13　A. Let me see now. The variance is n, p, 1 minus p, and
14　what we have there is a first term which is
15　combinatorial with n, times p, times 1 minus p. So it
16　does look suspiciously like a variance to me.
17　　My point here is that that formula creates a series
18　of numbers. So k equals nought to y, so you do it for y
19　equals 0 and you get one number; you do it for y equals
20　2 and you get another number; you do it for y equals 3
21　and you get another number.
22　　"... y is the observed number of defective coupler
23　connections in the sample."
24　　So before you have started you don't know what y is.
25　You have to do this for every possible number of

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1　potential defective coupler connections in the sample.
2　So you've got a sample size of -- well, total population
3　size of 273, so your sample size could go up to 273.
4　You don't know yet. So you do this calculation for all
5　273 cases, to give you one each for each of the
6　variances, and then you plot that as a curve. This is
7　why I was saying it's a graph where one of the axes is
8　the variance.
9　　So now you start opening up and as you go through
10　you get an estimate of the variance. So an awful lot of
11　this graph is now irrelevant, but it can't happen
12　because you have actually seen some examples as you go.
13　You have a calculation of the variance as you've got it.
14　So that if you've already seen two defectives, then the
15　case zero defectives and the case one defective are no
16　longer possible because you've actually seen two, so
17　you've ruled those out.
18　　So my point is that you can do this calculation at
19　the beginning and say, "Right, I've done my calculation.
20　Now let's just go in and dig up some concrete"; or you
21　can say, "I'm actually going to monitor this as I go
22　along and try and adapt my best estimate of the number
23　we need as we proceed. As data comes in, I'm prepared
24　to change my mind."
25　　I think this is one of the key things about

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1　statistics, that you need to be prepared to change your
2　mind. You start off with a hypothesis, with an idea,
3　and then, as you get real data, that has to change.
4　　All I'm saying here is that if you just do the
5　calculation upfront and then walk away and let people
6　get on with it, then it is my opinion that you have not
7　done as good a job as if you actually watched the
8　process, monitored it as each one comes in and said,
9　"Okay, we might actually be able to refine our estimate
10　as we go along."
11　　That's the only point I was making. I wasn't saying
12　that this is unsound. I was just saying, if you'd done
13　it slightly differently, then you would probably have
14　ended up with a smaller number of samples for the same
15　confidence level.
16　Q. Dr Wells, I'm not sure you've answered my question. My
17　question is simple. For Prof Yin to adopt this formula,
18　to work out the sample size of 84, he did not need to
19　know the population size or the variance of the
20　population. Do you agree?
21　A. Okay, in that case I will disagree, because if you don't
22　know what the population size is, for instance, then you
23　do not know what the upper limit is on this summation.
24　Are you going to it for k equals 0 to 0? Are you going
25　to it for k equals 0 to 1, k equals 0 to 2? What if

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1　your population size was 10 and you did it from k equals
2　0 to 20? What if your population size was 20 and you
3　only did it for k equals 0 to 10? You must have at
4　least an expectation to know how far up you need to go.
5　Q. Thank you, Dr Wells. I have registered your
6　disagreement and I would prefer to move on. Thank you.
7　　Can I now ask you to look at paragraph 4.41 of your
8　report.
9　CHAIRMAN: Mr Chow, could I just ask -- I appreciate these
10　discussions are not the easiest -- how are you
11　progressing, because I have to keep an eye on time?
12　MR CHOW: At the moment, I anticipate perhaps I will need at
13　least an hour to finish all the questions.
14　CHAIRMAN: That will take us to 6.00.
15　　Is there anybody else? Mr Boulding, do you intend
16　to ask any questions?
17　MR BOULDING: I have a few questions, sir. 20 or
18　30 minutes.
19　CHAIRMAN: Okay.
20　MR PENNICOTT: Sir, depending on the rest of the questions,
21　I only have one little area I want to cover, a few
22　questions, no more than five minutes, I hope.
23　CHAIRMAN: Mr Shieh?
24　MR SHIEH: I have one question to ask him, one topic in
25　re-examination.

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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.

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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

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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

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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

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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.

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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

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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

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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

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1   fail. It would be catastrophic if it did. If I were
2   measuring the strength of a rebar coupler, then
3   obviously I don't want the building to fail but I know
4   that if one rebar fails, it's got ones either side that
5   can do the job.
6   So the decision as to where to put that interval is
7   an engineering one, combined with a public safety one.
8   It is not a statistical one. A statistician doesn't
9   really have much to add to that.
10   Now let's look at the other graph, the Wilson one,
11   the slightly more pointy one and, critically, the
12   asymmetric one. This is very much a matter of
13   statistics. This is -- we can say that once you've told
14   me you want to be, let's say, 90 per cent confident,
15   I can now start doing some analysis on how much data do
16   you need to collect in order to make that confidence
17   level sufficiently reliable?
18   So again it can't be certain. Again it's just
19   a confidence. But this is much more statistical as
20   opposed to engineering.
21   So we've got these two different concepts. Now,
22   what we've been looking at in the holistic report, when
23   we talk about 95 per cent confidence, is generally, as
24   I understand it, the reddish-blue line, that we're
25   saying that we want most of our couplers to be

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1   effective. We want a certain number of them not to be
2   defective in order for the building not to fall down.
3   So that is the engineering part of it. That's where the
4   engineers say, "Well, it could be 85 per cent, it could
5   be 90 per cent, it could be 95 per cent", and it all
6   depends on how much redundancy there is in the
7   structure, how many rebars you put in.
8   This is where I have referred back to the ISO
9   standard, where there are tables, table after table of
10   suggestions for how much confidence you should apply
11   given a sample size, and so on. And the Standing
12   Committee have obviously come up with a figure of
13   90 per cent, I think, and then 95 per cent or
14   90 per cent -- they are not sure; no, that's not fair.
15   There are options depending on where you are in the
16   standard for 90 or 95 per cent in the green line on the
17   right.
18   MR CHOW: On that point, Prof Yin points out that you
19   have -- when you refer to CS2, that 90 per cent
20   requirement, instead of 95, Prof Yin points out that you
21   have misinterpreted the meaning of the term used in the
22   CS2. His position is "confidence level" is not the same
23   as "statistical tolerance interval" referred to in CS2.
24   Do you have anything to say in response to that?
25   A. I think what he said is what I have just tried to

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1   explain. The two are different. They are the
2   reddish-blue line and the green line on the diagram I've
3   just drawn.
4   Q. I see. So you are not advocating that under CS2,
5   90 per cent confidence level would be sufficient?
6   A. I am not advocating, I don't think. If I did in my
7   expert submission report, then I can only apologise.
8   I am trying to illustrate points, and the point I was
9   illustrating here is that throughout the holistic
10   report, 95 per cent has been used. When figures are
11   mentioned in the standard, they are either 90 or 90 or
12   95.
13   Now, in the one case, whether it's the green line or
14   the reddish-blue line, for one of them, regardless of
15   which way around we interpret those, one of them is
16   always going to be 90, as far as the CS2 standards are
17   concerned. The other one could be 90 or 95. So if we
18   were to treat this as being a sort of heads and tails
19   problem, then effectively we've now got three 90s and
20   one 95. And to therefore assume 95 throughout the
21   holistic report, without ever, as far as I could see --
22   and I might have missed it -- without ever actually
23   addressing the reason as to why 95 had been chosen,
24   I felt was an omission; that the standards are using 90
25   far more often than 95. I am not in a position to say

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1   which is right. I'm not an engineer. I'm a mere
2   statistician. All we can do is tell people what the
3   effects of their decisions are. The decision on 90 or
4   95 is an engineering one, based on considerations of
5   redundancy, safety factors and so on. I was merely
6   commenting that I thought it was strange that 95 had
7   been used throughout, without any apparent justification
8   or reference to theory.
9   In Prof Yin's response to my expert report,
10   I noticed that he refers to 95 per cent as the gold
11   standard and that's why he's chosen 95 rather than 90,
12   because 95 is the gold standard. Well, I would argue
13   that 99 is more like a gold standard, or 99.9 or 99.999
14   is a gold standard. I think simply saying, "This is the
15   gold standard and that's why we've used it" is perhaps
16   missing the point of how we choose confidence levels and
17   confidence intervals.
18   Q. Dr Wells, I believe that Prof Yin says more than that.
19   He is not suggesting 95 per cent is his golden ratio.
20   He is actually saying in conducting statistical
21   analysis, the general practice is to adopt a confidence
22   level of 95. Do you agree or --
23   A. No.
24   Q. Okay.
25   A. I thought I'd tried to explain this. There is no such

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1   thing as generality in this. If I'm designing
2   an aircraft engine, then 95 per cent is nowhere near
3   good enough, and so to say, "We've designed these
4   aircraft engines, they're 95 per cent reliable, that's
5   because 95 is the gold standard and it's generally
6   accepted". Now, 95 per cent means 5 per cent of the
7   time it's not going to work, so that means one in 20
8   trips from Hong Kong to London, we are going to expect
9   an engine to fail.
10   If this was a two-engine plane and one engine was
11   failing once in every 20 trips, I think I would take the
12   train, personally.
13   So I don't feel there is any concept to the
14   statement, "It's generally accepted in statistics that
15   we use 95 per cent." That just, to me, is a meaningless
16   statement.
17 Q. But actually Prof Yin refers to a specific guidance,
18   guidelines, the US FDA guidance on "Multiple Endpoints
19   in Clinical Trials guidance for Industry". He provides
20   the reference under paragraph 33 of his responses.
21   Are you aware of that guidance, guidance document?
22 A. No, I'm not. Probably the reason I'm not aware is that
23   I don't work in clinical trials. The reason that
24   Prof Yin probably is aware is that he does work in
25   clinical trials. And it may well be that when doing

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1   drug trials, there is a generally accepted standard of
2   95 per cent, but I would respectfully submit that this
3   is not a drug trial.
4 Q. Dr Wells, I would like to ask you a few more general
5   questions.
6   Perhaps, first of all, I would ask: do you accept
7   that at the moment MTRC has taken 84 samples from the
8   project in various locations, and that number of samples
9   would enable an estimation of the defective rate in the
10   population with a confidence level of 95 per cent? Do
11   you accept that?
12 A. Sorry, I need notice of the question. A sample size of
13   84 will give 95 per cent confidence at a certain
14   defective rate, I think. I don't think it covers every
15   defective rate.
16   Sorry, I would need to think a little bit more about
17   it, but I don't think that it is a statement that makes
18   sense on its own. I think that the 95 per cent
19   confidence and the number of 84 is actually read off the
20   graph that I was referring to earlier, at a specific
21   variance point, hence the number of defectives, I think.
22 Q. Dr Wells, the fundamental basis of the holistic proposal
23   and the holistic report is that the parties are
24   satisfied, so far, that by taking 84 samples, one would
25   be able to make an assessment of the actual defective

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1   rates of couplers in the structure with a confidence
2   level of 95 per cent, and the details are set out in
3   Prof Yin's report as well as, I believe, in the holistic
4   report as well.
5   In your report, I am not aware that you have ever
6   said that this is not the position. Am I right?
7 A. If I've not said it, then probably I don't believe it.
8   Why? Am I being questioned on things I've not said?
9 Q. I thought you agreed that with 84 sets of samples, one
10   would have enough number of samples to do an evaluation
11   of the condition of the coupler connections in the
12   structure with a confidence level of 95 per cent.
13   I would have thought this is a very important part of
14   the whole study and if you disagreed with that, you
15   would have spotted that and put it in your report.
16 A. My report was mostly trying to deal with how can you
17   analyse the data you have already got. You can always
18   go out and get more data and try to be more confident,
19   but I had understood that we now have data and we are
20   trying to analyse it, and my report concentrated on
21   that.
22   It is possible that there are some aspects of the
23   statistics that I have not commented on, and it is
24   possible that some of those aspects I agree with, and it
25   is possible that some of them I disagree with. I'm

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1   really not sure, to be honest. It's been a long --
2 Q. All right. Conceptually, assuming that we have enough
3   samples to provide us -- to estimate an actual failure
4   rate with a confidence level of 95 per cent, there is no
5   reason for us to go for a lower level of confidence
6   rate, say 95 per cent; do you agree?
7 A. I'm sorry, what do you mean by "there is no reason to go
8   for"?
9 Q. Well, if we have enough samples to enable us to do
10   an estimate or projection of the actual defective rate
11   with a confidence level of 95, with the same set of
12   samples available for the analysis, one would not adopt
13   a lower level of confidence in order to get a different
14   projection of the defective rate?
15 A. Okay. Thanks. I'm sorry. It took me a while to
16   understand what you are saying. I do apologise.
17   So you are referring to the green line, that the 95
18   gives us that green-line confidence. What I'm
19   suggesting is that the red line doesn't necessarily need
20   to be 95. It could be 90. It could be 99. I'm not
21   saying. I don't know. I keep saying I'm not competent
22   to say. I'm merely saying that I find it surprising
23   that there was no justification of this anywhere in the
24   report.
25   Let's not dispute the green line. Let's just take

25 (Pages 97 to 100)

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1   that as accepted. That's 95 per cent, you've got enough
2   data. Yes, we are happy that's 95 per cent.
3   Sorry, I thought we were going back to the question
4   of how did the 84 get derived. But regardless of how it
5   was derived, the green line, 95 per cent, great.
6   Now, how are we going to do that? How are we going
7   to use that information we've already got? We've got
8   some information. We need to calculate a strength
9   reduction factor. That means we want to be able to say
10   that we expect all of the not sampled, not measured
11   couplers, the ones which weren't opened up, the ones
12   that are still in there and still supporting the
13   structure, what can we say about those based on this
14   sample that we've already got?
15   Now, do we want to be 90 per cent confident in that,
16   do we want to be 95, do we want to be 99, do we want to
17   be 99.9? I feel that this is a legitimate question that
18   should have been asked quite early on, that the
19   engineers would be the ones who would come up with the
20   answer, and the fact that there was no consideration at
21   all of that in their holistic report struck me as being
22   an omission, really.
23   And hence I decided to recalculate based on
24   90 per cent instead of 95 per cent. I'm not suggesting
25   that should be used. I was simply trying to illustrate

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1   this point, that the omission of ever having justified
2   the 95 was important. It's a different 95 to the one
3   which is derived to give you the 84 sample size. That's
4   a different thing. That's the green line. I'm now
5   talking about the reddish-blue line.
6 Q. I'm sorry, Dr Wells. I'm not sure I'm referring to the
7   green or blue line, but I'm only thinking about
8   the level of confidence. My understanding is that to be
9   able to provide a reliable result with a confidence
10   level of 95 per cent, one would need to have at least 84
11   samples.
12   Now, conceptually, given that we have already got 84
13   samples available for the analysis, I would not go for
14   a lower level of confidence in order to come up with
15   a lower defective rate.
16   Have I made any mistakes in that statement?
17 A. Well, what you've effectively said is, "Looking at my
18   diagram, based on the length of the green line, I want
19   the red line to be a particular length." Okay? This is
20   a bit like saying, "Based on the fact that it rained
21   yesterday, I'm now going to have apples for my lunch."
22   We're talking about different things. If I can
23   refer you back to what you just quoted to me from
24   Prof Yin's response. He said that I was, in his
25   opinion, apparently confusing these two. Well, my

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1   opinion is that I'm not, but my opinion is that you are.
2 Q. Dr Wells, actually, I have moved on to another subject
3   already. My question is on a theoretical level, about
4   level of confidence and the result.
5   My understanding -- correct me if I'm wrong -- is
6   that on the basis of the same set of samples and the
7   corresponding result, if one adopts a confidence level
8   of 95 per cent, and correspondingly we have
9   an estimation of the defective rate -- for example, X --
10   with the same set of test results and the same number of
11   samples, 84, if one adopts a lower level of confidence,
12   say 90 per cent, the corresponding estimation of the
13   defective rate would be lower than X. Would you agree
14   with that as a general proposition?
15 A. I'm probably going to have to ask you to repeat it,
16   because it went a little bit over my head. But I think
17   I might be able to cut through a lot of this and explain
18   why your questions are not meaningful.
19   If we were to look at, for instance, the value of
20   0.366 in the holistic report for the strength reduction
21   factor in the EWL slab, the value of 0.366, where does
22   that come from? Any of those values would do; it
23   doesn't really matter. There we go, EWL, 366. What
24   does that number actually mean? That number is the
25   expected value plus an allowance for the possibility

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1   that the expected number might be wrong.
2   For instance, if I were to toss a coin 100 times,
3   I would expect to get 50 heads and 50 tails. In
4   practice, the chances of actually getting 50/50 are
5   quite small. I'm quite likely to get 49/51 or 51/49 or
6   48/52. There is an amount of variance in it, and we can
7   calculate that variance, and we can say 50 per cent of
8   the time I would expect to get between, let's say, 45
9   and 55 heads and hence 55 and 45 tails. I can put
10   a confidence level on the number of heads and number of
11   tails I would expect to get.
12   That value there, 0.366, is the expected value plus
13   a margin for the probable variation. How big should
14   that margin be? That margin was chosen to be
15   95 per cent. 95 per cent of what? Well, that's
16   a statistical matter. Let's gloss over that just for
17   a minute --
18 Q. Sorry, Dr Wells. Sorry to interrupt you. Perhaps it is
19   easier for me to illustrate a point by referring to your
20   own report. Your own report, in paragraph 4.34, under
21   table 2a -- do you see that? Now, the second column
22   from the left, you set out the strength reduction factor
23   adopted for the holistic report: 0.366, 0.332, and the
24   combined value, 0.350. Do you see that?
25 A. Yes.

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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.

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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.

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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

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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

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1　overarching standard ISO 3951-2:2013, which states that
2　standards should allow for a reduction in
3　testing/inspections in order '... to reduce inspection
4　costs (by means of a switch to a smaller sample size)
5　should consistently good quality be achieved'."
6　　　Then you go on to say because of what is stated in
7　this ISO, it actually means or "advocates a flexible
8　approach for quality assurance when applying standards,
9　rather than dogmatic adherence to rules".
10　　　Do you remember that?
11　A. Yes, indeed.
12　Q. My reading of your whole report, your second report, is
13　　　that you first of all refer to the international
14　　　standard for quality assurance, and from that you draw
15　　　an overarching spirit to the effect that if consistently
16　　　positive test result is achieved, then further tests may
17　　　not be required.　Is that the whole idea of your
18　　　approach?
19　A. Depending on how you use the term "further", yes.
20　Q. You refer to this specific ISO 3951-2.　Can I assume
21　　　that you are pretty familiar with that ISO?
22　A. It's not my bedtime reading but I refer to it from time
23　　　to time, yes.
24　Q. Fair enough.
25　　　Now, a few days ago, the government requested

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1　Leighton to provide copies of the various standards that
2　you relied on, and we did receive some extracts of the
3　relevant part.
4　　　The one that I would like to discuss with you is
5　this particular standard.　We have managed to obtain
6　certain other parts of this standard.　Maybe first
7　I will distribute copies of this standard, and for your
8　benefit I will read out the relevant part of it.
9　(Handed).
10　　　Mr Chairman and Prof Hansford, what you have got is
11　only two pages of the standard, this standard.
12　　　Dr Wells, what I have shown to the Commission and
13　the other parties in this room is only the introduction
14　part and also the first page of part 2.
15　　　Now, the introduction part of this ISO says:
16　　　"This part of ISO 3951 specifies an acceptance
17　sampling system of single sampling plans for inspection
18　by variables."
19　　　Then the second paragraph says:
20　　　"The objectives of the methods laid down in this
21　part of ISO 3951 are to ensure that lots of
22　an acceptable quality have a high probability of
23　acceptance and that the probability of not accepting
24　inferior lots is as high as practicable.　This is
25　achieved by means of the switching rules, which provide

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1　the following:
2　　　(a) automatic protection to the consumer (by means
3　of a switch to tightened inspection or discontinuation
4　of sampling inspection) should a deterioration in
5　quality be detected;
6　　　(b) an incentive (at the discretion of the
7　responsible authority) to reduce inspection costs (by
8　means of a switch to a smaller sample size) should
9　consistently good quality be achieved."
10　　　In fact this part (b) is the part you have referred
11　to in your report.
12　　　But the following paragraph says this:
13　　　"In this part of ISO 3951, the acceptability of
14　a lot is either implicitly or explicitly determined from
15　an estimate of the percentage of non-conforming items in
16　the process, based on a random sample of items from the
17　lot."
18　　　Then it is the following paragraph that I would like
19　to highlight.　It says:
20　　　"This part of ISO 3951 is intended for application
21　to a continuing series of lots of discrete products all
22　supplied by one producer using one production process.
23　If there are different producers or production
24　processes, this part of ISO 3951 is applied to each one
25　separately."

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1　　　If I may then go to the first page of part 2.　Now,
2　part 2, the title is "General Specification for single
3　sampling plan indexed by acceptance quality limit for
4　lot-by-lot inspection of independent quality
5　characteristics".　Under paragraph 1, "Scope":
6　　　"This part of ISO 3951 is primarily designed for use
7　under the following conditions:
8　　　(a) where the inspection procedure is to be applied
9　to a continuing series of lots of discrete products all
10　supplied by one producer using one production process.
11　If there are different producers or production
12　processes, this part of ISO 3951 shall be applied to
13　each one separately".
14　　　So the way I read, as a layman, the express term or
15　the caution put down in this ISO is that even the
16　so-called overarching spirit that you refer to only
17　applies to product from one producer from the same
18　process.
19　　　We understand that the untested batches of rebar
20　that are in question, they were not from the same
21　supplier.　They were not from the same country.　So
22　am I right, if one was to apply the overarching spirit
23　stated in the ISO 3951, one cannot mix up all the
24　previous test results from various different producers,
25　different sources, and say that because the previous

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1   test results provide positive results we don't need to
2   test certain batches of rebar which were delivered at
3   a later stage?
4   A. Sorry, was that the end of the question? "You cannot
5   mix up" was the start of the question; yes?
6   Q. Yes.
7   A. I totally agree with that, yes. I'm in complete
8   agreement.
9   COMMISSIONER HANSFORD: Mr Chow, without taking up time now
10   can you give us the references for where you say the
11   material comes from different suppliers and indeed
12   different countries --
13   MR CHOW: Yes.
14   COMMISSIONER HANSFORD: -- because that wasn't something
15   I was completely aware of?
16   MR CHOW: As far as I understand, that is already in the
17   hearing bundles.
18   COMMISSIONER HANSFORD: Is it?
19   MR CHOW: I think Prof Yin also briefly mentioned it in his
20   report too. I can certainly identify the bundle
21   references for the benefit of the tribunal.
22   COMMISSIONER HANSFORD: That would be useful. Thank you.
23   MR CHOW: I will do that.
24   A. So you did read out the relevant part of the ISO
25   standard, and then your question to me was on part of

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1   what you read out. If I may read back to you what you
2   read, the last part was "shall be applied to each one
3   separately", and that is precisely what I did when I was
4   doing my analysis. I applied it to each one separately.
5   So yes, I totally agree with you that we should not
6   mix them up, and that is why I did not mix them up,
7   because I agree with you that you should not mix them
8   up. I did exactly what the ISO standard states and
9   I applied it to each one separately. Not just to each
10   one separately but to each one specifically, so as to
11   look at which suppliers from which countries had
12   supplied the rebar which was not tested and only use
13   those manufacturers' mill tests in order to inform
14   a decision as to whether or not we had reached the
15   accepted level.
16   MR CHOW: Thank you, Dr Wells. I have no more questions for
17   you.
18   Sir, my colleague has identified the bundle
19   references.
20   COMMISSIONER HANSFORD: Yes.
21   MR CHOW: Actually, it is referred to by Prof Yin at page 23
22   of his second report, under footnote 4. The bundle
23   reference is CC11/7252 to 7282, and also the document in
24   item 332 in bundle CC11.
25   COMMISSIONER HANSFORD: Thank you.

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1   CHAIRMAN: Thank you.
2   MR CHOW: Mr Chairman and Prof Hansford, I have no more
3   questions for Dr Wells.
4   CHAIRMAN: Thank you.
5   MR BOULDING: Good afternoon, Chairman. Can I ask my
6   questions sitting down so that I can see the good doctor
7   on the monitor?
8   CHAIRMAN: Of course.
9   MR BOULDING: Thank you very much.
10   Cross-examination by MR BOULDING
11   Q. Good morning, Dr Wells.
12   A. Good morning.
13   Q. My name is Philip Boulding and I'm representing the MTR
14   in this particular matter. I've got one or two matters
15   that I would like to discuss with you, if I may.
16   I would like to start with the matter of clusters that
17   you discussed briefly with my learned friend Mr Anthony
18   Chow. Do you remember that?
19   A. Yes.
20   Q. If we could look, please, at your report, in particular
21   paragraph 4.7. The report, I'm told, is ER1, tab 10.
22   Thank you.
23   You will there see your paragraph 4.7, and it's in
24   the section which starts on page 3, under the heading
25   "Analysis. Point 1. Sampling prior to testing

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1   couplers"; do you see that?
2   A. Yes, I do.
3   Q. In your paragraph 4.7, starting at the very end of
4   page 4:
5   "If, as is stated in section 3.3.27 of the holistic
6   report, a major reason for defects is poor workmanship,
7   then defectives will probably be in clusters, and
8   therefore not independent."
9   Do you see that?
10   A. Yes.
11   Q. Then you go on to say that so far as you are concerned:
12   "This will lead to higher rates of defectives in the
13   sample than in the population and hence any results
14   (eg of strength reduction factors) will necessarily be
15   more conservative than should be the case."
16   A. Yes.
17   Q. Now, it's right, is it not, that you have not been able
18   to refer to any evidence which has been put before this
19   Inquiry for the proposition that defectives -- that's
20   your term -- will probably be in clusters; that's right,
21   is it not?
22   A. I think what I've said in 4.7 is:
23   "If, as is stated in section 3.3.27 of the holistic
24   report, a major reason for defects is ..."
25   So I am not making any statement. I am saying, "If

29 (Pages 113 to 116)

1   that is true, then ..." So all I have to rely on is

2   a statement in the holistic report. I'm saying that if

3   that is true, as we discussed earlier today, this means

4   we have localised areas of defects.

5 Q. Right. So basically --

6 A. Defects would likely occur in local areas. What I was

7   then saying was that in a statistical sense, if things

8   tend to occur in local areas, we call that clustering,

9   and clustering leads to conditions under which the

10   binomial assumption is incorrect.

11   All my statements here are purely statistical

12   statements. I'm not purporting to know anything at all

13   about the structural engineering or the workmanship or

14   any other issues. I'm merely making statistical points.

15 Q. I'm glad about that. So it seems to me that the answer

16   to my question is, "Mr Boulding, yes, I'm not aware of

17   any factual evidence that's been put before the

18   Commission to support this particular proposition";

19   that's right, is it not, Dr Wells?

20 A. I'm sorry, I thought 3.3.27 did -- didn't it?

21 Q. No. 3.3.27 I think is the reference that you drew to

22   Mr Chow's attention to local areas of rebar congestion.

23   That's all it says, isn't it?

24 A. Sorry, I must be misremembering. I thought that it said

25   that poor workmanship was associated with local areas of

1   rebar congestion. I was not commenting on the rebar

2   congestion. I was commenting on the local areas of

3   workmanship, poor workmanship.

4 Q. So that's the only matter you relied upon, is it,

5   Dr Wells?

6 A. Again, I might have misremembered, I'm sorry, in which

7   case I apologise, you are correct. But if we could have

8   a look -- and again it's only my reading of it. Are we

9   looking at ...

10 Q. It's OU3256, if you want to have a look at that, and

11   I think it's page 24, and it's that paragraph that you

12   took Mr Chow to, 3.3.27:

13   "The results of improper coupler connections

14   including unconnected and/or cut rebar in both the EWL

15   and NSL slabs are considered to be due to workmanship

16   issues during installation, misaligned or damaged

17   couplers and local areas of rebar congestion."

18 A. Now, my reading of that is that workmanship is related

19   to local areas of rebar congestion; yes?

20 Q. But that's all you can rely upon, is it not, Dr Wells?

21 A. It is indeed. That is all I need to rely on to say that

22   that report is stating that workmanship is potentially

23   related -- no, in fact, I don't think it even says

24   "potentially" -- that workmanship is related to local

25   areas; in other words, clustering. It's not evenly

1   distributed. It's related to specific local areas.

2   That's what we mean by "clustering". It means things

3   cluster together in small local areas rather than being

4   evenly distributed, evenly across the entire area.

5   That's what "clustering" means.

6   That paragraph is stating that workmanship is

7   clustered. I didn't make any assumptions. I simply

8   used what was in the holistic report.

9 Q. Well, we've all got our own views as to what that means

10   but thank you very much for clarifying that, Dr Wells.

11   Could you look at Prof Yin's report, please. ER1,

12   tab 12, page 16. I assume this is a report you have

13   read. I think in fact you told the learned

14   Commissioners earlier that you read this report, did you

15   not?

16 A. Sorry, I'm not looking at anything at the moment --

17   am I? Oh, here.

18 Q. Yes, you are.

19 A. Yes, okay. Right, yes, I'm looking at it.

20 Q. And do you see that he there refers to "Statistical

21   analysis of the PAUT results obtained from the

22   opening-up investigation"; do you see that? The

23   heading.

24 A. What paragraph am I reading?

25 Q. I'm reading from the heading, Dr Wells.

1 A. The opening-up exercise -- so it's:

2   "Statistical analysis of the PAUT results obtained

3   from the opening-up investigation.

4   Verification of defective rates.

5   The opening up exercise took place from December

6   2018 to April 2019. Throughout the period, I noted that

7   the opening up and PAUT results were published and

8   regularly updated on the Highways Department's website."

9   Do I really need to read from the top?

10   "After all the PAUT results became available, I was

11   invited to verify the accuracy of the estimated

12   defective rate calculated on the basis of the PAUT

13   results provided by MTRCL."

14 Q. That's all very interesting, Dr Wells, but I had in mind

15   3.1.3 --

16 A. Which is why I asked you which paragraph. Thank you.

17 Q. -- and there Prof Yin tells us what happened and says:

18   "The target sample size in each slab was at least 84

19   as suggested. MTR provided 90 valid PAUT results for

20   EWL slab of which 25 were found to be defective, and 93

21   valid PAUT results for NSL slab of which 23 were found

22   to be defective. I reviewed the opening up results, and

23   found no strong statistical evidence of clustering in

24   the sample."

25   So far as Prof Yin expresses that view in the last

1   sentence, you are not, are you, in a position to
2   disagree with it?
3 A. When I wrote my report, I was not in a position to
4   either agree or disagree because I am not a mind reader
5   and I had not been able to read Prof Yin's mind where he
6   knew in his mind but had never written down that he had
7   undertaken a review of the opening-up results and found
8   no strong statistical evidence of clustering in the
9   sample.
10   So, when I wrote my expert report, I was going on
11   the information I had, which was the holistic report.
12   The holistic report does not mention anywhere any
13   statistical analysis of the evidence. Therefore,
14   I thought it was a reasonable point on my part to raise
15   it as a potential issue. I have never said that my
16   report is either proving or disproving anything. I'm
17   trying to raise issues which I think might have been
18   missed.
19   Now, if they weren't missed, they were simply hidden
20   away in a drawer and nobody had told anybody about them,
21   that's fine, at least now we know, but I didn't know
22   that at the time I wrote my report.
23   I would also say that I can neither agree nor
24   disagree with the statement in 3.1.3 because it is
25   meaningless. "I found no strong statistical

1   evidence" -- what does he mean by "strong"? I have no
2   idea. I don't know what Prof Yin means by "strong".
3   It's probably different to something that you would mean
4   by the word "strong", or if you took a straw poll
5   through all the people in your room, you would probably
6   get lots of different answers as to what is meant by
7   "strong".
8   So I have no basis, even now that I have read that,
9   to either agree or disagree. But my main point is that
10   at the time I wrote my expert report, all I had to go on
11   was the material I had been given, which was the
12   holistic report, and at that time I felt it was my duty
13   to raise this point, that because clustering does
14   invalidate the assumptions of the binomial assumption,
15   then I thought that it was not at all unreasonable that
16   some clustering analysis had been undertaken.
17 Q. That's a very, very long speech, Dr Wells, if I may say
18   so, to what I thought was a very simple question. I'll
19   put it again. I've got to suggest that you have no
20   reason to refute what Prof Yin says there, and of course
21   he's coming along to give evidence on oath tomorrow.
22   You have no reason to refute that, have you?
23 A. I have no basis to refute it --
24 Q. Thank you.
25 A. -- because it is a meaningless statement. Everybody has

1   their own view as to what is "strong". It's
2   a meaningless statement, therefore I cannot refute it.
3   I have no basis to refute it. Nobody has any basis to
4   refute it. It is a non-refutable statement because it
5   is meaningless.
6 Q. Let me ask you this: have you reviewed the PAUT results
7   and found any statistical evidence of clustering?
8 A. No.
9 Q. Thank you.
10   Now, in your report at paragraph 4.7, you say -- and
11   I think we've been here once before -- that clustering
12   "will lead to higher rates of defectives in the sample
13   than in the population and hence any results will
14   necessarily be more conservative than should be the
15   case".
16   Can I suggest this, Dr Wells, that that's not
17   necessarily the case, is it? Because clustering may
18   also lead to lower rates of defective; that's correct as
19   a proposition, isn't it?
20 A. It is correct as a proposition. It is not what I said.
21   May I read it to you, please:
22   "Another important question to ask is: Are the
23   samples truly independent? The statistical technique
24   used (ie binomial distribution) assumes independence.
25   If, as is stated in section 3.3.27 of the holistic

1   report, a major reason for defects is poor workmanship,
2   then defectives will probably be in clusters, and
3   therefore not independent."
4   Right? So the last word in that sentence is
5   "independent". So when it then says "This", it refers
6   to the last word in the sentence, which is
7   "independent", not independence will lead to higher
8   rates of defectives, not clustering will;
9   non-independence will.
10   All I'm saying in this paragraph is that I think
11   there should have been an analysis. Since the holistic
12   report raised the point that there probably was
13   clustering, in fact it didn't even say "probably"; the
14   holistic report stated there is clustering, therefore,
15   I thought it was incumbent on the statisticians to check
16   for clustering.
17   I have now been told, I stand corrected, that it was
18   actually done. It's just that when I wrote this,
19   I didn't know it had been done, so I thought it might be
20   helpful to the Commission if I raised it as a possible
21   point.
22 Q. Well, I hear what you say, but I need to put to you that
23   clustering may lead to lower rates of what you refer to
24   as the defectives on the basis that random samples can
25   be obtained from areas where there's no defect

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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

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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.

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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

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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

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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

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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

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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 --

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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.

A Court Reporting Transcript by Epiq

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1   Dr Wells, can you still hear me?
2   A. Yes, I can.
3   Q. Splendid. Bearing in mind what we've just discussed, if
4   we go to the next column in from the left, "Strength
5   reduction factor based on 'engagement length cut-off
6   37 millimetres' alone", and we can see for the EWL that
7   the strength reduction factor is 0.354; correct?
8   A. Correct.
9   Q. And as a matter of fact, I would suggest that that is
10   not a significant difference at all, is it, from the
11   figure of 0.366?
12   A. It's not particularly different, no, you are right, yes,
13   I agree.
14   Q. Then if one looks at the next figure, 0.331, and compare
15   that to the figure in the column on the left, 0.332,
16   again you'd agree with me that that is not a significant
17   difference at all, is it? I think it's a second decimal
18   point; correct?
19   A. Yes.
20   Q. It would follow from that, would it not -- I know you're
21   not an engineer, but it would follow from that, would it
22   not, that neither of those figures, 0.354, 0.331, would
23   require suitable measures either?
24   A. I presume so, yes.
25   Q. Going on to your third column, "Strength reduction

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1   factor based on 'number of exposed threads ...' alone",
2   we've discussed that already so I don't think we need to
3   say any more about that.
4   Then my recollection is that you owned up to
5   a mistake so far as the fourth column was concerned,
6   "Strength reduction factor if both criteria are needed
7   for a 'fail'"?
8   A. I did indeed own up, I confess. I'm sorry.
9   MR BOULDING: Thank you very, very much indeed, Dr Wells,
10   particularly for coming in early so we can finish your
11   evidence today. Thank you very much. No further
12   questions.
13   WITNESS: Thank you.
14   MR PENNICOTT: I'm going to resist asking any more
15   questions. I don't think I need to.
16   CHAIRMAN: Are you sure?
17   MR PENNICOTT: Yes, I am sure.
18   CHAIRMAN: Mr Shieh?
19   Re-examination by MR SHIEH
20   MR SHIEH: Dr Wells, two areas to explore with you only in
21   re-examination. First of all, can I ask you to look at
22   the transcript of yesterday. I don't know whether you
23   have the transcript bundle in front of you in London.
24   Now we've lost you on our screen.
25   A. Okay.

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1   Q. May I just enquire whether or not in London -- Dr Wells,
2   you will have parts of the transcript of yesterday shown
3   to you. It is page 73.
4   CHAIRMAN: Gentlemen, I'm told that if we want the screen
5   back with assuredness, we could take some time to
6   reboot.
7   MR PENNICOTT: Dr Wells can hear.
8   MR SHIEH: Dr Wells can hear us.
9   CHAIRMAN: And he can see at least the documents.
10   MR SHIEH: Yes.
11   Now, Dr Wells, it's been a long day for you or a
12   long half-day for you. We've been told that if we want
13   the image of you back on our side, we need to reboot,
14   but I'm going to suggest, subject to the Commission's
15   direction, that we proceed without having to reboot and
16   bring up the image again.
17   CHAIRMAN: Yes.
18   MR SHIEH: Because otherwise it would take a lot of time and
19   it's been a long day.
20   So can I ask you to look at the transcript of
21   yesterday, page 73.
22   A. I see it.
23   Q. Now, from line 15 onwards -- actually, can we move up to
24   the top of that page -- sorry, middle, line 15 -- this
25   is Mr Chow asking you:

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1   "... just now you said you don't have the number of
2   couplers in the diaphragm wall panels. Now, when you
3   talk about one population, 175 panels without capping
4   beams and 62 panels with capping beams, the ratio you
5   determined -- if you simply compare 175 with 62, you
6   have 26 per cent, but if you compare the total number of
7   couplers within this group of 175 panels, with the total
8   number of couplers within another group of 62 panels
9   with capping beams, you may not have the same
10   percentage ... because the number of couplers in each
11   panel are different. Do you agree?"
12   And can we look at the next page. You said:
13   "I can neither agree nor disagree. All I can do is
14   tell you that if what you say is correct, then it
15   completely pulls the rug out from underneath all of the
16   mathematical analysis that followed on from this,
17   because everything that followed on from this then
18   assumes that you could multiply these numbers up by
19   assuming a ratio of 175 to 62.
20   So, if you can't assume the ratio of 175 to 62 is
21   actually the ratio in population, then yes, you are
22   right that my subsequent analysis in 4.4/4.5 might need
23   to be revisited, but unfortunately everything in the
24   holistic report then gets thrown out as well."
25   Do you see that?

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1   A. Yes.
2   Q. So, to summarise, what is being suggested to you, maybe
3   implicitly, is that you can't assume all the panels are
4   similar in width or contain the same number of couplers.
5   That's what your understanding is to be the thrust of
6   the question. Is that a fair way of putting it?
7   A. I think so, yes.
8   Q. Now, can I show you something in Prof Yin's report as to
9   the actual methodology used in picking specimens out of
10   the panels. But before I do that, let me cut to the
11   thrust of the matter. If I tell you that under the
12   methodology adopted for picking specimens out of
13   a population, however wide or however narrow a panel is,
14   once that panel is picked then a fixed number of three
15   couplers will be picked from that panel. It doesn't
16   matter how wide it is, it doesn't matter how many
17   couplers are in fact in that panel, but if a panel is
18   picked randomly, then three couplers are going to be
19   picked from that panel.
20   Do you follow what I'm saying? If I tell you that
21   this was in fact the methodology adopted --
22 A. Yes.
23 Q. -- would you still say that the entire calculation you
24   have done would have the rug pulled from underneath?
25 A. Well, the point you have just raised is that the

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1   two-pass sampling of 28 locations, then three from each
2   sample, is faulty because the three should actually vary
3   depending on how much of the population it is being
4   asked to represent. So that if some panels are bigger
5   than others and have more support within them, then
6   those ones should have a disproportionate number of
7   specimens taken from them.
8   Now, I understand that Prof Yin took that into
9   account in his 28 but didn't take it into account in his
10   three. So, yes, I agree, you have picked up a point
11   there that I didn't, so if you are looking for
12   an alternative career then you might decide to become
13   a statistician.
14   Now --
15 Q. Dr Wells, can I pause you here. That's not my point.
16   Maybe it's really been a long day. Maybe I will just
17   ask you to read -- because I'm not asking you to comment
18   on the faultiness or otherwise of the design. I'm just
19   testing an underlying premise of your acceptance of
20   Mr Chow's question to you yesterday.
21   Can I ask you to actually look at the report by
22   Prof Yin, because in an attempt to take a short-cut to
23   the matter I might have actually inadvertently prolonged
24   it. Can I ask you to look at Prof Yin's report for the
25   purpose of the holistic report, paragraph 2.2.2.

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1   Let me put it again. The comment you made about
2   randomness in your report assumes that there is a linear
3   correlation between the number of panels, the proportion
4   between the number of panels and the proportion between
5   the specimens picked. Is that a fair way of putting it?
6   So if the panels without capping beam and with capping
7   beam bears a ratio of 3 to 1, for example, roughly
8   speaking, then you would expect that the specimens drawn
9   from the panels roughly or should be more likely to bear
10   a similar proportion; is that a fair way of putting it,
11   in a rather layman-like, crude way?
12 A. Yes. If the sampling procedure is truly random, then
13   the ratio 26 per cent and the ratio -- what was it,
14   8 per cent, should be very close.
15   Now, it is possible, just by chance, that you might
16   get an odd result -- like I say, you can toss a coin ten
17   times and get ten heads. It won't happen very often,
18   and when it does probably the first thing you will do is
19   say, "Is that coin weighted?"
20   So I was really raising the point that if I had seen
21   8 per cent where I was expecting 26 per cent, the first
22   thing I would have done would have been to have gone
23   back and done a statistical analysis of the results and
24   tried to see what the probability is, and it might be
25   that actually the difference between 8 and 26 is

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1   statistically not all that significant, but I worked out
2   that it was significant, and the result -- doing that
3   calculation takes so little time that actually I think
4   Prof Yin probably spent longer on explaining why he
5   didn't do it than it would have taken him to do it, and
6   I just think that it's an omission not to; that simply
7   saying, "My sampling technique must be right because
8   I have devised it perfectly, therefore it has to be
9   right", I don't think is sufficient. I think it is
10   incumbent on us, as statisticians, to go back and make
11   a check on the actual numbers.
12 Q. But can I draw your attention back to what Mr Chow put
13   to you yesterday. The scenario he put to you yesterday,
14   encapsulated by the exchange that I read to you just now
15   on the transcript was that, "Aha, hang on a second. Not
16   all the panels contain the same number of couplers and
17   therefore you can't necessarily infer or assume that the
18   actual number of couplers with or without capping beams
19   bear the same proportion to the number of panels with or
20   without capping beams." That was your understanding of
21   the point put to you by Mr Chow yesterday; is that
22   a fair way of putting it?
23 A. Yes, that's a fair way of putting it --
24 Q. And you were saying that, ah, well, if the number of
25   couplers potentially open to be picked from the bag

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1   doesn't bear the same proportion to the number of
2   panels, then you can't draw any conclusion out of the
3   proportion of the specimens actually drawn? That's
4   really what you are accepting; correct?
5   A. That is true, yes. I think you have cut to the nub of
6   it, yes.
7   Q. But if I now tell you that in fact your original
8   assumption was correct, that the number of couplers
9   potentially open to be picked out of the bag does bear
10   a proportion to the number of panels with or without
11   capping beams, then your acceptance of Mr Chow's
12   proposition falls away? That must be so, as a matter of
13   logic; correct?
14   A. Okay. Yes.
15   Q. Now I'm going to show you how exactly the specimens were
16   picked out of a bag. Can you look at Prof Yin's report
17   at point 2.2.2. He said:
18   "D-wall panels available for selecting sampling
19   units at EWL and NSL slabs."
20   Do you see that?
21   A. Okay. Yes.
22   Q. "The EWL slab is connected to East D-wall and West
23   D-wall ... These D-wall ... connections can be divided
24   into four groups ..."
25   Then at 2.2.2, Prof Yin says:

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1   "Before conducting random selection of coupler
2   connection samples for verification, the government and
3   MTR, after going through the relevant construction
4   records, reached general consensus on the identification
5   of D-wall panels with or suspected to have coupler
6   connections among the 4 groups of connections. The
7   number of D-wall panels identified to have coupler
8   connections are summarised below".
9   Then there are four sectors, totalling 232. Then
10   similar for NSL slab:
11   "Similar to EWL slab, the NSL slab is connected to
12   East D-wall and West D-wall ..."
13   2.2.4:
14   "The government and MTR had gone through the
15   relevant construction records before the random
16   selection [process] ..."
17   And he talked about certain locations not being
18   accessible, but let's skip that for present purposes.
19   Let's then go to 2.3.3, "Phase 1 sampling
20   selection". Now, to understand the meaning of phase 1
21   and phase 2, can I ask you to look at 2.3.2:
22   "A two-phase cluster sampling scheme was adopted in
23   the selection of sampling units, each opening-up site
24   (or sampling unit) yielding three coupler connections.
25   Phase 1 sampling selection was to determine the

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1   locations of sampling units on plan, while phase 2
2   sampling selection was to determine the layer of coupler
3   connections to be exposed for workmanship verification
4   at locations selected in phase 1."
5   So 2.3.3 talks about phase 1, because -- so phase 2
6   means which layer you pick, phase 1 means which location
7   you pick. Having picked the location, you then decide
8   which of several layers you pick. Do you follow that,
9   Dr Wells?
10   A. Yes. Thank you.
11   Q. Now, 2.3.3 talks about "Phase 1 sampling selection":
12   "As described ... the government and MTR ...
13   identified 232 and 189 D-wall panel locations at EWL and
14   NSL ... respectively, which are physically
15   accessible ... Based on the prior decision made, 28
16   sampling units, each yielding 3 coupler connections,
17   would be selected from each of EWL slab and NSL slab.
18   For EWL slab, the top connections available for
19   sampling were significantly fewer ..."
20   I think we can skip that. Let's go to 2.3.6:
21   "In order to select D-wall panels on a random basis,
22   a number with 5 decimal places was randomly generated
23   from a uniform distribution ranging from 0 to 1 and
24   assigned to each D-wall panel in the group. D-wall
25   panels available for selection in each group were then

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1   sorted in a descending order based on the assigned
2   random number ... The D-wall panels listed after the
3   required number of selected D-wall panels formed the
4   'waiting list' and served as backup replacement
5   locations in case difficulties were encountered during
6   opening up of the coupler connections ... For instance,
7   for EWL East D-wall top connection where 3 sampling
8   units were to be selected, the top 3 D-wall panels
9   sorted out of 27 panels according to the values of the
10   randomly generated numbers would be chosen as the panels
11   to be opened up, and the 4th D-wall panel in the sorted
12   list would replace any one of the top 3 originally
13   selected D-wall panels ..."
14   Then 2.3.7:
15   "While the lengths of panels range from 2.8 metres
16   to 7.2 metres and that the size of the opening up area
17   was about 400 millimetres width for yielding 3 coupler
18   connections in the same layer, it was necessary to
19   determine the exact location of the opening up area on
20   plan at each of the D-wall panels selected as described
21   above. To achieve this, another random number with 5
22   decimal places valued from 0 to 1 was generated from
23   a uniform distribution ..."
24   Then if you look over the page at figure 1, you see
25   illustration for determining the "reference point". So,

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1   if there's a long D-wall, then if they need to pick
2   a particular width within that D-wall to choose their
3   three coupler connections, then this is the way they go
4   about doing it.
5   Then phase 2 talks about deciding which layer. But
6   let's gloss through all that. The effect of all this --
7   we can all read it -- seems to be that you pick a panel,
8   and within that panel, if it's a wide one, then you pick
9   a particular width within that panel, but however wide
10   or however narrow, for each panel chosen, you only
11   choose three coupler connections, irrespective of the
12   different number of couplers between different panels.
13   Do you see what I mean?
14   A. Yes.
15   Q. Right. Now, do not criticise this sampling technique.
16   This was in fact what happened; all right? So does it
17   or does it not appear to you that your original
18   assumption or your original premise that you can expect
19   a higher -- you should be able to expect a higher
20   probability of correlation between the number of panels
21   and the number of specimens chosen holds good?
22   Is it too long a question?
23   A. Sorry, does the question state or ask would we expect
24   what we see to match the population we were led to
25   believe of 175 to 63? Is that --

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1   Q. Yes.
2   A. Okay. Right. There are a lot of considerations in
3   there. This is a lot more detail than I've seen before,
4   and I think you are raising points, as I said, if you
5   want to have a second career -- you are raising points
6   that I probably should have raised, although, as I say,
7   I've only just seen all of this.
8   To randomly select from panels of different sizes,
9   we would first of all need to weight the randomness
10   according to the size of the panel, or according to the
11   engineering records which tell us how many specimens
12   there are in a panel, because the specimens may not be
13   evenly distributed through panels. So we would need to
14   go back through that exercise and decide whether or not
15   we need to weight them.
16   I didn't see a mention of weighting as you went
17   through this. Maybe it was done; maybe it wasn't.
18   I don't know.
19   The next point that I noted, as you were going
20   through this, is that if -- makes the same mistake as
21   I was pointing out yesterday -- no, earlier today --
22   about discards, that with this phase 1/phase 2, when you
23   get into phase 2, you try the first three on the list
24   and if one of them is not accessible for some reason,
25   then you try the fourth. That is obviously going to

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1   bias your sampling towards the ones which are most
2   accessible, because you are not discarding randomly; you
3   are discarding based on a criteria which is how
4   accessible are they, so you will necessarily have seen
5   a lot more specimens which are easily accessible in your
6   sample.
7   So what you've just been through has highlighted
8   I think several additional points about the reasons why
9   this might not actually be a correct sampling procedure.
10   But I don't think anything in there would -- other than
11   that I think it's not a good sampling procedure, I don't
12   think there's anything that would necessarily tell us
13   that we should be getting a different result so that the
14   26 per cent and the 8 per cent should still be the same,
15   and the fact that they are not is then asking us to go
16   back and look at some of these other points, such as
17   maybe if we had correctly applied the weighting then we
18   would have got a more representative sample, and
19   I really ought to be using the word "representative",
20   not "random" here. We are asking, is it representative
21   of the population, and quite clearly 8 per cent is not
22   representative of a population with 26 per cent.
23   As I said yesterday -- I was asked about oranges and
24   apples -- if the greengrocer has 175 oranges and 63
25   apples and you go in and pick them at random and you

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1   come out with 83 oranges and only seven apples, then
2   there is some evidence, not proof, that the greengrocer
3   was stacking the oranges in a more easily accessible
4   place because, for some reason, the oranges are perhaps
5   about to go out of date and they need to get rid of them
6   quickly.
7   So once you see a significantly different proportion
8   in your sample than you were expecting from the
9   population, you go back to your sampling technique and
10   ask, "Why might this be? It isn't what I expected."
11   There may not be a reason for it, it might be purely
12   random, but you at least go back and look. And here you
13   have I think highlighted several places where you could
14   usefully look. So, for instance, there's this phase 2
15   part, that the three is clearly biased because it's
16   discarding specimens that can't easily be reached.
17   Phase 1 appears to be faulty because the panels are of
18   different sizes and may or may not have different
19   numbers of couplers in them, and I didn't see
20   a weighting factor in there but you went through it
21   quite quickly and I might have missed it.
22   Q. Dr Wells, thank you. As I said, I wasn't asking you to
23   criticise or comment on the soundness of the procedure.
24   I was just asking you whether or not the point you made
25   about the proportion would remain good, having seen the

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1   way it's done.
2   Can I just clarify with you what you meant by
3   a certain sentence in the answer you had given. You
4   probably don't have the transcript in front of you as to
5   what you have just said. What you have just said is
6   this:
7   "... I don't think there's anything that would
8   necessarily tell us that we should be getting a
9   different result so that the 26 per cent and the 8 per
10   cent should still be the same ..."
11   I'm trying to understand what you mean by that. Are
12   you suggesting that your point about the disparity
13   between the 26 per cent in the population and the
14   8 per cent in the specimen would still hold good? Is
15   that the point you are trying to make?
16 A. Sorry, yes, the disparity still holds good. I cannot
17   see from that a reason why we should a priori expect
18   a different proportion in the sample to the proportion
19   in the population.
20   So, having seen a difference, we should now go back
21   and look. Now, the minutiae say, "Yes, here are some
22   places I could look", and those were the ones I just
23   mentioned, the phase 1 bias by discarding the not easily
24   accessible and the phase 1 possibly needing some
25   weighting factors in there. So these are possible

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1   places to look. But they are not a priori evidence of
2   a difference. They are merely possibilities for why the
3   difference, a difference, might have occurred.
4   But from that I would still say they should -- the
5   population and the sample should still match, and if
6   they don't it rings an alarm bell, that's all.
7 Q. Thank you.
8 A. At the very least it's worthwhile spending five minutes
9   on doing the calculation to see what that confidence is.
10 Q. Thank you very much.
11   I'm going to lastly pick up Mr Boulding's invitation
12   to take you to the holistic report and see where it
13   explicitly refers to cutting. First of all, can I ask
14   you to look at the opening-up bundle at page -- let me
15   see. Let's look at the text of the holistic report at
16   paragraph 3.3.25, and that is to be found at page 3256.
17   This is 3.3.25 of the holistic report. It says:
18   "There are a total of 48 defective samples in the
19   EWL and NSL slabs under the purpose (ii) opening-up,
20   including eight cases where the main reinforcement bars
21   were not connected to the couplers, and five cases where
22   the rebar would appear to have been cut."
23   Dr Wells, do you see that?
24 A. Yes, I do.
25 Q. Is that an occasion which you had in your mind when you

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1   said the holistic report explicitly mentioned when they
2   saw rebars had been cut?
3 A. Yes, it is.
4 Q. Can I then take you to appendix B3, the actual results.
5   Let me see. I might have lost the reference. If
6   you look at 3310, item 19, for example, you would see:
7   "Exposed rebar is unconnected to the coupler and
8   thread cut."
9   Do you see that?
10 A. Yes.
11 Q. Then item 20, again, there's a reference to "thread
12   cut"; do you see that?
13 A. Yes.
14 Q. Are these the examples which you had in your mind when
15   you said, in your evidence just now, that the holistic
16   report in fact mentioned the cutting of bars, if they
17   saw it?
18 A. Yes, it is. The two pieces of information together --
19   one says there were five that were cut and then this
20   table explicitly references which five they are -- led
21   me to believe that the others were not cut, and that
22   therefore the ones that were cut could not be relied
23   upon to have a number of exposed threads which was in
24   any way compatible with the amount of thread not
25   visible. Whereas if it hasn't been cut, I thought it

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1   was quite reasonable to assume that the amount of
2   exposed thread and the amount of unexposed thread are
3   added to make the total amount of thread.
4 MR SHIEH: Thank you very much, Dr Wells. I have no further
5   questions for you, subject to anything arising which the
6   Chairman and the Commissioner may want to ask you.
7 COMMISSIONER HANSFORD: No. Nothing from me.
8 CHAIRMAN: Anything at all, gentlemen?
9   Dr Wells, thank you very much. We appreciate the
10   fact that you came in so early and that you've stayed
11   with us for an extended period of time. Thank you very
12   much indeed. Your evidence is now concluded. Thank
13   you.
14 WITNESS: Thank you.
15   (The witness was released)
16 CHAIRMAN: Good. All right. We will, tomorrow morning,
17   start at what time?
18 MR PENNICOTT: 10 o'clock, sir.
19 CHAIRMAN: 10 o'clock tomorrow morning. Thank you all very
20   much.
21 (7.11 pm)
22   (The hearing adjourned until 10.00 am the following day)
23
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