COMMISSION RESUMES ON FRIDAY 24 FEBRUARY 2012 AT 9.30 AM

MR MILLS CALLS

PAUL TONKIN (SWORN)

Q. Your full name is Paul Keenan Tonkin?

A. That is correct.

Q. You're a construction programmer and planner with Woods Harris Consulting in Christchurch?

A. That's correct.

Q. And you're a resident of Christchurch?

A. That is correct.

Q. You joined Woods Harris Consulting in 2006?

A. Yes I did.

Q. And immediately prior to that you were with Fletcher Construction Limited?

A. Correct.

Q. And you were there for some 32 years?

A. Correct.

Q. During that time you held positions of site manager?

A. Yes.

Q. Project manager?

A. Yes.

Q. And construction manager?

A. That's true.

Q. And you were the site manager for the construction of the Forsyth Barr building?

A. Yes I was.

Q. You have in front of you there a brief of evidence that you prepared?

A. I've got my one, yes.

WITNESS READS BRIEF OF EVIDENCE COMMENCING AT PARAGRAPH 3

"I was the site manager for the construction of the Forsyth Barr building. In that role I was responsible for managing the construction of the

building process on site. This included managing both the sub-contractors and Fletcher's staff.

I have been asked to give evidence in relation to the seismic gap in the stairs in the Forsyth Barr. This involves two particular issues. First, the understanding that I had at the time of what I now understand is the critical importance of a seismic gap and the extent to which the importance of this was addressed with me by the consulting engineers on the project, Holmes Consulting Group, and by the Christchurch City Council. Second, the presence of the construction rubble polystyrene that I understand was found in some of the seismic gaps in the Forsyth Barr stairs during the course of inspections of the stairs following the 4 September earthquake and again following the 22 February 2011 earthquake..."

EXAMINATION CONTINUES: MR MILLS

Q. Can I just get you to pause a minute. I think there is a typographical error there and I will ask you to confirm it. You read, "Second, the presence of the construction rubble polystyrene....." would you accept there should be an "and" in between those words?

A. Yes.

WITNESS CONTINUES READING BRIEF OF EVIDENCE AT PARAGRAPH 6

"In relation to this issue I have been asked to give evidence about the inspections and other supervision carried out during the construction to ensure that the seismic gap as built, provided the gap that was specified in the structural drawings. The critical importance of the seismic gap was never brought home to me at the time the Forsyth Barr building was being built. It was shown on the drawings and I was, of course, aware of this, but I now realise I had an inadequate appreciation of its significance. Nothing was ever said to me about its critical role, by either the structural engineer on the job, Holmes Consulting Group, or by the Council. To my knowledge no-one from the Council came to the site during the construction to specifically check the stairs and I would

expect to know if this had happened. Any inspections of the seismic gap would have to have been before the sealant was put into the seismic gap and before the floor covering was installed over the landing and the seismic gap. I have no recollection of any specific inspection.

Looking back on this, I think that one of the reasons for my lack of any particular thought about the seismic gap was that I never thought the building would move the amount it obviously did in September and February. We were building a battleship. It was a very strong building and all of us working on the job were well aware of this. The thought that the building might shake in an earthquake in a way that would make the seismic gap relevant never crossed my mind and was never, to my recollection, a matter of discussion with the construction team or with the structural engineers.

There has been a dramatic increase in quality control over the last 25 years. At Fletcher Construction Ltd this was driven consistently from the top down. There has been much more formalisation of quality control. Today on a job like Forsyth Barr, Fletchers would have a written check list that would specifically include the seismic gap and details that have to be checked. Someone would have the responsibility of signing this off as a completed activity. The details to be checked and signed off would include ensuring that the full width of the gap was maintained and that it contained no obstructions.

However, I can only speak for the culture at Fletchers. During my time there I considered it to be a leader in the push for ever greater quality control.

The polystyrene that I understand has been found in the seismic gap would probably have been put in there as an edge to the formwork. The pre-cast stairs were put into place before the floor slab was poured. The polystyrene was used to create an edge up to which the concrete would be laid. While the polystyrene ought to have been removed once the concrete dried, I strongly suspect that when the contractor who was responsible for putting the flexible sealant into the seismic gap came to do this he would have seen the polystyrene as an ideal base for his

sealant. I suspect that what happened here is that the contractor probably cut a strip off the top of the polystyrene and then the sealant would have been installed over the top of that and into the seismic gap, after which the polystyrene strip would not have been visible. The floor coverings would then go over the top of that.

I have been also asked to comment on the section in the Beca report that appears to evidence an attempt to cut back the bottom of one of the stair flights by using a concrete saw. I had no knowledge of this prior to being made aware of what is in the Beca report, but it seems clear that one of the pre-cast sections must have been over-length. The building itself was built to very tight tolerances because of the aluminium and glass panels that needed to be fitted to the outside of the building, so the issue would have been with the pre-cast stair section rather than building tolerances being exceeded. In the course of preparing my evidence I have been shown the detail of the way in which the bottom of the stair was able to slide in the event of an earthquake. I understand that the concern now being expressed about limited tolerances for stair movement that this provides and the risk of the stair dropping off the edge of the seating channel. However, at the time I never had any concerns about the design we were working to. As I observed earlier in my evidence, we thought we were building a battleship.

What did cause me concern about the stairs at the time was that they were very lively. There was a lot of bounce in them. Initially this caused quite a lot of unease with the workmen on the site. As the workers ran down the steps for smoko the stairs would really bounce up and down. In my experience the design of the stairs was unusual. They were quite narrow and they were cast in one single length. The amount of steel under the middle of the landing was relatively light. My previous experience had been that pre-cast concrete stairs were invariably in two sections rather than one. Because of the shorter span length they did not have the potential to be as flexible as these stairs were.

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I was also accustomed to a lot more steel being used to support the mid-landing and this also made the stairs much more rigid.

I have reviewed the BECA report on the collapse of the stairs. I do not believe that enough consideration has been given to the vertical bounce of the building and the impact this would have had on these stairs. It is well documented that the vertical movement was recorded at a rate that exceeded 1g. Based on my observations of how lively the stairs were and how they bounced, and how they bounced," there's another error there, "when we ran down them it seems very likely that the vertical accelerations would have severely stressed these stairs, possibly to a point of failure."

JUSTICE COOPER:

Q. Just to clear that up. What you've written there I think is all right but, "Based on my observation of how lively the stairs were and how they bounced when people ran down them."

A. Yeah.

Q. "It seems very likely that the vertical accelerations would have severely stressed these stairs, possibly to the point of failure."

A. Correct.

Q. That's right.

A. Yep.

WITNESS CONTINUES READING BRIEF OF EVIDENCE

A. "While I'm not a structural engineer, no-one has given me a satisfactory explanation why the level 15–16 stair being the only one broken in half with the top half left hanging by the reinforcing cast into level 16. To me this implies that the stair broke in the middle with the lower half then being able to free-fall to the next stair and cause a domino effect that saw all the stairs from the upper floors collapse to the ground."

EXAMINATION CONTINUES: MR MILLS

Q. Yes thank you Mr Tonkin. I just have one or two matters I need to raise with you, not so much questions as matters that have been raised with us since you prepared your evidence.

A. Mmm.

Q. And I think you're aware of what these are. These are principally the site reports that have come into us from Holmes Consulting Group since you did your evidence and I need to take you to those because they do refer to various checks on the seismic gap during the course of the construction of the building

A. Mmm.

Q. And I just need to be sure that in light of that this doesn't cause you to have any different views than those that you've currently expressed in your evidence and I realise this is a long time ago and you prepared your evidence without seeing these so there'll be no particular criticism of you if you did have some further thoughts after seeing these. Now the first one I need to take you to is document WIT.HAR.0007.11. This is a site report dated 8 July 1988. You might have it there because I think these were sent to you but it will come up on the screen. Now it will be in front of you now if you don't have it in the hard copy there.

A. Yeah. yeah I do.

Q. And you'll see that this relates to levels one to three and it says, this is from J M Fisher who apparently was the supervising site engineer, and you'll see down the bottom there that it is copied to Fletcher Development and Construction.

A. Mmm.

Q. And I suppose first could I just ask you whether you would expect that you would have been a recipient of this.

A. Yes I would have seen that.

Q. And you'll see that what it says under that heading, Stair Seismic Gap, is, "The seismic gap at the bottom of stairs PS4A is 30 millimetre."

A. Mmm.

Q. "The stairs going up from north to south from levels 1 to 2 and 2 to 3 have less than 30 millimetre. The level 2 to 3 stair is to be moved before level 3 is poured to achieve the 30 millimetre seismic gap."

A. Mmm.

Q. "The level 2 stair is cast in place. The 30 millimetre gap is to achieved by cutting the required amount off the pre-cast beam." Now do you have any recollection of seeing this at the time?

A. No I don't.

Q. But you accept that it would have come –

A. Absolutely.

Q. – to your desk at least?

A. Yeah.

Q. Now as I understand what's being proposed there as a way of dealing with the 30 millimetre gap on the level 2 stair that was already cast in place is not to cut off the end of the stair but to cut into the beam. Is that a correct understanding of this?

A. Yes, yes that would be.

Q. How would you go about that?

A. To do that now I would instruct a concrete cutter to come and cut the vertical cut and then use a, just use a chisel to break it out, break the (inaudible 09:45:21).

Q. But that's essentially, I take it that's essentially what's shown on that little sketch there?

A. Exactly, yeah.

Q. Is that a complicated exercise?

A. Not particularly.

Q. Then let's take you to the next one that I think is relevant. This is document, it's another site report, this one for the 25th of January 1989 and it is WIT.HAR.0007.14. Now you'll see that this one appears to relate to level 17.

A. Mmm.

Q. And again under the Work Reviewed it refers to seismic stair gaps and then in the body of that document under the heading Seismic Stair Gaps

it says "the correction of the seismic gap on the stairs has not been carried out yet. This should be addressed as soon as possible." So that appears, tell me if you agree with this, to relate to some further previous instruction that must have been given to deal with something and it hasn't yet been dealt with?

A. I would say so, yes.

Q. Now again you'll see that it's copied to Fletcher Development and Construction.

A. Yes.

Q. And you again agree that would have at least come to your desk?

A. Yes.

Q. Do you have any recollection of seeing this?

A. No I don't.

Q. I'll take you next then to document BUI.COL764.0141.3. This one is dated February, sorry 2 November 1988. So these precedes the one that we just looked at. I've done it in this order because this is the way it came to us really. I probably should have reorganised this. Now you'll see there another site report, site report number 87. There is a, a reference at the top under the "Work Reviewed. Remedial work required, ground floor to level 13," and then further down under that larger heading, "Remedial Work Required. Ground floor to level 13," and point 2 is, "The seismic gap on all stairs needs to be checked. The seismic gap is 30 millimetres except at levels 2 and 3 where it is 25 millimetres. Where the gap is less than that required the adjustment is to be made to the pre-cast beam." Now again it comes to you. Do you have any recollection of receiving this?

A. No I don't.

Q. Now just to go back, I won't take you back but just to get this sequence in the order – I should have done it initially and I apologise for not doing that – but that would suggest wouldn't it that the site report on the 25th of November 1989 which said, "The correction of the seismic gap on the stairs has not been carried out yet," and which appears to relate to

level 17 would probably be a follow-up to this one of the 2nd of November do you think?

A. It would seem likely that that was, yep.

Q. And would you read that as I'm inclined to, as suggesting that it had been done on all levels except 17?

A. I don't know whether the one at level 17 refers to level 17 stair. The way I would read that, the way I would interpret that now is that it's referencing potentially the stair down at level 2. That was the, the, was it July, the first one that we looked at, was that July?

Q. Yes.

A. Referencing the July work.

Q. Yes.

A. Because the level, if we go back to the second site report that level 17 works was noted and then there was a separate heading for stair, and it didn't note what the stair level was.

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Q. Right.

A. So when I read that my interpretation of that was that it was in relation to the level 2 stair which had still to be remediated.

Q. I accept that as a possible reading of it but you don't have any recollection of this from the time?

A. No.

JUSTICE COOPER ADDRESSES MR MILLS:

Can we go back to that Mr Mills, that particular document?

EXAMINATION CONTINUES: MR MILLS

Q. So we'll go back then to document WIT.HAR.0007.11?

WITNESS REFERRED TO DOCUMENT

A. 14. So the way I would interpret that would be "Inspections of remedial work to level 17… sawdust, excavation, excavation" and then "seismic gap" is a separate heading as is "Ramps one to two: top portion" so I

would read those as three separate, and when I read that just recently my immediate thoughts were that that related to the -

Q. – the reference (overtalking 09:51:19).

A. – the earlier –

Q. – which is the one at 11. Can we go to the earlier one, 0007.11 which is the July one.

WITNESS REFERRED TO DOCUMENT

A. Correct.

JUSTICE COOPER:

It's an earlier one still, the suffix is 11.

EXAMINATION CONTINUES: MR MILLS

Q. That's the one you're referring to that you think –

A. I, when I read that yesterday my immediate thoughts were that was in relation to that work that had yet to be carried out. In my mind if it had been another stair then there would have been a reference in that November report to another stair.

Q. Well I do note though that the – and again one doesn't know. You might be able to comment on this but I'm not sure what level of precision to attach to the way words are used in the site reports but I do know that that one refers to seismic stair gap and when we look at the one we looked at earlier that initiated this discussion, it's referring to seismic stair gaps and then in the text underneath that it refers to the correction of the seismic gap on the stairs plural.

A. Mmm.

Q. So I guess –

(overtalking 09:52:40)

JUSTICE COOPER ADDRESSES MR MILLS:

Q. Well, it's not a statute is it Mr Mills?

A. Well that's why I said, I'm not sure how one reads these things.

Q. Well especially when in document we're looking at, although the heading is stair seismic gap, plainly the content of this memorandum is about two seismic gaps.

A. Yes. That's true too –

EXAMINATION CONTINUES: MR MILLS

A. One to two and two to three.

Q. Well we've got a couple of candidates don't we. We've got the, so the sequence is that initial one that Mr Tonkin's just referring to, then we've got the one in November that says, "all stairs need to be checked," and then we've got the follow-up which comes after both of them and I guess we're not going to resolve it beyond that are we? Your view is that it's probably a reference to this one.

COMMISSIONER CARTER ADDRESSES MR MILLS:

Q. Mr Mills before we leave this point there's one aspect that I think we could benefit from pursuing.

A. Yes.

Q. We note in that diagram that there is a steel angle cast onto the end of the precast stair to give it a sliding surface.

A. Yes.

COMMISSIONER CARTER ADDRESSES MR TONKIN:

Q. And I would suggest Mr Tonkin that that angle will have been held in place by some rag bolts that would be welded to it, that are cast back into the bottom of the precast stair.

A. Yeah, the bolts or what we used as a piece of flat normally with a fishtail on it.

Q. Yes, so effectively the cutting was intended to be to the precast beam to the right of that diagram?

A. Correct.

Q. That part of that beam is actually cast in situ though is it not, with though it would run across to the starting point of the other stair running up in the other direction which is cast into that beam?

A. Yes.

Q. By starter bolts, so in fact the precast beam finished part way up that steel channel and the top half of the beam was cast in situ concrete?

A. That was my recollection I think.

Q. Yes, that's what's shown on other joins.

A. Yeah.

Q. So there could just be the possibility. Couple this with the photograph we were shown which showed that there had been attempt to shorten the stair by making a saw cut. That would not be possible because of the presence of that steel angle at the bottom –

A. Yes.

Q. – that would have to be cut off and would have shortened the stair.

A. That's correct.

Q. I'm just wondering whether there may have been some confusion by referring to precast beam that the person reading it thought that he was being instructed to shorten the precast unit which was the staircase.

A. Yes.

Q. Rather than the cast in situ part which was the beam to the right and not a precast beam so there could have been a possibility for misunderstanding between the contractor and the engineer about exactly where the cut was going to be made, and we do have other evidence, photographic evidence that shows an attempt was made to open up the joint by cutting into the precast stair, but which of course would not have reduced – would not have increased the clearance to the required amount, so I just thought I'd point out this was an – there's an opportunity here for someone to misunderstand. He thought he was being told to cut the precast member which was the stair and was probably aware the cast in situ concrete was not being referred to by this wording here, so –

MR MILLS ADDRESSES THE COMMISSION:

Yes, well we certainly we do know is as you've pointed out Commissioner that there was cutting on – they don't know exactly how many but several of the stairs were cut back in exactly the way you describe and you'll recall I asked the BECA witnesses if they'd seen any evidence of cutting back into the in situ beam and while they didn't claim to be able to be certain that there was, they said they certainly didn't observe any when they were looking, so yes.

JUSTICE COOPER:

Although this document that we're looking at now, the July 88 one, says the 30 millimetres gap is to be achieved by cutting the required amount off the precast beam, so.

COMMISSIONER CARTER:

But it wouldn't be cutting off the precast beam because the precast beam part was down below, below all this. All right, so I don't know that I clarify anything particularly but just show that there could be different interpretations of the instruction.

MR MILLS:

Yes, well I will ask Mr Hare about this because it's clear from the evidence from the BECA's witnesses at any rate that irrespective of the intent of this direction given in the site report that we're looking at for the November one saying all the stairs have got to be checked, that that doesn't appear that it was successful at any rate because we've had the dimensions from the BECA witnesses which got down as low as 11 millimetres when they were finally got onto the site in September of this year.

EXAMINATION CONTINUES: MR MILLS

Q. Well the only question that I have for you really Mr Tonkin is whether having been taken through those various site reports, do you have – does that cause you to change any aspect of your evidence?

A. No it doesn't. The only thing it has jogged my memory to is in my evidence I stated that the stairs were cast in one piece, and that's clearly not true. They were two-piece with an in situ pocket at the mid-landing and my reference to the bounce and the flexibility of the stairs would obviously now only be relevant once that concrete had been cast and the props were removed, therefore creating a single flight.

Q. I think the evidence that we have, I understand why you would say that, from the drawings, but the evidence that we've had is that although the drawings showed it in two pieces it was actually put in as a single unit.

A. It was. Well that was my memory.

Q. Yes.

A. And when I looked at that I couldn't believe that my memory was that bad.

Q. Yes, well the evidence that we've had and I don't think it's been challenged.

A. Okay, that it was a single –

Q. That it was regardless of the structural drawings it was done as a single precast flight just as you have said in your evidence.

A. Okay. Then I'm happy that my evidence stands as read.

Q. Can I then just ask you one final question and it's about construction tolerances. There's no reference in the structural drawings in respect of the 30 millimetre seismic gap to any issue of construction tolerances –

A. Mmm.

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Q. – in constructing that gap. How would that normally be understood by the contractors?

A. In everything that we build there are construction tolerances. I think New Zealand Standard 3114 outlines those and in particular the reference, I think it's the 1987 document. Yeah I think it was revised in '87 for this, but for mine to view a set of construction documents that showed a gap of 30 millimetres that is what we would be expect – that's what we would expect to achieve.

Q. So no construction tolerance over and – that would have the prospect of reducing that gap?

A. Not specifically, not, not a conscious thought, we can make this 20 or we could make this 15. If it said 30 on the drawings that's what our aim would have been to achieve.

CROSS-EXAMINATION: MR LAING

Q. Mr Tonkin, could you just help me with some issues around the building site history. My understanding was that the construction work was started by Paynter Development?

A. That's correct.

Q. And were you working for Paynters at that stage?

A. Yes I was.

Q. So when you say that you were working for Fletchers for 32 years does that include your time with –

A. The whole team on that site was taken over in terms of employment and our employment was considered to be continuous with Fletchers.

Q. Yes.

A. So our employment records are 30 years, 32 years.

Q. Yes, no that's helpful. Thank you. So this was the first building project you had worked for with Fletchers?

A. Correct.

Q. Did you have any access to Fletcher's records when you were preparing your evidence?

A. No.

Q. And I think that's probably clear from the fact you hadn't seen the material now produced by Holmes?

A. Mmm.

Q. So you're simply relying on your, obviously your memory.

A. My memory.

Q. It's 20 years ago. Did you keep records of Council inspections?

A. I, I didn't but they were kept on the site.

Q. Yes and your role as the site manager or, was that, were you in charge of the whole site or was?

A. No I wasn't.

Q. Who was in charge of the site?

A. There was a project manager and there was a senior site manager.

Q. Yes. So who would have kept the records about Council inspections or Holmes inspections?

A. They would have been kept in the office but all of us were in a position to have read those.

Q. Yes. Yes. When you say that you weren't aware of the critical importance of the seismic gap, and it's not a criticism, it would have been, you would have been aware at the time based on what was seen from the Holmes records that that was important to have that achieved though?

A. Yes as important as any of the other structural details that we were working to.

Q. But in terms of its being singled out as a matter of importance. Was anything else singled out as important on the site?

A. No everything that was involved in the construction, in the structure, as is evidenced from the various comments as to other aspects of the structure from Ms Fisher's reports.

Q. So it wouldn't be surprising then that the importance of the seismic gap wasn't singled out as something for your special attention?

A. That was the comment that I made when I discussed it with Stephen, that it was, I considered it was just part of the, the construction process.

CROSS-EXAMINATION: MR HANNAN

Q. Now Mr Tonkin I've got a number of questions for you. You'll understand that our purpose here today is to understand what happened, learn lessons for the future. It's not a matter of finding people to criticise and so on. So that's the spirit in which these questions are asked. I'd just like to ask first of all, to give a bit of

context, about your personal experience, background and formal qualifications. I mean did you start in the trades or what's your –

A. Yes I'm a carpenter by trade.

Q. And then you went onto the role that you were doing at this time?

A. Mmm.

Q. So you know about bracing and triangulation and all that sort of thing?

A. Mmm.

Q. Now you would have known because this is what happens on all building sites that engineers and other design professionals will be coming around to inspect the building at various times.

A. Mmm.

Q. You would have seen these people coming around?

A. Absolutely.

Q. Would you go around with them?

A. In most cases, yes.

Q. You have conversations with them as they were going around?

A. Yes.

Q. Now if we can please have a look at document WIT.HAR.0007.8 and this is a site report from Holmes, 22 June 1988. If we can just go back to the larger, the larger view of it please. If you just take away the enlargement. Now just looking at the foot of the document. It says, "Copies to Fletcher Construction," and then there's a cross and then there's the numeral 2. So it's by 2, it means there's two copies gone.

A. Mmm.

Q. Do you see that?

A. Yes.

Q. Can you now recall, it will be perfectly understandable if you can't, just who those copies would have gone to within Fletcher?

A. No I, I can only imagine that one would have potentially gone to the office and one to the site.

Q. Yes thank you. Now if we could look at 0007.16. Now do you see that's a site report from the 3rd of May 1989. Do you see that?

A. Yes I see it on the screen.

Q. Now it's not about the stairs but it's more about seismic gaps, isn't it?

A. Yes it is.

Q. So it's fair to say isn't it that the inspecting engineers were working around the site and they were paying attention to these seismic gaps?

A. Certainly.

Q. If we can go please to 007.11 and this is the site report for the 8th of July 1988 headed, Stair, Seismic Gap. Just coming back to the discussion which earlier occurred in your evidence about this. We've got the little sketch below the text and at the end of the text, just after the words, "Off the pre-cast beam," you've got those two letters, ie. Now I suggest to you that what those letters mean is really something like, that is, and then the engineer is going on to give a sketch to demonstrate what the engineer wants.

A. Mmm.

Q. Is that right?

A. That's how I'd interpret that, yes.

Q. And that's a pretty, pretty typical sort of engineering practise with this site note isn't it?

A. Mmm.

Q. That you would say what you want done and you'd give a sketch to demonstrate how it's to be done?

A. Mmm.

Q. And would you agree that that sketch demonstrates that where the cut is wanted is into the, well what's there referred to as the pre-cast beam but certainly into let's say the larger mass of concrete there shown?

A. It certainly indicates that, yes.

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Q. Now if we could look please at BUI.COL764.0141.6. Now that's the specification for this job?

A. Mhm,

Q. Would you have seen or looked through at any point the specification?

A. Yes.

Q. It's a portion of the specification obviously. If we can look then at .12 and paragraph 2.13 there headed, "Cleaning and Protection of Work" and that's a pretty standard sort of clause which says that the work is to be kept clean and rubble kept away and rubble kept out of places where it shouldn't be?

A. Yep.

Q. And then if we could look at page .13 and then paragraph 2.16 and 2.17 which is really about the contractor having a foreman or a project manager and being responsible for setting out and making sure that there are no errors, that kind of thing?

A. Mhm, mhm.

Q. See that?

A. Yes.

Q. Now if we could look please now at document BUI.COL764.0016.2. Now these are the notes of an interview that you had on the 31st of May 2011 with Richard Sharpe of Beca and on the second page of those notes just down towards the bottom, the last paragraph, we've got the word, your name, "Tonkin" and then the paragraph starts, "I don't. The only stuff that..." and you say there, "I think the only material that could have got in there that may have compromised that would have been general construction rubble, rubbish, because the fact that that was cast prior to the stair being placed would indicate to me that the formwork would have been struck, the stair would have been placed and that gap may have stayed open with that sealant not being put in until the finishing stage of the project and so there could have been a degree of construction rubble and grit and dirt and a bit of tile liner and I'm not aware, I certainly don't have any recollection of there being a cleaning process apart from the fact that that would have been good trade practice to go ahead and clean that out." Now do you recall that interview and do you recall saying that?

A. Yes I do.

Q. And would you still agree with what you then said?

A. Absolutely.

RE-EXAMINATION: MR MILLS – NIL

QUESTIONS FROM COMMISSIONER FENWICK – NIL

COMMISSIONER CARTER

Q. Just one question. The specification refers to the architect being the responsible supervisor for the work. Is that how you understood it?

A. From my position the structural engineer would generally be involved during the structure phase of the project and that architect would then take over as we did the finishing stages of the project.

Q. Do you recall the architect having supervision on site?

A. Certainly during the finishing stages.

QUESTIONS FROM JUSTICE COOPER – NIL

WITNESS EXCUSED

MR HANNAN CALLS

JOHN HARE (AFFIRMED)

Q. Your name is Henry John Hare. You're an engineer employed by Holmes Consulting Group?

A. Yes.

Q. Now Mr Hare you've got two briefs of evidence – one is your initial brief of evidence prepared some time ago and then a supplementary brief prepared in response to some additional questions from counsel assisting the Commission and what I will get you to do firstly is to read the initial brief of evidence and I might stop you at one or two points along the way just to have a look at some documents and then we will go on and read through your supplementary brief.

WITNESS READS BRIEF OF EVIDENCE COMMENCING AT PARAGRAPH 3

A. I, on behalf of Holmes Consulting Group, provide this brief of evidence pursuant to the Canterbury Earthquakes Royal Commission's letter dated 21 November 2011 relating to the Forsyth Barr Building.

HCG is asked to comment on whether the Forsyth Barr Building's stairs as originally designed and constructed complied with earthquake risk and other legal and best practice requirements that were current at that time. In particular, HCG is asked to comment on the detail on page 45 of the BECA report which is described as superior to that which was used.

The building was designed and constructed in 1988. It was designed to predecessor standards of the current Building Code, comprising principally NZS4203:1984, the loadings Standard, and NZS3101:1982, the Concrete design standard.

HCG was instructed by Colliers Property Management, on behalf of the building owner, to carry out a post-earthquake assessment of the building on or around 12 October 2010. At that time, the building capacity pre-earthquake was considered to have a capacity in excess of 67% of the code levels of the day, based on a simple comparison of the loading standard at the time of design to AS/NZS1170.5, the then current loading standard.

HCG's Post Earthquake Assessment and Repair Report dated 29 November 2010 is attached. The Report sets out the repairs that HCG considered were required to the building as a result of damage sustained during the Darfield earthquake on 4 September 2010 and as reviewed by HCG. Beca Carter Hollings and Ferner Limited ("BECA") has been commissioned by the Department of Building and Housing to undertake an investigation into the collapse of the stairs. In a report dated 26 September 2011, Beca find that the stairs met the requirements of the day. Having considered Beca's report, I generally agree with its conclusions.

The Stair Detail: The detail referred to at page 45 of the Beca report is a detail that was developed many years after the original design and construction of the Forsyth Barr building. It was not available, or used, at the time of the original design of the building. HCG asked Beca to clarify this point in its report prior to its publication but it appears Beca elected not to. The Beca report states that this detail "should be encouraged as an alternative in **new** construction" (my emphasis). I note further that this detail has typically been used by HCG since approximately the early 1990s. Prior to that, the detail used in the Forsyth Barr building represented standard industry practice, as I recall it.

HCG is asked to comment on the circumstances of HCG's inspection and report following the 4 September 2010 earthquake, including the apparent failure to inspect the building's stairs. HCG was instructed by Michael Connolly of Colliers Property Management on behalf of 764 Colombo Street Limited to complete a structural review of the Forsyth Barr building following the Darfield earthquake that struck on 4 September 2010. Instructions were received from Michael Connolly in an email of 12 October 2010. A copy of the email and the attached HCG proposal dated 8 October (unsigned) is attached. There was no specific mention of the stairs in HCG's proposal. The only written instructions I can identify which make specific reference to the stairs are as contained in emails to HCG from Michael Connolly of Colliers

Property Management dated 12 October 2010 and 4 November 2010 as attached.

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Mr Connolly's first email identified as item 1 on the attached copy is timed at 9.58 am on 12th October 2010. The email was addressed to me. The email reads: "Please proceed with this report asap. Andy Christian of Pace has done a survey of the building so can advise on some areas of concern. I want to be sure that the stairs are okay and fixed correctly. Please note some cracks were covered by the plasterer and these need to be double checked and probably filled correctly."

HCG was unable to start the review of the building immediately following receipt of instructions from Michael Connolly, because of competing work demands. HCG seconded a project engineer, Mark Sturgess from an associated company in Australia who was tasked with conducting the review. Mr Sturgess arrived in New Zealand on 31st of October 2010. On 1st November 2010 Mr Sturgess and I met with Andy Christian of Pace Project Management on site, and walked through the building. I recall discussing the proposed repair work with, I believe, Andy Christian. The repair work being undertaken in the stairs at the time consisted of repairs to the gib board linings required primarily in order to restore the integrity of the fire protection. As these repairs were to non structural elements the consensus was that there was no specific structural review requirement of priority in relation to the stairs. My understanding at the time was that the work to the stairs had been previously instructed by or with the knowledge of the engineers previously involved with the building. In light of this in my briefing to Mark Sturgess I recommended that he concentrate initially on the primary structure which would then inform us of any need for a more detailed review of the secondary structural elements and fixings, dependent upon the extent of obvious damage and evidence in excessive displacement.

EXAMINATION CONTINUES: MR HANNAN

Q. And I'll just pause you there and ask you a supplementary question, because it probably best comes just in this particular part of the sequence. We know that BECA had carried out a level 2 inspection which had included some focus on the stairs. Did you get a copy of that report at the time or were you told of its contents?

A. No.

Q. So the time I'm focusing on now is really the period when you first became involved with the building and then you first start on your tasks?

A. Yes.

Q. So no copy of BECA report given to you at that time and its contents not discussed?

A. No, no we didn't see that report until the main building report came out.

Q. Thank you, would you please just continue reading.

WITNESS CONTINUES READING BRIEF OF EVIDENCE

A. I sent an email to Michael Connolly at 4.37 pm on 3rd November 2010 as a brief update following the onsite inspection which took place on 1st November 2010. A copy of this email is attached, identified as item 2. Michael Connolly responded by email at 7.48 am on 4th November 2010. His email read, "Thanks for this. I have a concern about the apparent drop in the stairs. I assume your report will cover this and the best way to repair." A copy of this email is attached and identified as item 3. As far as I can recall this email only came to my attention some time after it was initially sent. It seems that it must have been overlooked in the many emails that I was receiving at the time noting that I was out of the office onsite for much of the day during that period. However I recall that in discussions either with Michael Connolly or with Andy Christian some time after the date of the email the drop as referred to in the email was discussed. I wished to ascertain the nature of the possible movement prior to further review. I understood from that discussion that the drop was a sag in the mid span of the stairs although it was not clear over what timeframe the sag may have actually occurred. It light of my discussions with Andy Christian and/or Michael

Connolly, as explained above, I did not consider the sag in the stairs to be of immediate concern as the sag had no bearing on what may have happened at the point of support; and there was no sign of significant lateral drift of the primary structure that might have alerted HCG to significant concern. I understand that Andy Christian intended to have the vinyl lifted in the stairs in order to allow HCG to complete further inspections. I understand that these works had been scheduled shortly prior to 22 February 2011, to be carried out in early March 2011.

EXAMINATION CONTINUES: MR HANNAN

Q. Now I'll just pause you there. Now Mr Christian hasn't – and as I understand it will not be giving evidence. If we could look at document BUI.COL764.0037A.1

WITNESS REFERRED TO DOCUMENT

Q. Now Mr Christian worked for Pace, that's correct?

A. Yes.

Q. And this document indicates that it's a document from Pace Project Management dated 10 September 2010, Forsyth Barr House, Christchurch, vinyl to two x stairwells. Now firstly let me ask you when's the first time you've ever seen this document?

A. I don't remember exactly when, sometime, relatively recently.

Q. So not in September 2010 and indeed not in 2010, would that be right?

A. No.

Q. But, and I'm just getting you to look at it really to confirm whether the work that's being specified here or instructed here or quoted for here I suppose I should say, coincides with your understanding of what was to happen, so that first line under the heading "works, uplift existing vinyl to landings where concrete landings have dropped" and then the fourth line down, "note on two landings gaps may require further inspection by engineer after vinyl lifted", and then the bottom bullet point there under the heading "works, one set of stairs requires treads to be built up and new vinyl and nosings, exact detail of make good to be determined once vinyl removed and may require engineer's input". So I'm just drawing

your attention to those lines and inviting you to comment on whether that reflects your understanding of how this particular bit of the inspection was going to unfold?

A. Yes, that's – that really ties to what I've just said basically, that Pace would be removing the vinyl at some point so that we could – so that they could get on with the repairs, but also so that we could have opportunity to view what was underneath.

Q. Thank you, if you could just continue reading your brief at paragraph 26 I think we're at.

WITNESS CONTINUES READING BRIEF OF EVIDENCE

A. "Most of HCG's verbal instructions were relayed through Andy Christian, although HCG was in regular discussion with Michael Connolly in regard to a number of buildings and that there may, accordingly, have been periodic discussion with Michael Connolly in relation to the Forsyth Barr Building also. In light of the discussions held with Andy Christian and/or Michael Connolly, as identified above, the HCG Post-Earthquake Assessment and Repair Report dated 29 November 2010 did not provide any assessment or recommendations in relation to the stairs. This Report was seen as a 'live' document which would be amended as work proceeded. The email that accompanied the report stated: "As noted near the start of the report, this is a 'live' document, which on completion of all work can be finalised as a full summary to the owner of the damage, the repairs and the final outcome for the building. So it may go through further iterations once all work is complete." The report was intended as a draft document, released in order to allow Pace Project Management to proceed with the further repair work specified in the report. The stairs were not specifically mentioned but this was of no consequence to the other work required. HCG has no notes or photographs available in relation to the stairs. If there were any handwritten notes regarding the stairs, these may have been lost as HCG's former office was abandoned after the 22 February 2011 earthquake. HCG has been unable to locate any notes stored in its electronic archive. HCG's Post-earthquake Assessment and Repair

Report dated 29 November 2010 is attached. Informal discussions regarding the report took place but HCG has no further specific records about these discussions. HCG is not specifically aware of any inspection of the stairs being carried out by any other persons except those identified in the report prepared by Beca Carter Hollings & Ferner Limited BECA who were instructed to investigate the collapse of the Forsyth Barr Building stairs for the Department of Building and Housing. Beca's report confirms that a level 1 rapid assessment was undertaken on 5 September 2010 which resulted in the building being initially placarded red (unsafe).

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This was later revised by the level 2 assessment undertaken by BECA on 5 September 2010, first to yellow (restricted access) and, on 6 September 2010, following further investigation of the stairs (breaking open the timber framed-bulk heads under the flight with the most apparent movement and checking the seating of the lower landings – which indicated no significant movement) and propping of a vehicle ramp in the podium, to green (inspected). The Level 2 Seismic Assessment report of 6 September (not supplied to HCG) discusses the 40mm drop as flexural cracking at mid-span of the stair, concluding that, "Although the deformations in the stairs are significant, we believe that the stairs still contain sufficient capacity for normal use."

EXAMINATION CONTINUES: MR HANNAN

Q. Thank you. Now if you'll move onto your supplementary brief and I think you could simply start reading this at paragraph 3.

A. "Holmes Consulting Group Limited is asked whether it was the consulting engineer in the design of the building. Documentation –

Q. Just pause a moment. Start again at paragraph 3 please.

WITNESS CONTINUES READING BRIEF OF EVIDENCE

A. "Holmes Consulting Group Limited was asked whether it was the consulting engineer in the design of the building. Documentation including design drawings, construction plans, specifications, design

certificates, newspaper clippings, a design feature report, Geotechnical and Soils Reports, Calculation Sheets, photographs, site reports and sketches had been copied to disk and supplied to counsel assisting the Canterbury Earthquake's Royal Commission. The building appears to have been designed by Holmes Wood Poole & Johnstone Limited, HWPJ. HWPJ produced initial design drawings in or around October 1987. As from approximately mid to late November 1987 Holmes Wood Poole & Johnstone appear to have traded under the name of Holmes Consulting Group. The current business known as Holmes Consulting Group Limited, company number 441556, was incorporated on 6 September 1989. Accordingly Holmes Consulting Group Limited was not the entity which carried out the initial design of the building. That was carried out by a predecessor company. Holmes Consulting Group was asked to comment on where in the plans and/or specifications the seismic gap in the stairs was identified. The seismic gap in the stairs was identified in the design drawings. A sample design drawing is attached. The sliding detail of the stair is illustrated at detail numbered 1. This clearly shows the seismic gap requirement detail as 30 millimetres."

EXAMINATION CONTINUES: MR HANNAN

Q. Now I'll just pause you there and we should have a look at that document. That's WIT.HAR.0007.7 and if we can enlarge the upper right-hand quadrant which has the sliding detail there. Yes thank you. Now that's the drawing that you're referring to and that's the seismic gap detail for the stairs that you've referred to?

A. Yes that's the typical detail.

Q. If you continue reading please. Paragraph 9.

WITNESS CONTINUES READING BRIEF OF EVIDENCE

A. "Holmes Consulting Group Limited is asked whether the importance of the seismic gap was identified in the plans and/or specifications. The seismic gap is specifically detailed in the design drawings. No particular emphasis was given to the seismic joint as all design details are

regarded to be important. I would expect any construction company capable of constructing a building of such magnitude to be fully aware of the importance of seismic gaps and the importance of adhering to the design drawings. Holmes Consulting Group is asked whether the importance of the seismic gap was highlighted in any other document and/or instructions to any person involved in the construction of the building. The seismic gap was detailed in the design drawings only and repeated on sketches issued from time to time as construction proceeded. Numerous site inspections during the construction of the building were carried out. Site inspections would usually include an inspection of the works in progress, an inspection of any remedial works instructed to have been carried out by the construction contractor. The inspection would also usually include discussions with the construction contractor. The site inspection is carried out, typically inspections of representative work from time to time rather than continuous monitoring of work in accordance with our contract at the time and the industry standard practice."

EXAMINATION CONTINUES: MR HANNAN

Q. Now I'll just pause you there. You yourself didn't carry out site inspections on this building did you?

A. No I didn't.

Q. So your observations here are really based upon the records available to you and your knowledge of industry practice?

A. That is correct.

Q. Just continue at paragraph 15 please.

Q. witness of industry practice?

A. That is correct.

Q. Just continue at paragraph 15 please.

WITNESS CONTINUES READING BRIEF OF EVIDENCE

A. "A site report would be produced after an inspection. The site reports were copied to Fletcher Development and Construction Limited, the construction contractor; Paynter Developments Limited, the owner;

Warren & Mahoney Architects Limited, the architects; and Russell Drysdale & Thomas, quantity surveyors. I attach copies site reports dated 22nd June 1988, 27th June 1988, 29th June 1988, 8th July 1988, 8th August 1988, 11th August 1988, 25th January 1989, 3rd May 1989 and 3rd May 1989 which all make reference to the stairs or seismic joints."

EXAMINATION CONTINUES: MR HANNAN

Q. Now just pause there. I won't, I won't take you to each of those documents. They're on, they're available there and they've already been the subject of questions to Mr Tonkin and we've seen them. Just continue at paragraph 17 please.

WITNESS CONTINUES READING BRIEF OF EVIDENCE

A. "In the site report dated 8th of July 1988 the inspecting engineer gives specific instruction in relation to the widening of the seismic joint. Most importantly the report instructs, the report instructs the removal of concrete on the supporting pre-cast beam where the 30 millimetres specified in the plans has not been achieved rather than removal of concrete from the end of the stair. This instruction was given due to the engineer recognising the presence of the steel angle on the stair. This instruction was issued so as to ensure the 30 millimetre seismic gap as specified in the design drawings was achieved.

Site report dated 25th of January 1989 instructs the construction contractor that "the correction of the seismic gap on the stairs has not been carried out yet. This should be addressed as soon as possible." The report does not specify which floor this relates to but given the date of the report I assume it was fairly high up in the building. The site reports demonstrate that the design engineer was reviewing the seismic gap to the stairs. She recorded issues requiring remediation of the seismic gap on at least two occasions. She would, no doubt, have inspected the seismic gaps on numerous occasions but only recorded an inspection specifically if the gap was an issue."

EXAMINATION CONTINUES: MR HANNAN

Q. Now I'll just, just pause you there. No please continue reading through to the end of that paragraph and then, that supplementary question there.

WITNESS CONTINUES READING BRIEF OF EVIDENCE

A. "The lack of seismic gap in some cases was noted and an appropriate instruction for correction was issued. On one occasion the construction contractor was chased up to carry out remedial correction work."

EXAMINATION CONTINUES: MR HANNAN

Q. Now if we could have a look please at document BUI.COL764.0141.3 and this is the very site report from the 2nd of November, the 2nd of November 1988. Mr Tonkin's already had a look at that. You haven't mentioned it in your brief. Would you just have a look at that and tell the Commission what that is?

A. Yes that's obviously a site report with, making reference to remedial works between the ground floor and level 13 in the final paragraph. So it's sort of a check list of work required on those lower floors.

Q. Please continue at paragraph 21.

WITNESS CONTINUES READING BRIEF OF EVIDENCE

"I attach a copy of the relevant pages of the specification issued to the structural trades. Section 6 relates to the concrete contractor. At section 6.2.15 the specification obligates the concrete contractor to co-operate with the main contractor and all other affected sub-contractors in every way to ensure the correct finished relationship, both as to dimensions, details and such finishes between his work and all other surrounding work. Although not relating to the construction of the building I attach a copy of a letter from R G Wilkinson of Holmes Consulting Group to Trans Tasman Properties, dated 11 December 1997, dated some years after the completion of the building.

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EXAMINATION CONTINUES: MR HANNAN

Q. I will just pause you there. We will get that up – WIT.HAR.0007.39 and possibly if the main text could be enlarged.

WITNESS CONTINUES READING BRIEF OF EVIDENCE

A. "In this letter Mr Wilkinson confirms that he had been asked to look at a void that exists below the vinyl flooring at the stair landing adjacent to the ladies' toilet at level 10 of the building. In his letter Mr Wilkinson confirms that the void is intentional and a very important requirement of the safety of the stair flights. He also appears to have supplied copy drawings demonstrating the void as a 30mm seismic joint. He instructs Trans Tasman Properties to ensure the joint and all others elsewhere in the building is kept clear of incompressible material stating it is essential that the joint can freely open and close in a moderate or severe earthquake."

EXAMINATION CONTINUES: MR HANNAN

Q. Now just one or supplementary questions. Firstly you'll know that the Beca Report and the Beca witnesses concluded that even if the seismic gaps had been clear the stairs would have collapsed in the intensity of the February earthquake. Have you got a view about that?

A. Yes I would completely agree with that. The September event was relatively small and imposed relatively small drifts on the building which wouldn't have taken up anything like the capacity of the joint. By comparison the February event was much larger. The building was taken through significantly greater displacements to the extent that there is no way that the stairs probably could have survived that.

Q. Now just, and this is an unrelated topic, just on the topic of what was understood by representatives of the building owner about what the sequencing of the work was going to be about lifting the vinyl and inspecting this particular section, could we look please at document BUI.COL764.0029B.3 and this is an email. The top email in the chain at least is from Michael Connolly, dated 11 October 2010. Who is Mr Connolly?

A. He's, he was the property manager from Colliers.

Q. And he says, "My thoughts are the next stage of repairs should be after the engineer's report, not before it. By this I mean vinyl repairs and perhaps stairwell painting as the engineers may recommend other work." Now again just as I did with the Pace quote for the vinyl work I ask your comments on the degree to which that reflects your understanding of how this was going to unfold?

A. Well again we were trying as much as possible to co-ordinate our review with the work that was going on in the building at the time and so clearly the implication of this is that after we would be looking at the stairs after the vinyl was lifted, not before.

CROSS-EXAMINATION: MR MILLS

Q. Can I just start with an answer that you just gave to my friend Mr Hannon in response to one of the supplementary questions and if I've correctly noted it, and I'm sure you'll tell me if I haven't, you said in response to him that September would not have anywhere near taken up the capacity of the seismic gap. Have I correctly understood what you have said?

A. Yes, correct. I qualify that to say the seismic gap as detailed.

Q. Now the evidence that we heard from Becas yesterday. You were not here yesterday were you?

A. No I was not.

Q. Beca's position in evidence, both I think in their report and certainly under questioning, was that the 30mm gap, if that's what was there of course, was taken up in September as some degree of compression and tension was sustained by the stairs. Were you aware of that?

A. I was not aware of that precise detail.

Q. I don't think there's any disagreement that that's what they said and the report itself shows that in September there were inter-storey drifts that would have exceeded 30 at least on two occasions – perhaps one above their line and the other below their line – that appear to have

reached about the equivalent of taking up 34mm of movement. So that's the evidence that they have given.

A. Yes, I think I would comment to that. In our investigations or the work that we commenced working through the building in November we were very clear our starting point for that was to look at the primary structure and use our findings from that to determine what the implications might be for other elements. It's my view that for a building such as that we would think of the yield displacement, if you like, of the building which is the displacement it would take to impose cracking and inelastic displacement on the building would be something in the region of .5% which is to say that the displacement in any one storey would be .5% or thereabouts of the storey height. Now we didn't see any evidence of significant yielding. The frames were remarkably crack free and undamaged which actually goes back to the email that I sent to Michael Connolly shortly after our first inspection. Point five percent of the storey height would be somewhere in the region of 18mm I think – 18 to 20 – so certainly our expectation of that was based not on analysis of a theoretical building but on observations of the actual building.

Q. I just wanted to confirm that you weren't specifically taking issue with Beca's evidence yesterday and I take it you were not?

A. No, we arrived at our conclusions through different means.

Q. Now just one other preliminary point of clarification. You say in paragraph 8 of your first statement of evidence that you generally agree with the Beca Report. I just want to be sure if there is anything specific and of significance that you disagree with that perhaps you could tell me now. It is the word "generally". I'm just wondering if there's anything embedded in there that needs to be drawn out?

JUSTICE COOPER ADDRESSES MR MILLS

Q. Well there's some issues that he's referred to in his evidence already. You mean apart from anything he's mentioned?

A. Yes.

CROSS-EXAMINATION CONTINUES: MR MILLS

A. I don't think there's anything apart from what's been mentioned already.

Q. Now I just want to ask you some questions Mr Hare around this issue of the original design choice. I asked the same questions yesterday of the Beca's witnesses and there does seem to be some disagreement between you and Mr Jury I suppose in particular about whether there was a known alternative to the stair design that was used here at the time at which the Forsyth Barr building was being designed. You know what their position is on this. Do you maintain your earlier view that at the time at which the building was being designed there was no known design alternative to the one that was used in relation to the seismic gap question?

A. Well it's a matter of opinion of course because I can only give you my opinion based on my experience and knowledge at the time and certainly at the time I think that the detail used by most of the industry at any rate was the one used in that building.

Q. Now you've said in your evidence that by the early 1990s there was a shift away from that?

A. Yes.

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Q. Can you tell me why that shift occurred as far as you're concerned?

Yes, well I think there are two reasons but the primary one which is kind of evidenced by this building in some respects is that there were construction tolerance issues around this detail. It's from a construction perspective there are a lot of reasons why the stairs are laid out as they are and it's a matter of convenience to try and have the stairwell as the simplest – the stair opening I should say as the simplest rectangular opening that you can have trimmed by being a beam at each end and that way it makes a support and the construction a lot easier and the compromise is that we have a detail such as we have. I think in reviewing the way that that had been formed over the years we determined that we probably take the grief of having an odd shape stair opening and achieve a better support condition without the construction

tolerance issues. Later I believe, and I'm thinking about the mid 90s in fact, there was a re-evaluation of the way that building deformations in earthquake are considered which would have really made the detail as we used to use it, probably impractical anyway.

Q. And we're talking about the detail of the sliding arrangement in the Forsyth Barr stair are we?

A. Yes and variations of that theme.

Q. Did Holmes, or I suppose more directly you, did you have any specific experiences of, that had caused you concern with the stair detailing used in the Forsyth Barr building that had led to this shift away by the early 1990s?

A. Me personally, I think, I can think of maybe one or two occasions where I would have been a site engineer looking at the construction of those stairs with a similar detail and I think we probably would have echoed common experiences that the process of ensuring gap was maintained at an appropriate width as we thought it was at the time.

Q. Yes.

A. And ensuring that it was cleaned out before it was filled in was just an ongoing construction tolerance issue.

Q. So I take it, it was a combination then both of the stairs being longer than they ought to be and so the gap being smaller than it used – than it should have been. Is that was happening?

A. Potentially the stairs being longer may have been, although I note that there's – it was really a matter of construction practice. If there was sufficient room at the top of the stair to move it along slightly to achieve the detail, as was in fact noted in that site report we saw earlier, then that could have been done prior to casting in of the upper landing.

Q. So you just said to me it was this issue about these concerns with the stairs, which you personally had experienced. What about the wider Holmes Group? Were you aware of other issues within Holmes that caused a general move by the company away from that Forsyth Barr stair design?

A. Oh, I couldn't tell you in detail. I think that was what was happening at the time so I think we have a, you know, we had had common experience. There were a lot of buildings of that scale built at about that time although that was then, the construction boom at the time was drawing to a close, but certainly I recall around about that time we developed an internal practice of simply not using that detail and having it instead, a simple detail of the stair flight sliding over the landing which eased those problems.

Q. Yes, have you seen the alternative design that BECAs have referred to which show a stair sliding over the landing?

A. I believe so. It certainly, it's now common practice.

Q. So that's the one that you're referring to moving towards in the 1990s?

A. Yes.

Q. And so the issues that BECA particularly identify in their report about the lack of resilience in that stair design that was used in Forsyth Barr, and the easy compromise of the seismic gap. You're having similar concerns about that?

A. Oh certainly we would agree on the outcome if you like of the reasons why we would shift towards the detail we now use.

Q. Yes.

A. So it's purely about a matter of timing.

Q. And did you stop as a firm as well as you personally to the extent that you're aware of the firm's practice, was there a complete cessation of using the type of design that had been used in Forsyth Barr from somewhere in the 1990s?

A. I can't tell you exactly when. I can certainly say that from my perspective it's a complete taboo to use that now and I would hope that everyone followed practice. To the best of my knowledge they did.

Q. I'm just going to ask you a few questions now about the evidence that Mr Tonkin gave about the inspections process. Of course taking account of the side reports that subsequently came in. Now he acknowledged that as I think you had said in your evidence that any detail on the structural drawings is of equivalent significance to any

other. Is it ever your practice when there's something on a structural drawing which you're particularly concerned might be overlooked or not, might not be adequately focused on to make reference to that in the notes on the structural drawings?

A. I don't think I would consider it general practice. I'm not saying that it's never done, but I certainly would probably take the view that if it's something as that important we'd rather discuss it with the person on site doing the work to draw their attention to it at the time.

Q. Yes. The evidence at least that we've had from BECAs tells us that despite the site reports that we've looked at, that the seismic gap did not achieve the 30 millimetre gap that was intended. The site report that we looked at this morning which I think was in November of 1988, which referred to checking the seismic gaps on all floors. It would seem from the evidence from BECAs that whatever was said, that wasn't successfully achieved, at least not in the final outcome. What would have the practice have been do you think when the site engineer issues a direction of that kind? Is it just assumed that it will be followed up and dealt with?

A. Well not necessarily although obviously an instruction once given, it's assumed that it should be followed. Frequently if things may be followed up to the extent it actually requiring re-inspection before the detail is closed in. At other times I would think it reasonably common practice to give an instruction on the basis that this work once done can then be closed in on the assumption it will be followed. I think the issue that you have to consider there is that the spread of responsibility if you like between the contractor and the engineer.

Q. Yes, I'm not putting blame one way or the other. I'm just seeking clarity as to how this might have happened that we've got the site report saying check all gaps on all floors and yet the evidence from BECAs is that in many cases that gap was seriously compromised.

A. I understand and it comes down a little to what was able to be seen afterwards when the engineer came back. Certainly the disturbing one there I guess was the saw cutting over the angle where it would have

appeared from the top as if it was the right width, but clearly it hadn't been able to be achieved that way.

Q. Do you take from the fact that there was both the saw cutting back and also that site report directing in November that the seismic gap be checked on all floors, that the likelihood is that the precast stairs came in longer than they ought to have been?

A. That would be one possible explanation for it. It also comes down to the way the stairs were placed, even when – there could potentially have been some lengthening of the stair as the load was transferred from the hook and so that would sometimes necessitate lifting it up and moving it back again. So there would have been more than one way that the tolerance could have been achieved.

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Q. My reading of the powers that the structural engineer on site had and if need be I'll take you to the document but you're probably familiar with this, is that it included the right to inspect the stairs in their manufacturing state and to reject them if they didn't meet the requirements of the contract.

A. Mmm.

Q. Would it be normal for that to be closely scrutinised in the manufacturing stage before the stairs were brought out and put on site to see if they did meet the required dimensions?

A. It would be reasonably normal for an engineer to inspect the stairs in the yard although typically when an engineer goes looking at the pre-cast they're looking for the general detailing so, is the reinforcing adequate, are the details being followed? Dimensional accuracy is rarely if ever checked by the engineer because that's the responsibility of the contractor.

Q. Yes, all right. Thank you. I want to ask you some questions now about your engagement to do the work that you referred to in your evidence. Mr Michael Connolly engaging you on behalf of the building owner, leading up to the report that you did on the 29th of November.

A. Mmm.

Q. Do you accept that the terms on which Holmes was engaged to do that work did include an inspection of the stairs?

A. Yes I do.

Q. So the reference to it not being referred to specifically really is neither here nor there?

A. No.

Q. The proposal and I might perhaps just bring this up, it's WIT.HAR.0003A.2, and the page I'm interested in is page 6 – when it comes. Now can you just go to, I'll just get you to confirm, this is, of course, your fee proposal that went into Colliers.

A. It is.

Q. And I take it you would agree that the terms set out there were the ones that were accepted, became the basis of the contract?

A. Yes.

Q. So if we could just have a look at point 6. No, sorry, just stay there, that is the page I wanted. The reference under stage one on the scope of the review. That reference in the second point to identifying potential hot spots for more detailed investigation. Would you have considered the stairs to be a potential hot spot?

A. I would have only on review of the performance of the primary structure if we'd been concerned that there'd been excessive deflection. We would have in due course come to them as a more routine matter otherwise.

Q. You wouldn't in light of what you've said a moment ago about the concerns about the design and the deliberate decision to move away from that design have come at this with the concern that here you had stairs which Holmes didn't use any longer and didn't use any longer for good reasons?

A. Going back to my comments earlier about the reasons why we moved away from that due to the difficulty of achieving the gap required, we didn't say that we didn't think we'd achieved it, simply that we were feeling that it was too much effort. So I had no reason to think that those stairs had any less tolerance than they should have, sorry any

less seismic clearance than they should have. I was more concerned as to whether the building displacement had been such as to cause problems with what I assumed we had.

Q. As I understood your evidence though you, one of the reasons for moving away from that stair detail was because of the ease with which that seismic gap might be compromised?

A. Yes but as I say it was, it was more a matter of the difficulty of getting it corrected.

Q. Yes.

A. And so that we still, assuming that everything had been done on site as it was required, we would then at the end of the project still have to be satisfied that it had in fact been achieved.

Q. But you didn't have any reason for complete confidence did you that that had been achieved in the Forsyth Barr building?

A. I had no reason to believe that it hadn't been achieved.

Q. Would you accept that there was a risk that it hadn't been in light of the previous evidence you gave on the design question?

A. I, I would accept there was a risk, certainly.

Q. And if that risk had in fact been realised in the construction of the Forsyth Barr stairs, that would then properly have been described as a hot spot?

A. It could have been described as a hot spot. This was a work in progress on the way through so our initial concentration as I noted was on the performance of the primary frame and the diaphragms.

Q. And I think we're agreed now in light of Mr Christian coming into the same space that you're in, in terms of what the instructions were here, that it was not that the stairs were taken out of your instructions but rather there was a discussion which led you to conclude that it wasn't urgent?

A. Yes certainly I did have some level of misunderstanding at the start of the project but that was clarified fairly quickly for me and I note on item 3 there in the scope of work that it was a matter of co-ordinating with the contractor on being able to do things so we had to work with them on

the way through according to what they were doing. The, the initial repair work in the stair to the firewalls was already underway before we commenced on site.

Q. Yes. Just bear with me a minute. I just want to get your evidence. Now I'm just going to take you through those passages in your first statement of evidence that deal with this. Just beginning at the discussion at paragraph 17. Now this was preceded, and Mr Hannan took you to these emails in the course of you giving your earlier evidence, this had been preceded, hadn't it by two emails, one had come in on the 12th of October, the other on the 4th of November, from Mr Connolly speaking on behalf of the owner expressing specific concern about the stairs.

A. Yes.

Q. You then describe how you go out to the site at some stage, as I understand the sequence both before and after the 4 November email, and then at paragraph 23 you have a discussion about this apparent drop in the stairs that Mr Connolly had specifically expressed a concern about in his email of 4 November.

A. Yes.

Q. And in that discussion you say in paragraph 23 that you wanted to ascertain the nature of the possible movement prior to further review and you understood from that discussion which I think we've now confirmed was with Mr Christian rather than Mr Connolly that the drop was a sag in the mid-span of the stairs. Then you say, "It was not clear over what timeframe that this sag may have actually occurred." Would the timeframe over which that sag had occurred be at all relevant to your assessment of the significance of this as a structural engineer?

A. Yes it would because being as they were made from reasonably heavy concrete they have sustained dead loads on the stairs which can lead to creep displacements and so it wouldn't be unexpected to hear that there'd been creep deflections which could have built up over a period of time which could have resulted in displacement of about that amount, up to that amount, and so I had no indication at that point whether that

was something which had happened during the earthquake or something which had happened prior and been noticed after.

1110

Q. How would you ascertain the correct explanation for that?

A. Ultimately by inspecting the stairs. So we'd have to have a look. Even then we'd be looking for particular crack patterns or other evidence of movement to try and determine what had caused the displacement.

Q. And if in doing that you had concluded that cracking in the stairs, sag in the stairs, had been the result of the September earthquake –

A. Mmm.

Q. – would that have caused you any concern?

A. It may have done, yes.

Q. You see the difficulty I have with this is that as I read it you've got the background issues that we talked about with the design of the stairs, and the move away from it with what seemed to have been some good reasons and essentially agreement with BECA on those reasons. Then you've got two emails from Michael Connolly on behalf of the client expressing concern about the stairs. Then you have a discussion on site with Mr Christian who I think we will agree is not a structural engineering expert.

A. Mmm.

Q. And this question of the drop is discussed. It was not clear to you the timeframe over which this occurred. You've just agreed with me that that might be significant but you, on the basis of what Mr Christian has said to you, you don't go and take a look?

A. Yes there are, however, several points I think to make in response to that. The first one was that the, we were engaged some time after the event and obviously didn't, weren't able to commence work before November so that was some seven or eight weeks after the original event. So well aware that safety inspections had been done before we got on site including presumably a review of the stairs. I note that in the first email the reference was made to cracks, which have been covered by the plasterer, and I was well aware that the stair walls were in fact

lightweight construction and so what he was talking about there was cracking to, to gib board which is completely of a non-structural nature and therefore no concern at all about that and nor would we have any structural concerns with the, with the nature of the repairs. So it was only the second email which actually gave me any cause to consider any structural matters. As I've noted there, which is unfortunate I didn't, although that email was definitely sent to me at that time, I didn't open it until some time later. It was after that that I spoke to Andy and so having been well aware of the safety inspections earlier I considered that if the other engineer had not deemed it appropriate to take further immediate action therefore it would fit in with the rest of the inspections.

Q. All right. Let me then just take this in some little bites. If you had not been aware that BECA had done a previous assessment, would you have responded differently to the scenario that's described in your paragraph 23?

A. It's somewhat speculative now but, yes, I think I would have.

Q. All right. Now following this discussion of course we have the Boxing Day earthquake. It was a different fault line from September. Did that not cause you to feel that there might be a need to accelerate some examination of the stairs?

A. Not immediately, no because the Boxing Day earthquake was a very short duration, short rapid acceleration event. It certainly had a bigger impact on some of the smaller buildings around town, some of the unreinforced masonry buildings but for a long period, tall structures such as this we consider there to have been no likelihood of any damage and certainly nothing. We were responding to requests obviously to go and inspect buildings where there had been concerns of damage but nothing was relayed to us on that.

Q. Do you agree with me that a drop or sag in these pre-cast stairs could suggest that they had suffered compression?

A. With the benefit of hindsight I would probably agree that that may have been what had happened, but again it's speculation because we weren't able to define it, to verify it.

Q. Yes because you didn't go and look?

A. Correct.

Q. I just want to ask you then a little bit about, more about these BECA reports –

JUSTICE COOPER ADDRESSES MR MILLS

COMMISSION ADJOURNS: 11.15 AM

COMMISSION RESUMES: 11.32 AM

CROSS-EXAMINATION CONTINUES: MR MILLS

Q. Mr Hare, I was just about to ask you about what it was that you knew about the BECA reports or whatever you understood them to be that had been done on the Forsyth Barr building prior to Holmes' engagement to do an engineering report on the building. So what did you know about what BECAs had done?

A. I knew only that they had been through the building and given it a green placard.

Q. And how did you know that?

A. I assumed because there was a green placard on the door but certainly we were aware before we started work that they had been in the building doing the initial evaluations.

Q. Did you have any knowledge that that included the stairs?

A. No I didn't.

Q. And because it was green placarded do I take it that you would have assumed or known that it was a level 2 assessment?

A. Yes.

JUSTICE COOPER:

Q. Just on this issue about the stairs being included as part of the process that led to a green sticker. I would have thought that you wouldn't green sticker a building of this proportion unless there weren't any indications that the stairs being unsound. Is that – am I correct in that thought?

A. That's certainly what I would have assumed.

CROSS-EXAMINATION CONTINUES: MR MILLS

Q. So to that extent you had assumed that the stairs had been included in the level 2 assessment. Is that what I'm hearing in response to His Honour's question?

A. Yes. Well yes and because furthermore the work had been separately already commenced on the fire cell and I would presume no one would have done that work had they not looked at the stairs in general.

Q. Yes, but from your perspective – from what I'm hearing from you is that there were a series of assumptions that were being made by you?

A. Yes.

Q. Now we've been this way before so I won't labour it, but you're well aware that the level 2 assessment is quite a limited assessment?

A. I'm aware of what the level 2 assessment is, yes.

Q. But in the discussion with – apparently with Andy Christian that I was asking you about just before the adjournment, I understood your answer to be that in general terms that you took substantial comfort from the fact that BECAs had looked at the building in deciding that the issues around the drop in the stairs and when that might have occurred was not a matter that required you to relatively urgently inspect the stairs yourself.

A. Well recalling that the displacement of the stairs was something that I wasn't aware of until sometime really mid to late November, certainly when I went there my understanding of what was going on in the stairs was that the linings were being repaired which is consistent with general repair following that earlier assessment, so I had every reason from that to believe that there were no problems there.

Q. Have you now seen the BECA assessments?

A. Yes I have.

Q. Perhaps I could just remind you of what's in there, and I don't think we need to bring them up because we've seen them a number of times, but they do as you know include concerns about the seismic gap needing to be checked and potentially compromised. You recall seeing that?

A. I recall in general terms seeing that, yes.

Q. And the stairs might be unstable? If you want me to bring them up, I'll –

A. Yes please.

Q. All right, then let's bring them up, it's BUI.COL764.0003A.13 is the first of them.

WITNESS REFERRED TO DOCUMENT

Q. Now you'll see there, this started life as I understand the way these have been done with an inspection on the 5th of September but this one that we're now looking at has been overwritten by a later inspection which is shown by the fact that the original one which was restricted use Y2, which you'll see in that band at the top and you'll be familiar with this format, and it says now G2 refer attached. But the original form we're looking at was initiated on the 5th of September, and you'll see there in the first block with the handwritten notes, "stairs are generally settled and maybe unstable". See that?

A. Yes I see that.

Q. And then further down "stair landing bulkheads need to be removed to allow investigation", I think that is. See that?

A. Yes.

Q. Then if we go over to the next page which is 14 on our numbering system. You'll see there what I think says "apparent damage to base of stair". Do you see that?

A. Yes.

Q. Do you agree that's what it says?

A. Ah, yes.

Q. And then further down "stair settlement, 40 millimetres under supports at level 7", see that?

A. I see that.

Q. And then further down “stair supports need to be investigated prior to upgrading to green”, see that?

A. I see that.

Q. And then if we go over to page 16 and this one is the typed up version of a 6 September inspection and you’ll see down the bottom there the – well perhaps first of all under those three bullet points you will see the paragraph there. You see that it says “the majority of the stair flights had similar damage although it is believed that level 7 was the most damage and therefore representative”, and then the passage which you've referred to yourself, “although the deformations in the stairs are significant we believe that the stairs contain sufficient capacity for normal use”. Now you’ll see the bullet point above that which the reference to a majority of stairs seems to go back to, “flexural cracking in the base of the lower knee of the scissor flight has resulted in a residual deformation of the stair, with the stair settled by 40 millimetres at that location”. You see all that?

A. Mhm.

Q. And then at the bottom there in the handwriting, “the loose debris should be cleared from the seismic separation gap at the end of each stair flight to allow movement as originally intended”, I think we agreed that said.

JUSTICE COOPER ADDRESSES MR MILLS:

We've lost that one at the moment, we need to go back –

CROSS-EXAMINATION CONTINUES: MR MILLS

Q. See that one down there at the bottom hand-written. It's the second bullet point?

A. Yes.

Q. Now then there's a series of photos behind it which show the debris and the seismic separation. That's on page 17. This would all have been part of the report as I understand it. Next page. Then just complete what you would have seen if you’d seen this, we go to page 19. You’ll see the little handwritten note at the top there under comments, which

relates back to level 7 issue, “infill floor has sagged” and I take it that little symbol is more or less, or plus or minus?

A. Yes.

1142

Q. “Ten millimetres in one place” but it does say non structural, so there’d be some comfort taken from that. And then on the last page which is 20, you’ll see the handwritten reference at the bottom there is, “inspection on Monday the 13th of September of internal stairs between levels 6 and 7. Stairs have been previously removed (15 years plus) and infilled. Tenants noticed slight sag in the floor by door (level 7). Could not inspect without removing carpet – recommend further inspection with carpet removed and through suspended ceiling on level 6.” And then a reference in someone else’s handwriting which I understand is Mr Jury’s, “Floor sag likely caused by infill (‘*likely*’, I note). Sagging due to deflection of steel support beams. Sag is minimal. Steel beam connections could not be inspected due to access limitations. Suggest area of floor is re-levelled if deemed necessary.” Now that’s what you would have seen if you had seen the assessments that Beca did. Would you have taken a different view to the one you did in your discussion with Mr Christian if you had also been aware of this at the time?

A. Well there’s two different aspects of the building which you’ve touched on there. So the reference to level 7 is I think to an infill piece of flooring which is well away from the main stair. So at one stage there had been an inter-tenancy stair between two of the floors and we in fact did have a look at that because that was drawn to our attention specifically at some later time and it was a matter of no concern. It was simply about shrinkage and subsequent movement. So in that case we were made aware of that, did look at it and addressed it. In the case of the main stairs, I can only speculate with hindsight. I would imagine that we would have had a look at those if we’d been aware of this notice which we weren’t.

Q. You didn't ever ask Beca if you could see their assessments, did you?

A. Ah, no we didn't.

Q. And were you aware of the fact that these level 2 assessments are lodged with the Christchurch City Council?

A. Yes.

Q. Now the Council gave evidence yesterday they were accessible, reasonably readily accessible, if a request had been made to the Council to see a particular level 2 assessment. Were you aware of that?

A. Um, no I wasn't. In fact on some other sites I'd asked to have the identity of the assessor and then told that that was information not available so I didn't think to ask for this partly possibly for that reason.

Q. But there would have been no difficulty in picking up the phone to Beca's would there?

A. I could have done so, yes.

CROSS-EXAMINATION: MR LAING

Q. Mr Hare, one question for you. You didn't forward your report of 29 November 2010 to the Council did you?

A. No, we didn't regard it as complete at that point.

RE-EXAMINATION: MR HANNAN – NIL

QUESTIONS FROM COMMISSIONER FENWICK – NIL

QUESTIONS FROM COMMISSIONER CARTER – NIL

WITNESS EXCUSED

MR MILLS CALLS

DESMOND BULL (SWORN)

Q. Now you are well known to the Commission and to counsel. I asked you if you would come and give evidence to close off this hearing by covering a range of issues so I'll just refer to a couple of your formal qualifications and then leave you to it. You are an Adjunct Professor at the School of Engineering at Canterbury University?

A. Yes.

Q. And you have, amongst other things, done a report at the request of the Royal Commission dealing with the performance of stairs in the Christchurch earthquakes?

A. Yes.

Q. And I think you've got some Power Points that you are going to speak to and on that basis I'll sit down and just let you take us through those.

WITNESS PRESENTS POWER POINT PRESENTATION

A. My briefing, as I understand it, was to talk in general terms regarding the performance of stairs. I've caught part of the hearing so far and a lot of the specifics will be touched on in general terms and concepts through this power point but obviously by all means if there's things that require elaboration please don't hesitate.

JUSTICE COOPER

Q. Just explain the orientation of what we're looking at there. To a non engineer, which is me, what explains the fact that what appears to be the stairs, the steps that comprise the staircase, is facing away from us, appears to be on the underside?

A. That's one of the stairs that's come down from above and landed on it. Most of the stairs landed almost upright and this stair has landed upright and tilted and fallen away from its normal orientation.

Q. I see. So that's not in place –

A. No –

Q. – that's a visitor from above?

A. It's come from above. That's like 12 storeys above.

EXAMINATION CONTINUES: MR MILLS

A. Next slide. I'm not a great one for reading off slides but I'll try and stick to the content. Obviously as we all know stairs are in ramps as well. They are a critical egress from buildings during events like these. It's not a peculiar problem for concrete stairs. It applies equally to steel stairs. This is actually a nationwide problem. It's not peculiar to Forsyth Barr. Throughout New Zealand it's a quote from the Departmental, the Department of Building and Housing Practice Advisory 13 September 2011 on the egress of stairs which in part was related to a response from the Royal Commission report and the Engineering Advisory Group to the Department of Building and Housing and it's recognised amongst practising engineers that this is a generic or systemic issue for stairs in general and it's not just peculiar to the Forsyth Barr event.

Next slide thanks – These are the ones I'm personally aware of in terms of stair collapses – Forsyth Barr, Grand Chancellor, Clarendon and Heritage Hotel. Our staff also know of at least two others and that's not a comprehensive list at all. It's just what our practice, and the other thing I should probably disclose that I'm a technical director of Holmes Consulting Group as well. So this is partly to our personal knowledge, the buildings that we've worked on. There may be others in town. What's far more important is that many buildings suffered damage to their stairs and ramps to varying degrees. If you were far enough away from the epicentre you didn't have a problem. If you were near the epicentre of the occurring earthquakes it was almost inevitable that you had some trouble with your staircases. It's not in the slide but in case of steel stairs what tends to happen is that the connections to the landings fail, start failing and our very own building – 123 Victoria Street – when we stepped out onto the landing at level 5, took one look at the connections and thought we're all going to take one hell of a risk going down these stairs but we can't stay in the building and this is very common, same with the Copthorne, Durham, steel staircases. The connections used for steel staircases because they are a lot lighter than concrete ones tend to be on the lighter side and quite brittle so when

you get any inter-storey drift the relative movement horizontally between floors, you tend to find that the connections in the landings from steel staircases start to fail. It doesn't mean they drop the stairs but they can be severely compromised. If the earthquake had run longer, the February one in particular, we might have had many more stairs down than we did. Particularly prior to 1992, we could even argue 2004, the way engineers estimated the drifts, inter-storey drifts, the relative movement between the floors horizontally, tended to be underestimated and to be frank in a lot of what we understand today and it's in the report to the Royal Commission that probably even the current loading standing is underestimating the drifts associated with issues such as ramps and stairs.

1152

The estimation of drift to the building as a whole is reasonable but you tend to find that that drift for the building is about the average drift, where what we're really interested in is the peak drifts, at the maximum drift you can get, particularly when the floors separate, and that's not highlighted to any great degree in general practice and that's sort of what is now in the practice advisory to the industry, but you have to account for a number of factors that haven't been accounted for in the past. They weren't made obvious at the time and it wasn't codified and so fundamentally we're underestimating the drifts that these floors and ramps have to deal with up to the present day. Next slide thanks.

Now looking at stairs and ramps that are built in at each end solidly. They act as giant props and they're massive and what tends to happen is the way the earthquake loads moved through the building had changed. Unfortunately we have buildings and generations of engineering understanding where stairs and ramps were actually ignored in the analysis. If actually do build them in they're very large pieces of structure and this has been found all over the world in various earthquakes that ramps and stairs can interfere with the main structure and change the way the loads are dealt with and change the way the building behaves as a whole, and at the lower end of damage we tend

to fail the landings and if you have mid-height landings the horizontal piece of floor half way up the stair, you tend to fail the landing as well. One of the discussions, it's still being discussed at the moment, is vertical acceleration, the vertical accelerations we had massive vertical accelerations in February. It has been cited that this is the reason the stairs fell down. Well the general consensus is that that's not the primary reason at all. It may have contributed, but the primary reason is that the floors move relative to one other and jammed or pulled the stairs off one or more of the landings. If your stairs or ramps are built between floors they act as large compression members. Next slide thanks.

And this is the sort of damage that you get. What this stair is built at the landing above to another landing here, and from memory that's actually a mid-height landing, that's half way up the inter-storey height. The rest of the landing where the photographs been taken from is down below the light, that level, and what you tend to find is that the landings get broken and – at both ends as well as the stairs start to twist and this can overload the stairs to a point where they may collapse.

JUSTICE COOPER:

Q. Do you know where this photograph was taken?

A. This is a Christchurch building but I can't actually tell you which one it is sorry. I can find out.

EXAMINATION CONTINUES: MR MILLS

A. Next slide please. This one's taken from a building in Turkey and as an example 'cos the way I was approaching this presentation today was more a general discussion, an education discussion than specific issues with Christchurch.

JUSTICE COOPER:

Q. No, that's understood thanks.

EXAMINATION CONTINUES: MR MILLS

A. This is Turkey, a major event and again this is like a mid-height landing and there's a stair here and a stair running up to the rest of the storey. If the movements are big enough which you can indicate with the damage to the frames, you'll find that the stairs will actually completely let go and are egresses as perilous at death and at the – you know at the point these stairs are at the point of total collapse and this – this is not peculiar to Turkey. This – we have issues with this form of construction in New Zealand. Next slide thanks.

Ramps and stairs that are sliding one end, which has been the big discussion of Forsyth Barr. There are three possible modes of failure, one that I actually left off earlier reports, the most obvious one was that the landing was too small to start with and when the stair got pulled away from the landing it simply just fell off. There was no jamming or crushing, simply the landings weren't big enough. And that can be partly design. It can also be the fact that the construction tolerances were used up. It's just literally where the stairs were dropped off the crane and on occasions those desirable overlaps, the seating length for the stairs on top of whatever is supporting it, may have been on the low side and if the building moves away, the floors moves away from one another and drag the stairs it's quite possible that they simply just ran out of support.

The other one which we're looking at, the other mode of failure which we've seen cross town, or mode of overload and we've seen in Forsyth Barr, is when the stairs are jammed between floors and they get compressed and actually shorten and I won't spend too much time on that because there's been very good presentations were given prior to this and as the stair shortens and the earthquake reverses the stair now gets dragged from its support. The overall length of the stair is shorter and there's not enough residual landing support and now shortened stair, and the stair falls off. And again I just highlight that for a while it was being promoted that vertical accelerations were the cause of these failures. It's actually unlikely when you do the engineering assessment,

even at twice gravity. The stairs usually have enough capacity to resist that and it's also transitory. It's not there as a constant load which means the stairs are tougher than they appear. Next slide thanks.

You've seen variations of this slide that's on the screen and it's just a dramatic representation. The top stair is the stair sitting under gravity and no lateral movement. The middle stair is when the floor above moves to our left, jamming and compressing the stair and as part of that action, part of that action you actually do see the middle of the stair drop down. You've seen that to varying degrees in the photographs in some of the evidence where the stairs have moved the vinyl or the wallpaper and you can see a gap. When the earthquake reverses and that this part of the floor moves to the right, relative to the floor below, the now shortened stair falls off. Next slide thanks.

Just introducing the next section which I open with this slide. Next slide thanks. This is the Grand Chancellor and in my way of doing things I've thrown a few photographs in to put it into context. What you see here at the Grand Chancellor is these steel corbels are actually part of the staircase running away from us and they're sitting on a concrete landing. In the process these stairs have been pushed up against the landing as well as the stairs have been worked up and down as the building moves. There's a relative movement between the landing and the staircase and these quite strong steel members have popped the top concrete off the landing. Doesn't mean the landings have failed. It just means they've sustained significant damage. Next slide thanks.

Now this is the same building with the same detail. The difference here is that lovely rectangular slot if you remember the slide beforehand with those structural members. What's happened is the building's moved in such a way as that those steel corbels have been pulled right up to the very edge of the concrete landing and just simply punched through the lightly reinforced iron reinforced edges and this is this relative movement that we were worrying about with the stairs being pulled away from the support. In hindsight and moving forward in the future we might have armoured the edge, meaning put a structural steel member along that

edge to avoid this punch through. The practice of the day was such that if you had reinforcing steel along the edge that was deemed to be enough as general practice. In this particular case it clearly wasn't and that punch through led to a failure of a number of the stairs.

JUSTICE COOPER:

Q. So how would you armour them?

A. Say again.

Q. How would you armour the ledge supports?

A. You'd put a steel angle about 100 or 75 by 75, 10 millimetres thick piece of angled steel and it would have connections back into the floor and that would actually hold the whole edge of the concrete together. We call it armouring, make it much more resilient than basic concrete.

EXAMINATION CONTINUES: MR MILLS

A. Next slide thanks. You've seen variations of this. You've seen the one on the right as being pretty indicative of Forsyth Barr. The one on the left is one I've used myself during the 80s. I was designing, I was part of the design team for designing buildings. The idea of the cover is such that things like debris and rubbish don't get down into the slot, the movement slot, as you know. Unfortunately anecdotally and with some evidence of observations by myself and second hand, often these cover plates get taken out five or 10 years later because the guys are putting in new carpet or lino. They tend to be wear point for the lino and what they do is they fill up these gaps with levelling compound, hard cement effectively, and have a nice finished floor so they can lay the lino up and of course those gaps disappear.

1202

Is that a general problem? No, but there is enough incidence of it that the profession talks to itself saying, make sure that when they do a retrofit or a refurbishment if you're an engineer on the site for a particular part of the job that they don't fill up these gaps. It has happened. It's not general. But it has happened. Next slide.

What became common is this detail which gets away from, as Mr Hare's pointed out, is actually, it's more expensive to build but it gets away from the issues of those, either intolerances being used up and the gaps not being big enough or at some later date debris or whatever gets down into those cracks, those movement joints which we want left empty. The interesting thing about this. Well the good thing about this performance is that you end up with a very wide ledge sitting on a concrete beam or a steel beam. These are just schematics. If the stair moves to the left what it tends to do is bulldoze the carpet or lino out of the way. It tends not to jam. So this is why this became the favoured stair for the performance. It tends to be a bit more expensive, the building, in some respects what's going on in here, but this is generally how designers would visualise a stair, whether it's steel or concrete, landing on landing these days. Next slide thanks.

Again with respect to that previous slide with the steel landing on top of the landing and, as it's cited below, guidance that's been given by the Engineering Advisory Group to the Department of Building and Housing. When you do the numbers and those numbers have been introduced by way of example at the end of the report that went to the Royal Commission and has been expanded upon for the Department of Building and Housing, we find that that overlap it requires about 250 millimetres if you're going to allow for all the issues we allow for today which haven't been allowed for in earlier codes. It's not so much that the engineers were ignoring them, that they weren't asked to look at them and it wasn't common knowledge. They didn't have the cultural knowledge within the profession that we have today such as, are earthquakes being larger than the design earthquakes, that we're using peak drifts not the average drifts, and so when you allow for those you end up with an overlap which is about 250 millimetres. Next slide thanks.

JUSTICE COOPER:

Q. Does that vary or should that vary according to the characteristics of the building itself?

A. Very much so. That 250 mms is an upper-bound. If you have steel buildings that's 250 mms. That one's from an example where there's a concrete reinforced building in the worst case scenario. If you have a steel building you'd be looking at something in the order of 180 to 200 and depending if the drifts in the building are quite small because it's a wall building that might just get down to 150 mms. It very much depends on the characteristics of the building and the engineer would take that into account. That 250 mms is a dramatic upper bound.

EXAMINATION CONTINUES: MR MILLS

A. Retrofit concepts. Now this – I was asked to talk about retrofit and as you know every building is a individual creation design whether it's architectural or structural and it's hard to suggest a standard detail for a fix because what you tend to find is an engineer will take the concept and morph it. Design it for his particular or her particular landing situation and often architectural constraints. We'd like to stick a big steel beam under some of these stairs but we find that the head room is so small that you're going to bang your heads every time, and the architect gets upset and so do the people occupying the building. So you find that there has to be a degree of specific design to every situation. So what I did was restrict myself to common concepts rather than get into finer detail on, on a range of solutions. The obvious one is to replace the stair as a whole, and we're finding, if you go to repair Forsyth Barr it's highly likely that structural steel stairs will be put in rather than replacing them with concrete both on economy and the ability to get the stairs in. You're going to have to crane them in from the roof. So if engineers and owners are facing quite damaged stairs more often than not they'll revert to a structural steel stair. It's easier to put in. It's lighter and so some of the problems with overloading landings will be diminished by the fact that we're putting in a lighter structural steel stair.

Obvious answers: if the ledge supporting the stairs is too short we will need to extend that ledge. If the gaps between the end of the stair and the face of the landing is too small we have to widen the gap. The other one, what's been happening even prior to the earthquakes is actually putting supplemental supporting structures under the stairs, typically at the landings, change the way the stair carries its load. Next slide please.

Retrofit cutaway. That red area we would actually cut away out of the existing beam. Typically we wouldn't want to cut any reinforcing in the beam but you can get somewhere between 25 and 35 millimetres worth of cover concrete removed, treat that saw cut for corrosion issues which typically aren't a problem inside a building anyway and basically – next slide thanks – and you end up with a wider gap. I mean it's quite utilitarian and quite straightforward. Whether that gap's big enough or not that's up to the design engineer to decide whether they can actually achieve by just simply modifying the connection. Next slide thanks.

In this particular case the overlap between the stair above and the supporting beam below is too small so we'd build an additional support. Next slide thanks.

Something along those – schematic but it could be structural steel plates, a steel angle. It could be a steel box section which are quite nice, they tend to concentrate stresses and simply all we're doing is making that overlap so that when the inter-storey drifts occur in a very large earthquake we're not losing support and typically these things can be actually bolted back into the existing structure without too much effort. Next slide thanks.

This is quite common. Unfortunately I used the wrong name in the report. I called them scissor stairs. These are not scissor stairs. These are switchback. Scissor stairs are the ones which come down the landing and then go down another flight with a sister stair going the other way beside it.

JUSTICE COOPER:

Q. And you used the wrong name in your report to us are you saying?

A. Yes, yeah. The version I've got of it is wrong and that was my mistake. I apologise. Everything's got a nickname. These are called switchback stairs where the grey landing's half the height of the floor. So you come down, turn around at 90 degrees and go down the rest of the flights. These landings are typically solid and one of the slides I showed earlier on showed the landing being damaged.

EXAMINATION CONTINUES: MR MILLS

A. Next slide thanks. What tends to happen is the, as this floor moves in this direction, what it tends to do is this flight pushes hard up against the landing and this flight here doesn't want to move. What tends to happen is the landing warps and this introduces twisting into the staircases as well as a severe twisting into the concrete landing in the flight and twisting into the flight below as well as bending and axial load and it's actually quite a severe situation for those flights and the landings to be under and you tend to find that the, in the case of the Turkey case is that the landing shatters. The connection between the stair and the landing fails. Next slide thanks.

This is quite severe because not only do you have the damage but you can actually lose the stairs and we have a Forsyth Barr situation. The practice is to separate the stairs. The idea being that we physically saw cut them but before we can do that, remember typically this greyish landing doesn't have any support at all so we can't sort of just willy-nilly cut them. You have to put some form of supplement. One option is to put a supplementary support underneath. This could be a concrete wall, it could be a concrete block, it could be a steel portal frame, a light steel frame and what you tend to – this stair here is locked to the floor below. This forms a triangle. This stair here which is connected to the floor above here will simply slide back and forth on top of the intermediate support. Next slide thanks.

Another option if you don't want to have for various reasons architecturally services, mechanical services, whatever, there's often

these stairwells can have other uses within them in terms of their space. If you don't want to put a landing under here you can actually swing or suspend the stair from the floor above and what you have now is two nice rigid triangles here and a rigid triangle here and these stairs actually work independently of each other at the mid-height landing. Next slide.

This is an example of exactly that. This is a building in the University of Canterbury, retrofitted. They had mid-height concrete landings. The solution was to cut about 60–70 millimetres out of the landing because you can't leave a gap there so they put a seismic plate which is fixed on, sliding plate which is fixed on one side, free on the other. That allows people, it looks rough but it works. It allows people to traverse across the stair without having problems with the gap but it doesn't tie the two halves of the landing together. It allows it to move in the aftershocks so there's no more ongoing damage. Next slide thanks.

Some other issues with stairs that have to be addressed, dealt with to varying degrees from the late 1980s.

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Next slide – This is the situation where the flight meets the landing. This could be a landing out at floor level or this could be the mid height landing and we actually had a failure in a building in Wellington on a construction site in I think '87, Victoria Towers, where a four storey high pre-cast concrete stairs, it was morning tea. One of the crew ran up the stairs, actually steps down to level 4, hears an almighty whoosh. Looks back down. All the stairs are gone. And what happened was he's run out the stairs got the stairs bouncing and what happened was the top of the stair here blew off and once that's gone the cross section of stair is reduced to virtually nothing and the stair falls through and if one falls it takes all the others with it. This become a real issue for New Zealand because what traditionally we don't have any steel running in this direction. What seems to happen is you get this tension across that crack and the top pops off and we don't normally, up to that point, put reinforcing here. I mean concrete's great in compression but useless in

tension so where you've got tension you put reinforcing bars. We typically didn't have reinforcing going from the top of the stair to the bottom of the stair and all the stairs prior to that. Now we got asked back at the time, is this a massive problem? The thing was that these long stairs with landings were a relatively new idea, and so we sort of have a duration of about five or six years of these buildings with this sort of problem in them.

Next slide thanks – This was the typical reinforcing of the day. It was fine for gravity but wasn't any good if the stairs did bounce or they tended to get jammed or moved around in an earthquake. Back in the '70s and '80s a general awareness of these other sources of loading didn't prevail in the profession. You talk amongst engineers and they'd go, "Oh yeah, we get it, we get it" but it wasn't actually in general practice.

Next slide thanks – This is engineer heaven. What we have here is a number of stirrups being placed around extra bars in the top. These light pieces of steel typically 10s or 6s are there to capture the crack that might form where I'm putting the pointer. It won't stop the stair from being damaged but it will stop it from collapsing. It might settle 50 or 60mm but it's still got to be safe enough to egress out of the building and that was sort of developed as part of a research programme at the University of Canterbury and BRANZ New Zealand to confirm that we needed additional reinforcing. Varying this detail, this is again an extreme version of the detail, but that steel there was tending to be used from the late 80s onwards in New Zealand recognising the problem with Victoria Towers. The research in 2000 indicated we probably needed some extra strips along here as well, as well as this steel on the top of the stairs particularly in earthquake cases you tend to find the stairs go into tension on the top. In the gravity case they don't and in the gravity reinforcing you actually don't have this reinforcing but the recommendation from 2000 was that you actually did put some in.

Next slide thanks – Okay, this is very general and schematic. These details were promoted for moving forward with new stairs, not

necessarily old stairs, but in some respects it applies to old stairs in that if you have a stair spanning from here to here you've got a problem. It's going to jam, lock up, and one of the options for new stairs was actually to form a nice rigid triangle on one floor and have the other half a stair sliding on the landing. It's still architecturally achieved the egress routes you needed but you needed to put some form of support and that could be concrete walls, concrete block or lightweight, lighter steel frames. This sort of thing has been done as a retrofit to existing stairs where we've actually interceded and said, "Right we have to try and give it supplemental support." One end of the solution was if a stair gets damaged it's got some supplemental support. In other words they were accepting the fact that these landings might have got damaged. The other end of the solution for this was actually to form or make a way of making the stairs slide and more often than not that solution was to cut through here and put some form of supplemental support out here to give it some sliding.

Next slide thanks – Again this is one of these long span stairs with a sliding at the top end and that connection could be one of various solutions, not just Forsyth Barr or the ones that we were using in the '80s but a variation of slider up here. It's a long span steel. We were worried about what was happening with the knee. The idea was to put supplemental support in here which saves the knee from being damaged.

Next slide thanks – That's just another variation. Instead of having the sliding at this end we actually make it at the other end of the landing. These sort of ideas aren't peculiar to our practice. Variation of these are discussed throughout the industry. I'm prepared to say that the industry at large understands this even prior to the earthquakes of Christchurch, the significance of stairs and ramps jamming.

Next slide thanks – This is just one more issue to be highlighted. Again it's from the Turkey event but there are generations of buildings probably from the late '70s and earlier where it actually used the intermediate column to support the landing of the stair. What that tends

to do is form a very rigid triangle and the stair chops as the building moves, the stair literally just chops through the column. This does appear in a number of buildings in New Zealand. It's an older style solution. It has been used around the world and we say in modern design it obviously needs to be avoided. If you are assessing a building as a designer working for an owner that would be one of the hot spots you would go looking for. Is there interference with the ramps or stairs with the columns.

Next slide thanks – One of the issues that came home clearly in our events here in Christchurch was the idea that not only were we worrying about stairs moving this way but stairs could actually move this way. They tend to be giant pendulums. They are fixed at one end. Not only do the floors in the buildings actually do this. They don't read the codes. They don't know to do that or that, they just go anywhere they want to 'cos of the way the earthquake hits the building. We've been talking for the last couple of days about stairs that do that but also stairs if the fix at this end can swing like pendulums. There's evidence of some of the stairs actually smashing into stairs beside and through the walls, the lightweight walls and stairwells. I am prepared to say that a lot of engineers haven't thought about that until recent times and the advisory note from the Department of Building and Housing and the Royal Commission Report point this out to engineers saying, be aware of this. Part of the problem is the stairs do start to swing a lot, you'll tend to find that those bars will snap and that's not a good look. So again what's happened it's put a series of design questions in front of the engineers saying yes we can talk for ages on this but don't forget about this as well as things like mid height column supports and so forth. There are other issues where stairs can be just about as bad.

Next slide thanks – One of the ones, like any walk of life in the culture of the profession there are urban legends and one of them was that stairs built inside concrete cores you don't have to worry about. I'd say if it's a really big concrete box, solid walls on four sides with just a few doors it's probably getting to the truth but what we found in Christchurch that a

number of staircases inside concrete walls like a stair core or a lift core depending on the architecture if there were a lot of windows and the walls did something like this instead of, relative to one another, we actually found a number of stairs were starting to get stressed to the point of you can't put rescue crews in this building, a two man team only on the stairs. Yet if you'd asked an engineer prior to February what do you think about staircases, concrete stairs or steel stairs, concrete stairs in particular, steel stairs are less of a concern, in a solid concrete core, "Ah no don't worry about it" and again this was a cultural thing. No evidence but we all grew up with it. Evidence from this earthquake is that the stairs tend to warp and an earlier slide showed one stair moving relative to the other and warping in this mid height landing. We're seeing this in staircases that are concrete encased but to a lesser extent. It's not a cure-all. It's a hot spot that an engineer would want to go and have a look at just to make sure that the degree of damage was small enough to be acceptable or whatever repairs were required.

Next slide thanks – And that's my presentation thank you.

CROSS-EXAMINATION: MR LAING – NIL

CROSS-EXAMINATION: MR HANNAN – NIL

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COMMISSIONER FENWICK:

Q. One quick point. It's been suggested by someone from overseas that perhaps there ought to be a stop. When you get to your limit of movement, there's some form of – so if you go into tension you have some form of stop which will then act – cause the stair to act as either a prop or a tie in the extreme. I'd like to hear your comments on that suggestion.

A. Again I actually think it's not a – it's a good concept. The concept is if a stair, if these papers are a stair, and again remember that for want of a – an old professor of ours Richard would say the earthquakes don't read the codes. They'll throw anything at you if you can, as it will – the

situation even with all these allowances, there's a possibility heaven forbid that something goes wrong. A badly installed connection, the drifts we got, there's plenty of sources inside the behaviour of a building where the drifts can even get bigger than what I've indicated on the presentation. The question is do we have, for a want of a better way of putting it, a belts and braces approach, which is if the stair does fall off, do we have some form of connection, something as simple as a chain or supplemental reinforcing bar that captures the stair should in the absolute extreme event falls off, the answer's yes. It's relatively easy to do. It's not in the common lexicon of what engineers do today. What they're going to say is we need to make the drifts. We'll allow a residual about of overlap. That will be fine, but in a situation like a staircase which is totally needed for safe egress, maybe that next level of protection, supplemental protection is justified.

Q. So that could well be a retrofit for an existing stair just to hold the stair temporarily in place after an earthquake do you think?

A. Yes, you could, excellent idea, yeah exactly.

COMMISSIONER CARTER:

Q. I think it fairly obvious what your answer is, but critical vulnerabilities are an issue with respect to this earthquake in terms of, you know what people look for when they look at existing buildings built at different periods. Obviously you would agree that a staircase is one of the things you look at first – first up?

A. Without a doubt. I mean the first thing you do other than when you walk up to a building to assess a building is whether the panels are going to fall on you and the next thing you do is take a look at the staircase 'cos you're going to have to use that to get up through the building. In terms of assessment of a building, it can be done from a number of different ways. We've heard, you know whether it's analysis or whether it's by observation and probably to open Pandora's Box here, and I haven't heard all the evidence, I haven't read the reports, but one of the things that hit us at several levels and it's not just Forsyth Barr, and it's come

up a number of times, is that engineers globally in seismic aware countries are coached to understand that you have a major event and she calms down with time. Aftershocks dissipate. There's a general rule, one of the rules in evaluating these buildings is if you go in and there's relatively little damage, the odds are on that the building will sustain ongoing aftershocks. If there isn't tangible evidence that the drift capacity of the building's been used up. One of the problems with all these, like even level 2 inspections is that you are taking an assessment of the damage as you're looking at it. The big issue was that none of us globally expected February and I see a lot of concern about why they didn't expect bigger drifts and so forth, anticipating bigger drifts at some later date is because fundamentally the engineering profession is coached not to anticipate bigger drifts. Over the first week you might get a shock that's bigger than the main first shock. That's – we know that happens. We – given some months later, you're expecting not to be dealing with significant movement in the building and if basically if the building is functioning some months later an engineer would assume that everything's reasonably okay. February was a massive event and we're all asking could we have second guessed ourselves on the amount of drift and demand that that big earthquake caused. The answer's no. Because I believe generally the profession and not just New Zealand profession, but international seismically aware engineers would have done much a similar thing as that. The building's robust enough, the drift indications and fit out is that the drifts haven't been that large. Essentially give or take a number of hotspots the connection's still in place. The building as a whole typically be seen to over a short period of time, survive ongoing diminishing aftershocks and be it that every owner's advised to get a detailed report in due course. Unfortunately February caught everyone by surprise. I think I'll stop there.

Q. Thank you.

A. Wasn't a yes no answer sorry.

QUESTIONS FROM JUSTICE COOPER – NIL

WITNESS EXCUSED

MR MILLS ADDRESSES JUSTICE COOPER:

A. That concludes the evidence, Sir, and just before I close there's just one final matter I want to deal with and I've just been reminded that we had some correspondence with Fletcher Construction because we had identified them as a potentially affected party in relation to the role they played in the construction of the Forsyth Barr building and they've indicated that they may wish to file a written submission of some kind and they've been told yes, they can do that but they didn't want to appear at the hearing, but they also advise that because the construction of the building is so long ago they didn't hold any records. So that issue came up in passing as to whether there might have been records that they would have had of work done on site. The answer is they didn't have any at this late stage.

Q. When might we expect this submission if it's going to (overtalking 12:28:52).

A. They've given no indication of that.

Q. Well perhaps we should give them one.

A. Yes well we well might and we can discuss that unless you want to deal with that now.

Q. Well all right – sooner rather than later would be my feelings so and I can discuss that Mr Mills. There was one other statement in here which we should just record we're – going to take into account I suppose.

A. This is Mr Christian's one isn't it?

Q. Yes.

A. Do you want that read into the record or is it enough?

Q. Well no I think it's enough if we refer to it. It'll be published in the normal way. It's WIT.CHR0001.1 and following, statement of Andrew Christian.

EVIDENCE CONCLUDES

COMMISSION ADJOURNS: 12.30 PM