

HEARING RESUMES ON MONDAY 3 SEPTEMBER 2012 AT 10.04 AM**JUSTICE COOPER:**

Mr Zarifeh you are appearing. Mr Laing.

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MR LAING:

With Ms Judith Cheyne as Your Honour pleases.

JUSTICE COOPER:

10 Any other counsel present? Now Mr Zarifeh?

MR ZARIFEH OPENS:

Yes I will address the terms of reference requirement of the Royal Commission to inquire into the legal and best practice requirements for assessments and for remedial work on buildings after an earthquake, having regard to the lessons that have been learnt from the Canterbury earthquakes and also how those legal and best practice requirements compare to similar matters in other countries.

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The assessment process after the September earthquake and the Boxing Day aftershock has already been considered in some detail in the hearings related to individual buildings. The Commission has held hearings to consider the failure of in excess of 20 unreinforced masonry buildings in the city. It's also held hearings to consider the failure of the PGC building, the Forsythe Barr building, Hotel Grand Chancellor and most recently the CTV building, and this hearing is an opportunity to consider all of the assessment issues that arose in those hearings and there were similar issues, as the Commissioners will be aware, that were raised in more than one hearing. Consider all those issues and other issues that relate to the assessment of buildings in order to determine, essentially, how we in New Zealand can have a post-earthquake building management process and system that meets legal and best practice requirements.

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The current building assessment process, as Commissioners will be aware, arose out of guidelines that were developed by the New Zealand Society of Earthquake Engineers, and the Canterbury earthquakes –

5 **JUSTICE COOPER:**

Engineering.

MR ZARIFEH:

10 Engineering sorry, the Canterbury earthquakes was really the first real test of those guidelines on any major scale and really the huge scale of the earthquakes and their consequences, severely tested that process and the resources that were needed to operate it. And whilst generally the process worked reasonably well in the circumstances that Christchurch faced, there were issues and shortcomings and gaps in the regulatory framework that
15 over-arched the process and all of these became apparent throughout, and it's really those issues that this hearing will seek to discuss and tease out and address and try and look to the future how things could be done better, how things could be organised better, so that the system if something like this happens again, the system that can be put into place and all that entails will
20 be a better one.

In the hearing, it's intended that this hearing will focus on going forward rather than going over individual issues that arose in relation to particular buildings. As I've indicated in the individual hearings, there was some considerable time spent on that and I've no doubt those will come up as examples of particular
25 issues, but rather the focus it's hoped will be that they occurred, these issues, and as I say to look to the future and how they can be remedied or avoided in the future, and so that there is a better system in place.

Submissions in relation to this building management hearing have been received from some 20 people or entities, and those submissions have all
30 been logged on to the Royal Commission's website and have been made available. There's also a statement from a Ted Blaikie who was an Opus engineer who was on secondment for a few weeks after the September earthquake and some material that he subsequently added to his statement,

and that's going to be treated as a submission because he raises various issues, some of them have already been raised by other people, and those issues will be discussed as will the others raised in the 20 or so submissions received. Those submissions cover a wide range of issues and I don't intend to summarise them all. As I say, they're all on the Commission's website, but they include, and this is perhaps putting it in my words, but things like the trigger to require a building assessment process. That's something that will no doubt create some debate and this may not be the right word but my word is the test to be applied by engineers or building inspectors to determine re-occupancy of a building following a large earthquake.

The public's understanding of that test and the issue of risk and in particular what risk is acceptable to the public and how does that risk feed into the test that should be applied.

What information can there be available to engineers, to building inspectors, to people who were operating a building management system following a big earthquake from GNS Science to try and predict or try and give as much information as possible as to the likely aftershocks. That is relevant to this issue of risk and to the test to be applied.

Whether different considerations should apply to different types of buildings such as unreinforced masonry buildings, multi-storey buildings of some complexity or heritage buildings.

The placarding system in particular, the green placards.

The transition from the emergency period which will only last some days or weeks to the recovery period or as it is sometimes referred to business as usual period and the legislative framework that provides for those two areas and for the transition.

The capabilities and the training of engineers and building inspectors who are involved in this process.

And the communication between engineers and the public over concepts such as safe, or safe to occupy.

All of these issues are up for discussion and for debate in consideration obviously by the Royal Commission in this hearing.

So having outlined those matters I just want to turn now to briefly advise the Commissioner's on the hearing plan for the next two days. The format for the hearing is that there will be a number of presentations today and then a panel discussion tomorrow.

5 So this morning in a moment Commissioner's will hear from Mr David
Brunsdon who will deliver a Powerpoint presentation providing an overview of
the evaluation and management of buildings following earthquakes. Mr
Brundson, as Commissioner's will know, is a director of the Kestrel Group. He
is a structural engineer with considerable expertise in the area of
10 infrastructure risk management and emergency response management and
he has been responsible over the last decade for developing and
implementing New Zealand's post-disaster building safety evaluation and
rescue engineering arrangements and he assisted the Christchurch City
Council with coordination of the building safety evaluation process that
15 followed the September earthquake 2010. He was also involved in USAR
response following the February earthquake and since October of 2010 Mr
Brunsdon has led the engineering advisory group, EAG, which has developed
technical guidance for the assessment repair and reconstruction of buildings
in Canterbury. So that's essentially this morning's presentation.

20 At 2.15PM a video link has been arranged with USA, California and the
Commissioner's will hear from Mr Bret Lizundia. Mr Lizundia will provide
comment on Mr Brunsdon's presentation and also offer insights into the
building management process in the United States. The Commission has
heard from Mr Lizundia previously, was in the unreinforced masonry buildings
25 hearing last year. Mr Lizundia is a structural engineer and principal of
Rutherford and Chekene Consulting Engineers in San Francisco and he has
considerable experience in the field of post-earthquake safety evaluation and
management and he headed a, or was part of a group of American
construction engineers that visited Christchurch following the February
30 earthquake to assess how the safety evaluation system had been
implemented and to see essentially what America could learn from it. So
that's at 2.15.

Following that presentation the Commission will hear from Dr Ken Gledhill who is a geo-net project director and he is also the Department head, the Department head of geo hazards monitoring within the natural hazards division of GNS Science. Dr Gledhill is a technical and scientific project manager, also a seismologist and a telecommunication specialist of over some 30 years' experience. He will comment on developments in operational modelling at GNS and communication work from GNS and within GNS which could be of assistance for territorial authorities, engineers, building inspectors, building owners and the public following a large earthquake in terms of aftershocks likely. So that's really today's schedule.

I will perhaps say a bit more about tomorrow's tomorrow but just to highlight what will be tomorrow. It is intended that tomorrow will essentially be a panel discussion starting at 9.30 and able to take up the day or most of the day depending on how long it takes to discuss the various issues. There has been a hearing plan with topics and questions set out which just running through it quickly include the goals and objectives for a building management, how the assessment process should be implemented, the capabilities and training of the personnel, the framework for the management of the process, follow-up action particularly of green placarded buildings, barriers to the repair or rebuild or removal of buildings, the issue of cordons and the issue of information management and as I have already indicated in the issues that have been thrown up by the submissions there will be many more sub-topics if you like within those general topics.

The panel tomorrow will consist of Mr Brunsdon, Mr Peter Smith who the Commissioners have also heard from in relation to the individual buildings from the New Zealand Society of Earthquake Engineering. Mr Michael Stannard from the Ministry of Business Innovation and Employment. Again the Commissioner's have heard from him. Mr Peter Mitchell, general manager of Regulation and Democracy Services and Mr Steve McCarthy, Environmental Policy and approvals manager with the Council. Again the Commission has heard from both of these gentlemen. Mr John Hamilton and Mr Peter Wood from the Ministry of Civil Defence Emergency Management. Mr John Hare from Structural Engineering Society, again the Commission has heard from

him. Esther Griffiths, I think it is Esther Newman now. She was formerly an emergency management advisor with the Christchurch City Council and completed a report or a draft report that is on the Commission's website. Tony Saul who is the, I think I am right in saying the head of the New Zealand Property Council and then Richard Toner who is the chief building officer of the Wellington City Council to give a Wellington perspective to these matters. As I say I will go into those people and their backgrounds in a bit more detail tomorrow but unless there are any questions from the Commission I intend to ask Mr Brunson to come forward and to be sworn in and then present his presentation.

MR ZARIFEH CALLS:**DAVID RONALD BRUNSDON (SWORN)**

Q. Mr Brunsdon, can you give the Commission your full name please? \

A. David Ronald Brunsdon.

5 1020

Q. Now you would have heard in my opening remarks I spoke a bit about your experience. I just wonder rather than have you repeat that, whether in your words you can just give us a potted version of what you do and your background in particular as it relates to this issue.

10 A. The consulting company Kestrel Group that I'm a director of works at the interface of emergency management and risk management and crisis and business continuity planning and my linkage is with engineering processes and that has led me to the involvement in this particular area of post-earthquake building evaluation advice in amongst
15 rescue engineering and advising and being a member of New Zealand Urban Search and Rescue teams and related activities.

Q. And you're a structural engineer by qualification?

A. Correct.

20 Q. But is this an area that in the last, well at least 10 years if not more you have essentially specialised in?

A. Yes following on from a number of other engineers that first adapted international procedures into New Zealand and I'll cover that in my presentation but since the late 1990s I've been involved in trying to provide a greater clarity around how engineers would respond in large-
25 scale emergencies.

Q. Right. Thank you and we've got it on the document with your CV and it sets out in some detail some of those matters. All right now I think you've got a PowerPoint presentation you've developed to present to us this morning?

30 A. Yes.

Q. Right well I'll hand over to you and you can do that.

MR ZARIFEH ADDRESSES JUSTICE COOPER

EXAMINATION CONTINUES: MR ZARIFEH

Q. I think you estimate probably a couple of hours. Is that right?

A. Of that order.

Q. All right well we've have, usually have a break at 11.30 if you just want
5 to keep that in mind for your planning. All right. Thank you.

WITNESS COMMENCES POWERPOINT PRESENTATION

A. Commissioners, ladies and gentlemen. This overview presentation
10 covers the background to New Zealand's post-earthquake building
management arrangements and provides some aspects of how it was
implemented in both September and in 2010, in February 2011 and the
issues arising. I'll be focussing more on commercial buildings in relation
to the Commission's interest but will also be touching on residential
aspects because the process needs to encompass those dimensions.
15 I'll also cover the subsequent developments both technically and
generally in discussions with our international counterparts and I'll offer,
provide some thoughts on the key considerations for future
arrangements.

BRIEF DISCUSSION – TECHNICAL ISSUES

20 A. Covering these topics as outlined, one of the main themes in this
overview is that building management after earthquakes or, more
importantly, disasters of other origin it's more than just rapid
assessment and placarding and the three phases, the three elements
that comprise building evaluation are listed there. I'll go into more details
25 in a moment, there are three elements: over-all damage survey, rapid
assessment which typically results in placards being posted but then a
more evaluation and our process has been, is based on the Californian
approach developed by the Applied Technology Council (or ATC) and
we'll hear this afternoon from Mr Lizundia who's been closely involved in
30 that process and in turn the elements of the ATC process form the basis
of most international arrangements.

The New Zealand basis is currently the August 2009 guidelines for
territorial authorities prepared by the New Zealand Society for

Earthquake Engineering with support by the then Department of Building and Housing and the Ministry of Civil Defence and Emergency Management.

5 Looking at those levels in a bit more detail around the timeframes and who the key providers of those are in the hours after a physical impact the emergency services and, indeed, council staff as they both arrive for duty and do initial reconnaissance form a view from that broad survey as to how large the impacted area is and in, for example, the September 10 2010 response an early call was made that the worst affected area was within the four avenues as they're known here in Christchurch and that would be the focal point for, or firstly the police cordon and then a more intensive assessment within following, obviously, the need to declare a state of emergency. Once that emergency is declared then, and for as long as it is in place, the rapid assessment is typically undertaken. 15 Depending on the size of the event and the impacts it is to be carried out by engineers volunteering in addition to any staff engineers that the local council may have, building control officials and a range of other building professionals including architects and heritage advisors.

20 **JUSTICE COOPER:**

Q. Do you want us to ask you questions as you go to leave you to go through this and then ask you questions when you've finished?

A. Questions are welcome Your Honour as I progress, and Commissioners.

25 Q. All right well if I can just start that process. The way you've described these three levels of activity is very much in terms of the existing legal system I think in as much as in discussing the overall damage survey one of its purposes I think you said was to decide whether it's bad enough for a state of emergency to be declared. That's right isn't it?

30 A. Yes.

Q. And then in the rapid assessment process you actually say that that is during a period of state of emergency. So it immediately raises the issue about there being a damaging earthquake but not damaging

enough to cause a declaration of a state of emergency. What would be the process that was then applied to the assessment of building damage?

- 5 A. In such circumstances the local authority would have the responsibility for organising some form of systematic assessment and they would be using their normal Building Act arrangements.

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Q. Which may not be all that tailored to the particular purpose?

- 10 A. Correct, and the Building Act does have sections relating to dangerous buildings but the first element of the definition for a dangerous building is to exclude earthquake which creates an instant problem which has been recognised for some time and played out with a measure of difficulty, for example in the response to the Boxing Day 2010 earthquake aftershock.

- 15 Q. And then you come onto the detailed engineering evaluation which is an ongoing process, as I understand it, in Christchurch, but that is dependent on the legislative, special legislative framework that the CERA, the Canterbury Earthquake Recovery Act provides, is that right?

- 20 A. Yes, and aided by the clarity which the Canterbury Earthquake Recovery Act provided in relation to section 51 and I think section 45.

- Q. So is it, and I will stop asking questions in a minute, but is it a realistic goal do you think that we should have a set of statutory provisions now in place that would be effective given a future damaging earthquake, or is it, or is that unrealistic and we need to wait to see what disaster presents itself and then adapt the special legislative response?
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- A. I think if we reflect on the many lessons from the Canterbury Earthquake sequence we must view it more than just a realistic objective. I think it's a fundamental imperative to link together the, if you like, the everyday regulatory arrangements around dangerous buildings with the earthquake prone provisions with the operational arrangements for dealing, for managing buildings following disasters.
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- Q. You include earthquake prone buildings in that but some would say that that issue is a, can be seen as a discrete issues whereby you accord

signing system that looks forward in the period of leisure which is afforded before an earthquake, and lots of things that could be done so that when the earthquake strikes, earthquake prone buildings have been in fact attended to in a proper measured way and that can perhaps be dealt with as a reasonably discrete issue whilst, and then you're designing what should happen once there's been an earthquake, what should the response to that be?

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A. I think there's an element of traditional thinking has been to view them as two discrete activities but if you reflect on the considerable amount of information that should be and is being gathered under the earthquake prone provisions, that provides, if used, gathered properly and used effectively, and I'll come back to that in my presentation –

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Q. Yes.

A. – that provides an immense base of knowledge from which particularly the detailed engineering evaluation and possibly aspects of the rapid assessment can build upon.

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Q. Yes. In the sense that light has been shone on what things need to be looked for?

A. Yes.

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Q. Oh, yes I accept that. But they're, I'm just wondering though whether the legislative setting needs – to the pre-earthquake situation, dealing with earthquake prone buildings and the provisions that deal with what happens after an earthquake are, you come at that?

A. Yes Sir at this point I was to put on my emergency management sort of hat and this is the, the whole continuum of emergency management planning of the four Rs or risk reduction, readiness, response and recovery, and whilst this, we are dealing with what may be primarily seen as response in order, and recovery in order to improve our readiness. The first dimension is always risk reduction and keeping the focus on reducing mitigating the risk that we can.

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Q. The better prepared we are, the less we'll have to do once there is an earthquake. Right.

EXAMINATION CONTINUES: MR ZARIFEH

- 5 A. Just completing this slide, the detailed engineering evaluation is the more considered technical review of structures accessing drawings and plans and a fuller inspection of structures. It is something done for the owners of buildings and there is a point there that for critical structures, those that have a critical post-disaster function, they should be undertaken immediately. Ideally by engineers that are already familiar with those premises, but it is a longer term activity for others and involves parties other than engineers. I guess the important point here is that the rapid assessment, it is organised by the local Council and/or under the control is Egis, depending on the level of declaration, but the – it doesn't involve the provision of engineering assessment services to owners. That is, returns to being the responsibility of the owners. That is a distinction that probably hasn't been clear enough to date.
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- 15 The purpose of the rapid assessment is to expand, and this is an extract from the pre-event training material prepared by the New Zealand Society For Earthquake Engineering, pre-broad purpose, purposes to as it flows on from the overall damage assessment, that first look by emergency services and Council personnel is to confirm where damage is concentrated, to assist the broader response and recovery decision making and fundamentally the second point is all about whether there's a need to either enable or restrict or prevent access to buildings in various states, but also it's part of the gathering information for the recovery process, particularly around damaged buildings. Gathering information including where possible the cost of the damage to assist financial planning.
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- 30 The aims are expressed in a bit more detail in section 1.1 of the guideline document. This gives a slightly broader picture of the objective. The first one is the safe use of streets adjacent to damaged buildings, bearing in mind in the early stages, even within a cordon situation there will be other resources accessing the streets that do not have a technical training.

Then obviously the key point about which buildings can be occupied, particularly and early focus on emergency facilities, but with the aim always of the, whilst maintaining public safety, minimising the impact on commercial activity and the displacement of people and the rapid assessment process, particularly in the residential context has a strong emphasis on shelter. The, as identification of where temporary works are needed. Where for the sake of a small measure, for example, of stabilisation of façades or whatever, the streets could be made accessible and reflecting the heritage element of endeavouring to save property from unnecessary demolition, again with the economic impact in mind.

If we, this is essentially a triage process, with the rapid assessment being the second stage of the triage if you like and whilst for, for, for working within the cordoned area which inevitably follows an urban earthquake the objective really is the, the focus is, is to establish those buildings that are clearly unsafe or need to have access restricted, that is the, the focus, the early focus of a rapid assessment process.

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JUSTICE COOPER:

20 Q. This slide is headed by reference to the NZSEE guidelines, the previous one referred to NZSEE training material. The training material is, what's that called, is it, it's published is it?

A. Is it published and has been made available to –

Q. We've got it have we?

25 A. – the Commission yes. I just picked up two different forms of expression but in – there are two principal training modules developed and they, they both reflect those purposed statements.

Q. Right.

EXAMINATION CONTINUES: MR ZARIFEH

30 A. There are two levels of rapid assessment as, as people are now familiar the level 1 rapid assessment and a level 2 rapid assessment and I'll

briefly explain these. The focus of the level 1 assessment is again reflecting that initial attempt to identify which of the buildings are clearly dangerous. It is generally an exterior only assessment but obviously where buildings are open then access can, you know, where access is available it can be taken. It typically takes 15 to 20 minutes per building in very broad planning terms. It is also generally assumed to apply to you know to three or four storey buildings with larger structures or those with question marks, uncertainties following the level 1 assessment requiring a level 2 assessment which can take you know between one and four hours per building depending on the size and scale of the structure and of course the key element of that is getting access to those buildings to undertake that rapid assessment.

COMMISSIONER CARTER:

Q. What is the particular point of separating those two items there where they really would all be covered by the second wouldn't they?

A. They –

Q. If they –

A. They certainly would, you, this is where the, the linkage with the cordon management is, is important because once you place a cordon around an affected area the, there isn't the ability for owners or it's not straight forward for owners to come in and enable access to allow the, the level 2 rapid assessment and hence my earlier comment, the focus of a level 1 is more towards identifying those that are clearly unsafe and need to have access restricted and this is what we are now reflecting on in more detail as, as to whether following a level 1 rapid assessment that is enough to indicate continued occupancy.

Q. Okay, I follow thank you.

EXAMINATION CONTINUES: MR ZARIFEH

A. This is a damage based process, again consistent with the other international methodologies. The focus is on identifying damage that, that indicates whether further local hazards or overall collapse could

occur in anticipated aftershocks. It doesn't involve the assessment, the review of drawings or the assessment of other information typically.

Stepping back to the development of the system here in, in New Zealand it first came to New Zealand in 1989 via an interesting story whereby the New Zealand Society for Earthquake Engineering team which was returning from their reconnaissance of the Armenian earthquake happened to be in San Francisco at the time of the Loma Prieta earthquake and, which was the first event in California where the ATC, the recently completed ATC, procedures were implemented and some members of the New Zealand team including Mr Wood here today were thrown into a role that they experienced for the first time. It's worth noting as a, as in a quick aside the, the role of the Earthquake Commission who funded that reconnaissance team enabling the principal funder of approaching 20 overseas earthquake reconnaissance studies over the past three decades and a great deal has been learnt from these visits that typically are a matter of weeks following those earthquakes and many of them the, the teams have viewed the results of the rapid assessments in large scale earthquakes and, and again they have seen for themselves the reality of earthquake damaged structures and the decision making around them and if it wasn't for that investment in those visits I'm not sure that we, our process would not, it would not have developed to the point that it had prior to the Canterbury earthquakes.

The learnings from those reconnaissance visits shed insight on operational matters that we had had the good fortunate not to, not to experience in New Zealand but directly following that visit the then Ministry of Civil Defence commissioned the production of New Zealand procedures based on ATC 20 and the Earthquake Society built upon those procedures when they set up a working group in 1995 to progress and they produced what can be referred to as the first version of the guidelines in 1998 and distributed those to, to all the councils in New Zealand.

JUSTICE COOPER:

Q. Why are you describing this up dated guidelines that suggests that it was some earlier form of them?

5 A. The, the, sorry the first version was produced by Works Consultancy Services for the Ministry of Civil Defence in 1990.

Q. I see.

A. And that was, was, was, was broadened by the Earthquake Engineering Society.

Q. What was the name of that document?

10 A. I will have reference to it. Procedures for Post Earthquake Safety Evaluation of Buildings.

Q. And that's the, did you say it was done by Works Consultancy Services?

A. Yes.

Q. And published in 1990.

15 A. Yes, in a document, in a document by the Ministry of Civil Defence I'm not sure how widely that was distributed it was an operationally oriented manual I believe.

Q. And published did you say in 1990 or 1995?

A. 1990.

20 Q. 1990. But you don't think that was, would all the territorial authorities have had that?

A. I suspect not, I wasn't personally involved at that stage, so I can't comment further.

Q. All right thank you. Somebody else might know.

25 A. Mhm.

Q. We'll find out. Thank you.

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EXAMINATION CONTINUES: MR ZARIFEH

30 A. In 2004 the Earthquake Engineering Society commissioned a further update of the guidelines. There was awareness of limited take up by local authorities because it was a document produced by a technical engineering society. There was no legal mandate and, equally, the Civil

Defence Emergency Management Act had come to being in 2002 and the Building Act was updated and a new version in 2004, and so along with some other developments the society chose to update the document at that point and whilst this process was underway the
5 Gisborne earthquake occurred at the end of 2007 and that was the first application in New Zealand of a rapid assessment methodology and a great deal was learnt from that experience even though it was a small response in the context of Canterbury but it highlighted a number of operational management issues but also more broadly that the Building
10 Act didn't make any provision for a range of post-disaster matters.

COMMISSIONER CARTER:

Q. Was there public funding available for NZSEE to do this work?

A. Much of the efforts through the early phase of that update was provided
15 by the society itself. Funding, again following the reality that was learnt of the December earthquake and the work to be done the Department of Building and Housing did provide some funding for the completion and issue of the document but there was a strong element of voluntary input from the New Zealand Society for Earthquake Engineering members
20 with some paid contribution.

Q. Would it be possible to give some sort of estimate at some stage of how the costs fell for doing this valuable work for the community?

A. Yes.

Q. Thank you.

A. That can be made available. And, again, as part of endorsing the
25 update process the Department of Building and Housing established a national reference group to guide the final stages of the process and that involved representation from the Ministry of Civil Defence Emergency Management, IPENZ and key representatives, building control leaders from Christchurch City, Wellington City, Auckland City,
30 Gisborne District Council and New Plymouth District Council and the guidelines that I showed on the screen earlier were completed and published in August 2009.

Straight after that another international opportunity arose following the 30th of September Padang, Indonesia earthquake where the, through the New Zealand Government the New Zealand Society for Earthquake Engineering and others organised a team of 10 volunteer engineers to assist the affected community and particularly for doing rapid, the second phase of rapid structural assessments, essentially level 2 assessments and that, there were some very valuable process learnings from that mission as well as 10 engineers that had some more first-hand operational experience of evaluating buildings following earthquakes.

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The two, perhaps the two key learnings were the sheer difficulty of managing the data that flows from a major operation and the need to have a very sound data management system in place, the prototype of which was developed in Padang and was used by Christchurch City Council as a basis here. The second learning is that we developed some additional, what we termed usability categories, which again reflecting the slightly more detailed information available from a level 2, or a second-stage rapid assessment. We provided a bit more detail for each of the green, yellow and red levels and they were incorporated into a draft update and were actually used in the Christchurch City response.

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So in July 2010 the guidelines as I say were produced in update stage and sent to the national reference group for review along with some training material and indeed some draft field guides but they weren't processed by the time that 4th of September 2010 came along.

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At this point relevance to compare with international arrangements, just a quick bookmark that perhaps Mr Lizundia may elaborate on this afternoon, but our rapid assessment arrangements are similar to the United States, Japan and Greece. Our delivery mechanisms and the numbers of trained personnel are obviously far less developed than the US and Japan. The European Union has similar categories also but their procedures do not involve placards. The Italian system has a different set of categories and again no placards. The key underlining point though is that all of these systems are damage-based, quick inspections prior to a more detailed engineering evaluation to follow.

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JUSTICE COOPER:

5 Q. It's obvious to you because you're deeply immersed in this but you say delivery mechanisms and numbers of trained personnel are far less here than in the United States and Japan. Is that, what are the explanations for that?

10 A. I guess it's really reflected in that chronology that California has had arrangements in place since the late 1980s and Japan a similar timeframe but New Zealand's procedures had only just migrated from being technical guidelines without any regulatory frame of reference or mandate and so the whole operational processes had not developed anything like the level of detail that they had in other countries. I've got a slide just to reflect the level of detail that is in place in California.

15 Q. So as a result of events in Canterbury do we need to get onto that next level of preparedness?

A. Very much and it's the absence of a structured, you know, set of arrangements which are operationally oriented lies at the heart of some of, many of the issues that we are debating here.

20 Q. Yes and do you come back to the situation in Europe and Italy or you mentioning these here for the only time?

25 A. I don't come back in detail but I, there's a point in passing that one of the categories that Italy uses which reflects the specific risk to a building from its neighbouring building was one that we did incorporate in our Padang mission and in the July draft guidelines and used in September '04 as a usability category. So we did take elements from that procedure and I actually do have a interesting quote from their operational procedures to, which puts their interpretation of the rapid assessments in context that I was going to come to later.

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30 Q. I suppose because we've been studying our system and hearing from New Zealand and American engineers it's difficult to envisage how a system would work without placards which seems to be the general position in the European Union. How does it, do you know how it works?

A. I don't have a firsthand base of how it works but it is, as you say, challenging to envisage but again we are dealing with damage often on a potentially wider scale.

Q. Who is?

5 A. In other cities of the world but we do have some firsthand knowledge here in Canterbury from people involved in response to the L'Aquila, Italy earthquake in 2008. Professor Stefano Pampanin familiar to the Commission and his wife Dr (inaudible 11:00:49) were involved in the response.

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COMMISSIONER CARTER:

15 Q. I think the matter the matter that occurs to me in His Honour's question is that our placarding system is intended to inform others than those that own the building or work in the building, public information system. Is there such a system handled by some other means in these countries that don't have placard, are you aware?

20 A. I am not aware of that but I do know the Italian system places a great deal more emphasis on the management of data from the field. How the civil protection authorities communication that to the wider public I am not familiar with the details of. I guess the point from or the other point from the slide is that there is no one, on the one hand there is no one universal international system but that they do have that same technical theme behind them that they are all damage based assessments, whereas I will come to, there is renewed interest in international collaboration on these systems that have arisen from the experiences here in Canterbury.

25 Just highlighting one, the matter where we have defined different assessment levels in a matter of detail from the US system which we have, they, we have rapid level 1 and a rapid level 2 whereas the ATC20 system calls it rapid and detailed. They are essentially the same forms are used but we, prior to Canterbury were anxious to avoid the implication that by calling it a detailed evaluation that it may be viewed
30 in the way that people generally think of, about engineering processes.

Q. Does that mean it is more in the name rather than the work that was done?

A. Yes, yes, we didn't want – what was, very much a rapid assessment being communicated, labelled, communicated and conveyed as a detailed assessment.

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Q. Thank you.

EXAMINATION CONTINUES: MR ZARIFEH

A. Just a word on the Californian safety assessment programme which Mr Lizundia will comment on further but it is administered by the Californian Emergency Management Agency, supported by a steering committee of the industry professionals that actually operationalise, carry out the operations. It is resourced and administered by that agency. The outcome is the provision of SAP, SAP evaluators and coordinators to assist any affected local government in California. The engine that sits behind those arrangements are a database of more than 6000, I think it is up to nearer 7000 now, trained evaluators and coordinators and that comprises in addition to engineers there are architects and building officials. The database is maintained, the entry if you like to that database is the undertaking of a training course and the passing of that course and at that point there is accreditation process and a photo ID is issued and again following on from that is a whole lot of deployment details but again many things that the Institution of Professional Engineers New Zealand working with the Christchurch City Council you know, battle to put in place after September the ability to mobilise large numbers of engineers quickly and also the Building Officials Institute of New Zealand. There was not a system in place prior to the 4th of September to do that, and the associated linkage is that whenever California Emergency Management Agency deploys volunteers off its register they are afforded liability protection under legislation without necessarily there being a declaration of emergency so there is a linkage there which again Mr Lizundia may wish to elaborate on further this afternoon.

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So in summary, the state of development of prior to September 2010 of the rapid assessment arrangements, there were national guidelines and it was the basis of operations in this event. We had developed a pilot training module and delivered it to building officials and some engineers, the two modules refer to their, firstly a module on how to manage the process aimed at the senior building officials and any related engineers in local authorities and the second longer module on the process of evaluation for those that would be undertaking that work, and I need to acknowledge the initiative of Dunedin City Council and Christchurch City Council in commissioning these pilot training modules in 2009 they provided the basis for the training that was able to be delivered in other centres and to USAR engineers at the annual workshop in June of that year.

The focus of those training sessions for those councils were for building officials. Each of the Council's to varying extents had engineers involved in their planning operations and they attended accordingly those training sessions but we were just at the point of preparing to deliver a wider based set of training for consulting engineers generally.

Reflecting on the state of development of detailed engineering evaluations, they quite simply had yet to be specifically worked upon. There had been a general expectation that engineers would be able to draw upon and adapt the standard evaluation methodologies either from those that they are pretty more familiar with, the New Zealand Society for Earthquake Engineering, a document from 2006 for assessing existing albeit undamaged buildings or the use of international documents again typically from California that relate to earthquake damaged structures. The Federal Emergency Management Agency sponsored documents and also ATC had also produced a document in 2010.

Then we come to 4th of September and I am just going to – there are many facets of the implementation of rapid assessment. I am just going to give a brief overview of some of those aspects I note also that, Waimakariri District Council and Selwyn District Council each set up and

ran their own operations, based on, in broad terms on the national guidance and they did so typically without the benefit of the outer region resource that Christchurch City Council had the benefit of and again their efforts should also be acknowledged.

5 That was perhaps the characteristic that this operation was going on in three district councils contemporaneously. In overview, the rapid assessment of all blocks within the four avenues starting with the police cordon

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A. ...the four avenues, starting with the police cordon, that set the frame for running rapid assessment operations and the initial, the process for that was set up overnight or during the 4th of September overnight and then implemented on the morning of the Sunday the 5th, and the initial sweep

15 of all the blocks within the four avenues was largely completed by the end of that day again as an initial sweep, and that was followed by the principal arterial routes, Riccarton Road, Ferry Road, Papanui Road, Columbo Street, that was undertaken on the following Monday and Tuesday. And within each of these areas, that was followed by further

20 level 2 assessments and street assessments by senior engineers prior to the cordons being reduced, the local barricades, the strategic focus of the controller and the operations at this point was to having started with a broad area cordon, how could that cordon be reduced where it was appropriate to do so. And so quite detailed sweeps of the streets were

25 done, quality assurance if you like, prior to the cordons being changed, being reduced and there was a fair measure of quality assurance undertaken at that time.

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At the same time there was a major push, obviously to assess the worst affected residential areas, and a major operation called Project East was launched on the morning of the Wednesday and led capably and well by building officials with an appropriate measure of engineering support.

The teams that we organised, and inducted, and went out on the morning of Sunday, comprised level 1 assessment teams and also level 2 teams, because at that point there were a number of properties that from Council's intensive work on the Saturday the 4th, were clearly earmarked for level 2 assessments and in some cases – in many cases had the access, the ability to access those buildings via owner contact. And so the tip of the organised three person teams to do the level 1 assessments made up of an engineer, a building control person and at that point because we actually had the Urban Search And Rescue taskforces in Christchurch but with no rescuing functions to primarily deliver, we involved a number of those Fire Service rescue technicians in operations. It had always been envisaged that these would be combined teams effecting engineering skill sets and building control knowledge sets, but there were many cases of building control officials have a more detailed understanding of the general context of buildings, particularly older ones, than volunteering engineers. We increased the engineering specification level of the level 2 teams, placing, making five person teams with two engineers and making, putting the emphasis on the senior engineers that we had at our disposal that day to go into the level 2 teams.

The placards and forms were as per the August 2009 guidelines. So the placards were as per the August 2009 guidelines. The recording forms were the slightly more developed forms that reflected the experience from the Padang mission and had been developed to a good to go stage in July 2010, and they included those usability categories that I referred to before.

In the residential operations there was a modification of the placards and forms in order to reflect the health risk concerns. There was, in those suburbs that had extensive liquefaction there was the, in many cases that was contaminated by sewage and there was the need to convey that to the affected households and additional forms were developed to record that as well. As I mentioned before, we were fortunate to have the – we had a bit of firsthand experience in our

Padang mission on how to gather a large amount of data which doesn't necessarily fold in well with standard Council databases. We, members of our team that we involved directly with Christchurch City Council's data management team to get that process underway. Then just fast forwarding to the Boxing Day earthquake, and as we've touched upon already, the because there was no declaration of emergency made at that time, that led to an uncertainty of process within and across agencies. And this, the national process as per the title of the guideline document, it only applies in a declared emergency situation, something I haven't given a background to, but that is because the need to provide volunteering engineers and other personnel with some form of a liability exclusion, that is provided through section 110 of the Civil Defence Emergency Management Act for individuals working under the direction of a controller, and without that protection, without the declaration, that inhibited the amount of engineering input that was available to Council on the day, plus of course it was a holiday period at the end of a very demanding three month period of work for all concerned. I understand several processes were initiated, including versions of the rapid assessment process used in September, nevertheless, and ultimately the dangerous buildings provisions of the Building Act were used for the assessments and for the, for those buildings that were found to be dangerous.

JUSTICE COOPER:

- 25 Q. Which would mean that they had to be dangerous on the day and not dangerous in the future as a result of an earthquake, is that right? Or was that effected by order in council?
- A. I'm tempted to say all of the above. That was part of the uncertainty that prevailed at that time.
- 30 Q. Yes, I realise that is a big subject.

EXAMINATION CONTINUES: MR ZARIFEH

- A. Then of course we came, we come to the 22nd of February and the process after the tragic events of that day, the process that was implemented for assessing buildings did have the benefit of a number of the operational learnings and procedures from September, and again the number of people, both involved in the co-ordination of the process and the delivery that it had, we experienced from September, and more comprehensive structured process was able to be put in place, albeit on a larger and more dramatic scale, again in terms of damage to assess. One of the particular developments was in the management of resources and whereas I think there were almost a hundred engineers involved from around New Zealand following September, that number rose to almost 400 after February and they were very quickly able to arrive in Christchurch as a result of the learnings of process from September and the other key step was the integration of the many engineers that were already working for building owners in Christchurch following the September earthquake and that was an initial step that was set-up prior to the launch of the rapid assessment operation just to make sure there was not an overlap of inspections but, more importantly, all that knowledge that had already been gained in the five months following September was brought to bear but there was a continued lack of clarity in terms of what the placards meant for the public and agencies. Residential assessments was another even much larger operation again, and again acknowledgement of Christchurch City for the success of that operation with a range of agencies supporting. It was a major achievement. This added another dimension. It highlighted the risk of landslide and rock fall in the Port Hills, created complexity for those assessing individual houses below, around in the Port Hills area and there's the need to, there was a need evidenced to co-ordinate that better because you had situations where houses that did not have damage but were under immediate threat from loose rocks above and they needed a unsafe placard due to the rock fall but it was very difficult

to convey that to some of the affected people and even there were instances of some teams assessing from a building or structural perspective and placing a green placard on some of those. So a lot of further lessons learnt about the co-ordinating, the co-ordination of different disciplines and because the operation was undertaken with considerable urgency there were a call made to principally only leave red placards and that did leave some uncertainty for the houses with partial damage, chimneys and boundary walls and the like.

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Just to highlight some of the short comings identified from both events really, in other words just capturing the learnings from the two events. Clearly we had insufficient trained engineers and building officials, and another point that was highlighted was that we didn't have perhaps the optimum field guidance to assist the assessors. We certainly didn't have the quality of documentation that exists in California via the ATC

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suite of documents. The yellow or restricted use placards didn't really allow for the clear indication of restricted access areas. There were some, some short-comings in the structuring of those placards allied with the difficulty in training the people in how to use them and so whilst that didn't lead to as much a safety issue, they could have been used to better advantage to enable access in some situations and again the wider public communications around the placards, I should add not for the want of trying, on behalf of the councils and others they proved very challenging to put the right element around what the placards mean.

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And at this point I'll just show a slide from the Earthquake Society training module to the assessors which after a series of slides talking about the criteria for an inspected or green placard we make the point to the assessors that it does not mean safe but how to convey that equally to the wider, to building owners, tenants and the general public is obviously an issue which the Commission is examining. It was evident at the time and throughout the hearings that the people have placed great store on the green placard. It's perhaps thought provoking to put the placard up without the colour just to reflect on the wording and clearly all the wording and all the placards will be revised as a result of

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these events and possibly recommendations to come but the thrust of the wording, and I'll just highlight the second paragraph down below the left-hand little block, "Owners are encouraged to obtain a detailed structural engineering assessment of the building as soon as possible,"

5 and this is the linkage back, or the absence of a linkage back with normal regulatory arrangements. It was not possible to make that a requirement in the same way that for the yellow and red placards there was a distinct linkage with the dangerous buildings provisions.

As we've touched upon earlier there were a range of shortcomings if you like around the transition towards the detailed evaluations and that inability, as I've just referred to, to require owners of buildings that were in an area that received sufficient general damage to require placarding but not the ability to then require a detailed engineering evaluation plus, of course, the technical procedures and arrangements within Council to

10 receive and process those evaluations were not in place.

There's an important context and I guess the, perhaps highlighting the general expectation around what were the aftershocks that the assessors had in mind when they were viewing these properties, the premises and the general expectation for both the operational planning

15 of building evaluations and for Urban Search and Rescue and other operations at the time following an earthquake is generally, you know, up to one magnitude less with a reduction in intensity. Clearly the same magnitude and comparable intensity as the main shock is possible but it is much less common and it's usually viewed that the aftershocks will

20 have a similar directionality to the main shock and that they would most likely occur within several weeks and possibly a month or so of the main shock.

In discussions with GNS in the days and weeks following 4th of September nothing from the known knowledge indicated aftershocks

25 significantly different, from this but then of course the reality of the 22nd of February was that, putting magnitude to one side, the horizontal and vertical accelerations were significantly greater than the original event in the Christchurch area. It had elements of different directionality and it of

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course occurred many months after the original event. Hence, you know, the importance of this in relation to risk as we review the building evaluation process including how it is practised internationally reflecting the unusual nature of February, various international experts have referred to the unusual nature of it, and Dr Gledhill may comment further. More importantly GNS have made some further operational developments since that will make it possible, I understand, to tailor some aftershock advice to affected regions. I will leave him to discuss that this afternoon.

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10 1130

JUSTICE COOPER:

Q. Difficult when you're dealing with unknown faults.

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A. Indeed as opposed to known faults and earthquakes that come off established faults established faults reflecting on the likes of the Gisborne earthquake where we again asked the question as we commenced the operation of rapid assessments as to what were the, what was the likely nature of the aftershocks we'd experience and because it came from an offshore fault a well established fault with a long history of activation along the East Coast they were able to with a reasonable level of confidence say that the aftershocks should occur with a fairly sharp decay rate after the main shock and they were you know most unlikely to be greater than you know one magnitude less with a smaller intensity.

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COMMISSIONER CARTER:

Q. Do you happen to recall in the briefings that were taking place whilst the examination teams were being informed and sent out into the field et cetera whether the wording was around the magnitude of the earthquake that might be expected as, as differentiated from the accelerations and, that might be had, I mean perhaps the terminology was a factor there?

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A. Possibly, I mean again that you know the international, the, the, the, the reference around the general expectation of you know up to one magnitude less with a reduced intensity was, was the general advice. There was no specific advice on, on, on accelerations.

5 Q. Yes, thank you.

HEARING ADJOURNS: 11.32 AM

HEARING RESUMES: 11.48 PM

JUSTICE COOPER:

10 Q. Now had you finished what you wanted to say under this heading?

A. Yes Sir.

Q. All right. Thank you.

A. Following on from February there were other developments in relation to the application of rapid evaluation and placarding was actually applied in
15 a couple of weather events last year and the Nelson/Tasman flooding in December created some challenges that highlighted again, a bit like the Port Hills, the need to be a much more integrated process between geotechnical issues and structural issues. There were in that event, as I understand it, there were, again, places where houses were undamaged
20 structurally but were at danger of either threats from landslides above or the whole property moving and had to be effectively rated as unsafe and different processes were applied. I believe we can actually tie the processes together. This is why it is being viewed in a broader post-disaster context and not just post-earthquake.

25 A lot of work followed on through the Engineering Advisory Group from effectively April last year onwards through to the present in developing detailed engineering evaluation methodologies with emphasis on some of the characteristics of damage that were observed in the February earthquake. I'll come back to that in a moment. The other development
30 had some good interaction with the Californian agencies. There was a team from ATC including Mr Lizundia visited in June last year and I'm

just finalising now a comprehensive report on their observations and they have noted some of the adaptations of our system and the operational innovations such as the use of, the designation and the use of indicator buildings with a more conscious view to subsequent aftershocks and we were fortunate for Mr Wood and myself to meet with ATC representatives including Mr Lizundia at the beginning of last month and again to discuss amongst other things collaboration opportunities going forward.

The purpose that we've established in the detailed engineering evaluation procedures summarised in these three bullet points: informing the decisions by owners about the continued use of their buildings; to provide a starting point for decisions on any repair work to be carried out; and, again, to keep the broader understanding of the state of buildings generally reflecting but progressing the purpose statements if you like from the rapid assessment phase and again a significant amount of work led by Mr Hare and the commercial work stream of the Engineering Advisory Group has gone in to develop procedures which are being used under the CERA arrangements and will provide the basis for detailed engineering evaluation following subsequent events in New Zealand. The particular focus is understanding the likely performance in future earthquakes rather than just looking at the damage that the buildings have sustained.

To summarise and highlight a couple of the elements of the detailed engineering evaluation procedures. They don't all involve specific and detailed analysis. The important element of the procedures is to perhaps turn around the usual procedure that engineers follow of inspecting buildings and then going back and having a look at the drawings but to apply the discipline of where the documents are available to review the documents to identify areas of theoretical vulnerability, things that, again, are maybe within the structure and not visually apparent but once they are identified as areas of potential vulnerability they are used as the focus of the inspection. In other words there may be areas where floor lining, wall linings and floor coverings

need to be removed to check a specific, suspected vulnerability and obviously in relation to unreinforced masonry and other buildings there's an emphasis on looking at the hazards that could still topple and kill or injure people in future aftershocks and earthquakes even if the structure is not at risk of collapse. And where there is either significant damage found it may be visually obvious, it may only be apparent on assessment, quantitative assessment or an analytical analysis needs to be undertaken to varying degrees again or equally where little damage is found but the indications are that it is an earthquake prone building in terms of the Building Act, ie, less a third of new building standard. So there are various, there are process steps to go through which doesn't automatically involve a highly analytical approach to assessing buildings in the various states of damage that we have seen because going into a very, a detailed quantitative assessment takes a great deal of engineering time and so this process as developed has put a lot of emphasis on putting the engineering effort where it needs to be.

Equally reflecting that, as we've seen in Christchurch, it has taken, and will take, a while to go through the detailed engineering evaluations and there has been reflection on how, is there an intermediate step in the process and under the heading, "What are we really trying to achieve," this graph reflects the, on the one hand time on the horizontal axis and the level of, the parameter if you like or the strength of the building is a percent of new building standard on the vertical axis and 33% being the demarcator between earthquake prone or not in the current legislation. There are two building types to just quickly ponder. One is, (1) a building which sits under that threshold but is during the sequence of aftershocks is not degrading in any way versus a building which may start out above that requirement but either does or has the potential to further degrade with aftershocks and conceptually from, as we look towards, you know, occupancy criteria the general view is that building A is okay to occupy whereas B is the building that we are trying to avoid occupancy in, lest it degrades and with a real potential for collapse.

5 So bearing that concept in mind and bearing in mind the time it is taking
to work through the volume of detailed engineering evaluations an
interim use evaluation procedure has been developed by the
Engineering Advisory Group as an intermediate step and it basically
takes the level 2 rapid assessment one step further to specifically check
there is no significant hidden damage that may either impair the over-all
capacity of the building or represent life-safety hazards from toppling or
stairs or from neighbouring buildings and this requires again focus on a
qualitative review by suitably experienced engineers to assess the
10 damage, a conscious working through of the load path and where
necessary undertaking intrusive investigation with the objective of
identifying critical structural weaknesses or notable vulnerability that
could be leading to degrading performance in the short-term as opposed
to the long-term, the base strength of the building. It is, however, not to
15 be used for unreinforced masonry buildings where unless they have
been strengthened and verified as being strengthened above
earthquake prone levels and for unreinforced masonry buildings
generally there is the need to go straight to a detailed engineering
evaluation and particularly with that careful check of all of those clearly
20 life-threatening elements such as parapets and floor to wall connections.

Q. Now if I can come to an important question. Are you saying, or is it your
view that in the case of unreinforced masonry buildings that don't meet,
well unreinforced masonry buildings that are earthquake prone given an
earthquake of any significance there should be a DEE involving a
25 careful check of the elements you have referred to before it can be
reoccupied?

A. Essentially that is the thinking as we reflect on the public safety
objectives and the challenges in viewing unreinforced masonry buildings
you know, cursorily and they are equally fairly, they can be inspected
30 from the inside and a view can be formed as to whether they have the
potential to distress further.

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Q. So rather than fitting them in to the same evaluation system as every other class of building they'd be treated as a special case?

5 A. This is a view that has emerged from this, the sequence, that they need to be carefully reviewed for the occupancy if they are known to be earthquake prone hence the linkage with the information known before an earthquake gathered effectively by Council.

10 Q. And I suppose some might say another aspect of the experience of the Canterbury earthquakes is that it is not just a question of re-occupancy but it is a question of how you protect the public pending the completion of this DEE in situations where you have unreinforced masonry buildings of some height, perhaps three storeys on both sides of an urban street, failure in an aftershock would be lift threatening for anyone passing by including a motorist?

15 A. Certainly and this is why the focus of the Council following September, the 18th of October procedures enabled the longer securing was undertaken to parapets and elements that in a programme of upgrade was undertaken in buildings could be signed off by engineers because the, in balancing these objectives there is that need to maintain access and use of buildings where possible.

20 Not sure if I quite grasp the force of that answer. You are talking about understanding that has been developed amongst the Engineering Advisory Group I think who have been responsible for developing this new interim use evaluation for the purpose of buildings other than unreinforced masonry building. The unreinforced masonry buildings are to be subject to a detailed engineering evaluation following an earthquake, a significant earthquake before they can be reoccupied. That is the way it would work isn't it, or it is intended to work?

25 A. I guess I am advocating that some very careful thought needs to be given to, this is all part of the occupancy, re-occupancy -

30 Q. Yes.

A. – criteria.

Q. Well, this slide that is currently displayed is not to be used, that is the interim use evaluation, is not to be used for unreinforced masonry

buildings unless strengthened above earthquake prone levels. So the sub-set of building that we are now looking at is an earthquake prone unreinforced masonry building and then you say that the detailed engineering evaluation is required for unreinforced masonry buildings that do not meet this requirement. Now, the purpose of the detailed engineering evaluation is something which has to be – well the purpose of the evaluation is to determine whether the building can be reoccupied, is that right?

A. Yes.

10 Q. The point I am making is that the evidence we've heard, in many case, has been that it is not the people who are inside these buildings that are most at risk, although they are at risk, often from collapse of an adjacent building, but it is the people outside on the footpaths and on the roads who are also at risk. So my question is, is it – or do you care to comment on whether in situations where you have unreinforced masonry buildings of some height, two or three storeys on both sides of the street, the logic would suggest that the street should be closed pending the completion of a DEE. Do you – what do you say to that?

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A. Yeah, this comes back to the management of the process overall and what that is pointing to is this should be the absolute focus of the priority of the evaluation process.

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COMMISSIONER CARTER:

25 Q. You haven't gone quite as far I think as, His Honour was questioning, just putting it to you another way. Unless an unreinforced masonry building had in advance of the earthquake occurring, been strengthened beyond 33% and then it would not be allowed to be occupied until a DEE was carried out on the post-earthquake condition of that building?

A. Thank you –

30 Q. If the building had been – had had a DEE, it would still need to be examined to see if there was damage that then sent another level of caution about the occupation or not of that building. Is that a summary of where you –

A. That is the view that I am conveying, yes.

COMMISSIONER FENWICK:

5 Q. If you think of places like Paeroa area where quite a major road goes through, you would now be closing that road for a year or two, not only have you got to wait for the DEE but you have got to wait presumably for those buildings to be upgraded before you could then open the building again – open the road again, is this the implication?

10 A. Well this – as you look at the different scenarios for the smaller locations you actually have more resource to apply to the task but you know we need to reflect on the status of the buildings now and hence the comment I made earlier around the risk reduction emphasis. That we actually live with this risk, you know, currently and we do need to balance that going forward because that yeah, that is balancing the
15 public safety objective with the economic continuity of urban areas that is the challenge going forward.

COMMISSIONER CARTER:

20 Q. Bearing in mind the opportunity that we now have from this day forward to actually improve the condition so that these things are less likely to occur and that is your reduction, recommendation I understand that is how you are considering that matter?

25 A. And it is important to reflect on whether we are talking about today or five years time or 10 years time but there will always – you know, there will always be, there is always risk in the form of you know, unreinforced masonry buildings, people would be surprised at just how much there is, that is, a number of parapets and walls that are not restrained against earthquake...

30 **JUSTICE COOPER:**

Q. This is, brings us I suppose to the linkage between, before the earthquake and after the earthquake which we discussed before because supposing buildings were seismically strengthened in

accordance with some set timeframe. The category of buildings covered by this slide, would be, would reduce, you would be, you're not helping my point.

A. Sorry.

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Q. Yes, this category of buildings is one which is limited to buildings which are earthquake prone so if we reduce the number of earthquake prone buildings, the problems that are presented are after an earthquake correspondingly reduced.

10 A. And if I may clarify a point from Commissioner Fenwick's questioning of my earlier comments. It is the detailed engineering evaluation that is the activity and we reflect that we currently give buildings quite a period of time to be strengthened if they are found to be earthquake prone. What we are talking about is the engineering process, not necessarily, so it's
15 actually understand the status of the building and not necessarily mean they all need to be strengthened above earthquake prone level prior to re-occupancy and prior to the roads opening, it's all that understanding of future performance of the buildings in earthquake and the nature of the risk they pose.

20 Q. So just following that point further, suppose there's an earthquake prone URM building that has been the subject of a detailed evaluation and it's shown by the evaluation that it's well below what would be required to remove it from the category of earthquake prone buildings, what would you do then? Are you saying, "Well we've done the detailed evaluation,"
25 what would be the criterion for re-occupancy, or is that too simplistic a question?

A. The requirement I believe is that the principal vulnerability, ie, the parapets and the floor to wall connections that enable it to actually
30 behave as a structure, if they are addressed then again as we reflect on where most of the lives were lost in unreinforced masonry buildings in Christchurch, that is the primary requirement. It is not all about the absolutely strength of the building. It's how the, how the elements –

Q. If you addressed those elements, it's likely the building wouldn't be earthquake prone anymore though isn't it?

A. Well again the, once you have tied parapets and walls back to the primary structure there is still the walls can fail through other means.

5 Face loading or in plane effects, but again as we've seen in Christchurch, the, many buildings didn't actually collapse in on themselves, they lost components outwards, out into the street and that is a principal vulnerability of an unreinforced masonry building to prevent the heavy items falling, and to enable the walls to be tied into the floors
10 to resist high levels of shaking.

COMMISSIONER CARTER:

Q. (inaudible 23:14:34) remain standing even though they're earthquake prone characteristic, their earthquake prone characteristics would still
15 remain but they may not have fallen because the direction of the earthquake was not at the level that would stress them to failure, that the number of cycles of the earthquake were not as many as it would take to bring them down. It still leaves them as a very much a high risk building, and I think that was the question we're exploring about public
20 safety. If a building is under the earthquake prone rating then the leaving of it still standing and allowing it to be re-occupied and the public to pass in front of it, if it is an earthquake prone structure it still raises questions that need careful thought?

A. Very much and that will be the subject of discussion tomorrow I'm sure.

25 **EXAMINATION CONTINUES: MR ZARIFEH**

A. So as we, as we look this does bring us onto the looking forward element. The, just highlighting some of the core issues to be addressed, and it's again around about the goals and objectives and they need to be arguably better defined as well as communicated, and
30 it's the matching the objectives of the rapidity of the process to minimise the economic impacts, versus the need to maintain public safety and re-occupancy criteria flows straight from that. A large part is to do with the

roles and responsibilities of the owners versus the local authorities and that comes back again to the gaps identified through this experience on the, and the transition back to normal regulatory arrangements. And as we focus on evaluation methods, rapid and detailed, well particularly rapid, that's the level of training and the resourcing required and the annual costs of that. As we map forward there's a need to reflect on the two, on a couple of contrasting scenarios as we have in the previous discussion. A metropolitan centre where there is typically a mix of older buildings and multi-storey buildings as well as a large residential population, and a provincial centre be it Paeroa or Gisborne as mentioned where there is a preponderance of low rise older buildings, but there is a wider resource to assist in that process.

JUSTICE COOPER:

- 15 Q. "Low rise" in your terminology is two storeys or one?
 A. I'm thinking two or three storeys.
 Q. Two or three?
 A. But, yeah. A broad comment without definition, point taken. But again it's reflecting the different public risk. The traffic and human exposure as we discussed, the economic implication and the assessment resources and that's the ultimate proving ground, I think, of what we are trying to achieve.
- 20 Q. Who resolves those questions?
 A. It comes back to roles and responsibilities really. This is why we are having this wider debate, it's, and I come back to my earlier comment, the evaluation procedures have typically come from a technical origin without a wider public policy debate and without the linkages with the regulatory system that follows that wider debate and hence the vital importance of this inquiry in this topic area. But there needs to be a linkage with the philosophy and the way we design our buildings and again assess our existing buildings, and an appreciation that the built environment comprises a range of capabilities to resist disaster events,
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from the near new to the old with much less capacity, and that is the risk environment that we take, we live with.

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EXAMINATION CONTINUES: MR ZARIFEH

- 5 A. In the Earthquake Society's submission or commissioned paper in September last year we identified six key components. The framework elements if you like particularly aimed at the roles and responsibilities but also the technical elements of the criteria and process for building re-occupancy and also the resourcing and so those are three, those are
- 10 six component elements that I think probably still provides a framework for discussing the future system and arrangements. I'm just going to, in this last segment just raise and discuss some of the eight considerations that are also more specific components for discussion. They are by no means all of the issues that need to, need to be debated and worked
- 15 through. But again I want to emphasise the, that the management of buildings following disasters and earthquakes covers the whole process and not just the rapid assessment phase.
- But if we start with the rapid evaluation element that first question is, is, that's been debated. Now the hearings is the elements of residual
- 20 capacity assessment. Perhaps the more relevant question is, is where within the overall evaluation process should residual capacity feature and hence the, the linkage with known knowledge of our building stock. The general view is that adding elements, aspects of capacity assessment for, across all of the building stock would, would take it
- 25 beyond what is achievable as a rapid process, in terms of time and expectation on engineers. But again noting the linkage with discussion on objectives and re-occupancy criteria.
- The related, the related consideration is, is how to make appropriate allowance for the possibility of large aftershocks, which have the
- 30 potential for greater intensity or acceleration and different directionality, and as I mentioned before GNS have further developed their time varying hazard model that will enable a better measure of region

specific guidance following future events and I'll leave that to Dr Gledhill. We've been discussing the question of clarifying the, the both the criteria and the process for occupancy and whether there is, what, what interim occupancy how that should be articulated and the need, the

5 general feeling of avoiding inspected or green placards as they currently are on buildings of known low capacity without a more, with a more careful check. How to require owners of, of inspected placarded buildings to, to move swiftly to get detailed engineering evaluations undertaken currently outside the regulatory framework and again the

10 consideration of the proposal that this placard should no longer be green because of the connotation that that colour conveys. The point we touched upon at the outset that the need to integrate the building evaluation system with both earthquake prone building policy requirements and dangerous building provisions and again that risk

15 reduction element of addressing with priority the restraining of masonry parapets and addressing vulnerable elements generally and the linkage with emergency management principles there. Part of the process around earthquake prone buildings is gathering information on buildings that, Council's building stock under an active process and typically

20 undertaken through an initial evaluation procedure or IEP where a broad rating of the building is gathered and the, the point being that there is useful information for a range of structures not just earthquake prone buildings that are found to be earthquake prone that could usefully be made available in a response phase.

25 Training and accreditation, training outcomes should be linked with operational accreditation and if it could be linked with liability cover in a way that the California arrangements have that may, is one way of addressing the, the ability for smaller events that may not lead to declarations.

30 Need to think through the capability and capacity objectives and in our document in the Earthquake Society document should I say September last year a capability pyramid is portrayed with in very broad terms indicates that all building officials and structural and civil including

geotechnical engineers should you know should have at least an awareness training of evaluation arrangements but as we go further up the pyramid the senior building officials and chartered structural engineers should have further training particularly leading to pre-event accreditation and there's a, there's a case that a, there should be a national resource capable of leading a building safety evaluation operation that requires that special level of operation preparedness. That is effectively what has played out in both the, the Gisborne event and, and the September, 4th of September event that a group came to support the affected local authorities in setting up, managing, doing the technical briefing for the operation of rapid assessment and –

JUSTICE COOPER:

- Q. How many people were in the group that came to Christchurch in September for that purpose?
- 15 A. Probably of the order of, well what you had is a progression of resource that came with the first of us on that day mobilised from out of town and there were probably, that arrived with the urban Search and Rescue task force and it was, it was a progression but of the order of six to 10 probably key people initially but that needs to be structured and again that's where it's scalable if you had the small town, smaller council significantly affected then much of the operation can be set up and managed by out of, out of town resource paying the early attention to some of the effected buildings whereas when you have a metropolitan centre you've got to set up a much more considered operation and a lot of the resource will be brought from the, the effected council. In terms of –

COMMISSIONER CARTER:

- Q. Has any thought been given to the, I mean if you, if you create such a structure across the local authorities nationwide then there will be skilled, people with these level of skill in each council, smaller ones, with fewer people and larger councils with more so an event can then draw

upon the, the structures of other councils to reinforce their, their complement. Is that what you had envisaged?

5 A. Very, very much and want to emphasise that the key role that building officials have played in each of these responses in augmenting one another because their practices are similar and that, that must continue as well as some, some engineering and proc- and the process leadership can come as much from building officials as engineers it is that combination of skill sets.

1230

10 Q. Yes.

A. Particularly when we talk about the transition back to business as usual, it is not just about racing out the rapid assessments, it is having a clear view on how that transitions back and this is the sort of role that you know, Mr Stannard played in Gisborne and in September and the role that the building and housing group in ones view should have going forward in making sure that the best regulatory and legal advice around that is proffered to the effect of Council.

15

Q. Thank you.

A. Again I emphasis here without speculating any numbers but just to highlight a point from earlier there is a limited group of engineers that have had the benefit of seeing earthquake damage structures, much less - in New Zealand, much less the ability to actually work within them and came back to your earlier point that most younger engineers have little or no exposure to unreinforced masonry buildings in the ordinary course of events and it is just as we reflect on where our, some of the principle hazards in your building stock lie there is some perhaps linkages to next week's hearing on the training and education of engineers.

25

30

All these topics are interrelated but building information management is another underpinning element and as we reflect on, you know again, some of the shortcomings around current forms of recording of building information which the focus is on the land parcel whereas the physical inspection deals through buildings and street addresses and the need to

integrate that within property records, with a degree of urgency. From that, you know, in addition to that, the desire is to, when placards are placed or the status of buildings is determined that that is more readily available than has been in events. But a wider linkage as we reflect on what is involved in doing the elements of detailed engineering evaluations is the availability of documentation on buildings and building stock. Again including those previous capacity assessments and the need to have those as being readily accessible from Council records and that may, would require perhaps a greater attention to some aspects of business continuity management if it is afforded the importance that these processes suggest it should.

One of the discussions that we have had with the ATC folk who apply the criteria and placards without any distinction between commercial and residential property is the extent to which there needs to be difference, that needs to be worked through. The issue of sanitation does require more specific consideration, not just in earthquake but in flood events where you know floods have almost invariably have elements of sewage contamination and discuss the point on integration between wider geotechnical processes be it land slip or rock fall and primary effects on structure. So that's again another consideration that needs to be resolved and there have been some really useful pointers I think from these events and the two events in Hastings and in Nelson Tasman last year.

Finally another important overarching sort of a consideration is the leakages with Civil Defence Emergency Management Act obligations and under section 60 of the Civil Defence Emergency Management Act that requires critical facilities and lifeline utility operators to have – to plan to continue to operate to the fullest extent possible and there's an implication that this points them toward having their own specific arrangements with professional engineers for post-disaster assessments and possibly that implication could be converted into something a bit more specific.

Q. Have you given consideration to a matter that we had described to us by the Californians that many building owners there have appointed an engineer to understand their building and be therefore able in an emergency event to actually rapidly bring forward the information that is needed, was any thought given to this?

5

A. That is what has been advocated here in New Zealand, a less sophisticated approach but the term priority response agreement has been promoted through IPENZ and the Earthquake Engineering Society for close on 10 years now. The Californian approach is quite sophisticated, it is aimed at some of their taller structures but the same principles apply and they are applied by some lifeline utilities they do have contract arrangements that enable engineers to firstly assess buildings prior to earthquake to form a view on how they are likely to perform and then after earthquake, to assess them against those expectations ie hastening –

15

Q. Evaluation –

A. – effectively an interim use evaluation if you like, they have a platform to evaluate in and appraise the buildings. The - you know, there is an arrangement, a national arrangement between Telecom and a national consultant which is an example of best practice in New Zealand. There are other examples, they are just perhaps not as prevalent or as common as they should be.

20

EXAMINATION CONTINUES: MR ZARIFEH

A. Just some final comments just to recap really on the elements of this overview. New Zealand's post-disaster building evaluation process is based on international best practice.

25

But the arrangements were essentially still under development at the time of the September earthquake and we fairly have a much clearer view on where that development, where the effort needs to be placed in its further development.

30

The third point is that the February, last year earthquake represented an extremely large aftershock that you know, would have posed a significant challenge for any post-disaster building management system. The main shortcomings in gaps if we look at perhaps the more strategic ones, rather than the many tactical learnings that have come from the sequence are:

5

The need for appropriate regulatory context and provisions.

The whole issue of understanding, defining and communicating risk expectation and process to the public and key agencies.

10

Questions of capability and capacity, the level of readiness that should go into being able to deal with future events more efficiently. But the same question reflecting the relatively low probability of those events.

And putting in the appropriate technical procedures that are to follow, following the emergency phase.

15

And reflecting that many of the technical procedures needed to address the gaps have been subsequently developed and further enhancement is planned through international collaboration. That is not to say all the elements are in place. That is just to say that some of the technical procedures have been initiated and developed.

20

And finally the view that a legal framework provides an effective linkage between post-disaster and normal regulatory processes is a fundamental requirement of arrangements going forward.

I'd like to close by offering my condolences to those who have lost family and friends in the February earthquake and that have sustained significant injuries and I hope through this presentation you have an understanding of what the processes endeavour to achieve and the commitment of many to improve, enhance and produce more robust procedures for future events. I would also like to acknowledge the efforts of many building professionals who made themselves available,

25

many as volunteers, in roles they had little if any prior training in and the value of their contribution. Thank you.

30

1240

JUSTICE COOPER:

Now Mr Zarifeh is there anything further from you?

EXAMINATION CONTINUES: MR ZARIFEH

5 Q. If we've got time Sir I just wanted to raise a couple of issues from some
 submissions just to get Mr Brunsdon's comment. They follow up on
 things you've raised. There's a submission from the Structural
 Engineering Society of New Zealand, SESOC. I presume you'll have
 read it but it deals with this issue of detailed engineering evaluations
 and I'll just read you out the paragraph on page 3 that I want to refer you
 10 to.

*"The detailed engineering evaluations have shown that even allowing for
 the variation in ability and experience of the assessing engineers there
 is often remarkably little correlation between assessed capacity and
 damage to many buildings. This further underlines the point that the
 15 completion of quantitative analysis should not be required before
 reoccupation of undamaged buildings. However the identification of
 vulnerabilities in the buildings is considered of greater importance as
 these have more impact on the future performance of the building. This
 suggests that the earthquake prone building legislation could also be
 20 reviewed in this light."*

I'm just wondering if you had any comment about that observation and
 whether you agree with it and want to expand on it?

25 A. I agree with that point as submitted that, again this is the, it is not all
 about detailed calculation to arrive at a number. The focus is on
 understanding, firstly, being clear if damage to the critical structural
 elements have been sustained but, secondly, understanding the
 performance, the vulnerabilities that would impair or affect the
 performance of a structure in future events.

30 Q. And do you think that the way level 2s were conducted generally
 following September that critical vulnerabilities would have been picked
 up or do you think there's something more required if that's to occur?

A. I'll come back to the philosophy of the rapid assessments, level 1 and level 2. It is, to identify is there any notable damage that would lead to the building performing, not being as viable and as safe as it was prior to the event? I've lost my thread.

5 Q. I was asking if level 2s as they were generally conducted would disclose or discover critical vulnerabilities in buildings or in this, perhaps something that's going to be discussed tomorrow, or is something more than a level 2 required to ensure that?

10 A. Sorry the philosophy of the rapid assessments is to focus on, as currently envisaged, is focussing on damage, hence the need to map arrangements to establish the future performance of the earthquake, of the response of the building that is a separate, envisaged to be a separate, subsequent stage to the rapid assessments.

15 Q. Right and do you, I can't recall now who it was, I think it might have been Mr Hare in his paper or submission talked about perhaps a need for a different kind of assessment for different buildings and you've mentioned URM buildings and he mentions the same but also perhaps buildings, multi-rise buildings that might have some structural complexity or whose lateral loading systems is not clear.

20 A. Hence the, the interim use evaluation and the detailed engineering evaluation process which has been developed subsequently to focus on an understanding of how the building was designed, you know, how it currently sits if you like, then linking that with any visible damage but from the understanding of how the structure should perform, knowing
25 where to look for potentially hidden damage.

30 Q. Right. Okay and just the other submission or reference I wanted to draw to your attention was, and this is from Messrs Hare and Galloway's paper that's attached to I think the NZSEE submission and they discuss the idea of a level 1 rapid assessment not resulting in a green placard but only resulting in a red or yellow placard and even the possibility of perhaps doing away with the green placard as such so that all buildings in effect, as I understand it, would have a level 2 and it would only be after a level 2 that the issue of reoccupancy would be decided or

determined. You know, again, that's an issue we'll no doubt come to tomorrow but I just wanted to get your thoughts on that idea in general terms.

5 A. And that as much as anything reflects the focus when you do have a cordoned environment and that initial focus of identifying which are clearly unsafe and therefore reflecting that you haven't focussed on those that are, and nor can you from perhaps an externally focussed level 1 assessment, it is a, it is a valid viewpoint. This is, again, where discussions need to be reflecting on the linkage with residential
10 inspections but also the need to leave some form of notification on any building that is the subject of a rapid assessment and, you know, one way of doing that is through an inspected placard without a green colour. That's the mechanics that need to be thought through to operationalise that proposal.

15 Q. Of course that, the suggestion along those lines would meet the problem that the Commission saw in some of these hearings, unreinforced masonry buildings where there had been a level 1 resulting in a green placard and, as you say, a cursory external inspection and that as it eventuated was the only inspection carried out before the
20 February earthquake.

A. And that is not sustainable.

Q. Right.

A. But, you know, reflecting on our earlier conversation coming up with an appropriate procedure for that predominant category of buildings needs
25 to be handled with some care as again the objectives, public safety first but economic viability are matched, are balanced in some respect.

1250

CROSS-EXAMINATION: MR LAING

30 Q. Mr Brunsdon I was wondering if I could take you back to some of your earlier slides. I'll just find the relevant one. It's the one called, "Interim Use Evaluation Developed Number 3," and I just want to follow up on some questions that the members of the Royal Commission asked you.

Now where we have a situation where there is a URM building and when I say that I mean one under 33%, I think what you are suggesting is that there should not be any interim use evaluation procedure, you should move to a DEE. But I was just wondering where you would do that. Are you saying that as long as the building hasn't suffered any damage, then the building can be re-occupied, even if it was say only 10% of new building standard? Is that what you're saying or are you saying that there should be some work done on that building before it's re-occupied?

5

10 A. What I'm saying is that the, the life threatening, the life risk vulnerabilities identified from a more considered inspection need to be addressed, ie, the mason – the parapets or those, the ability of a wall to peel off from the floors and then there is a linkage though, it sits behind the question you're asking and it's a question which is current in
15 Christchurch and in other parts of New Zealand as to what level of rating, if you like, is considered below which is considered unacceptable –

15

Q. Yes, so for instance are you saying that if there was a parapet that, or corbel, or something, a decorative feature that was dangerous, that
20 should be dealt to before re-occupation?

20

A. Yes.

Q. Is that part of what you're saying?

A. I believe that, yeah.

25

Q. And what about the floor to wall connections? Is there some standard you're advocating in terms of how strong a connection there should be, or is it, is that something you perhaps haven't dealt – thought through yet?

A. That is a topic for discussion amongst engineers.

30

Q. Yes, and an issue that arose out of a lot of the Royal Commission's hearings relating to unreinforced masonry buildings was the degree of earthquake that would bring this sort of procedure into play, and for instance you can have a very small earthquake and I don't think many people were suggesting that all these procedures would come into play

at that stage. What's your view on that? What strength of earthquake should bring this sort of assessment procedure into force?

5 A. I think that is a key question and I know from the discussions with Mr Lizundia in California last month that they look at this through a different lens, just the sheer volume of buildings they have to deal with, and I think this is something which we should be discussing and will come up in tomorrow's panel discussion.

Q. No look thank you for that. Could you just turn very briefly to your overhead "Key Consideration Number 3" please?

10 **WITNESS REFERRED TO SLIDE**

Q. The third bullet point there refers to avoiding placing inspected placards on buildings of known low capacity. Now what I was really wanting to explore with you there is what are you suggesting in lieu of such a placard?

15 A. I think this is the linkage back with Mr Zarifeh's question of what level of technical assessment needs to go into buildings before re-occupancy is enabled, and the lower the capacity of a high risk category of building, the more careful the technical consideration is required.

20 Q. Yes so would you be suggesting that any building which is earthquake prone, that is less than 33% of NBS, not receive any green placard at all?

A. That is, that is a proposal.

Q. Yes.

A. Again, not receiving a placard from a rapid assessment.

25 Q. But what would fill that gap? The level 2 or something else?

A. A qualitative detailed engineering evaluation.

Q. So you would say that you would move immediately to that and do I also assume that you would say that the building would not be occupied then till that was done?

30 A. That's –

Q. Is that I –

A. That's an implication yes.

Q. Yes, no, thank you for that. Just finally –

A. The linkage with the, again come back to section 124, the linkage is with the dangerous building and the need to check that it's, verify that it is not if you like dangerous.

5 Q. Yes well hopefully it's something that will be coming to deal tomorrow as well, because I think you've made a very good point there.

10 On the next overhead, "Key Consideration Number 4" you talk about the register of earthquake prone buildings, "Should ideally extend to a summary of the structural capacity of all buildings". Now are you talking about structural capacity in terms of new building standard or what are you talking about there?

15 A. That is the current proxy or developer for the structural capacity, and this relates to as I touched upon the IEP or Initial Evaluation Process that typically local authorities with an active earthquake prone building policy are implementing. They are putting a priority focus on older buildings, but that in theory could be extended to provide an understanding of the set of structures.

Q. Do I understand you to be saying there that each building would really have to go through a detailed engineering evaluation?

A. Linking the process applied in general terms, not following earthquake.

20 Q. Yes, because I'm just trying to understand from you what, when you talk about "structural capacity", are you talking about structural capacity assessed after a detailed engineering evaluation, or some lesser assessment?

25 A. I'm talking at a lesser assessment which is the IEP, Initial Evaluation Process, from the "Earthquake Society Assessment Guidelines of 2006." It involves a fairly, and overview assessment of the structure, not a detailed engineering evaluation, but obviously in an earthquake affected region where detailed engineering evaluations are undertaken, and the qualitative part of a detailed engineering evaluation does involve
30 the IEP, then that same output is available.

Q. And who would you be envisaging to undertake the IEP, the building owner or the Council or?

A. In many of the other jurisdictions that are pursuing an active earthquake prone policy, they are commissioning consultants to do the IEP as a means of establishing potentially earthquake prone buildings after which they then ask owners to undertake, owner's engineers to undertake more specific assessments.

5

Q. And that's with public sector funding I take it?

A. Yes.

Q. Yes.

A. Which is again why the focus of IEPs is on typically on older building stock.

10

1300

COMMISSIONER FENWICK:

Q. Yes, without asking for it we seem to come across quite a few examples of where there was quite a lot of variability in the percentage new building standard that had been assessed. How can we reduce that variability between different organisations or groups or engineers assessing buildings? And does in fact new building standard mean anything?

15

A. That is a broader topic for debate amongst certainly the Engineering Advisory Group and, and, and the engineering profession. The percent NBS is simply the current tool that is, or current approach, current output which is being used as, you know, Mr Hare referred, or sorry as the, the other, the SESOC's submission eludes to variability is, is evident. I believe that should be a topic for discussion tomorrow.

20

25

COMMISSIONER CARTER:

Q. I think I'll reserve my questions until I hear the panel discussions tomorrow which would touch on lots of the things that you've talked about and yes there's a number of matters of interests in there for us. Thank you.

30

JUSTICE COOPER:

- Q. If we were to set up a legislative framework that will work in the post earthquake situation it would contain various features, I think there'd be common understanding of that such as liability exclusion for engineers assessing buildings and an ability to prevent access to buildings by their owners or restrict such access and ability to cordon off public places, prevent the public entering certain areas. All these things that were a feature of the response to the Canterbury Earthquakes will have to be provided for in a way that would foreclose the need for special legislation. Now I had thought over preceding months that a trigger on which you could hang, if that's not a mixed metaphor, the exercise of these various powers might be the declaration of a state of emergency and that once that is done then various things would follow because you need to be able to distinguish, well I've assumed that there is a need to distinguish between powers that might be exercisable when there hasn't been an earthquake and then the special set of powers would come into effect when there has been a earthquake and I think that is an inevitable distinction that has to be made. Now some of what you've said suggests to me that you would favour freeing these various legislative controls from being dependent on there having been a declared state of emergency so that these powers that might be designed would apply whether or not there had been a state of emergency and I think you referred to the Boxing Day situation in Christchurch. Is that, am I understanding your approach correctly?
- 5
- 10
- 15
- 20
- 25 A. That is what I am advocating.
- Q. Yes.
- A. And because there are – but the arrangements need to reflect the situation where there is a declared emergency and the process is under the broad, under the direction of the controller.
- 30 Q. Yes.
- A. So that must never be lost but equally the ability to have a process when there hasn't been a declaration and all of the scalability issues we

were discussing earlier for smaller scale events and not necessarily triggering undue process to follow.

Q. Right. Well from our point of view or from my point of view anyway hinging things on the declaration of local or national emergency had the advantage that well in the case of a national emergency the government would then through the Civil Defence mechanisms there would be a decision made that this was a situation that merited special treatment and where these special powers should apply and the decision would be made at a high level of authority which would be appropriate when the government was going to stand by things like the immunity for inspecting engineers. Now unless you – some responsible decision maker has to make that decision whether it's national or local, isn't that right?

A. Certainly.

15 1306

Q. So we preserve the situation much like now for national states of emergency. There's already power to declare a local state of emergency isn't there. Now that is made by the, is it the Council that does that, but you're envisaging a situation where that doesn't happen either, so where would the – have you given any thought to what might be the triggering event for the application of the kinds of special powers and the provision of the indemnity that you have envisaged in a situation where there is neither a national state of emergency nor a local one?

20

A. And this is where the Boxing Day earthquake is quite instructive. The issues are where the scale of actual or potential damage has occurred such that public safety concerns have arisen and there is a need to run some form of systematic assessment of affected buildings.

25

Q. Yes, well if it is not the national government through the Civil Defence hierarchy in powers it has got to be the Council isn't it?

30

A. Very much and that, to reflect on the continuum falls back from a local declaration to not a local declaration. In many cases the local controllers are actually the senior office bearers of Council and are making similar decisions or have the ability, the powers to make similar decisions on

whether to implement a building assessment process whether they are acting as controllers or just as senior managers or it is a power of the chief executive.

Q. Yes.

5 A. If you also go back to history when there was a larger population of engineers that were working directly for Councils, they also had an in-house capability to do these tasks which would have, you know, covered off your smaller events scenario.

10 Q. So there would have to be criteria which governed the exercise of that power wouldn't there?

A. Yes.

Q. Because the consequences are very real in terms of people's legal rights and liabilities?

A. Yes.

15 Q. So you'd have to actually in legislation describe the sort of situation where these powers could be exercised and I just wonder whether you are not actually really simply talking about a local state of emergency and defining something which is lesser but which would still enable this suite of special powers to be exercised might be very difficult?

20 A. I understand and agree that if you look at the other end of the continuum to single dangerous buildings where they are you know well established criteria for whether a building is dangerous or unsanitary, it is going from one to several, to many to multiple, that is the continuum which I believe needs to be mapped out. It may shed light on the criteria that you refer.

25 Q. All right well thanks very much for that and we look forward to continuing those discussions tomorrow but seeing it is the last time we will be hearing from you on your own, you left out of the list of people who are to be you know commended and thanked for their efforts yourself, and it is quite apparent to me from my involvement in this Commission and the
30 work that you have done for us that you should be recognised and thanked for the work you have done in this field for New Zealand and I do that.

A. Thank you Your Honour.

HEARING ADJOURNS: 1.12 PM

HEARING RESUMES: 2.15 PM

5 **JUSTICE COOPER:**

Mr Lizundia welcome. I understand it is Sunday where you are?

MR LIZUNDIA:

It is yes Sunday night. Good to be here.

10

JUSTICE COOPER:

Thank you. Can I just go through the process of asking you to make an affirmation if that's all right?

15 **MR LIZUNDIA:**

Sure.

BRETT JOSEPH LIZUNDIA (AFFIRMED) (VIA LINK UNITED STATES)

EXAMINATION: MR ZARIFEH:

20 Q. Mr Lizundia can I just get you to give the Royal commission your full name please?

A. My name is Bret Joseph Lizundia.

Q. You are a structural engineer by occupation?

A. Yes.

25 Q. And you are a principal of Rutherford & Chekene Consulting Engineers in San Francisco?

A. That's correct.

Q. And am I correct to say that you have some considerable experience in, not only in structural engineering but in particular in post-earthquake
30 evaluation of buildings?

A. I have some experience yes.

Q. I just wonder if you can, you've got a I think Power Point presentation prepared, is that correct?

A. I do.

5 Q. I will get you to come to that in a moment. I think also you were a member of the ATC group that came to New Zealand following the February earthquake?

10 A. That's right. Last summer in the end of June I was with a team of three, myself, Ron Gallagher and Jim Barnes and we spent a week in Christchurch and a little bit of time in Wellington and Auckland interviewing people, touring various sites and trying to gather as much information as we could about the process of post-earthquake safety evaluations, to learn what we could from the experience you've been through.

15 Q. I will hand over to you to present, for you to do your presentation and the Commissioners may have questions as you go through and if they do I'm sure they'll ask you as you go, but I'll hand it over to you now if that's all right?

A. Okay, yeah I'll try my best to answer questions as they come up.

20 Q. Thank you.

A. I cannot see a Power Point presentation; can you see it at your end?

JUSTICE COOPER:

25 Q. Not quite yet, we've got it on, now we can, can you? No well we've got your slides but you apparently don't so, have you got them in paper?

A. Okay, I do, yes. So, they've got a number in the bottom right corner so we'll work together to coordinate that.

Q. Yes, when you want to move on just say, "Next slide," all right?

A. Okay, will do.

30 Q. So we're looking now at a slide which has your title page and there's a photo of earthquake damage with the hotel Grand Chancellor in the background.

A. So we are on slide 1.

Q. Correct.

A. So it is a pleasure to be here. Thank you very much for asking me to help comment on and do what I can to shed our perspective on the process and contribute to the hearings. Why don't we switch to slide 2?

5 So here's an outline of what I intended to speak with you about today. The first is I know that you've heard from Mr Brunson earlier today about the background on the New Zealand process which I think was very valuable. I wanted to shed a little bit of light on the history as we've gone through it in the United States, just to give you a little bit of
10 comparison and context and perhaps a little bit of the differences, and then I will take some of the findings from the draft reconnaissance report that we've just completed on that effort, which was submitted through the Royal Commission process a couple of weeks ago, and then focus on Mr Brunson's comments and I'll offer some discussion on selected
15 slides and some of the things that he said earlier today, and then try and draw some of my own comments and considerations for you to take away, regarding conclusions. So how about slide 3?

Q. Yes, you can assume we've moved onto the next slide unless I tell you to the contrary, all right?

20 A. Okay, that sounds great. So as we mentioned I've been practising in San Francisco with the same firm, Rutherford & Chekene for many years. I've done a number of things, designed new buildings, retrofitted existing buildings, been involved in earthquake reconnaissance efforts, guideline development, applied research, some of which is included,
25 you know work related to evaluating damaged buildings, the FEMA 306 process I was involved in as well as evaluating buildings that haven't been through an earthquake yet. I'm involved in several projects with that right now. I thought to be maybe overly legalistic I'd disclose a few things here so you kind of understood what I know and perhaps what I
30 don't know.

We were only there for a week so obviously our perspective is limited very much so by that. We tried to learn as much as we could after we came back, but it's obviously no substitute for participating in or seeing

tagging as it takes place, which we did not do. In fact we deliberately waited several months after the event for things to settle down so that we weren't as much of a bother as we would be if we showed up right afterwards, and sure enough right as we arrived you had another major earthquake in the middle of June so that strategy didn't bear fruit too well. But none the less people were incredibly generous and thoughtful and we learned quite a lot. We talked to many people so one of them was Mr Brunsdon himself, both while we were there and then later, so it's a small world that we have here.

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I'll be summarising the reconnaissance report that the three of us have prepared. The lead author on that is actually Ron Gallagher but I've contributed significantly as well. And I think I can represent, you know, our findings there.

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On the other hand I just wanted to point out that my conclusions towards the end, and I suppose my answers to questions are obviously mine alone and don't represent the thoughts of the other team or ATC.

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Okay, let's move onto the next slide.

There's a fair number of ATC documents that people refer to and I often use ATC 20 but it's actually a family of documents that's evolved over the years. Primarily it's been done through limited funding or volunteer efforts or self funding by ATC and there's lots more that one could do. I think that's part of why we went is to learn how to improve the documents, but just to give you a feel for what's included. As Dave Brunsdon mentioned earlier today, it was actually the first document ATC 20 was published right before the 1989 Loma Prieta earthquake in San Francisco which is a sort of a shocking coincidence and a month later building officials were scrambling around trying to find the copy they had just received to potentially use it in their communities and in fact many did. And so it got its first real test in that event and much was learned from that. That included both a kind of a white eight and a half inch by 11 inch document, looks like a little book, and then a smaller little field manual and it was people were supposed to take out with them when they were doing work in the field.

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The lessons that were learned from the 1989 earthquake and then later the 1994 Northridge earthquake were incorporated in an addendum. It was issued in 1995 and it included many things in it. One of the perhaps more significant issues is that

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the nature of the tag, the yellow tag, was changed somewhat and there were attempts to clarify the purpose of it and the best use of it and the wording on tags changed and there was a long kind of document of equal size that provided quite a lot of added information. ATC and its consultants and then the State of California and the structural engineers of California, many many people, have provided training to individuals who were interested in this, so there is a training manual with slides and a show that trainers walk people through. Many years ago I helped do this training for people in the field. There was a case study document, a much thicker document, that goes through, in detail, selected real cases from '89 and 1994 earthquakes and shows people what happened and the issues involved in tagging and sort of the recommended way to fill out the forms. And then a perhaps less known but perhaps the most significant edition is the second edition of the field manual. So it's a small green manual that represents the latest thinking so that included updates on different building types, more information about aftershocks and what to expect and what to do in dealing with entering damaged buildings with the potential for aftershocks. It had advice on barricading and a whole other set of info. So one has to be careful when referring to ATC20 to know kind of which edition and whether you're really talking about the more recent version, this 2005 field manual or not and, unfortunately, one of the things we've learned is that many of the people in New Zealand were well aware of the original document but a little less so about some of the more recent ones and so we've tried to share that with people. Okay so slide 6.

Dave Brunson went through the different levels of assessment and as he mentioned there are definite almost equivalent parallels to what we've been doing in the US but I think it's worth just reminding people of

them here because, unfortunately, the terminology is slightly different, it can get kind of confusing, so we both do as, I think, anyone would do with, you know, just from a common sense point of view, is a windshield survey, a reconnaissance survey, an overall damage assessment as fast as you can after the earthquake to figure out the extent, the scale, where the most damaged buildings are to prioritise resources, get a feel for whether you need to call for an emergency declaration, just get the lay of the land. So that's identical in both procedures.

Then we come kind of the heart of what we're talking about today is the assessments that are discussed in detail in the various documents that were performed. So in the ATC20 terminology the first one is a Rapid Evaluation and I would say this is quite similar to New Zealand's level 1 rapid. It's intended to be performed by people who have been trained through these training programmes who have, are qualified. They are typically civil or structural engineers with either a professional engineering or a structural engineering licence. They can be building officials. They can be building inspectors of certain kinds and the kinds that we want are those who have knowledge of lateral load path issues and the goal of this process is to rapidly assess safety just as it is stated. We want to quickly identify those buildings which are clearly unsafe and those that potentially appear undamaged and we also want to identify those that need a more detailed level of assessment, the next level up from that. So this is quick, it's intended to be quick because there's a lot to do and we want to move rapidly. As Dave mentioned it's part of a triaging process so 10 to 20 minutes is kind of a recommended guideline. New Zealand has drawn a distinction between a level 1 and a level 2 where the level 1 does not include going inside. In the ATC one that's not specified. It's encouraged to go in when you need to when it's okay to go in, if you need more information, even at this lower rapid evaluation level. So next slide.

So the next level up in the ATC20 terminology is called a Detailed Evaluation. This is very similar to New Zealand's level 2 rapid assessment. We recommend that this be done by structural engineers,

not be done by those with less experience and qualifications. Two engineers are recommended for safety reasons, just to have two pair of eyes looking at things. This is intended to be visual. It's intended to be careful. It takes an hour to four depending on the kind of building it is.

5 Generally you're not removing finishes at all. You would be going inside where possible and you also would be identifying those buildings that even after that amount of time you're unable to make a conclusion and they need an even more thorough evaluation. That is what we call an engineering evaluation. So that is what New Zealand has been calling

10 the detailed evaluation. So that third level is typically done, well not typically I would say it's almost always done by structural engineering consultants hired by the owner, so this is not typically done as part of the community's assessment process. It's done, say an owner could hire me, for example. We would do a much more thorough

15 investigation. We would try and obtain any drawings that we could. We would be looking at any kind of documentation we have. We would be removing finishes where warranted. We would probably always be doing calculations. Typically this would end in a report. It would provide recommendations for repair and stabilisation and obviously the length of

20 time and effort has increased significantly compared to the first two levels. Okay slide 8.

So in, I wanted to give you a little bit of context. In the US about further underlying assumptions or background about how things are here because I think that informs and has guided some of the choices that

25 have been made in these documents and procedures. Much of this you're probably well aware of but it's not too long here. So the first thing is as far as seismic strengthening goes even in California it varies widely by local communities, cities and counties are kind of our equivalent to your territorial authorities. So some communities have mandatory

30 ordinances for selected building types. Los Angeles, San Francisco, for example, have mandatory URM strengthening ordinances. Other communities have only notification ordinances. There are few other building types that have been considered. Some communities have

passed requirements for soft storey buildings or weak storey wood framed buildings. Many of these buildings collapsed in the 1994 North Ridge earthquake. It's not a building type that you see too common, that I saw in Christchurch very often, but it's quite common in California due to the lack of land in urban areas. We have been talking about seismic rating systems. I know you have as well. We have many different versions of them out there. We don't have a standard commonly widely accepted one. There are community or institutions like the University of California which has, for many many years, had a good/fair/poor/very poor qualitative assessment that's gotten more sophisticated last year. Stanford University has a rating system and four performance levels for it's buildings. Many other institutions have them but there is not a sort of public standard one that applies to all buildings. And, similarly, I know there's been discussion of accumulating data in a database about the capacity of buildings. We don't have that except for very few examples. Like the UC system all their buildings have been rated and thus they're in a database and it's actually publicly available. Earthquake insurance. You had a lot of insured home owners and commercial buildings. We have far less than that. I, for example, do not have earthquake insurance on my home due to the cost. Some businesses have business interruption insurances,

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some do not, so it is varies. Slide 9.

One of the many issues with respect to legal standards and codes in New Zealand has been what requirements kick in for repairing and strengthening when certain levels of damage occur and this is something that has changed significantly in recent years in the United States and both nationally and at the state level and even at the local level so on a California building code, the most current one is the 2010, it is very similar to the international building code, forgive our arrogance there, but that's the one the we apply nationally, that is the 2012 IBC. They have very similar definitions of what we can substantial damage, so when you have substantial damage certain things kick in when you

have less than that other things don't apply so that is defined, I've paraphrased here, but when you are talking about the vertical elements of the lateral load resisting system, like walls or beams and columns in a moment frame. If that capacity of those elements has been reduced by more than 20% compared to its pre-earthquake condition those elements are considered to have substantial damage. Vertical elements, you have to have a certain size of elements to kick in, it is not just one little thing in a corner so there is a 30% threshold there and again if it has lost 20% and also has a less than necessary, that is considered, I think the first one is the one that typically we see kicking in. So when it is less than that you are permitted to repair back to what it was before. When you have substantial damage you have to assess the building to determine if it was strong enough to meet 75% of current code. If it was, then you can strengthen it to that level, if it was not then you have to bring it up to at least three quarters of current code requirements. So, this is somewhat similar to the percent NBS, idea in New Zealand you have 33 and 67 we have a 75 number that we've used for many years, somewhat similar. Slide 10.

We have not had the kind of devastating event that you have experienced in recent times here, of course we had in 1906 you know San Francisco earthquake that was devastating but we weren't doing modern tagging then. We, on the other hand, have trained a lot of people so Mr Brunson alluded to that earlier today as part of the structural assessment programme in California. Many, you know several thousand people are in the database and have gone through training. They actually get a card and the little card goes into your billfold that certifies you and you can show it to people in the field to kind of prove that you have been through something. This is a process that many different institutions and organisations are involved in, so it is sort of a private/public partnership if you will. The structural engineers of California for example has committees that deal with disaster assistance and they have been intimately involved in this process and they help train people. The state of California through Cal EMA helps train people

and they think about the programme and coordinating it. When there is an earthquake the state makes a call of whether they are going to deploy people and then they make a request to the structural engineers of California so let's say it is in Northern California then the Southern California engineers are asked to volunteer and only people who have agreed in the past to volunteer, you know are sent that request and based on our experience people do volunteer just like they did in New Zealand, people do here, it is kind of impressive the nature of people's goodwill. On the other side, you know, we as you, worry about liability and even when people are goodhearted whether people will take advantage of situations and so laws have been passed to try and protect people who are authorised evaluators, as long as they are trying to do the right thing, so that they are not liable.

Communities have passed ordinances to make placarding a legal process. I know that's a complicated issue in New Zealand but this is kind of a simple way that it has been done here.

Aftershocks as has been discussed many times earlier today have been typically assumed to be smaller and we say equal or smaller, but they are typically smaller and they have been, so it is not been our experience to experience what you went through where a much more intense event with higher accelerations occurred some months later, that is not what we have been through. So I think that is informed our thinking, for better or for worse.

Q. Can I just ask a question before you move on about the good Samaritan laws and the ordinances that local communities have given legal standing placards. Are these all measures that are in place all the time, effectively waiting for the next earthquake or is this something that happens after the earthquake has occurred?

A. Well I will have to admit I am definitely not an expert on the answer to either of those two questions, but my limited understanding is the good Samaritan laws are always in place.

Q. Yes.

A. They have been in place for quite a while, there is several of them covering different kind of issues. As far as local communities, I believe there are those that have this in place in advance and then there are those who have invoked it after the fact but I would have to check into that to know the details of that. It is a good question and I am not certain of that. My, as a sort of a practising engineer it's, in my experience never been an issue. I know it is a significant issue in New Zealand and the expiration dates of placarding and when certain laws, you know, authorise them and when those laws expire, what to do to replace them has been you know a serious controversial issue. I just, we have not had that debate and controversy here that I know of so getting to the bottom of the nuance has, oddly not, been something we have needed to do which is sort of ironic given our reputation as being rather overly legalistic.

15 Q. Yes, oh, well. Thank you.

A. Okay, so slide 11.
So I wanted to go through kind of our findings from this. I think they directly bear on the topic at hand and kind of will give you sort of an outsider's view of what we saw and what you've experienced. So our point of going was very specific, it was to see how the procedures that you had implemented and been through worked and what we could learn from that process, what went well, what didn't, what new ideas came into pass, what controversies existed, with the hope that we could improve them, both primarily for our own documents but I think since they are used by many people that would have an impact in many other places as well. And I think it was quite successful as you will see because we certainly learned a lot. So slide 12.

As I mentioned there were just three of us that went. It was small but we were a good group. Ron, I should mention has been the principal investigator and lead author of the majority of the ATC20 family of documents. He is a very experienced, knowledgeable structural engineer. He practises in Oakland, California and he's provided training to many people, so when we were talking about, you know, what was

the intent behind the words, “Ron knows,” the intent because he wrote the words. Jim Barnes on the other hand approached things from a different perspective. He was with the California Emergency Management Agency, Cal EMA and he was the one who coordinates that programme and so he brings that state agency view point and then my own experience is what I mentioned before, so like I said we had a short amount of time, you know looked where we could in the vicinity and talked to as many people as we could. Slide 13.

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So here's, I won't obviously go through the whole report

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but I wanted to pick out certain things that, that I think are relevant here so I'll talk a little bit about what I think is somewhat unique in Christchurch, what great ideas we learned from folks in New Zealand, some of the issues with respect to evaluation or tagging itself and then some related to the management of the programme, sort of the broader picture, what future needs we identified and – let's move onto slide 14.

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So I think every earthquake is unique and different to some extent. I think in Christchurch there are a lot of unique things, a lot of very significant issues because of the scale of the event so, one obvious one is the widespread extent of liquefaction and its impact on residential communities and even some commercial areas and then the combination of strong ground shaking and liquefaction and sort of the nature of where Christchurch is sited in its proximity to rivers and its high water table and the complications that that posed with flooding and the needing to de-water areas is somewhat unprecedented I would say. Slide 15.

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As you're well aware you have a fairly significant amount of damage to high rise buildings and many have been targeted for demolition. You know the percentage of buildings that have been demolished or will be demolished in the central business district is staggering really, it's amazing how pervasive that has become. The number of repeated large aftershocks is unusual, you know, as you well know having gone through them, it's not the typical scenario that we tend to see and then

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of course there are parts of the community that are near hills and have falling rocks and landslides and geotechnical issues. We haven't seen, we haven't seen much of the fractured rebar issue before, at least to my knowledge and I know this came to light pretty much just as we got there where minimal surface indications are present on the face of concrete walls and yet there are some instances that have been found where there are actually fractured rebar inside the wall and I think the engineering community and the scientific community is only beginning to understand why that's happening and what we need to do about it and of course you were faced with implementing a safety programme with somewhat limited preparation. Dave went through, you know, quite a lot that had been done but obviously not as much as he had wanted to. So that was a difficult challenge. Slide 16.

I think one of the most dramatic things is illustrated by this slide which is to scale. I took this from the CCC presentation where the aftershock was so much bigger in terms of the downtown ground accelerations and we will come back to that I'm sure over and over again. Okay. So slide 17.

So what did we learn and take away. Well there's quite a lot of things. So a very good use of triage. The Urban Search and Rescue personnel being used as safety escorts, at least in the CBD, that's not commonly done in, at least, or pervasively done here and that seemed prudent given the proximity of things. Sort of a cute interesting one, didn't have widespread use but, you know, I imagine this will be more and more used in the future of drones going in places where we're worried about people going.

I think a very relevant one on slide 18 is something we have not done which we thought was just a wonderful idea, the notion of using indicator buildings was developed with New Zealand and actively implemented to try and figure out with all these aftershocks whether you needed or didn't need to go and re-evaluate and retag buildings because you could study the damage there. So we will be, you know, certainly talking

about, we've already begun to implement that in certain things that Cal EMA has updated.

5 Because you had a lot of moderately damaged mid-rise and high-rise buildings, slide 19, there was a lot of powerful work that had to go in place to deal with temporary stabilisation of that until decisions could be made to get people into places or to assess other places and I think there will be many lessons that will come out of that. Slide 20.

10 I now it's a very controversial issue in New Zealand with pros and cons on both sides but I think the, at least from our viewpoint that the notion of actively and dynamically managing the downtown central business district cordoning process as, you know, information was acquired and buildings could be evaluated seemed thoughtful, progressive and quite well organised though I know this is a trade-off between disruption to businesses and the safety of residents and commercial occupants but it
15 seemed to us quite well done. Slide 21.

20 There has been discussion in the United States, I think primarily following the Katrina Hurricane in New Orleans, where it devastated much of New Orleans and the city, you know, was lost to some extent for a while, of the notion and the importance of trying to shelter people in place - in their homes when you can, when it's prudent and so that has become, you know, part of the mantra here of trying to think about the next generation of assessment strategies and retrofit goals and the word seismic, the term seismic resilience plays into that. So we've been
25 talking about it and thinking about it and writing papers about it but you have done it, at least to our extent in a very real way with community showers, with enormous collections of portable toilets and I think most significantly temporary utility lines that allowed people to stay in their homes. You know we have struggled with this and have had temporary shelters with limited effectiveness. So I think the sheltering in place was
30 very eye-opening to me. Slide 22.

You used the most, the largest collection of shipping containers in creative ways I think I've ever heard of or seen. Everywhere we look

there was, there was a shipping container doing something. That seems like we will learn much from that here. On slide 23.

Very interesting to us were the different operations that were put into place by the different Government organisations. I think the, what was prioritised was very interesting to us and kind of thought provoking because we have not necessarily done it the same way and I think what you did made a lot of sense so that the notion of focussing early on shopping centres because of medicine, because of food, because of milk, water was in retrospect seems very obvious but it's not something that we have thought very well about. So that's something we will want to do here as well. I think the, the level of military precision and organisation with the Operation Suburb and the amazing amount of inspections that were done is very impressive and we can certainly learn from that. Slide 24.

I think the land management, zone-ation programme is very interesting. You know you were faced with this dilemma of what to do with evaluating and whether or not to repair, strengthen or buy out homes in residential areas. I know that's quite controversial but I think that it was a very interesting and pragmatic approach to a very difficult and challenging problem. On-call locksmiths, great idea, we haven't tended to do that. Use of private engineers, the consulting firms. I know there were many that were doing work in various ways for the Christchurch City Council and for private owners but they were heavily involved, seemed like that worked pretty

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well, just public, private, volunteer, paid process. I think the use of the internet, certainly sitting here we could watch things that were going on there and the various websites that are available seemed quite cutting edge to us. The, lastly, slide 25.

As Dave mentioned, New Zealand has added the usability category notion to its forms. I think taking that from Italy and in other places. Initially I think we were sceptical of that, thought maybe this is overly complicated, yet another set of cryptic terms, but the more we wrestled

with that notion I think we think there's a lot of merit and so we will certainly be talking about the possibility of doing something like that here.

5 Okay so slide 26 is talking about some safety evaluation issues. First, you certainly are aware of the guidelines that were under development. There was a draft that had not yet been released but it had a long history. It had been used in the Gisborne earthquake to some extent and it was based, in some part, on the ATC20 family. In reading through it it's somewhat different though than the ATC20 family of
10 documents. It takes a big picture view about the overall process which is admirable but it has very limited information on tagging itself. So it's really not the same thing at all in terms of a document. If I was handed that and somebody told me go out and evaluate that building there's not much in there and I know that's probably something that will be worked
15 on as things move on.

In slide 27 there had been some training, as Mr Brunsdon mentioned, of building control officials and some structural engineers. It was more planned but just the nature of timing meant that it had not had widespread training. I'm on slide 27. So because of that it meant that
20 people had limited training. Here's a picture of people sort of being trained on the spot with a brief overview from people who have just been back and I think that slowed the process. I know there was re-tagging that had to occur because of quality assurance concerns. I'm certain that would happen here as well but I think the more training the
25 less of that occurs. I think things, from what I gather, got better and better as the process evolved and people gathered more experience. Slide 28.

We took a lot of photos of buildings and we saw a lot of different tags, some of which are drawn from the 2009 guidelines, some of which are
30 not. We saw placards like this where there were buildings that had a couple on them. I know this is not the intent but this is not the only instance of that, we saw quite a few of these interestingly and this is four months after the February event. Ink fades with the UV light on there so

there are many of these tags where we got up really close and we really had a hard time reading what it said. So I imagine that people who saw it the first time knew what it said but if people are interested in it later they may have been somewhat challenged in a few cases. I think these are pretty minor issues though.

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In slide 29 a more technical issue, and Mr Brunson alluded to this today as well, is that the yellow tag is not the easiest tag to understand. It's intended to restrict use to certain categories. So a good example would be if your building is otherwise undamaged but perhaps there is a parapet that is damaged over an entrance, that's an Area Unsafe Tag where we would yellow tag that and we would warn people with writing on this that you're restricted from using that entrance but the other ones where there's no damage it's okay. So that's an example and there are many other examples of how that could be used. The New Zealand tag carried this 'No Entry Except on Essential Business' though which, I think, confuses the issue because there are parts of the building where you don't have to be on official business, you don't have to be some building control official, you can go in because it's okay. This complicated issue is discussed in detail in the more recent ATC20 publications. Slide 30.

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As I mentioned in terms of the, so in addition to just the act of tagging where having a limited pool of people makes it tough. The overall process of managing a programme is difficult as well when you have had limited training of the trainers or when you're trying to figure out which volunteers are really the best people to do certain things and when there's no credential, you know, by the time we got there the process of getting into the central business district was quite rigorous and you got a RF ID tags so people knew who went in and out and you got little forms you had to sign and all this so there was a fair amount of bureaucracy at work there for good reason but just the simple, you know, being able to hold up your card is not there yet in New Zealand. Nonetheless I think from what we saw the volunteer efforts of the New Zealand engineers and other design community professionals is heroic,

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you know, and I mean that. It's pretty impressive what people are willing and able to do and that's one of the things I really took away is how committed people were to doing the right thing and to helping their fellow community members. It's really kind of heart-warming. All right so slide 31.

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I think this has been talked about I'm sure many many times in many hearings here and is the heart of today's discussion is the public, despite the best intentions and public fora and information going out and different flyers being left I don't think the public really understood well some of the tagging, yellow tags and in particular the inspected tag and as has been mentioned the term inspected was confused with being safe in a future earthquake and that is very definitely not what it is intended to mean and it says this quite clearly in the various publications. It also says it on the New Zealand forms which are

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somewhat different and I think actually much more proactive and I would say a little legalistic of the writing on there with plenty of disclaimers. So I mean if you read the words on the form you are warned about a lot of different things. But the point is 'Inspected' is only intended to mean the original seismic resistance has not been significantly decreased. The safety of the building, it may have been a poor building before. It may have been an unstrengthened unreinforced masonry bearing wall building and it still is and yet maybe it was not damaged in any way and so it's been tagged 'Inspected'. So that is, for better or worse, the deliberate intent of the document and communicating that is tough and I think some people think controversial as well. But we have, in general, it sounds like not done as good a job as we could've communicating that. Slide 32.

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This is a minor point I think but interesting one is when we were there we were told that the City Council had a list of the number of buildings in the community and it was quite big and when researchers went to look in detail and began documenting what happened they found less than half of those buildings are actually URM bearing wall buildings. So I think that if you're talking about having a database of capacity you can

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see that the database that was out there didn't even have the right building classification in the large number. So when you get into large numbers this management process and quality assurance process becomes a huge issue. Slide 33.

5 I think from where we sit, and this is, you know, an outsiders view, it seemed to us as though the laws that are in place are fairly complicated, fairly overlapping, somewhat confusing to me at least, and they tended to hamper the placarding process and they certainly spurred a lot of discussion. I know when we were at a meeting in June of last summer
10 where a whole set of people came and talked about issues and this is about at the time when the original placards date were going to expire and people were very very concerned in trying to figure out what to do about that and, as I mentioned before, we have not struggled with that dilemma here. So I think, you know, that's

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something I'm sure will be worked through in trying to synthesise and make the various requirements more compatible and more straightforward. I'm sure that's not an easy thing to do but it seems like an important task to work on. Slide 34.

20 Just as we, we had this issue here as well. We have struggled with coming up with guideline documents for doing the more rigorous, detailed evaluations, what we've been calling the engineering evaluation here. We have some but we need more. Similarly repair and strengthening guidelines in much more specificity than those simple
25 building code rules. We have had only limited ones. I know people have been hard at work with the engineering advisory group and I know there's at least a seventh draft of the document that's out there now to provide guidance so I think that's a very impressive and important effort. Slide 35.

30 I think there's a lot of research needs that come out of this some of which affect tagging so let's all bring them up here. Knowing what to do with fractured rebar. Can we identify it in any easy way? We need to figure that out. You have a lot of what are called cavity wall,

unreinforced masonry buildings, these are where the outer wide and the inner wide have an air gap in between them. This weakens the wall significantly compared to a monolithic, more integrated building where the courses are tied from front to back. We have some of this on the east coast as well in the United States. It's not something ordinances have dealt with and I think warning people when they see it will be important and then developing repair and strengthening guidelines for it. Because there was so much shoring and stabilisation going on and so much creativity in that I think there is a lot to be learned from how it worked. So buildings that were shored in the September event, how did they do in the February event? Or, similarly, in the February how did they do in the June of last year event? I think there's a lot to be learned. I think that figuring out how to use strong motion instrumentation for damage assessment is important. I would say New Zealand could do a lot more than you did and there's quite a lot of ground instrumentation in New Zealand. There is less building instrumentation than we have in the US from what I understand and that is very unfortunate. You have lost an opportunity to learn from the large ground motions how buildings responded compared to what could have been done. Other, in terms of future needs, slide 36.

We need engineering evaluation guidelines just as you do, repair guidelines. We would, I would like to document the lessons learned from the building control officials and the emergency management professionals in how to run a good programme, how to do good cordoning and barricading and shoring and then as Dave mentioned I think we have a training process, we've trained a lot of people but I think there's different levels of training, you know you can get a different, you can get a bachelor's degree, a master's degree, a PhD and you can a, a lower level training or you could get a more detailed level of training and be, be more useful for more complicated structures so I think I wholeheartedly agree with Mr Brunson on that point. Slide 37.

We, I think we could use here at least shelter in place guidelines, we need more information about aftershock risk and, you know, what we

can learn from events that have happened. The USGS and ATC partnered on some aftershock risk guidelines a few years back but I think the time has come to update those. I think learning about how tagging in the emergency days evolves through the recovery process is a really key issue that you're struggling with and we have not thought as much about as we could have and I think, you know, you've gone past the tipping point to some extent where you have so many buildings that are tagged that they have an inter-relationship on one another and it's not just the tree in the forest, the individual building that has been tagged, it is an entire forest to some extent that has been tagged and that is not something we've really been through. You know when we had the earthquake in Los Angeles it was big but Los Angeles is huge and so the number of affected buildings was small comparatively and it was widespread and we didn't lose an entire downtown area for long periods of time like that.

In slide 38 we, as Dave mentioned there's been a lot of discussion back and forth by many different layers and levels, by researchers and practitioners and buildings officials and the more of that that happens the better for all of us. There's talk of an international workshop. We, just as you have asked people around the world to help review your documents which I think is very thoughtful we would certainly welcome New Zealanders reviewing our documents and we will want to do that as we move forward and there's a lot of, you know, collaborators, here's just two examples, but there's plenty of people and organisations in New Zealand that could help. Slide 39.

So we've issued a draft report just for editing and, you know, graphic presentation. That's about the only thing left. We will issue that final reconnaissance report and that will be made available on the internet to anybody. Kind of the key thing is to update ATC 20 to reflect what we've learned to date and to have our larger white manual be consistent at a minimum with the 2005 field edition but, more relevantly, to be consistent with the lessons that have been learned recently. I think, I kind of envision an expanded family of documents that are made sort of

as time and money permits one of which, that we don't have, and I think the 2009 New Zealand guidelines have some of this in there, is how do you run a good programme? So we've been focussed on that tree. We've been focussed on how do you tag an individual building. We haven't spent a lot of time talking about how do you run a whole programme. We do have some guidance at Cal EMA on that. I think more would be needed to help building officials and local communities who haven't been through the process learn from people like you in New Zealand who have and several other things here you can see. Okay, so slides 40.

This is the beginning of some comments on Mr Brunsdon's presentation this morning. So this was emailed to me on Friday, US time, and I have read through it. I think it's an excellent presentation and so I will be taking certain slides that'll be on the right here and then offering my own suggestions or comments or questions or in some cases concerns about what's being proposed on the left. I've also reviewed a number of the submissions that were, the Commission received on the same topic from the various organisations that counsel alluded to earlier today as well but the focus I was asked to put on Mr Brunsdon's presentation so that's what I've done.

In general, slide 41, I think the upfront discussion of, you know, how the New Zealand 2009 document came to be and its over-all similarity and approach to the US approach is consistent with my understanding as well. I think his summary of what occurred in the various events is consistent with what I heard from the other people that we interviewed as well. So nothing stands out as clearly in conflict with, you know, several other people's views but admittedly my view and knowledge is limited by a small exposure. Slide 42.

So Mr Brunsdon identified what he called "Main short-comings" in various aspects and here, for example, the rapid assessment process. I agree with those. I think that's what we heard and saw and I've alluded to in our ACT report findings. There are a few others that I mentioned as well but nothing dramatically different. Slide 43.

In terms of the detailed evaluations I would agree that those were all short-comings, however, I would take some exception to the middle one there which says, "There's no ability for councils to require owners of green-placarded buildings to obtain a detailed engineering evaluation."

5 In the ATC 20 approach there is no

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intent for there to be a detailed engineering evaluation if the building receives a green placard and one is not recommended to acquire one, so, and we will talk about that in later slides here in detail. I think that's a fairly significant proposal that I have concerns with.

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In slide 44 Mr Brunsdon pointed, you know, just aside from terminology, just the name and he pointed out the very good reason why New Zealand changed that. They didn't want to over promise what was included in the one to four hour inspection. I understand that. I wasn't involved in writing these so I can't vouch for why the original authors called it detailed. It was just their definition of what was detailed, you know, evolved from a 10 to 20 minutes to a one hour to four hour presentation. I got the sense when I was there, and this could be incorrect, is that not all of the detailed evaluations that rapid level 2's took that long but I could be wrong. And then I know that the rapid level 1 is not intended to be an interior evaluation. In the ATC approach there's no restriction against going inside and people are encouraged to go inside when it's warranted and safe to do so. I even, what we called the rapid or you call the rapid level one level.

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In slide 45 there's a new, I think this was proposed in a June 2010 – 2012 document that I just saw the interim use evaluation, the IUE and I think the purpose here is to deal with damage that's not clearly visible even after you've done a level 2 assessment where you need to perhaps remove finishes to go in and look for things, and I would caution you that this can become a very difficult and very expensive procedure depending on how far you want to take it. Now every event, you know, has its special characteristics, but what I'm reminded of here is what we struggled with after the 1994 Northridge earthquake where

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one of the seminal issues there were the beam to column connection damage in steel moment frame buildings, where it was not immediately apparent that there was a problem. In fact it didn't come out for a while, and then it began, we began to hear rumours and talk of trouble with buildings and some were leaning more than we thought, and then we heard about fractured connections and eventually an enormous federally funded SAC project was what it was called, and it resulted in a number of documents that are, you know, publically available to try and figure out what exactly was going on and what we could do about it. But the issue with respect to a interim use evaluation or a more detailed evaluation is that to determine the hidden damage in a steel moment frame building is an extremely expensive issue in a big building because these connections are fireproof, and older fireproofing can have asbestos in it. This can be above ceilings, it can be behind hard finishes, but just getting access that's safe to go and look and peel back things to find the steel is hard. And so people thought about this and come up with procedures and statistical checks about how many to do, given what size the shaking, to try and you know make this a bit of a more engineering approach, but I would be careful to think that it's easy to figure out all the hidden damage in certain building types. It's not. So slide 46.

There was a fair amount of discussion and I think a lot of questions that came up in the earlier session today about unreinforced masonry and this is my own personal view. I testified before the Commission last year about URM buildings and the notion or the difficulty in dealing with these buildings that have not been strengthened. So my point there should have the notion that there is a non-earthquake prone unstrengthened URM in moderate to high seismicity is in my opinion a flawed notion. When you, we have countless examples in earthquakes, and you have just gone through one where you have seen that large numbers of URM bearing old buildings that were not strengthened were damaged. Some, you know, caused life threatening damage or killed people and the idea that you can go and look and somehow conclude

that these unstrengthened buildings lacking in adequate roof to wall tie are not earthquake prone and thus sort of off the hook, I just don't agree. Now the interesting point is that we live with these buildings every day. You have drawn a line just as we have about acceptable risk, and there have been territorial authorities, there have been cities and counties in the United States who have said, "Yeah there are a lot of things that we can do with our money, and we are choosing not to require mandatory strengthening of these buildings. We know they pose a risk but there's a lot of things in the world that pose a risk." So you have made a choice to live with those. So I find it interesting that in the aftermath of this there is a discussion of, you know, should we rethink that? Should we invoke rules after the fact, to have a more rigorous line or a shift in the line? And I question the notion of using the 2006 guidelines to do this evaluation. I do not think the IEP process is adequate. I do not think the idea that one can identify a percent NBS for an unstrengthened URM is a valid approach. A building with an inadequate roof to wall tie has minimal or negligible capacity. That percent NBS idea makes a lot of sense when we are talking about the in plane resistance of walls or moment frames. It doesn't make much sense when we're talking about something as simple as a missing critical component in the load path. So I was concerned about that before. I remain concerned about that notion here. I know the notion of percent NBS is embedded in even in the public culture of New Zealand which is very impressive. We don't have that here and I wish we did, but it becomes difficult when applied to URM buildings. Slide 47.

Mr Brunsdon identified kind of key future issues that needed to be addressed. I agree with all of those, definitely.

And then in slide 48, key components that were proposed by the New Zealand Society For Earthquake Engineering, I agree, all of the arrangements are worth development and should be a high priority. Slide 49.

Now we're getting to sort of the key, the devil in the details proposals here. So the first key consideration was brought up of whether a rapid

evaluation system, I have circled, you know, in red there “rapid” should be based on damage assessment which, as Mr Brunsdon pointed out, is what is done around the world including in the US historically. At what point should it or should it not include a quantitative assessment of residual capacity? So in my opinion this is not a realistic thing to do in a rapid assessment. It takes too much time. So we do not begin looking at calculations and quantifying things in the US until the engineering evaluation level, or what New Zealand calls the “detailed evaluation level”. That’s far beyond what a rapid person on the street can do.

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10 There are documents that are specifically designed to enable us to come up with a number. In the US we have, I worked on FEMA 306 many years ago and that came out of the Northridge earthquake specifically because we were struggling with trying to figure out how much capacity had been lost. So when we have a building code that says substantial damage means a loss of 20%, that’s an easy thing to say but to an engineer to try and quantify that and calculate that and figure out what that really means on an individual building is a very, very difficult thing and there is no consensus on that. So FEMA 306 was an attempt for concrete and masonry wall buildings to try and do that.

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20 The SAC project came up with one to do that with steel buildings. More recently ATC has done something similar for the city of San Francisco that includes wood buildings as well. So I know this has been done in New Zealand also. I think it’s important and already part

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25 of the process but to do it at the rapid level in my opinion is not practical. Slide 50.

This – the sort of tragic events that have happened in New Zealand where the aftershock was so much larger than the original shock and you know has different characteristics of shaking including apparently the direction, this is, as I mentioned before not something that we have thought strongly about because it has not been our experience. It is not what our geoscientists have taught us. It is not the history of what we have seen. I know there are other parts of the world, Italy for example

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where they often do have magnitudes that are, I mean aftershocks that aren't significantly smaller but it is not something we have thought about much here. Now I think, so the question is, is how should you design an entire programme or change an entire programme to deal with that or not and I think you know the question of whether we shift the line to open up the possibility of evaluating things for larger events in the future is one you take a lot of thought about before one does, given its sort of small statistical history in most environments, for one thing, but it also raises issues for society at large, so I mean the tagging process for better, for worse, aims to strike a balance between disruption and safety. So I think as a structural engineer my primary goal in life just as a doctor's loyalty is to their patient's health, my loyalty is to public safety at first but it exists in an environment and in a context where there is only so much money that we can have, so we can't be absolutists about things. We have to draw a line at some point that we think is a reasonable line. And if we go too far I think we can tend to over tag and you know kick everyone out of their buildings and increase homelessness, increase business disruption, increase the difficulty of recovery, so it's a tough subject. But it is definitely one that we need to be talking about and figuring out whether to switch that line or not. In slide 51.

ATC20 and our techniques in the US have tended to focus on damage and safety. We have not focused on sanitation issues, we haven't focused on lockable buildings and security and the utility damage and the infrastructure losses in the residential communities. In Christchurch it is obviously raised you know key questions about whether that makes sense in residential communities so I think this you know, the things you struggle with and the ideas you came up with to deal with that, there was the three S system that came in place and all the different emergency management, operational issues have reflected the experience you have gone through so I think that is something we here need to think a lot about because it seems to make a lot of sense to begin to deal with that in terms of, particularly as we want to keep

people sheltered in place more than we have in the past but I don't have the magic answer to where exactly to draw the line and how far to go but I think we certainly will want to be talking about that as a community. And slide 52.

5 As was mentioned before in this key considerations, it says avoiding and placing inspected placards on buildings of known low capacity such as those that are considered to be earthquake prone. Okay, as I have pointed out in the US the inspected tag is placed on a building which doesn't have significant damage. It doesn't matter if it was a poor building before or not. So this is a tough concept to deal with, you know when I am hired as a private engineer to go and evaluate a building, let's say in the aftermath of an earthquake, we would write a report and say well, your building is not significantly damaged compared to what it was before, but your building is a poor building and here's what is wrong with it and here's what you should – you know, we recommend you strengthen it. So that would be part of a report that a private engineer would do but it is not the same thing as tagging when your goal is somewhat different. There is also a notion here of, that has been raised about collecting as much information into a comprehensive database that could be linked to buildings and provide advice to inspectors in the field about previous information. I think that is a noble goal. We don't have that here. I think the cost of that would be significant in large communities where there is, you know, hundreds of thousands of buildings to do. As an engineer that would be a full employment act for structural engineers so it is hard to turn it down but from a taxpayer point of view I question the possibility. Slide 52.

THE COURT ADDRESSES WITNESS

HEARING ADJOURNS: 3.31 PM

30 **HEARING RESUMES: 3.47 PM**

JUSTICE COOPER:

Q. Yes Mr Lizundia, thank you if you could just resume where you left off?

A. I'd be happy to, I am on slide 53. Can you hear me all right?

Q. Yes we can thank you.

- 5 A. Okay, great, okay so I was just finishing off on Mr Brunsdon's key consideration (3) slide. So highlighted in red there is the issue of trying to require owners of inspected placarded buildings to move quickly to the detailed evaluation level and get those done. This is a very interesting notion and I think from an outsider's point of view it seems, at
- 10 least it strikes me as essentially making all buildings, even undamaged ones, and the owners of those buildings guilty until they prove themselves innocent which is the opposite of what we tend to do in a democratic society, just because they happen to be near somebody else's damaged building in an earthquake. They are in a community
- 15 where damage has occurred so they need to prove themselves okay. I think that in a community where there is a very small number of buildings that may be possible in a place like where I live with millions of people and hundreds of thousands of buildings, I can't imagine how that could really be implemented. I think there would be a lot of stakeholders
- 20 who would have concerns about that and it would be a very difficult political process to unfold. So moving on to slide 54.
- I think that the notion of integrating repair requirements and mandatory strengthening programmes is important, desirable and probably relatively straightforward when you have mechanisms in place. You
- 25 know it is interesting how the context though effects what you choose to do. So for example in San Francisco, remember how I was mentioning that every community has sort of a different context and history so the context in San Francisco is that many years ago, probably 30 years ago, a parapet safety ordinance was passed and this was a required
- 30 ordinance, so mandatory ordinance that applied to owners of all building types, so it wasn't unreinforced masonry, it could be a concrete building for example, you had to address your parapet. So if it needed to be strengthened, it had to be strengthened and that programme was sort of

long ago completed. So in the 1989 earthquake came around the vast majority of buildings that had parapets were supposed to have had their buildings evaluated and strengthened at least for that small portion of them at the time. So the idea that has been talked about in New Zealand of perhaps requiring parapets to be braced before you can reoccupy, you know in San Francisco would have been somewhat unnecessary because that was supposed to have been addressed. It doesn't mean that you would have a damaged parapet and you need to do something about it but at least that first measure of risk reduction as part of the overall process to some extent it had already been in place. Now there is an idea that developing this register as I mentioned before we don't have that, we would love to have such a thing, but we don't have that and acquiring and paying for that would be challenging when you get to large numbers of buildings.

In slide 55 there, I wholeheartedly agree that a training and accreditation programme is a worthwhile goal. We have done something similar in the United States primarily on the west coast, certainly in California but in Washington as well. Doesn't have to be like what we do by any means, but I think the overall idea of doing something like that is, would be very worthwhile. I think it's something that is in the public interest, you know it ought to be free for people to do and they are volunteering their time so, you know, paying for the training seems like the least we could do.

In terms of slide 56, the coloured triangle there, I think one of the key things that was talked about for some time, I completely agree with and I agree with it more after seeing more and more earthquakes is that it's actually, it's not enough to be an experienced structural engineer, to look at a damaged building and to have a good idea. You have to have some experience with damaged buildings. I know that sounds kind of glib and obvious but it's not, and so there's different layers and levels of training that are advantageous and so I think for the more sophisticated complicated, bigger, more important buildings having a higher level of training would be valuable so I like the triangle notion. We came away

with that same feeling that, was one of our report findings, I think that is one of the future documents and goals that we would like to promote here as well. Slide 57.

5 You know wonders of building information management, BIM, you know all the major buildings that my firm does we do in BIM, through the majority of structural engineers and architects here. I know that is the same thing that is happening in New Zealand as well so this is certainly where things are going. But you have sort of, kind of a cutting edge of a new building and then you have the reality of, you know, lots and lots of buildings in place with old documents, that may or may not exist in some location and trying to acquire information about them is very challenging. So it can get as simple as, what is the address of that building? Most buildings of any size have lots of addresses, you know, the building that I am in right now, faces two streets, you know, what is 10 the address of it. You know it has 530 Lytton but it could just easily have been a different street and I have seen this over and over again in every earthquake and every time I try to do research projects with large numbers of buildings, is this quality assurance process of trying to figure out what exactly is that building you are talking about? Is something we 15 have to deal with, so I think, you know, the goal of coming up with the unique identifiers sounds trivial but it is not and it's, would be an admirable thing, it would be a huge advantage for all kinds of GIS systems in the cities, you know, approach, beyond just earthquake safety. The notion of publishing on the internet for example, the placard status of a building seems like a great idea to me. We already are 20 posting the building, so it is not like it's a secret. Having it in an accessible simple way seems like a good thing. There is all kinds of advantages from emergency planning, from just public information, for quality assurance reasons, you know, I think there is a lot of virtue in that. However, the next step of making drawings and capacity 25 assessments available on line is a whole other step of costs and implication I think, still a noble goal perhaps but they, you know, just digitising and finding structural drawings from old buildings would be 30

quite a challenging task in many cases and at least here in the US, I can't really speak for New Zealand, but here in the US, there would be probably be privacy considerations that some owners or the owner management associations would have concerns about. You know, would they want the layout of their building and the structural adequacy of it published? Probably not. And would they want their property values diminished if people knew what their capacity assessment was? Certainly not. Would that spur the incentive of retrofit, yeah probably would to some extent. So we struggle with that dilemma and there's pros and cons on both sides but I can tell you that that, you know, I often see this proposed and I, just having been around a while I know this at least in our country would be very challenging to implement. Slide 58.

It was mentioned before about whether or not we should have different placards for different procedures for commercial versus residential buildings. We have not done that here but it's definitely worth study and worth thinking about because the issues as we have mentioned before are somewhat different. I know that there were concerns and some examples of the conversation that structural engineers and geotechnical engineers don't often have that we wish that they did, where perhaps the geotechnical engineer posted a building as maybe a red tag because it was threatened by the potential for land sliding or because it was in danger from adjacent source and then later a structural engineer didn't know what to look for, didn't think about it and over tagged that building with inspected perhaps not realising what the issues were, so I think our ACT20 family of documents have limited information on geotechnical considerations. Most of our documents always end with sort of a single chapter, a limited chapter on geotechnical and non-structural issues and I think the Christchurch earthquakes have really shown the vast importance in certain earthquakes of those issues. So we could do a whole lot better with both our guidelines and our training and educating evaluators on what to look for in certain geotechnical context. Slide 59.

So Mr Brunsdon was beginning a sort of summary comments. I agree with all of them, both on this slide and in slide 60.

You know, those are certainly the issues and concerns that I saw.

5 In slide 61, you know, it is mentioned that, collaboration with international folks would be advantageous, I wholeheartedly agree and we want to work with you all as best we can.

10 So I want to sum up towards the end here with a few observations and conclusions so in slide 62 you know, one of the things that I have alluded to a couple of times and just as you get older you realise that certain earthquake events have kind of signatures or seminal aspects to them. Not everyone does, but the big ones tend to, so you know in the '89 Loma Prieta earthquake there were certain aspects of it that informed our thinking and led us to realise you know issues we should do. The earthquake world tends to be relatively reactive, you know, we
15 tend to see what happens afterward and then try and figure out what to do about it for the next time around. It is sometimes hard to predict what will come down to pass and so, you know, with every earthquake we sort of see things we didn't anticipate or didn't expect which is sad for sure but on the other hand we tend to do something about it. So
20 after the Northridge earthquake we had a huge research project to deal with steel moment frame buildings. You know it is not a building type that's significant in Christchurch but it is in other parts of the world. We had tremendous amount of parking garage damage that led to building code changes. We began to realise that how we assign and assess the
25 nature of the damage and the severity of the damage when a crack is

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observed is a very problematic and controversial issue so we got led us to some publications that have begun to get some use in the US. In
30 Chile, even though technically there were a lot of issues with concrete buildings that I think were relevant to both New Zealand and the United States, one of the things I really came away with there was it's a very sophisticated country and very educated force and a lot of proactive thinking about earthquake resistance and there was a huge disconnect

between the public perception of what they thought they were getting and what engineers intended to provide and that sounds awfully familiar to me in earthquakes that we have observed in the United States and I think from what I'm hearing in New Zealand as well. So this experience with technical information not being clearly and effectively communicated to the public is not just something that happens in New Zealand, it seems to happen all over. Slide 63.

So we've listed lots of things that are significant about Christchurch. You know, it's a major event, obviously for you a tragic one, but I think it's a great opportunity for us to learn around the world and I've listed lots of issues that strike me among the many that are there.

In slide 64 I think the thing about this communication issue, and I know this at least sounds obvious to me, we've all heard it, but it just, we have a difficult time of explaining to people that risk is unavoidable. There is always risk. We can't make it go away. You can't have absolute safety. We can't make all these buildings not earthquake prone tomorrow and I think one of the really eye opening and heart-warming and impressive things that's happening here, that's quite rare, is that you are having a debate through the Royal Commission process and hearings in public.

You are having an opportunity to talk about what is acceptable risk. You are soliciting opinions from learned societies, from laymen, from all kinds of different communities. You're hearing from the families of victims. You're hearing from a lot of people about what risks are acceptable. We would love to do that here. We have tried to do that here. We have struggled. It is so hard and difficult to do. So I really think you have a golden opportunity here to have the conversation with you know more stakeholders than normal about what is okay because in the past it's basically engineers who have been deciding behind the scenes what they think society wants and can tolerate and can pay for and that's noble in a way but it's informed by our own viewpoint so I think to me that's one of the underlying really important things you're doing. Slide 65.

I think, I really come away with though the Christchurch earthquake sequence is very big and significant I think it's somewhat unusual. You know this is generally not the experience of the much more damaging aftershocks, so we always have to sort of couch our reaction to it in the procedures that we change and evolve from it with it's somewhat statistical unusualness. I think that the evaluation programme in general was quite successful. I think there's lots of ideas and practices that were implemented that you will implement in future earthquakes, that we will implement here in the US and that people from around the world will learn from that. I think that the need to do rapid assessments, you know, the question basically is should we keep doing this concept rapid assessments that people came up with, you know, 20/30 years ago and I guess my conclusion is yes. I think it generally serves its purpose, it is a difficult thing to do. It has obviously pros and cons on both sides but, in general, I think it's essential to our understanding quickly of the extent of damage, figuring out which buildings are probably okay and which are probably not and in helping the community to draw that important line and get people reoccupied when it is warranted.

Okay almost the end here, slide 66.

In terms of the green tag, the 'Inspected' tag. In some of the proposals that have been put forward, I mentioned this before but you want me to summarise a few of these concerns in this slide. I think the notion of requiring owners of buildings who have that 'Inspected' placard to obtain a detailed evaluation before they are allowed to reoccupy, which is I don't think what is being proposed in general here, is not practical or warranted, so I mean that is one end of the spectrum is that somehow because you're in the vicinity of, you know, a heavily shaken area that you now can't go back in your building even after somebody has looked at it, albeit quickly and decided it's okay, you're still not able to go in. I think that's going way too far and so that's to me one end of the spectrum. A step up from that is you don't prevent them from reoccupying immediately, on the other hand you say if you're inspected then you need to get a detailed evaluation within a certain timeframe in

the future. That would be a major change from what we've been doing in the US. It would have significant costs. It would likely raise many objections from building owners and stakeholders due to the costs involved but it's a step down in the spectrum of possibilities. So another

5 step down is you would pick selected building types, perhaps those that are already subject to mandatory ordinances, and if they have received an 'Inspected' placard – so let's say it's an unreinforced masonry bearing wall building in a community that has a mandatory earthquake strengthening programme for those buildings and it wasn't heavily

10 damaged, it wasn't significantly damaged in any way, so it gets the 'Inspected' placard – then you get a certain amount of time to do your evaluation. Now the dilemma's always gonna be well what if they don't do it? Do you kick them out if they don't do it? Do you have to bring in the police to somehow kick them out? You know, this would be a tough

15 thing to do so you always have to ask the question how do these programmes work in practice. But that would be a little more possible I think. So, moving onto slide 67.

One thing that was not mentioned this morning. It was alluded to in some of the submissions like the Hare and Galloway paper, in the

20 United States through the ATC52-4 document, which I'm showing on the corner there, this came out of this long programme that the city of San Francisco had, the Community Action Plan for Seismic Safety, it has a whole bunch of aspects to it, one of which was to come up with better guidelines for repair and strengthening so in developing those

25 guidelines for three targeted building types, one of which was wood frame buildings, one of which was concrete buildings, we came up with this idea of disproportionate damage. So disproportionate damage notion was a bit of an engineering Darwinianism concept where we would use the earthquake to identify the worst performing buildings. So

30 we can do that with an evaluation quantitatively but we can also say, you know, the earthquake, all other things being equal, is a somewhat good predictor or decider of what's a better and a worse building. So if we find certain buildings that have higher than expected levels of

damage in lower levels of shaking then we can say those buildings are worse than other buildings and we're going to make them have more stringent strengthening requirements to repair the damage they experienced. So what we did is we set a triggering threshold fairly low –

5 this is the short period spectral acceleration, so that's not the ground shaking, that's basically two and a half times the ground shaking, so that's a pretty small level there and we have definitions of what disproportionate damage clauses are in these guidelines – we said if you say are a soft storey wood frame building and you have had

10 moderate shaking of this level and yet there was a certain significant amount of damage then you have to repair to a higher level as part of that process. So that has actually been talked about and, I believe, passed quite recently by the City of San Francisco and is now part of their local building code ordinances. So that's a pretty significant thing

15 and that would not necessarily have had too much applicability here in the September versus February events but it has a lot of applicability in the normal aftershock sequence. So something worth considering.

The last slide here is the slide 68, or next to last I

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20 guess. In my opinion the change to a residual capacity assessment for rapid assessments is not a practical task. I don't want to see people standing there on the street looking at buildings, trying to do calculations of the building. I don't think anybody's proposing that but I sure hope not because that just really flies in the face of the whole notion of triage.

25 On the other hand doing residual capacity assessments as part of a later stage of evaluations such as the New Zealand (inaudible 16:10:44) evaluation makes plenty of sense and is already part of, you know, the process in a variety of ways. So I don't see any harm and I see a lot of good in doing residual capacity assessments and in fact what I think is

30 very valuable, and this is what FEMA 306 talks a lot about, is that they go hand-in-hand. That understanding the damage and doing calculations and bouncing them back and forward off one another and informing your calculations with your observations to make sure your

calculations aren't coming up with an answer that flies in the face of the field observation is the best possible situation. So I think combining those two makes a lot of sense. I think guidelines are under development both in New Zealand and in other parts and that's the right way forward. So the last slide here is a reminder to me I think to, of the feeling I came with of what happens, you know, in the aftermath of a big event is that there are a lot of people who we need to care about and take these things very seriously and have struggled mightily and are working very hard to remain, you know, healthy and safe and in their homes and operational and we need to think about what we can do as best we can to help them.

JUSTICE COOPER:

- Q. Thank you very much
- 15 A. So are there questions?
- Q. We'll find out.

JUSTICE COOPER ADDRESSES MR ZARIFEH – NO QUESTIONS

CROSS-EXAMINATION: MR LAING – NIL

20 **QUESTIONS FROM COMMISSIONER FENWICK – NIL**

QUESTIONS FROM COMMISSIONER CARTER:

- Q. We understand that in California the various local authorities all choose their own standards to work to. Now you've related what we're doing here to ATC 20. Could you just, just give us a brief comment on the extent to which the various local authorities accept these standards and to what level of compulsion does a standard like ATC 20 lead for local authorities?
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- A. I would say that in California it is the standard and that all communities use that and that no communities that I'm aware of are doing anything differently. It is just, it's sort of a momentum thing of, you know, when it
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came around in 1989 it was hot off the presses. It was a volunteer effort. There were no mandatory requirements to do this. It was just grabbed because there wasn't anything else and it was relatively successful and so it took off and now we have all programme and process and state training and state agencies that are doing that and I think local communities have thus said, okay, that's good, we'll adopt that. What I was alluding to about the difference in communities is not so much in the tagging procedures they use, it's more in the requirements they have for seismic strengthening or not. So, for example, in the early 1980s there was a political debate in California about what to do about unreinforced masonry bearing wall buildings and the conclusion was, yes, we need to do something but there was not the political will to make a defined, mandatory line that all communities would have to do. So as part of the means of getting that law passed it was left to every community to decide what their ordinance would be. So to me that sounds very similar to what's happened in New Zealand with earthquake prone buildings. It's being left to territorial authorities to some extent to choose the nature of their communities laws. So, for example, in California we might have a city like Los Angeles which has a very comprehensive, mandatory set of requirements for all unreinforced masonry buildings to bring them up to the same level and it's been done and they're pretty much all taken care of, at least to that level. Then there's other communities where they just have to notify the owner that they're the proud, you know, owner of an unreinforced masonry bearing wall building and there is not a mandatory requirement forcing owners to do something about it. So we have a whole range of programmes that came out of that law where it was left to local communities to decide. That's what I was alluding to when I said that.

Q. Do you see that changing. Is it becoming less acceptable to have no specific requirements to strengthen?

A. Not really. I think, you know, that ordinance sort of played itself out and communities chose where they stood. I think what will happen is the next time there is a damaging earthquake and the next time somebody

dies in an URM building in California then the whole debate will start over again and communities that have more relaxed ordinances will probably struggle with whether they, you know, want to up that. What I do think is changing slowly is that we're slowly tackling other building types that are considered to be hazardous but not perhaps as hazardous as URM bearing wall buildings. So, for example, many communities are thinking about, debating, or have passed ordinances related to multi-family, multi-storey, wood-frame residential buildings that have a weak, soft storey at the bottom. Sometimes they're called tuck-under buildings or soft-storey buildings. They did very, very poorly in the 1994 Northridge earthquake. A number of people were killed in the Northridge Meadow apartment building and we think they're very dangerous. So that is being tackled. Tilt-up buildings where concrete walls are poured on the ground, tilted-up and were connected with connections that aren't as good as we'd like them to be today. There are a few communities that have rules about that. There are some with a few other things in them, you know, like San Francisco had this parapet safety ordinance that applied to all buildings. So a little bit of a smorgasbord of buildings and as the years go by a little bit of additional buildings, building types are added to the mix but it's a slow process due to the cost.

QUESTIONS FROM JUSTICE COOPER:

Q. Mr Lizundia can I just refer you to slide 17 where you make a reference to, under the heading, "Useful Ideas and Good Practices", "Use of Unmanned Aerial Vehicles." Now I haven't heard of that after the Christchurch earthquake. Is this something you observed or were told about here?

A. Something I was told about and read about in the media. So I believe there's at least two instances, one where a drone was flown into a church, through a window, to look around, that's the major cathedral in, one of the major cathedrals in Christchurch –

Q. I see, right.

A. – and then a second one was a robot went in upon the ground, you know, and did a similar kind of thing. So that the first one I think is particularly interesting because it was very low cost and, you know, was equipped with a camera so they were able to sort of fly in and look at things. So it sounds quite sexy actually and I think that, you know, I can imagine more of this happening down the road in the future.

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Q. Yes, all right, thank you and then slide 53, you talk about, you use a legal analogy in respect of buildings being taken to be guilty until they prove themselves innocent. Do you see, would there be, leaving legal difficulties aside would there be difficulties from a practical or from an

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engineering point of view if that stance, a policy stance were adopted which said given there's been an earthquake which caused damage to a URM building, that URM buildings should be subject to a detailed engineering assessment before they could be reoccupied after the earthquake?

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A. Well I think on the face of it, it sounds reasonable, but the dilemma that I struggle with is that you, we as a community here and in New Zealand have allowed people to live in that building before the earthquake and the notion of the inspected placard is that the building is not significantly changed from what it was before. So to me it seems as though the standard has suddenly changed from what people were permitted to do, the based decisions on that for better, for worse, they made purchasing decisions, they allocated resources and now after an earthquake, you know, they're standing there looking at their building and they're saying that it's nothing changed about it, I don't see any cracks in it, I don't see any damage, why can I not go back in it. I could go back in it yesterday, why can't I go back in it today? To me that's a very difficult position to put people in on and I think when I've, since this came up, since I was asked to do this I've been flying, I've been on the plane and for business reasons in a number of places so I've talked to a couple of people in different locales and they all just sort of raise their eyes and say, "How could you do that?" You know, "This is sort of my building, right, who

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gives you the right to do that?" So I think that's the sort of lay reaction. Now the counterbalancing problem as well. You know there probably is an increased risk to some extent because we're in an aftershock sequence, right, but do we know that the aftershock is going to be bigger or of different nature or it's going to cause something tomorrow that it didn't in yesterday's event? We don't, so there's a possibility of that. So that's why I was raising, you know, changing that line, that threshold of acceptance to one that would include the possibility of worse, different direction, larger events is a challenging one. Now I think if you were going to pick a building type to do something like this on though, that's the one. So, you know, I think it would be sort of pragmatic in a way if you said, okay, this is all for the good, you know, we're trying to save people's lives. We should have passed ordinance last time, now we have our chance. Okay, people are concerned more, they're more willing to do this than they were yesterday so let's do it while we can then if you're saying, well there's too much to ask to do this for all buildings so let's pick ones that we know are the ones that would get the most benefit from it. So I think if you were going to do that then this is the right one to pick.

20 Q. Well in terms of fatalities in the February earthquake, fatalities in public places were in the vast majority a result of the failure of URM buildings and part of the context with which we are grappling is that although we have legislation which is aimed to secure the seismic strengthening of buildings up to a set minimum, long periods of time have been allowed for owners to achieve that, and that might be part of the answer, that is given the question, for the kind of question that you're raising here that the occurrence of an earthquake fortuitous as the, or opportunistic as it may be from a regulatory point of view, should cause this, that and the record we have of how dangerous these buildings are to the public and to their neighbours might be policy justifications for this kind of approach. Do you care to comment on that?

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A. I, yeah I think that's a very thoughtful point, and I think that as I believe Dave Brunson mentioned that the history of this particular building type

is that you're far more likely to die or be injured from a URM building when you're outside of it than when you're inside of it. Which is very interesting. You know, I mean the people in CTV and Pyne Gould were inside. The people in the streets downtown were outside. That's not unique to Christchurch. That happens all the time in every event. The URM walls don't fall in, they fall out, so we have lots of examples of a neighbouring tall URM building wall falling outward, falling through the roof of the lower building next door and damaging it or killing somebody inside it or out on the street, you know, either way. Sideways or outward. So that's the nature of that building type. So I think one could say, well in the public interest, you know, you are the owner of a dangerous building that is not just endangering you, you know, so you get to choose I guess whether you want to put yourself at risk, but we're not going to let you choose to put other people at risk. We do that, you know, with other things I suppose in life and other laws that we pass, so to me I think that would be a good argument to use in the political process, and I think there's technical merit in it too. So that's why I was, it was a better explanation of my statement about this is the right building to top, to pick. This is one of the reasons why this is the right building to pick if you're going to pick one to do that with.

Q. Well thank you very much for the time that you've put into your presentation and for the stimulating way that you've presented it. Thanks very much.

A. It's been my pleasure.

25 **WITNESS EXCUSED**

HEARING ADJOURNS: 4.28 PM

HEARING RESUMES: 4.31 PM**MR ZARIFEH CALLS****KENNETH RONALD GLEDHILL (AFFIRMED)**

- 5 Q. Dr Gledhill can you give your full name to the Commission please?
A. Kenneth Ronald Gledhill.
Q. And I've already covered it in opening but I'll just go over your qualifications and position. You're the GeoNet Project Director and Department Head of Geo-hazards Monitoring.
- 10 A. Mhm.
Q. That's within the Natural Hazards Division of GNS Science.
A. Yes.
Q. And I think you're also currently the chair of the Intergovernmental Coordination Group on the Pacific Tsunami Warning and Mitigation System.
- 15 A. Yes.
Q. And, Dr Gledhill, you are a technical and scientific project manager, scientific instrumentation and telecommunication specialist and, of course, a seismologist.
- 20 A. Correct.
Q. And I think with something more than 30 years' experience in those fields.
A. Correct.
Q. Now you have prepared, I think, a PowerPoint presentation.
- 25 A. Yes.
Q. And I think I'm correct in saying that it essentially covers developments within GNS in relation to operation modelling and the issue of communicating particular aftershocks after a large earthquake to the public and various interested parties.
- 30 A. Yes.
Q. All right I'll hand over to you if you can take us through that thank you.

A. Okay, so before beginning I'd just like to introduce the changes that have really happened in the last decade to the amount of the data we have available to use. Then I was asked to talk about three things, the first of which is really how unusual the Christchurch earthquake was and the second two are around new ways of looking at the information or how that can help the building management and how that can be communicated so this is going to be fun, I've gone the wrong way already.

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(Instructions given on how to operate Powerpoint)

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So obviously what I'm going to talk about has a cast of thousands who have contributed and the vision of EQC in actually funding a lot of the instrumentation should be mentioned. So I just want to take you back a decade and say if these earthquakes had happened a decade ago what would we have actually had to record them and basically we only had

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one real time station in this whole region and two real time stations in the whole South Island and a number of dial up stations. So the world was quite a different place is really what I'm trying to get here and there's the comparison graphically on what it was like in 2000, for example, and what it was like in 2012. One of the things I'd like to

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mention is that because the original planning for the GeoNet programme was based on risk that there's areas of the country that aren't that well instrumented and so some of the products or the new information we'll talk about may not be as good in those areas even now if you look at the bottom of the South Island for example for the density of stations.

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Canterbury, on the other hand, oh there's one other thing I wanted to mention after the previous speaker's mention of building arrays and how it was a missed opportunity that so few building arrays were available for this series of earthquakes. In fact because it was done on a risk based basis there was only one building array fully instrumented in

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Christchurch compared with a dozen or so in Wellington, for example. So that was a perception of where the earthquakes were more likely to happen that that was based on.

In Canterbury region, because of the foresight of one of the lecturers from the University and the GeoNet programme the area is very well instrumented so a lot of things you have been hearing at these proceedings actually are informed by the fact that there were so many instruments but that was, sorry I thought I sent a new version of this that didn't do that.

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So just going on to the idea is how unusual was this sequence of earthquakes and it's really only the last point on that page that I want to bring, so there's two parts to this. How unusual is the sequence of earthquakes and how unusual is the Christchurch earthquake itself of February 22nd?

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So the sequence itself, we can look, and this is the work of Lichfield and Berryman, at a number of other sequences that have been similar starting with the New Madrid sequence in the 1800s but in that sequence there was several earthquakes that were about the same size but in a low strain rate region, so that's a region that doesn't have earthquakes very often. There's the Oamaru earthquakes of 1876 which were around about magnitude 5.7 and spread over a period of about 46 days. There's been some earthquakes in Tasmania. The other one, probably the best New Zealand example is the Buller, the Murchison, starting with the Murchison earthquake in 1929 and heading forwards from that where the, you could take that as far forward as the Inangahua earthquake which would be roughly 40 years but if you look at just the three that happened in that sequence it was more like the Canterbury earthquakes in that there was a main shock and an aftershock sequence. In Australia in '88, 1988, we had the Tennant Creek series of earthquakes, a bit more like the New Madrid earthquakes and then there's the Landers series of earthquakes in 1992 to 1999. So really what I'm saying is that they're not hugely, as a sequence it isn't hugely unusual but as a, but the Christchurch earthquake itself had quite a few unusual points to it which we've already heard quite a lot about so I don't want to spend a lot of time on

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this but the most important one is actually location. It was very close to the city. There is other factors, the kind of

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rupture it was, the directivity towards the city which I think has already been mentioned. These earthquakes, and all of the Canterbury earthquakes have this, they're high energy for their earthquake magnitude and that's an important point to remember, and that's because the rock is pretty solid and the energy has been building up for a long period of time.

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So as we go forward, so again on the how unusual is it, if you look at this plot up to February the 22nd you had a pretty classic aftershock sequence that decayed with time, it's a total number of earthquakes against time and if you smooth over the four sequences we've had the sort of productivity of the series is not that unusual, what is unusual is

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that sort of burst of activity that we have regularly, well not regularly but periodically. And this is the kind of thing that you expect, you would expect going from that range from six to 6.9 going down to five, to 5.9 to be a roughly, in order of magnitude a factor of 10 difference and again down to the four to 4.9 (inaudible 16:43:01), so what I'm saying is

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they're not that unusual as a sequence. So the really nub I think of what I was asked here to talk about is what is a, what are the new developments that GNS Science and others have been working on that will, can feed into building management after earthquakes and faster earthquake locations is one of them. There's the GeoNet Rapid system

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that is actually coming into full production as in being a public beta since March but will go into full production. There's this thing called ShakeMap which has been used in the US for quite a long time but it can give us a good idea of what the shaking levels are at various places using both instrumental information and information about the actual

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ground. And then an important one is how quickly we can actually change the, our perception or at least the hazard levels following an earthquake, a major earthquake and introduce concepts like time bearing hazard

which I think was done in the matter of several months after the February earthquake but we're working on ways to be able to do that very quickly.

5 And then there's the emphasis on how do we communicate this kind of information that's been talked about quite a lot here already? In this category and other perils we tend to have expert panels that we use to ensure the communications between the practitioners in the area. An example would be volcanology where they

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10 have scientific advisory groups for the various volcanoes, another example would be tsunami where you have expert panels. So to ensure really good communications between the scientific community and the practitioners, engineers et cetera maybe that is an idea that needs to be looked at.

15 So just going through a little bit those few new developments if you like. There's the GeoNet rapid system which uses a new earthquake location system called SeisComP3, so I've shortened it to SC3 on that diagram, whereas doing earthquake locations basically manually or at least manually reviewing what the machines do took 15 to 20 minutes. We
20 now can get the first location out in something around a minute and then often you have to refine the magnitude for a few minutes in a larger earthquake for longer, probably around about five minutes.

If we look at, for the September and the February earthquakes the visualisation that we used at the time of shaking was just to use
25 coloured squares that got bigger and changed colour around the stations themselves, we called the shaking Z, and that was on the front page of the GeoNet website and gave some indication of what the shaking level, and in fact those of us who do duty look at this and are informed by it, but what we're developing and is a better method of
30 doing that, that will give a lot more detail and can be used to go right down and give spot values for the acceleration or the shaking levels at various points. So this is an example of the Christchurch earthquake and a ShakeMap of it. This would be the kind of one that you might put

on a television or for public consumption but once you have that information, and this information is a convolution of what the instruments are telling you and what you know about the geology and soils and everything in a region, and that is worked out using the near surface
5 shear wave velocity. So it involves those two things and this particular one I'm showing here also incorporates the "felt" information where people actually report information, how they've felt it as well. So it convolves all those three together. Once you have that information you can then give maps of peak ground acceleration at those points at a
10 whole lot of contours basically, so you can actually get an idea for a particular building what it might have been subjected to, and also we can go as far as giving estimates of the spectral acceleration. I've got the example here of one second period but we can do the usual periods that people would want, be interested in for characterising what shaking
15 levels buildings have had. So this is the kind of information that could be produced relatively quickly after earthquakes, in a matter of minutes to less than an hour and they could be backed up with the kind of calculations that were done after the February earthquake which worked on working out the Z values and the like, the hazard values over a lot
20 shorter period. Now on the GeoNet website at the moment we have a map of aftershock probabilities. If you look at it at the moment it's kind of blank because for Canterbury there hasn't been many aftershocks recently and it's based on what's happened in the past basically and it's used the relatively classic aftershock sequence but that process can be

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improved to take into account the time bearing nature. So I haven't bothered to display the actual map because it's just a map of the Canterbury region but this is the sort of one year forecast if you like of aftershock probabilities for the Canterbury region.

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JUSTICE COOPER:

Q. But this table reflects the experience since –

A. Yes.

Q. – the February earthquake.

A. Correct.

Q. And it is not information of a kind that would have been available for you to tell Christchurch City about it on the 23rd of February is it?

5 A. No because it has to build up –

Q. Yes.

A. – a little over time. So it's, in a more classic aftershock sequence you would have had the, the information wouldn't have changed so dramatically but because of the nature of this aftershock sequence there was these step changes almost in the hazard.

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Q. Yes.

A. I think it's, one of the things that's important to note is that although the assumption has always been that a main shock, an aftershock won't be more damaging than an aftershock, it's all about location really. So if you have a main shock relatively close to a city then the probability is just about the area of the city compared with the area of the aftershock zone and so the probability basically goes up somewhat. If you have it in Fiordland you're in a different situation so then you're further away from the aftershocks. So I think that's all I wanted to say explicitly.

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Obviously because of the amount of data available for Christchurch, the Canterbury region now, from this series of earthquakes we're going to understand a lot more but that process takes a bit of time. What has changed if you like is how quickly we've been able to go through a process that used to take a long time and how we're working out how you can give more information a lot quicker. You have to have the data to be able to do it but you also have to have the processes in place. Before September we didn't have those processes in place.

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EXAMINATION CONTINUES: MR ZARIFEH

Q. Just perhaps one question to clarify. You talked about similar earthquakes, or similar sequences, and you gave some, those examples. Is there any way that GNS can give the probability of a sequence such as we had within Canterbury with September and then

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the February earthquake occurring before you actually have to go through the aftershocks to build up the information?

5 A. I think that in future if we're looking at those low strain rate, long return period kind of regions then what we'd seen before February we just thought the aftershocks would go on for longer but you wouldn't get this kind of sudden burst of activity every now and then. I think that if you look at the examples I presented and they're all in those low strain rate, high, long return period you'd at least flag that and use a slightly different model. You could go through New Zealand for example, and I think this is already covered in the GNS report, you could identify regions in New Zealand. There's two pre-conditions I suppose. One is that slow strain rate and the other is the strength of the earth's crust and so you'll have some areas that are quite high strain rate and high strength but they actually are in the record already because they happen quite often. Other regions are like Canterbury which is low strain rate and strong rock and areas, for example, probably most of the East Coast of the South Island could be put in that category.

10 Q. And is it fair to say that because of what happened in Canterbury with the February aftershock being stronger than the September earthquake that that's caused a rethink if you like rather than the realisation of that before it, before February?

15 A. I think if you'd looked at the aftershock sequence as it developed after September I suppose the hint was the Boxing Day earthquake but that was right in the city and that kind of explained why it was so strongly felt. I think it would have been difficult to say that we were definitely in one of those kind of sequences until you had another event, another larger event. Some of those ones that, Litchfield and Berryman brought forward as examples of similar sequences are actually more like swarms or clusters than a main shock, aftershock.

20 Q. Right so I take it from what you've said that we've got to look at it as, as you say, unusual but not unique?

25 A. Yes I think that's, that's the way I'd put it but I think in the Christchurch earthquake a few, a reasonable number of things came together to

5 make it a lot worse than it might have otherwise been. If it had happened out to the west of the Darfield earthquake we wouldn't be here probably and that was, I mean if you look at the probabilities that was a possibility. Even, even, almost all of the earthquakes in the series have been, or at least the larger ones, have been those high impact events. The Christchurch one just had a few extras thrown in.

Q. Thank you.

CROSS-EXAMINATION: MR LAING

10 Q. Just one question. You said that the Boxing Day earthquake was a hint. Was that hint communicated to anybody?

A. I think there were some special studies done on it not quite soon after. I couldn't answer that definitively, no.

QUESTIONS FROM COMMISSIONER FENWICK:

15 Q. Most of the earthquakes we record or experienced in the past have been earthquakes either on major fault lines or in the Alps.

A. Yes.

20 Q. Now I take it – or up the West Coast, sorry the, up the East Coast. Now I take it for those type of earthquakes can we sort of be pretty sure that the magnitude rule applied and that direction will be similar from aftershocks as from the main event. The magnitude rule, generally accepted, I think generally accepted aftershock is likely to be of the order of one magnitude less than the main shock –

A. Mmm.

25 Q. – and the directionality will be similar. Would that be a fair sort of assumption for sort of the 95% of the earthquakes we experience in New Zealand or not?

A. Are you asking for the East Coast of the South Island or generally?

30 Q. No I'm asking for the general area of New Zealand where we have experienced major earthquakes in the past. I'm excluding Canterbury as being something unusual.

A. Yes most sequences are that main shock, aftershock about one magnitude unit less. There's regions in New Zealand, and an example would be the Gisborne 2007 where the earthquake was in the subducting Pacific plate, and they have very few aftershocks. So there's a huge spectrum. Even in those examples that Litchfield and Berryman have put together you'll notice there was a huge range in what they actually did and I think that's kind of the cautionary tale here is that, well the cautionary message is the lot of them, there's a wide range of behaviours. In some areas we might be able to say there's this behaviour and in that – but normally we'd expect you have a main shock and then an aftershock sequence that has one or more that's about one magnitude unit less. The problem is that if you're near a city that one magnitude unit less is a higher impact earthquake.

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15 Q. Mmm higher intensity.

A. Mmm.

Q. Now the fact that our major events were more or less in a line can one draw any conclusions from that coming down from the west down the Greendale fault and then we had the faults in February and then the offshore faults and more or less travelling towards the east. Is that a general observation that occurs?

A. There certainly seemed to be a propagation of the activity to the east but if you look at what actually happened in those events, the June one was actually at right angles, you know, the break was at right angles to the February ones and then the ones offshore were different again and the December ones were not particularly high impact events for their size like the other ones have been. Quite often in an environment like the low strain rate region you do get propagation of activity but knowing where it's going to propagate is quite difficult. I don't know if I've answered your question totally.

30 Q. Well I mean the stress field, I understand, hasn't changed, its still got in the same direction. I wonder if that was an indication of one could

expect, you know, the earthquakes to more or less be in a straight line with that condition or not?

A. I'm not sure I could answer that.

5 Q. No all right that's probably chance. I just wondered whether one could draw any conclusion. The other conclusion, I wonder if you could, when the earthquake fault is close to you then would that be a warning another earthquake related to that fault, aftershock, might have a different direction of attack because it's so much closer. Is this a warning one should put out. I mean we had the predominant movement
10 in the Greendale fault at Darfield which is one direction and then the February earthquake, of course, the direction was almost at right angles to it but that was presumably due to the close location of the Port Hills fault or faults was it? I mean is this something one should warn assessors in future if it's a local earthquake watch out the next
15 aftershocks may come at a different direction. I'm trying to think in terms of how one might warn people doing assessments.

A. That's quite difficult. What we've seen in these larger earthquakes is actually quite complex like the September earthquake was actually three
20 or four fault breaks folded into one and what we saw in February was a break very close to where there'd been an aftershock quite soon after the September event and then having the June one at right angles to the February one it's very complex. I don't know if you can generalise easily enough to say that you'll definitely get it different. What I'd tend to think is if you get a large earthquake near a city you have to assume
25 there's a reasonable probability that one of the aftershocks could do damage within the city.

Q. So perhaps it's just adequate to add the warning to structural engineers if it's a distant earthquake you can expect it to have a similar directionality.

30 A. Mmm.

Q. But if it's a local earthquake watch out there'll be a difference, there could be a major difference in the direction about it.

A. Mmm.

Q. And that's probably enough to issue a warning but I think it's important that that warning, if it's a true one or likely to be, is given to structural engineers so they know when they're assessing buildings look out for weaknesses in the other direction. It's not just adequate that that building withstood the first earthquake another earthquake of a similar or even lesser magnitude may be more critical because of the directionality and that's what I'm trying to get at. Is there anything that one can draw those conclusions from what we've been through or what might be.

A. Right, I'm not sure I can put my hand on my heart and say that you've really, that that's really the case. I think there's a problem with most

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earthquakes don't actually occur on known faults. So we know about the Alpine fault. We know about the really big fault systems but New Zealand, because it's been in the plate boundary region for a very long time, is broken up with faults all over the place and I don't think it's very easy to take one earthquake and say what will happen locally.

QUESTIONS FROM COMMISSIONER CARTER:

Q. The question has particular interest for us because it's pretty apparent that many of, if not most of, the inspecting engineers didn't seem to consider that the next shake could be in a different, completely different direction. So any information that could relate to what an inspecting engineer might keep in mind when they're making an assessment is important.

A. Right.

Q. And it seemed to have been overlooked to quite a considerable degree in these events and I think what Commissioner Fenwick is trying to find, if there's something that the scientists could indicate for this sort of earthquake sequence that the possibility that the direction of the shaking might change quite considerably between the first earthquake and then subsequent aftershocks. So anything that was available from these other sequences that might show that that's unlikely or show that that is

possible or has happened in other cases would be useful information for us to receive.

5 A. Yeah I find it difficult to generalise in that whereas most of the energy in the Darfield earthquake, the September earthquake, went into a big strike-slip fault that then basically caused a huge perturbation in the stress field in this whole region then that had to be relaxed and it could be relaxed in many different ways and the fact that in February you had an earthquake that was predominantly a thrusting up towards the central business district I would have thought would have been extremely hard to pick in advance and so I'm not sure that apart from being able to say that because the September earthquake happened relatively close to a city there's a higher probability of getting aftershocks, of almost any orientation, close to the city exists, I don't think we can actually pin down what the mechanism will be.

10 Q. No and that's very helpful to just get to that point. It's not unhelpful to say we don't know because if that's just a warning to actually be prepared for anything and I think that's perhaps a message that we might need to have in mind in the future because there was an assumption of directionality I think –

20 A. Okay.

Q. – implicit in the way the engineers reported on the damage that they'd observed and the possibility that the next earthquake would be less damaging to the building but the building itself was far weaker in one direction than another possibility so a different strength of earthquake might still be a more damaging event than is appreciated. That's sort of what we're trying to get out heads around if you can understand.

25 A. Yes I can see that.

Q. Thank you.

QUESTIONS FROM COMMISSIONER FENWICK:

30 Q. Can I call on your hindsight now. The hindsight was, and I remember a slight alarm coming up with the Boxing Day earthquake, this is a

potential fault, it might be a forerunner but what about the very nasty little earthquake on the 8th of September.

A. Mmm.

5 Q. And I know it was nasty because it was almost, very close to where I live which caused far more damage to the local buildings than did the 4th of September earthquake. Now in hindsight could one have seen that as being a warning that the fault or the faults involved with the February the 22nd earthquake, the Port Hills fault, could that have been seen, I say in hindsight that that might have been a sort of warning that
10 we might expect something in a different area?

A. Certainly in –

Q. Sorry that was a 5.1 earthquake so it's quite a lot bigger than the one in the central city.

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15 A. Yes the one on the Wednesday after September. Yes, I mean in hindsight, yes, and if you look at, I think the acceleration, the level of acceleration is at the Women's Hospital one of the strong motion instruments, was actually quite a lot higher because it was a smaller earthquake, it had more high frequencies in it, so it had a different
20 characteristic obviously to a more distant, but yes that was in hindsight, but at the time the thought was that that's just an aftershock, it just happens to be very close to where there was recording instruments and infrastructure rather than, that that was telling us anything about the total sequence and I think that's the previous presenter, talked about the
25 assumption that the aftershocks are always going to be less damaging than the main shock and I think that is an example, that that's just not true basically. It's where we live that, or where the earthquakes are compared with where we live and work that is the issue.

30 Q. If the same sort of earthquake occurred again would that still be a hindsight or do you think that might be a foresight to watch out for a potential (inaudible 17:11:22), sorry that's an impossible task, impossible question isn't it?

- A. It is, certainly we were being, we were not being encouraged to talk a lot about the level of aftershock activity that might go on at the time and I don't believe we were proactive enough after September in actually putting the information that we knew out there compared with what we
5 got a lot more traction after February because everybody then could see what could happen than we did before then. I don't know if I'm actually saying anything anybody doesn't already know.
- Q. Thank you very much.

FURTHER QUESTIONS FROM COMMISSIONER CARTER – NIL

10 QUESTIONS FROM JUSTICE COOPER:

- Q. We have heard from many engineers about the assumption, the fundamental assumption that if the building had survived the September earthquake then aftershocks are likely to be a magnitude lower therefore the building has survived the first event, it is likely to be able to
15 survive the aftershocks. Now, I appreciate of course nobody can expect GNS to foretell what is going to happen but I wonder whether and this is a hindsight question too, where you have a damaging earthquake situated quite close to a major urban centre, the situation is that on the current state of knowledge if what has ruptured is a fault that was
20 previously unknown so we are not talking about one of the major faults which are recognised, an aftershock is likely to be one magnitude less that has been the experience of the sequence, but better watch out because the energy dissipated may come from a different direction, the earthquake may be much closer to the surface and it may be much
25 closer to town?
- A. Mmm.
- Q. Consequently thought processes which are based on the idea you survive one earthquake, you will survive the aftershock, cannot be seriously maintained. Now do you agree with that?
- 30 A. I think the reason some of these ideas get out there is that we tend to concentrate on magnitude too much.

Q. Yes.

A. And not on potential impacts and I think that's the paradigm shift that has to be made at some stage to actually start thinking about what the impacts are. The magnitude, a magnitude 8 earthquake in Fiordland, well

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we had a 7.8 in 2009, did surprisingly little damage anywhere, but a 6.2 near Christchurch did considerable damage and so we get tied up with magnitude and not potential impact. So all of our information needs to be couched in terms of potential impact particularly when we're dealing with places where people live and work.

10

Q. And that's one of the lessons of this series of earthquakes isn't it?

A. Yes and so I think the, the kind of things like the Shaking Maps that can be provided in GIS form and give a better idea of what the impacts will be rather than a single number which can never fully characterise an event are probably the better option. The problem is that we in the western world at least have had fixed in our brain that the magnitude as being an important thing and that's what is always asked and it is a single number so it's easy for the media and others to use.

15

20 Q. Now you said after September you weren't being encouraged to speak about earthquake risks. What do you mean by that?

A. I think you've put me on the spot slightly here because –

Q. I have and I'm sorry about that. We're all on the spot here actually.

A. I think as a community, and I'm talking about New Zealand in general now, we're almost celebrating the fact we had a major earthquake near a city and no loss of life and very few injuries and maybe we just weren't in the state of mind to actually consider that other things could be on the way. I don't think I could point, point fingers at anybody in particular. I just think that we weren't in the state of mind to actually consider what could happen.

25

30

Q. Well it's a fair answer but I was going to ask you whether from your point of view having regard to the role that GNS is uniquely able to play after a serious earthquake whether your position, whether the

organisation would be better able to perform its function were it actually given a specific statutory role to give appropriate advice to councils and others involved where there has been a declaration of state of emergency after a significant earthquake because my impression has been, and you correct me I'm wrong, that your, GNS's involvement is dependent on others asking you to perform?

5

A. Again a difficult question. I don't know if statutory requirements would really change that much. I think that, I mean if you're, I don't think you're talking about liability issues because I mean they are –

10

Q. No.

A. – are usually covered off by doing a good job hopefully. I'm not –

1720

Q. Well I suppose, you may not be able to answer this, I don't know what your involvement was after September but is there any institutional feeling of which you are aware within GNS that they might have given advice if asked different questions?

15

A. No I don't really think so. I think that, as I said, I didn't think we were proactive enough at pushing information out but that was because we hadn't really been in that situation before rather than any reluctance to do so. I know that some organisations approached us and were given what we knew at the time and all the data that we base our assessment on is freely available so others could also give the same advice.

20

Q. But working –

A. I think it was really tied up more with not really having been in that situation before for a very long time and that's the problem with these low probability high impact events is that we were all in that boat I think.

25

Q. We, apart from your presence here, for which we're grateful, I don't think we've, we haven't got any input from GNS other than what we've asked for, for which we've been very grateful. So is there nothing the institution wants to say to us about how things could be done better in the post-earthquake situation to manage the building stock or improve public perceptions and understanding of risk.

30

A. I think you have submission from Terry Webb for this session.

Q. Did we?

A. Yeah.

Q. And that is?

5 A. I haven't been deeply involved before so there is the report that was done as well which maybe you asked for, I don't know.

Q. Yes we, the GNS report we've procured two but I was just asking if there was anything you wanted to add from an institutional perspective.

A. I think it's slightly outside the brief where I came here.

Q. All right no that's all right. Yes thank you, you may go now.

10 A. Thank you.

HEARING ADJOURNS: 5.24 PM

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