Under **THE COMMISSIONS OF INQUIRY ACT 1908**

In the matter of the **CANTERBURY EARTHQUAKES ROYAL COMMISSION OF INQUIRY INTO THE COLLAPSE OF THE CTV BUILDING**

OPENING ADDRESS FOR ALAN REAY CONSULTANTS LIMITED AND DR REAY

Dated 11 July 2012

BUDDLE FINDLAY
Barristers and Solicitors
Christchurch

Solicitor Acting: **Willie Palmer / Kelly Paterson**
Email: kelly.paterson@buddlefindlay.com
Tel 64-3-379 1747 Fax 64-3-379 5659 PO Box 322 DX WP20307 Christchurch 8140

Counsel Acting: **H B Rennie QC**
Harbour Chambers Tel 64-4-4992684 Fax 64-4-4992705 PO Box 10242 Wellington

MAY IT PLEASE THE COMMISSIONERS:

1. Alan Reay Consultants Limited ("**ARCL**") and Dr Alan Reay have been granted status as affected parties before the Royal Commission.

2. Dr Reay was the founding director of ARCL in 1988, remains on its board and works as one of its engineers.

3. Before 1988 Dr Reay maintained a professional practice as Alan M Reay, Consulting Engineer ("**ARCE**").

4. In 1986, that firm undertook the structural design for a building project which was ultimately built and became the CTV Building. The staff engineer who was responsible for that work moved to other employment in 1988.

5. In 1988 ARCL was incorporated as the successor to Dr Reay's professional practice. Dr Reay was the initial principal. In 1990-91 (by which time the CTV building had been constructed), ARCL was asked to consider the adequacy of the design in relation to the connection of the floor slabs at the northern shear wall. This was investigated, and uncertainty as to the extent of that connection (as constructed) led to the installation of additional connection by drag bars.[1]

6. ARCL and Dr Reay had no further involvement with the building.

7. The catastrophic collapse of the CTV building, and the deaths and injuries which were caused, shocked and distressed Dr Reay and all who work with him in ARCL. His feelings are insignificant compared to the impact on those who died, those who lived, and their families. But they are nonetheless very real, and retain their impact every day. No adequate words exist to convey his feelings for their loss.

8. Dr Reay and ARCL have organised their representation in this hearing in order to best know the truth as to what caused the collapse of the building. So do many others. Engineers do not design buildings to fall down. The Code to which they are designed sets the criteria that engineers, over time, have established to limit and direct how individual designs are developed,

[1] In his Opening [at 111, TRANS.20120625.OS and at .61] Mr Mills QC referred to legal advice being obtained by ARCL in 1991. That advice was obtained by ARCL's insurer under its rights of subrogation at the insurer's cost. ARCL is not able to disclose that advice. There has otherwise been full disclosure, and ARCL did not meet the repair costs.

and it is against that code that the consenting authorities review each design. Engineers design the structure buildings which meet their clients' needs (and respond to their wishes and the work of architects and others); but in doing so must work within and respond to the requirements of that Code. This imposes safe practice on structural design – the Code is not the minimum standard but the required standard.

9. The first (and continuing) response of Dr Reay and ARCL has been to investigate and so understand what happened. As will be shown in evidence, their intention of doing this in co-operation with other investigators was rebuffed (in particular by the Department of Building and Housing ("**DBH**")). This rebuff is contrary to long-established professional principles, and (rightly or wrongly) was seen as an implied accusation and with degrees of pre-judgment.

10. The consequence has been that ARCL and Dr Reay were left to attempt their own parallel investigation, with such information as they could obtain. Only at the start of December 2011 was the draft Building Collapse Report provided, with a short time period for response. They believe that despite their response, they had no meaningful input into that Report.

11. On 9 February 2012, the DBH publically released a report which included "conclusions" on the cause of the collapse of the CTV Building. These conclusions made by the report writers were not part of their terms of reference [BUI.MAD249.0189.69]. The expert panel held a wider range of views. It was inappropriate for the DBH to claim certainty before this Royal Commission considered the CTV Building under terms of reference which are more extensive, and with much greater information.

12. ARCL and Dr Reay determined to complete the research and investigation they had undertaken (for which experts had been engaged and key investigations also initiated), and present it to this Royal Commission.

13. Every effort has been made to complete that work to a high forensic standard, independently, and with no pre-determined outcome. A particular focus has been to put the issues in the hands of independent experts and be guided by them. Where that process leads is a matter for the Royal Commission to determine in its findings.

14. From the perspective of ARCL and Dr Reay, the design work should be assessed based on the information available and the practices adopted in at the time of the design, and not with perfect hindsight vision.

An outline history for the CTV collapse

1986 Building designed: it is now seen to have issues as to code compliance on some points but was typical of its time, was consented and, in respect of those issues, probably not different to many others. Its intended use was as an office building and later uses (television, education, health services) were not contemplated.

1986-7 Building constructed: It is likely to have had less reinforcing (particularly in beam to column joints) than the design specified. The builder was a reputable construction firm of its time (re-established by its management during construction).

1990 HCG engaged to report on the building as part of due diligence for the Canterbury Regional Council who considered occupying it: HCG doubted that the slab floors were sufficiently tied to the north shear wall – it was never finally determined whether the specified reinforcing was in place. The Regional Council did not take up occupancy.

1991 A new owner acquired the building: They were informed by ARCL (not HCG) of the issue of slab to shear wall connection. Drag bars were installed on some floors. This work was designed to be code compliant at the time, and probably was (but in accordance with common practice of the time was not separately consented). The focus was on achieving the planned tie, not on any overall review of the structure, which was reasonable given that the HCG structural review had been done.

1991-2010 Building left to "look after itself" with minimal review or maintenance:

(a) Initially occupied by the ANZ.

(b) From 1995 to 2000, holes may have been drilled through beam reinforcing and the floors.

(c) It is now known that in 1998 or 1999 Mr Mitchell of Opus (who did many peer reviews of structures on CCC's instructions) did a desk-top review. He concluded that the building would be vulnerable to a moderate earthquake, but closed the file and did not pass on this information. In contrast Mr Tyndall, perhaps four years before, did not find any signs of damage.

(d) In 2000 CTV moved in and installed a staircase from level 1 to level 2 next to the south shear wall. This modified the junction of the level 2 floor slab to the south beams at that point.

(e) In the 2000s there were two changes of use for language schools (one consented, one not) and, later on, a medical centre. Consent was sought for the Going Places tenancy in 2001 (Level 3). It does not seem that loadings, or building structural design, were appropriately considered as part of the consenting process. In principle, a school increases the loading requirement from 250kpm to 300kpm, and this requires an engineer's review but none appears to have been done in either case. From the fact of the Opus review, it is reasonable to predict that, if it had been done, some further investigation of the structure is likely to have been triggered. No consent was sought for the Kings Education tenancy (Level 4) or (if required, which depends on whether the detail of its use meant it was a “health facility”) the medical clinic (Level 5).

2010 A series of events begins, triggered by the 4 September 2010 M7.1 Darfield earthquake:

(a) 4 September earthquake - the building survived a design level quake and was visually intact. The actual structural damage may have been greater than was visible - we will now never know.

(b) 5 September – Level 1 Rapid inspection. The team included a CPEng engineer.

(c) 7 September – Level 2 Rapid inspection by 3 CCC inspectors, wrongly understood by many connected with the

building to have been an inspection by 3 engineers. It was green stickered. The start of the twin myths "green sticker means good to go" and "the engineers have checked the building".

(d) 29 September to 19 October - Mr Coatsworth reviewed the building in some detail, with a quantity surveyor, and recommended repair work including epoxy injection to cracks. His work proposal offered an initial structural review, but later in the offer stated that his work would not be a structural review and he did not perform a structural analysis. In consequence there was no review of the structural plans, no interpretation of seismic records and no calculations were done. His report reinforces the erroneous belief of both owner and occupants that the building had undergone structural review by engineers, and passed.

(e) However at this stage Mr Coatsworth may have been right to conclude that the building was repairable for the damage it was known to have. The uncertainty is whether that damage was more severe and unseen.

(f) November to December - Demolition was undertaken on the neighbouring property to the west. The effects of the removal of the old building, including the excavation of foundations along the west wall (after which the building movement became greater) and the vibrations from the wrecking ball may have been an alert to hidden weaknesses but it is doubtful that it caused any actual damage.

(g) From 4 September onwards, many aftershocks occurred. The ground acceleration effect on the CTV building varied considerably. An aftershock on Boxing Day caused building occupants to believe that the building had sustained new and worrying damage. Certainly there were observations of visible change – an increasingly sloping “hump” on Level 4 (Godkin), slope on desks (Aydon, Brehaut), it goes "out of square" (Reynish). Beams and columns are visibly damaged (e.g. the Level 6 Higgins evidence). The level 1 stairwell

starts to "jump around" (Jackson).

(h) However, a second green sticker was assigned by the Council on 27 December 2011.

(i) Post Boxing Day 2010/2011. The building manager, Mr Drew, took no action (stating to the level 6 manager Mrs Vivian that an engineer has checked the building).

2011 Continuation of events triggered by 4 September 2010 earthquake:

(a) January - the medical clinic on Level 5 was added. The owner's position is that the building may look damaged but is safe as engineers have said so. Staff were uneasy.

(b) In January and February 2011 Mr Drew slowly got around to organising quotes for the recommended repairs but not many were started. Histime-frame may have been related to the owners and insurers. Mr Coatsworth was not brought back.

(c) The visible damage was now more extensive, motion of the building had increased (one witness speaks of sea-sickness from the motion), and noise from building movement was reported.

22 February 2011 Under a fresh, severe aftershock, near-field, with vertical uplift assessed at almost twice the force assumed in the code, the building collapsed over a period of about half a minute, In this sudden and disastrous collapse 115 people lost their lives.

Summary of ARCL evidence

Dr Alan Reay

15. Dr Reay has submitted three statements of evidence.

16. In his first statement Dr Reay provides factual evidence in relation to the design of the CTV Building and the 1991 retrofit works. Dr Reay's evidence will be that he was not principally involved in the design of the project. It was a project undertaken by Mr David Harding, an experienced engineer

who had joined the practice with an interest in undertaking such work. Mr Harding was considered capable and was prepared to undertake the work. Dr Reay would have ensured that appropriate resources were available to assist Mr Harding. Dr Reay confirms that Mr Harding, a registered engineer, was appropriately qualified and experienced for the project.[2] Dr Reay does not recall having anything to do with the Council permit process or with the construction.

17. Dr Reay outlines the history of the addition of drag bars to the building in 1991. This potential issue was brought to his attention by Holmes Consulting Group who had carried out a review for a potential purchaser of the building. Mr Geoff Banks from ARCL handled the matter at ARCL and Dr Reay was not directly responsible for resolving it. ARCL was unable to verify whether adequate reinforcing had been added during construction. As required by its professional cover, it notified its insurers. Some time passed, and ARCL then noted from *The Press* that the building had been sold. ARCL notified the new owners of the potential issue. Mr Banks prepared construction drawings for the remedial works and the works were carried out by CBD Construction Limited. Mr Banks' calculations showed that the drag bars were necessary at Levels 4, 5 and 6 only. The building owners met the cost of the remedial works, which was around $5,000.

18. In his first statement Dr Reay also covers some background to the DBH reports released in February 2012 and references ARCL's comments on the draft reports.

19. In his second statement of evidence Dr Reay provides expert opinion on a number of issues relevant to the collapse including:

    (a) The design of the Landsborough House building which has been raised in evidence by other witnesses. Landsborough House was designed by John Henry while he was with ARCE. Dr Reay outlines the similarities and differences between that building and the CTV building. There is some evidence that the drawings and calculations for Landsborough House may have been given to Mr Harding at the time he started design of the CTV building, and influenced his decisions.

[2] Reference was made in opening by Counsel Assisting to issues of "supervision" arising. While Mr Harding was in a legal sense an employee, he had substantial experience in his earlier positions as an engineer and could have practiced on his own account as an engineering principal. He was not junior staff recruited to be trained under detailed supervision.

(b) The DBH report. Dr Reay outlines a number of areas where he rejects matters in the DBH report. These include:

(i) The computer analyses that have been conducted by the authors of the DBH report. Dr Reay proposes other analyses that ought to have been conducted including a scale physical model on a shake table.

(ii) Concrete. Dr Reay is critical of the concrete strength utilised by the authors of the DBH report in conducting their analyses and refers to the concrete testing commissioned by ARCL.

(iii) Geotechnical report. Dr Reay notes that no advice was sought from the original geotechnical engineer who prepared the site report in 1986 (Ian McCahon), particularly with respect to the likely soil stiffness properties that would have been recommended at the time of design. Dr Reay produces this advice from Ian McCahon. He also refers to another ARCL witness (Dr Brendan Bradley) who reports on the results from a seismic recording device placed on the CTV site by ARCL.

(iv) Dr Reay comments on the DBH report's references to construction tolerances in relation to the installation of spandrel panels with either limited or no gap between the end of the panel and the concrete column. Dr Reay considers that it is unlikely construction was completed in this manner and produces photographs from another building constructed by Williams Construction showing good alignment of the spandrel panels.

(v) Destruction of evidence. Dr Reay is critical of the authors of the DBH report for making no attempt to retain the sections of the remaining shear wall and floor elements that were intact after the collapse, in breach of good forensic practice.

(c) Dr Reay was asked by the Royal Commission to express an opinion on the compliance of the CTV building with the code of the day. In his statement, Dr Reay notes that it is not possible to definitively state whether the building complied as there is no certainty about the documentation issued to the building contractor. However he notes that after the addition of drag bars in 1991 and based on the 1990

report by Holmes Consulting Group, it is his opinion that the building complied after the completion of those works.

(d) Dr Reay then expresses a view on scenarios that have not been adequately considered in relation to the collapse of the building. These issues are:

(i) Reinforcing strain hardening. Dr Reay comments on this phenomenon which has been discovered in a number of buildings around Christchurch including the IRD Building. It involves the concrete reinforcing being strained to the point of being stretched beyond repair, resulting in an irretrievable loss of capacity to the building.

(ii) Vertical accelerations. Dr Reay believes that the effects of very high vertical accelerations have not been adequately accounted for in the collapse analysis to date.

(iii) South wall lateral load resistance. Dr Reay comments that the lateral load resistance of the southern wall has not been adequately considered. Vertical accelerations affect the gravity restoring force provided by the gravity loading of the floor.

(iv) Building modifications. Dr Reay comments on the evidence of Daniel Morris in relation to holes drilled in the building during the 1990s for the installation of cabling and ducting, including through some of the reinforcing. He also comments on the installation of an internal staircase between levels 1 and 2 of the building in 2000. Dr Reay notes that both of these issues have not been adequately considered by other experts.

(v) Finally Dr Reay discusses the possibility of cumulative damage to the building as a result of ongoing aftershocks between September 2010 and February 2011 and produces a schedule listing all such major aftershocks. This evidence is also dealt with by other ARCL witnesses.

20. Finally, Dr Reay produces time records from ARCE from the time of CTV Building project which identifies the number of hours worked by various staff members on the job. The time records are that Dr Reay recorded 3.5 hours for the job. Mr Harding spent 304 hours.

21. In his third statement of evidence, Dr Reay responds to evidence given by some other witnesses. Primarily he focuses on the evidence of Mr John Henry.

22. Dr Reay's evidence will be presented in a number of stages. This week, his evidence on collapse considerations will be given. Later in the hearing, Dr Reay will be heard on the topics of code compliance, design and drag bars.

Professor Robin Shepherd

23. Professor Shepherd is a consulting engineer who divides his time between Tauranga and California, USA. Professor Shepherd specialises in earthquake analyses and this is the focus of his consultancy business. Professor Shepherd has been engaged as an expert to advise on a number of issues relevant to the issues before the Commission:

    (a) Forensic engineering practice: Professor Shepherd outlines standard practice for carrying out a forensic engineering investigation into structural failures. Professor Shepherd is critical of the authors of the DBH report for failing to properly examine and preserve the remains of the building for proper examination.

    (b) Evolution of seismic design standards: Professor Shepherd comments generally on the development of earthquake investigation practices including strong ground motion measuring instruments and the contribution to earthquake investigations. Over the years there has been an increasing recognition of the need to provide for earthquake resistant designs in design standards.

    (c) Cumulative earthquake damage: Professor Shepherd comments on the effect of successive earthquakes and aftershocks on structures. He notes that the ongoing practice of repairing cracked reinforced concrete structures by injecting epoxy resin into cracks attempts to reinstate the strength and stiffness of the building and, in doing so, recognises the fact of cumulative damage. Professor Shepherd expresses the view that the CTV Building may well have been damaged more seriously in the September 2010 earthquake than was appreciated immediately following the event.

    (d) Seismic excitation at the CTV Building site: Professor Shepherd expresses the view that a recording instrument ought to have been placed at the CTV Building site promptly after the earthquake on 22

February 2011. Records obtained from the several subsequent significant aftershocks would have provided evidence regarding the unique properties of that site. In the absence of any records from the CTV Building site the actual vertical acceleration experienced by the CTV Building can only be a matter of conjecture but Professor Shepherd notes that it was clearly enough to apply loads significantly in excess of those typically anticipated in code requirements.

(e) Dynamic analyses: Professor Shepherd comments on the developing use of digital computers over the last half century and their use to predict the response of structures to earthquakes. Professor Shepherd comments on the analyses conducted in the DBH report and expresses the view that the computer analyses appear to have been conducted with a view to proving a certain hypothesis rather than investigating all collapse possibilities without prejudice.

24. Professor Shepherd's evidence will be presented this week in the context of collapse considerations.

Dr Brendan Bradley

25. Dr Bradley is a lecturer at the University of Canterbury and also has an independent seismic engineering consultancy practice. Dr Bradley will give expert evidence on two key issues:

(a) An analysis of ground motion aspect of the Canterbury earthquakes; and

(b) A statistical analysis of the concrete test data presented in the DBH report.

26. Dr Bradley's seismic report will be presented this week in relation to the collapse considerations. Dr Bradley analyses the case for utilising the four strong motion stations near the CTV site (CCC – Christchurch Cathedral College, REHS – Christchurch Resthaven, CHHC – Christchurch Hospital and CBGS – Christchurch Botanical Gardens). Seismic analysts use readings from these and other sites to assess the likely seismicity at any given place. In the analyses carried out for the DBH the REHS site readings were disregarded. The justification for this related to the ground conditions at the REHS site. Dr Bradley disagrees and notes that the readings from the REHS site were consistently higher than the readings from the other three sites taken into account.

27. Dr Bradley's opinion is that all four strong motion stations near the CTV site are appropriate for use in analyses. This conclusion feeds into analyses being carried out by other experts. It appears to now be accepted by other experts, notably Mr Sinclair.

28. Dr Bradley also comments on the readings from the instrument deployed by ARCL at the CTV at March 2012. Importantly, Dr Bradley concludes that the general response at the CTV site is consistent with those at the other four CBD stations.

29. The second part of Dr Bradley's evidence will be presented later in the concrete section. Using his expertise as a statistical engineering specialist Dr Bradley has analysed the concrete column test data presented in the DBH report. Dr Bradley reviews the correlation between different types of strength tests, the statistical distribution of the results and then adopts recognised analysis methods to reach conclusions. Dr Bradley concludes that there is no credible evidence to suggest that the observed concrete strengths are lower than the specified concrete strengths in the construction contract. Dr Bradley also presents two figures which analyse the results of the strength tests commissioned by ARCL. The graphs (attachment C to Dr Bradley's statement) demonstrate the higher observed distribution of concrete strengths in the tests carried out by CTL Thompson.

Professor John Mander

30. Professor Mander is a New Zealand citizen who is currently a Professor at Texas A & M University in USA. His evidence is presented as a formal submission, which he will speak to and in the academic sense "defend".

31. Professor Mander provides a critique of the DBH report. He also analyses and discusses results of new work done since the completion of the DBH report. Finally, Professor Mander presents an alternative hypothesis and three scenarios for the collapse.

32. Among the points made by Professor Mander about the DBH report are the following:

    (a) The DBH report essentially neglects the effect of the earlier (pre 22 February 2012) earthquakes on the structure of the CTV Building. In his opinion it is evident that the structure must have sustained hidden damage in earlier earthquakes and ought to have been red-stickered.

(b) The DBH conclusion that exceptionally high vertical ground motions helped lead to the demise of the building is supported by him as correct, but he considers the authors essentially neglect the effect of earlier earthquakes. It is contended that the exceptionally high vertical ground motions were a primary contributor to triggering the CTV Building's failure and subsequent collapse.

(c) Although the columns of the building did not have substantial transverse reinforcing, this was in his opinion neither a problem nor a cause of failure within the CTV Building. Dr Bradley's analyses show there is no statistical significance in the claim that the columns had a lower concrete strength than specified. The claim in the DBH report that the concrete had low strength in the critical columns is rejected as erroneous.

(d) The interaction of the perimeter columns with the spandrel panels on the building may have been a contributing factor in the final demise of the structure but was neither the trigger nor the cause of the collapse.

(e) Separation of the floor slabs from the north core is problematic but it should be recognised that the structure survived the design level Darfield earthquake and many aftershocks without collapse.

(f) The DBH report has overstated the impact of the asymmetry of the shear wall layout.

33. Professor Mander then discusses supplementary investigation work conducted on the CTV Building by ARCL. He reports on Dr Bradley's findings in respect of the seismic readings and repeats that it was inappropriate to remove the REHS recording station from the analyses and that it should remain. Professor Mander presents the results of the strong motion device at the CTV site.

34. Professor Mander comments on the concrete testing results and makes recommendations as to the strength to be used for future computational analyses. Professor Mander also comments on the testing of full columns carried out under his instruction at the University of Canterbury. Professor Mander is to provide further comment on the results of this testing, which will be presented later in the hearing in the concrete section.

35. Professor Mander presents and discusses an exemplar structure used as part of the educational process at the University of Canterbury known as

the "Red Book Building". This is a conceptual building designed according to current codes in all respects. Professor Mander's presents analyses which show that even the Red Book Building could have collapsed in the 22 February earthquake. Thus he reports that even modern buildings constructed to text book standards may not necessarily have survived the Christchurch earthquakes.

36. Finally, Professor Mander presents an alternative collapse scenario. His hypothesis takes into account the exceptionally high vertical accelerations and their effect on the load bearing elements of the building. Professor Mander puts forward three general failure modes:

(a) A four storey double bending buckling failure starting on column 1B leading to the E-W collapse failure mode;

(b) A northerly motion induced collapse failure mode;

(c) A southerly motion induced collapse failure mode.

37. What is common to all three failure modes is that they require the same class of buckled columns over the lower four storeys. The lower four storeys were able to buckle due to the relative movement of the floors with respect to the shear wall system. In his assessment, the relative movement necessary to achieve this need not have been large. Professor Mander concludes that the collapse is primarily caused by the substantial increase in axial loads on the columns due to the exceptionally high vertical accelerations.

38. A second statement of evidence by Professor Mander further expresses his views on the effect of the 4 September 2010 earthquake and other earthquakes on the CTV Building prior to the 22 February 2011 earthquake that resulted in its collapse. This is in the light of additional information. He develops his earlier evidence on the issue of low cycle fatigue. Professor Mander concludes that prior to the 22 February earthquake, and most certainly during the course of it, the CTV Building was exposed to cyclic demands considerably greater than what would be expected at the time the structure was designed in the 1980s. He considers that after the 4 September earthquake and immediate aftershocks, all concerned should have beensuspicious about the state of the building. In his opinion such suspicions could only be allayed by the performance of a structural analysis with reference to the building plans, seismic and other information.

39. The majority of Professor Mander's evidence will be presented this week with the other ARCL collapse evidence. He will also appear later in the hearing in the concrete section.

Douglas Haavik

40. Douglas Haavik resides in California, USA. He is a consultant engineer specialising in concrete and concrete materials. As an expert he will advise on concrete issues and will appear in person in week 7 of the hearing.

41. Mr Haavik is critical of aspects of the DBH report concrete testing. He quotes and supports sections of the report by Mr James MacKechnie who has also been critical of aspects of the DBH concrete testing. Criticisms of the DBH testing include:

    (a) Poor test sample selection, including small core diameter samples and horizontal sampling;

    (b) Poor recording of core strength testing;

    (c) Tenuous correlations being made between core strength tests and Schmidt Hammer strength results;

    (d) No microscopic examination of core sections.

42. Mr Haavik engaged the services of other experts to assist with aspects of the concrete analysis, and reports on the outcome of this work carried out by him with those inputs. The cores were sampled under Mr Haavik's instruction by ARCL employees in March 2012. The core samples were dispatched to USA and a series of tests were carried out.

43. The cores were tested by Olsen Engineering, using an Ultrasonic Pulse Velocity (UPV) instrument to determine pulse velocity over the length and diameter of each core tested. The results were typical of concrete considered to be of sound condition.

44. At CTL Thompson, Orville (Bud) Werner carried out compressive strength tests. The results indicate that all cores tested were above the 25MPa specified strength requirement for columns at level 3 and above. The results were consistently higher than the DBH results.

45. The petrographic examination was conducted by Dr Rothstein at DRP Consulting Inc. Petrography involves assessment of thin sections from

concrete cores examined under very powerful microscopes. The eight cores examined were relatively uniform and the cement and aggregates were similar. A close analysis of the samples showed that the contractor performed a proper job of handling and placing the concrete. Minimal microcracking was observed. There was no evidence of fire damage in the samples tested.

46. Mr Haavik concludes that a wider scale testing should be conducted but the results of the tests and examinations carried out showed that there is no reason to believe that there was a systematic reduction in concrete strength supplied to the project.

Arthur Tyndall

47. The Commission has already heard the evidence of Arthur Tyndall. Mr Tyndall is a senior semi-retired structural engineer (aged 78). He is appropriately qualified and experienced.

48. Mr Tyndall reported in his evidence that he inspected the CTV Building for earthquake damage following an Arthurs Pass earthquake of magnitude 6.7 in June 1994. He reported some cracking in the block work in the entry foyer suggesting that the building had experienced some twisting in the earthquake. However, he could find no other evidence that the building had twisted. Mr Tyndall noted that he looked at the western block wall and was impressed with the design engineer's efforts to reduce the stiffness in that wall and he also noticed the detailing and workmanship of the western wall was of a high quality. Overall, he concluded that the building had not been damaged in such a way that materially changed its structural integrity.

Alan Edge

49. Alan Edge is a director of Southern Demolition and Salvage Limited. His evidence has also been heard already. Mr Edge attended the CTV Building site approximately two hours after the earthquake on 22 February 2011 with staff and equipment to assist with the recovery operation.

50. The purpose of Mr Edge's evidence was to provide eye witness evidence of the timing and location of the fire which broke out on the site, covering around one-third of the building footprint and lasting for a number of days. It was fought with water, including by monsoon bucket. The impact of fire and water may affect the quality of the concrete that was sampled from the site.

Daniel Morris

51. Mr Morris' evidence was presented last week. Mr Morris previously owned a concrete cutting business. In the mid to late 1990s his company was engaged to drill a number of holes in concrete beams in the CTV Building for the purposes of installing cabling and air-conditioning. The holes ranged in size from 40mm to 100mm. Sometimes his staff would hit reinforcing but were told by the head contractor to keep drilling. Mr Morris states that the drilling was extensive and the holes were all over the place on all floors. Mr Morris estimated that employees of his company drilled between 100 and 200 holes.

52. He was unable to be specific about timing or number and has no records to corroborate his recollection. The events occurred years ago and Mr Morris sold his business a short time after. He volunteered the evidence (initially to DBH) because he thought it may be relevant to the Commission's inquiry. Its relevance is as much to the absence of building owner intervention and prior engineering review of such work, as it is to any impact on the CTV structure.

Douglas Latham

53. Mr Latham is a structural engineer at ARCL. Mr Latham's evidence relates to the core sampling of columns carried out at the Burwood landfill and dispatching the samples to the USA. This evidence is “chain of custody” evidence and it is proposed may be taken as read without Mr Latham having to appear.

54. Mr Latham is also part of an expert panel reviewing the ERSA analyses carried out by the DBH. It is possible that further evidence will come out of this when that work is complete. If so it is proposed this will be presented in a later stage of the hearing (probably in the code compliance section).

Paul Smith

55. Paul Smith is a senior draughtsman employed by ARCL. He first started working for ARCL in November 1987. He is now a director and shareholder of ARCL.There has been other evidence presented on the working environment at ARCL in the late 1980s. Mr Smith provides his experience. He states that Dr Reay was primarily involved in client contact, seeking projects and managing those relationships. Dr Reay’s involvement in projects was when a particular issue arose requiring his expertise. In

general the structural design for a project was assigned to a qualified structural engineer, who carried out the project and supervised draughting staff assigned to it.

Chris Urmson

56. Mr Urmson is another structural engineer at ARCL. His evidence covers the collection of column samples from the Burwood landfill and delivery to Canterbury University for testing. Mr Urmson's evidence is also "chain of custody" evidence and it is proposed may be taken as read.

Concluding remarks

57. The Commission's work is likely to result in the best possible understanding of the causes of the building's collapse and contribute to ensuring that New Zealand is in the future safer in all its buildings.

58. ARCL and Dr Reay are committed to this process. The evidence we will call should not be assessed on whether it is “favourable” to ARCL and Dr Reay. Our single aim is to put forward such matters as will, taken with the other evidence, ensure that all facts and all issues are before the Royal Commission.

Dated this 11th day of July 2012

HB Rennie QC

WJ Palmer

KM Paterson

Counsel for ARCL