



Christchurch City Council

Warren Park Community Building

PRK 1567 BLDG 003

Detailed Engineering Evaluation

Quantitative Engineering Report





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Quantitative Engineering Report

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Summary

Warren Park Community Building
PRK 1567 BLDG 003

Detailed Engineering Evaluation
Quantitative Report - Summary
Final

Background

This is a summary of the quantitative report for the Warren Park Community Building, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 16 August 2012, measured-up sketch drawings and calculations.

Key Damage Observed

No major damage was identified. No signs of foundation movement or liquefaction were noted.

Critical Structural Weaknesses

The corner column was identified as a critical structural weakness. Although it is not part of the main lateral load system, it does support a portion of the roof and is below the minimum requirement under current standards.

Indicative Building Strength

Based on the information available, and from undertaking a quantitative assessment, the building's seismic capacity has been assessed to be 67%NBS in the transverse direction as limited by the in-plane capacity of the walls and 70%NBS in the longitudinal direction as limited by the out-of-plane capacity of the walls (including the wing wall).

It is therefore classed as low earthquake risk under the NZSEE classification system, however the corner column detail increases this to moderate risk as it supports a part of the lightweight roof and does not meet the minimum requirements of the current standard with only 1 bar instead of the 4 currently recommended.

Recommendations

We recommend that the following be undertaken:

- a) Corner column be retrofit to improve its capacity to that required as a minimum under the current standard for resilience.

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1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Warren Park Community Building, located in Hornby, 29 Oakley Crescent, following the M6.3 Christchurch earthquake on 22 February 2011.

The purpose of the assessment is to determine if the building is classed as being earthquake prone in accordance with the Building Act 2004.

The seismic assessment and reporting have been undertaken based on the quantitative procedures detailed in the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011.

2 Compliance

This section contains a brief summary of the requirements of the various statutes and authorities that control activities in relation to buildings in Christchurch at present.

2.1 Canterbury Earthquake Recovery Authority (CERA)

CERA was established on 28 March 2011 to take control of the recovery of Christchurch using powers established by the Canterbury Earthquake Recovery Act enacted on 18 April 2011. This act gives the Chief Executive Officer of CERA wide powers in relation to building safety, demolition and repair. Two relevant sections are:

Section 38 – Works

This section outlines a process in which the chief executive can give notice that a building is to be demolished and if the owner does not carry out the demolition, the chief executive can commission the demolition and recover the costs from the owner or by placing a charge on the owners' land.

Section 51 – Requiring Structural Survey

This section enables the chief executive to require a building owner, insurer or mortgagee to carry out a full structural survey before the building is re-occupied.

We understand that CERA require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). CERA have adopted the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011. This document sets out a methodology for both initial qualitative and detailed quantitative assessments.

It is anticipated that a number of factors, including the following, will determine the extent of evaluation and strengthening level required:

1. The importance level and occupancy of the building.

2. The placard status and amount of damage.
3. The age and structural type of the building.
4. Consideration of any critical structural weaknesses.

Christchurch City Council requires any building with a capacity of less than 34% of New Building Standard (including consideration of critical structural weaknesses) to be strengthened to a target of 67% as required under the CCC Earthquake Prone Building Policy.

2.2 Building Act

Several sections of the Building Act are relevant when considering structural requirements:

Section 112 - Alterations

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to the alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

The Earthquake Prone Building policy for the territorial authority shall apply as outlined in Section 2.3 of this report.

Section 115 – Change of Use

This section requires that the territorial authority is satisfied that the building with a new use complies with the relevant sections of the Building Code ‘as near as is reasonably practicable’.

This is typically interpreted by territorial authorities as being 67% of the strength of an equivalent new building or as near as practicable. This is also the minimum level recommended by the New Zealand Society for Earthquake Engineering (NZSEE).

Section 121 – Dangerous Buildings

This section was extended by the Canterbury Earthquake (Building Act) Order 2010, and defines a building as dangerous if:

1. In the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
2. In the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
3. There is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a ‘moderate earthquake’ (refer to Section 122 below); or
4. There is a risk that other property could collapse or otherwise cause injury or death; or

5. A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone (EPB) if its ultimate capacity would be exceeded in a ‘moderate earthquake’ and it would be likely to collapse causing injury or death, or damage to other property.

A moderate earthquake is defined by the building regulations as one that would generate loads 33% of those used to design an equivalent new building.

Section 124 – Powers of Territorial Authorities

This section gives the territorial authority the power to require strengthening work within specified timeframes or to close and prevent occupancy to any building defined as dangerous or earthquake prone.

Section 131 – Earthquake Prone Building Policy

This section requires the territorial authority to adopt a specific policy for earthquake prone, dangerous and insanitary buildings.

2.3 Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in 2006. This policy was amended immediately following the Darfield Earthquake on 4 September 2010.

The 2010 amendment includes the following:

1. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
2. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
3. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
4. Repair works for buildings damaged by earthquakes will be required to comply with the above.

The council has stated their willingness to consider retrofit proposals on a case by case basis, considering the economic impact of such a retrofit.

If strengthening works are undertaken, a building consent will be required. A requirement of the consent will require upgrade of the building to comply ‘as near as is reasonably practicable’ with:

- The accessibility requirements of the Building Code.

- The fire requirements of the Building Code. This is likely to require a fire report to be submitted with the building consent application.

Where an application for a change of use of a building is made to Council, the building will be required to be strengthened to 67% of New Building Standard or as near as is reasonably practicable.

2.4 Building Code

The Building Code outlines performance standards for buildings and the Building Act requires that all new buildings comply with this code. Compliance Documents published by The Department of Building and Housing can be used to demonstrate compliance with the Building Code.

On 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

- increase in the basic seismic design load for the Canterbury earthquake region (Z factor increased to 0.3 equating to an increase of 36 – 47% depending on location within the region);
- Increased serviceability requirements.

2.5 Institution of Professional Engineers New Zealand (IPENZ) Code of Ethics

One of the core ethical values of professional engineers in New Zealand is the protection of life and safeguarding of people. The IPENZ Code of Ethics requires that:

Members shall recognise the need to protect life and to safeguard people, and in their engineering activities shall act to address this need.

- 1.1 *Giving Priority to the safety and well-being of the community and having regard to this principle in assessing obligations to clients, employers and colleagues.*
- 1.2 *Ensuring that responsible steps are taken to minimise the risk of loss of life, injury or suffering which may result from your engineering activities, either directly or indirectly.*

All recommendations on building occupancy and access must be made with these fundamental obligations in mind.

3 Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The loadings are in accordance with the current earthquake loading standard NZS1170.5 [1].

A generally accepted classification of earthquake risk for existing buildings in terms of %NBS that has been proposed by the NZSEE 2006 [2] is presented in Figure 1 below.

Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance	
					Legal Requirement	NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended		Not recommended. Acceptable only in exceptional circumstances
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement required under Act)	Unacceptable	Unacceptable

Figure 1: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines

Table 1 below compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year).

Table 1: %NBS compared to relative risk of failure

Percentage of New Building Standard (%NBS)	Relative Risk (Approximate)
>100	<1 time
80-100	1-2 times
67-80	2-5 times
33-67	5-10 times
20-33	10-25 times
<20	>25 times

3.1 Minimum and Recommended Standards

Based on governing policy and recent observations, Opus makes the following general recommendations:

3.1.1 Occupancy

The Canterbury Earthquake Order¹ in Council 16 September 2010, modified the meaning of “dangerous building” to include buildings that were identified as being EPB’s. As a result of this, we would expect such a building would be issued with a Section 124 notice, by the Territorial Authority, or CERA acting on their behalf, once they are made aware of our assessment. Based on information received from CERA to date and from the DBH guidance document dated 12 June 2012 [6], this notice is likely to prohibit occupancy of the building (or parts thereof), until its seismic capacity is improved to the point that it is no longer considered an EPB.

3.1.2 Cordoning

Where there is an overhead falling hazard, or potential collapse hazard of the building, the areas of concern should be cordoned off in accordance with current CERA/territorial authority guidelines.

3.1.3 Strengthening

Industry guidelines (NZSEE 2006 [2]) strongly recommend that every effort be made to achieve improvement to at least 67%NBS. A strengthening solution to anything less than 67%NBS would not provide an adequate reduction to the level of risk.

It should be noted that full compliance with the current building code requires building strength of 100%NBS.

3.1.4 Our Ethical Obligation

In accordance with the IPENZ code of ethics, we have a duty of care to the public. This obligation requires us to identify and inform CERA of potentially dangerous buildings; this would include earthquake prone buildings.

¹ This Order only applies to buildings within the Christchurch City, Selwyn District and Waimakariri District Councils authority

4 Building Description

4.1 General

The Warren Park Community Building is a single storey concrete block and timber structure with lightweight roofing and significant window openings on two elevations. The foundation consists of a slab on grade, likely with shallow footings beneath the walls (no details available).

The building is approximately 7.1m long by 3.9m wide in the transverse direction, with an attached external wingwall/windbreak. The building is a single room referee shed.

The building age is unknown, but it is expected to have been built around the 1970s.

4.2 Gravity Load Resisting System

The roof consists of lightweight corrugated iron sheeting on timber rafters spanning between the blockwalls.

4.3 Seismic Load Resisting System

The seismic loads are predominantly from the walls themselves and are resisted by the walls acting both in-plane and out of plane due to the apparent lack of horizontal reinforcing steel. There is no specific diagonal bracing or lining on the roofing to transfer out of plane wall loads into the perpendicular walls.

5 Survey

At the time of inspection the building did not have a placard.

Copies of the following drawings were referred to as part of the assessment:

- Measured-up sketches of the building completed by Opus International Consultants, titled “Warren Park Changing Room and Scoring Box, Existing Plan and Section”.

No copies of the design calculations nor structural drawings have been obtained for this building. A cover meter was used to identify the presence of any reinforcement.

The sketch drawings and survey photos have been used to confirm the structural systems, investigate potential critical structural weaknesses (CSW) wherever possible, and identify details which required particular attention.

6 Damage Assessment

The building structure does not appear to have suffered major damage as a result of the recent earthquake events.

7 General Observations

Overall the building has performed well under seismic conditions which would be expected for a single storey, reasonably regular structure. The building has sustained little damage and other buildings in the immediate area appeared to have only minor damage.

8 Detailed Seismic Assessment

8.1 Critical Structural Weaknesses

As outlined in the Critical Structural Weakness and Collapse Hazards draft briefing document, issued by the Structural Engineering Society (SESOC) on 7 May 2011, the term ‘Critical Structural Weakness’ (CSW) refers to a component of a building that could contribute to increased levels of damage or cause premature collapse of the building.

The corner column has been identified as a critical structural weakness due to its support of the roof load in the corner and its reinforcement and dimensions less than minimum recommended. The current configuration is 190mm square with 1 approximately 10mm bar and the current minimum requires 240mm square with 4 bars.

8.2 Seismic Coefficient Parameters

The seismic design parameters based on current design requirements from NZS1170.5:2004 and the NZBC clause B1 for this building are:

- Site soil class D, clause 3.1.3 NZS 1170.5:2004;
- Site hazard factor, $Z=0.3$, B1/VM1 clause 2.2.14B;
- Return period factor $R_u = 1.0$ from Table 3.5, NZS 1170.5:2004, for an Importance Level 2 structure with a 50 year design life;
- $\mu_{max} = 1.25$ for wall bracing elements due to partially filled cells with vertical reinforcing only.

8.3 Detailed Seismic Assessment Results

A summary of the structural performance of the building is shown in the following table.

Table 2: Summary of Seismic Performance

Structural Element/System	Failure mode and description of limiting criteria	% NBS based on calculated capacity
Walls in the transverse direction	Bracing capacity of wall across the building	67%
Walls in the longitudinal direction	Bracing capacity of wall across the building	100%
Walls out of plane	Out of plane bending	70%

8.4 Discussion of Results

The building has a calculated capacity of 67%NBS in the transverse direction as limited by the in-plane capacity of the walls and 70%NBS in the longitudinal direction as limited by the out-of-plane capacity of the walls (including the wing wall).

As the building has a capacity of 67%NBS it is defined as low earthquake risk building under the NZSEE classification system. The corner column supports a portion of the roof load and currently has only a quarter of the number of bars required under the current minimum requirements. If the wall capacity is exceeded this column is not expected to perform in a ductile or resilient manner. Minor strengthening work is recommended for the building to improve the load paths between the walls and improve out of plane capacity of the walls.

8.5 Limitations and Assumptions in Results

The observed level of damage suffered by the building was deemed low enough to not affect the capacity. Therefore the analysis and assessment of the building was based on it being in an undamaged state. There may have been damage to the building that was unable to be observed during assessments that could cause the capacity to be reduced; therefore the current capacity of the building may be lower than that stated.

The results have been reported as a %NBS and the stated value is that obtained from our analysis and assessment. Despite the use of best national and international practice in this analysis and assessment, this value contains uncertainty due to the many assumptions and simplifications which are made during the assessment. These include:

- Simplifications made in the analysis, including boundary conditions such as foundation fixity;
- Assessments of material strengths based on limited drawings, specifications and site inspections;
- The normal variation in material properties which change from batch to batch;

- Approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.

9 Geotechnical Summary

A geotechnical assessment has not been carried out as there was no observed ground damage at or adjacent to the site.

10 Conclusions and Recommendations

Based on the information available, and from undertaking a quantitative assessment, the building's seismic capacity has been assessed to be 67%NBS in the transverse direction as limited by the in-plane capacity of the walls.

It is therefore classed as low earthquake risk under the NZSEE classification system, however the corner column detail increases this to moderate risk as it supports a part of the lightweight roof and does not meet the minimum requirements of the current standard with only 1 bar instead of the 4 currently recommended.

We recommend that the following repairs and remedial works be undertaken:

- (a) Corner column be retrofit to improve its capacity to that required as a minimum under the current standard for resilience.

11 Limitations

- (a) This report is based on an inspection of the structure with a focus on the damage sustained from the 22 February 2011 Canterbury Earthquake and aftershocks only. Some non-structural damage is mentioned but this is not intended to be a comprehensive list of non-structural items.
- (b) Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at the time.
- (c) This report is prepared for the CCC to assist with assessing remedial works required for council buildings and facilities. It is not intended for any other party or purpose.

12 References

- [1] NZS 1170.5: 2004, *Structural design actions, Part 5 Earthquake actions*, Standards New Zealand.
- [2] NZSEE: 2006, *Assessment and improvement of the structural performance of buildings in earthquakes*, New Zealand Society for Earthquake Engineering.
- [3] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure*, Draft Prepared by the Engineering Advisory Group, Revision 5, 19 July 2011.
- [4] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Non-residential buildings, Part 3 Technical Guidance*, Draft Prepared by the Engineering Advisory Group, 13 December 2011.
- [5] SESOC, *Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes*, Structural Engineering Society of New Zealand, 21 December 2011.

Appendix A – Photographs

Warren Park Community Building – Detailed Engineering Evaluation



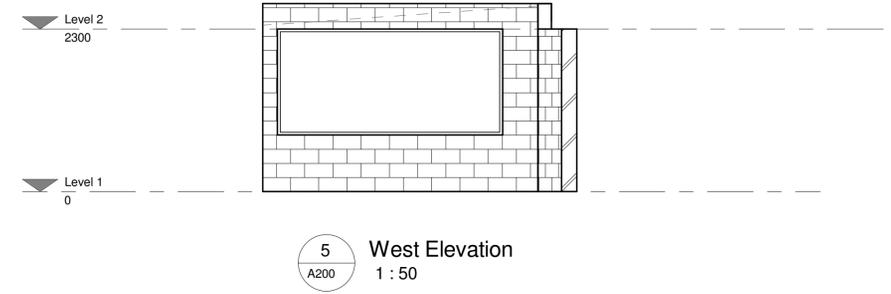
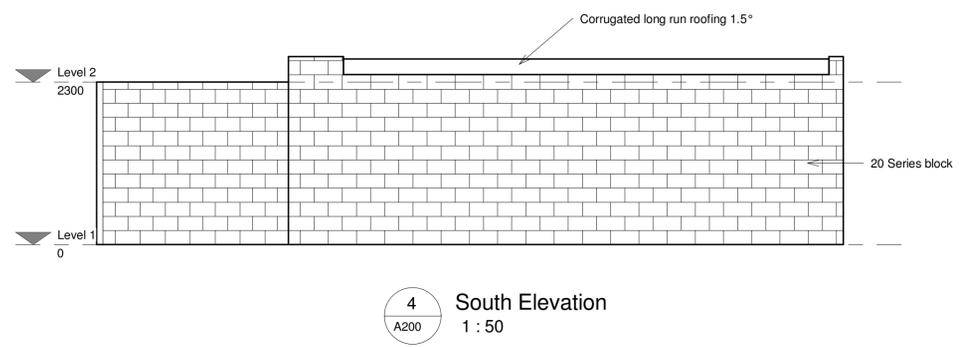
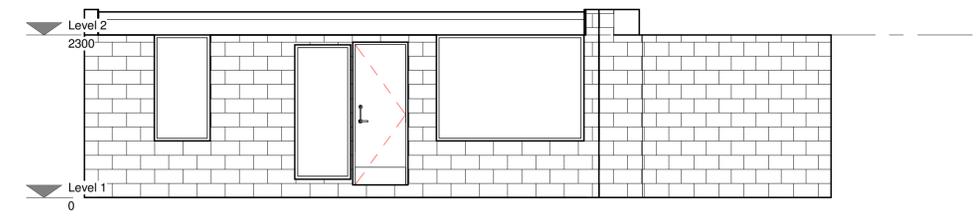
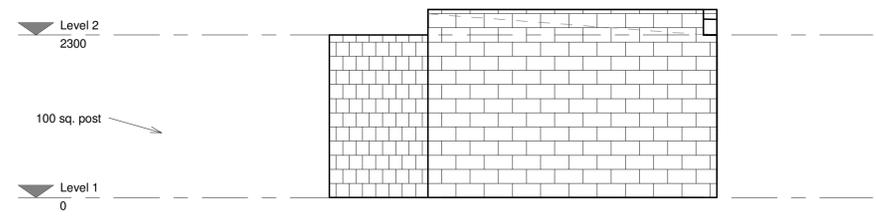
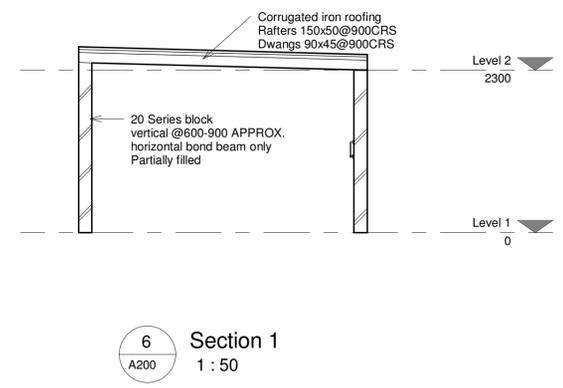
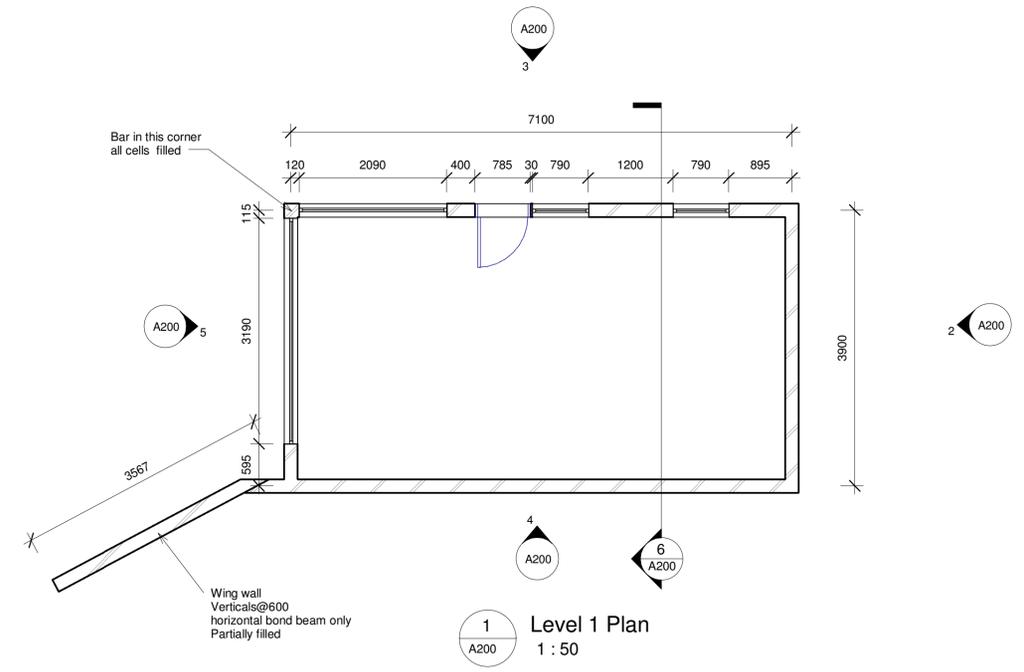
Photo 1: View of the building (right)



Photo 2: View of eastern wall

Appendix B – Measure-up Sketches

300mm
200mm
100
50
10mm
0



Draft

Revision	Amendment	Approved	Revision Date

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Project
CCC
Warren Park
Referees Rooms (15SC)
Title
Existing Floor Plan, Elevations, Section.

Drawn	Designed	Approved	Revision Date
Author	Designer	Approver	

Project No. 6-QUCC1.92
Scale 1 : 50

Drawing No. 6/1366/292/8602
Sheet No. A200
Revision RA

Appendix C – CERA DEE Data Sheet



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