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Fire Engineering

49 Stoneleigh Drive, Rolleston - Expert Opinion

Prepared for Ministry of Business, Innovation and Employment (Client)

Prepared by Beca Ltd (Beca)

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Revision History

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1	**Martin Wong**	Final Report Issued	05/07/2018
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Document Acceptance

Action	Name	Signed	Date
Prepared by	**Martin Wong**		19/07/2018
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Approved by	**Daryn Glasgow**		19/07/2018
on behalf of			

Contents

Executive Summary

- The Ministry of Business, Innovation and Employment (MBIE) engaged Beca Limited (Beca) to provide an expert opinion on the fire engineering design methodology of the existing building at 49 Stoneleigh Drive Rolleston, Canterbury.
- The instruction from MBIE to Beca is that although this Warehouse was newly built in 2015, the consent did not include construction of racking or raised platform (which were later moved from the existing building in Hornby), hence the building is to be assessed as a "new building" under Section 17 of the New Zealand Building Act 2004 and not to Section 112.
- MBIE have requested an assessment of the gaps between the proposed design compared with the NZ Building Code. The site visit and desktop assessment has observed and highlighted the following gaps to the Acceptable Solutions:
  - The mezzanine floor well exceeds the maximum floor area limit of 35m^2. The building is considered as a warehouse with storage higher than 3m.
  - The mezzanine floor construction and its supports do not achieve the minimum required fire resistance rating of 30/30/30 and 30/-/- FRR respectively.
  - Exit signage was deficient due to the racking system.
- The building, as currently constructed with the internal racking fitout, does not comply with NZBC C1-C6.
- Beca reviewed the FEB prepared by Enlightened Solutions as an alternative solution and concluded the following:
  - The use of an equivalency method with C/AS5 for the racking platform is not sufficient to show compliance with NZBC.
  - The inherent fire resistance of the flooring and supporting system using AS 1720.4 is not considered adequate to comply with NZBC.
  - Lack of demonstrating compliance for smoke control within the warehouse caused by the extended mezzanine.
  - Lack of demonstrating compliance with firefighting access and operations.
- It is in our Opinion that:
  - The alternative solution approach based on the FEB will not lead to a compliant building with the NZ Building Code C1-C6.
  - Additional quantitative fire engineering analysis would be required in support of demonstrating compliance.

Disclaimer

1 This is an independent report prepared for the Ministry of Business, Innovation and Employment (MBIE) by an Assessor contracted by the Chief Executive of the MBIE to provide specific information on buildings as part of the Determination process described in The Building Act 2004 section 187.

2 On completion, this report is to be provided to the MBIE official who requested the report on behalf of the Chief Executive of the MBIE. Drafts or copies of the report are not to be provided to any other person except as directed by the MBIE.

3 The investigation for this report was carried out to provide information required by the MBIE. It is based on the following:

- Base build fire safety report by TM Consultants
- Fire Engineering Brief prepared by Enlightened Solutions

- Correspondence with Building Consent Authority and Fire and Emergency NZ
- Observations from a site walkthrough conducted on 18th May 2018

4 Documents referred to in the preparation of this report were provided by the MBIE, as follows:

- MBIE task brief received by email dated 11 May 2018
- Base build fire safety report by TM Consultants
- Fire Engineering Brief prepared by Enlightened Solutions

5 The report is provided for the use of the MBIE only. No other party should rely on its findings and no liability to any third parties is accepted.

1 Introduction

The Ministry of Business, Innovation and Employment (MBIE) engaged Beca Ltd (Beca) to carry out an assessment for the fire safety compliance of the existing warehouse storage building at 49 Stoneleigh Road, Rolleston in the Selwyn District in Canterbury.

The instruction from MBIE to Beca is that although the Warehouse was newly built in 2015, its consent did not include the construction of racking or raised platform which were moved from an existing building in Hornby. Hence the building, with the fitout, is to be assessed as a "new building" under Section 17 of the New Zealand Building Act 2004 and not to Section 112.

MBIE have requested an "*expert opinion on the compliance of the fire safety design proposed by Enlightened Solutions taking account of any relevant technical comments made by FENZ*". We have completed a review of the proposed fire safety design methodology for the building as "a new building" and not "alterations to an existing building".

Our opinion identifies the "*gaps, if any, between what is now proposed (by Enlightened Solutions FEB) and what should be provided to satisfy the NZ Building Code for a new building"* when using the Compliance Documents C/AS5 and C/AS2 November 2017.

The report concludes Beca's opinion on the proposed compliance methodology.

2 Scope of Service

2.1 Basis of Beca's Assessment

The basis of this assessment is the information received from MBIE together with information collected from a site walkthrough carried out by Fadi Jirjees on 18th May 2018. The information received includes:

- Drawings for proposed new warehouse and offices by Graton Holdings Ltd dated April 2015.
- Drawings for proposed racking by Forbes and Davies dated August 2016
- Protection from Fire Design Report for Graton Holdings Warehouse, 49 Stoneleigh Drive, Rolleston by TM Consultants dated 26th January 2015, Issue A.
- Fire Engineering Brief for New Platform in existing Warehouse at 49 Stoneleigh Drive, Rolleston by Enlightened Solutions Revision 0 dated 10th October 2016

2.2 Relevant Regulatory Framework

Compliance Methodology

This method for assessing the compliance with NZBC is as follows:

- Acceptable Solution C/AS5 - Acceptable Solution for Buildings used for Business, Commercial and Low Level Storage (Risk Group WB).
- Acceptable Solution C/AS2 - Acceptable Solution for Buildings used for Sleeping (Risk Group SM).

3 Principle Building Characteristics

3.1 General

The existing building is located on Lot 650 DP 468876 on the corner of Stoneleigh Drive and Hannover Drive. The building consists of a 928m^2 warehouse storage space with 110m^2 of associated office space. The office area also includes a self-contained bedroom for overnight accommodation. The building is purposed for rack storage occupancy and has a roof apex of 7.9m high.

The building is constructed of steel portal frames lined with precast concrete tilt panels at low level to most of its exterior and topped with profiled steel sheet cladding up to roof level. The south-side boundary wall is a boundary wall and consists of a 150mm thick precast concrete panel. Floor plan and elevation are shown below.

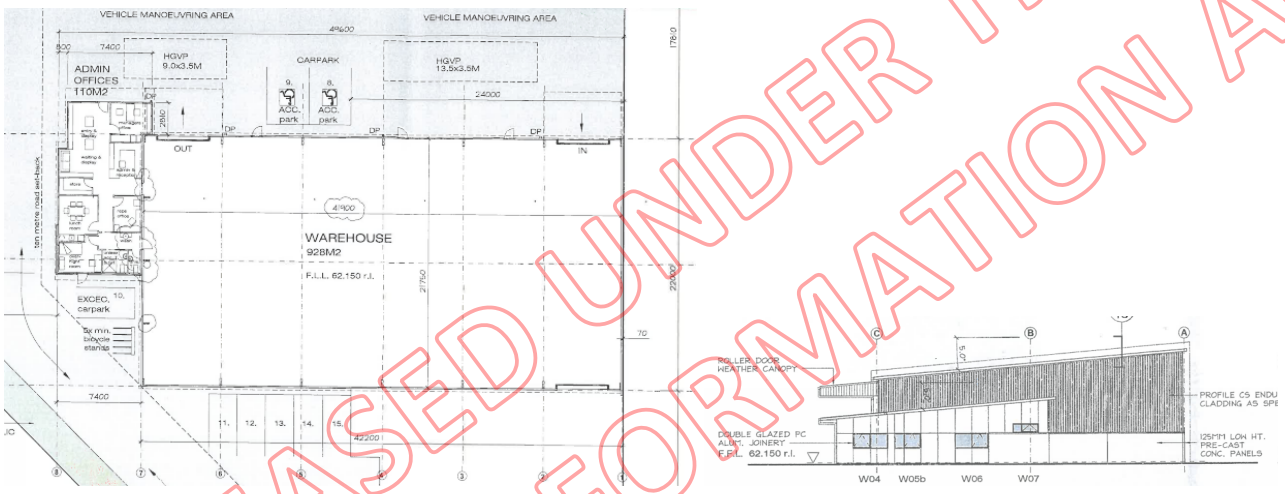

Figure 1 - Floor Plan & Elevation

The warehouse contains a racking system which has two levels. The top level, also referred to here as mezzanine or platform, is served by two open stairs one at each end. The floor area for the mezzanine is some 452m^2.

The mezzanine is structurally supported to the light-weight racking system and comprises of 100 x 50mm one-way span timber joists topped with particleboard flooring. The mezzanine is approximately 2.2m high measured to its underside. See picture below.

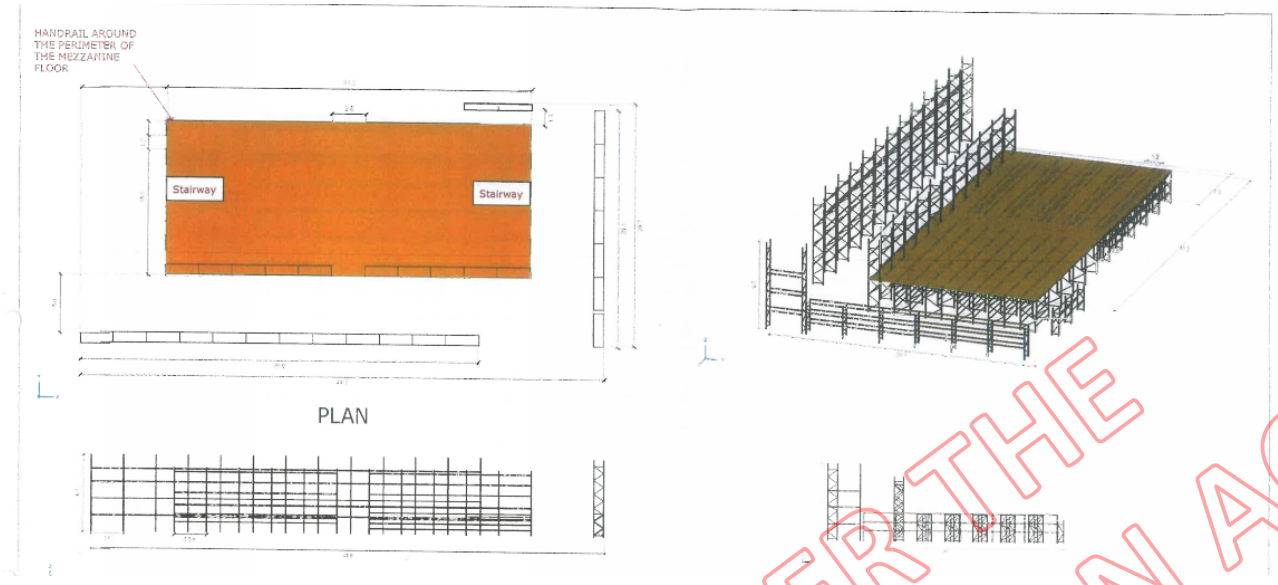

Figure 2 - Racking System

3.2 Occupancy and Occupant Load

3.2.1 Occupant load

The occupant load calculation below is based on Table 3.1 of C/AS5 as follows:

Table 3-1: Occupant Load

Area	Floor Area (m^2)	Occupant Density (m^2/person)	Design Occupant Load (persons)
Warehouse Storage	928	100	9
Racking Storage	452	100	5
Offices	110	10	11
Sleeping Area	-	1 bed	1
		Total	**26**

3.3 Occupant Characteristics

The warehouse is securely accessed so only staff are permitted into the building. Visitors are permitted only through invitation and will be accompanied by staff.

All occupants are considered mobile and capable of self-evacuation without assistance. All staff are considered familiar with the building. For this assessment, the following was assumed:

- Staff and maintenance contractors are considered awake, alert and familiar with the building.
- Members of the public (visitors) are considered awake and unfamiliar with the building but always accompanied by staff who are familiar with the escape routes.
- Sleeping occupants are assumed to be familiar with the space and able to self-evacuate

3.4 Fire Safety Systems

The base-build fire design prepared by TM Consultants considers storage height to over 5.0m and requires the following fire safety precautions be provided for the building:

- Type 3 automatic heat detection system throughout all areas with manual call points complying with NZS 4512:2010.
- Type 1 smoke alarm within the sleeping accommodation.
- Shutdown of the air handling system on smoke detection (Type 9)
- Internally illuminated exit signage to F8 of the Building Code.
- Emergency lighting to F6 of the Building Code.

The site visit could not fully confirm the coverage of these systems however a fire alarm system and emergency lighting were noted in the building.

In the event of a fire alarm activation, all occupants are intended to evacuate the building simultaneously, a "one-out all-out" evacuation strategy. The building has multiple direct escape points to the outside. The sleeping room has its own direct escape to the outside.

3.5 Internal Fire Separations

The fire separations of the building proposed in the original fire report include the following:

- Internal fire separation of 60/60/60 FRR for the sleeping accommodation. This includes a certified fire door of -/60/30 Sm FRR.
- External boundary firewall of 180/180/180 FRR.

These fire ratings could not be fully confirmed from the site walkthrough but were assumed to have been provided as the building was granted a code compliance certificate for its base build.

4 Compliance with Acceptable Solutions

This section briefly assesses the building's compliance with the Acceptable Solutions C/AS5 and C/AS2 as the means to demonstrate compliance with NZ Building Code.

4.1 Fire Safety Systems

For a building with less than 4m escape height, less than 8m apex height and floor area of less than 4200m^2 the following fire safety systems are required by paragraph 2.2.1 C/AS5. The mezzanine's escape height is 2.2m only and the building's apex height is less than 8m high, therefore fits within the constraints of C/AS5.

- Type 3 – Automatic fire alarm system with heat detection and manual call points. A direct connection to the Fire Service is not required where a phone is available.
- Type 18 – Fire hydrant system unless the Fire Service hose run is less than 75m to any point on the floor.

For firecells within 15m of a relevant boundaries, their floor areas need to not exceed 5000m^2, Paragraph 2.1.1 C/AS5. The building has a total floor area of 1038m^2 and can therefore form one firecell.

C/AS2 has no requirement for fire alarm as escape from the sleeping area is direct to the outside however a Type 1 system is required.

The building currently has a Type 3 fire alarm system with Type 1 in the sleeping area. This achieves the minimum requirements, however the coverage of the fire alarm could not be determined.

A Fire Service hose run of 75m would allow access from any point on the platform to a parking place at the main entrance.

Emergency lighting is to be provided in the building according to NZBC F6 at all areas with travel greater than 20m. Extent of emergency lighting could not be confirmed on site. Both these systems were observed in the building during our site walkthrough. Their full level of compliance could not be determined during our site walkthrough.

According to paragraph 2.3.1 of C/AS5 the fire resistance ratings required for this building is as follows:

- Life Rating 60 minutes FRR
- Property Rating 180 minutes FRR as storage is greater than 3m.

4.2 Means of Escape from Fire

The warehouse is provided with three final exits on the east elevation. The office and sleeping spaces are each provided with its own final exit to the outside. Each area is provided with at least two escape routes, either direct to outside or through another space in the building to outside. This meets the requirements of Paragraph 3.2.1 C/AS5 and C/AS2.

The minimum escape route height of 2100mm is provided throughout the building. This satisfies Paragraph 3.3.1 C/AS5.

All escape routes achieve the minimum escape route widths required by paragraph 3.3.2 C/AS5. All doors have widths in excess of the minimum of 760mm required by Paragraph 3.15.5 C/AS5.

The widths between storage racks is 1000mm or greater. The stairs to the mezzanine floor are 1000mm wide. The required escape width is therefore provided as these are non-accessible areas.

Single-side handrails are provided to both stairs which complies with the requirement of paragraph 3.3.3 C/AS5.

The maximum travel distance shall be single direction of 35m and total open path of 75m with a Type 3 fire alarm system according to paragraph 3.4.1.

The maximum dead end open path is 6m for the lunchroom. Travel along an open platform needs to be extended by 1.5 times according to paragraph 3.4.3 C/AS5. The actual travel distance is 29m on the mezzanine, 5m down the stairs and then 8m to the exit. With an increase of 1.5 times the distance on the mezzanine the total open path length is 57m. The maximum travel distances are therefore met.

For the sleeping area, escape routes need to terminate at a final exit or horizontal safe path in accordance with paragraph 3.9.6 C/AS2. This is provided for the overnight accommodation with a final exit direct to the outside.

All escape doors are hinged on one side and self-closing according to paragraph 3.15.1 C/AS5. All escape doors can open in either direction as there are not more than 50 people according to Paragraph 3.15.3.

Exit signage is required throughout the building as required by Paragraph 3.16.1 C/AS5. Some illuminated signs are provided in the building. More directional signage in between the racks to identify escape paths.

4.3 Control of Internal Fire & Smoke Spread

The structural stability of fire rated building elements shall be achieved according to paragraph 4.3.1 C/AS5. It could not be confirmed on site whether the support elements to the external wall on the boundary achieve the required fire resistance rating.

Sleeping areas shall be separated from non-sleeping areas as required by paragraph 4.6.1 C/AS2. The sleeping accommodation shall be enclosed with life rating of 60 minutes FRR. A fire rating of 60/60/60 FRR is provided to the overnight accommodation as required. The door into the sleeping room is a certified fire door of -/60/30 Sm FRR.

Per paragraph 4.13.4 C/AS5, the mezzanine "platform" and the two stairs are to be rated to 30 minutes FRR. The existing floor system is a particleboard flooring on light steel frame system and does not provide the required fire resistance. This is identified as a gap between Enlightened Solutions proposed design and the Compliance Document.

Intermediate floors in warehouses capable of storage at a height of more than 3m shall be limited to 35m^2 according to paragraph is 4.13.7. As the storage of the warehouse is greater than 3m the upper level of racking is 472m^2 and exceeds the maximum of 35m^2 and this is another compliance gap that needs to be addressed.

Interior surface finishes are to comply with paragraph 4.17.1. All new walls and ceiling surfaces shall follow NZ Group Number classifications, and equivalent Australian and European classification:

Location	NZ Group Number (using ISO 9705 or ISO 5660)	Australian Group Number (using AS ISO 9705)	European Classification (using EN 13501-1:2007+A1:2009)
Walls/Ceilings in sleeping space	1S or 2S	1 or 2	A1, A2 or B & s1 or s2
Internal HVAC duct surfaces	1S	1 or 2	A1, A2 or B & s1 or s2
External HVAC duct surfaces	1, 2 or 3	1, 2 or 3	A1, A2, B, C or D
Walls in all other areas	1, 2 or 3	1, 2 or 3	A1, A2, B, C or D

These surface finish requirements do not apply to:

- Small areas of non-conforming product having a total aggregate surface area of less than 5m^2
- Doorsets
- Continuous areas of permanently installed openable wall partitions having a surface area of not more than 25% of the divided floor area or 5m^2, whichever is less.

The existing wall and ceiling surface finishes are painted plasterboard lining and ceiling tiles within the office and sleeping areas, and uncoated steel sheet in the warehouse. The underside of the mezzanine floor is particleboard which would achieve Group Number 3.

Compliance of the building underlay membranes and their flammability indices could not be verified.

According to paragraph 4.17.3 all new flooring is demonstrably achieving a minimum critical flux (when tested to ISO 9239 Part 1) as follows:

- All other areas 1.2 kW/m^2

Existing flooring is polished concrete to warehouse with hardwearing carpet and vinyl in the offices. The mezzanine is particleboard. There are no concerns for combustibility of the flooring.

Paragraph 4.18.1 requires all ventilation to shut down when smoke detection is activated. This is to be provided as part of the new Type 4 system to be installed.

4.4 Control of External Fire Spread

According to paragraph 5.3.2, walls within 1m of the boundary shall be fire rated from both directions. The property rating is 180 minutes FRR so the south elevation wall shall provide 180/180/180 FRR.

The boundary wall was observed to be of 150mm thick precast concrete panel. This is expected to provide the required 180/180/180 FRR.

Cladding within 1m of the boundary shall achieve a maximum peak heat release rate of 100 kW/m^2 and total HRR of 50 MJ/m^2. All other cladding shall provide a peak HRR of 150 kW/m^2 and total HRR of 50 MJ/m^2. The precast concrete and metal cladding do achieve these HRR limits.

4.5 Fire Fighting

Access for firefighters is via the main entrance and the front elevation. Vehicle access is within 20m of the front entrance. The required loadings for the driveway to withstand fire trucks is envisaged to have been provided for this newly constructed building.

4.6 Summary

The following is a summary of the gaps identified in the assessment against the Acceptable Solution C/AS5 and C/AS2:

- The existing floor system is of particle board flooring on a light steel frame system and does not provide the required fire resistance of 30/30/30 and 30/-/- FRR respectively.
- The intermediate floors (mezzanine) is larger than 35m^2.
- Directional EXIT signage is required throughout the building to clearly identify escape routes.

The compliance of fire safety systems, fire rated elements, structure and roading could not be confirmed on a walk around site visit and any deficiencies would also be a gap to compliance however this would need to be independently checked and verified by others.

5 Fire Engineering Brief by Enlightened Solutions

Enlightened Solutions prepared a fire engineering brief (FEB) in 10 October 2016 that addresses the building's compliance with the construction of the racking system and raised platform (mezzanine). The floor area for the mezzanine exceeds the maximum permitted area by the Acceptable Solution.

The brief does not provide all documentation and assessments necessary to determine compliance with NZBC but only outlining the approach. However the following provides Beca comment on the FEB as this has been proposed as a basis for an alternative solution approach.

5.1 Mezzanine Floor Area

Enlightened Solutions proposed that the means of escape from the platform is to be demonstrated via equivalency to the Acceptable Solutions. According to Acceptable Solution C/AS5 the maximum area of intermediate floor is 35m^2 for storage over 3m in height for a warehouse. The proposed racking floor is 452m^2 which is substantially more than 35m^2.

Enlightened Solutions propose equivalency with a compliant mezzanine floor of the dimensions 23 x 1.5m which would have a compliant travel distance. However with a large mezzanine floor there are other factors to consider such as entrainment of smoke from under the floor and through voids that could threaten escape. The mezzanine floor has a total perimeter of some 86m long which would create a very long unrestricted balcony spill plume resulting in large quantities of air being entrained and very large mass flow rate of smoke entering the upper layer (BRE 368 Chapter 6.2). It is therefore not appropriate to show equivalency with the Acceptable Solutions just for travel distance for an alternative solution as the Acceptable Solutions assume a much smaller mezzanine floor.

Additionally, the Acceptable Solutions place limitation on the floor area of intermediate floor for which additional smoke control assessments are not required within these documents. The proposed mezzanine occupies over 50% of the warehouse floor area and as such would instigate smoke control assessment.

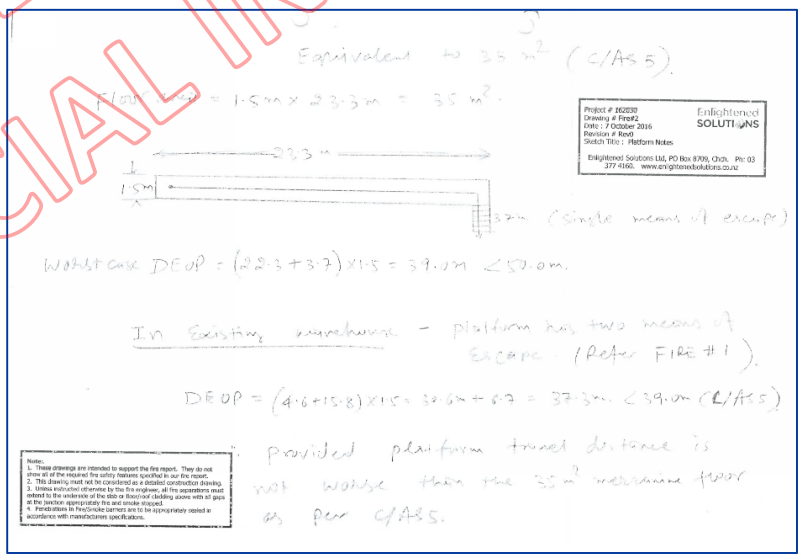

Figure 3 - Proposed Equivalency of the Intermediate Floor

The intent of the limited area intermediate floor in storage buildings is due to risk of occupants exposed at height with potential for rapid fire growth. With reference to the Verification Method C/VM2 Table 2.1 a t-cubed fire growth rate is required for storage over 3m which recognises the risk of rapid fire growth of high

rack storage. Occupants on elevated platforms could quickly be overcome by smoke from a rapidly growing fire below. For this reason, the Acceptable Solution is conservative in the size of the mezzanine floor without restriction on type of material stored, storage height or volume of the space. A suitable means of assessment of large intermediate floors would be the ASET vs RSET criterion using fire engineering modelling to determine fire growth rate and smoke flow rates to demonstrate compliance with NZBC C4.3 for safe evacuation from fire.

Additionally, the size limitation of the intermediate floor within Acceptable Solution also assists firefighting and rescue operations. This compliance aspect should also be addressed as required by NZBC C5.6 with consultation with Fire & Emergency New Zealand.

This advice aligns with the comments of Stephen Lambert of NZFS (at the time) within his letter of 29 November 2016 (Item 2).

5.2 Fire Resistance Rating for the Platform

Enlightened Solutions propose to assess the inherent fire resistance of the racking floor when compared to the time to escape the platform. The proposed analysis uses the char rate of timber using AS 1720.4. The mezzanine floor is 25mm particle board on a light weight steel frame supporting system.

The preface of AS 1720.4 states that *"this standard is to provide a computational method for determining the fire resistance for structural adequacy of solid, plywood, laminated veneer lumber (LVL), and glued-laminated structural timber members as an alternative to the test method specified in AS 1530.4".*

This standard is therefore not applicable for particleboard. Particleboard is a composite material consisting of timber particles and glue and would not have the performance of standard solid timber. The charring rate for timber should not be used for particleboard in order to determine its inherent fire resistance rating.

The FEB describes justification of the structure of the upper floor by using an RSET escape time. However the fire resistance rating of the intermediate floor is not only for life safety. Together with NZBC C4.3 the Fire Service may need to perform search and rescue efforts on mezzanine floors so the fire rating of floors and access stairs also provides protection to fire fighters. Any alternative solution would also need to demonstrate compliance with NZBC C5.6 for safe access for fire fighters in consultation with FENZ.

Figure 4 - Racking Steel Support System

The structural support to the floor system is light steel members as thin as 1.5mm as shown above. The inherent fire resistance of such steel frame is envisaged to be minimal. The fire engineering brief does not provide a proposed analysis to determine the FRR for the mezzanine steel frame supporting structure. A fire engineering analysis would be required to show that the inherent performance of the steel frame and connections. It is considered unlikely that the steel frame system would provide sufficient fire resistance for both life safety and firefighting without additional fire protection.

6 Conclusion

This report provides Beca's opinion on the compliance of the fire safety design as proposed in Enlightened Solutions fire engineering brief for the building on 49 Stoneleigh Drive, Rolleston. The report also provides an assessment of the building's current compliance level with NZBC Building Code by means of Acceptable Solutions and highlighted the following issues:

- The mezzanine floor is 452m^2 and exceeds the maximum permitted floor area limit of 35m^2 by C/AS5.
- The mezzanine floor construction of light steel frame with exposed particle board flooring does not provide the minimum of 30/30/30 FRR.
- Additional EXIT signs are recommended to better indicate escape routes through the racking system.

Additionally, we have provided an assessment of the FEB prepared by Enlightened Solutions as a basis for an alternative solution. We believe that the FEB methodology is not sufficient as follows:

- The use of an equivalency method with C/AS5 for the racking platform is not sufficient to show compliance with NZBC C4.3 and C5.6
- The inherent fire resistance of the flooring and supporting system using AS 1720.4 is not considered adequate to comply with NZBC C4.3 and C5.6.
- Lack of demonstrating compliance for smoke control within the warehouse caused by the extended mezzanine
- Lack of demonstrating compliance with firefighting access and operations

It is in our Opinion that:

- The alternative solution approach proposed in the FEB will not lead to a compliant building with NZ Building Code C1-C6.
- Additional quantitative fire engineering analysis would be required in support of demonstrating compliance.