RAWFIRE
Fire Safety Engineering

Consultant Advice

Project:	Metcash Distribution Centre: Mustang extension	**Project No.:**	s121076
From:	RAWFire Safety Engineering	**Date:**	29 October 2013
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Introduction

A Fire Engineering Report (FER) s100643_Metcash_HY_FER_03, dated 21 October 2011 was prepared on behalf of Hansen Yuncken Pty Ltd to demonstrate that the design of the Metcash storage and dispatch facility in Bungarribee Industrial Estate complies with the requirements of the Building Code of Australia (BCA).

The project included the construction of three (3) independent warehouses and a two storey open deck carpark on the allotment.

The assessment analysed issues of non-conformance with the prescriptive requirements of the BCA in relation to perimeter vehicular access; fire resisting construction; travel distances to the nearest exit and between alternative exits; fire hose reels and smoke hazard management to demonstrate that the design meets the Performance Requirements and thereby complies with the statutory requirements.

This addendum, whilst complementary to the FER, has been prepared to provide assessment of the extension on the southern part of Warehouse 1. Similar to the FER, this document has been prepared to demonstrate that the additional non-conformance associated with the extension still meet the Performance Requirements of the BCA.

In that respect this addendum and the FER are intended to be read in unison, with the fire safety requirements in both documents to be implemented and referenced on the building's fire safety schedule.

Overview of works

The new works include the construction of a first floor dock office to be used as a lunch room and viewing office overlooking the internal portion of the existing warehouse. The area shall be served by an internal stair and have complaint egress provisions.

Additional to this shall be an to the southern end of Warehouse 1. This includes an additional 9,380m ^{2} of floor area with the intent for a future 1,412m ^{2} extension at a later date. The works associated with the initial warehouse extension are referred to herein as the 'Mustang' works with the future works referred to as the 'Stage 5C' works. The extension shall have a similar use to the existing storage and dispatch warehouse with the exception that the storage mechanism will consist of automated racking structure where contents of pallets are sorted and distributed prior to being re-assembled in pallets for dispatch.

The existing warehouse has a ridge height of 12m. The automated racking structure will extend to a height of 22m above finished floor level (FFL) with the roof ridge height at 27m above FFL. The southern wall of the existing warehouse is constructed of metal sheeting and shall be maintained from a height of 2.2m above FFL with forklift access doors either side of the automated racking. The sheeting will provide high level separation between the existing warehouse and the Mustang extension.

The automated portion of the racking structure will be fully enclosed with access restricted to plant service mechanic staff only. General access to personnel will be provided around the extremities of the automated racking structure for them to access the work bays as illustrated in the following Figures. The BCA compliance review states that the automated area shall be fully fenced, will be inaccessible to staff at all times during operation and will only be accessed for maintenance under strictly controlled conditions.

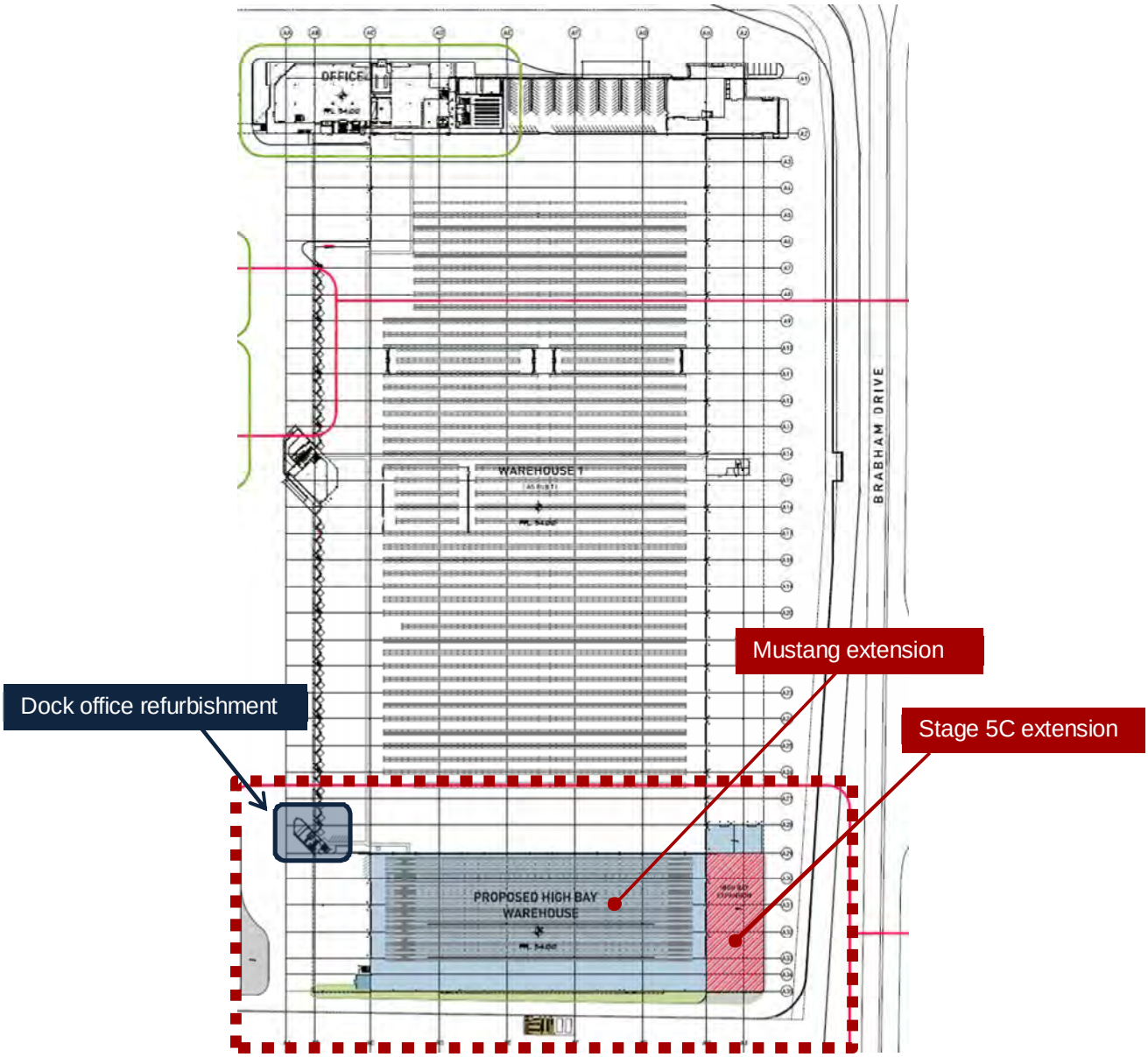

Figure 1: Mustang extension (blue) and Stage 5C extension (red)

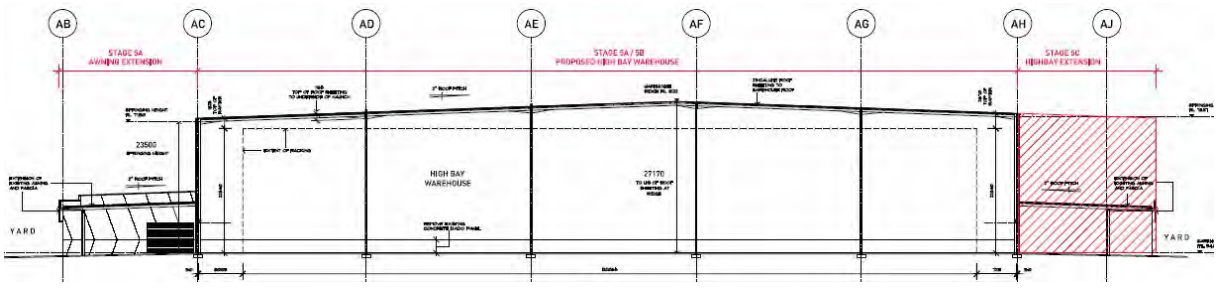

Figure 2: Southern elevation (Stage 5C extension in red hatch)

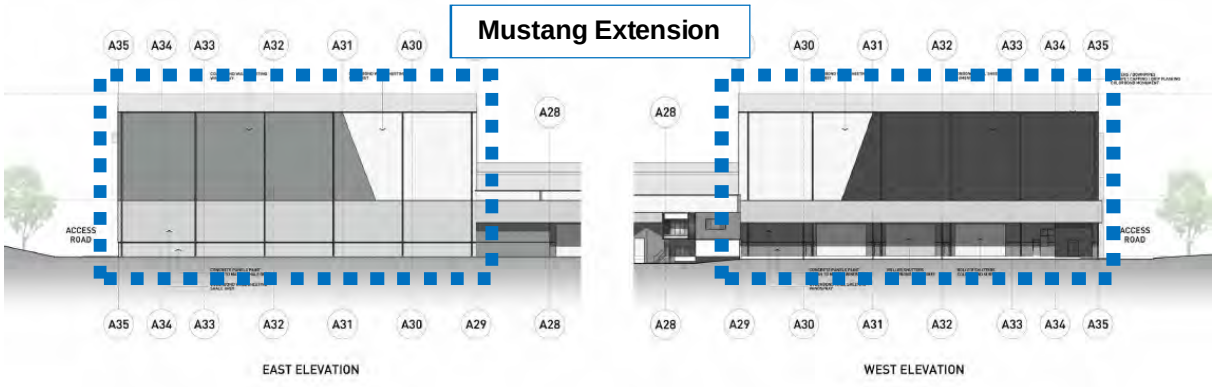

Figure 3: Eastern and western elevations

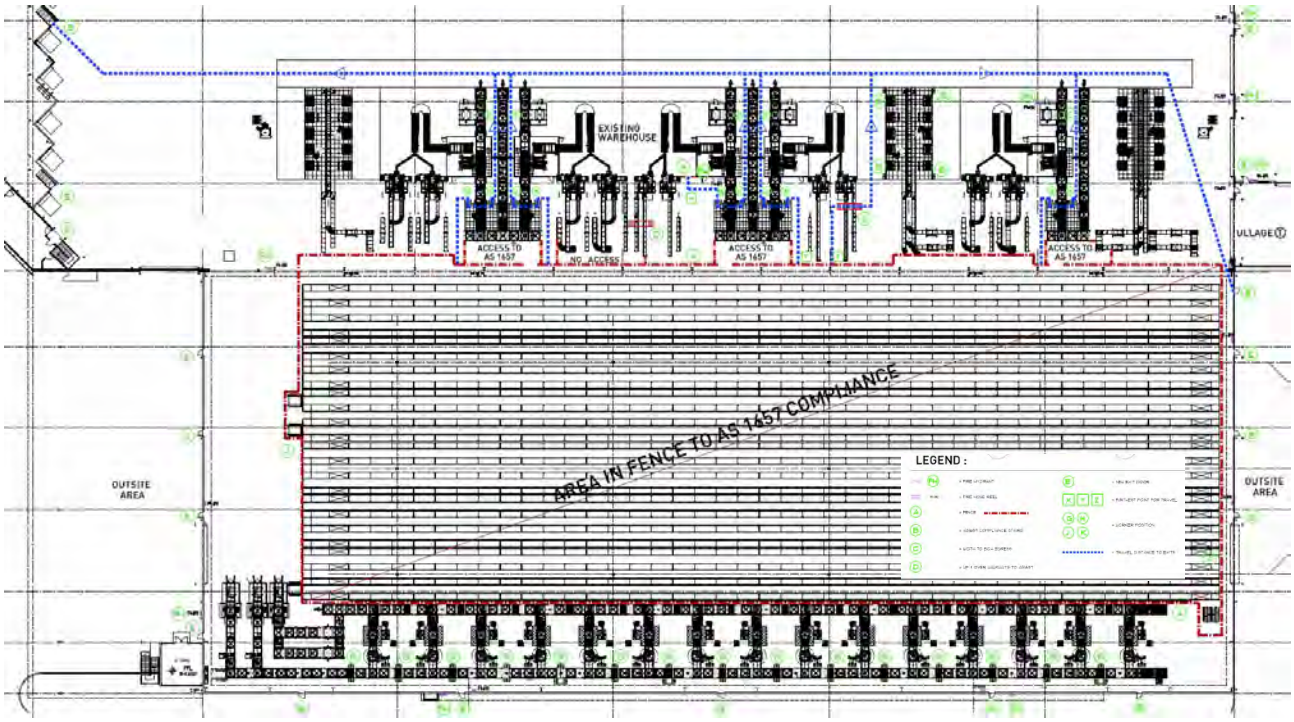

Figure 4: Automated racking layout (restricted access plant area defined)

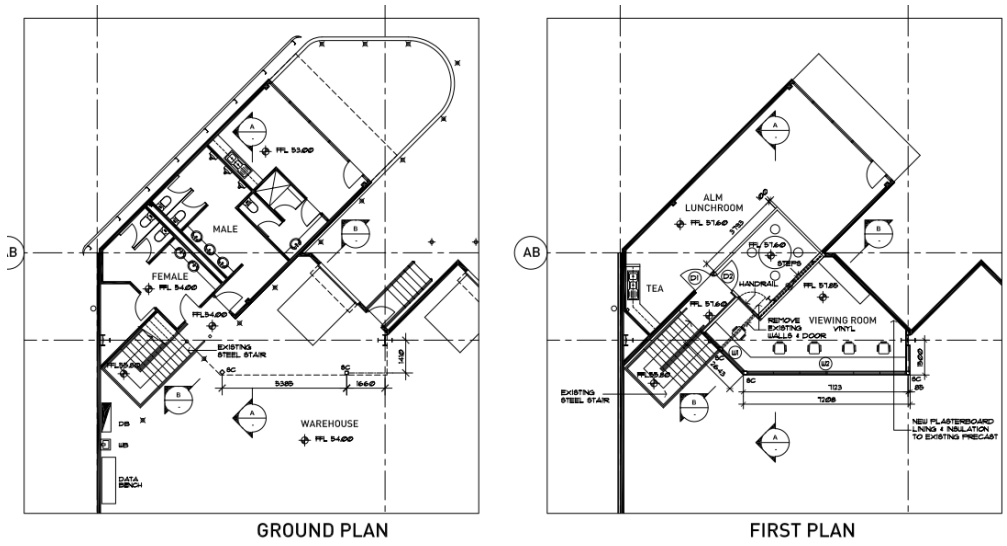

Figure 5: Ground and first floor dock office works

Sources of Information

The following sources of information have been provided by the design team in preparing this document:-

- Building BCA compliance report prepared by Blackett Maguire + Goldsmith; Reference No.: 120462-1, dated 15th November 2012); and
- Architectural Plans prepared by Giles Tribe Architects; Drawings 01-11, Development Application Issue C, dated 24th October 2012 and New Viewing Room drawing (ref: 13054A-200-C).
- Fire Engineering Brief meeting chaired by John Black of Fire and Rescue New South Wales on the 11/04/2013.

Fire Engineering Requirements

To comply with the BCA and demonstrate compliance with the Performance Requirements in addition to the fire safety systems detailed in the FER (except where modified herein), the following additional fire safety measures are to be employed:-

Table 1: Summary of Fire Engineering Requirements from Trial concept design

FIRE ENGINEERING REQUIREMENT	DETAILS	STANDARD OF COMPLIANCE
Fire Resistance		
Type of construction	All new works or modifications to the base building are to comply with the prescriptive requirements of the BCA (i.e. Type C fire-resisting construction).	BCA Spec C1.1 (Table 5)
Access and Egress		
Exit travel distance	Travel distances to an exit, between alternate exits and to a point of choice are to be in accordance with the FER (i.e. 110m to the nearest and 220m between alternative exits in the warehouse) with the following exceptions permitted:- ■ Travel distances to a point of choice are up to 30m from the de-palletising area; and ■ Travel distances in the viewing dock office are to be DTS compliant.	BCA clause D1.4, D1.5 and Alternative Solution
Walkways, stairways and ladders	Walkovers provided for occupant egress over conveyors are permitted to be in accordance with AS1657.	BCA clause D2.18 and Alternative Solution
Services and Equipment		
Sprinklers	An automatic fire sprinkler system shall be fitted throughout the area of new works. The sprinkler system shall be connected to the FIP to activate the building occupant warning system and direct brigade alarm upon detection of a fire. ■ In the warehouses a storage mode system shall be provided in accordance with BCA Specification E1.5, AS2118.1:1999 and Factory Mutual Guidelines 2-0 and 8-9 at roof level. ■ In-rack sprinklers shall be provided to automated racking structure in accordance with Specification E1.5 and AS2118.1:1999. ■ In the dock and maintenance offices and beneath the warehouse awnings the system shall comply with BCA Specification E1.5 and AS2118.1:1999.	BCA Specification E1.5, AS2118.1:1999, FM Global Data Sheets FM2-0 & FM8-9 and Alternative Solution.

FIRE ENGINEERING REQUIREMENT	DETAILS	STANDARD OF COMPLIANCE
Smoke Hazard Management	A manually operated smoke clearance system shall be installed to the extension. The smoke clearance system shall meet the following performance requirements: ■ Initiation switches shall be located on or adjacent to the main FIP. ■ Signage alerting the Fire Brigade to the operation of the smoke clearance system must be provided. ■ Fire rated fans and fire rated cabling shall be used and designed to operate at 200°C for a period of 60 minutes. ■ System capacity must be capable of one enclosure air change per hour. ■ Multiple fans be provided and be evenly distributed to otherwise comply with the requirements of Specification E2.2b Clause 5 of the BCA. ■ Adequate make-up air shall be provided at low level to facilitate the clearance system's designed operational capacity. The make-up air shall be provided at low level by:- o Permanently open natural ventilation louvers; and/or o Mechanically operated louvers that open upon activation of the fans. All motors and cables must be fire rated to operate at 200°C for a period of no less than 60 minutes. ■ If used for general ventilation, the air flow rate at any sprinkler head must be less than 1.5m/s and the system must shut down automatically upon any fire alarm, with manual override available to fire fighters	BCA Clause E2.2, Table E2.2a, AS/NZ1668.1: 1998 and Alternative Solution
Occupant warning system	A building occupant warning system must be provided throughout to initiate on fire detection.	BCA clause E1.5, E2.2 (Clause 6) and AS1670.1:2004
Fire hydrants	The existing fire hydrant system shall be extended to cover the extension in accordance with BCA Clause E1.3 and AS2419.1:2005. ■ External hydrant connections shall be provided with the heat shields per the requirements of AS2419.1 (i.e. FRL 90/90/90 2m either side and 3m above the hydrant connection point) or be setback more than 10m from the building. ■ All new connection points must be fitted with Storz hose couplings which comply with Clause 7.1 and 8.5.11 of AS2419.1:2005. Further information is available from the FRNSW Guide Sheet No.4 '*Hydrant system connectors*' available at www.fire.nsw.gov.au. ■ Updated block plans (not less than A3 in size) shall be provided at the booster assembly.	BCA clause E1.3, AS2419.1:2005 & Fire Authority requirements
Fire hose reels	The existing fire hose reel system shall be extended to cover the extension in accordance with BCA Clause E1.4 and AS2441:2001.	BCA clause E1.4 and AS2441:2005

FIRE ENGINEERING REQUIREMENT	DETAILS	STANDARD OF COMPLIANCE
Fire extinguishers	Portable fire extinguishers must be provided throughout the general access areas with their location and selection relevant to the risk class in accordance with the relevant regulatory requirements. ■ Additional portable fire extinguishers shall be installed to the de-palletising areas provided with travel distance greater than 20m to a point of choice.	BCA clause E1.6, AS2444:2001 and Alternative Solution
Fire Brigade intervention		
Notification	An automatic link shall be provided directly to an approved monitoring centre on activation of the sprinkler systems.	Specification E2.2a Clause 7 & Clause 3.2 of AS2118.1:1999
Block plans	Block plans are to be updated to incorporate the extension.	AS1670.1:2004 & AS2419.1:2005
Building Management		
Emergency management plan	An emergency management plan shall be implemented. This must include:- (a) The development of an emergency plan and response procedures. (b) The establishment, authority and training of an emergency control organization. (c) The testing and validation of emergency response procedures. (d) Emergency related training. The plan should also specifically deal with the provisions for fire brigade entry into and around the automated racking system during and after a fire event, that is, access for fire brigade, power shutdown, and return to base function for the sorting machinery and local command point.	AS3745:2010 and Alternative Solution

BCA DTS NON-COMPLIANCE ASSESSMENT AND ACCEPTANCE CRITERIA

BCA DTS NON-COMPLIANCE ASSESSMENT

Overview

The following BCA DTS non-compliances have been identified through the regulatory review as provided by the Authority Having Jurisdiction and design team. Where not listed herein the building is required to achieve compliance with the document, relevant BCA DTS clauses and relevant codes/Standards approved at the time of consideration.

The following table lists the departures from the DTS provisions of the BCA for the extension and the analysis methodology for the Fire Engineering assessment, which is to be generally in accordance with the IFEG [3].

Table 2: Summary of Alternative Solutions

BCA DTS PROVISIONS & PERFORMANCE REQUIREMENT	PERFORMANCE BASED SOLUTION
BCA DTS Provisions Clause D1.4: Distance to the nearest exit. Clause D1.5: Distance between exits. Clause EP2.2: Smoke hazard management **Performance Requirement** DP4 & EP2.2	***BCA DTS Provision*** Clause D1.4 states that no point on a floor shall be more than 20m from a point of choice, with an additional 20m travel permitted from that point to the nearest exit. Clause D1.5 states that the travel distance between alternative exits must not exceed 60m. Clause E2.2 *(inter alia Table E2.2a)* requires large isolated buildings with a ceiling height above 12m and a floor area or volume more than 18,000m ^{2} or 108,000m^3 respectively to be equipped with an automatic smoke exhaust system. ***DTS Non-Compliance*** As a result of the extension and associated racking/conveyor fitout the following non-conformances have been raised in the existing warehouse (in the de-palletizing area):- ■ 30m to a point of choice ■ 110m travel to an exit ■ 180m between alternative exits *NB: It is noted that the FER assessed travel distances of 110m to the nearest exit and 220m between alternatives.* Further a manually operated smoke clearance system shall be installed in the Mustang extension in lieu of the DTS required automatic smoke exhaust system. ***Alternative Solution*** The Alternative Solution relies on the volume of the warehouse enclosure to act as a smoke reservoir for hot combustion products with significant reserve so as to provide the population with adequate time to safely evacuate the building prior to the onset of untenable conditions. ***Assessment Methodology*** The assessment methodology adheres to Clauses A0.5(b)(i), A0.9(b)(ii), and A0.10 of the BCA. The analysis will be absolute and quantitative where the results of the deterministic assessment are measured directly against the agreed acceptance criteria, with a supporting qualitative argument. Computational Fluid Dynamics (CFD) will be used to simulate the fire development and smoke spread in the warehouse with these results utilised in an ASET/RSET time-line analysis to demonstrate occupant and fire brigade life safety. ***Acceptance Criteria*** ASET calculated for the worst credible design fire scenarios must be better than or at least equivalent to the RSET for the worst credible design fire scenarios incorporating

BCA DTS PROVISIONS & PERFORMANCE REQUIREMENT	PERFORMANCE BASED SOLUTION
	a safety factor of 1.5: ■ $ASET_{WC} \geq 1.5 \times RSET_{WC}$ ASET calculated for the sensitivity and redundancy fire scenarios must be at least equivalent to the RSET for the sensitivity and redundancy fire scenarios: ■ $ASET_{Sen/Red} \geq RSET_{Sen/Red}$
BCA DTS Provisions Clause D2.18: Fixed platforms, walkways, stairways and ladders **Performance Requirement** DP4	***BCA DTS Provision*** Clause D2.18 requires that a walkway, stairway, any going and riser, landing handrail or balustrade may comply with AS1657 in lieu of D2.13, D2.14, D2.16 and D2.17 provided it serves only a room dedicated for machinery, plant or non-habitable room. ***DTS Non-Compliance*** Walkovers outside the dedicated plant area are designed in accordance with AS1657, i.e. to provide egress over the automated racking conveyors. ***Alternative Solution*** The Alternative Solution relies upon the type of activities being undertaken in the area to depict a certain type of occupant (i.e. familiar and able bodied) and the low occupant loading to draw comparison to the DTS provisions for acceptance of AS1657. ***Assessment Methodology*** The assessment methodology adheres to Clauses A0.5(b)(ii) and A0.9(c) of the BCA. The analysis is comparative and qualitative in demonstrating that life safety is not compromised above other parts of the building permitted to use the design standard AS1657. ***Acceptance Criteria*** Occupant types in the areas served by the walkovers are comparable to DTS.

FIRE ENGINEERING ANALYSIS

EGRESS PROVISIONS (Incorporating smoke hazard management)

Regulatory Assessment

In order to assess the non-compliance of the relevant BCA DTS clause(s) the following table is provided to outline the relevant regulatory requirements and assessment methods.

Table 3: Regulatory Assessment

REGULATORY REQUIREMENT	DESCRIPTION / DETAILS
BCA DTS Requirement:	Clause D1.4 states that no point on a floor shall be more than 20m from a point where travel to two alternative exits is available, with an additional 20m travel permitted from that point to the nearest exit. Clause D1.5 states that the travel distance between alternative exits must not exceed 60m. Clause E2.2 *(Table E2.2a)* requires large isolated buildings with a ceiling height above 12-metres and a floor area or volume more than 18,000m^2 or 108,000m^3 respectively to be equipped with an automatic smoke exhaust system
Non-compliance with DTS provisions:	As a result of the extension and associated racking/conveyor fitout the following non-compliances have been raised in the existing warehouse (in the de-palletizing area):- ■ 30m to a point of choice ■ 110m travel to an exit ■ 180m between alternative exits *NB: It is noted that the FER assessed travel distances of 110m to the nearest exit and 220m between alternatives.* Further a manually operated smoke clearance system shall be installed in the Mustang extension in lieu of the DTS required automatic smoke exhaust system.
Relevant Performance Provision(s):	DP4 and EP2.2
Assessment methodology:	The assessment methodology adheres to Clauses A0.5(b)(i), A0.9(b)(ii), and A0.10 of the BCA. The analysis is absolute and quantitative where the results of the deterministic assessment are measured directly against the agreed acceptance criteria, with a supporting qualitative argument. Computational Fluid Dynamics (CFD) are used to simulate the fire development and smoke spread in the warehouse with these results utilised in an ASET/RSET time-line analysis to demonstrate occupant and fire brigade life safety.
Acceptance criteria:	ASET calculated is greater than, or at least equivalent to, the RSET for the worst credible scenarios incorporating a safety factor of 1.5: ■ $ASET_{WC} \geq 1.5 \times RSET_{WC}$ ASET calculated is greater than, or at least equivalent to, the RSET for the sensitivity and redundancy scenarios: ■ $ASET_{Sen/Red} \geq RSET_{Sen/Red}$

Introduction

BCA DTS clause D1.4 states that no point on a floor shall be more than 20m from a point where travel to two alternative exits is available, with an additional 20m travel permitted from that point to the nearest exit, while clause D1.5 deals with the distance between alternative exits and requires that this distance does not exceed 60m.

BCA DTS clause E2.2 (Table E2.2a) requires large isolated buildings with a ceiling height of more than 12m to be equipped with an automatic smoke exhaust system.

As a result of the extension and associated racking/conveyor fitout the following non-compliances have been raised in the existing warehouse (in the de-palletising area):-

- 30m to a point of choice
- 110m travel to an exit
- 180m between alternative exits

Further a manually operated smoke clearance system shall be installed in the Mustang extension in lieu of the DTS required automatic smoke exhaust system.

The FER assessed the compliance of 110m travel distance to the nearest exit, 220m between alternative exits and the provision for a manually operated smoke clearance system in lieu of an automatic smoke exhaust system in the existing warehouse portion of the building. To that extent, the new works do not increase the level of non-conformance above the FER with the exception of the 30m to a point of choice located in the de-palletising area.

It should also be noted that the works associated with the first floor dock office will achieve DTS compliant egress provisions.

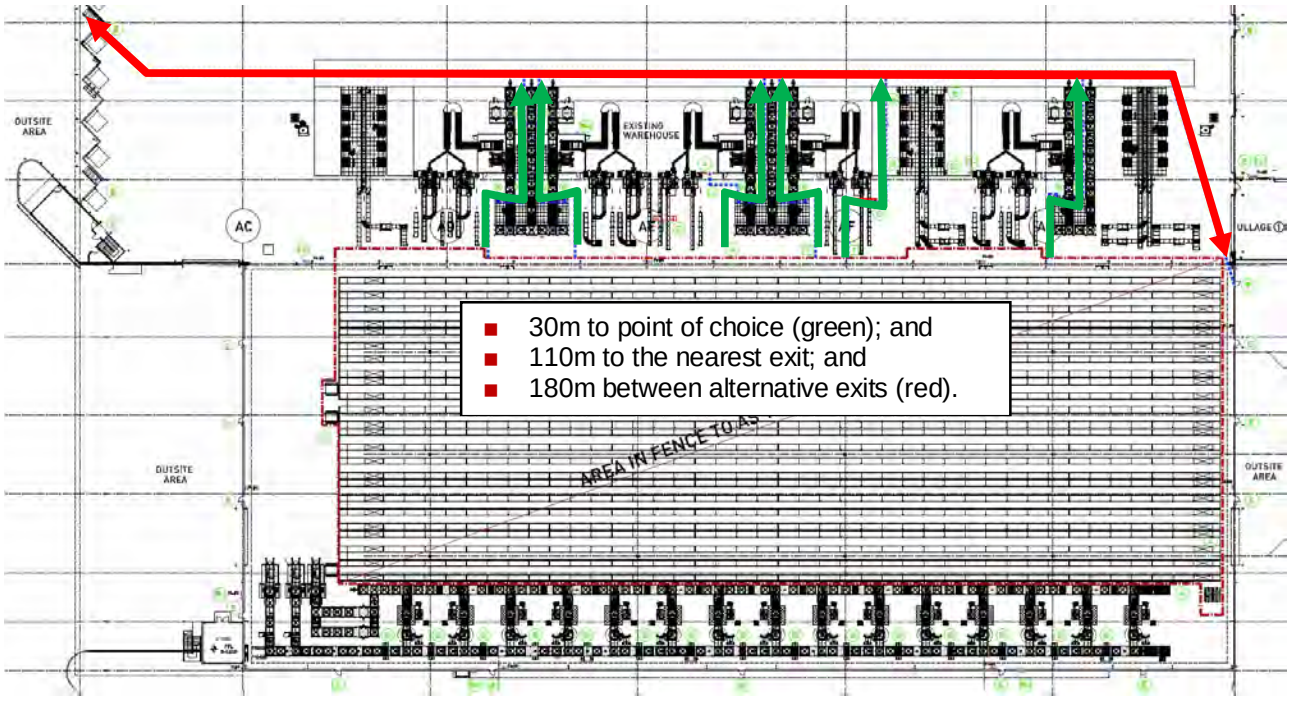

Figure 6: Non-conformant travel distances

Intent of the BCA

To assess whether the Alternative Solution achieves compliance with Performance Requirement DP4 and EP2.2 the intent of the BCA must first be understood.

The Guide to the BCA [2] states that DP4 is designed to take into account, the distance travelled; the number of occupants and their characteristics in order to determine what is an acceptable travel time having regard to the function of the building and its likely fuel load; its height and whether the exit is from above or below ground level. Similarly, EP2.2 is required to consider a number of comparable elements in demonstrating that suitable conditions exist within the fire enclosure to facilitate the safe evacuation of all occupants from the building.

The criteria that need be satisfied to demonstrate compliance with Performance Requirement DP4 and EP2.2 is for the total movement time of occupants, and the subsequent conditions during that time being maintained to an agreed standard. In other words the assessment must demonstrate whether the building design is capable of satisfying the following nominated fire safety objectives:-

- *Safe evacuation of building occupants in the event of fire* ; and
- *Internal Fire & Rescue NSW intervention in the event of fire* .

Alternative Solution

Similar to the FER, the Alternative Solution relies upon the volume of the enclosure to act as a smoke reservoir for hot combustion products with significant reserve so as to provide the population with adequate time to safely evacuate the building prior to untenable conditions forming.

Provided conditions for occupants and fire brigade are acceptable, it will be demonstrated that the travel distances are acceptable and a smoke exhaust system is not warranted, and thus a manually operated smoke clearance system shall be installed for post fire operations.

Methodology & Acceptance Criteria

The approach used to ensure that Performance Requirements DP4 and EP2.2 of the BCA are achieved and demonstrate that the acceptance criteria have been met is in accordance with Clause A0.5(b)(i) of the BCA. The documentary evidence used to support this “Alternative Solution” is based on an absolute approach, where a quantitative deterministic fire safety engineering assessment was conducted in accordance with the procedures outlined in the *International Fire Engineering Guidelines* [3].

It is recognised that the quantitative fire engineering methodology to be followed in the development of the assessment results in an idealised fire scenarios and likely outcomes. An output arising from the methodology is the margin between the Available Safe Egress Time (ASET) and Required Safe Egress Time (RSET). This can be considered as a measure of the level of life safety inherent in the building design. Given the conservatism applied in the design (Therefore, the acceptance criterion for this assessment is:

- ASET calculated is greater than, or at least equivalent to, the RSET for the worst credible scenarios incorporating a safety factor of 1.5:
  - $ASET_{WC} \geq 1.5 \times RSET_{WC}$
- ASET calculated is greater than, or at least equivalent to, the RSET for the sensitivity and redundancy scenarios:
  - $ASET_{Sen/Red} \geq RSET_{Sen/Red}$

The tenability criteria for occupant life safety is defined in the FER and based on the SFPE Handbook of Fire Protection Engineering and CIBSE Guide E – Fire Safety Engineering [16, 19], Similarly, conditions for Fire Brigade Invention are adopted from the FER.

Fire Engineering Assessment

ASET Calculation

This assessment uses computational fluid dynamics (CFD) program Fluid Dynamic Simulator (FDS) to predict the time during which tenable conditions are likely to be maintained in the escape routes under differing design fire scenarios, thereby permitting the calculation of the ASET.

For a specific set of inputs, FDS calculates the fire-spread and smoke movement within the building. The results of the simulation including the spread of fire and smoke throughout the various rooms, enclosures and fire compartments are then assessed to determine the expected conditions within the building.

DESIGN FIRE LOCATION

The warehouse is spread over an area of approximately 42,000m ^{2}, with a further 10,000m ^{2} of additional floor space included in the extension. Within the warehouse there are smaller enclosures such as dock offices, maintenance offices and the Ullage and store rooms however in the event of a fire in one of these enclosures occupants are able to exit into the main warehouse where they will be provided with the benefit of a large enclosure volume (with diluted fire hazards) or an adjacent enclosure/room where provided with temporary separation from the fire hazards while egressing to an exit. Therefore for the CFD modelling undertaken, no individual fires have been modelled within the smaller enclosures in the warehouse.

The FER assessed two fire locations in the existing warehouse, and as the extent of the non-conformant travel distances have not been increased or altered in the existing portion of the warehouse above that assessed in the FER, no further analysis of a fire in this part is required to be re-evaluated.

Non-perforated metal sheeting extends from the roof to 2.2m above ground floor at the junction between the existing warehouse and the Mustang extension, thus the combustion products are not expected to adversely affect occupants in the Mustang portion to any greater degree than in the existing warehouse. Thus similarly no further modelling of fires in the existing warehouse are required to be re-assessed.

As such the following design fire locations in the extension have been considered. Central racking fire (DF1) and corner racking fire (DF2) as detailed below.

1) **DF1:** An initial design fire has been chosen to be located centrally within the high bay automated racking area. This is due to the dense fuel load located within the storage arrangement.
2) **DF2:** A second fire location is considered in the south-western corner of the warehouse as this blocks exits in the area and conversely to the central fire locations, the corner fire will provide for an uneven smoke spread over the warehouse roof dropping at different locations due to the smoke spread deflecting downwards as it interacts with the roof space and bounding walls. Additionally the interaction of the fire plume with the bounding walls will restrict entrainment into the plume creating larger flame heights and thus increased temperatures in the smoke layer.

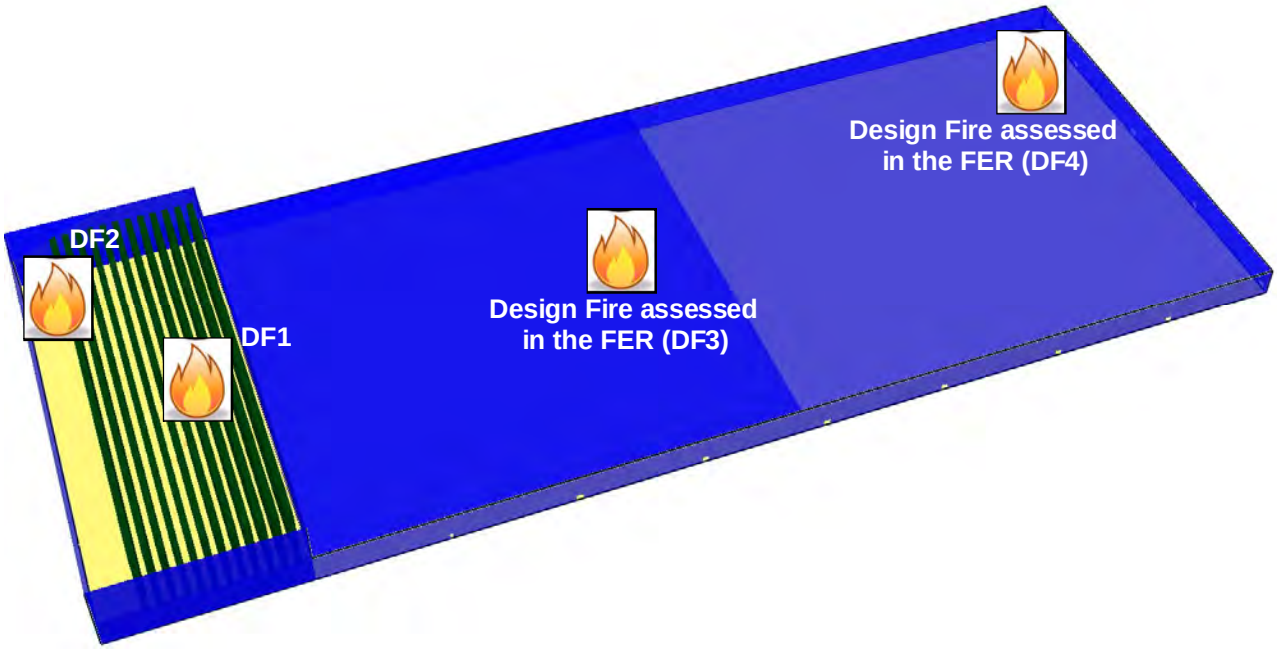

Figure 7: Computational domain and fire locations

DESIGN FIRE SCENARIOS

The warehouses are considered to generally contain mixed types of commodities, where in some cases cellulosic materials are mixed with plastics and non-combustible materials on the same racks. While flammable liquids and aerosols are expected to be located in the facility, they will be palletised manually, and not pass through the automated racking system.

Both roof level storage mode sprinklers and in-rack sprinklers shall be provided to the extension, whereas the existing warehouse was provided with only roof level storage mode sprinklers. Generally roof level and in-rack sprinklers are expected to be a more effective suppression system than scenarios where only roof level sprinklers are installed. However as a conservative assumption the fires in the extension have been considered to grow to the same values as determined in the FER regardless of the installation of in-rack sprinklers.

- **Worst credible design fires:** An Ultra-Fast t-squared fire growth rate has been selected to represent an assumption of rapid fire development in the high bay racking until the activation of sufficient sprinkler heads to control fire growth, at which point it shall be maintained for the remainder of the model.
- **Sensitivity design fires:** The fire designed to grow at the same rate as the worst credible design fire, Ultra-fast growth rate, however the maximum heat release rate is permitted to grow to approximately double the size.

Table 4: Fire scenario summary: Warehouse fire scenarios

FIRE SCENARIO CHARACTERISTIC				
FIRE SCENARIO	**DF1** Worst Credible	**DF1** Sensitivity	**DF2** Worst Credible	**DF2** Sensitivity
Fire growth rate	Ultra-Fast t-squared fire growth rate			
Maximum heat release rate	8 MW	20 MW	8 MW	20 MW
Material soot yield	Polyurethane equivalent 0.1g/g.			
Simulation time	Model is run until steady state conditions or the time of fire brigade attack, whichever occurs first			
Ventilation conditions due to natural smoke relief	No mechanical exhaust is provided. Natural leakage through the enclosure walls and doors can be expected. To allow for natural ventilation and any roller/exit doors open, complete combustion of the design fire and ensure the most onerous conditions in regards to smoke and heat production the exit doors have been modelled as being open. This ensures the designated fire growth is provided and complete combustion prescribed for the fire model occurs.			
Suppression by automatic equipment	Both fires are considered to be controlled by the in-rack and roof level sprinklers.			

CFD RESULTS

The FDS modelling inputs are detailed in Appendix A and the results of the modelling illustrated in Appendix B. The results indicate that in all simulations visibility is the limiting factor in relation to occupant tenability.

RSET Calculation

To establish the RSET, **Equation 1** is used. In the first instance evacuation will be modelled using hydraulic flow calculations based on first principles. The egress analysis evaluates the time necessary to initiate occupant response to an alarm or cue of a fire and the required time for occupants to reach a safe place during evacuation. The RSET is measured from the same point in time as the initiation of ignition. The calculated RSET is the sum of times incurred during the following three stages of the evacuation process:

- ***Alarm time*** – Time taken from ignition to the receipt of a cue by the occupants regarding the awareness of a fire. In open plan areas occupants can also receive a cue upon development of a visible smoke layer under the ceiling.
- ***Response (pre-movement) time*** – Time which extends from the alarm or cue to the time when occupants decide to evacuate. The degree of training and familiarity with the surroundings, as well as the general nature of the population, has an impact on the response time, together with the type of cue received. This period covers the time for occupants to assimilate the cue, resolve any ambiguity, undertake pre-evacuation actions and commence evacuation.
- ***Egress time*** – Occupant evacuation time, which can be calculated on the basis of human walking speeds affected by crowding and occupant mobility.

The abovementioned elements are expressed through the following equation:

$$t_t = t_a + t_p + t_m \text{ (s)} \qquad \textbf{[Eqn. 1]}$$

Where: t_t = total egress time (s)
t_a = alarm time (s)
t_p = pre-movement time (s)
t_m = movement time (s)

ASSUMPTIONS

- Occupants are awake and generally familiar with the areas of the building which they commonly access and use.
- While overall egress width is important, travel distances to an exit or place of relative safety are considered to be the critical components of the design.
- Occupant density is likely to be very low to low and the complexity of the building is relatively simple.
- All occupants are to start egress at the same time, regardless of their location to the fire base.
- Exits which do not conform to the DTS requirements, such as roller shutters and the like are not included in egress calculations despite their ability (and likelihood) to be used to exit from the building in emergency.

ALARM TIME

The alarm time is taken as the activation of the in-rack sprinkler system. While the activation of a sprinkler head may not result in the instantaneous initiation of the occupant warning alarm due to the time required for de-pressurisation of the system, the noise generated by the sprinkler water discharge is expected to create an initial cue to arouse the curiosity of occupants in the area. It is then expected that either secondary cues from the fire or other occupants are registered (in regards to olfactory, visual or further audible) or the building occupant warning alarm will activate within the 180 second pre-movement time assigned.

PRE-MOVEMENT TIME

As detailed above and in concurrence with the assumptions in the FER, a pre-movement time of 180 seconds is assumed based on Table 1 of PD 7974-6:2004 [17].

TRAVEL TIME

Four scenarios are considered in the RSET analysis.

- The first scenario considers occupants located in the existing warehouse that are provided with up to 110m to the nearest exit and 220m between alternative exits;
- The second scenario considers occupants located in the Mustang extension that are provided with DTS compliant travel distances, up to 40m to the nearest exit and 60m between alternative exits.
- The third scenario considers occupants in the palletising and de-palletising areas that are required to traverse across walkovers enroutre to an exit. These walkovers are located no more than 30m from their initial point of egress, and as such are required to travel 30m. For these occupants the tenability criteria is taken at 2m above the walkover height, in lieu of the 2m point used for scenarios 1 and 2 above.
- The fourth scenario considers occupants having to travel from the first floor dock office, i.e. the viewing room down the open internal stair and through the warehouse. Travel distance from the first floor balcony, through the office, down the stairs and to an exit door is 34m.

For scenarios 1 and 2 the worst credible considers all occupants travelling the maximum distance to an exit, i.e. 110m and 40m for the existing warehouse and mustang extension occupants respectively. Further, a redundancy scenario assumes 50% of the available exits doors are compromised by fire, smoke or otherwise unavailable for egress. This will result in occupants travelling the maximum distance to an exit, then travel to an alternative exit (220m based on the occupant travel distances in the FER and 60m in the mustang extension).

Due to the low occupant loading and exits situated around the building perimeter, in all cases the time taken to travel to the exits is far greater than the time required to travel through the doors. Subsequently as the travel time and time queuing at exits due to congestion are mutually exclusive events, the total physical travel time is calculated by using only the greater of the two, the travel time.

Scenario 1: Existing Warehouse

With a travel speed of 1m/s [18] the travel times for worst credible and redundancy scenarios are calculated to be 110 seconds and 330 seconds respectively. The final RSET calculation is completed in Table 5.

Scenario 2: Mustang Extension

With a travel speed of 1m/s [18] the travel times for worst credible and redundancy scenarios are calculated to be 40 seconds and 100 seconds respectively. The final RSET calculation is completed in Table 7.

Scenario 3: Walkover egress

With a travel speed of 1m/s [18] the travel time is taken as 30 seconds. The final RSET calculation is completed in Table 7.

Scenario 4: Dock office (viewing room) egress

With a travel speed of 1m/s [18] the travel time is taken as 34 seconds. The final RSET calculation is completed in Table 7.

Table 5: RSET Scenario 1 (existing warehouse) RSET Calculations

FIRE SCENARIO	EVACUATION SCENARIO	IN-RACK SPRINKLER DETECTION	PRE-MOVEMENT / ALARM TIME	TRAVEL TIME	RSET
DF1-WC	EV-WC	93 sec	180 sec	110 sec	383 sec / 6.4 min
DF1-SEN	EV-WC				
DF1-WC	EV-RED			330 sec	603 sec / 10 min
DF2-WC	EV-WC			110 sec	383 sec / 6.4 min
DF2-SEN	EV-WC				
DF2-WC	EV-RED			330 sec	603 sec / 10 min

Table 6: RSET Scenario 2 (mustang extension)

FIRE SCENARIO	EVACUATION SCENARIO	IN-RACK SPRINKLER DETECTION	PRE-MOVEMENT / ALARM TIME	TRAVEL TIME	RSET
DF1-WC	EV-WC	93 sec	180 sec	40 sec	313 sec / 5.2 min
DF1-SEN	EV-WC				
DF1-WC	EV-RED			100 sec	373 sec / 6.2 min
DF2-WC	EV-WC			40 sec	313 sec / 5.2 min
DF2-SEN	EV-WC				
DF2-WC	EV-RED			100 sec	373 sec / 6.2 min

Table 7: RSET Scenario 3 (occupants crossing walkovers in the palletising/depalletising areas)

FIRE SCENARIO	EVACUATION SCENARIO	FIRE DETECTION	PRE-MOVEMENT / ALARM TIME	TRAVEL TIME	RSET
DF1-WC	EV-WC	93 sec	180 sec	30 sec	303 sec / 5.0 min
DF1-SEN					
DF2-WC					
DF2-SEN					
DF3-WC#		60 sec#	180 sec#	30 sec#	270 sec / 4.5 min#
DF3A-SEN#					
DF4-WC#					
DF4A-SEN#					

 # Values for fire scenarios 3, 3A, 4 and 4A are taken from the FER.

Table 8: RSET Scenario 4 (occupants crossing walkovers in the palletising/depalletising areas)

FIRE SCENARIO	EVACUATION SCENARIO	FIRE DETECTION	PRE-MOVEMENT / ALARM TIME	TRAVEL TIME	RSET
DF1-WC	EV-WC	93 sec	180 sec	34 sec	307 sec / 5.1 min
DF1-SEN					
DF2-WC					
DF2-SEN					
DF3-WC#		60 sec#	180 sec#	34 sec#	274 sec / 4.6 min#
DF3A-SEN#					
DF4-WC#					
DF4A-SEN#					

 # Values for fire scenarios 3, 3A, 4 and 4A are taken from the FER.

ASET / RSET ANALYSIS

In determining the onset of untenable conditions, the ASET is calculated according to the set of criteria governing conditions once the smoke layer descends below 2m. Namely this relates to:-

- Smoke Temperature exceeding 60°C; or
- Visibility falling below 10 m (optical density < 0.1 m^{-1}); or
- The CO toxicity rising above 1,400ppm.

The results of the assessment and the summarised *available safe egress time* for each design scenario are compared against the *required safe egress time* in the following tables.

Table 9: ASET/RSET Assessment Scenario 1 (Occupants in the Existing Warehouse)

Design Fire Scenarios	DESIGN FIRE 1		DESIGN FIRE 2	
	Worst Credible	Sensitivity	Worst Credible	Sensitivity
RSET	383 sec	383 sec	383 sec	383 sec
Temperature *(>60°C)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
Visibility *(<10m)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
CO *(>1400ppm)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
ASET	1800 sec	1800 sec	1800 sec	1800 sec
Margin of Safety	1417 sec	1417 sec	1417 sec	1417 sec
Factor of Safety	**>4.7**	**>4.7**	**>4.7**	**>4.7**
Conforms with Acceptance Criteria	✓ *(>1.5 required)*	✓ *(>1.0 required)*	✓ *(>1.5 required)*	✓ *(>1.0 required)*

Table 10: ASET/RSET Assessment Scenario 1 (Occupants in the Existing Warehouse)

Design Fire Scenarios	REDUNDANCY EVACUATION SCENARIOS	
	Design Fire 1 - Worst Credible	Design Fire 2 - Worst Credible
RSET	603 sec	603 sec
Temperature *(>60°C)*	>1800 sec	>1800 sec
Visibility *(<10m)*	>1800 sec	>1800 sec
CO *(>1400ppm)*	>1800 sec	>1800 sec
ASET	1800 sec	1800 sec
Margin of Safety	1197 sec	1197 sec
Factor of Safety	**>3.0**	**>3.0**
Conforms with Acceptance Criteria	✓ *(>1.0 required)*	✓ *(>1.0 required)*

Table 11: ASET/RSET Assessment Scenario 2 (Occupants in the Mustang Extension)

Design Fire Scenarios	DESIGN FIRE 1		DESIGN FIRE 2	
	Worst Credible	Sensitivity	Worst Credible	Sensitivity
RSET	313 sec	313 sec	313 sec	313 sec
Temperature *(>60°C)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
Visibility *(<10m)*	1355 sec	1215 sec	960 sec	850 sec
CO *(>1400ppm)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
ASET	1355 sec	1215 sec	960 sec	537 sec
Margin of Safety	1042 sec	902 sec	647 sec	1417 sec
Factor of Safety	**4.3**	**3.9**	**3.1**	**2.7**
Conforms with Acceptance Criteria	✓ *(>1.5 required)*	✓ *(>1.0 required)*	✓ *(>1.5 required)*	✓ *(>1.0 required)*

Table 12: ASET/RSET Assessment Scenario 2 (Occupants in the Mustang Extension)

Design Fire Scenarios	REDUNDANCY EVACUATION SCENARIOS	
	Design Fire 1 - Worst Credible	Design Fire 2 - Worst Credible
RSET	373 sec	373 sec
Temperature *(>60°C)*	>1800 sec	>1800 sec
Visibility *(<10m)*	1355 sec	960 sec
CO *(>1400ppm)*	>1800 sec	>1800 sec
ASET	1355 sec	960 sec
Margin of Safety	982 sec	587 sec
Factor of Safety	**3.6**	**2.6**
Conforms with Acceptance Criteria	✓ *(>1.0 required)*	✓ *(>1.0 required)*

Table 13: ASET/RSET Assessment Scenario 3 (Occupants crossing walkovers in depalletising area)

Design Fire Scenarios	DESIGN FIRE 1		DESIGN FIRE 2	
	Worst Credible	Sensitivity	Worst Credible	Sensitivity
RSET	303 sec	303 sec	303 sec	303 sec
Temperature *(>60°C)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
Visibility *(<10m)*	1575 sec	985 sec	1105 sec	860 sec
CO *(>1400ppm)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
ASET	1575 sec	985 sec	1105 sec	860 sec
Margin of Safety	1272 sec	682 sec	802 sec	557 sec
Factor of Safety	**5.2**	**3.3**	**3.6**	**2.8**
Conforms with Acceptance Criteria	✓ *(>1.5 required)*	✓ *(>1.0 required)*	✓ *(>1.5 required)*	✓ *(>1.0 required)*

Table 14: ASET/RSET Assessment Scenario 3 (Occupants crossing walkovers in depalletising area)

Design Fire Scenarios	DESIGN FIRE 3/3A		DESIGN FIRE 4/4A	
	Worst Credible	Sensitivity	Worst Credible	Sensitivity
RSET	270 sec	270 sec	270 sec	270 sec
Temperature *(>60°C)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
Visibility *(<10m)*	1300 sec	690 sec	>1800 sec	>1800 sec
CO *(>1400ppm)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
ASET	1300 sec	690 sec	1800 sec	1800 sec
Margin of Safety	1030 sec	420 sec	1530 sec	1530 sec
Factor of Safety	**4.8**	**2.6**	**>6.7**	**>6.7**
Conforms with Acceptance Criteria	✓ *(>1.5 required)*	✓ *(>1.0 required)*	✓ *(>1.5 required)*	✓ *(>1.0 required)*

Table 15: ASET/RSET Assessment Scenario 4 (Occupants egressing from the new dock office)

Design Fire Scenarios	DESIGN FIRE 1		DESIGN FIRE 2	
	Worst Credible	Sensitivity	Worst Credible	Sensitivity
RSET	307 sec	307 sec	307 sec	307 sec
Temperature *(>60°C)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
Visibility *(<10m)*	1575 sec	985 sec	1105 sec	860 sec
CO *(>1400ppm)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
ASET	1575 sec	985 sec	1105 sec	860 sec
Margin of Safety	1268 sec	678 sec	898 sec	553 sec
Factor of Safety	**5.2**	**3.3**	**3.6**	**2.8**
Conforms with Acceptance Criteria	✓ *(>1.5 required)*	✓ *(>1.0 required)*	✓ *(>1.5 required)*	✓ *(>1.0 required)*

Table 16: ASET/RSET Assessment Scenario 4 (Occupants egressing from the new dock office)

Design Fire Scenarios	DESIGN FIRE 3/3A		DESIGN FIRE 4/4A	
	Worst Credible	Sensitivity	Worst Credible	Sensitivity
RSET	274 sec	274 sec	274 sec	274 sec
Temperature *(>60°C)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
Visibility *(<10m)*	1300 sec	690 sec	>1800 sec	>1800 sec
CO *(>1400ppm)*	>1800 sec	>1800 sec	>1800 sec	>1800 sec
ASET	1300 sec	690 sec	1800 sec	1800 sec
Margin of Safety	1026 sec	416 sec	1526 sec	1526 sec
Factor of Safety	**4.8**	**2.6**	**>6.7**	**>6.7**
Conforms with Acceptance Criteria	✓ *(>1.5 required)*	✓ *(>1.0 required)*	✓ *(>1.5 required)*	✓ *(>1.0 required)*

For the above ASET/RSET assessment it is concluded that all scenarios permit the safe evacuation of the population in the event of a fire, thereby demonstrating that the travel distances and replacement of the automatic smoke exhaust system with a manual smoke clearance system will not have an adverse impact on occupant life safety.

Travel to a Point of Choice

Parts of the de-palletisation area are provided with up to 30m to a point of choice when occupants are located at the southern end of the work stations. The six (6) areas of non-conformance are depicted in Figure 9 by a star and their egress pathways to the point of choice at the northern end of the conveyors.

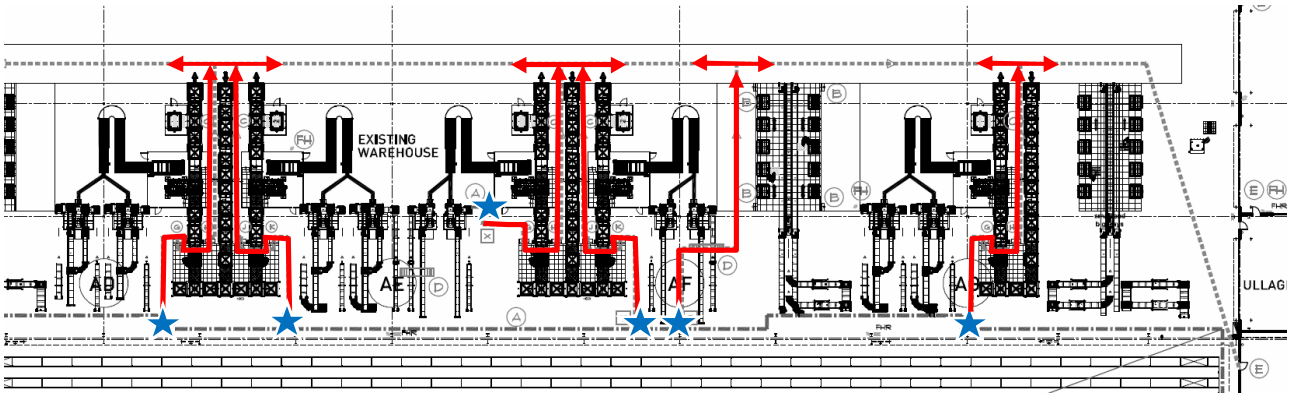

Figure 8: Areas provided with up to 30m to a point of choice

The Guide to the BCA states that the intent of placing a limit on the travel distance is to reduce the probability of occupants being entrapped by a fire that occurs in the first 20m of travel. To this extent occupants must be provided with 20m travel to an exit, or where two or more exits are available this may be extended to 20m to a point of choice with an additional 20m to the nearest exit.

In the subject building occupants are provided with up to 30m to a point of choice. Once reaching this point of choice they are able to evacuate through a large warehouse enclosure in the opposite direction the fire hazard. As demonstrated in the ASET/RSET calculations it is unlikely that occupants will be overcome by fire hazards following them reaching the point of choice as safety factors of up to three were calculated. Therefore the additional 10 seconds required to reach the point of choice will not affect overall occupant life safety during an evacuation.

The following discussion therefore assesses the first 30m of travel.

Occupant Characteristics

The BCA permits the travel distance to a single exit to be extended to 30m in Class 5 or 6 buildings on the basis that occupants, including customers are-

- Generally aware of their surroundings in these types of buildings which are typically small shops or offices located at or near ground level; and
- Familiar with location of the exit which is typically the main entrance to the shop or office; and
- Familiar with the path of travel to reach the exit thereby allowing a prompt and direct egress from the space.

Similar to the occupant characteristics assumed by the Guide to the BCA above, the occupants in the de-palletising area will be awake and aware of their surroundings as the area forms their daily workplace. Further they are expected to have a high familiarity of the egress routes available as these are the routes by which they entered the area to commence work.

The de-palletising area is only accessed by trained staff and due to the nature of the works being undertaken, occupants are expected to be provided with good conditions to obtain visual, olfactory and audible cues from a fire. Therefore enabling occupants to detect a fire quickly and undertake the required measures to avoid the fire hazards.

Therefore the occupant type is deemed to have a similar level of awareness and familiarity to those permitted by DTS to have up to 30m travel to a single exit.

Fire Load and Ignition Sources

The de-palletising area is used to transfer goods stored in bulk crates into smaller packages that are distributed in to the automated racking system. This provides for a possible fuel load that could facilitate combustion in the path of travel blocking egress. However as the staff in the area are working directly with these stock items it is unlikely that a fire would be permitted to ignite without their notice; and as there are no highly flammable items in the area that would sustain rapid combustion a fire is not expected to grow to a size that would threaten egress prior to occupant intervention or travel past the area concerned.

Notwithstanding the above, to assist in manual intervention additional fire extinguishers shall be provided for staff/occupant use in all areas provided with non-conformant travel distances.

Building Layout

A DTS scenario may comprise of travel distances through multiple enclosures or corridors prior to reaching a point of choice. In these scenarios occupants do not have a clear line of sight across the 20m travel path, and they may not be able to receive fire cues until the adjacent enclosure is fully involved in flames.

This is not the scenario presented in the subject building. The de-palletising area provides occupants with an open floor plate to allow occupants to register fire cues (visual, olfactory or audible), thereby providing early warning of a fire that may potentially block their egress path. This open plan design allows early manual intervention or escape activities to be undertaken. To this extent, the subject design provides a better level of protection than a DTS compliant design that has occupants in a dead end enclosure regardless of the additional 10m travel.

Considering the above discussion on occupant characteristics, fuel load and the building layout, the alternative solution is deemed to provide adequate measures to justify the 30m travel to a point of choice in the de-palletising area.

Fire Brigade Intervention

In considering the impact of removing smoke exhaust on fire fighting personnel, reference has been made to the Fire Brigade Intervention Model [4]. The following fire-fighter tenability limits are applied during routine conditions as the most onerous conditions with all conditions being relative to a height of 1.5 m above the finished floor level.

Routine Conditions

Elevated temperatures, but not direct thermal radiation

- Maximum Time: 25 minutes
- Maximum Air Temperature: 100°C (in the lower layer)
- Maximum Radiation: 1kW/m^2

As indicated above, air temperature and thermal radiation are the two factors used to determine the tenable conditions for fire fighters. It should be noted that visibility and toxicity have not been listed to determine the

tenable conditions for fire fighters. Fire brigade personnel are expected to encounter smoke conditions in any significant fire event.

The temperature at 2m above FFL did not reach 60°C throughout the modelling period in all of the design fire scenarios modelled and therefore conditions are considered to be adequate for fire brigade intervention.

Performance Requirement Assessment

The following table provides assessment of each relevant BCA Performance Requirement, thereby achieving compliance with the BCA.

Table 17: Performance Requirement Assessment (DP4)

DP4		CONCLUSION
Exits must be provided from a building to allow occupants to evacuate safely, with their number, location, and dimensions being appropriate to -		
(a)	the travel distance; and	The assessment has demonstrated that occupants are provided with adequate time to safely evacuate the building prior to the onset of untenable conditions.
(b)	the number, mobility, and other characteristics of occupants; and	The staff population are expected to be familiar with their place of employment and the egress provision in and around their workstations, and the open plan design provides for early occupant detection.
(c)	the function or use of the building; and	The building's function lends to a population that are awake and familiar with the egress path by which they entered the building, it is deemed that the building's function provides for minimal hazard to occupants and further assists the implementation of the alternative solution.
(d)	the height of the building; and	The affected area has direct access to outside. This demonstrates that there is a low level of risk to occupant entrapment, and allows fire brigade personnel to easily access all levels of the building with minimal obstructions or delays.
(e)	whether the exit is from above or below ground level.	General staff and clients are all on ground floor level allowing quick egress from the building.

Table 18: Performance Requirement Assessment (EP2.2)

EP2.2		CONCLUSION
In the event of a fire in a building the conditions in any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building so that-		
(i)	The temperature will not endanger human life; and	The temperature is shown to remain below a tenability limit of 60°C to the end of evacuation of occupants remote from the fire plume. Visibility is shown to remain above 2-metres for the period it takes occupants to evacuate in all simulated scenarios. Carbon monoxide (CO) concentrations do not reach the limits of tenability indefinitely in any of the modelled scenarios.
(ii)	The level of visibility will enable the evacuation route to be determined; and	
(iii)	The level of toxicity will not endanger human life.	
The period of time occupants take to evacuate referred to in (a) must be appropriate to:-		
(i)	The number, mobility and other characteristics of the	The redundancy scenario found that even with 50% of the egress doors unavailable the travel distance remains as the limiting factor. Characteristics of occupants are not expected to influence their ability to

EP2.2		CONCLUSION
	occupants; and	egress from the building by their own volition.
(ii)	The function or use of the building; and	High level staff supervision and monitoring will provided to the building by virtue of the nature of the use and staff operation.
(iii)	The travel distances and other characteristics of the building; and	Distances to points of choice are extended and deemed to be appropriate provided the high level of staff awareness in the area. Distances of travel to exits and between exits are increased within the warehouse, however to no greater degree than in the FER. Despite the increased travel distance occupants are able to reach an exit in acceptable enclosure conditions.
(iv)	The fire load; and	The fast fire growth rates included in the design fires consider the most likely fuel load that would be expected in the warehouse.
(v)	The potential fire intensity; and	The fires have been modelled to reach differing maximum peak heat release rates so as to allow for any uncertainty in the simulation.
(vi)	The fire hazard; and	The fire hazard is relative to the function of the building and the application of management in use systems. In this instance the hazard associated with the development of fire has been assessed through the use of computer modelling and determining relevant acceptance criteria for occupants and fire fighters. The Ultra-fast fire growth rate considers the fire hazard expected in the building.
(vii)	any active fire safety systems installed in the building; and	The sprinkler system will assist in reducing fire growth and hence smoke production.
(viii)	fire brigade intervention.	The sprinkler system aids in fire brigade intervention. Enclosure temperature levels remain within fire fighter tenability limits outside the fire plume to allow fire brigade intervention.

Conclusion

Within the building the following fire safety strategies are relied upon so as to permit the rationalisation of the smoke exhaust system and travel distances provided:-

- Increased probability of fire suppression through the installation of an automatic fire sprinkler system.
- Increased likelihood of prolonged tenable conditions for occupants and fire fighters associated with the large building volume.

The Alternative Solution described herein has been assessed in accordance with A0.5(b)(i), A0.9(b)(ii) and A0.9(c) and therefore complies with the requirements of A0.8, A0.10 and Performance Requirements **DP4** and **EP2.2** by demonstration that occupants have adequate time to evacuate the building prior to the onset of untenable conditions.

WALKWAYS PLATFORMS STAIRS

Regulatory Assessment

In order to assess the non-compliance of the relevant BCA DTS clause(s) the following table is provided to outline the relevant regulatory requirements and assessment methods.

Table 19: Regulatory Assessment

REGULATORY REQUIREMENT	DESCRIPTION / DETAILS
BCA DTS provision:	Clause D2.18 requires that a walkway, stairway, any going and riser, landing handrail or balustrade may comply with AS1657 in lieu of D2.13, D2.14, D2.16 and D2.17 provided it serves only a room dedicated for machinery, plant or non-habitable room.
Non-compliance with DTS provisions:	Walkovers outside the dedicated plant area are designed in accordance with AS1657, i.e. to provide egress over the automated racking conveyors.
Relevant Performance Requirement(s):	CP9
Assessment methodology:	The assessment methodology adheres to Clauses A0.5(b)(ii) and A0.9(c) of the BCA. The analysis is comparative and qualitative in demonstrating that life safety is not compromised above other parts of the building permitted to use the design standard AS1657.
Acceptance criteria:	Occupant types in the areas served by the walkovers are comparative to DTS plant areas.

Introduction

BCA Clause D2.18 requires that a walkway, stairway, any going and riser, landing handrail or balustrade may comply with AS1657 in lieu of clauses D2.13, D2.14, D2.16 and D2.17 of the BCA provided it serves one of the following areas:-

- Machinery room
- Boiler house
- Lift-machine room
- Plant room; or
- A non-inhabitable room such as an attic, storeroom or the like that is not used on a frequent basis in a sole-occupancy-unit in a Class 2 or 4 building.

The confines of the automated racking has restricted access to maintenance workers only and is a dedicated plant/machinery room commensurate to the areas listed above. The de-palletisation area to the north and the palletising area to the south of the racking does not have restricted access yet is provided with walkover stairs that comply with AS1657 in lieu of BCA DTS Clause D2.13, D2.14, D2.16 and D2.17. It should be noted that the automated racking area is classified as plant area by the Authority having Jurisdiction and therefore the use of AS1657 walkways, stairs and platforms complies with the DTS provisions.

The location of the non-conformances and an indicative design of the walkover are illustrated in Figure 10.

Intent of the BCA

The Guide to the BCA [2] states that DP4 is designed to take into account the distance travelled; the number of occupants; and the occupant characteristics in order to determine what is an acceptable travel time having regard to the function of the building; it's likely fuel load; it's height; and whether the exit is from above or below ground level.

The Guide continues to state that, ' *some areas are only accessed by maintenance or specialist workers. In such areas, access and egress requirements for members of the public no longer apply, and the requirements are permitted to fall outside the various measurements applying elsewhere.'* Therefore it can be reasoned that if the subject area is only accessed by 'specialist' workers then the provision for access stairs and platforms in accordance with AS1657 are appropriate.

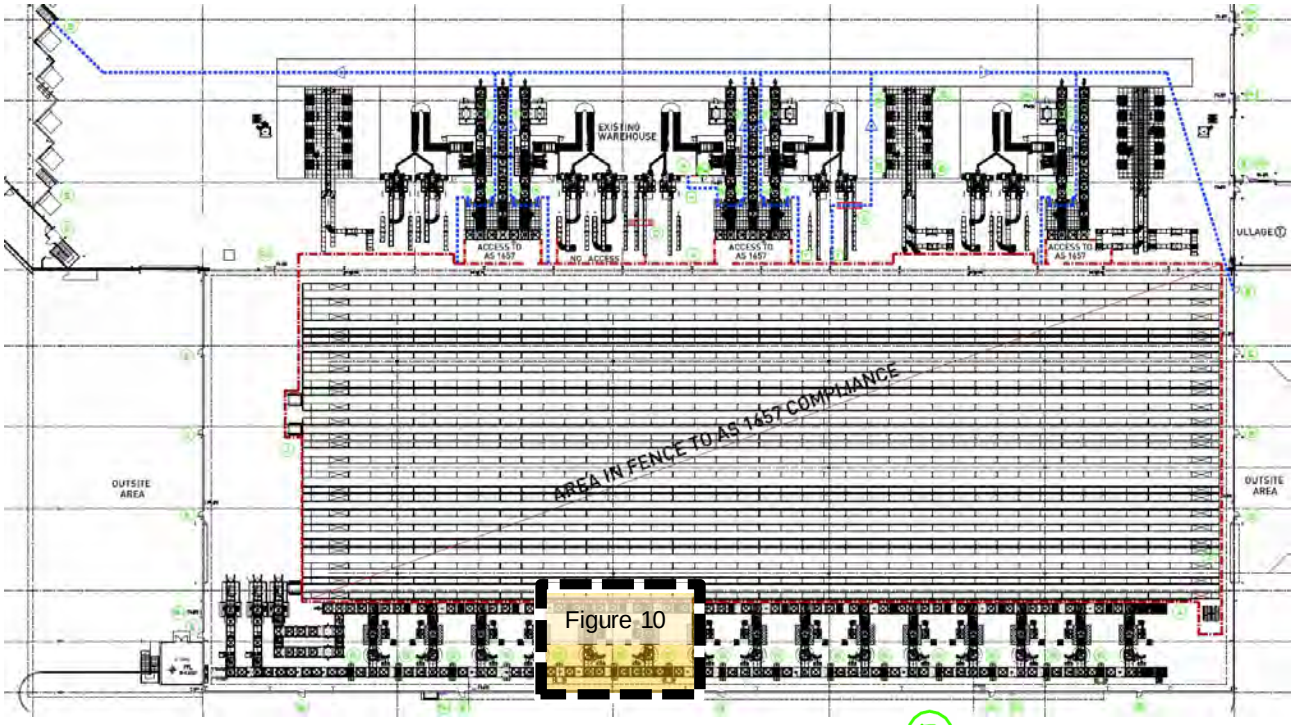

Figure 9: Location of AS1657 walkover stairs indicated by the symbol Ⓑ

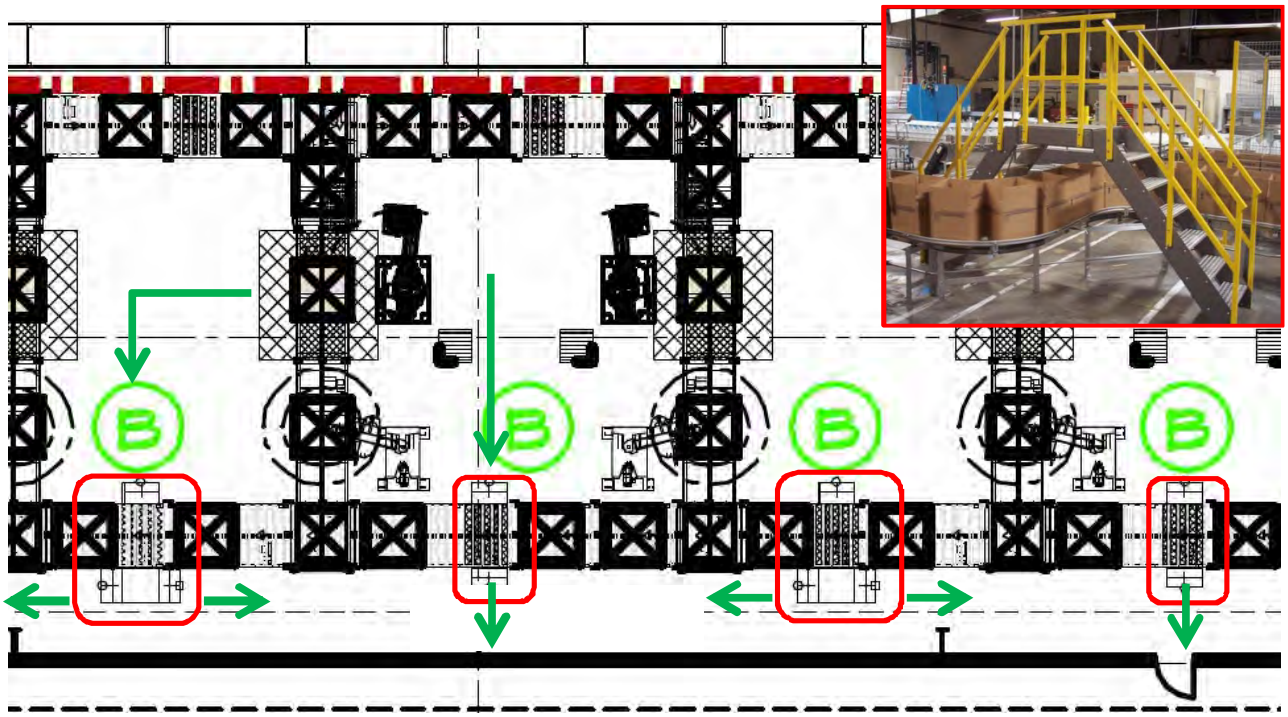

Figure 10: Indicative walkover types and locations in the southern palletising area

Fire Engineering Analysis

The palletising and de-palletising areas of the automated racking system do not form dedicated plant areas however the only occupants in these areas are staff that have been trained in the use and function of that part. They must also undergo the general site induction and building/area specific induction. Therefore not only will occupants of the general public not be present in the affected areas but neither will the general staff who have not undergone specific work place training. Further these areas will consist of one or two staff members at any point in time, with the areas primarily vacant.

The BCA permits areas that are not accessed by the general public to have egress pathways designed to a less stringent standard. This is due to the fact that any person occupying the space is likely to be fully aware of the activities being undertaken in the area, be familiar of the available egress routes and be appropriately capable of entering and exiting the area without requiring assistance from other occupants.

This does not suggest that occupants with mobility disabilities are not permitted within the subject areas, however if their specific disabilities restrict their ability to undertake the required work tasks within the palletising/de-palletising areas, they are not expected to be employed in this area and therefore not required to navigate the AS1657 stairs.

DTS Clause D1.16 permits a ladder to form part of the egress route provided the floor plate is limited to no greater than 100m^2. The Guide to the BCA states that this is due to occupant familiarity and the low population in the area. A low population indicates that there will be minimal queuing at the egress pinch points. The affected areas serve small parts of the building with one or two staff present at any one time. Therefore similarly to DTS Clause D1.16, during an evacuation the lack of occupant queuing will allow staff to safely navigate the stairs without the pressure of crowd interaction.

Considering the type of occupants required to pass over the conveyors via the AS1657 walkovers it is deemed that the population are not subject to conditions any worse than permitted in a DTS plant room, machine room or the like.

Performance Requirement Assessment

The following table provides assessment of each of the relevant BCA Performance Requirements thereby achieving compliance with the BCA.

Table 20: Performance Requirement Assessment (DP4)

DP4	CONCLUSION
Exits must be provided from a building to allow occupants to evacuate safely, with their number, location, and dimensions being appropriate to -	
(a) the travel distance; and	Previous assessments have demonstrated that occupants are provided with adequate time to safely evacuate the building prior to the onset of untenable conditions incorporating safety factors. The use of the subject stairs and walkovers are equivalent to a DTS scenario where occupants must egress from a plant or machinery room.
(b) the number, mobility, and other characteristics of occupants; and	Staff will be familiar with their place of employment and the egress provision in and around their workstations. The open plan design provides for early occupant detection and the type of work being undertaken indicates they are capable of navigating the A1657 walkovers.
(c) the function or use of the building; and	The building's function lends to a population that are awake and familiar with the egress path by which they entered the building, it is deemed that the building's function provides for minimal hazard to occupants and further assists the implementation of the alternative solution.
(d) the height of the building; and	The affected area is on ground floor level. This demonstrates that there is a low level of risk to occupant entrapment, and allows fire brigade personnel to easily access the building with minimal obstructions or delays.
(e) whether the exit is from above or below ground level.	General staff and clients are all on ground floor level allowing quick egress from the area.

Conclusion

Within the building the following fire safety strategies are relied upon so as to permit the rationalisation of AS1657 walkovers:-

- Only trained specialist staff will be located in the affected areas.
- Low population load and occupants with good mobility.

The Alternative Solution described herein has been assessed in accordance with A0.5(b)(ii) and A0.9(c) and therefore complies with the requirements of A0.8, A0.10 in demonstrating an equivalent level of safety as a DTS building and thus complies with Performance Requirement **DP4**.

RAW Fire Safety Engineering

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APPENDIX A - FDS INPUT FILES

```
!!! Generated by BlenderFDS 2.0.1 on Blender 2.65 (sub 0)
! Blender file: D:\Mustang Local\Blender\Mustang.blend
! Date: Tue, 05 Feb 2013 08:53:48

&HEAD CHID='Mustang', TITLE='Racking Fire', /

!!! External config file

&TIME T_END=1800.0, SYNCHRONIZE=.TRUE. /
&DUMP NFRAMES=360 /

&MISC SURF_DEFAULT='INERT', TMPA=21./

&VENT MB='XMIN', SURF_ID='OPEN' /
&VENT MB='XMAX', SURF_ID='OPEN' /
&VENT MB='YMIN', SURF_ID='OPEN' /
&VENT MB='YMAX', SURF_ID='OPEN' /
&VENT MB='ZMAX', SURF_ID='OPEN' /

-------
! Smoke detectors
-------
&PROP ID='Smoke Detector', QUANTITY='spot obscuration', LENGTH=1.8, ACTIVATION_OBSCURATION=12/

------
! SPRINKLERS 101*C
-------
&PART ID='Water',
    WATER=.TRUE.,
    AGE=60.00,
    SPECIFIC_HEAT=4.18,
    MELTING_TEMPERATURE=0.00,

VAPORIZATION_TEMPERATURE=100.00,

HEAT_OF_VAPORIZATION=2.259000E003/

&PROP ID='sprinkler',
    QUANTITY='SPRINKLER LINK TEMPERATURE',

ACTIVATION_TEMPERATURE=101.00,
    RTI=50.00,
    PART_ID='Water',
    DROPLET_VELOCITY=10.00/

sens
&SURF ID= 'SENS_BURNER', HRRPUA=1250.0, RAMP_Q='SENS_BURNER RAMP' / Sensitivity 4 x 4 - 20,000 kW
&RAMP ID= 'SENS_BURNER RAMP', T= 0, F= 0.0000/
&RAMP ID= 'SENS_BURNER RAMP', T= 20, F= 0.0038/
&RAMP ID= 'SENS_BURNER RAMP', T= 40, F= 0.0150/
&RAMP ID= 'SENS_BURNER RAMP', T= 60, F= 0.0338/
&RAMP ID= 'SENS_BURNER RAMP', T= 80, F= 0.0600/
&RAMP ID= 'SENS_BURNER RAMP', T= 100, F= 0.0938/
&RAMP ID= 'SENS_BURNER RAMP', T= 120, F= 0.1351/
&RAMP ID= 'SENS_BURNER RAMP', T= 140, F= 0.1838/
&RAMP ID= 'SENS_BURNER RAMP', T= 160, F= 0.2401/
&RAMP ID= 'SENS_BURNER RAMP', T= 180, F= 0.3039/
&RAMP ID= 'SENS_BURNER RAMP', T= 200, F= 0.3752/
&RAMP ID= 'SENS_BURNER RAMP', T= 220, F= 0.4540/
&RAMP ID= 'SENS_BURNER RAMP', T= 240, F= 0.5403/
&RAMP ID= 'SENS_BURNER RAMP', T= 260, F= 0.6341/
&RAMP ID= 'SENS_BURNER RAMP', T= 280, F= 0.7354/
&RAMP ID= 'SENS_BURNER RAMP', T= 300, F= 0.8442/
&RAMP ID= 'SENS_BURNER RAMP', T= 320, F= 0.9605/
&RAMP ID= 'SENS_BURNER RAMP', T= 340, F= 1.0000/
&RAMP ID= 'SENS_BURNER RAMP', T= 1800, F= 1.0000/

wc
&SURF ID= 'WC_BURNER', HRRPUA=889.0, RAMP_Q='WC_BURNER RAMP' / Worst Case 3 x 3 - 8,001 kW
&RAMP ID= 'WC_BURNER RAMP', T= 0, F= 0.0000/
&RAMP ID= 'WC_BURNER RAMP', T= 20, F= 0.0094/
&RAMP ID= 'WC_BURNER RAMP', T= 40, F= 0.0375/
&RAMP ID= 'WC_BURNER RAMP', T= 60, F= 0.0844/
&RAMP ID= 'WC_BURNER RAMP', T= 80, F= 0.1501/
&RAMP ID= 'WC_BURNER RAMP', T= 100, F= 0.2345/
&RAMP ID= 'WC_BURNER RAMP', T= 120, F= 0.3376/
&RAMP ID= 'WC_BURNER RAMP', T= 140, F= 0.4596/
&RAMP ID= 'WC_BURNER RAMP', T= 160, F= 0.6002/
&RAMP ID= 'WC_BURNER RAMP', T= 180, F= 0.7597/
&RAMP ID= 'WC_BURNER RAMP', T= 200, F= 0.9379/
&RAMP ID= 'WC_BURNER RAMP', T= 220, F= 1.0000/
&RAMP ID= 'WC_BURNER RAMP', T= 1800, F= 1.0000/

-------------
! Material Properties
-------------
! CONCRETE
-------
&MATL ID = 'CONCRETE',
    FYI = 'Quintiere, Fire Behavior',
    SPECIFIC_HEAT = 0.88,
    DENSITY = 2100,
    CONDUCTIVITY = 1.0 /
-------
! &SURF ID = 'SLAB',
    ! RGB = 156,102,31,
    ! MATL_ID = 'CONCRETE',
    ! THICKNESS = 0.15 / TRANSPARENCY 0.95

! &SURF ID = 'WALL 1',
    ! RGB = 25,25,112,
    ! MATL_ID = 'CONCRETE',
    ! THICKNESS = 0.15 / TRANSPARENCY 0.5

! &SURF ID = 'OFFICE WALL',
    ! RGB = 65,105,225,
    ! MATL_ID = 'CONCRETE',
    ! THICKNESS = 0.15 / TRANSPARENCY 0.7

! &SURF ID = 'WALL TRANS',
    ! RGB = 25,25,112,
    ! MATL_ID = 'CONCRETE',
    ! THICKNESS = 0.15,
    ! TRANSPARENCY = 0.3 /
-------
! GLASS
-------
&MATL ID = 'GLASS',
    CONDUCTIVITY = 0.76,
    SPECIFIC_HEAT = 0.84,
    DENSITY = 2700 /
-------
! &SURF ID = 'GLASS',
    ! MATL_ID = 'GLASS',
    ! FYI = 'Quintiere, Fire Behavior',
    ! THICKNESS = 0.005,
    ! BACKING = 'EXPOSED',
    ! TRANSPARENCY = 0.2 /
-------
! GYPSUM PLASTER (GYPROCK)
-------
&MATL ID = 'GYPSUM PLASTER',
    FYI = 'Quintiere, Fire Behavior',
    CONDUCTIVITY = 0.48,
    SPECIFIC_HEAT = 0.84,
    DENSITY = 1440 /
-------
! &SURF ID = 'CEILING',
```

```
    ! RGB             = 184,184,184,
    ! MATL_ID        =          'GYPSUM
PLASTER',
    ! THICKNESS    = 0.2,
    ! TRANSPARENCY          = 0.3 /
-------
! STEEL
-------
&MATL ID          = 'STEEL',
    FYI               = 'Quintiere, Fire
Behavior',
    EMISSIVITY    = 0.95,
    DENSITY       = 7850,
    CONDUCTIVITY  = 45.8,
    SPECIFIC_HEAT = 0.46 /
-------
! &SURF ID          =          'SHEET
METAL',
    ! MATL_ID       = 'STEEL',
    ! COLOR         = 'CYAN',
    ! BACKING       = 'EXPOSED',
    ! THICKNESS                = 0.03 /
TRANSPARENCY   0.3

! &SURF ID          = 'STAIR',
    ! MATL_ID       = 'STEEL',
    ! COLOR         = 'BLACK',
    ! BACKING       = 'EXPOSED',
    ! THICKNESS     = 0.2 /

! &SURF ID          = 'PLANT',
    ! MATL_ID       = 'STEEL',
    ! RGB                      =
34,139,34,
    ! BACKING       = 'EXPOSED',
    ! THICKNESS     =        0.2        /
TRANSPARENCY  1

! &SURF ID          = 'RACK',
    ! RGB             = 34,139,34,
    ! MATL_ID       = 'STEEL',
    ! THICKNESS     = 0.15,
    ! TRANSPARENCY          = 0.3 /



-------
! Gas Phase Reaction
-------
&REAC ID        = 'POLYURETHANE',
    FYI         = 'C_6.3 H_7.1 N O_2.1,
NFPA Handbook, Babrauskas',
    SOOT_YIELD = 0.10,
    N           = 1.0,
    C           = 6.3,
    H           = 7.1,
    O           = 2.1,
    CO_YIELD    = 0.05,

MASS_EXTINCTION_COEFFICIENT
=8100,
    VISIBILITY_FACTOR=8/



-------
! Output
-------

! Radiation
! -------
! ! 2A
! ---
! &DEVC QUANTITY='RADIATIVE
HEAT FLUX GAS', XYZ=62,42,1.5,
ORIENTATION=0,1.0,0 /
! ! &OBST XB=62,63,42,43,0,1.5,
RGB=255,0,0,
PERMIT_HOLE=.FALSE./
! &DEVC QUANTITY='RADIATIVE
HEAT FLUX GAS', XYZ=130,15,1.5,
ORIENTATION=0,1.0,0 /
! ! &OBST XB=130,131,15,16,0,1.5,
RGB=255,0,0,
PERMIT_HOLE=.FALSE./
! &DEVC QUANTITY='RADIATIVE
HEAT FLUX GAS', XYZ=62,135,1.5,
ORIENTATION=0,1.0,0 /
! ! &OBST XB=62,63,135,136,0,1.5,
RGB=255,0,0,
PERMIT_HOLE=.FALSE./
! &DEVC QUANTITY='RADIATIVE
HEAT FLUX GAS', XYZ=110,134,1.5,
ORIENTATION=0,1.0,0 /
! ! &OBST XB=110,111,134,135,0,1.5,
RGB=255,0,0,
PERMIT_HOLE=.FALSE./
! &DEVC QUANTITY='RADIATIVE
HEAT FLUX GAS', XYZ=145,134,1.5,
ORIENTATION=0,1.0,0 /
! ! &OBST XB=145,146,134,135,0,1.5,
RGB=255,0,0,
PERMIT_HOLE=.FALSE./
! ! 2B
! ---
! &DEVC QUANTITY='RADIATIVE
HEAT FLUX GAS', XYZ=8,15,1.5,
ORIENTATION=0,1.0,0 /
! ! &OBST XB=8,9,15,16,0,1.5,
RGB=255,0,0,
PERMIT_HOLE=.FALSE./
! &DEVC QUANTITY='RADIATIVE
HEAT FLUX GAS', XYZ=50,15,1.5,
ORIENTATION=0,1.0,0 /
! ! &OBST XB=50,51,15,16,0,1.5,
RGB=255,0,0,
PERMIT_HOLE=.FALSE./
! &DEVC QUANTITY='RADIATIVE
HEAT FLUX GAS', XYZ=8,110,1.5,
ORIENTATION=0,1.0,0 /
! ! &OBST XB=8,9,110,111,0,1.5,
RGB=255,0,0,
PERMIT_HOLE=.FALSE./
! &DEVC QUANTITY='RADIATIVE
HEAT FLUX GAS', XYZ=50,132,1.5,
ORIENTATION=0,1.0,0 /
! ! &OBST XB=50,51,132,133,0,1.5,
RGB=255,0,0,
PERMIT_HOLE=.FALSE./

! ! LAYER HEIGHT
! -------
! &DEVC XB= 68,68,11,11,0,13.75,
QUANTITY='LAYER HEIGHT',ID='2A
SW SMOKE LAYER CONFECT
STORE'/
! &DEVC XB= 145,145,11,11,0,13.75,
QUANTITY='LAYER HEIGHT',ID='2A
SE SMOKE LAYER'/
! &DEVC XB= 68,68,147,147,0,13.75,
QUANTITY='LAYER HEIGHT',ID='2A
NW SMOKE LAYER'/
!           &DEVC           XB=
145,145,147,147,0,13.75,
QUANTITY='LAYER HEIGHT',ID='2A
NE SMOKE LAYER'/
! &DEVC XB= 10,11,13.75,
        QUANTITY='LAYER
HEIGHT',ID='2B SW SMOKE LAYER'/
! &DEVC XB= 47,11,13.75,
        QUANTITY='LAYER
HEIGHT',ID='2B SE SMOKE LAYER'/
! &DEVC XB= 10,127,13.75,
        QUANTITY='LAYER
HEIGHT',ID='2B NW SMOKE LAYER'/
! &DEVC XB= 47,127,13.75,
        QUANTITY='LAYER
HEIGHT',ID='2B NE SMOKE LAYER'/

!!! Boundary condition defs

! Basic Wall
&SURF          ID='Basic          Wall',
RGB=2,0,204,
TRANSPARENCY=0.700, /
! BurnerRegion
&SURF              ID='BurnerRegion',
RGB=204,0,15,
TRANSPARENCY=0.288, /
! Domain
&SURF ID='Domain', RGB=0,204,191,
TRANSPARENCY=0.510, /
! Door
&SURF ID='Door', RGB=197,204,0, /
! Door.001
&SURF                ID='Door.001',
RGB=197,204,0, /
! Material.001
&SURF              ID='Material.001',
RGB=204,0,167, /
! Racking
&SURF ID='Racking', RGB=0,54,9, /

!!! Computational domain

! Domain.008, 93240 cells, cell size is
1.000 x 1.000 x 1.000, from bounding
box, in 0.000 s
&MESH              ID='Domain.008',
IJK=148,63,10,
    XB=-
82.000,66.000,38.000,101.000,0.000,
10.000, /
! Domain.009, 46990 cells, cell size is
2.000 x 2.000 x 2.000, from bounding
box, in 0.000 s
&MESH              ID='Domain.009',
IJK=74,127,5,
    XB=-
82.000,66.000,101.000,355.000,0.000
,10.000, /
! Domain.010, 171288 cells, cell size
is 1.000 x 1.000 x 1.000, from
bounding box, in 0.000 s
&MESH              ID='Domain.010',
IJK=104,61,27,
    XB=-38.000,66.000,-
23.000,38.000,0.000,27.000, /
! Domain.011, 418176 cells, cell size
is 0.500 x 0.500 x 0.500, from
bounding box, in 0.000 s
&MESH              ID='Domain.011',
IJK=88,88,54,
    XB=-82.000,-38.000,-
23.000,21.000,0.000,27.000, /
! Domain.012, 20196 cells, cell size is
1.000 x 1.000 x 1.000, from bounding
box, in 0.001 s
```

```
&MESH ID='Domain.012',
IJK=44,17,27,
    XB=-82.000,-
38.000,21.000,38.000,0.000,27.000, /

!!! Geometry

! Burner.004, from bounding box, in
0.000 s
&OBST ID='Burner.004',
SURF_IDS='WC_BURNER','INERT','I
NERT', PERMIT_HOLE=.FALSE.,
    XB=-81.000,-77.000,-22.000,-
18.000,0.000,2.000, /
! BurnerRegion.002, from bounding
box, in 0.000 s
&HOLE XB=-81.500,-72.500,-22.500,-
13.500,0.250,23.750, /
! Ceiling, from 23 faces, in 0.001 s

!!! Evacuation


!!! Control logic and output

! CO1.5m, from 1 faces, in 0.001 s
&SLCF QUANTITY='carbon
monoxide', PBZ=1.500, /
! CO2m, from 1 faces, in 0.000 s
&SLCF QUANTITY='carbon
monoxide', PBZ=2.000, /
! CO2m.001, from 1 faces, in 0.000 s
&SLCF QUANTITY='carbon
monoxide', PBZ=4.000, /
! Smoke Detector.000, from center
point, in 0.000 s
&DEVC ID='Smoke Detector.000',
SURF_ID='Material.001',
PROP_ID='Smoke Detector',
    XYZ=-89.500,-30.500,23.300, /
! Smoke Detector.001, from center
point, in 0.000 s
&DEVC ID='Smoke Detector.001',
SURF_ID='Material.001',
PROP_ID='Smoke Detector',
    XYZ=-69.500,-30.500,23.300, /
! Smoke Detector.010, from center
point, in 0.000 s
&DEVC ID='Smoke Detector.010',
SURF_ID='Material.001',
PROP_ID='Smoke Detector',
    XYZ=-69.500,-10.500,23.300, /
! Smoke Detector.011, from center
point, in 0.000 s
&DEVC ID='Smoke Detector.011',
SURF_ID='Material.001',
PROP_ID='Smoke Detector',
    XYZ=-89.500,-10.500,23.300, /
! Sprinkler.032, from center point, in
0.000 s
&DEVC ID='Sprinkler.032',
PROP_ID='sprinkler', XYZ=-84.000,-
16.000,23.000, /
! Sprinkler.033, from center point, in
0.000 s
&DEVC ID='Sprinkler.033',
PROP_ID='sprinkler', XYZ=-84.000,-
19.000,23.000, /
! Sprinkler.034, from center point, in
0.000 s
&DEVC ID='Sprinkler.034',
PROP_ID='sprinkler', XYZ=-84.000,-
22.000,23.000, /
! Sprinkler.035, from center point, in
0.000 s
&DEVC ID='Sprinkler.035',
PROP_ID='sprinkler', XYZ=-84.000,-
25.000,23.000, /
! Sprinkler.036, from center point, in
0.000 s
&DEVC ID='Sprinkler.036',
PROP_ID='sprinkler', XYZ=-81.000,-
25.000,23.000, /
! Sprinkler.037, from center point, in
0.000 s
&DEVC ID='Sprinkler.037',
PROP_ID='sprinkler', XYZ=-81.000,-
22.000,23.000, /
! Sprinkler.038, from center point, in
0.000 s
&DEVC ID='Sprinkler.038',
PROP_ID='sprinkler', XYZ=-81.000,-
19.000,23.000, /
! Sprinkler.039, from center point, in
0.000 s
&DEVC ID='Sprinkler.039',
PROP_ID='sprinkler', XYZ=-81.000,-
16.000,23.000, /
! Sprinkler.040, from center point, in
0.000 s
&DEVC ID='Sprinkler.040',
PROP_ID='sprinkler', XYZ=-78.000,-
16.000,23.000, /
! Sprinkler.041, from center point, in
0.000 s
&DEVC ID='Sprinkler.041',
PROP_ID='sprinkler', XYZ=-78.000,-
19.000,23.000, /
! Sprinkler.042, from center point, in
0.000 s
&DEVC ID='Sprinkler.042',
PROP_ID='sprinkler', XYZ=-78.000,-
22.000,23.000, /
! Sprinkler.043, from center point, in
0.000 s
&DEVC ID='Sprinkler.043',
PROP_ID='sprinkler', XYZ=-78.000,-
25.000,23.000, /
! Sprinkler.044, from center point, in
0.000 s
&DEVC ID='Sprinkler.044',
PROP_ID='sprinkler', XYZ=-75.000,-
25.000,23.000, /
! Sprinkler.045, from center point, in
0.000 s
&DEVC ID='Sprinkler.045',
PROP_ID='sprinkler', XYZ=-75.000,-
22.000,23.000, /
! Sprinkler.046, from center point, in
0.000 s
&DEVC ID='Sprinkler.046',
PROP_ID='sprinkler', XYZ=-75.000,-
19.000,23.000, /
! Sprinkler.047, from center point, in
0.000 s
&DEVC ID='Sprinkler.047',
PROP_ID='sprinkler', XYZ=-75.000,-
16.000,23.000, /
! Temp1.5m, from 1 faces, in 0.000 s
&SLCF
QUANTITY='TEMPERATURE',
PBZ=0.000, /
! Temp2m, from 1 faces, in 0.000 s
&SLCF
QUANTITY='TEMPERATURE',
PBZ=2.000, /
! Temp2m.001, from 1 faces, in 0.001
s
&SLCF
QUANTITY='TEMPERATURE',
PBZ=4.000, /
! TempVert, from 1 faces, in 0.000 s
&SLCF
QUANTITY='TEMPERATURE', PBX=-
60.000, /
! TempVert.001, from 1 faces, in 0.000
s
&SLCF
QUANTITY='TEMPERATURE', PBX=-
35.000, /
! TempVert.002, from 1 faces, in 0.000
s
&SLCF
QUANTITY='TEMPERATURE', PBX=-
5.000, /
! TempVert.003, from 1 faces, in 0.000
s
&SLCF
QUANTITY='TEMPERATURE',
PBX=26.000, /
! TempVert.004, from 1 faces, in 0.000
s
&SLCF
QUANTITY='TEMPERATURE',
PBX=58.000, /
! Temperature Device, from center
point, in 0.000 s
&DEVC ID='Temperature Device',
QUANTITY='TEMPERATURE', XYZ=-
52.000,-29.000,2.000, /
! Temperature Device.001, from
center point, in 0.000 s
&DEVC ID='Temperature Device.001',
QUANTITY='TEMPERATURE',
    XYZ=3.000,-39.000,2.000, /
! Temperature Device.002, from
center point, in 0.000 s
&DEVC ID='Temperature Device.002',
QUANTITY='TEMPERATURE',
    XYZ=39.000,-42.000,2.000, /
! Temperature Device.003, from
center point, in 0.000 s
&DEVC ID='Temperature Device.003',
QUANTITY='TEMPERATURE',
    XYZ=-54.000,30.000,2.000, /
! Temperature Device.004, from
center point, in 0.000 s
&DEVC ID='Temperature Device.004',
QUANTITY='TEMPERATURE',
    XYZ=14.000,47.000,2.000, /
! Vis1.5m, from 1 faces, in 0.000 s
&SLCF QUANTITY='VISIBILITY',
PBZ=0.000, /
! Vis2m, from 1 faces, in 0.000 s
&SLCF QUANTITY='VISIBILITY',
PBZ=2.000, /
! Vis2m.001, from 1 faces, in 0.000 s
&SLCF QUANTITY='VISIBILITY',
PBX=-60.000, /
! Vis2m.002, from 1 faces, in 0.000 s
&SLCF QUANTITY='VISIBILITY',
PBX=-35.000, /
! Vis2m.003, from 1 faces, in 0.000 s
&SLCF QUANTITY='VISIBILITY',
PBX=-5.000, /
! Vis2m.004, from 1 faces, in 0.000 s
&SLCF QUANTITY='VISIBILITY',
PBX=26.000, /
! Vis2m.005, from 1 faces, in 0.000 s
```

```
&SLCF        QUANTITY='VISIBILITY',
PBX=58.000, /
! Vis2m.006, from 1 faces, in 0.000 s

&SLCF        QUANTITY='VISIBILITY',
PBZ=4.000, /

!!! Others

&TAIL /
! Generated in 49.783 s.
```

APPENDIX B - FDS OUTPUT FILES

OCCUPANTS LOCATED AT GROUND FLOOR LEVEL

The following results illustrated the tenability criteria relative to occupants located on ground floor level. As such the modelling slices files are taken at head height, i.e. 2m above floor level.

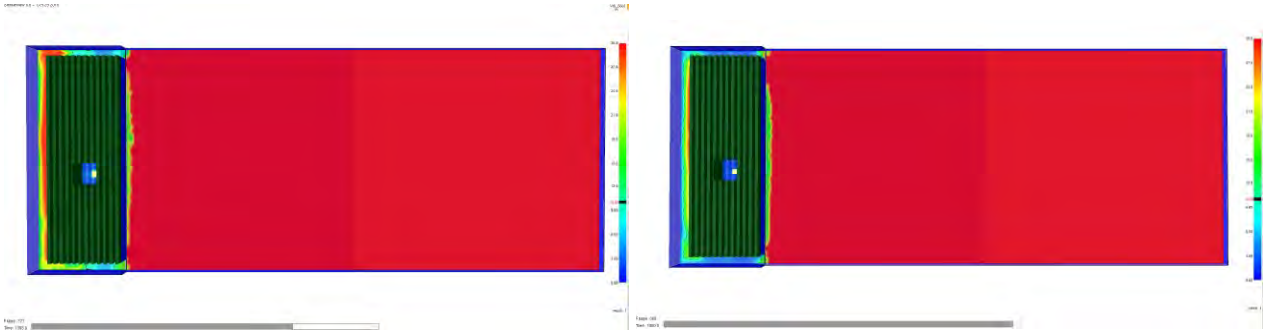

Figure 1: DF1 | Worst Credible | 10m visibility at 2m above FFL | Extension untenable at 1355 seconds and the existing warehouse remains tenable at 1800 seconds *(Rendered by Smokeview)*

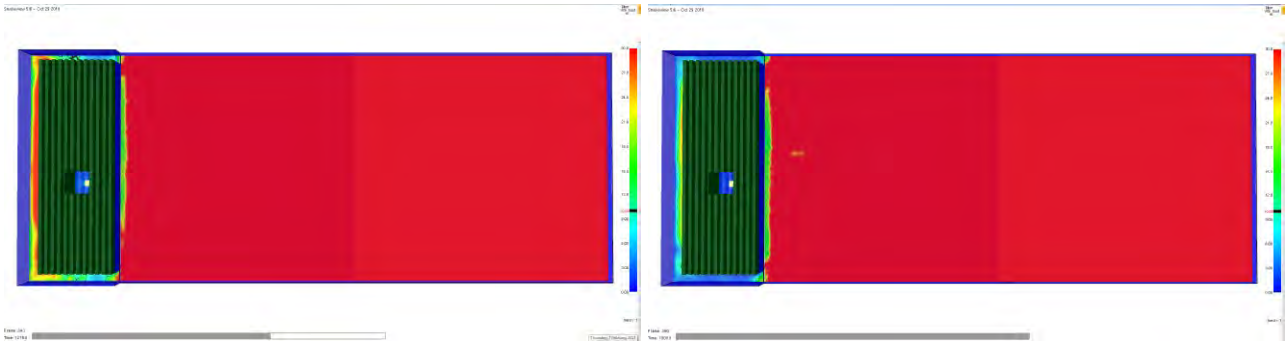

Figure 2: DF1 | Sensitivity | 10m visibility at 2m above FFL | Extension untenable at 1215 seconds and the existing warehouse remains tenable at 1800 seconds *(Rendered by Smokeview)*

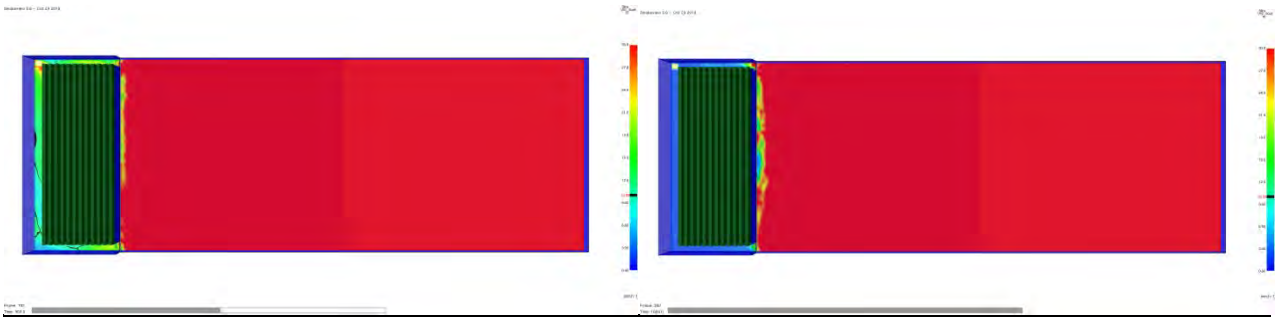

Figure 3: DF2 | Worst Credible | 10m visibility at 2m above FFL | Extension untenable at 960 seconds and the existing warehouse remains tenable at 1800 seconds *(Rendered by Smokeview)*

Smoke spills into the existing warehouse at 690 seconds via the forklift access doors at either side of the racking, with conditions in the Mustang extension considered untenable at 850 second. Throughout the modelling occupants in the existing warehouse are able to safely evacuate via tenable exits away from the fire/smoke hazard.

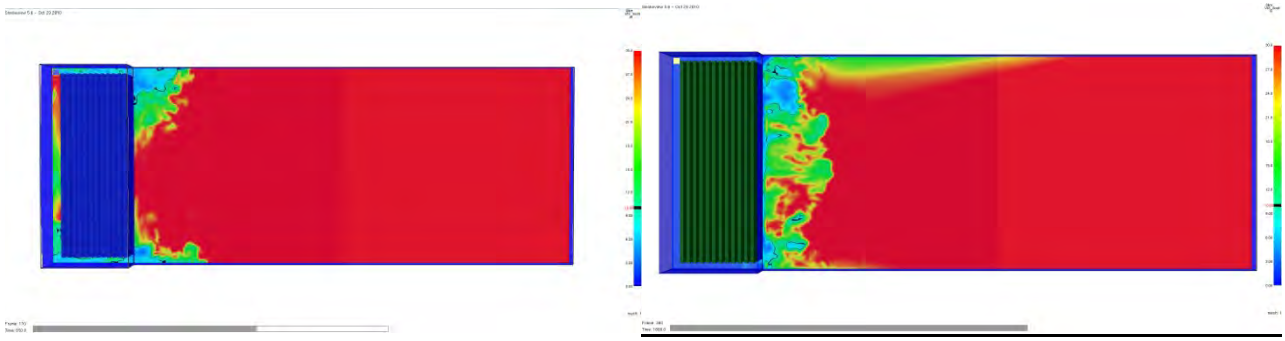

Figure 4: DF2 | Sensitivity | 10m visibility at 2m above FFL | Extension untenable at 850 seconds and the existing warehouse remains tenable at 1800 seconds *(Rendered by Smokeview)*

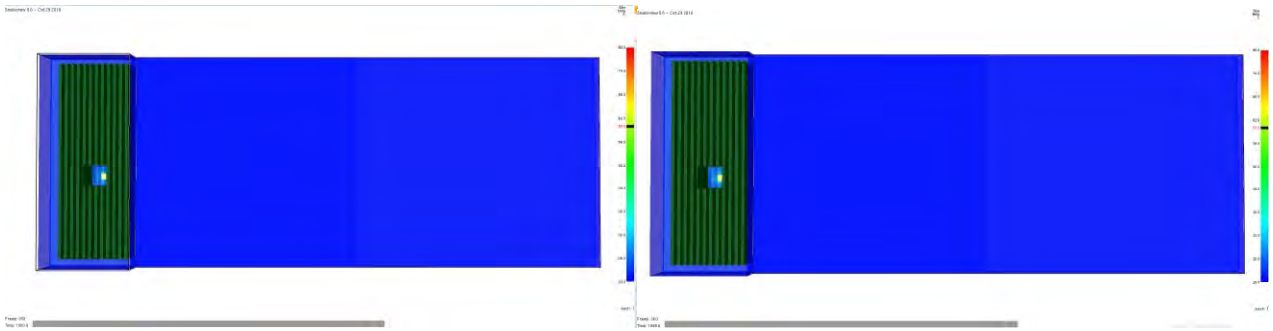

Figure 5: DF1 | Worst Credible and Sensitivity | Temperature at 2m above FFL | Conditions maintained tenable throughout at 1800 seconds *(Rendered by Smokeview)*

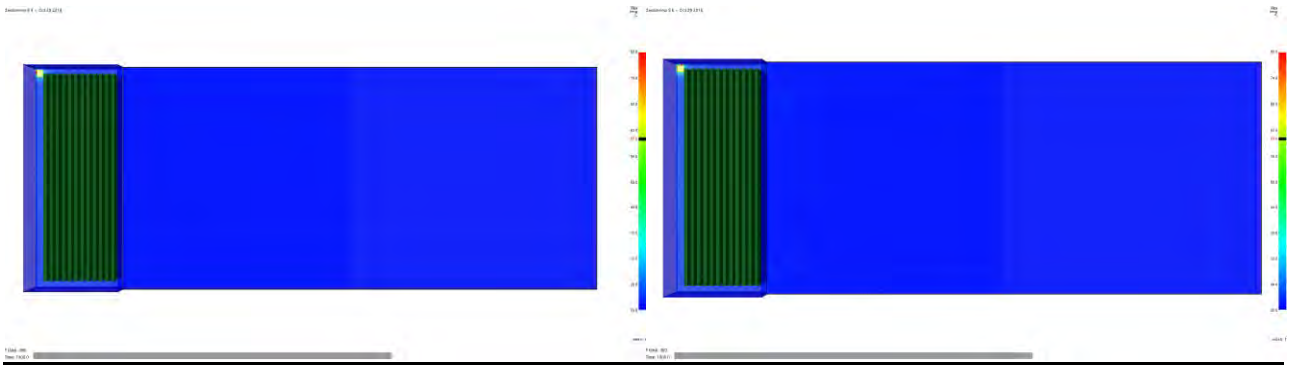

Figure 6: DF2 | Worst Credible and Sensitivity | Temperature at 2m above FFL | Conditions maintained tenable throughout at 1800 seconds *(Rendered by Smokeview)*

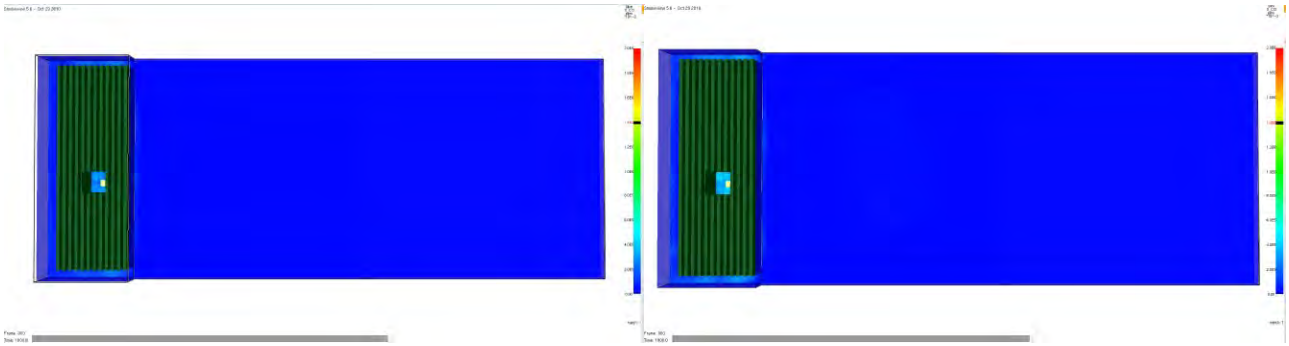

Figure 7: DF1 | Worst Credible and Sensitivity | 1400ppm (CO) at 2m above FFL | Conditions maintained tenable throughout at 1800 seconds *(Rendered by Smokeview)*

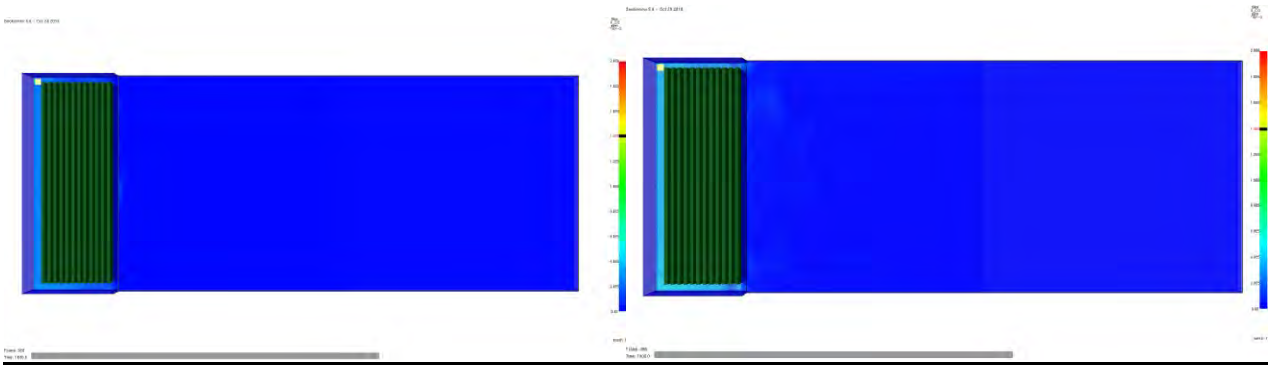

Figure 8: DF2 | Worst Credible and Sensitivity | 1400ppm (CO) at 2m above FFL | Conditions maintained tenable throughout at 1800 seconds *(Rendered by Smokeview)*

OCCUPANTS LOCATED ON THE CONVEYOR WALKOVERS

The following results illustrated the tenability criteria relative to occupants temporarily located on the conveyor walkovers. As such the modelling slices files are taken at head height, i.e. 2m above the walkover heights (4m above floor level).

As the FER did not assess occupant presence at these elevated locations, the results of the design fires in the existing warehouse portion are included in the following outputs. The design fires used from the FER are DF3 and DF4 for the central and corner fires respectively.

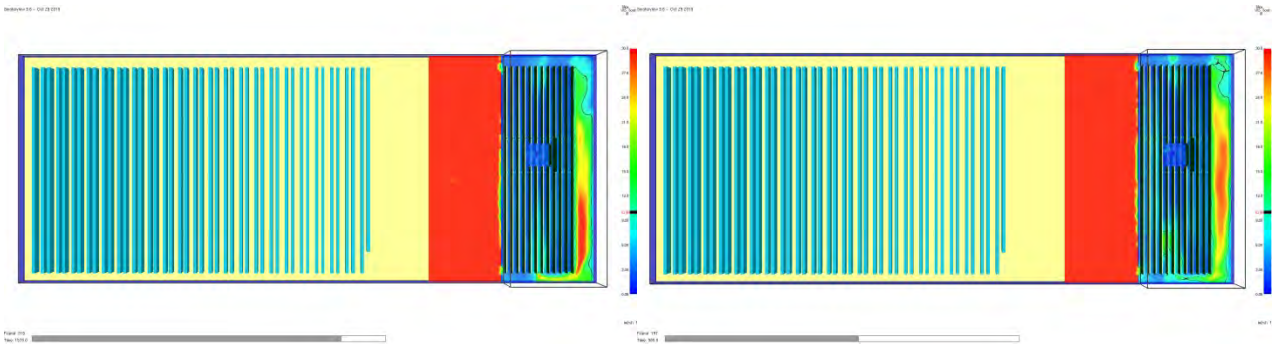

Figure 9: DF1 | Worst Credible and Sensitivity | 10m visibility at 4m above FFL | palletising area untenable at 1575 and 985 seconds *(Rendered by Smokeview)*

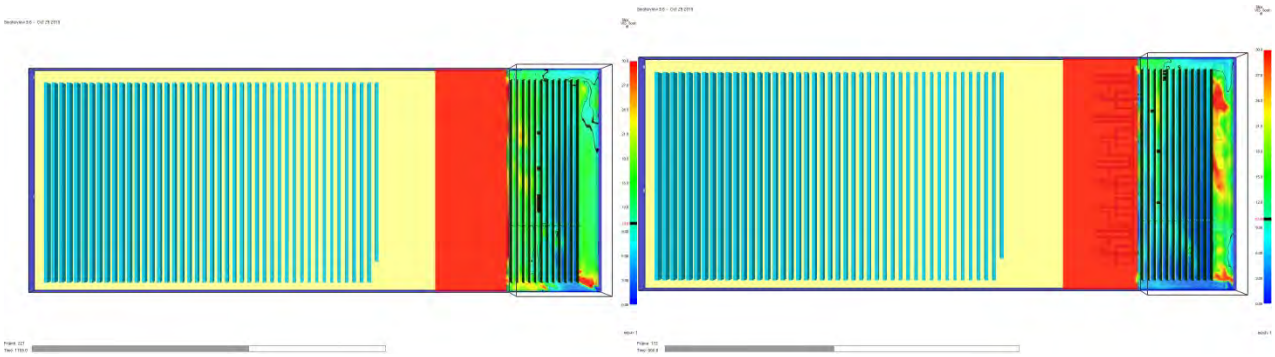

Figure 10: DF2 | Worst Credible and Sensitivity | 10m visibility at 4m above FFL | palletising area untenable at 1105 and 860 seconds *(Rendered by Smokeview)*

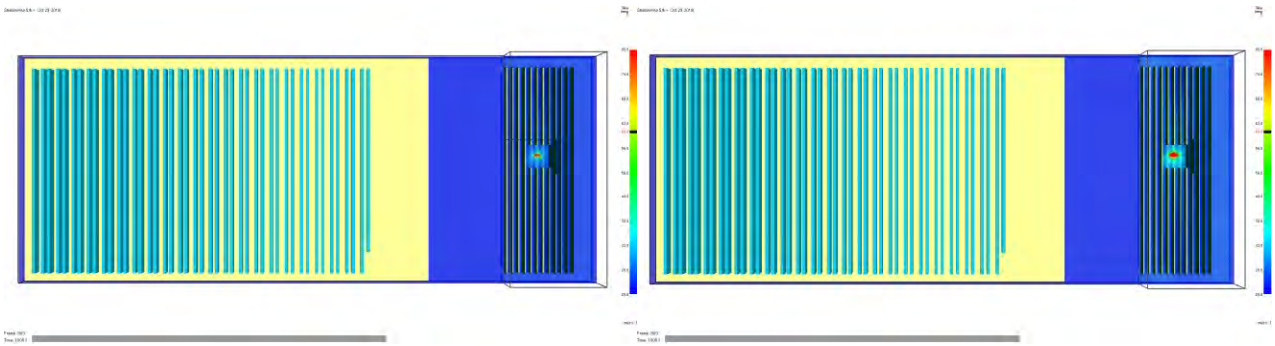

Figure 11: DF1 | Worst Credible and Sensitivity | Temperature at 4m above FFL | Conditions maintained tenable throughout the palletising and depalletising areas *(Rendered by Smokeview)*

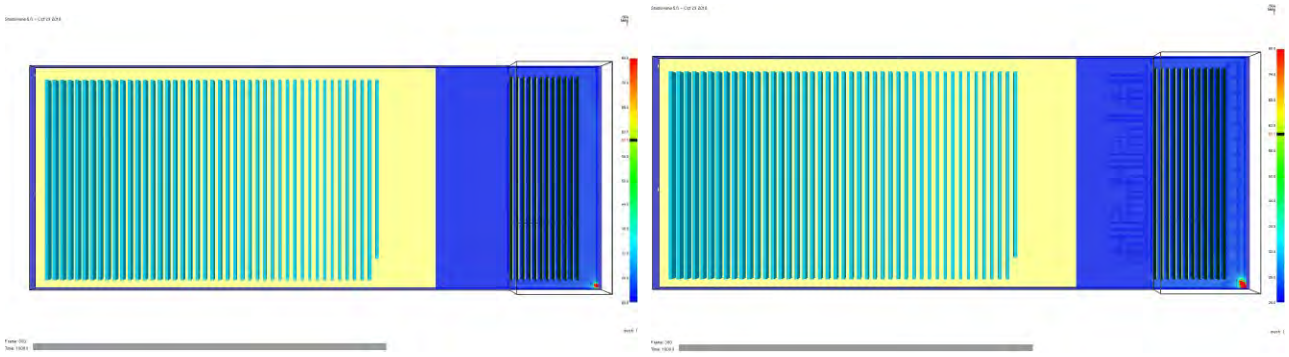

Figure 12: DF2 | Worst Credible and Sensitivity | Temperature at 4m above FFL | Conditions maintained tenable throughout the palletising and depalletising areas *(Rendered by Smokeview)*

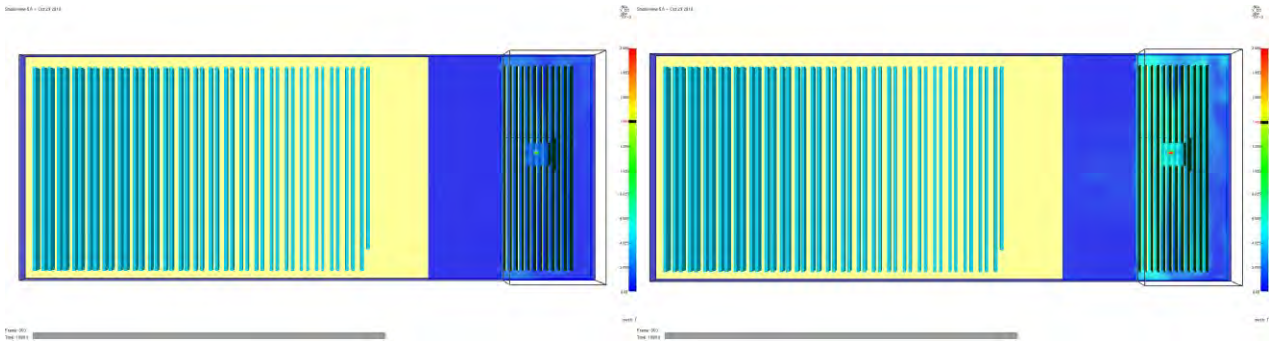

Figure 13: DF1 | Worst Credible and Sensitivity | 1400ppm (CO) at 4m above FFL | Conditions maintained tenable throughout the palletising and depalletising areas *(Rendered by Smokeview)*

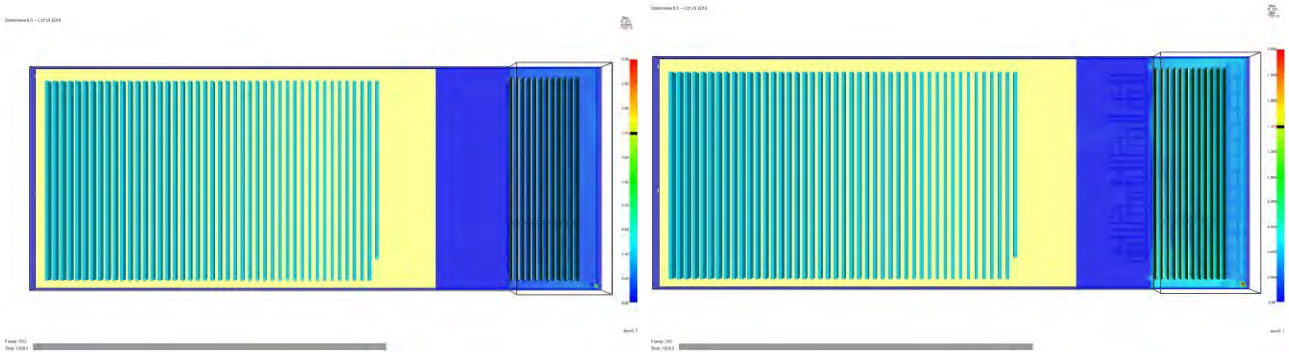

Figure 14: DF2 | Worst Credible and Sensitivity | 1400ppm (CO) at 4m above FFL | Conditions maintained tenable throughout the palletising and depalletising areas *(Rendered by Smokeview)*

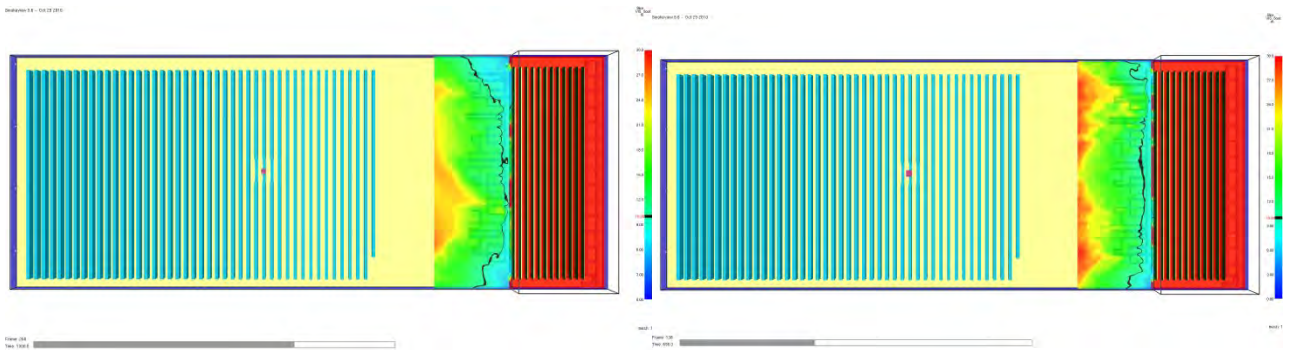

Figure 15: DF3/DF3A | Worst Credible and Sensitivity | 10m visibility at 4m above FFL | depalletising area untenable at 1300 and 690 seconds
(Rendered by Smokeview)

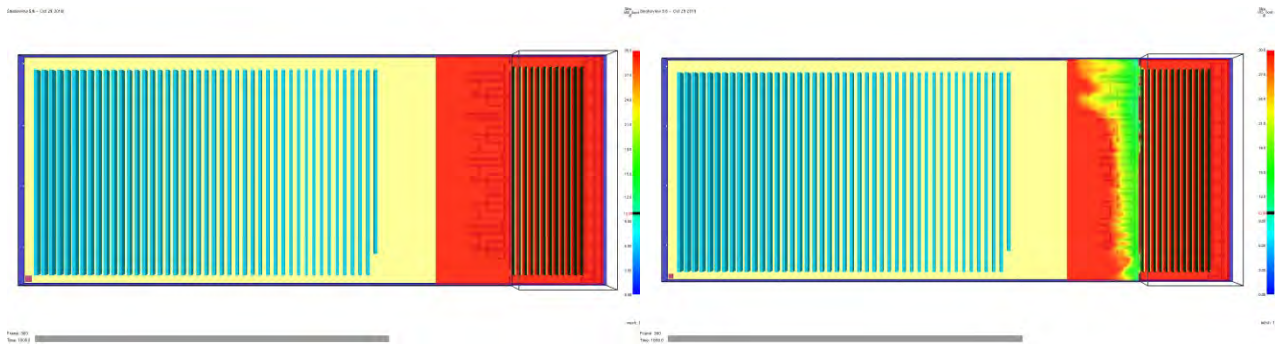

Figure 16: DF4/DF4A | Worst Credible and Sensitivity | 10m visibility at 4m above FFL | Conditions maintained tenable throughout the palletising and depalletising areas *(Rendered by Smokeview)*

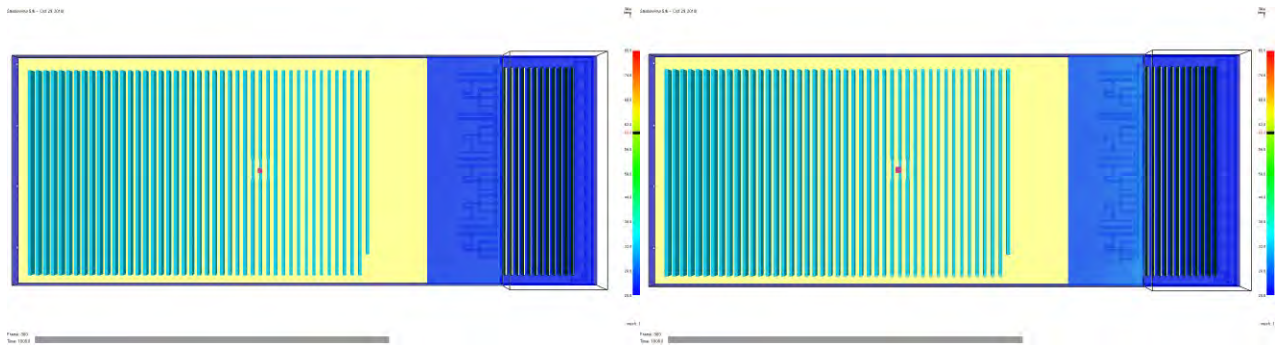

Figure 17: DF3/DF3A | Worst Credible and Sensitivity | Temperature at 4m above FFL | Conditions maintained tenable throughout the palletising and depalletising areas *(Rendered by Smokeview)*

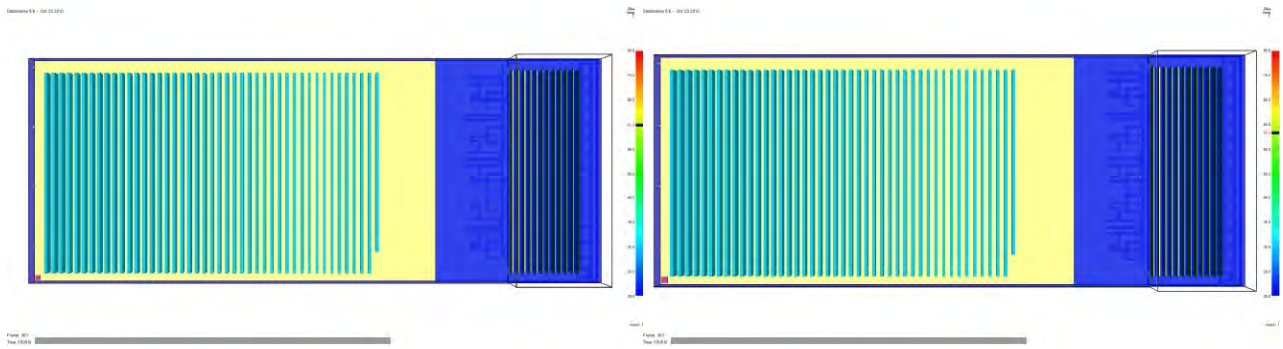

Figure 18: DF4/DF4A | Worst Credible and Sensitivity | Temperature at 4m above FFL | Conditions maintained tenable throughout the depalletising area *(Rendered by Smokeview)*

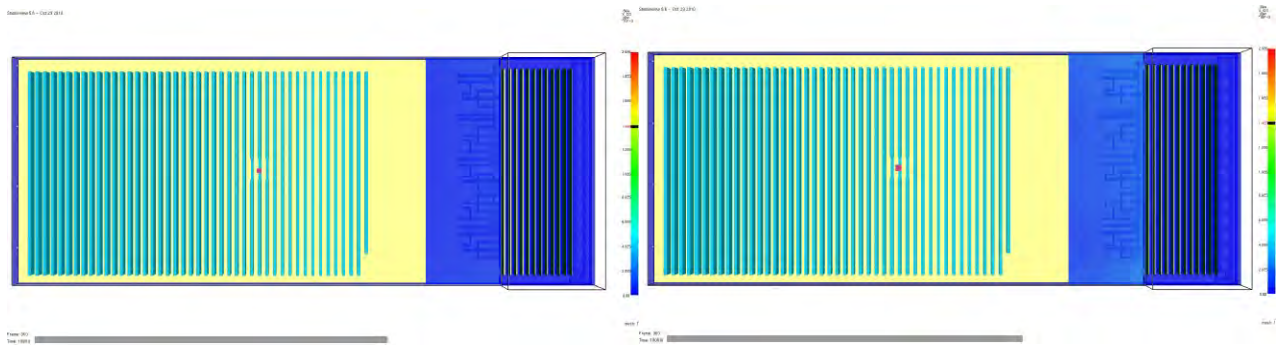

Figure 19: DF3/DF3A | Worst Credible and Sensitivity | 1400ppm (CO) at 4m above FFL | Conditions maintained tenable throughout the depalletising area *(Rendered by Smokeview)*

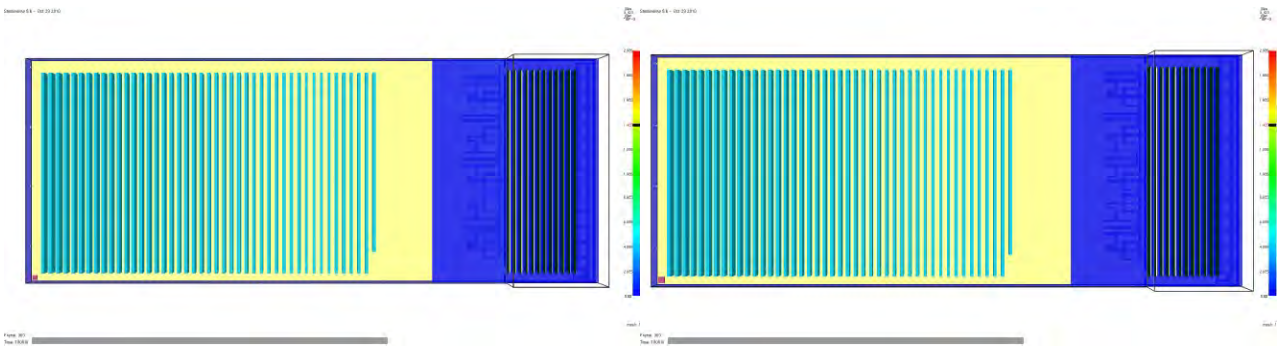

Figure 20: DF4/DF4A | Worst Credible and Sensitivity | 1400ppm (CO) at 4m above FFL | Conditions maintained tenable throughout the depalletising area ***(Rendered by Smokeview)***