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Dangerous Goods Design Review

17 Roberts Road, Eastern Creek, NSW 2766

Report Number: 370224-LoteDGDR-EasternCreekDC-RevD

Date: 18/05/2020

Client:

Canberra Data Centres

Conditions of Use

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Report Reading Guide

The scope of this Dangerous Goods Design Review (DGDR) is to assess the proposed dangerous goods design against the relevant standards.

EXECUTIVE SUMMARY

1.0 INTRODUCTION

2.0 METHODOLOGY

3.0 PRINCIPLE BUILDING CHARACTERISTICS

4.0 DANGEROUS GOODS DESIGN

5.0 CONCLUSION AND RECOMMENDATIONS

The project stakeholders will have varying degrees of involvement in the fire engineering process with an interest in different sections. It is recommended that each stakeholder read the entire document, paying particularly attention to the sections indicated in Table 0.

Table 0 – Recommended reading guide table for project stakeholders

Stakeholder	Executive Summary	1	2	3	4	5	Appendices
Client	✓	✓	✓	✓	✓	✓	✓
Architect	✓	✓	✓	✓	✓	✓	✓
Certifying Authority	✓	✓	✓	✓	✓	✓	✓
Project Manager	✓	✓	✓	✓	✓	✓	✓
Services Engineers	✓	✓	✓	✓	✓	✓	✓
Fire Brigades	✓	✓	✓	✓	✓	✓	✓
Managing Contractor	✓	✓	✓	✓	✓	✓	✓
Sub-Contractor	✓	✓	✓	✓	✓	✓	✓

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Executive Summary

Background

Canberra Data Centres has proposed to develop a data centre to be located at 17 Roberts Road, Eastern Creek. The data centre will require a reliable source of power and will utilize batteries as an uninterruptable power supply along with diesel generators which will operate in the event of sustained power failure. The batteries to be used are Class 9 Dangerous Goods (DGs) while diesel will be used to fuel generators for extended power outages. The site will also contain a variety of other DGs for ancillary uses. As these products are classified as hazardous chemicals, it is necessary to store and handle them in accordance with the Work Health and Safety Regulation 2017 (WHS).

Canberra Data Centres has engaged Lote Consulting (Lote) to prepare a DG assessment of the storage to confirm compliance with the applicable standards and regulations. This document represents Lote's assessment of the facility.

Conclusions

A review of the proposed facility and commodities was conducted to identify whether the facility was a Major Hazard Facility, the required storage locations for the proposed products, the associated design requirements for each storage and finally the studies required to obtain approval. It is concluded that should the findings of this report be followed a compliant design will arise and the risks associated with planning and approval of the proposed facility will be managed.

In addition, a review of the site DG thresholds indicates the facility would not be classified as a Major Hazard Facility (MHF) and is therefore not subject to a formal safety case assessment and review by SafeWork NSW.

It is noted that based on the Consultants Advise prepared by Lote (Ref: 370224-Lote-EasternCreekDC-CA-RevB-Issue) the subject site is not proposed to accommodate more than 2,000 tonnes of diesel.

Recommendations

The following recommendations have been made for the facility:

1. The tank fill points shall be provided with impact protection.
2. Tank fill points shall be provided with signage clearly identifying the location of the fill points.
3. The tanks shall be provided with high level monitoring and alarms per Clause 5.3.3 of AS 1940-2017
4. At least one powder type extinguisher shall be accessible within 10 m of the diesel tanks.
5. The hydrant system shall be able to provide at least 20 L/s

1.0 Introduction

1.1 Background

Canberra Data Centres has proposed to develop a data centre to be located at 17 Roberts Road, Eastern Creek. The data centre will require a reliable source of power and will utilize batteries as an uninterruptable power supply along with diesel generators which will operate in the event of sustained power failure. The batteries to be used are Class 9 Dangerous Goods (DGs) while diesel will be used to fuel generators for extended power outages. The site will also contain a variety of other DGs for ancillary uses. As these products are classified as hazardous chemicals, it is necessary to store and handle them in accordance with the Work Health and Safety Regulation 2017 (WHS).

Canberra Data Centres has engaged Lote Consulting (Lote) to prepare a DG assessment of the storage to confirm compliance with the applicable standards and regulations. This document represents Lote's assessment of the facility.

1.2 Objectives

The objectives of the assessment are to:

- Review the DG classes and quantities to determine the classification of the storages.
- Document the design requirements for each of the DG storage(s).
- Confirm how each DG should be stored to achieve compliance with the applicable standards.

1.3 Scope of Services

The scope of work is to prepare a DG assessment of the Class 9, combustible liquid and assorted other storages to be developed at the 17 Roberts Road, Eastern Creek site for the portion of the site under the State Significant Development Application (SSDA).

This includes Buildings 4, 5, 6 and the 36 generators in individual enclosures located along the Western Boundary and the North-Eastern Corner of the site. In addition, the assessment includes the 12 generators approved for construction under the Complying Development Certificate (CDC) located to the North of the site. A total of 48 generators servicing the proposed data centre have been included in this assessment. Building 3 has been previously approved under a Complying Development Certificate (CDC) and is not within the scope of the assessment in this report

1.4 Abbreviations

The following definitions apply to terminology used in this report

Abbreviation	Description
AS	Australian Standard
BCA	Building Code of Australia
CDC	Complying Development Certificate
DG	Dangerous Goods
ESS	Energy Storage System
FRL	Fire Resistance Level
LAH	High Level Alarm
LAHH	High-High Level alarm
PTU	Power Train Units
SSDA	State Significant Development Application
WHS	Work Health and Safety

2.0 Methodology

The following methodology is proposed:

- Review the classes, quantities and specific UN Nos of the DGs proposed to be stored to fully identify the risks and sub-risks (if present) to inform the direction of the design.
- Document the key design requirements of the facility based on the commodities being stored.
- Document the findings in a report for submission to Canberra Data Centres.

3.0 Principal Building Characteristics

3.1 Site Location

The site is located at 17 Roberts Road, Eastern Creek which is approximately 35 km west of the Sydney Central Business District (CBD). Figure 3-1 shows the regional location of the site in relation to the Sydney CBD.

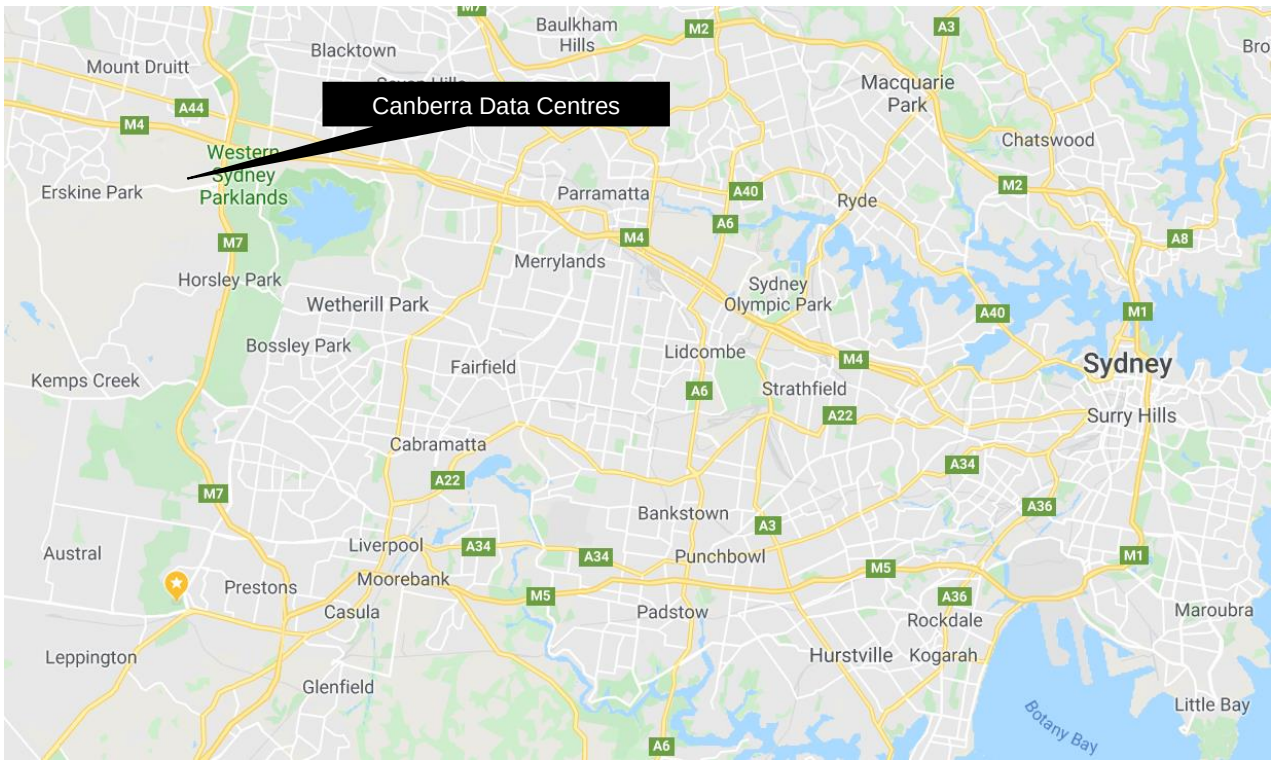

Figure 3-1: Canberra Data Centres Site Regional Location (Source Google Maps)

3.2 General Description

The site will house a data centre to store and manage cloud operations. Continued operation of such centres is fundamental to the business which requires a high reliability of power supply to prevent disruption to the service provided to customers. To achieve the reliable operability, the site will contain several Power Train Units (PTUs) which are battery packs that allow the site to operate without interruption as the batteries can discharge immediately as required. However, sustained operation from the batteries cannot be maintained indefinitely due to the energy demand of the site and the limitations on battery quantity. For continued operation during extended power interruptions the diesel generators will operate to provide continuous power until the main electrical supply is re-established. The site will consist of several High Voltage (HV) transformers, PTUs, and generators with sub-diesel tanks.

DG classes and volumes are discussed in Section 3.3. Figure 3-2 may be used to assist in understanding the description provided above.

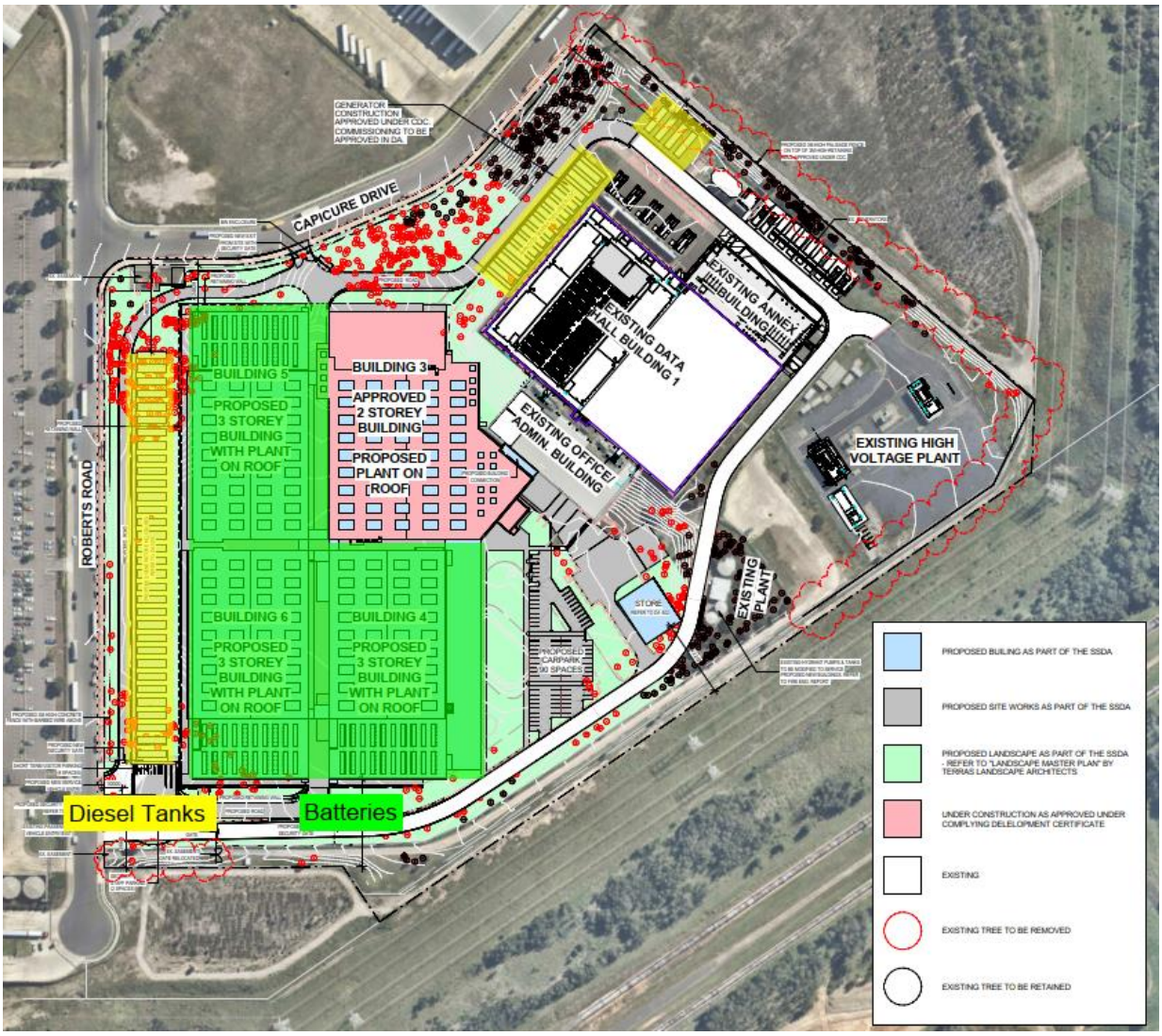

Figure 3-2: Site Layout

3.3 Materials Stored

Provided in Table 3-1 is a summary of the DG classes and quantities that will be stored at the site.

Table 3-1: Proposed Dangerous Goods to be Stored

Material	Class	Total Quantity
PTUs (Batteries)	9	2,519 kg*
Diesel	C1	1,584,000 L (33,000 L per Generator with 48 Generators)
Aerosols and Nitrogen Gas	2.2	100 kg
Flammable Liquids	3	100 kg
Pest Control Products – Corrosive Substances	8	100 kg

*Lithium content in batteries

4.0 Dangerous Goods Design

4.1 Introduction

There are two main storage types within the facility that require assessment which includes the PTUs and the diesel fuel storages. Each area has been assessed in the following sections. The minor quantities of Class 2.2, 3 and 8 DGs have not been assessed further due to low risk these quantities pose as these would be defined as minor storage and are used for ancillary purposes within the facility (i.e. maintenance, kitchen areas, etc.).

4.2 Power Train Units

The energy storage medium within the batteries is Lithium-ion which is classified as a Class 9 DG. Class 9 is strictly speaking only a transport classification and is not applicable during storage and is not subject to the Work Health and Safety Regulation 2017[1]. Notwithstanding this, Lithium-ion batteries have the potential to thermally degrade resulting in fires and explosions. Therefore, it is necessary to demonstrate that the products are stored appropriately to minimise the potential for incidents to occur. The applicable standard for the storage and handling of Class 9 DGs is AS/NZS 4681:2000[2].

The approximate weight of Lithium content within the batteries of 2,519 kg. A review of the standard indicates this would be classified as a package store under the standard. Provided in Table 4-1 is a summary of the design requirements and the assessment of the facility. It is noted that under the minor storage section of the standard there is no limit of Lithium-ion batteries which would exceed minor storage; nonetheless, the storage has been assessed as a package store for conservatism.

1 SafeWork NSW, “Work Health and Safety Regulation,” SafeWork NSW, Lisarow, 2017.
2 Standards Australia, “AS/NZS 4681:2000 - The storage and handling of class 9 (miscellaneous) dangerous goods and articles,” Standards Australia, Sydney, 2000.

Table 4-1: Lithium Battery Storage Assessment Against AS/NZS 4681:2000

Clause	Requirement	Assessment	Recommendations
3.2.2	Class 9 DG shall be separated from protected places and boundaries by at least 3 m	Lithium-ion batteries are exempt from this clause per 3.2.2.1(d)	n/a
3.3.1	a) Store shall be designed and constructed so that the house keeping requirements can be carried out. b) Main structural members, floors, and wall and roof sheeting shall be non-combustible and resistant to attack by the goods being stored. c) Floors shall be designed and constructed so that, in a fire, any molten chemicals are safely diverted to a suitable area for disposal. d) All electrical wiring and lighting shall conform to AS/NZS 3000. e) Any shelving shall be designed and installed so that residues cannot build up along ledges or in corners, and any spillage can be readily noticed and cleaned up. f) Where racking systems are installed, their layout shall allow for clear passage of personnel. g) Storage areas shall be secured against unauthorised entry at all times. h) Were appropriate, a supply of water shall be available at a nearby location, for personal hygiene. i) Exits shall be provided in accordance with the BCA.	a) The batteries will be installed for use allowing sufficient space for maintenance activities which would allow the storage to comply with this clause. b) All members, floors, walls, etc. are to be constructed from non-combustible materials. c) Any fire scenario sufficient to cause molten metals will make any such system irrelevant. d) All electrical equipment will comply with AS/NZS 3000 by virtue of obtaining approval for the facility. e) No shelving installed – n/a. f) No racking systems installed – n/a. g) Access is only available to authorised personnel. h) Batteries are not opened; hence, personnel to do not directly contact the material – n/a. i) Exits will comply with the BCA.	n/a
3.3.2	During the house of operation, lighting shall be sufficient to provide – a) Safe working conditions; and b) Clear visibly of all signs, labels, instruments and other necessary items	Lighting will be provided to allow personnel to utilise the space with clear visibility.	n/a

Clause	Requirement	Assessment	Recommendations
3.3.3	Whenever people are in the storage area, the following ventilation requirements apply: a) Adequate natural or mechanical ventilation shall be provided complying with AS/NZS 1668.2	The area will be ventilated as required by AS/NZS 1668.2	n/a
3.3.4	Where liquids are to be stored, spillage containment shall be provided. a) The following requirement apply to spillage containment: b) The capacity of the spillage containment compound shall be at least 100% of the volume of the largest package, plus 10% of the total storage area up to a maximum of 5,000 L c) The spillage containment system shall be constructed of materials that are resistant to attack by the materials being stored. d) The capacity of the on-site containment shall be including the output of any fire protection sprinklers over a 20-minute period. e) The compound shall be impervious to the materials it is designed to contain. f) Provision shall be made so that any spills cannot run directly into drains which lead to outside the premises.	Lithium batteries contain solid anodes and cathodes along with a liquid electrolyte. The whole unit is sealed to provide containment within the battery. Furthermore, the batteries are individual cells stacked together to form an overall unit resulting in low volumes of electrolyte within a solitary unit. Failure of an individual cell within a unit does not result in large volumes of liquid and total failure of all cells within a unit is incredibly unlikely. Therefore, any spills which occur would be contained within the immediate vicinity of the batteries; hence, spillage containment is not considered to be required for this storage.	n/a

4.3 Diesel Fuel Storage

Diesel fuel is classified as a C1 combustible liquid and is subject to AS 1940-2017[3]. The diesel will be stored in 33,000 L sub-tanks as part of a diesel genset combination with a total combined storage of 1,584,000 L.

A review of each storage indicates they would be classified as bulk storages under the standard. The individual storage is identical. Hence, an overall review of a storage has been provided in Table 4-2 to determine compliance applicable to all storages.

It is noted that based on the Consultants Advise prepared by Lote (Ref: 370224-Lote-EasternCreekDC-CA-RevB-Issue) the subject site is not proposed to accommodate more than 2,000 tonnes of diesel.

3 Standards Australia, AS 1940-2017 - Storage and Handling of Flammable and Combustible Liquids, Sydney: Standards Australia, 2017.

Table 4-2: Diesel Fuel Storage Assessment Against AS 1940-2017

Clause	Requirement	Assessment	Recommendations
5.3.2	The fill point for any tank intended to be filled from a tank vehicle shall comply with the following requirements: a) The fill point shall be readily accessible b) The fill point shall be protected from accidental damage c) The fill point for any tank containing a flammable liquid shall be in open air and no ignition sources shall be located within the hazardous area defined in accordance with AS/NZS 60079.10.1 d) Where practicable, the fill point for any tank containing a combustible liquid shall be outside. e) The fill point for a tank shall be located so that a tank vehicle is not required to enter the tank compound to make delivery. f) For any tank containing a flammable liquid, the location shall be such that the tanker can stand wholly off any public road. g) Each fill point shall be clearly identified. h) The areas around the tank fill point and the vehicle hose connection point shall be impervious to the product.	a) The fill point is located in a readily accessible location b) The fill point will be protected from damage c) Flammable liquids are not stored – n/a d) Fill point is located outside e) Tank vehicle is not required to enter the compound. f) Flammable liquids are not stored – n/a g) Fill point shall be clearly identified h) Tank fill point will be located on hardstand area which is impervious to diesel	• The tank fill points shall be provided with impact protection. • Tank fill points shall be provided with signage clearly identifying the location of the fill points.
5.3.3	a) It shall be possible to monitor or gauge the amount of liquid in any tank intended to receive a delivery. This gauge or monitor shall also show the normal fill level of the tank. The following shall apply: b) The normal fill level shall not exceed 95% of the tank capacity. c) All combustible liquid tanks exceeding 25,000 L shall have a suitable high level alarm (LAH) set at a maximum of 97% of tank capacity. This alarm is the first stage overfilling protection and shall be set to warn when the normal fill level has been exceeded.	The final tank selection has not been determined at this stage. However, they will be double skin walled tanks.	• The tanks shall be provided with high level monitoring and alarms per Clause 5.3.3 of AS 1940-2017

Clause	Requirement	Assessment	Recommendations
	d) Any tank filled by gravity shall be fitted with an automatic flow limiting device which reduces the flow rate int the tank by 98% when the normal fill level of the tank has been attained. e) A content gauge or monitoring device together with a LAH, remote from the tank shall be provided at the fill point. f) In addition to the LAH, they shall incorporate a physically and electrically independent high-high level alarm (LAHH). It will warn of a failure of some element of the primary control system.		
5.7.2	A tank or tanks shall be located so that the following minimum separation distances are maintained: a) Security fences: 3 m b) Onsite protected places: 5.6 m c) Protected place beyond the site boundary: 5.6 m	a) Security fences are located >3 m away from the closest tanks b) Onsite protected places are located closer than 5.6; however, the wall separating the protected places is rated to 240/240/240; hence, results in compliant separation c) All tanks with the exception of one are located >5.6 m away. The variation of one tank by 600 mm is considered acceptable as the separation distance is based upon likely fire scenarios occurring from a tank leaking into a bund. As the tanks are double skinned, any leaks will be contained within the tank structure which prevents ignition sources from contacting the fluid resulting in a fire. Based on the low risk of leakage due to a double-skinned tank and consequently row ignition risk ~600 mm variation is considered acceptable.	n/a
5.7.6	a) Horizontal tanks shall be separated from each other by at least 600 mm	a) Tanks are separated by 600 mm b) Tanks are not arranged end-to-end	n/a

Clause	Requirement	Assessment	Recommendations
	b) Tanks shall not be arranged end-to-end		
5.8.2	The net capacity of a compound shall be at least 110% of the capacity of the largest tank or 25% of the total capacity of all tanks within the bund, whichever is greater.	The tanks are not stored within a tank compound; hence, this clause does not technically apply. Nonetheless, the tanks are double skinned (integrally bunded) tanks which are capable of containing the full volume of the internal tank within the outer tank.	n/a
5.9.2	The following requirements apply to tanks with integrally secondary containment: a) The tank shall not be used for the storage of PG I flammable liquids b) The capacity of the tank shall not exceed – 110,000 L for C1 materials c) The primary (inner) tank shall be constructed to AS 1692 d) The secondary containment shall be adequately designed and constructed to contain the entire contents of the primary tank. e) Means shall be provided to establish and monitor the integrity of the primary tank. f) Where flammable liquid or vapour could escape from the interstitial space of a tank, the tank shall be separated by at least 3 m from any ignition source. g) Spacing between adjacent tanks shall be at least 600 mm h) The tank shall be protected from damage caused by an impact. i) Means shall be provided to prevent release of liquid by siphon flow from the tank. j) The tank shall be fitted with a means of determining the level of its contents. Such means shall be available to the delivery operator.	The tanks will be sourced from a reputable supplier and provided with certification of compliance with AS 1940-2017.	n/a

Clause	Requirement	Assessment	Recommendations
	k) All piping connections to the tank shall be above the normal maximum fill level. l) Tanks shall not be manifolded unless provisions are made to prevent their being overfilled. m) Overfill protection shall be provided by a suitable alarm with the flow of liquid being stopped, before the tank over flows. n) Each fil point shall be provided with spill containment having a minimum capacity of 15 L per fill point. o) Where a tank having multiple compartments is installed, the separation distance to protection places shall be based on the aggregate volume of the compartments and the lowest flash point of the liquid in any tank compartment. p) Venting shall comply with Clause 5.4. q) Where the interstitial space is enclosed, it shall be provided with venting in accordance with this standard.		
11.11.1	Where a tank containing C1 liquid is located within a building, but is not in a tank chamber, it shall be provided with at least one powder type extinguisher located within 10 m of the tank and a hydrant system capable of supplying 20 L/s.	Required fire protection will be provided	• At least one powder type extinguisher shall be accessible within 10 m of the diesel tanks. • The hydrant system shall be able to provide at least 20 L/s

5.0 Conclusion and Recommendations

5.1 Conclusions

A review of the proposed facility and commodities was conducted to identify whether the facility would be capable of meeting the applicable standards to determine whether the risks were managed 'so far as is reasonably practicable' as required by the Work Health and Safety Regulation 2017. The review indicated the facility was capable of meeting the relevant requirements for items that were readily verifiable given the design at this stage. Where compliance was unable to be confirmed (i.e. due to incomplete design) a recommendation was made such that the specific requirement would be included in the design.

Provided that all recommendations are complied with, the storages at the data centre would be capable of meeting the applicable standards and thus the WHS Regulation 2017.

5.2 Recommendations

The following recommendations have been made for this facility:

1. The tank fill points shall be provided with impact protection.
2. Tank fill points shall be provided with signage clearly identifying the location of the fill points.
3. The tanks shall be provided with high level monitoring and alarms per Clause 5.3.3 of AS 1940-2017
4. At least one powder type extinguisher shall be accessible within 10 m of the diesel tanks.
5. The hydrant system shall be able to provide at least 20 L/s.

Appendix A – Preliminary Fire Engineering Battery Assessment

BCA Review

The update to the Building Code of Australia (BCA) 2019 was adopted on the 1st of March 2019 with a key amendment being the inclusion of battery systems as a defined term within the BCA. A battery system is defined as a "one or more chemical cells connected in series, parallel or a combination of the two for the purpose of electrical energy storage".

In the case of the subject site, the Lithium ion battery units fall within this definition of the BCA and are captured under BCA Clause C2.12 shown in Figure A-1.

C2.12 Separation of equipment

(a) Equipment other than that described in (b) and (c) must be separated from the remainder of the building with construction complying with (d), if that equipment comprises—

- (i) lift motors and lift control panels; or
- (ii) emergency generators used to sustain emergency equipment operating in the emergency mode; or
- (iii) central smoke control plant; or
- (iv) *boilers*; or
- (v) a *battery system* installed in the building that has a total voltage of 12 volts or more and a storage capacity of 200 kWh or more.

(b) Equipment need not be separated in accordance with (a) if the equipment comprises—

- (i) smoke control exhaust fans located in the air stream which are constructed for high temperature operation in accordance with Specification E2.2b; or
- (ii) stair pressurising equipment installed in compliance with the relevant provisions of AS 1668.1; or
- (iii) a lift installation without a machine-room; or
- (iv) equipment otherwise adequately separated from the remainder of the building.

(c) Separation of on-site fire pumps must comply with the requirements of AS 2419.1.

(d) Separating construction must have—

- (i) except as provided by (ii)—
  - (A) an FRL as *required* by Specification C1.1, but not less than 120/120/120; and
  - (B) any doorway protected with a *self-closing* fire door having an FRL of not less than –/120/30; or
- (ii) when separating a lift *shaft* and lift motor room, an FRL not less than 120/–/–.

Figure A-1 – Extract from the Building Code of Australia (BCA) 2019 Clause C2.12

It is noted that BCA Clause C2.12 specifies a threshold value of 12 volts and 200 kWh before requiring any additional level of protection. However, full scale tests conducted recently by FM Global discussed below have shown that Energy Storage Systems (ESS) with a storage capacity of less than 200 kWh can be a serious fire source feature.

A fire in a lithium ion cell is prone to thermal runaway in which can result in a cascade to adjacent battery cells or even spread to adjacent units containing multiple batteries. Under such circumstances it is hard to put out a lithium ion cell fire as they are prone to reignition and in most circumstances it is best to let the fire burn out. For this reason, it is recommended that the rooms containing lithium ion ESS be separated and sprinkler protected to mitigate fire spread between ESS units, egress paths and other areas of the building potentially containing sensitive equipment.

FM Global Full-Scale Test

Recent full-scale tests were undertaken by FM Global and a report[4] published in June 2019 for chemical Energy Storage Systems (ESS) with the following recommendations being made from the findings:

i. Each unit containing batteries should be spaced up to 1.8 m from non-combustible items and 2.7 m from combustible including other battery units for a sprinklered space.

ii. The sprinkler system should be design as a high hazard system (3 m x 3 m) to operate of an area of at least 230 m^2 with the following parameters:

   a) A discharge density of 12 mm/min;

   b) K-factor of 81 L/min/$bar^{1/2}$; and

   c) RTI of 27.6 $m^{1/2}s^{1/2}$

iii. The sprinkler system should be designed to operate for the entire room containing the batteries for at least 90 minutes for Iron Phosphate (LFP) or 45 minutes times the number of adjacent racks for Nickel Manganese Cobalt Oxide (NMC) batteries.

It is noted that the full-scale tests conducted are based on a specific battery types outlined in the FM Global report. The report also outlines that the design of the housing in which the batteries are stored enable the entire unit to be engulfed and contribute to the fire while shielding the batteries and fire from the sprinkler system.

Fire Safety Recommendations

The following recommendations are made for the facility to mitigate fire spread as a result of a fire within a Lithium ion battery unit:

1. The rooms containing Lithium ion batteries be enclosed by fire rated construction such that the fire compartment is no greater than 230 m^2. The walls enclosing the batteries should be designed such that they achieve:

   a) At least a 240/240/240 FRL if the battery system has a voltage of 12 volts or more and a storage capacity of 200 kWh or more and comply with BCA Clause C2.12; or

   b) At least a 120/120/120 FRL for battery systems less than the trigger thresholds of BCA Clause C2.12 outlined in a).

2. The sprinkler system should be designed to operate for the entire fire compartment containing Lithium ion batteries for a period of at least 90 minutes or 45 minutes for each adjacent unit depending on the type of ESS and number installed.

4 Ditch, B. Zeng, D. “Development of Sprinkler Protection Guidance for Lithium Ion Based Energy Storage Systems” FM Global, June 2019