

S4

Backup Power Report

NEXTDC

Reference: 521243

Revision: E



Document control record

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Document control		aurecon				
Report title		Backup Power Report				
Document code		Project number		521243		
File path		https://arecongroup.sharepoint.com/sites/521243/5_WorkingFiles/Engineering/Site Infrastructure/Backup Power Report - 1 Dec 23/NEXTDC S4 Backup Power Report.docx				
Client		NEXTDC				
Client contact		James Cameron		Client reference		Technical Director
Rev	Date	Revision details/status	Author	Reviewer	Verifier (if required)	Approver
A	2023-12-20	Draft Issue	JC	SK		SS
B	2024-03-11	Final Issue for Adequacy Review	JC	SK		SS
C	2024-04-19	Final Issue	JC	SK		BM
D	2024-06-14	Final Issue	JC	SK		BM
E	2025-04-24	RTS Issue	JC, SH	HM		JL
Current revision		E				

Approval			
Author signature	 	Approver signature	
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1 Preface

1.1 Executive Summary

This *Backup Power Report* has been prepared by *Aurecon* on behalf of NEXTDC Limited to accompany a detailed State Significant Development Application (SSDA) for the S4 data centre development at 16 Johnston Crescent, Horsley Park. The site is legally described as Lot 305 in Deposited Plan 1275011.

This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (SSD-63741210). This report concludes that the proposed data centre development is suitable and warrants approval subject to the implementation of the following mitigation measures.

- Acoustic attenuation on generator engine equipment
- Limiting testing frequency

Following the implementation of the above mitigation measures, the remaining impacts are appropriate.

Backup power is required for the proposed mission critical facility as outlined in Section 3. While alternatives have been considered in Section 4, ultimately the site will be supported by backup diesel generators housed within acoustic-rated enclosures. Considerations for the design have been outlined in Section 5 in terms of the generator itself, acoustics and the fuel used. The exact frequency and duration of testing is not known at this stage but information has been provided within Section 5 to provide a general overview.

2 Introduction

2.1 Purpose of this Report

This report has been prepared to accompany a detailed SSDA for the proposed S4 data centre development at 16 Johnston Crescent, Horsley Park (SSD-63741210).

The application seeks consent for construction and operation of a data centre development and includes site preparation works, bulk earthworks and infrastructure, and construction of the buildings, ancillary facilities, and associated site works.

The key features of the Proposal are summarised as follows:

- Site preparation works including bulk earthworks including tree removal.
- Staged construction and operation of two data centre buildings comprising a total gross floor area (GFA) of 61,695m² including 56,464m² of technical data hall floor space and 5,231m² of ancillary office floor space, including 'front of house' meeting and administrative spaces.
- Ancillary development including a centralised security office building at the main vehicle entrance, on-site parking for 200 cars, business identification signage (pylon and elevation signage), civil and stormwater works and 12,769m² of deep soil landscaping.
- Provision of a high-voltage (HV) power connection delivering 294 megawatts of power, including a 330kV substation and a 33kV switching station, plus above ground diesel storage tanks and above ground water tanks for industrial water and fire water.
- The project will be delivered in four construction stages as follows:
 - Stage 1 = Building C, HV switching building, 330kV substation, HV external cabling route, entrance to site, centralised security office, and water tanks.
 - Stage 2 = Building D
 - Stage 3 = Building A
 - Stage 4 = Building B

This report has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs) dated 27 October 2023 issued for the SSDA (SSD-63741210). Specifically, this report has been prepared to respond to the SEARS requirement issued below.

Table 2-1 SEARs Compliance

Item	Description of Requirement	Section Reference (this Report)
10. Backup Power Requirement	<ul style="list-style-type: none">■ Provide a detailed overview of any proposed back-up power system, including the scale and capacity of the system, and any associated testing procedures (frequency and duration).■ Provide a detailed justification for the proposed back-up power system, including alternatives considered.	3 Backup Power Requirement 4.2 Alternatives Considered 5.2 Generator Design 5.3 Fuel on Site 5.4 Testing Procedures

2.2 The Site

The site is located at 16 Johnston Crescent, Horsley Park within the Fairfield Local Government Area (LGA). The site is legally described as Lot 305 in Deposited Plan 1275011.

An aerial photograph of the site is provided at Figure 1. The site comprises vacant land which has been cleared of vegetation and does not contain any existing built form structures. Bulk earthworks approved under DA-893-201 are currently underway on the site.

The site will be well serviced by infrastructure. The signalised intersection of Lenore Drive and Old Wallgrove Road at Eastern Creek is approximately 2 kilometres to the north, providing access to Wallgrove Road and the Westlink M7 Motorway to the east and Erskine Park Road and Mamre Road to the west. Each of these roads provides access to the M4 Motorway to the north and M5 Motorway to the south. A utilities and site services report will accompany the EIS.

The site is located approximately 35 kilometres west of the Sydney Central Business District (CBD), 17 kilometres west of the Parramatta CBD and 10 kilometres north-east of the future Western Sydney International (WSI) airport.

The site is within a developing employment precinct, including the ESR Horsley Logistics Park, Oakdale Central, Oakdale South and Horsley Park Employment Precinct. It is also close to other established and emerging employment-generating precincts, including Eastern Creek to the north, Huntingwood to the north-east, Wetherill Park and Mamre Road West to the north-west and Wetherill Park to the east.

Figure 2.2.1 Site Aerial Photograph



Source: Nearmap (2023)

2.3 Detailed Project Description

The key components of the Project are listed in the following table.

Table 2-2 Project Details

Element	Amended Proposal
Land Use Activity	Data centre with 24 data halls, ancillary office floor space
Development Area	8.206 ha (site) plus land within HV route (11,617m ²)
Site Area	8.206 ha
Total GFA	61,695m ²
Data Hall GFA	56,464m ²
Ancillary Office / Admin GFA	5,231m ²
Floor Space Ratio	0.75:1
Car Parking	200 spaces
Bicycle Parking	8 spaces
Motorbike Parking	5 spaces
Maximum Building Height	Building AB – 38.67 metres over four storeys Building CD – 38.67 metres over four storeys
Deep Soil	12,769m ² (15.6% of site area)
Tree Removal	0 trees required to be removed for main data centre site. Six trees to be removed on Old Wallgrove Road at interface with TransGrid substation for the HV external cabling route.
Cut and Fill Volume	Net cut 26,000m ³ (approximately)
Power Consumption	294 megawatts
Operating Hours	24-hours, 7 days a week
Jobs - full-time equivalent (FTE) employees	Construction: 1,111 Operation: 411
Generators	120
Utilities and services	<u>Diesel Tanks:</u> Building AB: 16 x 136kL Building CD: 16 x 136kL <u>Industrial Water Tanks:</u> Building A+B: 3 x 2124kL Building C+D: 3 x 2124kL <u>Fire Water Tanks:</u> 2 x 400kL <u>Substation:</u> 330kV substation plus a 33kV switching station on site

2.4 Stakeholder Engagement

Stakeholder consultations with Transgrid & Lumea are ongoing. Refer to Section 6 of the *S4 SEARs Infrastructure Report* for further details on stakeholder consultations.

2.5 Methodology

This section outlines the methodology used to define the baseline and undertake the assessment of selection and potential impacts of the proposed backup power system on the surrounding area.

2.5.1 Study Area

The assessment area will be limited to the subject site (including site boundary) and the surrounding roads/buildings.

2.5.2 Method of Assessment

To address the project SEARs, this report has analysed the proposed electrical topology of the site and calculated the individual and aggregate backup power required for each building. The backup power sources have been identified through availability in the market, suitability for Data Centres, and viability for the proposed site. Through vendor discussions and application of Australian design standards, the designs of the generator enclosures and fuel storage have been proposed.

2.6 Existing Environment and Considerations

There are no backup power sources at scale known to exist at the current site. While already located in an industrial zone, there are residential properties to the east of the site which may be impacted by the proposed site while in construction and in operation.

The noise and emissions from the site backup power generation needs to be considered and mitigated through the design and operation of the site. While individual backup generation sources may produce limited pollution individually, the aggregate contribution of the site to the environment is of particular interest. Refer to Section 5.2 for further details and references to other relevant reports.

3 Backup Power Requirement

The new development is proposed to be supplied by a new Lumea 330kV/33kV Substation. The power supply will be distributed within the site via the proponent's own underground electrical infrastructure. The new substation may also supply developments in the proximity of the site.

The data centre is a mission critical facility and therefore requires back up generation if there is interruption to the utility supply. Each building will be provided with diesel-generators and uninterruptible power supply (UPS) systems. The UPS system is designed to maintain supply between loss of utility and changeover to the generator supply, it is not intended to maintain the full load on site for an extended period. For the purposes of this report, only the diesel-generators are considered as "Backup" power, the UPS and battery system are for energy storage and short-term supply only.

Although the energy transmission system in the area is designed to be highly reliable, there is always risk of interruption to utility supplies. The maximum allowable unserved energy per year from the upstream Sydney West 330kV supply point is 1 minute [1] however this does not capture incidental disruptions due to accidents, storms, etc. Any interruption without backup power generation on site would be of extreme detriment to the general community through disruption to the internet services facilitated by the data centre in the area.

4 Backup Power Selection

4.1 Selected Power Generation Technology

The Proponent has opted for diesel-generator sets for the backup power source for the proposed site. This is based on the most appropriate technology for a mission critical data centre and the market readiness for this technology in New South Wales. Alternatives have been considered for this site, but none are considered viable except for alternative fuel for the generator engines. See Section 4.2 for further details.

4.2 Alternatives Considered

Aurecon has previously investigated several options for backup power supply technologies for Data Centre applications in terms of suitability for deployment in data centres, technological maturity in Australia, and viability for the site [2].

4.2.1 Potentially suitable for deployment

The following table describes the backup supply technology, rates its technology maturity, and provides a recommendation on its suitability for data centres.

As outlined in the table, the following technologies were recommended as potentially suitable for deployment as long duration backup supply in data centres:

- Lithium-ion batteries
- Vanadium redox flow batteries
- Diesel generators with renewable diesel (HVO) as a fuel
- Open Cycle Gas Turbines (OCGT) or Reciprocating Engines with natural gas as a fuel
- Hydrogen Fuel Generators

Table 4-1 Backup Power Options Analysis Summary

Technology	Description	Technology maturity	Suitability for deployment in data centres	Trigger points for viability	Viability for proposed site
Lithium-ion battery	<ul style="list-style-type: none"> Lithium-ion batteries uses a cathode (positive electrode), an anode (negative electrode) and electrolyte as conductor. Li-ion battery cells come in many varieties – but all use lithium ions. During charging the lithium ions flow from the cathode to the anode through the electrolyte and separator. When discharging the flow of ions reverses from the anode to the cathode. 	<ul style="list-style-type: none"> High - Lithium-ion batteries have been widely deployed in electric vehicles and are increasingly being deployed as stationary storage for grid applications. 	<ul style="list-style-type: none"> Potentially suitable - The high energy and power density, proven performance and declining costs of lithium-ion batteries make it an attractive option as a backup energy source. Required physical footprint, standby power consumption and fire risk management to be considered. Fire prevention and protection requirements shall be in accordance with the regulatory requirements at the design time. Possible risk assessment might also be required because of the Li-ion batteries. 	<ul style="list-style-type: none"> Capex costs drop per MWh to levels in line with alternatives Space requirements reduce (unlikely for this tech) 	<p>Due to the spatial requirements of Lithium-ion batteries for both fire-separation, fuel separation, and general safety requirements, it is difficult to provide enough battery storage to the site for a medium-term power failure. The current provision for battery storage on site is for short-term supply and energy storage only, to facilitate the switch between utility supply and the backup power supply if interruption to utility occurs (up to 5 minutes only). Thus, this technology is not viable be used as a standalone backup power supply for this site.</p>
Vanadium redox flow battery	<ul style="list-style-type: none"> Flow batteries store energy in electrolytes in electrolyte tanks. The active material of flow batteries comprises of electrolyte solutions that are stored in tanks. The electrolyte is pumped through a reaction stack of electrochemical cells, in which charge, and discharge reactions take place at electrode surfaces. Vanadium redox is the leading flow battery technology in terms of technical and commercial readiness. 	<ul style="list-style-type: none"> Low / Moderate – Limited number of vanadium redox flow batteries in commercial deployment. Most deployments are currently 10-20MWh in energy storage capacity. One 800MWh project is planned is under construction in China. 	<ul style="list-style-type: none"> Potentially suitable – Vanadium redox flow batteries are well suited to long duration storage (4+hrs) by increasing the size of the electrolyte tanks. Cost per MWh expected to decrease as storage duration increases. Higher costs and bigger physical footprint required compared to lithium-ion batteries. 	<ul style="list-style-type: none"> Capex costs drop per MWh to levels in line with alternatives Space requirements reduce (unlikely for this tech) but potential to stack to reduce m2 requirements, potentially advantageous over lithium ion batteries 	<p>Not viable for this site due to commercial availability and scale required to achieve energy autonomy on site during utility failure.</p>

Technology	Description	Technology maturity	Suitability for deployment in data centres	Trigger points for viability	Viability for proposed site
HVO renewable diesel fuel	<ul style="list-style-type: none"> Biodiesel is produced from a diverse mix of resources including vegetable oils (corn, soybeans, rapeseed, palm etc.), animal fats (beef tallow, pork lard etc.), and recycled cooking oil. Conventionally feedstock goes to a transesterification process and becomes biodiesel, which can be blended with petroleum diesel. Advanced methods such as hydrotreatment, gasification, and pyrolysis can be used to produce 'drop in' biofuels. These biofuels are chemically the same as petroleum diesel fuel and is compatible with existing infrastructure designed around petroleum. 	<ul style="list-style-type: none"> Moderate – The biodiesel supply chain is still a localised industry, with some regions having higher biodiesel availability due to access to feedstock, or government mandates. No large scale HVO supply chain or policy support exists yet in Australia. ~440ML of biodiesel produced p.a. (not all are HVO) 	<ul style="list-style-type: none"> Potentially most suitable short-term solution – Biodiesel blends and renewable diesel that are compatible with the existing diesel generator infrastructure. Biodiesel has lower emissions compared to petroleum diesel. Full lifecycle emissions are dependent on the feedstock source. 	<ul style="list-style-type: none"> Supply chain readiness in Sydney & AU around HVOs Confirm high volume of diesel tanker trucks are possible to site for refills 	<ul style="list-style-type: none"> Moderate viability - This site is proposed to use diesel generators and HVO renewable diesel fuel could be used in lieu of standard diesel fuel subject to local supply chain availability.
Natural gas fuel	<ul style="list-style-type: none"> Natural gas as a fuel source, can be used as a backup power source through gas turbines generators. Gas turbine generators draw air into the engine and combusts the fuel to produce a high-pressure gas. This gas expands and rotates the turbines to produce electricity. Can also be used as fuel in fuel cells (e.g. Bloom Energy) 	<ul style="list-style-type: none"> High/ Moderate - Natural gas has a mature global supply chain, with gas turbines widely deployed in electricity grids around the world. 	<ul style="list-style-type: none"> Potentially suitable - Gas turbines are a proven technology. Fuel delivery can be through existing gas pipelines. Natural gas has slightly lower emissions compared to petroleum diesel Fire detection and suppression requirements as a standalone infrastructure will need to be considered to suit the NG turbine plans. 	<ul style="list-style-type: none"> Environmental approvals possible: depends on exact technology selected, expected usage, emissions profile, noise outputs, etc Pipeline capacity confirmed as feasible, impacting transmission throughout Sydney / Newcastle given other gas plants planned for the area 	<ul style="list-style-type: none"> Not viable – the technology requires more space than is currently possible on site compared to other solutions due to increased cooling/ventilation requirements. The impact of a 500MW gas turbine on existing natural gas pipelines may require significant upgrades in the area.

Technology	Description	Technology maturity	Suitability for deployment in data centres	Trigger points for viability	Viability for proposed site
Hydrogen fuel	<ul style="list-style-type: none"> Hydrogen can be used as a fuel source to using fuel cells. A fuel cell consists of a negative electrode (anode) and a positive electrode (cathode) sandwiched around an electrolyte. A catalyst at the anode separates hydrogen molecules into protons and electrons, which then flow to the cathode through different paths. The electrons go through an external circuit, creating a flow of electricity. The protons migrate through the electrolyte to the cathode, where they unite with oxygen and the electrons to produce water and heat. 	<ul style="list-style-type: none"> Moderate – The hydrogen production, delivery and storage supply chain are still immature, but progress is accelerating. One data centre owner is trailing a 3MW hydrogen fuel cell. 	<ul style="list-style-type: none"> Potentially suitable - Highly dependent on further cost reductions and the emergence of an established supply chain Hydrogen storage and delivery requires detailed planning to ensure safety and reliability Case-by-case fire and risk assessment studies need to be considered. Storage likely to trigger Major Hazard Facility requirements 	<ul style="list-style-type: none"> Safety exclusion zones for storage addressed – large site required H2 supply chain established, including market to contract supply H2 pipeline established, including safety and operational concerns addressed Capex costs drop per MWh to levels in line with alternatives 	<ul style="list-style-type: none"> Not Viable – significant spatial requirements of industrial tanks for 24-48 hours of hydrogen fuel on site. No current hydrogen pipeline would be possible within site development timeframe. Additional safety requirements for hydrogen usage on site. Safety considerations for nearby residential areas.

5 Backup Power Generators

5.1 Site Design

The generators are located adjacent to the buildings they serve in an external generator structure (Figure 5.1.1). The generators are housed on raised 3-level structures and are located on the central internal road of the site. Refer to Section 6 of the *S4 SEARs Infrastructure Report* for breakdown of generator quantities per building.

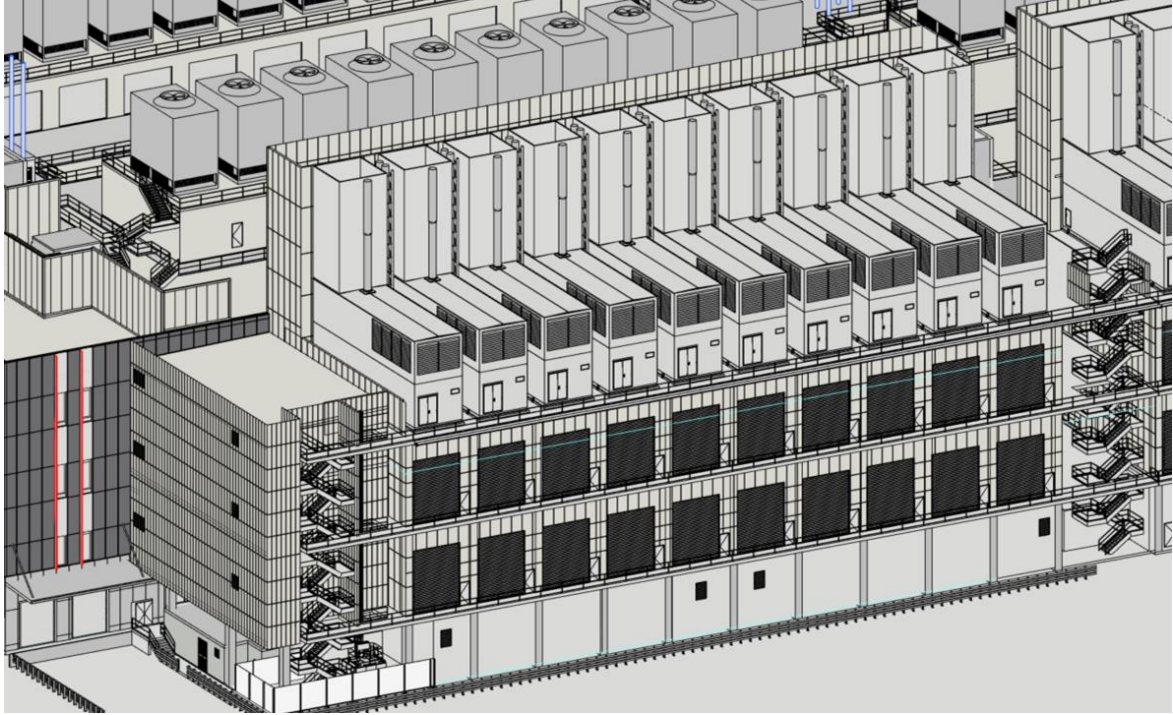
Figure 5.1.1 Location of Generators on Proposed Site (Green)



5.2 Generator Design

The proposed site will use 120 low voltage 3.1MW generators for the Lot 305 buildings (Buildings A-D). These generators will only operate in the event of a mains utility failure to the respective electrical block or for testing purposes. These generators provide a total capacity of 372MW backup power.

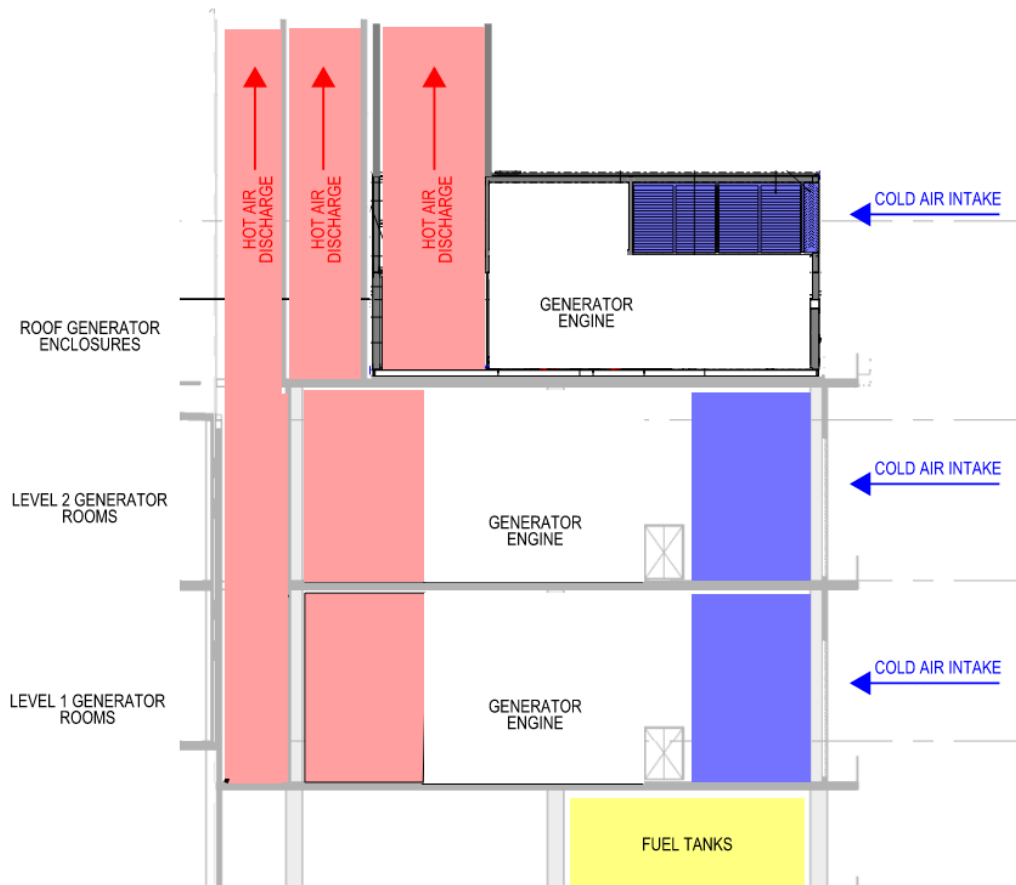
On the 3-level generator structure, the first two levels house in-situ generator rooms while the third/top level supports prefabricated enclosures for the same generator engines. The design of each type is outlined in the following sections.



5.2.1 Generator rooms and enclosures

Each half of Building AB and CD features a repeatable 3-Level generator design. On ground floor tanks provide bulk storage of diesel fuel for the stack of generators, Level 1 and 2 house rows of 10 generator rooms each (20 total), and the third level (roof) provides a platform for 10 prefabricated generator enclosures. Each level of generators has a separate hot air discharge plenum at the building-side of the structure to improve structural support and allow clear installation access for new generator engines and other equipment during the construction of the building.

Figure 5.2.1 Typical 3-Level Generator Slice



Each room/enclosure generally includes the following:

- Generator Engine Set.
- Fuel System, including pumps.
- Control and Power Panels.
- Acoustic attenuation for cold air intake, hot air discharge (for ventilation).
- Exhaust Gas Silencer & Flue.
- Radiator & Fan

5.2.2 Acoustics

At this early stage the final acoustic requirements are not known. For preliminary results and details on the noise modelling for the site (including the generator enclosures) refer to *P521243 NEXTDC S4 Noise and Vibration Assessment*.

5.2.3 Emissions

For further details please refer to the *NEXTDC S4 Air Quality Impact Assessment*.

5.3 Fuel on Site

The generator engines on site will use diesel fuel to generate power. All 3.1 MW generator enclosures will be located on a generator stack. Each generator enclosure contains a fuel day tank. These generator day tanks will be supplied fuel by bulk fuel tanks located in fuel chambers on the ground floor. The fuel systems in each building provide sufficient fuel to run the generators for 48 hours. Fuel tanks will be designed to comply with AS 1692 and AS 1940.

The following table provides the storage requirements per building based on the proposed design.

For the purpose of SEPP 33 planning approvals, the quantity of diesel in the SEARs Infrastructure Requirements Report is 4,472 kL or 3,800 tonnes.

Table 5-1 Fuel Storage per Building

Building	Nominal Fuel Storage Capacity	Comment
Building A	1,118 kL	30 x 3.1MW Gensets with 8 x 136 kL Bulk Tanks and 30 x 1 kL Day Tanks
Building B	1,118 kL	30 x 3.1MW Gensets with 8 x 136 kL Bulk Tanks and 30 x 1 kL Day Tanks
Building C	1,118 kL	30 x 3.1MW Gensets with 8 x 136 kL Bulk Tanks and 30 x 1 kL Day Tanks
Building D	1,118 kL	30 x 3.1MW Gensets with 8 x 136 kL Bulk Tanks and 30 x 1 kL Day Tanks
Total	4,472 kL	~3,800 tonne

5.3.1 Buildings A to D

The fuel storage for the hyperscale buildings is provided by bulk storage tanks. The following table summarises the sizing of the fuel storage.

The fuel efficiency of generators varies with load. The hyperscale fuel system is based on the fuel consumption of the MTU 20V4000 DS4000 or similar performing generator at full load. The generators are less efficient at 100% load, making this the governing case for fuel consumption.

The fuel storage requirement for each building is based on the following:

Description	Value	Comment
N Gensets Required	24	30 total, with 6 redundant
Consumption per Genset	806 L/h	Based on MTU 20V4000 DS4000 at Full Load
Total Consumption	19,344 L/h	
Backup Provided	48 hours	
Pumpable Fuel Required	928,512 L	

Table 5-2: Fuel Volume Calculation for Bulk Tanks

The storage for each building will be provided by the following:

Description	Value	Comment
Bulk Tank Capacity	136 kL	Rounded
Bulk Tank Working Volume	116 kL	Rounded
Number of Bulk Tanks	8	
Total Bulk Tank Fuel Available	930 kL	Rounded
Day Tank Capacity	1000 L	
Day Tank Working Volume	850 L	
Number of Day Tanks	24	30 total, with 6 redundant
Total Day Tank Fuel Available	20 kL	
Total Fuel Available (Bulk + Day Tanks)	950 kL	Rounded
Backup Provided	48 hours	

Table 5-3: Fuel Tank Size Calculation for Bulk Tanks

The custom rectangular bulk tank size was selected based on transportation requirements and spatial constraints on site.

5.3.2 AS 1940 Separation Distances

AS 1940 has separation distance requirements dependent on the size and type of tank. The design utilises rectangular single skin tanks within tank chambers. The tank chamber should be designed as per section 5.13 of AS 1940. There are no specific separation distances which apply to tanks within a tank chamber.

5.4 Testing Procedures

The Generators will each be tested to ensure they are functional in the event of a utility failure. Initially all generators as they are installed at the proposed site will undergo commission testing which involves several hours that the generator will run. After the generator is installed and commissioned, regular testing will occur for all generators. For a breakdown of generator testing across the site, refer to Table 5-2 below.

Table 5-2: Summary of Site Generator Testing

Parameter	Value
Number of generators	120
Test frequency per generator	4 standard tests per year
Run time per test	2 tests run for 20 minutes, 1 test runs for 40 minutes, 1 test runs for 90 minutes. Total runtime of 170 minutes per year)
Number of generators per test	Up to 2 generators per standard test
Number of tests per day	Up to approximately 33 tests could be run in a single day. Dependant on the test, personnel efficiency, etc
Testing schedule	07:00am and 06:00pm (Monday to Saturday or Public Holidays) or 08:00am and 06:00pm on Sundays
Total testing time for all generators	170 hours per year

Generators are tested by connecting to a load bank (equipment that consumes electricity for testing purposes). Only one generator per building would be tested at any one time due to only one load bank being proposed for each building at any one time. However up to two buildings are proposed to run standard tests at the same time to reduce the total testing time of all generators per annum.

6 Conclusion

This report has provided an overview of the proposed diesel backup power system which will support the 294MW of electrical capacity through 120 no. 3.1MW generators. These generators will be tested at commissioning for several hours each, and subsequently once every few months for several hours at a time. Housing these generators inside acoustic-rated enclosures and rooms will mitigate risks of excessive noise pollution in the area. Limiting testing to the frequency mentioned within this report will reduce overall emissions and fuel usage at the site.

Although alternative technologies exist to provide backup power generation, none are viable for the site due to several factors. The main issues for alternatives are market availability and infrastructure readiness to cater for the increase in load, and the space available on site to make alternative options work for a medium-term utility power interruption.

The backup power generation design has been curated to deliver the most viable solution for the proposed site and ensure this state significant development will provide its services as early as possible with minimal impact to the surrounding area and community.

7 References

- [1] D. Harwin, *NSW Electricity Transmission Reliability and Performance Standard 2017*, Sydney: NSW Government, 2017.
- [2] Aurecon, "Low carbon Backup Options," Aurecon, Sydney, 2022.

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