Best Available Techniques Assessment

Hayes Data Centre Emergency Back-up Generation Facility

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APPENDICES

1.0 INTRODUCTION

This Best Available Technique (BAT) assessment has been prepared by HDR on behalf of the operator *Amazon Data Services UK Limited (ADS) (the Operator)* in support of the application for a new bespoke Environmental Permit (ref DP3442QV) for the Hayes Data Centre Emergency Back-up Generation Facility to be located at Bulls Bridge Industrial Estate, North Hyde Gardens, Hayes, UB3 4DG.

ADS as the legal operator are required to apply to the Environment Agency (EA) for an Environmental Permit because the total thermal capacity of the Emergency Back-up Generation Facility combustion plant exceeds the 50MW threshold stipulated in the regulations[1] (See 0).

At the time of writing the installation is not yet operational with commissioning planned to commence in early 2023, pending receipt of the Environmental Permit, or permission to operate from the Environment Agency.

Purpose of this report

At the time of writing there are no relevant published BAT reference documents (BREF notes) for data centres. The previous guidance document: 'Combustion Activities (EPR 1.01)' was withdrawn in August 2018. To replace this, the EA have produced a working draft BAT guidance document specifically for data centres: 'Data Centre FAQ Headline Approach v11' (May 2020).

This report is structured using this guidance document and seeks to provide evidence of BAT or justification where the requirements have not been met.

Some of the design choices that have been made are in response to local planning requirements and are specific to the constraints and circumstances for the site location. This report is therefore specific for this site only and should not be taken to represent the BAT position for other Data Centre developments.

Note: Each individual Standby Emergency Generator is significantly below the threshold of 15MWth for large combustion plant. Therefore, the BAT requirements for large combustion plant are not relevant for this installation.

[1] The Environmental Permitting (England and Wales) Regulations 2016 (as amended)

2.0 SITE SUMMARY

We have presented a high-level summary below. Please refer to the Non-technical Summary (NTS) document submitted with the application for a permit for a non-technical introduction to the site and the application for a permit.

The installation and associated emissions points outlined in Figure 2.1 below, is one of three Data Centres to be constructed on the site. At the time of writing the other two Data Centres are due to be under the control of a separate operator and are likely to be covered under a separate environmental permit.

The construction of the Datacentre will see x14 no. 3.2MWe Rolls Royce MTU DS4000 emergency back-up diesel generators installed over several floors in Energy Centre 1 (EC1). At the theoretical design load, only 12 of the generators would need to operate to carry the sites electrical load with two acting as redundancy. Each generator has an approx. thermal capacity of 8MWth, giving an aggregated capacity of approximately 112MWth (See 0).

These generators are solely used as standby plant for emergency power provision in the event of grid failure. There is no capacity agreement in place or elective operation of the plant for generating revenue. As such, operation of the generators is likely to be limited to monthly maintenance and testing of approximately 17 hours/year/generator.

The generators are to be fitted with Selective Catalytic Reduction (SCR) equipment to reduce the NO_x emissions in response to local planning requirements.

The Directly Associated Activities (DAA) include the fuel storage tanks, urea tanks, pipework and the drainage network.

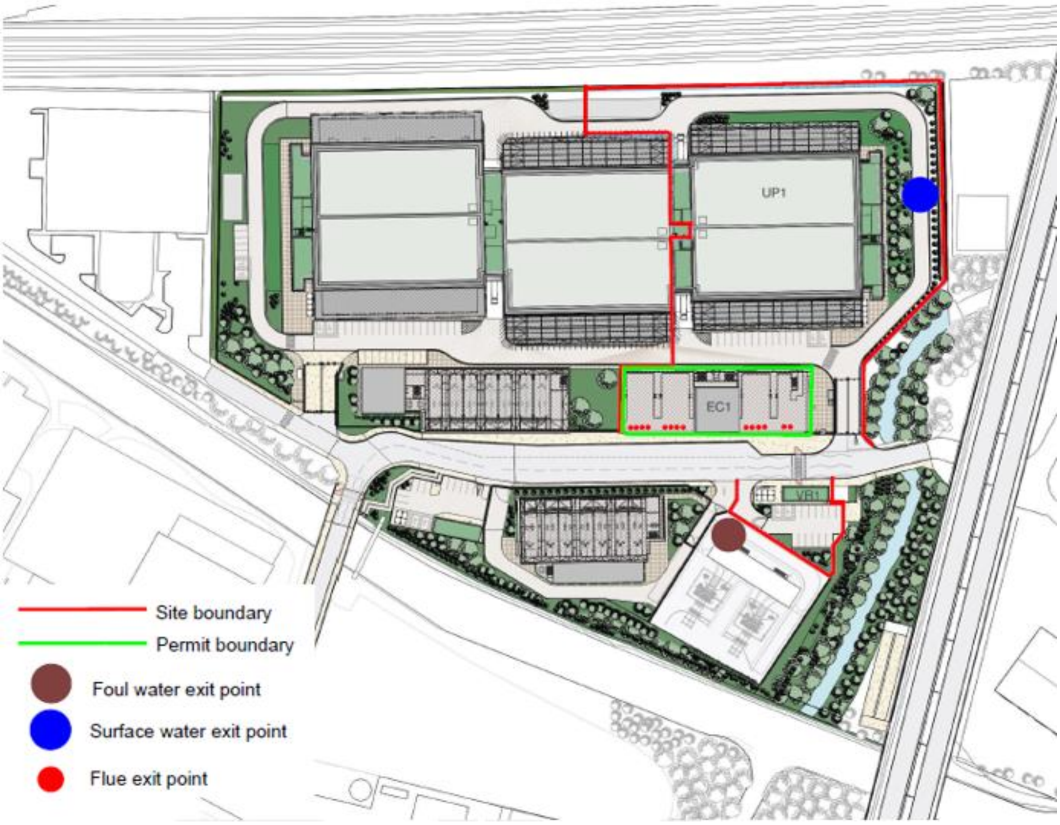

Figure 2.1 - Installation boundary and emissions points

3.0 DATA CENTRE DESIGN

Requirement for resiliency

The Data Centre functions by renting out data halls to customers to fill with various servers and associated IT equipment. This equipment requires a stable and constant supply of electricity to operate. Electricity is supplied via the National Grid without the need for an intermediary such as a Distribution Network Operator (DNO).

As with all buildings supplied with power via the grid, there is risk of a mains failure event (black out) or fluctuations in quality of mains power outside of acceptable limits (brown outs). Power failures or voltage drops, even momentarily, could have significant negative implications to site services, both in terms of direct financial costs and indirectly through reputational damage. Therefore, resilience of power supply is critical to the sites ability to operate.

Given this risk, the installation has emergency back-up generators to provide an electrical supply to the site. In the event of grid failure, the generators will start up, but they will not be able to take the electrical load immediately. Power is initially provided by the site's Uninterruptible Power Supply (UPS) (arrangement of batteries) until the generators start to take the site's electrical load. The generators start from 'cold' to take on the load from the UPS (typically within 30-60 seconds). The backup generators then provide ongoing power until a stable mains electrical supply is restored.

Grid electrical supply

For resilience reasons, it is preferable to have numerous power supplies to the site; this provides an alternate route to switch to, should one supply be compromised during an outage. This can be provided in several ways, but the common option is to have separate supply routes within one substation, or to have multiple substations onsite. If one supply route fails, the site can switch to an alternate supply that is unaffected. A process known as "bus coupling". This ability to switch to an unaffected supply route reduces the duration for which the generators operate in the event of an outage.

The grid electrical infrastructure to the site are as follows (see Figure 3.1and Figure 3.2):

Iver 275KV substation

North Hyde 66kV substation

Each substation has two feeds (A & B). Each feed can support the full site load, meaning that if one feed was to fail, electrical provision to the installation would not be compromised. A site wide failure is considered extremely rare as it would require a catastrophic regional failure on the grid, or at the supplying power station, and would likely impact not only the site but the surrounding London area.

A grid reliability study has been completed to assess the reliability of the electrical infrastructure (See 0). The report concluded that electrical grid supplies are highly reliable and have potential for meeting 99.999605% reliability. This equates to approx. 22mins of downtime per year. No grid outages from the grid supply have been reported to date. As such a grid outage is considered to be a highly rare event. Operation is therefore likely to be limited to testing and maintenance for approximately 17 hours / generator / year.

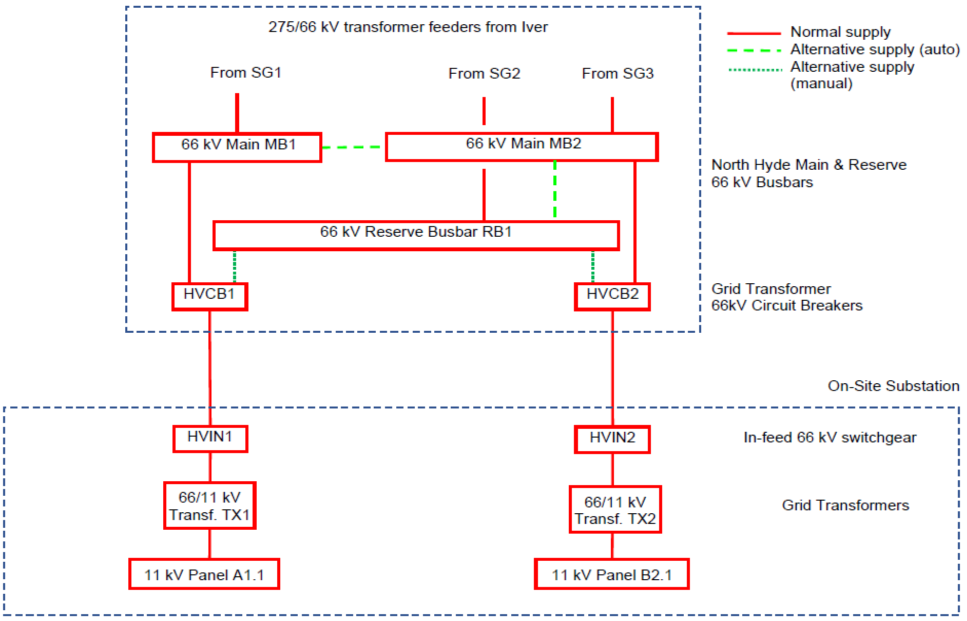

Figure 3.1 - Site electrical Supplies

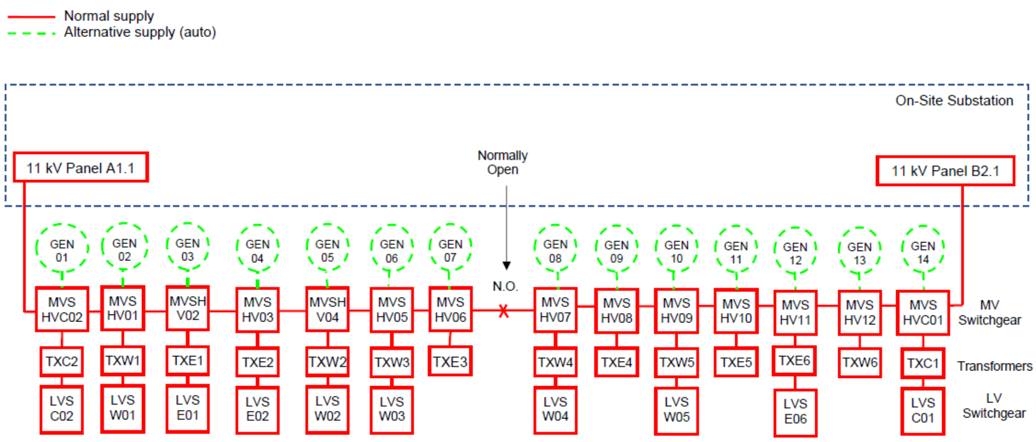

Figure 3.2 - Block electrical supplies

Redundancy arrangement

The installation has incorporated redundancy / resilience as a risk measure to help ensure that power provision is not interrupted even in the event of a mains failure. The number and size of the generators that have been selected are based on the likely maximum electrical demand by prospective customers.

The site has adopted a redundancy arrangement which means if any generator fails to start, the other generators can still carry the site electrical load. This is possible because the standby generators can provide more than the maximum amount of power that the site could ever require.

At the installation, the redundancy arrangement for the generators is 'N+2' where 'n' is the number required to carry the maximum electrical load. A catcher system is in place with a '12+2' generator design. All 14 generators will start during an outage and then will drop off according to load. 12 generators will have an average load of 30MW - i.e. 2.5MW per gen (~80%) – assuming data halls are fully built out (max peak).

This redundancy arrangement means that only a proportion of the sites' generators will be required to operate in the event of an outage. This design approach also means that it is not possible to operate all the sites' generators simultaneously, as the power provision would exceed that required by the site.

Technology selected to provide emergency power

Standby Diesel generators have been selected to provide emergency power to the installation in the event of grid failure. A BAT assessment considering alternative technologies and why Diesel generators are considered BAT is presented below.

There are currently no BAT reference documents or BREF notes that have been made available by the European Commission for the specific provision of backup power in the data centre industry. We are therefore proposing an alternative which is based on the guidance in the EA's "Data Centre FAQ Headline Approach v11".

The key criteria used in the selection of the BAT to fulfil the backup power requirements are split into two categories:

- Operational requirements
- Environmental risks

The criteria for both categories have been chosen based on the main risks posed and is in accordance with the risk assessment guidance for bespoke permits.

3.1.1 Operational requirements

Table 3-1 - Operational requirements

Criteria	Considerations	Weighting
Cost benefit analysis	The initial capital cost of the technology being considered, and the potential cost of any mitigation measures need to be considered to ensure they are not disproportionately high compared to the environmental benefits. Otherwise, the operator will cease to be competitive.	High – impacts competitiveness
Proven as a reliable technology	The resilience requirements of data centres are such that the key operational criterion is for the technology used to be a proven and reliable technology. An indication of reliability of a technology can be taken from the number of instances that the technology in question has been successfully utilised in the industry, i.e. whether this is a tried and tested technology or is it new and emerging. The technology also needs to suit the prevailing model of the industry.	High – if technology is not proven it presents a risk to the operator
Cold start capability	The technology will need to have the ability to start operating quickly in the event of a sudden loss of power. A warm start configuration would necessitate 24/7 operation of generators at the site: creating unnecessary fuel costs and environmental impacts. A slow start technology would necessitate additional energy storage UPS capacity (in the form of batteries or flywheels), taking up additional space and creating additional cost.	High – the ability to provide instant power is critical to business functions
Space requirements	Space requirements are relevant as an environmental consideration as a technology that requires excessive use of space (in the form of generator units, energy storage UPS capacity, and fuel storage) will reduce the amount of space available at the site for the IT equipment it is designed to host. This will necessitate a larger site area or construction of additional sites to provide the same level of service.	High / Medium – space limitations often dictate the technologies that can be considered
Fuel suitability	The fuel used needs to be capable of being stored / transported to and across the site without excessive risks to operations e.g. low risk of combusting.	Medium – low volatility and low risk is vital

Criteria	Considerations	Weighting
Lifetime of stored fuel	The fuel will need to be stored onsite potentially over a long period of time as mains failure events are rare and as such the generators are not routinely operated, other than for maintenance and testing purposes. The fuel stored onsite may remain unused for a long period of time and should therefore be of a type that will remain useable under these conditions – rather than becoming a waste product in need of disposal.	Medium to low – whilst an added cost it is not top priority

3.1.2 Environmental risks

Table 3-2 - Environmental risks

Criteria	Considerations	Weighting
Air quality impact	Local air quality impacts from exhaust of combustion gases when operating the technology in combination with the fuel being combusted.	High – internal combustion engines perform poorly but they are run infrequently
Noise / odour	The technology should not incite regular Odour / Noise complaints from nearest sensitive receptors e.g. residences.	Low – complaints are unlikely due to infrequent operation
Global warming impact	The global warming impact of the fuel being combusted should compare favourably against the electrical output of the technology.	Medium – impact is high but combustion of fuel is infrequent
Release to water (fuel spillage)	The risk of fuel escaping to the environment, e.g. local river course / ground should be low.	Low – fuel use is low due to infrequent operation
Fugitive emissions (leak of gaseous fuel)	The risk of fuel escaping to the air, e.g. gaseous escape should be low.	Low – fuel use is low due to infrequent operation

The following technologies were considered for the provision of emergency power to the Data Centre:

- Diesel Generators
- Diesel rotary uninterruptible power supply engines (DRUPS)
- Natural Gas (piped) Fuelled Generator – Spark Ignition Engine
- Natural Gas (piped) Fuelled Generator – Gas Turbine (CCGT or OCGT)
- Liquid Petroleum Gas (LPG) Fuelled Generator – Spark Ignition Engine
- Hydrogen Fuel Cell Technology: Polymer Electrolyte Membrane (PEM) Fuel Cells
- Hydrogen Fuel Cell Technology
- Standby Gas turbine Technology

The conclusion of the assessment was that Gas generators outperform diesel generators on air emissions, but they are inferior when comparing their cold start capability and their reliability in providing an uninterruptible power supply, due to the reliance on an off-site supply of natural gas.

Emissions optimised diesel generators (with SCR) have therefore been selected as BAT for this installation for the following reasons which are in line with EA guidance on BAT for Data Centres:

- Proven technology for providing reliable power supply
- Start-up time & cold start capability
- Space requirements
- Capital expenditure
- Environmental impact
- Fuel storage

Generator emissions performance

The EA guidance for new Data Centre generators is that they, as a minimum achieve the following standards:

“TA-Luft 2g’ or Tier II USEPA with guaranteed emissions: this has requirements for 2000mg/m^3 NO_x; 650 mg/m^3 for CO; particulates and dust 130 mg/m^3 and 150 mg/m^3 for hydrocarbons (all at reference conditions and 5% O_2).”

The generators that have been selected are emissions optimised and achieve the Tier II US EPA standard (See 0). For the size and output, the engines selected are best in class for NO_x emissions.

The installation is located within an Air Quality Management Area (AQMA) for NO_2 and near an Air Quality Focus Area (AQFA). As a result, during the planning process, the London Borough of Hillingdon (LBH) required that abatement be implemented on the generators to achieve a NO_x emissions rate of 95mg/m^3 (at 5% O_2). In response to this planning requirement, the operator has made significant investment in NO_x abatement technology in the form of Selective Catalytic Reduction (SCR).

Once the SCR is fully operational the NO_x emissions will be reduced to a level that surpasses what can generally be achieved by a gas generator of equivalent size and output. A warranty letter confirming SCR effectiveness has been provided in 0.

This SCR system is to be located on top of the generator container and connected to the generator flue system. The system works by dosing the exhaust gases with ammonia to convert NO_x to Nitrogen (N_2) and water (H_2O).

The generator emissions rates used in the Air Quality Impact Assessment (See Section 0) are presented in the table below.

Table 3.3 - Air Quality Model Inputs & Emissions rates

Parameter	Unit	Emissions per generator at 100% load	Emissions per generator at 25% load
Power	KW	3307	827
Stack(s) height	m	23	23
Stack(s) diameter	m	0.7	0.7
Exhaust gas temperature	ºC	482	403
Exhaust Volumetric Flow (actual)	$m^3.s^{-1}$	11.9	2.97**
Exhaust Volumetric Flow (dry, 5% O_2)	$Nm^3.s^{-1}$	2.57	0.74
NO_X emission rate (unabated concentration of 2362 $mg.Nm^{-3}$)	g/s	6.063	1.011
NO_X emission rate (concentration post SCR of 95 $mg.Nm^{-3}$)	g/s	0.244	0.070
Time weighted NO_X emission rate	g/s	2.18	0.38
PM_{10} and $PM_{2.5}$ emission rate	g/s	0.018	0.041
CO emission rate	g/s	0.276	0.322
Hydrocarbons (benzene) emission rate	g/s	0.0459	0.037
SO_2 emission rate	g/s	0.0028	0.001
*It has been assumed that 100% of the PM is emitted as both PM_{10} and $PM_{2.5}$ **Estimated assuming moisture content of 14% in exhaust gas			

Generator noise attenuation

The SCR system includes a silencer system to reduce the engine exhaust noise in line with the required levels. Target: 70dB(A) @ 1m from the perimeter of the canopy at 1.5m from the ground. This is achieved through the use of exhaust silencers to dampen the flow noise and lagging of SCR equipment to reduce the airborne noise. The lagging also reduces the touch temperature of the system to 60ºC.

Generator flue design

Each generator set will have a dedicated flue / 'stack' (see Figure 3.3 and Figure 3.4 below). The stacks will be unimpeded by flaps / cowls and exit vertically out the top of EC1 at a height of approx. 23m, approx. 1m above roof height. Plume analysis via dispersion modelling has demonstrated this to be optimal for providing adequate flue gas dispersion. This has been further discussed and demonstrated in Section 2 of the Air Quality Assessment. The design of the flues is therefore considered to be BAT for this application.

During the design process consideration was given to implementing a common windshield to group stacks as this is understood to improve dispersion in certain situations. Common windshields require additional support structure and the EC1 building design could not support this. Additionally, if the common windshield was compromised for any reason the data centre's requirement for redundancy could be compromised also. During normal operation, generators are tested individually to minimise air quality and noise impacts. Thus, a combined flue arrangement would have little impact on emissions.

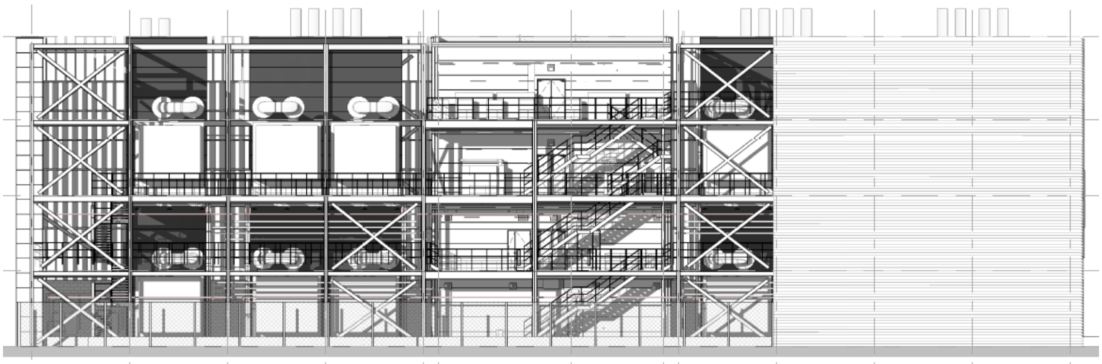

Figure 3.3 - EC1 North Elevation

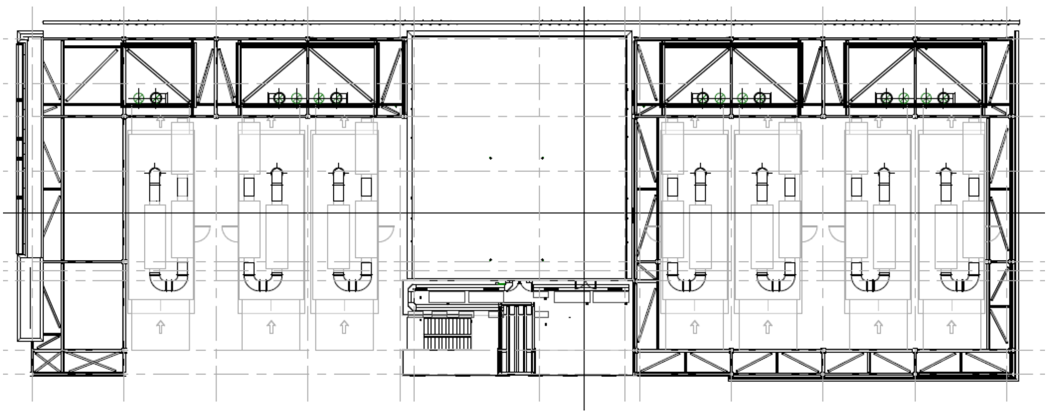

Figure 3.4 - EC1 Top View

Fuel storage

The onsite fuel storage has been designed to allow the generators to provide 24 hours' worth of electricity to the site when running at 100% continuous rated load. All tanks will comply with the Oil Storage Regulations (SI 2001/2954. The Control of Pollution (Oil Storage) (England) Regulations 2001).

3.1.3 Bulk fuel tanks

Each of the 14 no. generators will have its own dedicated 26,000 litre (29,000 litre brim-full) tank that sits below the generator (see Figure 3.5). These 'belly tanks' will therefore be internal to EC1. Having the tanks located internal to the building will significantly reduce the risk of spillages entering the environment. Tanks will be connected via pipes directly to the emergency generators.

Tanks are to be fitted with digital OLE electronic gauges which can be read at the tank or remotely via the BMS (or alternative system).

Each generating set shall be fed via the onboard fuel pump and an internal connection from the belly tank through to the canopy. The tanks shall conform to BS 799 pat 5 type J 2010. The tank plates shall be constructed from 6mm steel, fully welded internally and externally, and manufactured to comply with the oil storage regulations as referenced above in 3.1.2.

Tanks and pipework are to be bunded to 110% as per the oil storage regulations (see Section 3.1.2). Overfill Prevention Valves (OPV) are to be fitted to the tank fill line to help prevent overfilling. Each tank shall have sufficient capacity for 20% overfill prevention. Leak detect float switches will be provided within tank bund should the primary tank become compromised. This reduces the risk of accidents, impacts, theft, vandalism, and fugitive emissions from entering the environment and causing harm.

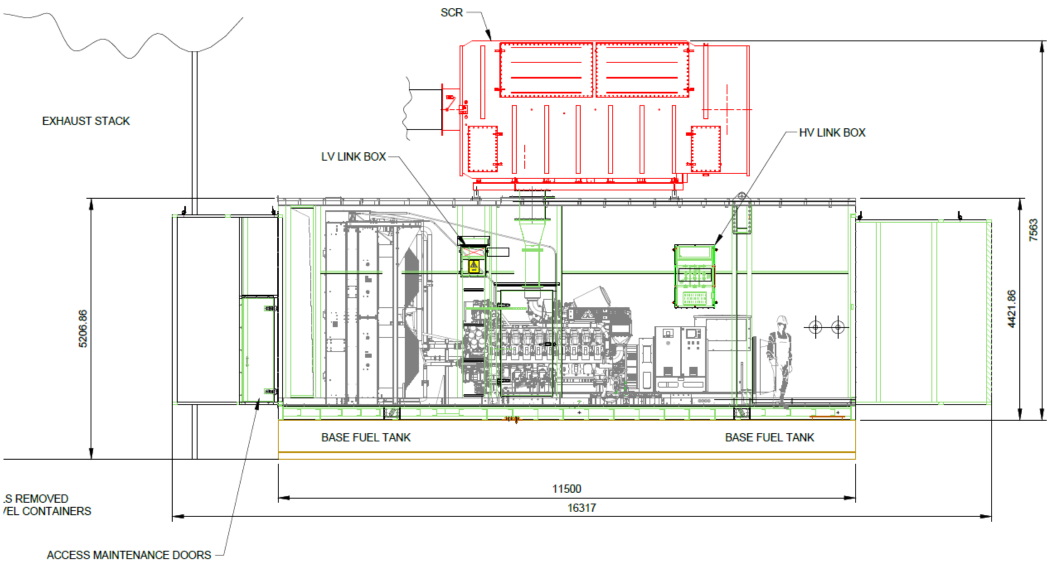

Figure 3.5 – Generator bulk fuel tanks

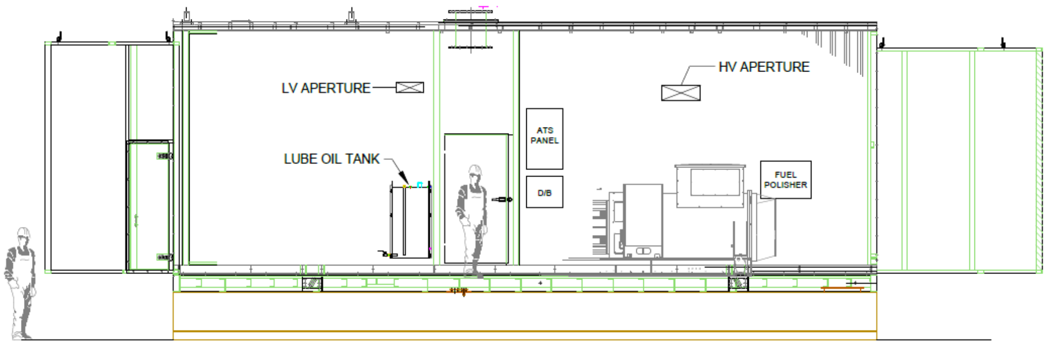

Figure 3.6 – Generator container

3.1.4 Receiver tanks

The 14 no. belly tanks will be fed from 2 no. 2,500 litre (2,750 brim-full) receiver / 'day tanks. Each tank will be integrally bunded to 110% and connected to one of the 2 no. fill points that each connect to all 14 no. belly tanks. The tank plates shall be constructed from 3mm sheet steel, fully welded internally and externally and manufactured to the water environment standard for oil storage.

A bunded pump cabinet with roller shutter door and internal leak detection shall be connected at the end of the fuel oil receiver tanks to contain the fuel transfer pump system. Pipework between the fill cabinet and the receiver tanks shall route via DN50 in DN80 pipe in pipe.

The tanks will also be fitted with an OPV fitted to the tank fill line and a leak detect float switch within the tank bund.

The Tanks OLE gauge shall provide detailed fuel level information and the tank bund shall incorporate a leak detect float switch to alarm if a leak is detected.

3.1.5 Fill points

The 14 no. bulk tanks will be refuelled via 2 no. independent fill point cabinets when the motorised valves located on each belly tank are actuated. These valves shall be located within the bunded canopies providing an N+1 system. The 2 no. 24V motorised valves shall connect to individual overfill protection valves per belly tank.

The 2 no. fill points are to be located external to EC1 to the East of the building and will be located in a lockable cabinet with a drip tray to capture minor spills. A fuel interceptor is to be installed at the re-fuelling point to prevent any spillages from entering the surface water drainage system (See 0). The area will be covered in hard standing to help ensure any spillages are directed to the nearest drain.

Within each fuel fill cabinet shall be a fuel control panel which shall display the current fuel level of all 14 belly tanks and both receiver tanks. The control panel can be used to select each tank for individual filling. This shall control the transfer pumps and motorised valves in each canopy and provide the overfill prevention controls / alarms at the fill cabinet for the fill operator.

Details of fuel polishing can be found in section 8.

3.1.6 Overfill protection

A Hi/Hi float switch connected to the generator controller is situated in each individual belly tank on the belly tank fuel fill line. If the generator controller detects that the levels have risen to a pre-set high level within the belly tank, the generator will provide a signal to the motorised valve to shutoff the fuel supply to ensure no overfill spillages.

An audible alarm will be provided once the HI/HI pre-set level has been reached within the bulk tank. This will sound at the fill point cabinet via the tank alarm, alerting the person supplying the fuel to stop filling. If the fuel is still filling the tank above the pre-set level, an OPV has been installed to provide a failsafe and stop the tank from overfilling.

3.1.7 Urea tanks

The tanks serving the SCR system will be integrally bunded and located inside the generator rooms within EC1 (See Figure 3.7 and Figure 3.8 below). Monitoring of the system is to be achieved remotely once connected to BMS (or similar system).

In total 7 no 2,500 litre tanks will be used with 1 no tank serving 2 no. generators for 24 hours at 100% load. As with the fuel tanks these tanks will have appropriate overflow protection and leak detection devices.

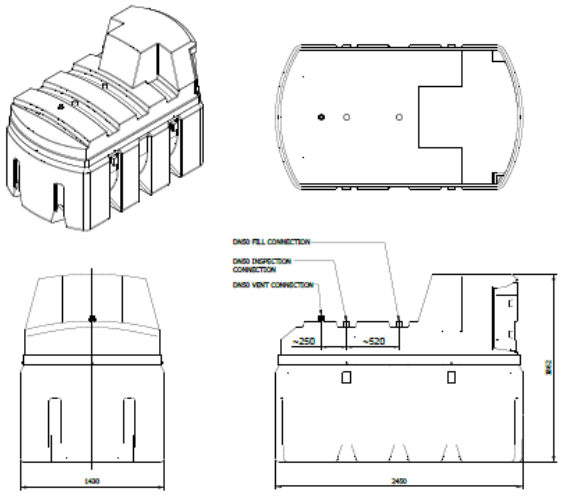

Figure 3.7 Urea tank design

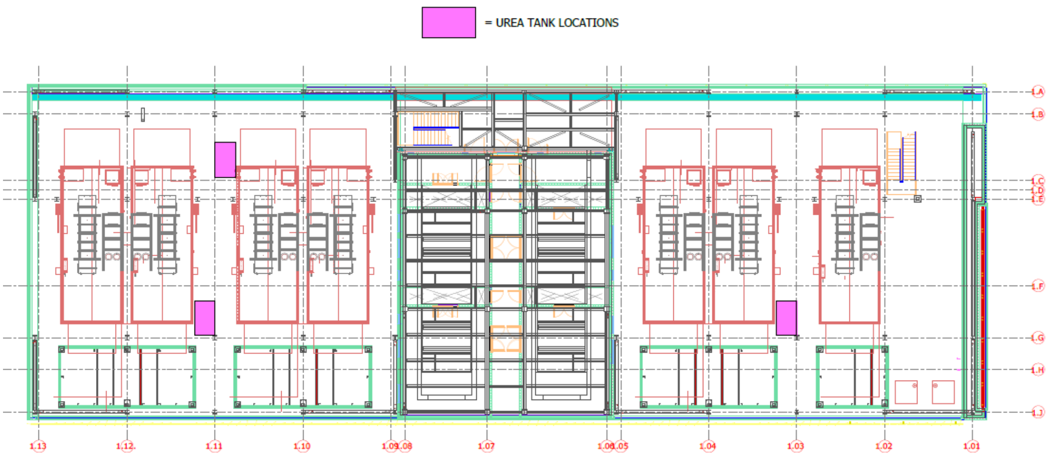

Figure 3.8 Urea tank locations

Drainage

The sites drainage system is split into separate foul and surface water networks (See 0). Indicative locations for where these enter the local networks is shown in Figure 2.1 above.

Maximum daily volume of discharges is not thought to exceed 54m^3. Thames Water were consulted and confirmed that a Trade Effluent License is not required due to wastewater from cooling not considered as trade effluent. Discharges are likely to be limited to surface run-off which is unlikely to contain significant levels of contaminated liquid. Mitigation measures are in place (described below) to minimise potential risk from fuel storage e.g. fuel / oils.

The foul network will discharge to the existing Thames Water sewer manhole located by the 66kV/11kV substation (out with site boundary) which directly connects to the strategic foul water sewer.

The surface water drainage system is connected to a forecourt separator / interceptor prior to discharging to the local network. This will be fitted with an automatic sensor for detecting the presence of spilt fuel and will close when actuated.

The interceptor will be subject to periodic visual inspections and integrity testing as part of the PPM regime. Emptying of the tank will occur periodically / in the event of a spillage with spilt fuel disposed of via a licenced contractor as hazardous waste.

Once operational, procedures for managing and inspecting the drainage networks are to be implemented. These will include visual inspections of run-off and the interceptor for evidence of spilt fuel.

3.1.8 Management procedures and security

Once the site is fully operational it will be manned 365 days a year with monitoring by security staff from a security office using an extensive CCTV system. Entry and exit to the site will be tightly controlled via a security gate and turnstiles. The ~2.5m palisade security fence will act as an impenetrable perimeter to prevent unauthorised access to the site.

Fuel tank filing will be carried out by trained fuel tanker drivers, with on-site supervision provided by a trained member of site engineering team. This removes any significant risk of vapour release and spillages during deliveries.

Once the site is operational suitable procedures are to be developed and implemented. This is likely to include refuelling activities, spill response, emergency preparedness and / or pollution prevention plan. Relevant and responsible staff are to receive appropriate training and awareness on these procedures and documented through the operator’s management system.

Once operational, a PPM regime is to be implemented that will include regular visual checks for leaks / spills with spill kits available within close proximity of fuel storage and fill points. Fuel delivery procedures will also be implemented, and suppliers will be required to adhere to site procedures.

Fuel consumption is expected to be very low at this installation due to the plant being used for emergency back-up power generation only. Fuel deliveries will likely only occur periodically e.g. less than once per year.

The fuel storage procedures and infrastructure mentioned above have been designed to achieve BAT in accordance with EA guidance.

Future site expansion

There are currently no plans to expand the installation. The Operator is aware of the requirement to vary the permit if additional plant is added to the site which wasn’t included in the original permit application.

4.0 OPERATING TECHNIQUES

Generator operation

The generators are to be used purely as standby plant to provide emergency standby power in the event of grid failure. There is no capacity agreement in place or elective operation of the plant for generating revenue (e.g. STOR, Triad avoidance, Demand Side Response, Peak Demand etc.). As such operation of the generators is likely to be limited to monthly maintenance and testing of approx. 17 hours/year/generator.

Maintenance & Testing

The emergency back-up plant at this installation will follow a set maintenance schedule based on manufacturer recommendations. Following the manufacturers recommendations will help prolong the life of the equipment, reduce the use of raw materials (e.g. replacement parts, oil changes) and ensure the engines perform efficiently to prevent increases in pollutant levels or black smoke.

Testing regimes for monthly and annual testing are detailed below. The Air Quality assessment has not identified any significant impacts to short term Air Quality from the proposed test regime (See Section 10.2). Each generator is expected to run for 17 hours per annum and is considered to be BAT.

Table 4-1 Annual operational hours per generator

Generator Test Frequency	Description	Load Profile	Individual Test Duration	Total hours of operation, per generator
Fortnightly test	Testing each generator separately at 25% load for 0.5 hour every two weeks per year. *The quarterly and bi-annual tests would supersede the requirement for 6 fortnightly tests.*	25%	30 mins	**10**
Quarterly Test	Testing each generator separately at 25% load for 1 hour each quarter.	25%	1 hour	**4**
Bi-annual test	Testing each generator separately at 100% load for 1.5 hours, twice a year.	100%	1.5 hours	**3**
			Total hours of operation per generator	**17**

5.0 F-GAS

Fluorinated gases or ‘F-gas’ will not be used in the permitted activities e.g. generators and associated fuel storage.

There is potential that F-gases will be used in the chiller plant and or air conditioning units. This plant is to be maintained in accordance with manufacturer specifications and recommendations with relevant documentation retained. Once the site is operational, an F-gas register is to be maintained onsite, and will include details such as plant make, model and serial, the type and volume of refrigerant, and maintenance history. Any significant releases or leaks are to be recorded and, where significant, notified to the EA as soon as possible.

6.0 ENERGY EFFICIENCY

General energy management

As energy prices rise and customers demand more of their providers there is increasing attention on energy efficiency and better energy management. The most prominent indicator of a data centre's energy efficiency is PUE (Power Usage Effectiveness), and this is often reported as a metric to customers. PUE is the ratio of the total energy delivered to the site compared with the energy used by just the IT equipment. A PUE of 2 means that 50% of the power delivered to the site is used to run the IT equipment. The closer the PUE is to 1, the more efficient the site is. Most efficient data centres are seeking to achieve a PUE of approx. 1-1.2. The annualised / seasonally adjusted PUE at 100% IT load for the Data Centre is likely to be approx. 1.16.

Once operational there are plans to implement an effective Environmental and / or Energy Management System (EMS / EnMS). A key focus of this will be improving energy efficiency particularly for high energy consuming activities such as cooling.

UK ETS

The site will need to apply for a Greenhouse Gas (GHG) Permit from the EA to participate in the UK Emissions Trading System (UK ETS). This is required for installations with combustion plant in excess of 20MWth[2].

Participating in UK ETS will require extensive monitoring of generator operational hours and fuel use to determine CO2 emissions per year. This data will likely need to be externally audited or 'verified' prior to submitting to the EA annually.

EED

The Energy Efficiency Directive (EED) provides an exemption for emergency back-up plant operating under 1500 hours per year. The current testing and maintenance plans (14 generators x 17 hours each = 238 hours) do not exceed this limit and therefore EED requirements are not deemed to be applicable.

ESOS

The UKs Energy Savings Opportunities Scheme (ESOS) is a mandatory energy assessment scheme for organisations in the UK that meet the qualification criteria. At the time of writing these criteria are any company that either:

- employs 250 or more people
- has an annual turnover in excess of £44 million, and an annual balance sheet total in excess of £38 million

There is potential that this site could form part of an ESOS submission which would seek to identify opportunities to improve energy efficiency.

CCA

Once the site is operational there is potential for the operator to apply for a Climate Change Agreement (CCA) or amend existing agreements to cover this installation. These agreements are voluntary agreements made between UK industry and the EA to reduce energy use and CO2 emissions.

Energy management techniques will be implemented to monitor, record and track power usage effectiveness (PUE) within the data centre.

[2] https://www.gov.uk/government/publications/participating-in-the-uk-ets/participating-in-the-uk-ets#free-allocation

Measures to improve energy efficiency

The electricity efficiency of the generators ranges from 30-40%. Heat recovery on generators is not a viable option since these generators are backup plant that operates infrequently (approx. <20 hours per year).

Once the site is operational, a periodic preventative maintenance (PPM) regime is to be implemented. This will involve regular checks of the generators to help ensure each generator is operating efficiently.

7.0 EFFICIENT USE OF RAW MATERIALS

The main raw materials that will be used within the permitted installation are as follows.

Diesel

The installation will store enough diesel on site to provide 24 hours' worth of electricity when running at 100% continuous rated load. Due to the highly reliable grid supply, it is unlikely that large volumes of fuel will be consumed by this installation. Fuel use will mostly be limited to maintenance running of the generators. The PPM regime will help ensure efficient fuel use by the generators.

As per Section 0, each generator is tested for 17 hours per year. The generator datasheets provide fuel consumption at 50, 75 and 100% load. Using 50% load, the total fuel consumed per generator would be 8,580 litres. This is highly conservative given the monthly tests are at 25% load.

Diesel has been selected due to the ability to store sufficient volumes on site to ensure security of supply. Other fuels have been considered but do not currently provide the same level of security of supply. Natural gas could not be stored in sufficient volumes and would be reliant on the National Transmission System, a contract for uninterruptable supply would be excessively costly given the infrequency of use. Due to the limited hours of operation, any potential benefits from the lower impacts associated with emissions from natural gas are reduced.

Lubrication oils

The engines will require lubrication oil to reduce wear and tear through friction. Periodic replacement of this oil will be required with waste oils to be disposed of responsibly and in accordance with the applicable legislation.

Urea

Urea is to be used in the Selective Catalytic Reduction (SCR) equipment to reduce the NO_x emissions. It is expected that there will be urea deliveries every 1 to 2 years as limited amounts will be required during routine site operation.

8.0 AVOIDANCE, RECOVERY AND DISPOSAL OF WASTES

Waste

Waste streams will arise as a result of operation and maintenance of the combustion plant. Maintenance extends the life of the plant and resolves issues in a timely manner, reducing waste associated oils, lubricants & replacement parts. The installation will not produce significant amounts of waste due to the standby nature of the generators.

A licenced third-party maintenance contractor will be responsible for removing waste produced as a result of generator maintenance. The operator will be responsible for retaining Duty of Care information including waste carriers' licences and transfer notes.

Waste streams expected at this installation may include:

- Lubrication oils used in maintenance and servicing (minimal)
- Air and fuel filters (minimal)
- Fuel that has reached end of life (infrequent)
- Used spill kits (emergency only)
- Decommissioned plant (end of life only)

In line with the permit requirements the operator will aim to minimise waste generation through efficient use of raw materials including diesel, filters, and lubrication oils.

For example, the need to dispose of waste fuel will be reduced / minimised by utilising in-situ fuel polishers present within each fuel tank. The fuel polisher is programmed to operate at pre-defined (user settable) intervals. When operating, the polisher pump will draw fuel from the belly tank before passing it through a 5-micron particulate and water separator before returning it to the opposite end of the belly tank. The aim of these is to help maintain the fuel to a usable standard, preventing early degradation and ultimately extending the life of the fuel.

9.0 GENERAL MANAGEMENT

Management Standards

Once the Data Centre is operational, the following management standards (or equivalent) are to be developed:

- ISO 14001:2015 specifies the requirements for an environmental management system that an organization can use to enhance its environmental performance.

- ISO 50001: 2018 is for organizations committed to addressing their impact, conserving resources and improving the bottom line through efficient energy management.

- Designed to support organizations in all sectors, this ISO standard provides a practical way to improve energy use, through the development of an energy management system (EnMS).

- ISO/IEC 27001:2013 specifies the requirements for establishing, implementing, maintaining, and continually improving an information security management system within the context of the organisation. It also includes requirements for the assessment and treatment of information security risks tailored to the needs of the organisation. The requirements set out in ISO/IEC 27001:2013 are generic and are intended to be applicable to all organisations, regardless of type, size or nature.

- ISO9001:2015 specifies the requirements for establishing, implementing, monitoring, managing and improving quality throughout the organisation.

Environmental Management System (EMS)

Once the site is operational there are plans to implement an effective EMS for the site. The management system developed will be in accordance ISO 14001:2015, or a suitable equivalent standard.

Once implemented, the EMS will include the policies, management principles, organisational structure, responsibilities, standards / procedures, process controls and resources in place to manage environmental protection across the permitted activities at the installation.

Specific focus will be placed on:

- Reducing risks to the environment to a level that is as low as reasonably practicable using best available techniques
- Integrating EMS responsibilities within line management
- A commitment to personnel environmental awareness and competence
- The ongoing monitoring and review of environmental performance
- A commitment to working to achieve continuous improvement in environmental performance.

Integral to the EMS will be an overarching environmental policy. This will seek to underpin the EMS and help ensure uptake by all staff with sufficient training provided as required.

The operator will maintain records associated with the management system. These records will be stored on their central system and will be updated in line with the management system's policies. Records kept could include:

- Organisational procedures
- EMS manual
- Aspect register
- Compliance register
- Monitoring documents
- Accident, prevention, and control procedures

- Training records
- Review and audit records
- Environmental risk assessments

10.0 EMISSIONS

There will be no point source emissions to water, air or land, except from the sources and emission points identified in Figure 2.1.

Emissions identified as significant have been further expanded in the following sections.

Noise Impact assessment

A noise impact assessment was completed as part of the planning application and for the application for an environmental permit. This report identifies sensitive receptors and potential sources of noise from the installation. The primary noise sources are the sites emergency back-up generators.

The report concluded that "noise levels are predicted to achieve the noise limits at the nearest noise sensitive properties and therefore noise impacts are not considered to be significant.". Further information can be seen in the 'Noise Impact Assessment v1' submitted as part of this application.

Air Quality Impact assessment

Emissions to air will occur as a from the operation of the standby emergency generators. It is expected due to the data centre's high levels of resilience, that operation will be limited to maintenance and testing only with no elective operation as detailed in Section 0.

An Air Quality Impact Assessment (AQIA) was completed to predict the impacts on short- and long-term air quality. This has been supplied as part of the application for a permit and modelled the following scenarios. Further information can be seen in the 'Air Quality Assessment v1' submitted as part of this application.

Monthly test regime (Testing Scenario 1)
Each generator unit is tested separately at 25% load for half an hour every two weeks per annum. There is also a 1 hour test each quarter, totalling 14 hours per generator.

Annual maintenance (Testing Scenario 2)
In addition to monthly tests, each generator unit will be tested separately at 100% load for 1.5 hours, twice per annum. This equates to 3 hours per generator.

Emergency scenario: (Mains outage Scenario)
As per EA requirements the model accounted for a 72-hour grid failure event, with all generators running concurrently at 100% load.

The results of the dispersion model assessment have been summarised below. Further details including the methodology can be found in the accompanying report provided with the application for a permit.

10.1.1 Results – Testing and Maintenance

Long term impacts
Emissions associated with normal testing and maintenance are not considered to have a significant impact on the annual mean concentrations of PM_{10}, $PM_{2.5}$, NO_x or benzene at locations of relevant exposure.

Short term impacts – NO_x
There was an exceedance of the 10% screening criterion at one of the nineteen tested receptors during the modelling for short term impacts of NO_x. The results of the testing are based on highly conservative assumptions (testing to occur every hour of the year), and therefore the short-term impacts are not considered to be significant and can be screened out.

Short term impacts – SOx
There were no instances where concentrations of SO_2 would cause significant short-term impacts as a result of maintenance and testing.

Short term impacts - CO
There were no instances where concentrations of CO would cause significant short-term impacts as a result of maintenance and testing.

Short term impacts – PM10
There were no instances where concentrations of PM_{10} would cause significant short-term impacts as a result of maintenance and testing.

10.1.2 Results - Emergency operation

Long term impacts
Emissions associated with a prolonged grid failure are not considered to have a significant impact on the annual mean concentrations of PM_{10}, $PM_{2.5}$, NO_x or benzene at locations of relevant exposure.

Short term impacts – NO_2
The concentrations of NO_2 exceeded the 10% screening criterion at 11/19 receptors and then at 4 further receptors during secondary screening. The contribution from site activities is less than the 200 mg/m^3 standard at all receptors. As a result, significant short-term impacts on NO_2 as a result of an emergency grid failure are not anticipated.

It is also noted that all concentrations of NO_2 are substantially lower than the US EPA’s Acute Exposure Guidance Levels (AEGLs). The AEGL for non-disabling impacts is at 940 $\mu g.m^{-3}$, whereas no modelled receptor is expected to experience hourly concentrations in excess of 150 $\mu g.m^{-3}$.

10.1.3 Results – Conclusion

The conservative assessment predicted that the impact of the standby generators during both testing/maintenance and during emergency grid failure scenarios would be ‘not significant’ for both short- and long-term impacts.

10.1.4 Air Quality Management Plan

The AQIA identified that an Air Quality exceedance is most likely to occur during a prolonged outage. BAT is therefore to develop an Air Quality Management Plan (AQMP) to be implemented in the event of a prolonged outage.

Once the site is operational an AQMP is to be developed for the site using the Air Quality Model as a basis for identifying which receptors may be affected and if notification is required. The AQMP should also include information on the following:

- Outage occurrence – e.g. date, time, season, meteorologic factors
- Receptors – e.g. AQ model receptors, general public
- Outage situation – e.g. likely duration, how receptors are affected

The plan is to be developed in conjunction with the Local Authority and its Local Air Quality Management (LAQM) process.

11.0 MONITORING

Emissions limits & flue gas monitoring

The generators are to be classed as new Medium Combustion Plant (MCP). The purpose of the emergency standby plant is to provide power in the event of failure of national grid supplies and will operate for less than 50 hours per year.

As such the generators are classes as “excluded generators” under the Environmental Permitting Regulations and are therefore exempt from meeting the BAT emissions limit values (ELVs) for new plant. Monitoring of flue gas emissions is to be completed in accordance with EA requirements. Monitoring will be conducted In-line with BAT guidance received during engagement with the EA, it is expected that the operator will need to demonstrate that the engines are BAT by including the provision of flue gas sampling ports to allow for NO_x and CO monitoring, designed to meet BS EN 15259.

Any testing will be undertaken by an organisation with the EA’s MCERTS accreditation for these measurements, so that the data meets the requirements of the MCERTS certification for emissions monitoring systems.

It is expected that periodic measurements shall be required at least when three times the number of maximum average annual operating hours have elapsed for medium combustion plants with a rated thermal input >1MWth and less than <20 MWth. This is for plant which operate <500 hours and have no ELVs associated with their operation.

Total mass emissions for NO_x, SO_x, PM and CO are to be reported to the EA annually.

Generator operation

Generator operational hours and fuel consumption for maintenance, testing and for an outage are to be monitored and reported to the EA annually. In addition to the annual report, outages should be notified to the EA within 24 hours of emergency operation commencing.

Discharges to sewer

As per Section 0, discharges to sewer are not anticipated. Any surface water run off which discharges to surface drainage will pass via the drainage interceptor. This which will be subject to periodic visual inspections. The EA is to be notified by the operator where significant pollution incidents occur that have the potential to cause harm.

12.0 CONCLUSION

We have set out the proposed design and operating techniques for this installation and these are considered to meet the EA’s BAT requirements for this Data Centre.

APPENDIX A

Thermal Schedule

APPENDIX B

Generator Engine & Emissions Datasheets

APPENDIX C

Grid Reliability Statement

APPENDIX D

NOx Warranty Letter

APPENDIX E

Drainage Plan