Air Quality Impact Assessment

Kao Data

February 13, 2025

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1 Executive Summary

Kao Data is planning to expand its Harlow Data Center campus by constructing a third data center building. The project includes the installation of 11 new diesel-fired generator engines to supply backup power to the new facility in the event the primary power supply is interrupted. As part of the project Kao proposes to add six more backup generators to supply backup power to its two existing facilities.

Generator engines are routinely exercised (run) to ensure on-demand reliability and readiness. Emissions of regulated air pollutants from the engines were quantified and analyzed for evaluating potential impacts to air quality. This analysis was prepared in accordance with Environmental Agency (EA) guidance including procedures specifically developed for backup power generator engines at data centers. The analysis used EA-recommended air dispersion modeling methods to predict maximum air concentrations at off-site locations. The significance of maximum modeled concentrations is subsequently evaluated for each regulated air pollutant by referencing EA Air Quality Standards (AQS) and ecological criteria that are considered to be protective of human health and the environment.

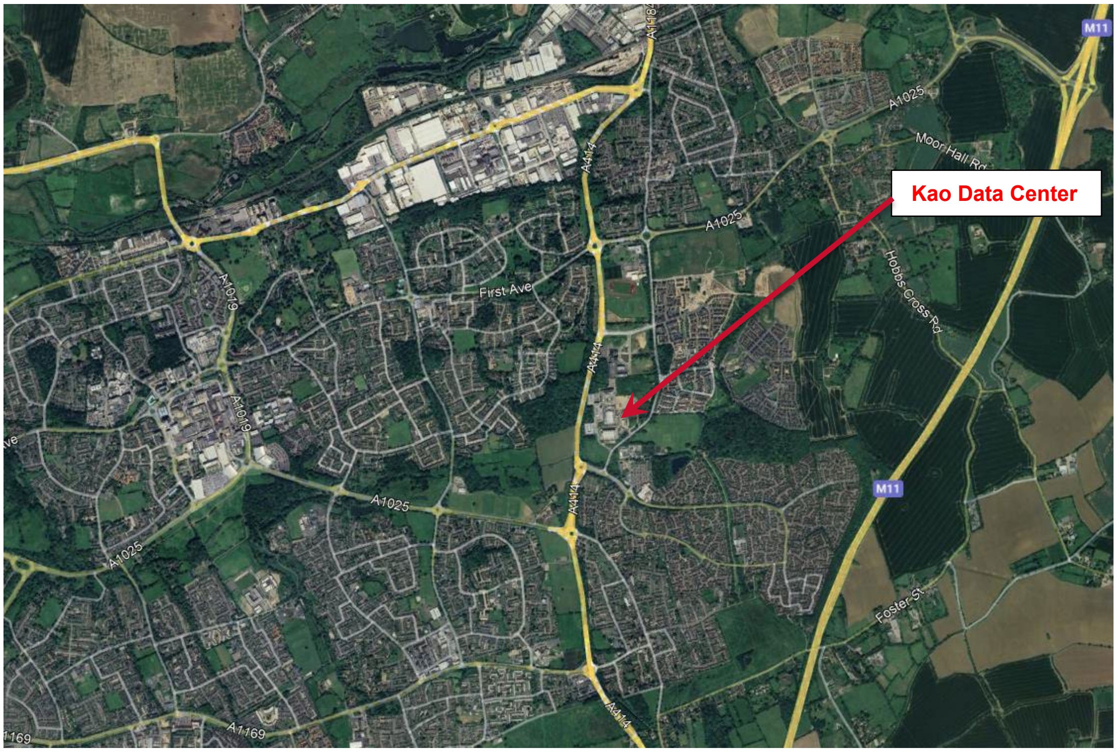
This dispersion modeling analysis indicates that maximum ambient air concentrations of NO2, PM10, PM2.5, SO2, and CO at publicly accessible receptor locations will not result in an exceedance of the applicable AQS. Moreover, the analysis indicates that peak NO2 air concentrations and nitrogen deposition rates in ecologically sensitive areas are insignificant and within acceptable levels.

An emergency power outage scenario was also modeled, assuming all engines would operate continuously for 72 hours. Although the model results for this scenario indicate a potential peak 1-hour concentration for NO2 that is greater than the allowable threshold, a statistical analysis was prepared to indicate how improbable such occurrence is, considering the very low probability that a power outage incident will coincide with least dispersive meteorological conditions for the Harlow area and Kao Data Center campus location.

2 Introduction

Kao Data is planning to expand its data center located on London Road, Harlow CM17 9NA by installing a third building, referred to as KLON03. Figure 1 depicts the location of Kao Data in Harlow. The expansion project includes the installation of 17 new emergency diesel generators (EDGs) which will supply power to the facility the event of a disruption to the power supply from the local utility. Eleven (11) EDGs will be installed to provide the necessary emergency power generation for KLON03. As part of this expansion project, Kao Data plans to add two (2) new EDGs in support of the existing KLON01 building and four (4) new EDGs in support of the existing KLON02 building.

Figure 1. Kao Data Centre Facility Location



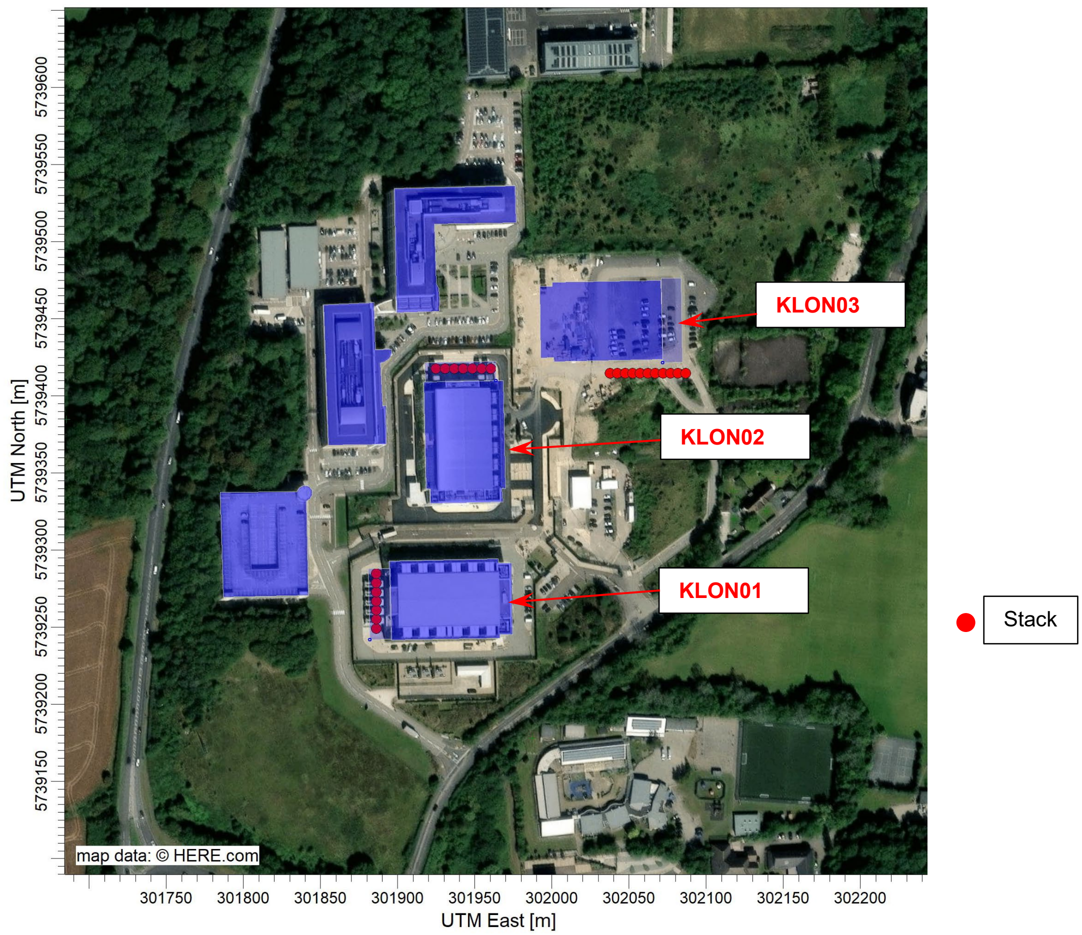
The EDGs will be routinely run for maintenance and to assure readiness for supplying emergency power on-demand. The new EDGs represent an increase in emissions of regulated air pollutants from the Kao Data center complex. HDR quantified the potential emissions from the EDGs and conducted dispersion modeling to predict ambient air concentrations of regulated air pollutants from periodically running the EDGs. The analysis also addresses a potential major emergency power outage scenario during which the generators are simulated to run continuously for 72 hours. This report outlines the methodology for conducting the dispersion modeling analysis and summarizes the predicted ambient air concentrations in the context of the current UK air quality standards and regulatory policy to inform whether the proposed expansion design will be acceptable.

2.1 Facility Description

Kao Data currently operates a data center complex that consists of two nearly identical buildings that house the computer servers, administrative offices, electrical and mechanical support equipment. These buildings are referred to as KLON01 and KLON02 and are illustrated in Figure 2. Kao Data will have a total of seven (7) EDGs for supplying backup power to KLON01 and, after adding four more EDGs to the KLON02 building, will have a seven (7) EDGs for supplying backup power to KLON02. A total of 14 EDGs will serve KLON01 and KLON02, each rated at 2.0 kW.

The proposed KLON03 building has a similar design footprint as KLON01 and KLON02 and will include the addition of eleven (11) new EDGs, each rated at 3.2 kW. The EDGs for KLON01, KLON02 and KLON03 are located immediately adjacent to the primary building as illustrated in Figure 2. Equipment and operations within the data center buildings do not result in emissions of regulated air pollutants in any appreciable quantities. Therefore, the EDGs are the only sources of quantifiable emissions that are addressed by this modeling analysis.

Figure 2: Facility Layout



Emissions of nitrogen oxides (NO_x), particulate matter having an aerodynamic diameter of 10 microns or less (PM_{10}), particulate matter having an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$), carbon monoxide (CO), and sulfur dioxide (SO_2) occur as products of combustion from the EDGs. The additional EDGs represents an increase in potential emissions of these regulated air pollutants that requires an ambient air quality impact evaluation.

Kao Data proposes to install selective catalytic reduction (SCR) on the four (4) new EDGs at KLON02 and the eleven (11) new EDGs at KLON03 to control emissions of NO_x. The SCR technology is expected to control NO_x emissions to a concentration equivalent to 190 mg/Nm^3 at 15% O_2 or better. The existing EDGs for KLON01 and KLON02 do not have SCR nor will they be modified to use SCR technology for controlling NO_x.

2.2 Scope

This report summarizes air dispersion modeling methodology and regulatory framework for evaluating the potential effects that the Kao Data center complex will have on air quality, including existing EDGs with the proposed expansion design. Specifically, Kao plans to install 17 new EDGs, 2 x 2.0 kW each for KLON01, 4 x 2.0 kW each at KLON02, and 11 x 3.2 kW each at KLON03. SCR controls will be installed on the 4 new EDGs at KLON02 and all 11 EDGs at KLON03. In addition, all existing stacks at KLON01 and KLON02 will be extended in height and oriented to exhaust vertically. Specific stack design metrics that were modeled are listed in Tables 4-3 and 4-4.

Maximum predicted ambient air concentrations for each test scenario are compared with allowable thresholds to inform the level of risk that the emissions may pose to human health and the environment. Generally, a conservative approach was taken toward modeling emissions by which maximum potential emission rates from the EDGs for 100% engine load were modeled. Although actual engine loads will likely be less than 100%, this approach was taken to provide assurance that predicted concentrations do not underestimate actual concentrations after the EDGs are installed and operated. The engine readiness testing protocol includes a once-per annum “Black Building” test where all EDGs per building are tested simultaneously for 30 minutes, simulating a main supply failure for each building individually. For this Black Building test, this impact analysis conservatively simulates a 50% operating load scenario, where in practice the engines will be tested at approximately 30% load. Further details on the EDG testing and model scenarios are available in Section 3.3.

3 Regulatory Policy

3.1 Air Quality Standards

The UK Air Quality Strategy (UKAQS)[1] sets Air Quality Standard (AQS) concentrations for regulated air pollutants. Table 3-1 summarizes the AQS concentrations, averaging periods and frequency metrics which take into account allowable variances (exceedances) from the standard. The locations where ambient air concentrations are modeled are publicly accessible locations where it is reasonable to expect human exposure to occur for the duration of the pollutant averaging period.

Table 3-1. UK Air Quality Standards

Pollutant	Air Quality Standard (ug/m3)	Averaging Period	Frequency
NO_2	200	1-hour	Not to be exceeded more than 18 times per year
	40	Annual	High 1st High

[1] https://assets.publishing.service.gov.uk/media/5a758459ed915d731495a940/pb12654-air-quality-strategy-vol1-070712.pdf

Table 3-1. UK Air Quality Standards			
Pollutant	**Air Quality Standard (ug/m3)**	**Averaging Period**	**Frequency**
PM_{10}	50	24-hour	Not to be exceeded more than 35 times per year
	40	Annual	High 1st High
$PM_{2.5}$	20	Annual	High 1st High
SO_2	266	15-minute	Not to be exceeded more than 35 times per year
	350	1-hour	Not to be exceeded more than 24 times per year
	125	24-hour	Not to be exceeded more than 3 times per year
CO	10,000	8-hour	Max Daily mean
	30,000	1-hour	High 1st High

NO_2 is the primary pollutant of concern in this analysis. In addition to the AQS, the maximum predicted ambient air concentrations are compared with the United States Environmental Protection Agency's (USEPA's) Acute Exposure Guideline Levels (AEGLs). The AEGLs represent guideline concentrations at which toxicological health effects can occur. For NO_2, the AEGL is 940 $\mu g/m^3$ (1-hour average), which is the threshold at which non-disabling adverse impacts are likely to occur.

3.2 Ecological Standards

Assessing potential ecological impacts requires the evaluation of both ambient air concentrations of pollutants in the context of what are defined as Critical Levels and potential for deposition impacts in the context of what are defined as Critical Loads.

Critical Levels represent maximum air concentration thresholds above which significant harmful effects to vegetation and ecosystems may occur, and are specified within the Air Quality Standards Regulations and the Air Emissions Risk Assessment (AERA) guidance available from the EA. For this analysis, potential impacts of NOx are evaluated for potential ecological impacts using the Critical Levels summarized in Table 3-2.

Table 3-2. Critical Levels for Ecological Exposure		
Pollutant	**Critical Level ($\mu g/m^3$)**	**Averaging Period**
NO_X	75	24 Hour mean
	30	Annual

Critical Loads represent deposition exposure levels below which the potential for adverse effects to an ecosystem is not known to occur. Air Pollution Information System (APIS)[2] provides Critical Loads for nitrogen deposition (leading to eutrophication) and acid deposition (leading to acidification). Critical Loads for nitrogen deposition are in units of kilograms of nitrogen per hectare per year (kg N/ha/year) and vary with habitat sensitivity. Critical Loads for acid deposition vary depending on the receptor location and sensitive species within the ecosystem.

3.3 Methodology

The *Guidelines for the Preparation of Short-Range Dispersion Modelling Assessments for Compliance with Regulatory Requirements – An Update to the ADMLC 2004*[3] was followed when preparing this assessment. The latest *Environmental Protection UK (EPUK) & IAQM guidance on Planning for Air Quality* [4] was also referred to for the impact assessment. For the assessment of emissions from the EDGs, Department for Environment, Food & Rural Affairs (DEFRA) guidance[5] on assessing air emissions for environmental permitting and the Environment Agency's guidance on assessing impacts on limited hour operations specific to EDGs at data centers was also followed.

3.4 Existing Air Quality Conditions

The baseline (or background) air quality conditions for the Harlow area are established through the compilation and review of appropriately sourced ambient air concentration estimates and local monitoring data. DEFRA provides estimated ambient air concentrations of the UKAQS pollutants at the UK Air Information Resource (UK-AIR) website. These estimates are derived using complex modeling tools which calculate estimated concentrations on a 1 square kilometer resolution across the UK, referenced to the National Grid coordinates. The ambient air concentrations for 2024 are based on 2018 data. The maximum projected baseline concentration reported among an array of locations across Harlow are presented in Table 3-3. The full array of projected air quality concentrations obtained for the Harlow area are available for review in Appendix A.

Table 3-3. Projected Annual (2024) Mean Background Concentrations for Harlow

Pollutant	Annual Mean Concentration (ug/m^3)
NO_2	15.2
PM_{10}	16.9
$PM_{2.5}$	10.4

[2] http://www.apis.ac.uk/

[3] https://admlc.com/wp-content/uploads/2021/02/admlc-rms-guidelines-2021-final-with-admlc-r12.pdf

[4] https://smartnet.niua.org/sites/default/files/resources/air-quality-planning-guidance.pdf

[5] https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit

4 Air Dispersion Modeling Approach

4.1 Model Selection

The latest version of USEPA's AERMOD model (version 24142) was used for predicting ambient air quality impacts from this project. AERMOD is a steady-state Gaussian model widely used for predicting ambient air concentrations of regulated air pollutants from industrial and commercial source types. It incorporates planetary boundary layer characteristics, terrain, building downwash, and source characterization to calculate pollutant concentrations and deposition rates. The AERMOD Modeling System includes the preprocessor programs AERMET (24142), AERSURFACE (24142), and AERMAP (24142) to create the required input files for meteorology and receptor terrain elevations. AERMOD is the recommended model in USEPA's *Guideline on Air Quality Models* (40 CFR Part 51, Appendix W) and is commonly used world-wide for predicting ambient air concentrations for projects such as this one.

4.2 Model Options

There are many options available for executing AERMOD, and the most appropriate options depend on the overall objectives, context, and purposes for the analysis. For the Kao Data Center expansion project, the Regulatory Default option in AERMOD was selected which controls algorithms with settings that conform to methods recommended by USEPA and most other regulatory agencies. The Regulatory Default option commands AERMOD to use:

- Elevated terrain algorithms requiring input of terrain height data for receptors and emission sources,
- Stack tip downwash (building downwash automatically overrides),
- Calms processing routines,
- Buoyancy-induced dispersion, and
- Missing meteorological data processing routines.

4.3 Emission Source Description

Kao Data's Harlow campus has two data center buildings, referred to as KLON01 and KLON02. Each data center building will have 7 EDGs, Model MTU 16V4000 DS2250, that will deliver backup power in the event of a disruption to the primary power supply. Kao Data is proposing to construct a third data center building, KLON03 that will include 11 additional EDGs, Model MTU 20V4000DS4000. Figure 2 provides a site layout for the facility including the proposed KLON03 location. The four (4) new EDGs at KLON02 and eleven (11) new EDGs at KLON03 will be equipped with selective catalytic reduction (SCR) for controlling emissions of nitrogen oxides (NO_X) to a level of 190 mg/Nm^3 at 15% oxygen.

The generators will be routinely tested for readiness according to the following schedule:

- Monthly, 1 hour per generator, weekdays 9-5 PM

- Once per year, 2 hours per generator, weekdays 9-5 PM
- Once per year, 30 minutes, Black Building test running all generators at each KLON, weekdays 9-5 PM

In addition to these routine testing scenarios, a scenario in which all 25 generators are continuously operating simultaneously for 72-hours was modeled to simulate an emergency event where the primary power supply is interrupted.

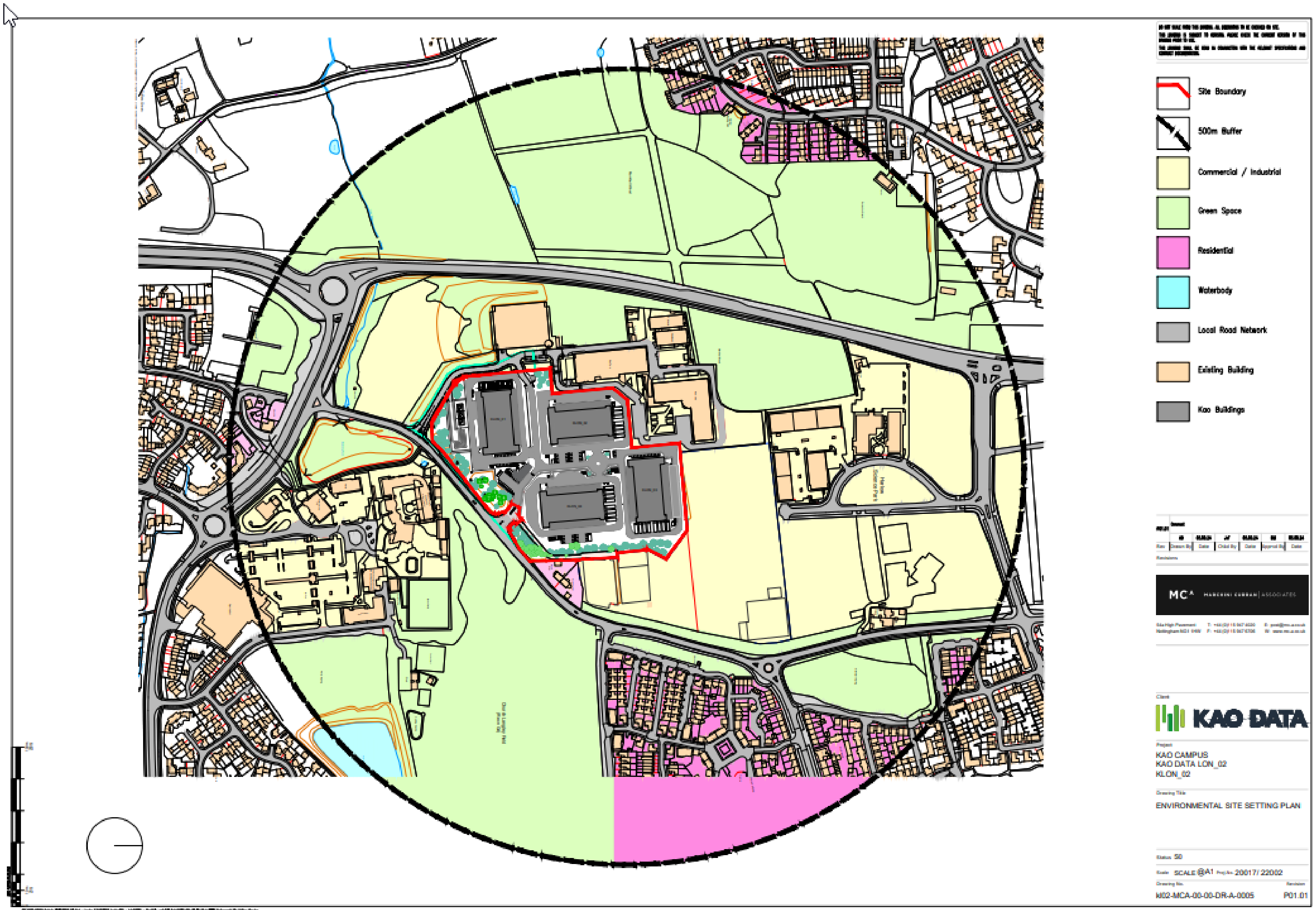
It should be noted that the routine readiness testing will be conducted while the generators are running at approximately 30% of the full load capacity. To be conservative, for this assessment the potential emission rates from operating the generators at 100% of the load capacity are modeled. For the Black Building test, the generators are modeled at 50% load capacity. It should also be noted that the EDG readiness testing and Black Building testing will occur during daytime hours, between 9:00AM and 5:00PM, when atmospheric conditions are more conducive to greater plume dispersion in contrast to evening and overnight conditions that tend to be calm.

Emission rate calculations were developed using the manufacturer performance data and are available in Appendix B. NOx emission rates for EDGs with SCR are calculated assuming a 15-minute warmup period before the catalyst temperature stabilizes to the proper level required for the system to be effective. Time-weighted emissions rates for the 30-minute Black Building test and routine 1-hour readiness test were modeled.

4.3.1 Land Use and Dispersion Coefficients

AERMOD has urban and rural dispersion coefficients that must be selected based on the land use in the study area. Urban dispersion coefficients and mixing heights are selected if the majority of the land use is urban; otherwise, rural coefficients and mixing heights should be selected. The surrounding land use is illustrated in Figure 3, indicating that the majority of the land surrounding the facility is open space. Based on this observation, the rural dispersion coefficients were selected.

Figure 3: Kao Data Environmental Site Settings Plan



4.3.2 Receptors

Receptor locations modeled consist of residences and neighborhoods, parks, schools and other publicly accessible locations where human exposures can occur. These locations were identified for the study area using the MAGIC database and by consulting with EA, who provided a list of discrete receptors. Table 4-1 lists the receptor locations where ambient air impact concentrations were assessed and Figures 4 and 5 illustrate the location of these receptors relative to the Kao Data Center campus.

Table 4-1. Discrete Receptors

Description	Type	Distance (km)
Adjacent Resident	Residential	0.2
Adjacent Resident	Residential	0.2
Adjacent Resident	Residential	0.2
Adjacent Resident	Residential	0.2
Church Langley	School, Playfields, Fishery	0.2
Brenthall/Barnsley Wood	Local Wildlife Site	0.7
Perry Spring	Local Wildlife Site	0.4
Harlow Common	Local Wildlife Site	1.4
Markhall Wood	Local Wildlife Site	0.3
Latton Common	Local Wildlife Site	1.8
Netteswell Plantation	Local Wildlife Site	2.0
Rye Meads Gravel Pit	Local Wildlife Site	8.4
Gravelpit Spring, New Hall	Local Wildlife Site	0.5
New Hall Reedbeds	Local Wildlife Site	1.0
Newpond Spring	Local Wildlife Site	0.8
Gravelpit Springs, Latton Farm	Local Wildlife Site	0.7
Kingsdon Ponds	Local Wildlife Site	0.9
Brays Grove	Local Wildlife Site	1.5
The Moors	Local Wildlife Site	53.3
Vicarage Wood	Local Wildlife Site	1.2
St. Andrew's, Netteswellbury	Local Wildlife Site	1.3
Harlow Park	Local Wildlife Site	2.0
Fletimores Meadows	Local Wildlife Site	2.6
Marshgate Spring	Local Wildlife Site	2.2
Foster Street Burial Ground	Local Wildlife Site	2.2
Mill Street Green	Local Wildlife Site	2.0
Epping Forest	Special Protection Area	9.9

Table 4-1. Discrete Receptors		
Description	**Type**	**Distance (km)**
Lee Valley Lock	Special Protection Area	16.4
Lee Valley 70 Acres Reserve	Local Nature Reserve	11.9
Lee Valley Rye Marsh	Local Nature Reserve	8.4
Harlow Marsh	Local Nature Reserve	2.8
Parndon Reserve	Local Nature Reserve	4.0

Ecological receptors and site relevant Critical Loads were identified using the UK Air Pollution Information System (APIS)[6] and Simple Calculation of Atmospheric Impact Limits (SCAIL)[7] Combustion utility. Table 4-2 lists the Ecological receptors with designation and distance from the Kao facility and Figure 6 illustrates the location of these receptors relative to the Kao facility.

Table 4-2. Ecological Receptors		
Description	**Designation**	**Distance (km)**
Amwell Quarry	SSSI	9.0
Epping Forest	SSSI	5.6
Epping Forest	SAC	9.3
Harlow Woods	SSSI	3.6
Hatfield Forest	SSSI	9.0
Hunsdon Mead	SSSI	4.7
Lee Valley	Special Protection Area	7.7
Little Hallingbury Marsh	SSSI	7.4
Rye Meads	SSSI	7.7
Sawbridgeworth Marsh	SSSI	6.1
Thorley Flood Pound	SSSI	7.8

SSSI – Sites of Special Scientific Interest
SAC – Special Areas of Conservation

Receptor elevations were assigned using AERMAP, the terrain preprocessor for AERMOD, which extracts elevations from surface elevation data files produced by various geological survey resources. For this analysis the USGS Shuttle Radar Topography Mission 1 data files having a 30 m resolution were referenced for executing AERMAP. AERMAP uses interpolation procedures to assign elevations to a receptor as follows:

- For each receptor, the program searches through the data index files to determine the two profiles (longitudes or eastings) that straddle the receptor.

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[6] https://www.apis.ac.uk/srcl

[7] https://www.scail.ceh.ac.uk/index.html

- For each of these two profiles, the program then searches through the nodes in the index file to determine which two rows (latitudes or northings) straddle the receptor.
- The program then reads the elevations for these four points. A two-dimensional distance-weighted interpolation is then used to determine the elevation at the receptor location based on the elevations at the four nodes determined above.

Figure 4: Nearfield Model Receptor Locations

Figure 5: Far field Model Receptor Locations

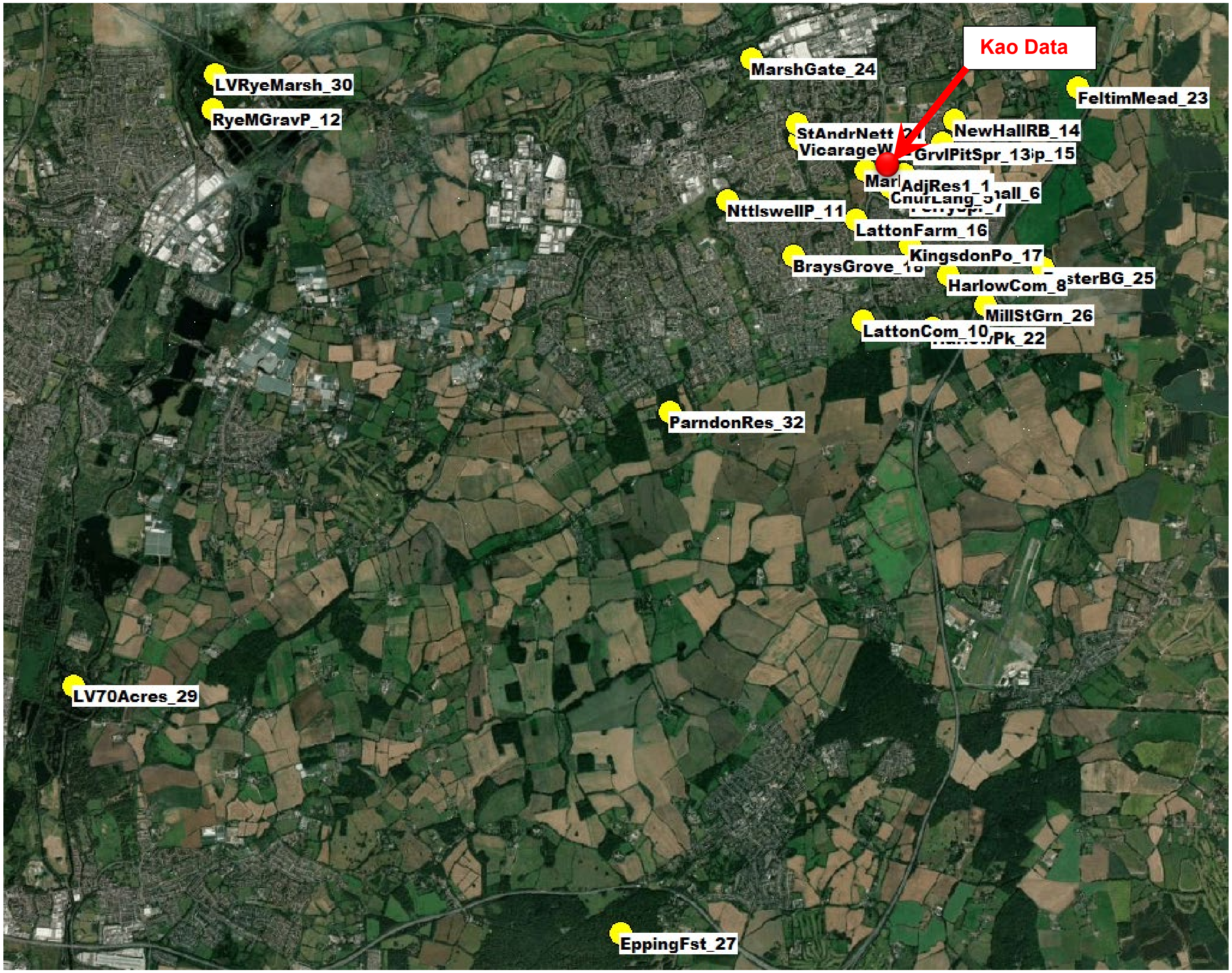
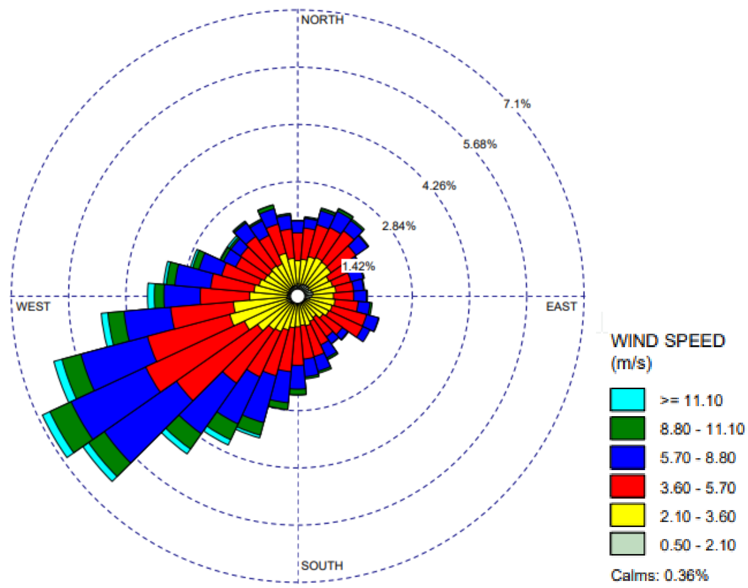


Figure 6: Ecological Receptor Locations

4.3.3 Meteorological Data

Hourly meteorological data is used by the model to simulate upper atmospheric and surface level conditions that drive dispersive forces on an hour-by-hour basis. Five years of prognostic meteorological data for Harlow were obtained from Lakes Environmental. The prognostic data was processed using the Weather Research and Forecasting (WRF) model using a 4 km x 4 km Grid Cell resolution and the Mesoscale Model Interface (MMIF) program. Execution of MMIF was done according to the recommendations found in the USEPA *Guidance on the Use of the Mesoscale Modeling Interface Program (MMIF) for AERMOD Applications* document.[8] Meteorological data representing the period from 2019 through 2023 were used for this analysis. Figure 7 shows the 5-year wind rose plot for this dataset.

Figure 7: Harlow Wind Rose for 2019-2023



Surface characteristics measured as the albedo, Bowen ratio, and surface roughness length are generated by the MMIF for the pseudo met station and are integrated into the meterological data files for running AERMOD.

4.3.4 Source Input Data

The AERMOD air dispersion model program requires the input of certain site-specific data to produce results that are representative of the actual site conditions. These data include stack coordinates, height, diameter, emission rates, exit temperature and exit flow rate. A list of the emission points and their parameters from Kao Data's existing and proposed new sources are provided above in Tables 4-3 and 4-4. Figure 2 illustrates the locations of modeled emission sources.

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[8] https://gaftp.epa.gov/Air/aqmg/SCRAM/models/related/mmif/MMIF_Guidance.pdf

The EDGs will be tested during daytime hours, between 9:00 AM and 5:00 PM during weekdays only. Therefore, a variable emission factor was incorporated within the model by which a zero coefficient was applied to the emissions for the hours outside of this operating period.

4.3.5 Building Downwash Effects

A stack height analysis is required for new and existing air pollution sources subject to a modeling analysis in order to determine if wake effect and downwash conditions need to be accounted for in the dispersion modeling algorithms and analysis. Building wake effects may cause the predicted concentrations near a point source to be higher than they would be in the absence of these effects.

The USEPA Building Profile Input Program (BPIP) was used to produce the model input information necessary to account for building wake effects, based on the dimensions of buildings in the vicinity of the stacks. The “PRIME” version of BPIP (BPIPPRM) (Schulman et al. 1997) is used for models such as AERMOD that are capable of calculating potential air quality impacts within the building “cavity” region. BPIPPRM requires the 3-dimensional coordinates of the facility’s buildings and stacks and other nearby structures that may affect the plume dispersion. The position and height of buildings relative to the stack positions must be evaluated to calculate building downwash input parameters for the AERMOD model. Coordinates for each building tier corner and stack were identified using a geo-referenced aerial image of the facility in addition to design plans for the new installation. Building downwash parameters generated by BPIPPRM are included in the AERMOD input so that wind direction-specific effects from downwash are included in predicted output concentrations. Due to the close proximity of the KLON01, KLON02, KLON03, adjacent buildings and a parking garage in the business park, these structures were included in the BPIPPRM analysis to account for downwash influences. Figure 2 illustrates the structures included in the BPIPPRM analysis.

4.3.6 NO_x to NO_2 Conversion Rates

The majority of the oxides of nitrogen (NOx) emissions from combustion sources are in the form of nitric oxide (NO), whereas the AQS is in the form of nitrogen dioxide. NO reacts with atmospheric oxygen, O_2 or O_3 (ozone), to form NO_2. Other reactive pathways for NO to NO_2 formation have been researched and are beyond scope of this modeling evaluation. The EA Air Quality Modeling and Assessment Unit investigated the NO to NO2 transformation in ***Diesel generator short term NO_2 impact*** (AQMAU-C1457-RP01)[9] and provide recommendations depending on the distance from the source and time period. Based on the findings of this study, the following approach is applied for estimating the NO to NO_2 conversion rate:

- 15% for short-term concentrations with 500 meters from the sources
- 35% for short-term concentrations beyond 500 meters from the sources
- 70% for long-term concentrations for any distance

[9] https://consult.defra.gov.uk/airquality/medium-combustion-plant-and-controls-on-generators/supporting_documents/Generator%20EA%20air%20dispersion%20modelling%20report.pdf

Table 4-3. Model Source Input Parameters – 100% Load

Source ID	Description	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
01A	KLON01 EDG	301886.24	5739249.21	75.0	15.5	0.5265	34.91	738.15
01B	KLON01 EDG	301886.24	5739255.11	75.0	15.5	0.5265	34.91	738.15
01C	KLON01 EDG	301886.24	5739261.01	75.0	15.5	0.5265	34.91	738.15
01D	KLON01 EDG	301886.24	5739266.91	75.0	15.5	0.5265	34.91	738.15
01E	KLON01 EDG	301886.24	5739272.91	75.0	15.5	0.5265	34.91	738.15
01F	KLON01 EDG	301886.24	5739278.91	75.0	15.5	0.5265	34.91	738.15
01G	KLON01 EDG	301886.24	5739284.91	75.0	15.5	0.5265	34.91	738.15
02A	KLON02 EDG	301924.84	5739417.80	76.7	15.5	0.5265	34.91	738.15
02B	KLON02 EDG	301930.74	5739417.80	76.7	15.5	0.5265	34.91	738.15
02C	KLON02 EDG	301936.64	5739417.80	76.7	15.5	0.5265	34.91	738.15
02D	KLON02 EDG	301942.54	5739417.80	76.7	15.5	0.5265	34.91	738.15
02E	KLON02 EDG	301948.44	5739417.80	76.7	15.5	0.5265	34.91	738.15
02F	KLON02 EDG	301954.34	5739417.79	76.7	15.5	0.5265	34.91	738.15
02G	KLON02 EDG	301960.24	5739417.79	76.7	15.5	0.5265	34.91	738.15
03A	KLON03 EDG	302037.60	5739414.75	76.2	15.5	0.5265	54.66	755.15
03B	KLON03 EDG	302042.50	5739414.73	76.2	15.5	0.5265	54.66	755.15
03C	KLON03 EDG	302047.40	5739414.71	76.2	15.5	0.5265	54.66	755.15

Source ID	Description	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
03D	KLON03 EDG	302052.30	5739414.69	76.2	15.5	0.5265	54.66	755.15
03E	KLON03 EDG	302057.20	5739414.66	76.2	15.5	0.5265	54.66	755.15
03F	KLON03 EDG	302062.10	5739414.64	76.2	15.5	0.5265	54.66	755.15
03G	KLON03 EDG	302067.00	5739414.89	76.2	15.5	0.5265	54.66	755.15
03H	KLON03 EDG	302071.90	5739414.87	76.2	15.5	0.5265	54.66	755.15
03I	KLON03 EDG	302076.80	5739414.85	76.2	15.5	0.5265	54.66	755.15
03J	KLON03 EDG	302081.70	5739414.83	76.2	15.5	0.5265	54.66	755.15
03K	KLON03 EDG	302086.61	5739414.83	76.2	15.5	0.5265	54.66	755.15

Table 4-4. Model Source Input Parameters – 50% Load

Source ID	Description	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
01A	KLON01 EDG	301886.24	5739249.21	75.0	15.5	0.5265	21.97	691.8
01B	KLON01 EDG	301886.24	5739255.11	75.0	15.5	0.5265	21.97	691.8
01C	KLON01 EDG	301886.24	5739261.01	75.0	15.5	0.5265	21.97	691.8
01D	KLON01 EDG	301886.24	5739266.91	75.0	15.5	0.5265	21.97	691.8
01E	KLON01 EDG	301886.24	5739272.91	75.0	15.5	0.5265	21.97	691.8
01F	KLON01 EDG	301886.24	5739278.91	75.0	15.5	0.5265	21.97	691.8
01G	KLON01 EDG	301886.24	5739284.91	75.0	15.5	0.5265	21.97	691.8
02A	KLON02 EDG	301924.84	5739417.80	76.7	15.5	0.5265	21.97	691.8
02B	KLON02 EDG	301930.74	5739417.80	76.7	15.5	0.5265	21.97	691.8
02C	KLON02 EDG	301936.64	5739417.80	76.7	15.5	0.5265	21.97	691.8
02D	KLON02 EDG	301942.54	5739417.80	76.7	15.5	0.5265	21.97	691.8
02E	KLON02 EDG	301948.44	5739417.80	76.7	15.5	0.5265	21.97	691.8
02F	KLON02 EDG	301954.34	5739417.79	76.7	15.5	0.5265	21.97	691.8
02G	KLON02 EDG	301960.24	5739417.79	76.7	15.5	0.5265	21.97	691.8
03A	KLON03 EDG	302037.60	5739414.75	76.2	15.5	0.5265	31.9	707.15
03B	KLON03 EDG	302042.50	5739414.73	76.2	15.5	0.5265	31.9	707.15
03C	KLON03 EDG	302047.40	5739414.71	76.2	15.5	0.5265	31.9	707.15
03D	KLON03 EDG	302052.30	5739414.69	76.2	15.5	0.5265	31.9	707.15

Source ID	Description	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
03E	KLON03 EDG	302057.20	5739414.66	76.2	15.5	0.5265	31.9	707.15
03F	KLON03 EDG	302062.10	5739414.64	76.2	15.5	0.5265	31.9	707.15
03G	KLON03 EDG	302067.00	5739414.89	76.2	15.5	0.5265	31.9	707.15
03H	KLON03 EDG	302071.90	5739414.87	76.2	15.5	0.5265	31.9	707.15
03I	KLON03 EDG	302076.80	5739414.85	76.2	15.5	0.5265	31.9	707.15
03J	KLON03 EDG	302081.70	5739414.83	76.2	15.5	0.5265	31.9	707.15
03K	KLON03 EDG	302086.61	5739414.83	76.2	15.5	0.5265	31.9	707.15

5 MODEL RESULTS

5.1 Significance Criteria

The significance of impacts from the proposed data center is determined in terms of criteria set out in DEFRA's *Air emissions risk assessment for your environmental permit*, EPUK and IAQM's *Planning for air quality*' and USEPA's AEGL for NO_2. The significance of impacts is considered both in terms of the Process Contribution (PC), which is the impact of direct, additional emissions associated with the new processes only, and the Predicted Environmental Concentration (PEC), which is the impact associated with ***combined*** PC and existing background pollutant concentrations.

Per DEFRA's guidance, when preparing a detailed modeling analysis, the PC can be considered insignificant if:

- the long-term PC at a sensitive receptor is <1% of the long term AQS; and
- the short-term PC at a sensitive receptor is <10% of the short term AQS.

If the above criteria are exceeded, the combined PEC impacts can be considered insignificant if:

- the short-term PC is less than 20% of the short-term environmental standards minus 2X the long-term background concentration; and
- the long-term PEC is less than 70% of the long-term environmental standards.

If the impacts exceed these significance criteria, further analysis is warranted. Particularly for NO_2, if the PEC at specified receptors indicates that the short-term hourly standard has the potential to be exceeded more than 18 times a year, then the EA requests a statistical analysis be performed of the likelihood of this occurring.

5.2 Routine Readiness and Maintenance Testing

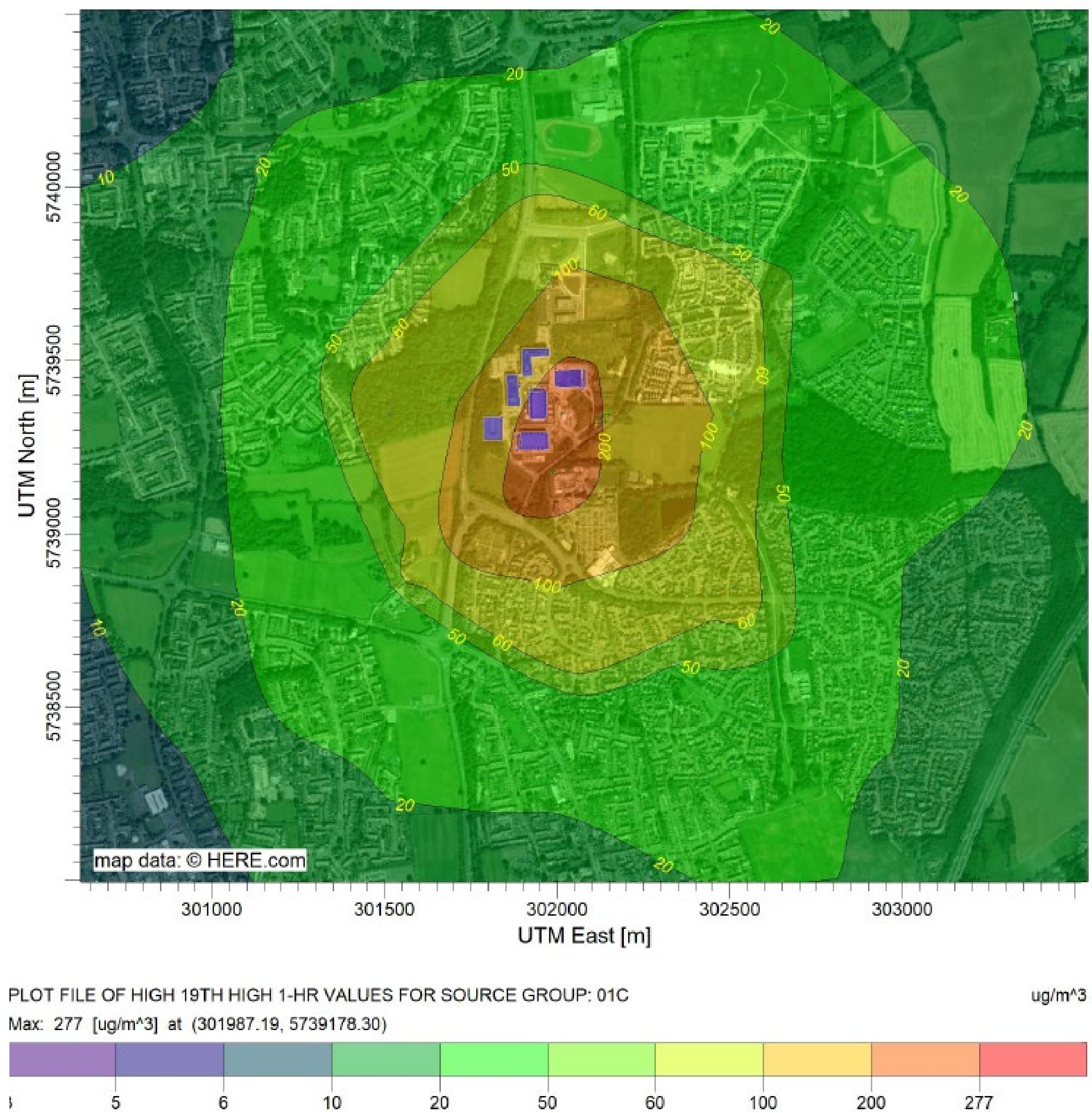
Maximum predicted concentrations for routine readiness and maintenance testing are tabulated in comparison with the respective AQS and AEGL thresholds in Table 5-1 below. Figure 8 illustrates the concentration contours generally representative of the maximum predicted 1-hour air concentrations in the near field surrounding the facility. Each engine will be tested individually, and concentration contours will vary from engine to engine, however this figure illustrates the rate at which concentrations decline with distance.

With the exceptions of NO_2 and the 24-hour PM_{10} impacts, the maximum predicted impacts are shown to be below significance levels (PC< 10% for short-term and < 1% long term thresholds). Although the maximum predicted concentrations for NO_2 are predicted to be above significance levels for short-term and long-term thresholds, the maximum 1-hour concentration plus twice the baseline is below the 200 $\mu g/m^3$ threshold. Similarly, PM_{10} 24-hour impacts, although not insignificant, are shown to be below the AQS. It should be noted that the predicted PM_{10} 24-hour concentration shown is a conservative representation of emissions in that it represents all EDGs operating on the same day, whereas in practice, only a selection of EDGs will operate on a given day for testing. Maximum concentrations are caused primarily by emissions from the KLON01 EDGs.

Table 5-1. Peak Air Modeling Results - Routine Testing.

Pollutant	AQS (ug/m3)	Averaging Period	Max PC	%	Baseline	PEC	%	Max Receptor	Distance (km)
NO_2	200	1-hour	42	21%	30.4	72	36%	Church Langley	0.2
	940	1-hour	51	5%	30.4	82	9%	Church Langley	0.2
	40	Annual	1.18	3.0%	15.2	16.4	41%	Adjacent Resident	0.2
PM10	50	24-hour	9.22	18.4%	16.9	26.1	52%	Church Langley	0.2
	40	Annual	0.0175	0.04%	16.9	16.9	42%	Adjacent Resident	0.2
PM2.5	20	Annual	0.0175	0.09%	10.4	10.4	52%	Adjacent Resident	0.2
SO2	266	15-minute	3.40	1.3%	--	--	--	Markhall Wood	0.3
	350	1-hour	2.70	0.8%	--	--	--	Markhall Wood	0.3
	125	24-hour	1.39	1.1%	--	--	--	Church Langley	0.2
CO	30,000	1-hour	319	1.1%	--	--	--	Markhall Wood	0.3
	10,000	8-hour	157	1.6%	--	--	--	Markhall Wood	0.3

Figure 8: 1-hour Maximum NOx Isopleth for Routine Testing



5.3 Black Building Tests

Black Building tests entail running the group of all EDGs for each data center building simultaneously for no more than 30 minutes at approximately 30% load. These tests will be run once per year per building and only during daytime working hours, between 9:00 AM and 5:00 PM. Model emission rates are derived assuming a 30-minute run-time at 50% load (conservatively) and, for engines equipped with SCR, a15 minute warmup period where NO_x emissions are uncontrolled plus a second 15-minute period where NO_x is controlled to a level equivalent to 190 mg/Nm^3 at 15% O_2. Maximum predicted concentrations for the 30-minute Black Building test runs are tabulated in comparison with the respective AQS and AEGL thresholds in Table 5-2 below.

With the exceptions of NO_2 and the 24-hour PM_{10} impacts, the maximum predicted impacts are shown to be below significance levels (PC< 10% for short-term and < 1% long term thresholds). Although the maximum predicted concentrations for NO_2 are predicted to be above significance levels for short-term and long-term thresholds, the maximum 1-hour concentration plus twice the baseline is below the 200 ug/m^3 threshold. Similarly, PM_{10} 24-hour impacts, although not insignificant, are shown to be below the AQS. It should be noted that the predicted PM_{10} 24-hour concentration shown is a conservative representation of emissions in that it represents all EDGs operating on the same day, whereas in practice, only a selection of EDGs will operate on a given day for testing. Maximum concentrations are caused primarily by emissions from the KLON01 EDGs.

Table 5-2. Peak Air Modeling Results - Black Building Tests

Pollutant	AQS (ug/m3)	Averaging Period	Max PC	%	Baseline	PEC	%	Max Receptor	Distance (km)
NO_2	200	1-hour	120	60%	30.4	151	75%	Church Langley	0.2
	940	1-hour	139	15%	30.4	170	18%	Church Langley	0.2
	40	Annual	1.18	3.0%	15.2	16.4	41%	Adjacent Resident	0.2
PM10	50	24-hour	9.22	18.4%	16.9	26.1	52%	Church Langley	0.2
	40	Annual	0.0175	0.04%	16.9	16.9	42%	Adjacent Resident	0.2
PM2.5	20	Annual	0.0175	0.09%	10.4	10.4	52%	Adjacent Resident	0.2
SO2	266	15-minute	3.40	1.3%	--	--	--	Markhall Wood	0.3
	350	1-hour	2.70	0.8%	--	--	--	Markhall Wood	0.3
	125	24-hour	1.39	1.1%	--	--	--	Church Langley	0.2
CO	30,000	1-hour	319	1.1%	--	--	--	Markhall Wood	0.3
	10,000	8-hour	157	1.6%	--	--	--	Markhall Wood	0.3

5.4 Emergency Scenario

Maximum predicted concentrations for the proposed design under an emergency run scenario where all EDGs are operating simultaneously are tabulated in comparison with the respective AQS and AEGL thresholds in Table 5-3 below. With the exceptions of NO_2 and the 24-hour PM_{10} impacts, the maximum predicted impacts are shown to be below significance levels (PC< 10% for short-term and < 1% long term thresholds).

The maximum 1-hour concentration plus twice the baseline exceeds the 200 ug/m^3 threshold. Given the relative infrequency for running all EDGs in an emergency power outage condition, further evaluation of the probability for the worst-case meteorological data to coincide with EDG operating schedule is warranted. Per EA's *Specified generators: air dispersion modelling example short term statistical analysis*[10] guidance, the statistical probability for this to occur was calculated using the hypergeometric distribution method. Details for the statistical calculation are provided in Appendix C, indicative of a probability less than 1%, which is considered "highly unlikely".

Table 5-3. Air Modeling Results – Emergency Scenario

Pollutant	AQS/AEGL (ug/m3)	Averaging Period	Max PC	%	Baseline	PEC	%	Probability	Max Receptor	Distance (km)
NO_2	200	1-hour	376	188%	30.4	407	203%	< 1%	Church Langley	0.2
	940	1-hour	424	45%	30.4	454.4	48%	--	Markhall Wood	0.3
	40	Annual	1.18	3.0%	15.2	16.4	41%	--	Adjacent Resident	0.2
PM10	50	24-hour	9.22	18.4%	16.9	26.1	52%	--	Church Langley	0.2
	40	Annual	0.0175	0.04%	16.9	16.9	42%	--	Adjacent Resident	0.2
PM2.5	20	Annual	0.0175	0.09%	10.4	10.4	52%	--	Adjacent Resident	0.2
SO2	266	15-minute	3.40	1.3%	--	--	--	--	Markhall Wood	0.3
	350	1-hour	2.70	0.8%	--	--	--	--	Markhall Wood	0.3
	125	24-hour	1.39	1.1%	--	--	--	--	Church Langley	0.2
CO	30,000	1-hour	319	1.1%	--	--	--	--	Markhall Wood	0.3
	10,000	8-hour	157	1.6%	--	--	--	--	Markhall Wood	0.3

5.5 Statistical Analysis for NO_2 Impacts

If the PEC at specified receptors suggests that the short-term hourly standard for NO_2 has the potential to be breached more than 18 times a year, then the Environment Agency guidance on dispersion modelling for oxides of nitrogen assessment from

[10] https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

specified generators requests a statistical analysis of the likelihood for this occurring be prepared. This statistical analysis is prepared to identify the likelihood of EDGs emergency run scenario to coincide with meteorological conditions that are less conducive to dispersion when the model is predicting the air quality standard to be exceeded. The guidance does not specify a particular statistical method that must be followed, but rather provides a hypergeometric distribution as an example. As the operating hours are not fully random, the calculated probability was multiplied by 2.5, as recommended in the guidance document. The detailed statistical calculations are provided in Appendix C.

Per the guidance materials, statistical probabilities are interpreted as follows:

- ≤1%, highly unlikely.
- <5%, unlikely within 20 years of operation; and
- ≥5%, likely potential for significance. In this case, proposals to reduce the risk of the exceedance are required.

Results for the statistical analysis indicate a probability of << 1% for the facility to operate the EDGs at a time that coincides with meteorological conditions under which dispersion forces are poor such that ambient air concentrations of NO_2 may exceed the standard.

5.6 Ecological Impacts

Potential impacts to nearby ecological receptors were evaluated according to the EA's risk assessment guidance. The evaluation is limited to effects from NOx emissions and predicted maximum ground level concentrations to applicable Critical Levels (Cle) and Critical Loads (CLo). Potential impacts due to sulfur dioxide and particulate emissions are considered insignificant with the use of ultra-low sulfur diesel for fueling the EDGs.

5.6.1 Routine Readiness Testing

Each generator will individually run once per month for approximately 1 hour at 30% of its load capacity. For one month, the generators will each run for approximately 2 hours at 75% of its load capacity. Readiness testing will only be done during daytime working hours between 9 AM to 5 PM. Nonetheless, to simplify the analysis in a conservative manner, emission rates representing a 2-hour run time per 24-hor period running at 100% load capacity were modeled. No time-of-day exclusions were applied, so results include nighttime hours when atmospheric dispersive forces tend to have the least effect, resulting in higher predicted concentrations than daytime hours. Moreover, the analysis reflects no downtime between instances of testing, as if all generators will be tested in a single 24-hour period, thereby overstating actual daily emissions in the model.

Annual impacts are predicted using time-weighted average emission rates derived including a 72-hour emergency run event plus the routine readiness testing (including 1 hour per month for 11 months, 2 hours for 1 month plus 30 minutes for a black building test) for a total of 85.5 hours per year.

Results for this analysis are summarized in Table 5-4. Potential impacts of NO_x emissions on daily and annual Critical Levels are less than 10% and 1% screening criteria, respectively, indicating that results are insignificant, requiring no further analysis.

Table 5-4. Ecological Impacts – Critical Levels – Readiness Testing						
Receptor	Max 24-hr PC NO_x (ug/m^3)	24-hr NO_x Cle (ug/m^3)	PC NO_x/Cle %	Annual PC NO_x (ug/m^3)	Annual NO_x Cle (ug/m^3)	PC NO_x/Cle %
Amwell Quarry	1.39	75	1.9%	0.0052	30	0.02%
Epping Forest	3.02	75	4.0%	0.0089	30	0.03%
Epping Forest	5.91	75	7.9%	0.0088	30	0.03%
Harlow Woods	6.23	75	8.3%	0.0177	30	0.06%
Hatfield Forest	1.48	75	2.0%	0.0112	30	0.04%
Hunsdon Mead	2.28	75	3.0%	0.0107	30	0.04%
Lee Valley	2.31	75	3.1%	0.0048	30	0.02%
Little Hallingbury Marsh	1.55	75	2.1%	0.0109	30	0.04%
Rye Meads	2.31	75	3.1%	0.0048	30	0.02%
Sawbridgeworth Marsh	2.01	75	2.7%	0.0149	30	0.05%
Thorley Flood Pound	1.48	75	2.0%	0.0098	30	0.03%

5.6.2 Black Building Testing

Once per year the group of engines at each KLON will be run for approximately 30 minutes at approximately 30% of the load capacity. Conservatively, emission rates for running at 50% load were modeled. This testing will be conducted only during daytime working hours between 9:00 AM and 5:00 PM. Maximum potential impacts of NO_x emissions on daily Critical Levels occur when KLON01 is tested and are less than 10% screening criteria for significance; therefore, no further analysis is necessary. Results for each receptor location are shown in Table 5-5. Potential annual concentrations given in Table 5-3 are inclusive of Black Building testing events, all of which are less than the 1% screening criteria for significance.

Table 5-5. Ecological Impacts – Critical Levels – Black Building Tests			
Receptor	Max 24-hr PC NO_x (ug/m^3)	24-hr NO_x Cle (ug/m^3)	PC NO_x/Cle %
Amwell Quarry	1.47	75	2.0%
Epping Forest	3.37	75	4.5%
Epping Forest	2.65	75	3.5%
Harlow Woods	3.59	75	4.8%
Hatfield Forest	1.78	75	2.4%
Hunsdon Mead	2.04	75	2.7%
Lee Valley	0.68	75	0.9%

Little Hallingbury Marsh	2.13	75	2.8%
Rye Meads	0.68	75	0.9%
Sawbridgeworth Marsh	2.00	75	2.7%
Thorley Flood Pound	2.04	75	2.7%

5.6.3 Emergency Event

Emissions of NO_x from the generators operating at 100% load continuously were modeled to evaluate potential impacts that may occur at ecologically sensitive receptors on a 24-hour averaging period. Maximum predicted concentrations are summarized in Table 5-6, indicating that NO_x is not predicted to exceed critical levels at any of the modeled ecologically sensitive receptors. Potential annual concentrations given in Table 5-3 are inclusive of a 72-hour Emergency event, all of which are less than the 1% screening criteria for significance.

Table 5-6. Ecological Impacts – Critical Levels – Emergency Event

Receptor	Max 24-hr PC NO_x (ug/m^3)	24-hr NO_x Cle (ug/m^3)	PC NO_x/Cle %
Amwell Quarry	15.03	75	20.0%
Epping Forest	32.59	75	43.4%
Epping Forest	64.17	75	85.6%
Harlow Woods	67.42	75	89.9%
Hatfield Forest	15.82	75	21.1%
Hunsdon Mead	24.23	75	32.3%
Lee Valley	24.97	75	33.3%
Little Hallingbury Marsh	16.79	75	22.4%
Rye Meads	24.97	75	33.3%
Sawbridgeworth Marsh	21.58	75	28.8%
Thorley Flood Pound	15.69	75	20.9%

5.6.4 Annual Critical Loads

Potential impacts of NO_x emissions on annual Critical Loads for dry deposition rates (eutrophication) were evaluated and found to be less than 1% of the CLo screening criteria. As noted above in Section 5.6.1, emission rates for this analysis includes a 72-hour emergency run time plus the monthly routine readiness testing. Results for each receptor location are shown in Table 5-7. The maximum PC deposition flux is less than 1% screening threshold for all receptors; therefore, no further analysis is required.

Table 5-7. Ecological Impacts – Eutrophication					
Receptor	Annual PC NO_2 (ug/m³)	Deposition Flux (ug/m²/s)	PC Deposition Flux (kgN/ha/yr)	CLo (kgN/ha/yr)	PC/CLo %
Amwell Quarry	3.65E-03	1.09E-05	0.00105	10	0.010%
Epping Forest	6.20E-03	1.86E-05	0.00178	5	0.036%
Epping Forest	6.13E-03	1.84E-05	0.00176	5	0.035%
Harlow Woods	1.24E-02	3.73E-05	0.00357	15	0.024%
Hatfield Forest	7.84E-03	2.35E-05	0.00226	5	0.045%
Hunsdon Mead	7.47E-03	2.24E-05	0.00215	10	0.021%
Lee Valley	3.39E-03	1.02E-05	0.00097	10	0.010%
Little Hallingbury Marsh	7.61E-03	2.28E-05	0.00219	--	--
Rye Meads	3.39E-03	1.02E-05	0.00097	5	0.019%
Sawbridgeworth Marsh	1.05E-02	3.14E-05	0.00301	15	0.020%
Thorley Flood Pound	6.83E-03	2.05E-05	0.00197	10	0.020%

Potential impacts of NO_x emissions on annual Critical Loads for acid deposition rates (acidification) were evaluated and found to be less than 1% of the CLo screening criteria for all receptors. No further analysis is necessary for receptors with a maximum PC acid deposition flux less than 1% of the CLo. The PEC for Epping Forest receptors were evaluated and found to be below the CLo. Results for each receptor location are given in Table 5-8.

Table 5-8. Ecological Impacts – Acidification					
Receptor	Annual PC NO_2 (ug/m³)	Dep Flux (ug/m²/s)	PC Dep Flux (keq/ha/yr)	CLo (keq/ha/yr)	PC/CLo %
Amwell Quarry	3.65E-03	1.09E-05	0.0072	4.856	0.15%
Epping Forest	6.20E-03	1.86E-05	0.0122	1.584	0.77%
Epping Forest	6.13E-03	1.84E-05	0.0121	1.584	0.76%
Harlow Woods	1.24E-02	3.73E-05	0.0244	11.017	0.22%
Hatfield Forest	7.84E-03	2.35E-05	0.0154	10.92	0.14%
Hunsdon Mead	7.47E-03	2.24E-05	0.0147	4.856	0.30%
Lee Valley	3.39E-03	1.02E-05	0.0067	4.856	0.14%
Little Hallingbury Marsh	7.61E-03	2.28E-05	0.0150	--	--
Rye Meads	3.39E-03	1.02E-05	0.0067	4.856	0.14%
Sawbridgeworth Marsh	1.05E-02	3.14E-05	0.0206	--	--
Thorley Flood Pound	6.83E-03	2.05E-05	0.0134	--	--

6 Conclusion

Kao Data is proposing to add a new structure, KLON03 and 17 new diesel-fired generator engines to its Harlow campus. This dispersion modeling analysis was prepared to evaluate potential impacts from routinely testing all existing and new generator engines. Although the engines will be operated at approximately 30 percent load during the testing, this analysis conservatively evaluates potential impacts from operating the engines at 50 and 100 percent loads. Four new engines at KLON02 and all 11 new engines at KLON03 will be equipped with SCR control technology to minimize emissions of NO_x.

This dispersion modeling analysis indicates that maximum ambient air concentrations of NO_2, PM_{10}, $PM_{2.5}$, SO_2, and CO at publicly accessible receptor locations will not result in an exceedance of the applicable AQS. Moreover, the analysis indicates that peak NO_2 air concentrations and nitrogen deposition rates in ecologically sensitive areas are within acceptable levels or considered insignificant.

An emergency power outage scenario was also modeled, assuming all engines would operate continuously for 72 hours. Although the model results for this scenario show a potential peak PEC greater than the allowable threshold of 200 ug/m^3 for NO_2, a statistical analysis of the model results indicates that it is highly unlikely for an exceedance to occur as predicted by the model (i.e. that the meteorological conditions with poorest dispersion characteristics will coincide with a 72-hour power outage).

Appendix A: Mean Annual Background Projections for Harlow

Harlow District Council

Estimated Background Air Pollution Maps (base year 2018), downloaded from https://uk-air.defra.gov.uk/data/laqm-background-home.
Total annual mean concentrations based on 1 km x 1 km grid squares are provided. For further information please refer to the LAQM Support Helpdesk at https://laqm.defra.gov.uk/helpdesk/laqm-helpdesk.html

Concentrations are as ug.m-3 NO2

Local_Auth	x	y	geo_area	EU_zone_a	Total_NO2_24
119	546500	212500	6	29	11.08864
119	547500	212500	6	29	11.2914
119	544500	211500	6	29	12.0175
119	545500	211500	6	29	11.38679
119	546500	211500	6	29	15.16671
119	547500	211500	6	29	11.07632
119	548500	211500	6	29	9.992098
119	542500	210500	6	29	9.874938
119	543500	210500	6	29	11.19869
119	544500	210500	6	29	12.39462
119	545500	210500	6	29	11.28325
119	546500	210500	6	29	11.48605
119	547500	210500	6	29	10.57925
119	548500	210500	6	29	10.28327
119	542500	209500	6	29	14.46122
119	543500	209500	6	29	11.47616
119	544500	209500	6	29	11.66063
119	545500	209500	6	29	11.36842
119	546500	209500	6	29	11.72346
119	547500	209500	6	29	10.98464
119	548500	209500	6	29	13.65223
119	543500	208500	6	29	11.24235
119	544500	208500	6	29	11.32743
119	545500	208500	6	29	11.22036
119	546500	208500	6	29	11.73436
119	547500	208500	6	29	11.24779
119	543500	207500	6	29	9.976478
119	544500	207500	6	29	10.28152
119	545500	207500	6	29	9.765425
119	544500	206500	6	29	8.887403
				Max:	15.16671

Harlow District Council

Estimated Background Air Pollution Maps (base year 2018), downloaded from https://uk-air.defra.gov.uk/data/laqm-background-home. Total annual mean concentrations based on 1 km x 1 km grid squares are provided.
For further information please refer to the LAQM Support Helpdesk at https://laqm.defra.gov.uk/helpdesk/laqm-helpdesk.html

Concentrations are as ug.m-3 gravimetric PM2.5

Local_Auth	x	y	geo_area	EU_zone_a	Total_PM2.	Motorway_i	Motorway_	Trunk_A_Rd	Trunk_A_Rd	Primary_A_	Primary_A_	Minor_Rd+(	Minor_Rd+(	Brake_tyre_	Brake_tyre_	Road_Abra	Road_Abra	Industry_in	Industry_ou	Domestic_i	Domestic_(	Rail_in_24	Rail_out_24	Other_in_24	Other_out_	PM_second	Residual+S	Point_Sourc
119	546500	212500	6	29	8.953367	0	0.002924	0	0.000187	0.001405	0.005586	0.003308	0.006053	0.017678	0.060062	0.005854	0.027916	0.01155	0.277752	0.00527	0.268115	0.000101	0.000148	0.0532	0.085064	5.532829	2.498933	0.089431
119	547500	212500	6	29	9.051017	0	0.003653	0	0.000231	0.004753	0.004845	0.00339	0.006416	0.041921	0.060627	0.013911	0.029145	0.021388	0.27495	0.156096	0.264423	0.000122	0.000146	0.014419	0.087795	5.532829	2.457865	0.072092
119	544500	211500	6	29	9.337793	0	0.002504	0	0.000137	0.009954	0.006328	0.00259	0.006583	0.049253	0.061245	0.022088	0.028388	0.020317	0.263537	0.025818	0.291649	0.000117	0.000151	0.120826	0.064584	5.536703	2.742566	0.082455
119	545500	211500	6	29	8.983601	0	0.0028	0	0.000163	0.005823	0.006885	0.003296	0.007664	0.044835	0.070272	0.014937	0.031861	0.010868	0.286599	0.035259	0.32823	0.000127	0.000148	0.009658	0.102681	5.532829	2.418192	0.070473
119	546500	211500	6	29	9.37685	0	0.003288	0	0.000194	0.009458	0.005746	0.006922	0.007549	0.077404	0.069393	0.026029	0.031511	0.062932	0.238217	0.111258	0.350925	0.000015	0.000161	0.224376	0.060482	5.532829	2.515523	0.042637
119	547500	211500	6	29	9.210872	0	0.004211	0	0.000237	0.000594	0.006047	0.006812	0.007278	0.039266	0.072766	0.012958	0.034115	0.031852	0.280073	0.235892	0.325506	0	0.000145	0.012705	0.09252	5.532829	2.453788	0.061278
119	548500	211500	6	29	9.125733	0	0.007093	0	0.00028	0	0.003962	0.003867	0.006224	0.022413	0.064507	0.007396	0.036392	0.0169	0.245983	0.136332	0.286557	0	0.000128	0.006087	0.052732	5.532829	2.652792	0.043259
119	542500	210500	6	29	8.770498	0	0.002368	0	0.000093	0.00062	0.005669	0.001459	0.005985	0.006839	0.054651	0.002307	0.026267	0.009295	0.267758	0.005741	0.272259	0.000087	0.000308	0.009607	0.102078	5.536703	2.405704	0.054702
119	543500	210500	6	29	9.278794	0	0.002525	0	0.000117	0.003347	0.006263	0.00437	0.007171	0.041707	0.062159	0.014022	0.028736	0.029888	0.278309	0.211828	0.289348	0	0.000181	0.009987	0.114842	5.536703	2.576627	0.060663
119	544500	210500	6	29	9.278447	0	0.002764	0	0.000141	0.006176	0.006764	0.012511	0.007522	0.070443	0.070878	0.023571	0.03174	0.045611	0.269686	0.196007	0.362546	0	0.000148	0.029183	0.088991	5.536703	2.460289	0.056772
119	545500	210500	6	29	9.371929	0	0.003119	0	0.000167	0	0.007901	0.00686	0.009031	0.035783	0.083093	0.011726	0.036024	0.048283	0.285177	0.298587	0.399335	0	0.000146	0.0158	0.081851	5.532829	2.460859	0.055358
119	546500	210500	6	29	9.442048	0	0.003748	0	0.000198	0.005872	0.006682	0.005984	0.008503	0.06357	0.079977	0.021214	0.03583	0.044246	0.273511	0.298271	0.423661	0	0.000137	0.016443	0.081336	5.532829	2.485036	0.054998
119	547500	210500	6	29	9.242737	0	0.005263	0	0.000239	0	0.006195	0.003981	0.007921	0.021795	0.079539	0.007148	0.038265	0.014765	0.265428	0.072967	0.429522	0	0.00013	0.008991	0.063039	5.532829	2.642462	0.042256
119	548500	210500	6	29	9.526851	0.003391	0.008527	0	0.00028	0	0.003964	0.000667	0.0068	0.01202	0.069758	0.009937	0.040759	0.005593	0.253815	0.00887	0.352945	0	0.000125	0.00245	0.048401	5.532829	3.131887	0.033832
119	542500	209500	6	29	9.253326	0	0.002591	0	0.0001	0.003017	0.004622	0.007976	0.006363	0.042021	0.054576	0.014091	0.025795	0.120935	0.242363	0.010069	0.317534	0	0.000332	0.385599	0.045059	5.532912	2.390104	0.047268
119	543500	209500	6	29	9.084831	0	0.002777	0	0.000123	0.003666	0.005911	0.005751	0.008343	0.04268	0.069665	0.014265	0.030944	0.029167	0.284752	0.141808	0.372095	0	0.000185	0.027148	0.123698	5.532912	2.337833	0.051106
119	544500	209500	6	29	9.18699	0	0.003071	0	0.000147	0.006714	0.006491	0.005993	0.009047	0.052585	0.078139	0.017718	0.034109	0.026155	0.279335	0.124755	0.45879	0	0.000142	0.010512	0.077591	5.532912	2.413577	0.049208
119	545500	209500	6	29	9.42718	0	0.003528	0	0.000172	0.006215	0.007144	0.005397	0.00901	0.058906	0.082468	0.019878	0.036339	0.039592	0.277444	0.30613	0.478812	0	0.000138	0.013095	0.067476	5.528336	2.440969	0.046132
119	546500	209500	6	29	9.669539	0	0.00433	0	0.000203	0.013078	0.0063	0.00439	0.008614	0.091912	0.079993	0.031006	0.03705	0.033332	0.276245	0.251661	0.502821	0	0.000139	0.011561	0.06091	5.528336	2.685538	0.042119
119	547500	209500	6	29	9.430743	0	0.006855	0	0.000244	0	0.006743	0.007901	0.007206	0.034942	0.081949	0.011451	0.042433	0.052138	0.262064	0.408567	0.419004	0	0.000138	0.018719	0.050549	5.528336	2.45484	0.036665
119	548500	209500	6	29	10.384	0.023512	0.007544	0	0.000284	0	0.004135	0.004633	0.006175	0.069715	0.064598	0.064442	0.037906	0.034661	0.25615	0.295153	0.341993	0	0.000141	0.013768	0.041821	5.528336	3.557013	0.032023
119	543500	208500	6	29	9.255366	0	0.003052	0	0.00013	0.007336	0.00467	0.006852	0.007969	0.076149	0.063762	0.025185	0.029301	0.04253	0.262919	0.303147	0.405747	0	0.000216	0.013877	0.071326	5.532912	2.353793	0.044495
119	544500	208500	6	29	9.461352	0	0.003412	0	0.000155	0.004121	0.005952	0.007449	0.008486	0.054782	0.074741	0.017997	0.033509	0.058352	0.266001	0.435973	0.465606	0	0.000176	0.023597	0.06192	5.532912	2.359213	0.046999
119	545500	208500	6	29	9.47464	0	0.004056	0	0.00018	0.004228	0.006119	0.006745	0.008296	0.054683	0.076011	0.017966	0.035197	0.048618	0.271312	0.38123	0.501914	0	0.000148	0.020637	0.058819	5.528336	2.407682	0.042463
119	546500	208500	6	29	9.61611	0	0.005403	0	0.00021	0.008792	0.005787	0.006109	0.00744	0.075462	0.073608	0.026045	0.037183	0.071074	0.23086	0.401616	0.452418	0	0.000153	0.020536	0.049924	5.528336	2.579164	0.03599
119	547500	208500	6	29	9.464931	0	0.008894	0	0.000251	0.00382	0.005841	0.004214	0.006496	0.037334	0.07675	0.016717	0.044753	0.030132	0.260401	0.242587	0.399606	0	0.000158	0.009486	0.043919	5.528336	2.712392	0.032845
119	543500	207500	6	29	9.12308	0	0.003347	0	0.000128	0	0.004569	0.005506	0.007127	0.025515	0.061664	0.008362	0.029218	0.040846	0.253101	0.250158	0.388961	0	0.000261	0.01434	0.051698	5.532912	2.403954	0.041415
119	544500	207500	6	29	9.481967	0	0.003759	0	0.000152	0	0.00455	0.006374	0.007138	0.029286	0.061794	0.009612	0.029933	0.046225	0.252346	0.371049	0.416469	0	0.000224	0.035713	0.04916	5.532912	2.590723	0.03455
119	545500	207500	6	29	9.417403	0	0.004593	0	0.000176	0	0.004629	0.003671	0.006897	0.017557	0.062872	0.005837	0.031847	0.028111	0.250157	0.240227	0.422039	0	0.000194	0.009148	0.050282	5.528336	2.712704	0.038126
119	544500	206500	6	29	8.869257	0	0.004178	0	0.00015	0	0.003938	0.000408	0.00606	0.002751	0.053856	0.000997	0.028299	0.002002	0.241083	0.002287	0.363008	0	0.000276	0.000743	0.044145	5.532912	2.54477	0.037394
				Max:	10.384																							

Harlow District Council

Estimated Background Air Pollution Maps (base year 2018), downloaded from https://uk-air.defra.gov.uk/data/laqm-background-home. Total annual mean concentrations based on 1 km x 1 km grid squares are provided.
For further information please refer to the LAQM Support Helpdesk at https://laqm.defra.gov.uk/helpdesk/laqm-helpdesk.html

Concentrations are as ug.m-3 gravimetric PM10

Local_Auth	x	y	geo_area	EU_zone_a	Total_PM10	Motorway_i	Motorway_	Trunk_A_Rc	Trunk_A_Rc	Primary_A_	Primary_A_	Minor_Rd+(	Minor_Rd+(	Brake+Tyre	Brake+Tyre	Road_Abra	Road_Abra	Industry_in	Industry_ou	Domestic_i	Domestic_	Rail_in_24	Rail_out_24	Other_in_2	Other_out_	PM_second	Residual+S	Point_Sourc
119	546500	212500	6	29	14.00167	0	0.002897	0	0.000185	0.001392	0.005535	0.003279	0.005998	0.03185	0.108214	0.010742	0.051227	0.039876	0.52926	0.005288	0.272308	0.000087	0.000243	0.052854	0.085923	6.441933	6.254582	0.098002
119	547500	212500	6	29	13.90999	0	0.00362	0	0.000228	0.00471	0.004802	0.003359	0.006358	0.075529	0.109233	0.025526	0.053484	0.07623	0.517417	0.158836	0.26859	0.000105	0.000238	0.01471	0.088694	6.441933	5.976662	0.079724
119	544500	211500	6	29	14.85092	0	0.002482	0	0.000136	0.009863	0.006271	0.002567	0.006524	0.088739	0.110345	0.040533	0.052093	0.076149	0.531203	0.026042	0.296177	0.000101	0.000258	0.119951	0.065714	6.447272	6.880154	0.088345
119	545500	211500	6	29	13.67978	0	0.002775	0	0.000161	0.005769	0.006822	0.003266	0.007595	0.080778	0.126608	0.02741	0.058466	0.035144	0.582998	0.035711	0.33336	0.000109	0.000258	0.009716	0.103675	6.441933	5.740711	0.076517
119	546500	211500	6	29	14.27209	0	0.003258	0	0.000193	0.009373	0.005694	0.006858	0.00748	0.139457	0.125024	0.047764	0.057825	0.20977	0.514676	0.112262	0.356605	0.000013	0.000271	0.222796	0.061925	6.441933	5.90429	0.044625
119	547500	211500	6	29	14.1818	0	0.004173	0	0.000235	0.000588	0.005992	0.00675	0.007212	0.070746	0.131102	0.023779	0.062603	0.123113	0.55717	0.239889	0.330665	0	0.000255	0.013286	0.093626	6.441933	6.000975	0.067711
119	548500	211500	6	29	14.49689	0	0.007028	0	0.000277	0	0.003925	0.003832	0.006168	0.040381	0.116221	0.013573	0.066783	0.063545	0.486484	0.138552	0.291191	0	0.00024	0.006397	0.054073	6.441933	6.709385	0.046901
119	542500	210500	6	29	13.58734	0	0.002346	0	0.000092	0.000614	0.005617	0.001445	0.005931	0.01232	0.098464	0.004234	0.048201	0.023967	0.56005	0.005779	0.276578	0.000075	0.000777	0.009558	0.102657	6.447272	5.922628	0.058737
119	543500	210500	6	29	14.57663	0	0.002503	0	0.000116	0.003317	0.006207	0.00433	0.007106	0.075144	0.111992	0.02573	0.052733	0.12047	0.573137	0.215007	0.29396	0	0.000346	0.010611	0.115422	6.447272	6.44586	0.065368
119	544500	210500	6	29	14.23859	0	0.002739	0	0.00014	0.006121	0.006702	0.012397	0.007453	0.126918	0.127701	0.043254	0.058245	0.197901	0.567438	0.198865	0.368402	0	0.000272	0.03007	0.090089	6.447272	5.885376	0.061235
119	545500	210500	6	29	14.53477	0	0.003091	0	0.000164	0	0.007829	0.006798	0.008949	0.06447	0.149709	0.021518	0.066107	0.201226	0.598968	0.30331	0.405806	0	0.000275	0.016844	0.083259	6.441933	6.093974	0.060536
119	546500	210500	6	29	14.42727	0	0.003714	0	0.000196	0.005819	0.006621	0.005929	0.008425	0.114534	0.144094	0.03893	0.06575	0.178241	0.592606	0.303258	0.430531	0	0.000271	0.017337	0.082859	6.441933	5.925721	0.060502
119	547500	210500	6	29	14.73028	0	0.005215	0	0.000237	0	0.006139	0.003945	0.007849	0.039267	0.143304	0.013117	0.070219	0.075141	0.57186	0.074072	0.43664	0	0.000266	0.009379	0.064724	6.441933	6.720773	0.046202
119	548500	210500	6	29	15.79136	0.00336	0.00845	0	0.000278	0	0.003928	0.000661	0.006738	0.021655	0.125683	0.018236	0.074795	0.034079	0.521116	0.008945	0.358779	0	0.000266	0.00264	0.049987	6.441933	8.073101	0.036727
119	542500	209500	6	29	14.13896	0	0.002567	0	0.000098	0.00299	0.00458	0.007904	0.006306	0.07571	0.09833	0.025857	0.047335	0.377204	0.512349	0.010151	0.32258	0	0.000892	0.382155	0.046299	6.442749	5.72277	0.050137
119	543500	209500	6	29	13.6954	0	0.002753	0	0.000122	0.003633	0.005857	0.005699	0.008267	0.076895	0.125516	0.026177	0.056784	0.102281	0.618069	0.14434	0.37808	0	0.000437	0.027411	0.124469	6.442749	5.490751	0.055106
119	544500	209500	6	29	13.95686	0	0.003043	0	0.000146	0.006653	0.006432	0.005938	0.008965	0.094743	0.140782	0.032514	0.062591	0.110836	0.614397	0.1273	0.466288	0	0.000303	0.01108	0.079137	6.442749	5.689834	0.053129
119	545500	209500	6	29	14.31203	0	0.003496	0	0.000171	0.006158	0.007079	0.005348	0.008928	0.10613	0.148583	0.036476	0.066684	0.16482	0.617008	0.31118	0.486837	0	0.000292	0.013949	0.069262	6.436618	5.77302	0.049993
119	546500	209500	6	29	14.95982	0	0.00429	0	0.000202	0.01296	0.006242	0.00435	0.008537	0.165598	0.144124	0.056899	0.067988	0.14003	0.613264	0.255922	0.511278	0	0.0003	0.012288	0.062782	6.436618	6.410373	0.045773
119	547500	209500	6	29	14.34681	0	0.006793	0	0.000242	0	0.006681	0.00783	0.00714	0.062954	0.147647	0.021013	0.077866	0.217866	0.556245	0.416023	0.425939	0	0.000304	0.019806	0.052245	6.436618	5.843799	0.039798
119	548500	209500	6	29	16.89639	0.023299	0.007476	0	0.000282	0	0.004097	0.004592	0.00612	0.125604	0.116386	0.118255	0.06956	0.162179	0.507481	0.300412	0.347596	0	0.000315	0.01462	0.04334	6.436618	8.573317	0.034837
119	543500	208500	6	29	13.94039	0	0.003024	0	0.000129	0.00727	0.004628	0.00679	0.007896	0.137196	0.114879	0.046217	0.053768	0.157373	0.573696	0.308138	0.412372	0	0.000558	0.014621	0.072681	6.442749	5.528635	0.047771
119	544500	208500	6	29	14.29958	0	0.003381	0	0.000153	0.004083	0.005898	0.007382	0.00841	0.0987	0.134659	0.033024	0.06149	0.248203	0.588349	0.44364	0.473348	0	0.000426	0.024791	0.063596	6.442749	5.606938	0.050357
119	545500	208500	6	29	14.39896	0	0.004019	0	0.000178	0.00419	0.006064	0.006684	0.008221	0.098523	0.13695	0.032968	0.064587	0.201776	0.603844	0.388032	0.510372	0	0.000331	0.021606	0.060657	6.436618	5.76774	0.045604
119	546500	208500	6	29	14.77964	0	0.005353	0	0.000209	0.008713	0.005735	0.006054	0.007373	0.13596	0.132619	0.047795	0.068234	0.258243	0.526885	0.4094	0.459896	0	0.000347	0.021369	0.051689	6.436618	6.158171	0.038977
119	547500	208500	6	29	14.59472	0	0.008814	0	0.000249	0.003785	0.005788	0.004176	0.006437	0.067264	0.13828	0.030677	0.082123	0.118647	0.536705	0.245981	0.406384	0	0.000362	0.010101	0.045543	6.436618	6.411213	0.035567
119	543500	207500	6	29	14.0375	0	0.003317	0	0.000126	0	0.004528	0.005457	0.007062	0.04597	0.111099	0.015343	0.053616	0.17799	0.533374	0.254582	0.395207	0	0.000708	0.015239	0.053089	6.442749	5.873639	0.044407
119	544500	207500	6	29	14.97105	0	0.003724	0	0.000151	0	0.00451	0.006316	0.007073	0.052764	0.111334	0.017637	0.05493	0.19549	0.546177	0.37777	0.423316	0	0.000583	0.036511	0.050755	6.442749	6.601665	0.037598
119	545500	207500	6	29	15.15266	0	0.004552	0	0.000175	0	0.004588	0.003638	0.006835	0.031631	0.113276	0.01071	0.058442	0.113782	0.538832	0.244592	0.429057	0	0.000475	0.009715	0.051879	6.436618	7.052926	0.040936
119	544500	206500	6	29	13.97326	0	0.00414	0	0.000149	0	0.003902	0.000405	0.006005	0.004957	0.097033	0.00183	0.051929	0.006006	0.50991	0.002306	0.368832	0	0.000746	0.000847	0.045562	6.442749	6.385717	0.04023
			Max:		16.89639																							

Appendix B: Emission Rate Calculations with Engine Specifications

Emission Calculations

Project	Kao Data Harlow UK	Computed	KRS
Subject	Potential Emissions	Checked	
Source	Emergency Diesel Engine	Sheets	1

Hours	Engine Output Capacity hp	Fuel Consumption gal/hr	Fuel Heat Content Btu/gal, HHV	Maximum Heat Input MMBtu/hr, HHV
83.5	3,058	142	138,000	19.60

Criteria Air Pollutants	CAS#	Emission Factor g/hp-hr	Potential Emissions g/s	Potential Emissions lb/hr	Potential Emissions tpy
Nitrogen Oxides (NO_x)[a]	10102-43-9	5.92	5.03	39.9	1.67
Carbon Monoxide (CO)[a]	630-08-0	0.44	0.37	2.97	0.12
Particulate Matter (PM)[a]	-	0.05	0.042	0.34	0.014
Particulate Matter < 10 Microns (PM_{10})[a]	-	0.05	0.042	0.34	0.014
Particulate Matter < 2.5 Microns ($PM_{2.5}$)[a]	-	0.05	0.042	0.34	0.014
Volatile Organic Compounds (VOC)[a]	-	0.31	0.265	2.10	0.088
Sulfur Dioxide (SO_2)[b]	7446-09-5	0.0055	0.005	0.037	0.0015

Notes:

[a] Emission factor provided by engine manufacturer, Rolls Royce, Model mtu 16V4000 DS2250.

[b] SO_2 emission factor from AP-42 *Fifth Edition Compilation of Air Pollutant Emissions Factors* , Section 3.4 - Large Stationary Diesel And All Stationary Dual-fuel Engines. A sulfur content of 0.15% is assumed.

Annualized model emission rate for NOx is derived by multiplying by total run time hours / 8760 = (72+11+2+0.5)/8760
= 0.048 g/s
Similarly for PM: 0.000405 g/s

NOx Emission Rate controlled by SCR at 190 mg/m3 at 15%O2 for Short-Term Impact Analysis:

Adjust to average O2 content of 11.9% O2 for actual exhaust conditions

Multiply by : $(20.9 - 11.9) \div (20.9 - 15)$

	289.8	mg/m3	at 0 C
Flow at 100% Load:	456	m3/min	
Flow at 100% Load:	169	m3/min	at 0 C
NOx Emission Rate:	0.815	g/s	Controlled By SCR
Uncontrolled:	5.027	g/s	Emission Rate During SCR Warmup
Time Weighted Averages:	2.921	g/s	30 min average
	1.461	g/s	Model Emission Rate for 30 Min Black Bldg Test
	1.868	g/s	Model Emission Rate for 60 min test
	1.342	g/s	Model Emission Rate for 120 min test
Temp:	465	C	

Adjusted to 50% load - estimated in proportion to KLON3 engine data (in absence of available data at 50% load for this model engine)

Flow Adjustment Factor:	0.629		
Temp Adjustment Factor:	0.900		
NOx Adjustment Factor:	0.364		
NOx Emission Rate:	0.187	g/s	Controlled By SCR
Uncontrolled:	1.828	g/s	Emission Rate During SCR Warmup
Time Weighted Averages:	1.007	g/s	30 min average
	0.504	g/s	Model Emission Rate for 30 Min Black Bldg Test
	0.597	g/s	Model Emission Rate for 60 min test
	0.392	g/s	Model Emission Rate for 120 min test
Adjusted Temp:	418.7	C	

Diesel Generator Set

mtu 16V4000 DS2250 50 °C

2,045 kWe/60 Hz/Data Center Continuous Power (Fuel Consumption Optimized)
380 - 13,800V
Reference: *mtu* 16V4000 DS2250 (2,250 kWe) 50 °C for Standby (Fuel Consumption Optimized) Rating Technical Data

System ratings

Voltage (L-L)	380V † ‡	416V † ‡	440V † ‡	480V † ‡	600V ‡	4,160V	12,470V
Phase	3	3	3	3	3	3	3
PF	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Hz	60	60	60	60	60	60	60
kW	2,045	2,045	2,045	2,045	2,045	2,045	2,045
kVA	2,556	2,556	2,556	2,556	2,556	2,556	2,556
Amps	3,884	3,548	3,354	3,075	2,460	355	118
skVA@30% voltage dip	6,899	5,573	4,047	4,816	6,271	5,852	4,266
Generator model*	841-M70	841-L75	641-VL95	641-VL95	841-S60	841-S60	4P6.6-2800
Temp rise	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C
Connection	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE

Voltage (L-L)	13,200V	13,800V
Phase	3	3
PF	0.8	0.8
Hz	60	60
kW	2,045	2,045
kVA	2,556	2,556
Amps	112	107
skVA@30% voltage dip	4,017	4,390
Generator model*	4P6.6-2800	4P6.6-2800
Temp rise	130 °C/40 °C	130 °C/40 °C
Connection	6 LEAD WYE	6 LEAD WYE

* Consult the factory for alternate configuration. Generator model may end with -M or -R, depending on selection.
† UL 2200 offered
‡ CSA offered

A Rolls-Royce solution

Certifications and standards

- Emissions
  - Fuel Consumption Optimized (FCO)
- Generator set is designed and manufactured in facilities certified to standards ISO 9001:2008 and ISO 14001:2004
- Seismic certification – optional
  - 2021 IBC certification
  - HCAI pre-approval
- UL 2200 - optional (refer to *System ratings* for availability)
- CSA - optional (refer to *System ratings* for availability)
  - CSA C22.2 No. 100
  - CSA C22.2 No. 14
- Performance Assurance Certification (PAC)
  - Generator set tested to ISO 8528-5 for transient response
  - Verified product design, quality, and performance integrity
  - All engine systems are prototype and factory tested
- Power rating
  - Data Center Continuous Power (DCCP) rating is optimized for data center applications
  - Uptime Institute compliant for Tier III and IV data centers
  - No runtime limitation
  - 100% load factor
  - 10% overload available
  - Accepts rated load in one step per NFPA 110

Standard features*

- Single source supplier
- Global product support
- Two (2) Year/3,000 Hour Basic Limited Warranty
- 16V4000 diesel engine
  - 76.3 liter displacement
  - Common rail fuel injection
  - 4-cycle
- HVO and GtL fuels meeting fuel specification EN15940
- Complete range of accessories
- Cooling system
  - Integral set-mounted
  - Engine-driven fan
- Generator
  - Brushless, rotating field generator
  - 2/3 pitch windings
  - Permanent Magnet Generator (PMG) supply to regulator
  - 300% short circuit capability
- Digital control panel(s)
  - UL recognized, CSA certified, NFPA 110
  - Complete system metering
  - LCD display

Standard equipment*

Engine
- Air cleaners
- Oil pump
- Oil drain extension and shut-off valve
- Centrifugal oil filtration
- Closed crankcase ventilation
- Jacket water pump
- Inter cooler water pump
- Thermostats
- Blower fan and fan drive
- Radiator - unit mounted
- Electric starting motor - 24V
- Governor - electronic Isochronous
- Base - structural steel
- SAE flywheel and bell housing
- Charging alternator - 24V
- Battery box and cables
- Flexible fuel connectors
- Flexible exhaust connection
- Fuel consumption optimized

Generator
- NEMA MG1, IEEE, and ANSI standards compliance for temperature rise and motor starting
- Sustained short circuit current of up to 300% of the rated current for up to 10 seconds
- Self-ventilated and drip-proof
- Superior voltage waveform
- Digital, solid state, volts-per-hertz regulator
- Brushless alternator with brushless pilot exciter
- 4 pole, rotating field
- 1 bearing, sealed
- Flexible coupling
- Full amortisseur windings
- 125% rotor balancing
- 3-phase voltage sensing
- ± 0.25% voltage regulation no load to full load
- 100% of rated load - one step
- 5% maximum total harmonic distortion

Digital control panel(s)
- Digital metering
- Engine parameters
- Generator protection functions
- Engine protection
- CANBus ECU communications
- Windows®-based software
- Multilingual capability
- Communications to remote annunciator
- Programmable input and output contacts
- UL recognized, CSA certified, CE approved
- Event recording
- IP 54 front panel rating with integrated gasket
- NFPA 110 compatible

* Represents standard product only. Consult factory/***mtu*** Distributor for additional configurations.

Application data

Engine

Manufacturer	***mtu***
Model	16V4000G24S
Type	4-cycle
Arrangement	16-V
Displacement: L (in^3)	76.3 (4,656)
Bore: cm (in)	17 (6.69)
Stroke: cm (in)	21 (8.27)
Compression ratio	16.5:1
Rated rpm	1,800
Engine governor	electronic isochronous (ADEC)
Maximum power: kWm (bhp)	2,280 (3,058)
Steady state frequency band	± 0.25%
Air cleaner	dry

Liquid capacity

Total oil system: L (gal)	300 (79.3)
Engine jacket water capacity: L (gal)	175 (46.2)
After cooler water capacity: L (gal)	50 (13.2)
System coolant capacity: L (gal)	719 (190)

Electrical

Electric volts DC	24
Cold cranking amps under -17.8 °C (0 °F)	2,800
Batteries: group size	8D
Batteries: quantity	4

Fuel system

Fuel supply connection size	-16 JIC 37° female 1" NPT adapter provided
Fuel return connection size	-16 JIC 37° female 1" NPT adapter provided
Maximum fuel lift: m (ft)	1 (3)
Recommended fuel	diesel #2/HVO
Total fuel flow: L/hr (gal/hr)	1,200 (317)

Fuel consumption

At 100% of power rating: L/hr (gal/hr)	536 (142)
At 75% of power rating: L/hr (gal/hr)	398 (105)
At 50% of power rating: L/hr (gal/hr)	277 (73)

Cooling - radiator system

Ambient capacity of radiator: °C (°F)	50 (122)
Maximum restriction of cooling air: intake and discharge side of radiator: kPa (in. H_2O)	0.12 (0.5)
Water pump capacity: L/min (gpm)	1,350 (357)
After cooler pump capacity: L/min (gpm)	583 (154)
Heat rejection to coolant: kW (BTUM)	840 (47,770)
Heat rejection to after cooler: kW (BTUM)	560 (31,847)
Heat radiated to ambient: kW (BTUM)	202.1 (11,493)
Fan power: kW (hp)	101.4 (136)

Air requirements

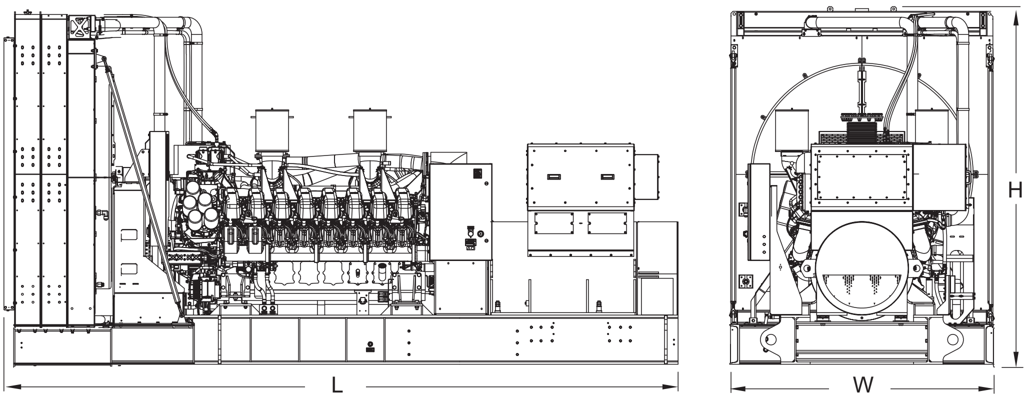
Aspirating: *m^3/min (SCFM)	186 (6,569)
Air flow required for radiator cooled unit: *m^3/min (SCFM)	3,168 (111,890)
Remote cooled applications; air flow required for dissipation of radiated generator set heat for a maximum of 25 °F rise: *m^3/min (SCFM)	739 (26,241)

* Air density = 1.184 kg/m3 (0.0739 lbm/ft^3)

Exhaust system

Gas temperature (stack): °C (°F)	465 (869)
Gas volume at stack temperature: m^3/min (CFM)	456 (16,103)
Maximum allowable back pressure at outlet of engine, before piping: kPa (in. H_2O)	8.5 (34.1)

Weights and dimensions



Drawing above for illustration purposes only, based on standard open power 480 volt generator set. Lengths may vary with other voltages. Do not use for installation design. See website for unit specific template drawings.

System	Dimensions (L x W x H)	Weight
Open Power Unit (OPU)	6,474 x 2,539 x 3,434 mm (254.9 x 99.9 x 135.2 in)	21,554 kg (47,523 lb)

Weights and dimensions are based on open power units and are estimates only. Consult the factory for accurate weights and dimensions for your specific generator set.

Sound data

Unit type	DCCP full load
Level 0 (OPU): dB(A)	98.6

Sound data is provided at 7 m (23 ft). Generator set tested in accordance with ISO 8528-10 and with infinite exhaust.

Emissions data

NO_x + NMHC	CO	PM
6.23	0.44	0.05

— All units are in g/hp-hr and shown at 100% load (not comparable to EPA weighted cycle values). Emission levels of the engine may vary with ambient temperature, barometric pressure, humidity, fuel type and quality, installation parameters, measuring instrumentation, etc. The data was obtained in compliance with US EPA regulations. The weighted cycle value (not shown) from each engine is guaranteed to be within the US EPA standards.

Rating definitions and conditions

— Data Center Continuous Power (DCCP) ratings apply to data center installations where a utility power is available and comply with Uptime Institute Tier III and IV requirements. At constant or varying load, the number of generator set operating hours is unlimited. A 10% overload capacity is available for one hour in twelve. Ratings are in accordance with ISO 8528-1, ISO 3046-1, BS 5514, and AS 2789. Average load factor: ≤ 100%.

— Nominal ratings at standard conditions: 25 °C and 300 meters (77 °F and 1,000 feet).

— Deration Factor:

- Consult your local ***mtu*** Distributor for altitude derations.
- Consult your local ***mtu*** Distributor for temperature derations.

Emission Calculations

Project	Kao Data Harlow UK	Computed	KRS
Subject	Potential Emissions	Checked	
Source	Emergency Diesel Engine	Sheets	1

Hours	Engine Output Capacity hp	Fuel Consumption gal/hr	Fuel Heat Content Btu/gal, HHV	Maximum Heat Input MMBtu/hr, HHV
83.5	4,435	216	138,000	29.82

Criteria Air Pollutants	CAS#	Emission Factor g/hp-hr	Potential Emissions g/s	Potential Emissions lb/hr	Potential Emissions tpy
Nitrogen Oxides (NO_x)[a]	10102-43-9	1.01	1.25	9.90	0.41
Carbon Monoxide (CO)[a]	630-08-0	0.402	0.50	3.93	0.16
Particulate Matter (PM)[a]	-	0.027	0.033	0.26	0.011
Particulate Matter < 10 Microns (PM_{10})[a]	-	0.027	0.033	0.26	0.011
Particulate Matter < 2.5 Microns ($PM_{2.5}$)[a]	-	0.027	0.033	0.26	0.011
Volatile Organic Compounds (VOC)[a]	-	0.067	0.083	0.66	0.027
Sulfur Dioxide (SO_2)[b]	7446-09-5	0.004	0.005	0.039	0.0016

Notes:

[a] Emission factor based on SCR manufacturer performance specification of 190 mg/m3 NOx. Details shown below.

[b] SO_2 emission factor from AP-42 *Fifth Edition Compilation of Air Pollutant Emissions Factors* , Section 3.4 - Large Stationary Diesel And All Stationary Dual-fuel Engines. A sulfur content of 0.15% is assumed.

Annualized model emission rate for NOx is derived by multiplying by total run time hours / 8760 = (72+11+2+0.5)/8760

= 0.012 g/s

Similarly for PM: 0.000315 g/s

NOx Emission Rate controlled by SCR at 190 mg/Nm3 at 15%O2 for Short-Term Impact Analysis:

Adjust to average O2 content of 11.9% O2 for actual exhaust conditions

Multiply by : $(20.9 - 11.9) \div (20.9 - 15)$

NOx Conc:	289.8	mg/m3	at 0 C
Flow at 100% Load:	714	m3/min	at 482 C
Flow at 100% Load:	258	m3/min	at 0 C
NOx Emission Rate:	1.25	g/s	Controlled By SCR
Uncontrolled:	6.06	g/s	Emission Rate During SCR Warmup
Time Weighted Averages:	3.66	g/s	30 min average
	1.83	g/s	Model Emission Rate for 30 Min Black Bldg Test
	2.45	g/s	Model Emission Rate for 60 min test
	1.85	g/s	Model Emission Rate for 120 min test
Temp:	482	C	

Flow at 50% Load:	417.1	m3/min	at 434 C
Flow at 50% Load:	161.1	m3/min	at 0 C
NOx Emission Rate:	0.78	g/s	Controlled By SCR
Uncontrolled:	2.20	g/s	Emission Rate During SCR Warmup
Time Weighted Averages:	1.49	g/s	30 min average
	0.746	g/s	Model Emission Rate for 30 Min Black Bldg Test
	1.13	g/s	Model Emission Rate for 60 min test
	0.96	g/s	Model Emission Rate for 120 min test
Temp:	434	C	

Inhaltsverzeichnis

Contents

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G94LF				
Rated power [kW]	3308				
Rated speed [rpm]	1500				
Application group	3D				
Emission Stage/Optimisation	NEA Singapore for ORDE				
Test cycle	D2				
Data Set No.	XZ54954100068				
Data Set Basis	NEA Singapore for ORDE				
Fuel sulphur content [ppm]	7				

Unterschriftenweg	EDS erstellt	~~TETC Teamleiter~~	~~TET Leiter Org.-Einheit~~	Baureihen - Teamleiter	Baureihen Leiter Org.-Einheit	Freigabe im EDM
Datum	04.04.2017	-	-	11.04.2017	13.04.2017	18.04.2017
Org.-Einheit	TET	-	-	TKF	TKF	TKM
Name	T. Lenhof	-	-	B. Mink	Dr. Baumgarten	M. Link

MTU Friedrichshafen GmbH	WORD	Datum/ Date	Name	Projekt-/Auftrags-Nr. Project/Order No. / Verwendbar f.Typ Applicable to Model — Format/Size A3
	Erstell. Drawn	20.09.2017 09:35:43	zwislerp	Material-Nr./Material No. **EDS 4000 1162**
	Bearb. Change	20.09.2017 13:37:26	zwislerp	
	Inhalt Content	10.04.2017	Locher	Benennung/ Title **Emissionsdatenblatt** **Emission Data Sheet**
	Gepr. Checked	20.09.2017	Kneifel	
	Motortyp / Engine Type **20V4000G94LF**			

Aenderungsbeschreibung/Description of Revision | Kommt vor/Frequency
Angabe Sauerstoffgehalt im Abgas bei Bezug auf 5% angepasst

Zeichnungs-Nr./Drawing No. **ZNG00005084**

Blatt/ Sheet **1** von/of **6**

Buchst./Rev. Ltr.	Aenderungs-Nr./Revision Notice No.	Bearbeitungsstatus/Lifecycle
b.1		In Arbeit

Beschreibung/Description

Revision *Change index*					

Motordaten

engine data

	Genset	Marine	O & G	Rail	C & I
Application	x				
Engine model	20V4000G94LF				
Application group	3D				
Emission Stage/Optimisation	NEA Singapore for ORDE				
Test cycle	D2				
fuel sulphur content [ppm]	7				
mg/mN³ values base on residual oxygen value of [%]	measured				

Motor Rohemissionen*

*Engine raw emissions**

Cycle point	[-]	n1	n2	n3	n4	n5	n6	n7	n8
Power (P/PN)	[-]	1	0,75	0,50	0,25	0,10			
Power	[kW]	3307	2480	1653	827	331			
Speed (n/nN)	[-]	1	1	1	1	1			
Speed	[rpm]	1500	1499	1499	1500	1499			
Exhaust temperature after turbine	[°C]	482	427	434	403	268			
Exhaust massflow	[kg/h]	19196	15930	12083	7485	5323			
Exhaust back pressure (total)	[mbar]	52	32	14	5	0			
NOx	[g/kWh]	6,6	5,9	4,8	4,4	9,1			
	[mg/mN³]	1641	1326	930	676	776			
CO	[g/kWh]	0,3	0,4	1,0	1,4	2,8			
	[mg/mN³]	77	85	192	219	233			
HC	[g/kWh]	0,05	0,07	0,09	0,16	0,72			
	[mg/mN³]	13	14	16	25	60			
O2	[%]	9,9	11,2	11,9	13,1	15,8			
Particulate measured	[g/kWh]	0,02	0,03	0,10	0,18	0,05			
	[mg/mN³]	5	6	19	27	4			
Particulate calculated	[g/kWh]	-	-	-	-	-			
	[mg/mN³]	-	-	-	-	-			
Dust (only TA-Luft)	[mg/mN³]	-	-	-	-	-			
FSN	[-]	0,2	0,2	0,6	1,0	0,1			
NO/NO2**	[-]	-	-	-	-	-			
CO2	[g/kWh]	645,7	632,1	669,3	721,6	844,5			
	[mg/mN³]	155278	136196	126261	109200	70577			
SO2	[g/kWh]	0,003	0,003	0,003	0,003	0,004			
	[mg/mN³]	0,7	0,6	0,6	0,5	0,3			

* Emission data measurement procedures are consistent with the respective emission evaluation process. Noncertified engines are measured to sales data (TVU/TEN) standard conditions.
These boundary conditions might not be representative for detailed dimensioning of exhaust gas aftertreatment, in this case it is recommended to contact the responsible department for more information.
Measurements are subject to variation. The nominal emission data shown is subject to instrumentation, measurement, facility, and engine-to-engine variations.
All data applies to an engine in new condition. Over extended operating time deterioration may occur which might have an impact on emission.
Exhaust temperature depends on engine ambient conditions.

** No standard test. To be measured on demand.

Aenderungsbeschreibung/Description of Revision	Kommt vor/Frequency
Angabe Sauerstoffgehalt im Abgas bei Bezug auf 5% angepasst	

Buchst./Rev. Ltr.	Aenderungs-Nr./Revision Notice No.	Bearbeitungsstatus/Lifecycle
b.1		In Arbeit

MTU Friedrichshafen GmbH

WORD	Datum/ Date	Name
Erstell. Drawn	20.09.2017 09:35:43	zwislerp
Bearb. Change	20.09.2017 13:37:26	zwislerp
Inhalt Content	10.04.2017	Locher
Gepr. Checked	20.09.2017	Kneifel

Motortyp / Engine Type: **20V4000G94LF**

Projekt-/Auftrags-Nr. Project/Order No.

Verwendbar f.Typ Applicable to Model

Format/Size: **A3**

Material-Nr./Material No.: **EDS 4000 1162**

Benennung/ Title

Emissionsdatenblatt

Emission Data Sheet

Zeichnungs-Nr./Drawing No.: **ZNG00005084**

Beschreibung/Description

Revision *Change index*						

Motordaten

engine data

	Genset	Marine	O & G	Rail	C & I
Application	x				
Engine model	20V4000G94LF				
Application group	3D				
Emission Stage/Optimisation	NEA Singapore for ORDE				
Test cycle	D2				
fuel sulphur content [ppm]	7				
mg/mN³ values base on residual oxygen value of [%]	measured				

Not to exceed Werte*

*not to exceed values**

Cycle point	[-]	n1	n2	n3	n4	n5	n6	n7	n8
Power (P/PN)	[-]	1	0,75	0,50	0,25				
Power	[kW]	3307	2480	1653	827				
Speed (n/nN)	[-]	1	1	1	1				
Speed	[rpm]	1500	1499	1499	1500				
Exhaust back pressure (total)	[mbar]	52	32	14	5				
NOx	[g/kWh]	8,6	7,7	6,2	6,6				
	[mg/mN³]	2133	1724	1209	1014				
CO	[g/kWh]	0,5	0,7	1,9	2,9				
	[mg/mN³]	131	145	365	438				
HC	[g/kWh]	0,09	0,11	0,17	0,33				
	[mg/mN³]	22	24	30	50				
O2	[%]	9,9	11,2	11,9	13,1				
Particulate measured	[g/kWh]	0,03	0,05	0,15	0,27				
	[mg/mN³]	7	10	28	40				

* Calculated values are not proven by tests and therefore the accuracy cannot be guaranteed.
Emissions data measurement procedures are consistent with those described in the applicable rules and standards.
The NOx, CO, HC and PM emission data tabulated here were taken from a single new engine under the test conditions shown above and are valid for the following conditions:

- Ambient air pressure 1 bar
- Air intake temperature approx. 25°C
- Rel. Humidity 30%-60%
- New Engine
- New standard- air filter
- Exhaust gas back pressure according the given value in this EDS
- Fuel according to EN 590 or US EPA 40CFR89
- Coolant and Lubricants according MTU Fuels and Lubricants Specification

The nominal emissions data shown is subject to instrumentation, measurement, facility and engine to engine variations. Emissions data is based on single operating points and thus cannot be used to compare to EPA regulations which use values based on a weighted cycle. Emissions data may vary depending on the type of exhaust gas aftertreatment that may be installed on the engine, therefore it is suggested that the engine manufacturer be contacted directly for further information.
Field emission test data are not guaranteed to these levels. Actual field test results may vary due to test site conditions, installation, fuel specification, test procedures, and instrumentation. Over time deterioration may occur which may have an impact on emission levels. Engine operation with excessive air intake or exhaust restriction beyond published maximum limits, or with improper maintenance, may results in elevated emission levels.
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Revision *Change index*					

Typzulassung für NEA Singapur

Type approval for NEA Singapore

	Genset	Marine	O & G	Rail	C & I
Application	x				
Engine model	20V4000G94LF				
Application group	3D				
Emission Stage/Optimisation	NEA Singapore for ORDE				
Test cycle	D2				
Data Set	XZ54954100068				
Serial-Number	V122				
Test-Report-Number	EDS40001162				
Test Location	P126				
Date of test	29.03.2017				
Tester	MTU Friedrichshafen GmbH				
Date of EDS	04.04.2017				

Emissions Zykluswerte*

*Engine cycle emissions**

Emission	Cycle Value [g/kWh]	U.S. T2-Limit [g/kWh]
NOX	5,47	-
HC	0,1	-
NOX+NMHC	5,57	6,4
CO	0,80	3,5
PM	0,074	0,20

* Cycle values based on not rounded values, differences between single values and added values, e.g. NOX/HC/NOX+HC.
NMHC = 0,98*HC (40 CFR Part 1065.650 (c)(5))

Aenderungsbeschreibung/Description of Revision	Kommt vor/Frequency
Angabe Sauerstoffgehalt im Abgas bei Bezug auf 5% angepasst	

Buchst./Rev. Ltr.	Aenderungs-Nr./Revision Notice No.	Bearbeitungsstatus/Lifecycle
b.1		In Arbeit

MTU Friedrichshafen GmbH

WORD	Datum/ Date	Name
Erstell. Drawn	20.09.2017 09:35:43	zwislerp
Bearb. Change	20.09.2017 13:37:26	zwislerp
Inhalt Content	10.04.2017	Locher
Gepr. Checked	20.09.2017	Kneifel

Projekt-/Auftrags-Nr. Project/Order No.

Verwendbar f.Typ Applicable to Model

Format/Size **A3**

Material-Nr./Material No. **EDS 4000 1162**

Motortyp / Engine Type **20V4000G94LF**

Benennung/ Title **Emissionsdatenblatt**
Emission Data Sheet

Zeichnungs-Nr./Drawing No. **ZNG00005084**

Beschreibung/Description

Revision *Change index*	a	b			

Motordaten

engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G94LF				
Application group	3D				
Emission Stage/Optimisation	NEA Singapore for ORDE				
Test cycle	D2				
fuel sulphur content [ppm]	7				
mg/mN³ values base on residual oxygen value of [%]	5				

Motor Rohemissionen*

*Engine raw emissions**

Cycle point	[-]	n1	n2	n3	n4	n5	n6	n7	n8
Power (P/PN)	[-]	1	0,75	0,50	0,25	0,10			
Power	[kW]	3307	2480	1653	827	331			
Speed (n/nN)	[-]	1	1	1	1	1			
Speed	[rpm]	1500	1499	1499	1500	1499			
Exhaust temperature after turbine	[°C]	482	427	434	403	268			
Exhaust massflow	[kg/h]	19196	15930	12083	7485	5323			
Exhaust back pressure (total)	[mbar]	52	32	14	5	0			
NOx	[g/kWh]	6,6	5,9	4,8	4,4	9,1			
	[mg/mN³]	2362	2172	1639	1375	2411			
CO	[g/kWh]	0,3	0,4	1,0	1,4	2,8			
	[mg/mN³]	111	139	339	445	723			
HC	[g/kWh]	0,05	0,07	0,09	0,16	0,72			
	[mg/mN³]	19	23	29	50	187			
O2	[%]	5,0	5,0	5,0	5,0	5,0			
Particulate measured	[g/kWh]	0,02	0,03	0,10	0,18	0,05			
	[mg/mN³]	7	10	33	55	13			
Particulate calculated	[g/kWh]	-	-	-	-	-			
	[mg/mN³]	-	-	-	-	-			
Dust (only TA-Luft)	[mg/mN³]	-	-	-	-	-			
FSN	[-]	0,2	0,2	0,6	1,0	0,1			
NO/NO2**	[-]	-	-	-	-	-			
CO2	[g/kWh]	645,7	632,1	669,3	721,6	844,5			
	[mg/mN³]	223605	223061	222522	222035	219215			
SO2	[g/kWh]	0,003	0,003	0,003	0,003	0,004			
	[mg/mN³]	1,0	1,0	1,0	1,0	1,0			

* Emission data measurement procedures are consistent with the respective emission evaluation process. Noncertified engines are measured to sales data (TVU/TEN) standard conditions.
These boundary conditions might not be representative for detailed dimensioning of exhaust gas aftertreatment, in this case it is recommended to contact the responsible department for more information.
Measurements are subject to variation. The nominal emission data shown is subject to instrumentation, measurement, facility, and engine-to-engine variations.
All data applies to an engine in new condition. Over extended operating time deterioration may occur which might have an impact on emission.
Exhaust temperature depends on engine ambient conditions.

** No standard test. To be measured on demand.

Aenderungsbeschreibung/Description of Revision	Kommt vor/Frequency
Angabe Sauerstoffgehalt im Abgas bei Bezug auf 5% angepasst	

Buchst./Rev. Ltr.	Aenderungs-Nr./Revision Notice No.	Bearbeitungsstatus/Lifecycle
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Projekt-/Auftrags-Nr. Project/Order No.
Verwendbar f.Typ Applicable to Model
Format/Size: A3
Material-Nr./Material No.: **EDS 4000 1162**
Benennung/ Title: **Emissionsdatenblatt**
Emission Data Sheet
Motortyp / Engine Type: **20V4000G94LF**
Zeichnungs-Nr./Drawing No.: **ZNG00005084**
Beschreibung/Description

Revision *Change index*	a	b			

Motordaten

engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G94LF				
Application group	3D				
Emission Stage/Optimisation	NEA Singapore for ORDE				
Test cycle	D2				
fuel sulphur content [ppm]	7				
mg/mN³ values base on residual oxygen value of [%]	5				

Not to exceed Werte*

*not to exceed values**

Cycle point	[-]	n1	n2	n3	n4	n5	n6	n7	n8
Power (P/PN)	[-]	1	0,75	0,50	0,25				
Power	[kW]	3307	2480	1653	827				
Speed (n/nN)	[-]	1	1	1	1				
Speed	[rpm]	1500	1499	1499	1500				
Exhaust back pressure (total)	[mbar]	52	32	14	5				
NOx	[g/kWh]	8,6	7,7	6,2	6,6				
	[mg/mN³]	3071	2824	2131	2063				
CO	[g/kWh]	0,5	0,7	1,9	2,9				
	[mg/mN³]	189	236	644	890				
HC	[g/kWh]	0,09	0,11	0,17	0,33				
	[mg/mN³]	32	39	55	100				
O2	[%]	5,0	5,0	5,0	5,0				
Particulate measured	[g/kWh]	0,03	0,05	0,15	0,27				
	[mg/mN³]	10	16	49	82				

* Calculated values are not proven by tests and therefore the accuracy cannot be guaranteed.

Emissions data measurement procedures are consistent with those described in the applicable rules and standards.

The NOx, CO, HC and PM emission data tabulated here were taken from a single new engine under the test conditions shown above and are valid for the following conditions:

• Ambient air pressure 1 bar
• Air intake temperature approx. 25°C
• Rel. Humidity 30%-60%
• New Engine
• New standard- air filter
• Exhaust gas back pressure according the given value in this EDS
• Fuel according to EN 590 or US EPA 40CFR89
• Coolant and Lubricants according MTU Fuels and Lubricants Specification

The nominal emissions data shown is subject to instrumentation, measurement, facility and engine to engine variations. Emissions data is based on single operating points and thus cannot be used to compare to EPA regulations which use values based on a weighted cycle. Emissions data may vary depending on the type of exhaust gas aftertreatment that may be installed on the engine, therefore it is suggested that the engine manufacturer be contacted directly for further information.

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Buchst./Rev. Ltr.	Aenderungs-Nr./Revision Notice No.	Bearbeitungsstatus/Lifecycle
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Gepr. Checked	20.09.2017	Kneifel

Motortyp / Engine Type: **20V4000G94LF**

Projekt-/Auftrags-Nr. Project/Order No.

Verwendbar f.Typ Applicable to Model

Format/Size: **A3**

Material-Nr./Material No.: **EDS 4000 1162**

Benennung/ Title

Emissionsdatenblatt

Emission Data Sheet

Zeichnungs-Nr./Drawing No.: **ZNG00005084**

Beschreibung/Description

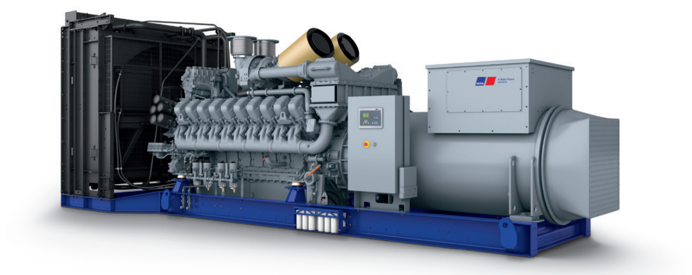
Blatt/ Sheet **6** von/of **6**

ROLLS ROYCE

Diesel Generator Set

mtu 20V4000 DS4000

11 kV/50 Hz/standby power/NEA (ORDE) + Tier 2 optimized 20V4000G94LF/water charge air cooling



Optional equipment and finishing shown. Standard may vary.

Product highlights

Benefits
- Low fuel consumption
- Optimized system integration ability
- High reliability
- High availability of power
- Long maintenance intervals

Support
- Global product support offered

Standards
- Engine-generator set is designed and manufactured in facilities certified to standards ISO 2008:9001 and ISO 2004:14001
- Generator set complies to ISO 8528
- Generator meets NEMA MG1, BS5000, ISO, DIN EN and IEC standards
- NFPA 110

Power rating
- System ratings: 3950 kVA - 4000 kVA
- Accepts rated load in one step per NFPA 110
- Generator set complies to G3 according to ISO 8528-5
- Generator set exceeds load steps according to ISO 8528-5

Performance assurance certification (PAC)
- Engine-generator set tested to ISO 8528-5 for transient response
- 85% load factor
- Verified product design, quality and performance integrity
- All engine systems are prototype and factory tested

Complete range of accessories available
- Control panel
- Power panel
- Fuel system
- Fuel connections with shut-off valve mounted to base frame
- Starting/charging system
- Exhaust system
- Electrical driven radiators
- Medium and oversized voltage alternators

Emissions
- Tier 2 optimized engine
- NEA (ORDE) optimized

Certifications
- CE certification option

mtu A Rolls-Royce solution

Application data [1)]

Engine

Manufacturer	mtu
Model	20V4000G94LF
Type	4-cycle
Arrangement	20V
Displacement: l	95.4
Bore: mm	170
Stroke: mm	210
Compression ratio	16.4
Rated speed: rpm	1500
Engine governor	ADEC (ECU 9)
Max power: kWm	3308
Air cleaner	dry

Fuel system

Maximum fuel lift: m	5
Total fuel flow: l/min	27

Fuel consumption [2)]	l/hr	g/kwh
At 100% of power rating:	818	205
At 75% of power rating:	598	200
At 50% of power rating:	429	215

Liquid capacity (lubrication)

Total oil system capacity: l	390
Engine jacket water capacity: l	260
Intercooler coolant capacity: l	50

Combustion air requirements

Combustion air volume: m^3/s	4.7
Max. air intake restriction: mbar	30

Cooling/radiator system

Coolant flow rate (HT circuit): m^3/hr	80
Coolant flow rate (LT circuit): m^3/hr	44
Heat rejection to coolant: kW	1270
Heat radiated to charge air cooling: kW	930
Heat radiated to ambient: kW	105
Fan power for electr. radiator (40°C): kW	105

Exhaust system

Exhaust gas temp. (after engine, max.): °C	482
Exhaust gas temp. (before turbocharger): °C	693
Exhaust gas volume: m^3/s	11.9
Maximum allowable back pressure: mbar	50
Minimum allowable back pressure: mbar	–

Standard and optional features

System ratings (kW/kVA)

Generator model	Voltage	NEA (ORDE) + Tier 2 optimized		
		without radiator		
		kWel	kVA*	AMPS
Leroy Somer LSA54.2 ZL12 (Medium volt. Leroy Somer)	11 kV	3160	3950	207
Marathon 1040FDH7105 (Medium volt. Marathon)	11 kV	3200	4000	210
Leroy Somer LSA54.2 ZL14 (MV Leroy Somer oversized)	11 kV	3160	3950	207
Leroy Somer LSA54.2 ZL14 (Engine output optimized)	11 kV	3200	4000	210

* cos phi = 0.8

1 All data refers only to the engine and is based on ISO standard conditions (25°C and 100m above sea level).

2 Values referenced are in accordance with ISO 3046-1. Conversion calculated with fuel density of 0.83 g/ml. All fuel consumption values refer to rated engine power.

Standard and optional features

Engine

- ■ 4-cycle
- ■ Standard single stage air filter
- ■ Oil drain extension & shut-off valve
- ■ Closed crankcase ventilation
- ■ Governor-electronic isochronous
- ■ Common rail fuel injection
- ■ Tier 2 optimized engine
- ■ NEA (ORDE) optimized engine

Generator

- ■ 4 pole three-phase synchronous generator
- ■ Brushless, self-excited, self-regulating, self-ventilated
- ■ Digital voltage regulator
- ■ Anti condensation heater
- ■ Stator winding Y-connected, accessible neutral (brought out)
- ■ Protection IP23
- ■ Insulation class H, utilization acc. to H
- ■ Radio suppression EN55011, group 1, cl. B
- ■ Short circuit capability 3xIn for 10sec
- ■ Winding and bearing RTDs (without monitoring)
- ■ Excitation by AREP + PMI
- ■ Mounting of CT´s: 3x 2 core CT´s
- ■ Winding pitch: 5/6 winding
- ■ Voltage setpoint adjustment ± 5%
- ■ Meets NEMA MG-1, BS 5000, IEC 60034-1, VDE 0530, DIN EN 12601, AS1359 and ISO 8528 requirements
- ■ Leroy Somer medium voltage generator
- ☐ Marathon medium voltage generator
- ☐ Oversized generator

Cooling system

- ■ Jacket water pump
- ■ Thermostat(s)
- ■ Water charge air cooling
- ☐ Electrical driven front-end cooler
- ☐ Jacket water heater
- ☐ Pulley for fan drive

Control panel

- ■ Pre-wired control cabinet for easy application of customized controller (V1+)
- ☐ Island operation (V2)
- ☐ Automatic mains failure operation with ATS (V3a)
- ☐ Automatic mains failure operation incl. control of generator and mains breaker (V3b)
- ☐ Island parallel operation of multiple gensets (V4)
- ☐ Automatic mains failure operation with short (< 10s) mains parallel overlap synchronization (V5)
- ☐ Mains parallel operation of a single genset (V6)
- ☐ Mains parallel operation of multiple gensets (V7)
- ☐ Basler controller
- ☐ Deif controller
- ■ Complete system metering
- ■ Digital metering
- ■ Engine parameters
- ■ Generator protection functions
- ■ Engine protection
- ■ SAE J1939 engine ECU communications
- ■ Parametrization software
- ■ Multilingual capability
- ■ Multiple programmable contact inputs
- ■ Multiple contact outputs
- ■ Event recording
- ■ IP 54 front panel rating with integrated gasket
- ☐ Remote annunciator
- ☐ Daytank control
- ☐ Generator winding- and bearing temperature monitoring
- ☐ Modbus TCP-IP

Power panel

- ☐ Available in 600x600 mm
- ☐ Phase monitoring relay 230V/400V
- ☐ Supply for battery charger
- ☐ Supply for jacket water heater
- ☐ Supply for anti condensation heating
- ☐ Plug socket cabinet for 230V compatible Euro/USA

■ Represents standard features

☐ Represents optional features

Standard and optional features

Fuel system

- ■ Flexible fuel connectors mounted to base frame
- ☐ Fuel filter with water separator
- ☐ Fuel filter with water separator heavy-duty
- ☐ Switchable fuel filter with water separator
- ☐ Switchable fuel filter with water separator heavy-duty
- ☐ Seperate fuel cooler
- ☐ Fuel cooler integrated into cooling equipment

Starting/charging system

- ■ 24V starter
- ☐ Starter batteries, cables, rack, disconnect switch
- ☐ Battery charger
- ☐ Redundant starter 2x 15kW

Mounting system

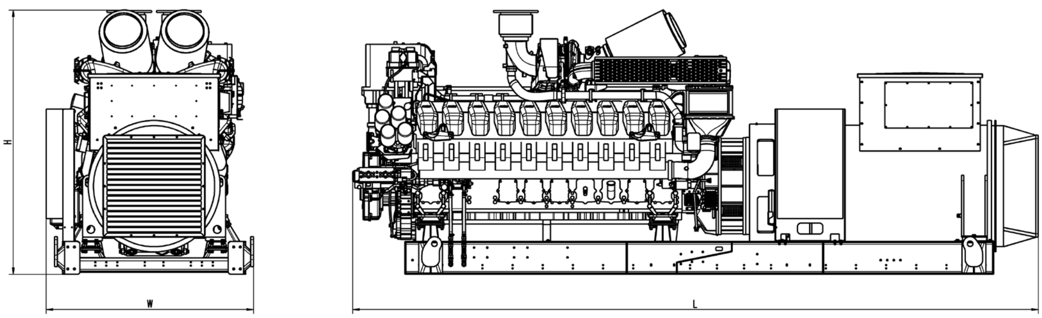
- ■ Welded base frame
- ■ Resilient engine and generator mounting
- ■ Modular base frame design

Exhaust system

- ■ Exhaust bellows with connection flange
- ☐ Exhaust silencer with 10 dB(A) sound attenuation
- ☐ Exhaust silencer with 30 dB(A) sound attenuation
- ☐ Exhaust silencer with 40 dB(A) sound attenuation
- ☐ Y-connection-pipe

■ Represents standard features
☐ Represents optional features

Weights and dimensions



Drawing above for illustration purposes only, based on a standard open power 11 kV engine-generator set. Lengths may vary with other voltages. Do not use for installation design. See website for unit specific template drawings.

System	Dimensions (LxWxH)	Weight (dry/less tank)
Open power unit (OPU)	6339 x 1887 x 2415 mm	19350 kg

Weights and dimensions are based on open power units and are estimates only. Consult the factory for accurate weights and dimensions for your specific engine-generator set.

Sound data

— Consult your local ***mtu*** distributor for sound data.

Emissions data

— Consult your local ***mtu*** distributor for emissions data.

Rating definitions and conditions

— Standby ratings apply to installations served by a reliable utility source. The standby rating is applicable to varying loads for the duration of a power outage. No overload capability for this rating. Ratings are in accordance with ISO 8528-1, ISO-3046-1, BS 5514 and AS 2789.
  Average load factor: ≤ 85%. operating hours/year: max. 500.

— Consult your local ***mtu*** distributor for derating information.

Subject to change. | 32310771 | Edition 01/21 | ESM 2021-01.

Appendix C: Statistical Analysis for Predicted NO2 Impacts

Hypergeometrical Distribution Statistical Analysis

The modeling results presented in Section 4.4 indicate that the Emergency Scenario is predicted to have more than 18 exceedances of the hourly NO2 standard in a year. Per EA guidance, a statistical analysis must be prepare to identify the likelihood of Emergency Run scenarios coinciding with unfavourable meteorological conditions , and therefore result in an exceedance of the air quality standard. The guidance does not specify a particular statistical method but provides a hypergeometric distribution as an example. The corresponding formula was used:

$$\sum_{i=0}^{N-19} \frac{\binom{K}{i}\binom{M-K}{N-i}}{\binom{M}{N}}$$

The parameters are defined as follows:

N: Number of operational hours (hours during which a Emergency Run may cause an exceedance at a specific receptor)

M: Operating envelope, 8760 hours

K: Number of non-exceedance hours (hours over a year during which no exceedances are predicted);

As the operating hours would not be fully random, the calculated probability was multiplied by 2.5, as recommended in the guidance document.

The MAXIFILE output option in AERMOD was specified to produce a table with a count of the number of exceedances predicted over the 5 year meteorological period. A threshold concentration for the MAXIFILE was specified as follows:

1130.667 Threshold Concentration for MAXIFILE, equal to 200 minus 30.4 (background) / 0.15 (NOx to NO2 conversion rate within 500m)

The maximum count of exceedances above this threshold for the 5 year period reported by the MAXIFILE is 2285.

The calculaton uses the HYGEOM.DIST Function in Excel, whereby:

e	No. of exceedance hrs	2285	no. of failures	MAXI File report
K	non-exceedance hrs	41539	population_s	Met data period minus no. of exceedances
N	Operating hours	360	"number_sample"	Operating hours
M	Population Size ; operating envelope	43824	"number_pop"	Met Data period
		265	sample_s	Operating hours - 19 non-exceedance hours

	2.27E-40		
x 2.5 =	**5.67E-40**	<<	**1%**