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BEST AVAILABLE TECHNIQUES STATEMENT FOR A PROPOSED GAS RECIPROCATING ENGINE EMERGENCY BACK-UP FACILITY AT KILLINGHOLME POWER STATION

prepared for
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SUMMARY

This Best Available Techniques (BAT) Statement has been produced to support the development of additional emergency plant capability at Killingholme Power Station, specifically emergency power supply.

Killingholme Power Station was not constructed with this ability to provide emergency power supply. To meet environmental permit requirements, a revision is needed to the current IED site permit (EPR/VP3933RJ, as most recently varied in 2019) to accommodate the operation of the proposed facility.

Whilst the emergency power supply system will be part of an Industrial Emissions Directive regulated site, containing Large Combustion Plant, the regulations most applicable to the new plant are those for Medium Combustion Plant (MCP). The facility proposed for installation at the Killingholme Power Station site comprises of seven individually containerised natural gas fired reciprocating combustion engines. This provides emergency electrical generation from the plant. As the proposed plant is in a 6+1 configuration, there is some margin to ensure successful power delivery in an emergency. Whilst this could be provided by a single larger open cycle gas turbine, the lead time for one of these units would not meet the required timescale for the availability of emergency supplies.

For emergency plant of this type, no Emission Limit Values are set for MCPs. The proposed plant is also not subject to the Specified Generator Controls. Nevertheless, expected emissions are low and are as outlined below:

- NOx 188 mg/Nm3
- CO <300 mg/Nm3
- NMHC <113 mg/Nm3
- CH <450 mg/Nm3

All emissions are quoted at 15% O_2 (dry vol), 0°C and 1013 mbar.

Overall, given the low expected number of annual operating hours to deliver this capability, the proposed arrangements can be considered to represent Best Available Techniques for Killingholme Power Station.

Prepared by **Approved for publication**

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ABBREVIATIONS/NOMENCLATURE

AEL	Associated Emission Levels
BAT	Best Available Techniques
BAT AEL	Best Available Techniques Associated Emission Levels
BREF	Best Available Techniques Reference Document
CH_4	Methane
CO	Carbon Monoxide
ELV	Emission Limit Values
GRE	Gas Reciprocating Engine
IED	Industrial Emissions Directive
ISO	International Standards Organisation
LCP	Large Combustion Plant
mbar	Millibars
MCP(D)	Medium Combustion Plant (Directive)
mg/Nm^3	Milligrams per normal metre cubed (quoted here at 15% O_2 (dry vol), 0°C and 1013 mbar)
MWe	Megawatt Electrical
MWth	Megawatt Thermal
NG	National Grid
NGR	National Grid Reference
NMHC	Non-Methane Hydrocarbons
NOx	Nitrogen Oxide and Nitrogen Dioxide
OCGT	Open Cycle Gas Turbine
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest

1 INTRODUCTION

This Best Available Techniques (BAT) Statement has been produced to support the development of additional emergency power supply capacity at Killingholme Power Station.

In general, all power stations need an electrical supply to start up: under normal operation this supply would come from the transmission or distribution system; under emergency conditions this may not be available. This proposed upgrade is intended to ensure electrical energy is available on site in these circumstances.

To achieve environmental permit requirements, a revision is required to the current IED site permit (EPR/VP3933RJ [1], as most recently varied in 2019) to accommodate the operation of the proposed emergency generation facility.

2 CURRENT PLANT

The text below is taken as an extract of the current IED permit, describing the current plant and its functionality. The permit was most recently varied in 2019 to implement the BAT Conclusions [2] arising from the Large Combustion Plant Best Available Techniques (LCP BREF) review process.

Killingholme Power Station is located on the south bank of the Humber Estuary, approximately 5 km north-west of Immingham Dock to the east of the villages of East Halton and North Killingholme. The site covers an area of 43 hectares and is centred on NGR 515371 418965. There is a Site of Special Scientific Interest (SSSI) within 2 km and a Natura 2000 site within 10 km of the installation as follows:

- North Killingholme Haven Pits SSSI, Humber Estuary – 1 km away
- Humber Flats, Marshes and Coast Special Protection Areas (SPA) and Ramsar (Natura 2000) – 4.2 km away

The Large Combustion Plants on site will operate only in open-cycle mode to meet capacity demand during critical times of the year (less than 500 hours for each large combustion plant (LCP) per annum), allowing up to 2,000 hours operation for the installation with the four LCPs. The plant is classified as non-emergency plant for the purposes of the BAT Conclusions.

The net thermal input of the LCP(s) are as follows: LCP 108, LCP 109, LCP 110 and LCP 111 each consist of one 446 MWth open cycle gas turbine (OCGT).

The installation comprises two open cycle gas turbine modules, each consisting of two 150 MWe gas turbines. Each module has a gross baseload output of 300 MWe. Each gas turbine has a thermal input of 446 MWth. All the gas turbines are fitted with dry low NOx burners. Both modules now only operate in open cycle mode where the waste gases are emitted directly to atmosphere through four separate 33m high bypass stacks.

3 PROPOSED PLANT

The new facility proposed for installation at the Killingholme Power Station site comprises of seven individually containerised natural gas fired reciprocating combustion engines for emergency use where the site is disconnected from the National Grid. Whilst the final supplier of equipment has not been selected yet, and hence exact technical details may change, this document has been produced using data provided by Siemens for one of their standard packaged gas engine units. This data is typical of the performance of the class of machine being considered for applications of this type.

Each of the seven engines will be packaged with its own associated auxiliary, control and utility equipment. The engines have an electrical efficiency at these conditions of 39.8%. The emissions of the engines are expected to be as outlined below.

NOx	188 mg/Nm^3
CO	<300 mg/Nm^3
NMHC	<113 mg/Nm^3
CH_4	<450 mg/Nm^3

All emissions are quoted at 15% O_2 (dry vol), 0°C and 1013 mbar [3].

Key to the successful delivery of emergency power is robustness and reliability, therefore the engine mapping and set-up are such that this can be maximised for what will otherwise be very low operation units. Lower NOx emissions are possible from engines of this type, but not for the configuration offered for emergency power supply services where a rapid load acceptance and response of auxiliary power provision is necessary. These lower emissions also come at the expense of efficiency and, critically in this application, peak generation.

Each engine will be provided in its own individual container and arranged with suitable separation between neighbouring containers for access, maintenance and to reduce fire spread potential in a fire emergency. The containers themselves are of dimensions 12192 mm x 2438 mm x 2896 mm (excluding engine flue), a typical example of such a container is shown in Figure 1 below. Note this, flue cap design is not the proposed solution for this installation.

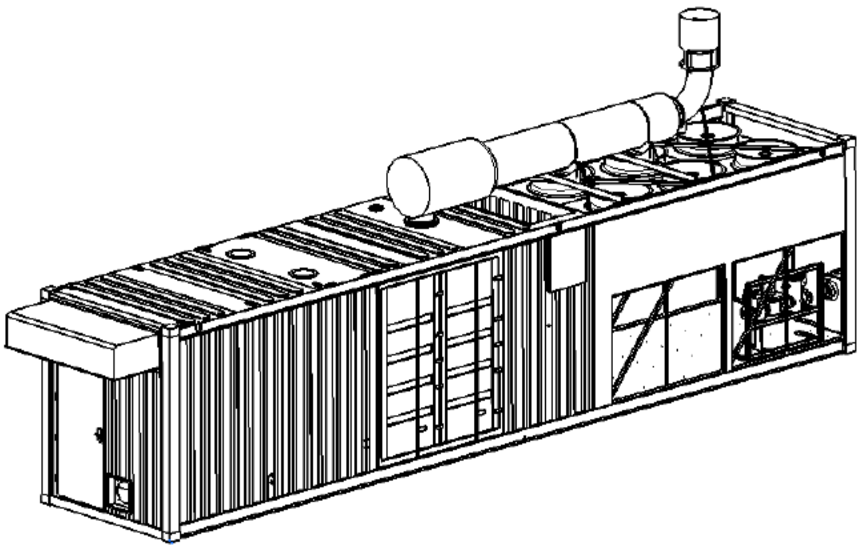

Figure 1: Standard containerised back-up power module including flue [4]

Overall, each containerised package comprises the following major items:

- Gas engine driven generator set
- Lubricating oil pump

- Lubricating oil pump
- Fuel gas ramp
- Auxiliary circuit water pump
- Main cooling circuit water pump
- Auxiliary circuit temperature control valve
- Main circuit temperature control valve
- Twin-core dry air cooler
- Exhaust silencer
- Control and power cabinet
- Acoustic baffles
- Electrically driven air recirculation fans
- Relief valves
- Expansion tank

For this application a taller chimney flue is envisaged than in the standard package, this is shown in Figure 2, with the release point being around 8.2 m above ground. This also allows the air coolers to be mounted on the roof of the container.

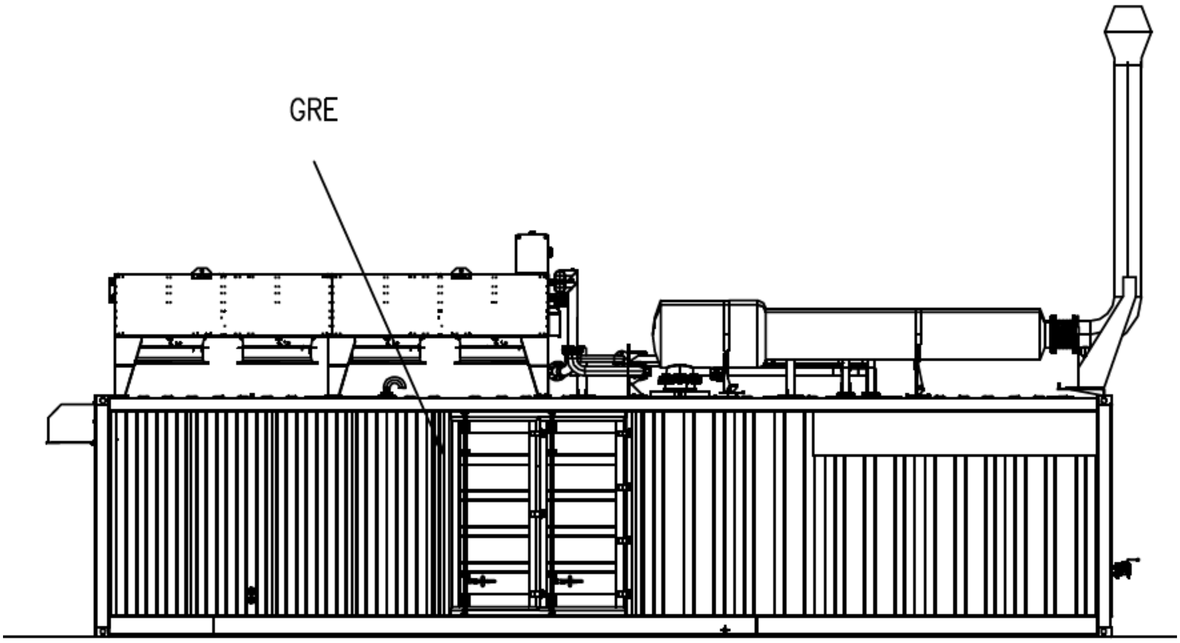

Figure 2: Containerised back-up power module including taller flue and twin-core cooler [based on 5]

Due to the containerised nature of the plant with independent flues, which are themselves relatively narrow, there is little sense in aggregating these into a single flue as this would increase draft loss, reduce power output, and increase capital cost, whilst having uncertain benefits in terms of dispersion (given the low running proposed and the potential for not all engines to be running at simultaneously). A plant layout is presented below (Figure 3) and eastern elevation in Figure 4.

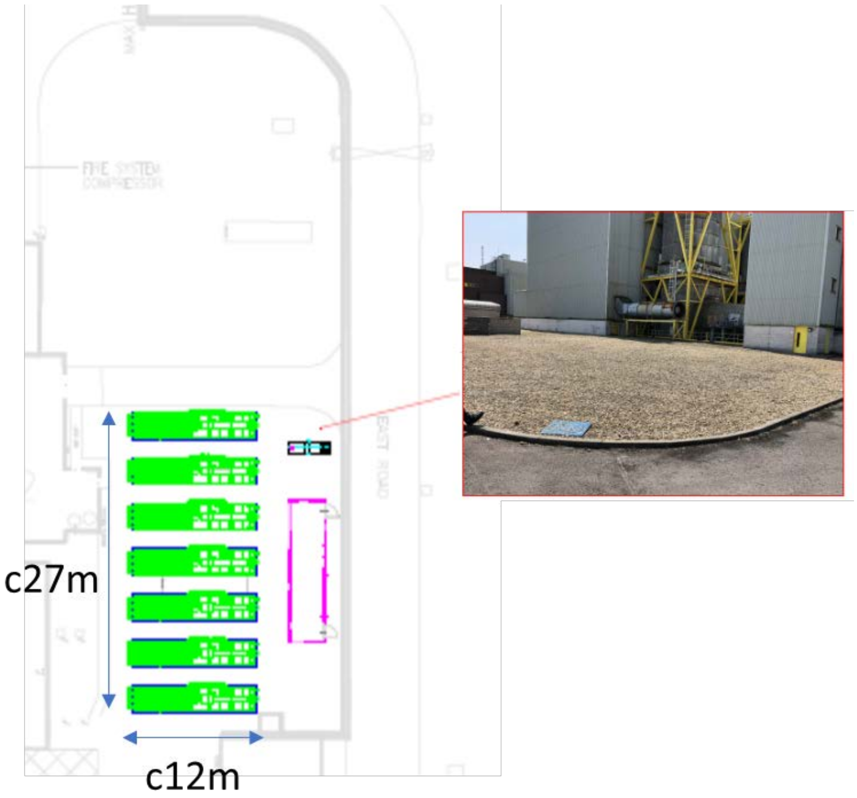

Figure 3: Plant Layout

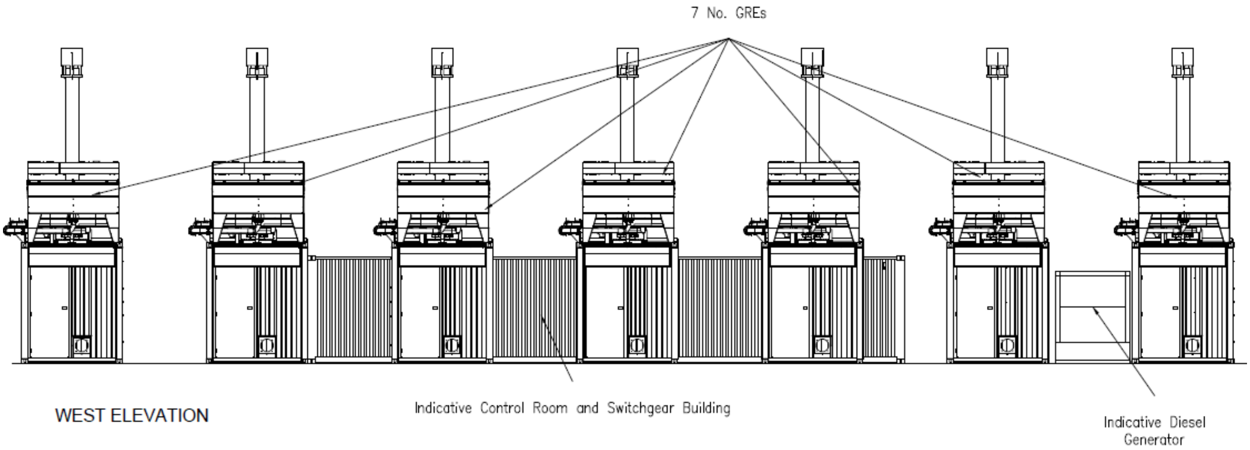

Figure 4: Western Elevation

Given this layout, and the lack of a common flue, it is not considered that these items form a single plant of less than 20 MWth.

The total emergency electrical generation includes some small over capacity (the plant proposed is an 6+1 configuration to ensure security of delivery of this service).

4 MAINTENANCE

The plant will be maintained in line with the recommendations of the manufacturer, and in line with their preventative maintenance program [6]. This comprises activities to be completed during commissioning and as the new plant “beds in”, as wells as cyclic maintenance activities for completion periodically. Cyclic activities fall into the following categories:

- Monthly (including checks to be performed with the engine stopped, idling and stabilised)
- Three monthly
- Every 1000 hours of operation, or two years

Furthermore, any additional maintenance, inspection or testing as required to meet Uniper engineering standards and environment permit conditions will be completed over and above the manufacturers minimum standards. As these engines are intended to provide high reliability, then it is in Uniper’s interest to follow the recommendations of the vendor with respect to maintenance of the plant. it is envisaged that, at least in early operation, engine operation will be tested for 30-60 minutes per week.

5 OPERATION

The gas reciprocating engines will only be operated under instruction in the event of a total or partial system shut-down of the transmission network system resulting in emergency power being required on site. This power supply will allow site systems to remain energised in this event. These events are rare, and this emergency capability is rarely called on to be used. Therefore, emergency units are characterised by very low annual operating hours, the vast majority of which in any calendar period are for reliability testing. Overall, it is envisaged that given engine operation for 30-60 minutes per week to allow testing, annual operation will be c50 hours.

The primary driver for the selection of this containerised engine solution, is the short lead time for delivery, alongside proven robustness in this duty. It is possible that a single large open cycle gas turbine (OCGT) could have been used to provide this duty. However, the lead time for this item is too long, indicated as 12-18 months, plus construction and installation time. This lead time would mean that emergency supplies could not be provided in the timescales required.

6 PREVAILING REGULATIONS AND EMISSION LIMITS

The Killingholme site is currently permitted under the Industrial Emissions Directive [7], as an Annex I activity. The IED sets emission limit values (ELVs) for gas fired plant of >50 MWth. However, for this new facility each standalone unit is not only below this threshold, but would also be below the 15 MWth threshold for aggregation. However, even if the 7 units were to be aggregated this gives a total installed capacity below this threshold. Therefore, in isolation, the new emergency generation facility would not constitute an LCP, and therefore would not be subject to ELVs. In any case, as the installation here is expected to require 50 operating hours a year for testing only, the total annual operation is well below 500 hours. At this threshold, regardless of size, the IED does not mandate ELVs for emergency plant (Annex V, Part 2/6).

Chapter II of the IED also requires that BAT [8] be applied to plant regulated under the Directive. As is the case in the IED, the proposed equipment here falls below the thermal input thresholds for BAT Associated Emission Levels (BAT AELs) to be set. This is as, whilst the installation is >50 MWth, the new engines do not themselves individually or if aggregated, comprise an LCP of 50MWth or greater. Therefore, these units are out of scope of the BAT Conclusions. In any case, even if the total size was 50 MWth or greater the general considerations state, “the BAT-AELs set out in these BAT conclusions may not apply to liquid-fuel-fired and gas-fired turbines and engines for emergency use operated less than 500 h/yr, when such emergency use is not compatible with meeting the BAT-AELs”.

Whilst the new proposed equipment will form part of a site regulated under the IED, the most relevant piece of legislation governing equipment of this size if the Medium Combustion Plant Directive [9]. This sets out how emissions from combustion plant in the range of 1-50 MWth should be regulated. Annex 2, table 2 of the directive sets ELVs for natural gas fired reciprocating engines. For new build units these would be 95 mg/Nm^3 for NOx. However, a number of caveats and flexibilities are foreseen, specifically:

- Paragraph 19 of the preamble allows exemption of plant installed for emergency use
- Article 6(8) states that exemptions to ELVs may be granted to plant operating for <500 hpa on a rolling 5 year average
- Engines running between 500 and 1500 hours per year may be exempted from compliance with those emission limit values if they are applying primary measures to limit NOx emissions and meet the emission limit values set out in footnote (4).

Confusingly, no ELVs are set out in footnote 4. However, it seems clear that the headline ELVs are stated in the Annex of the MCPD are not intended to apply to engines operating <500 hpa in emergency mode.

Therefore, overall, the regulations do not mandate any ELVs for emergency units such as being proposed here.

The specified generator controls do not apply in this case as this installation would be considered an emergency back-up generator [10].

Considering efficiency, the units will show very low running hours, so efficiency will not have a major impact on the CO2 emissions arising from the site. Nevertheless, it is instructive to consider that at 39.8%, the efficiency does sit in the range of values set for engines in the Large Combustion Plant BAT Conclusions (39.5-44%).

7 MONITORING

As the proposed plant will be operated for only a very low number of hours per year, the environmental impact is low, as well as the opportunity for monitoring being practically very limited. Annex III, Part 1 of the MCPD [9] states that;

Periodic measurements shall be required at least: — every three years for medium combustion plants with a rated thermal input equal to or greater than 1 MW and less than or equal to 20 MW

However, it goes on to say that this frequency may be varied such that monitoring is carried out at a frequency of three times the maximum average annual operating hours for plant subject to Article 6(8). In any case monitoring shall not be less frequent than every five years. Part 3 of the Annex states that monitoring is only for those species where an ELV is set by the directive (none in this case) and for CO in any case. Therefore, it would only be a requirement to periodically monitor CO for the plant proposed here, and for simplicity it will be conducted on a three yearly basis by the service engineer or a test house.

Results will be retained by site.

8 BAT SUMMARY CONCLUSIONS

Whilst the emergency back-up facility will be part of an Industrial Emissions Directive regulated site, containing Large Combustion Plant, the prevailing regulations are those for Medium Combustion Plant (MCP).

For emergency plant of this type, no Emission Limit Values are set for MCPs. The proposed plant is also not subject to the Specified Generator Controls. Nevertheless, expected emissions are low and are as outlined below:

- NOx 188 mg/Nm^3
- CO <300 mg/Nm^3
- NMHC <113 mg/Nm^3
- CH <450 mg/Nm^3

All emissions are quoted at 15% O2 (dry vol), 0 °C and 1013 mbar

The facility proposed for installation at the Killingholme Power Station site comprises of seven individually containerised natural gas fired reciprocating combustion engines. The engines should not be aggregated for assessing thermal input, and though this is the case the engines comprise a maximum total thermal input rating of <20 MWth. As the proposed plant is in a 6+1 configuration, there is some margin to ensure successful back-up power delivery. Whilst this could be provided by a single larger open cycle gas turbine, the lead time for one of these units would not meet the delivery timeframe required by the site.

9 REFERENCES

[1] Environment Agency, 2019; Permit Number EPR/VP3933/RJ issued October 2019

[2] OJEU, 2017; BAT Conclusions for Large Combustion Plant (2017/1442/EU) August 2017

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[4] Dresser Rand, 2017; ACOUSTIC PRESSURE LEVEL IN DRESSER-RAND CONTAINERIZED GEN-SET, Siemens document reference IC-O-D-2-001869-11-01e, January 2017

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[6] Siemens, 2019; MAINTENANCE OF NATURAL GAS SGE-SL 1500 RPM, Siemens document reference OF_IO-G-M-00-026e, June 2019

[7] OJEU, 2010; Industrial Emissions Directive (2010/75/EU) November 2010

[8] OJEU, 2017; establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants, July 2017

[9] OJEU, 2015; Medium Combustion Plant Directive (2015/2193/EU) November 2015

[10] Gov.uk, 2020; Specified generator: when you need a permit, last updated 20 December 2019 https://www.gov.uk/guidance/specified-generator-when-you-need-a-permit#definition-of-a-specified-generator accessed 20th May 2020

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