MA13 – Emissions Analysis for Worle Quarry Facility

Introduction

The site will in initially be powered by five diesel generators, as shown in Table 2 'Emissions' of Part C2.5 of the permit variation application. Table 2 is reproduced below.

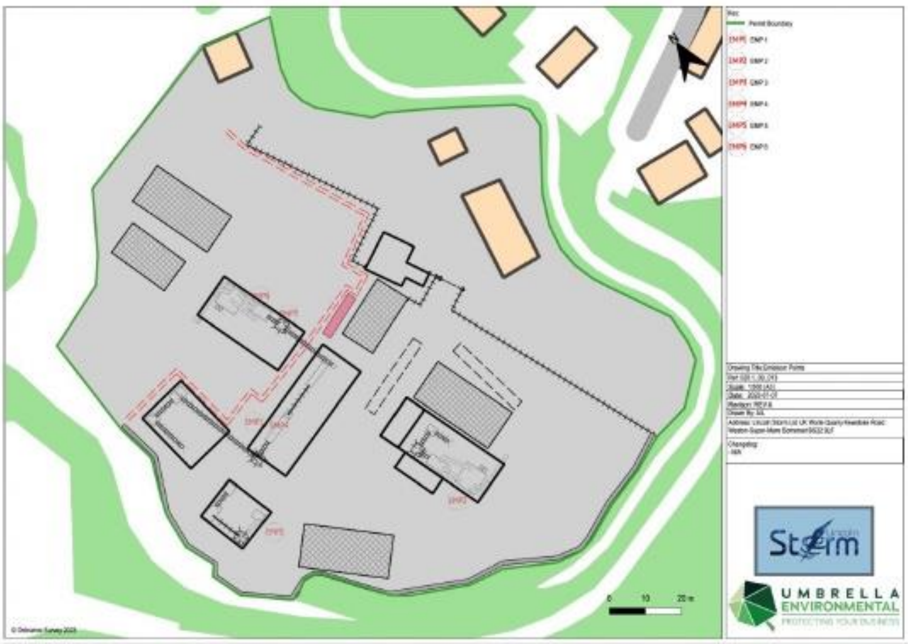
Table 2 – Emissions

Installation or Regulated Facility name	Lincoln Storm Limited			
Point-source emissions to air resulting from proposed change				
Emission-point reference and location (NGR/Latitude & Longitude)	Source	Parameter	Concentration	Units
51 - 21 - 50.41 N & 2 - 55 - 59.28 W	AD1015	NO2	see MA13	see MA13
51 - 21 - 50.94 N & 2 - 56 - 1.82 W	AD410	NO2	see MA13	see MA13
51 - 21 - 51.89 N & 2 - 56 - 1.12 W	AD630	NO2	see MA13	see MA13
51 - 21 - 51 N & 2 - 55 - 59 W	AD630	NO2	see MA13	see MA13
51 - 21 - 52.87 N & 2 - 56 - 0.04 W	AD630	NO2	see MA13	see MA13

These three generator types (Aksa Doosan AD1015, AD410 and AD630) have, respectively rated thermal inputs of up to 2.08 MW, 0.83 MW and 1.33 MW. Therefore the total rated thermal input for the site will be 6.9 MW.

The only other emission point is the dryer, which produces H_2O in the form of steam. The amount of steam produced is 180 kg per hour when operating. A chart showing the curve of steam production is attached to at Annex 1.

The total annual operating hours for all emission points is expected to be no more than 3,120 hours per annum, given the working week will be five days, with operations of 12 hours a day between 0700 and 1900. The six emission points are shown below.



Reducing NOX with selective catalytic reduction (SCR)

The NOX emissions from each generator must be reduced below the 190 mg/NM^3 specified by the Medium Combustion Plant (MCP) regulations.

Each generator has two exhaust vents and these will be fitted with abatement using selective catalytic reduction (SCR).

This operates by injecting a urea-based solution (commonly known as Diesel Exhaust Fluid or DEF) into the exhaust stream, which then reacts with the NOx emissions in the presence of a catalyst to form harmless nitrogen and water vapor.

The expectation (to be verified through modelling and testing with our technical advisors (SOCOTEC) and the selection SCR installation specialist) is that SCR can achieve NOX reduction efficiencies of c. 80% to 90%.

Our initial modelling uses the following fuel consumption parameters for the three generator types:

- Generator 1 AD 410 (EU)
    - Fuel Cons. Prime with 100% Load lt/hr = 76
    - Fuel Cons. Prime with 75% Load lt/hr = 57.1
    - Fuel Cons. Prime with 50% Load lt/hr = 38.8

- Generator 2 AD 630 (EU)
    - Fuel Cons. Prime with 100% Load lt/hr = 123.6
    - Fuel Cons. Prime with 75% Load lt/hr = 94.2
    - Fuel Cons. Prime with 50% Load lt/hr = 64.8
    - Fuel Cons. Prime with 50% Load lt/hr = 64.8

- Generator 3 AD 1015
    - Fuel Cons. Prime with 100% Load lt/hr = 192
    - Fuel Cons. Prime with 75% Load lt/hr = 162
    - Fuel Cons. Prime with 50% Load lt/hr = 110

Based on this fuel consumption data, our modelling indicates that reductions in NOX would be achieved as follows:

- Generator 1 AD 410 (EU): Based on a fuel consumption rate of 76 litres/hour at 100% load, the approximate exhaust gas flow rate is around 322 Nm3/hour. Assuming a typical NOx emission level of around 350 mg/Nm^3 for a generator of this size and age, retrofitting with SCR technology could potentially reduce NOx emissions to around 35-70 mg/Nm^3.

- Generator 2 AD 630 (EU): Based on a fuel consumption rate of 123.6 litres/hour at 100% load, the approximate exhaust gas flow rate is around 523 Nm^3/hour. Assuming a typical NOx emission level of around 450 mg/Nm^3 for a generator of this size and age, retrofitting with SCR technology could potentially reduce NOx emissions to around 45-90 mg/Nm^3.

- Generator 3 AD 1015: Based on a fuel consumption rate of 192 litres/hour at 100% load, the approximate exhaust gas flow rate is around 814 Nm^3/hour. Assuming a typical NOx emission level of around 500 mg/Nm^3 for a generator of this size and age, retrofitting with SCR technology could potentially reduce NOx emissions to around 50-100 mg/Nm^3.

We are therefore confident that we can bring each generator well with the required 190 mg/NM^3 limit.

An installation plan will be prepared with the selected SCR installation specialist, which will specify the steps and requirements for:

- Conducting a site survey to assess the installation requirements and identify any potential issues or challenges.
- Designing the SCR system to meet the specific needs of the generator and its operating conditions.

- Fabricating and assembling the SCR system components, including the reactor, catalyst, and control system.

- Preparing the generator for installation of the SCR system, which may involve modifications to the exhaust system, fuel system, and other components.

- Installing the SCR system and connecting it to the generator's electrical and control systems, including:

  - Preparation of the generator: The generator may need to be modified to accommodate the SCR system, which may involve modifications to the exhaust system, fuel system, and other components.

  - Installation of SCR components: The SCR system components, including the reactor and catalyst, are installed in the exhaust system of the generator.

  - Electrical and control systems integration: The SCR system must be integrated with the generator's electrical and control systems to ensure proper operation.

  - Testing and commissioning: The SCR system is tested and commissioned to ensure that it is operating correctly and meeting the required emissions reduction targets.

- Testing and commissioning the SCR system to ensure that it is operating correctly and meeting the required emissions reduction targets.

Considerations to ensure effectiveness

With the selected installation specialist we will be looking carefully at optimising dimensions which can reduce or improve SCR efficiency at NOX reduction. This includes:

- Temperature: SCR systems require a certain temperature range to function effectively. If the exhaust gas temperature is too low, the reduction of NOx will be incomplete, and if the temperature is too high, it can damage the SCR catalyst. Therefore, the SCR system must be designed to operate within the optimal temperature range. This will be assessed and optimised as part of installation and monitored on an ongoing basis.

- Catalyst Quality: The quality of the SCR catalyst can have a significant impact on its efficiency. Higher quality catalysts are typically more effective at reducing NOx emissions and have a longer lifespan. This will be assessed and optimised as part of installation and monitored on an ongoing basis.

- Exhaust Gas Flow Rate: The exhaust gas flow rate can impact the efficiency of the SCR system. If the flow rate is too high, it can reduce the time the exhaust gas spends in the catalyst, reducing the effectiveness of the SCR system. This will be assessed and optimised as part of installation and monitored on an ongoing basis.

- Catalyst Poisoning: Contaminants in the exhaust gas, such as sulphur, phosphorus, or ash, can poison the SCR catalyst, reducing its effectiveness. Therefore, careful consideration must be given to the quality of the fuel being used to minimize the risk of catalyst poisoning. We are confident that the fuel supply (of 'white diesel') is from a reliable source and of consistent quality.

- Maintenance: Proper maintenance of the SCR system is crucial for its effectiveness. Regular monitoring, cleaning, and replacement of components such as the catalyst and ammonia injection system are necessary to ensure optimal performance. This will be built into the site plant preventative maintenance programme.

- Ammonia Injection: The accuracy and effectiveness of ammonia injection into the exhaust gas stream can impact the efficiency of the SCR system. This will be assessed and optimised as part of installation and monitored on an ongoing basis.

The last of these, Ammonia Injection, is particularly critical to the effectiveness of the SCR. With the selected installation specialist and as part of the site's procedures in its OTEMS, optimisation of the accuracy of the Ammonia Injection will include the following dimensions:

- Proper System Design: The ammonia injection system should be designed to meet the specific requirements of the SCR system. This includes consideration of factors such as exhaust gas temperature, flow rate, and composition, as well as the catalyst type and size. The design should also account for variations in operating conditions to maintain accuracy over a range of conditions.

- Accurate Sensor Placement: Proper placement of sensors is critical to ensure accurate measurement of exhaust gas parameters such as temperature, pressure, and flow rate. These measurements are essential for proper dosing of ammonia and should be taken at key points throughout the system to ensure optimal accuracy.

- Calibration and Testing: Regular calibration and testing of the ammonia injection system are essential to maintain accuracy. This includes regular calibration of sensors, controllers, and dosing pumps to ensure that the correct amount of ammonia is injected into the exhaust gas stream. Regular testing of the system under varying conditions can also help to identify and correct any issues that may impact accuracy.

- High-Quality Components: The use of high-quality components, such as dosing pumps and injection nozzles, can help to ensure accurate and consistent dosing of ammonia into the exhaust gas stream. Regular inspection and replacement of worn or damaged components can also help to maintain accuracy.

- Operator Training: Proper training of operators on the use and maintenance of the ammonia injection system is critical to ensure optimal performance and accuracy. This includes training on proper dosing procedures, monitoring of system performance, and troubleshooting of any issues that may arise.

- Ammonia Storage and Handling: Proper storage and handling of ammonia are critical to ensure accurate dosing and prevent any safety issues. Ammonia should be stored in a dedicated, well-ventilated area, away from potential sources of ignition and incompatible materials. Proper safety equipment, such as eye protection and gloves, should be used when handling ammonia.

- Monitoring and Control: Continuous monitoring and control of the ammonia injection system are essential to maintain accuracy. This includes monitoring of key parameters such as ammonia flow rate, exhaust gas temperature, and NOx concentration, as well as control of dosing pumps and other system components. Automated control systems can help maintain optimal performance and accuracy while minimizing operator error.

- Regular Maintenance: Regular maintenance of the ammonia injection system is critical to ensure optimal accuracy and prevent any issues that may impact performance. This includes regular inspection and cleaning of injection nozzles, replacement of worn or damaged components, and calibration of sensors and dosing pumps.
- Quality Control: Regular quality control testing of the ammonia injection system can help to ensure that it is operating within acceptable limits and that NOx emissions are being effectively reduced. This includes testing of the SCR system under various conditions to ensure accuracy and consistency of performance.

Additional measures

As part of this programme of work, we will also be looking:

- with Aksa/Doosan at any re-mapping of the generators (at the control unit level) which can further improve fuel usage efficiency; and

- with other providers at additional measures, where feasible, either as alternatives or complements to SCR technology. One system (EcoPro) works by improving the fuel burn at the point of combustion using hydrogen as a catalyst to create a more complete burn, thus reducing the unburnt particles and emissions. reducing pollution and saving fuel costs. EcoPro is currently used in marine engine applications and so its suitability in this context is not yet confirmed.

Other forms of emission

Other emissions generated by diesel fuel include carbon dioxide (CO2), particulate matter (PM), sulphur dioxide (SO2), carbon monoxide (CO), and hydrocarbons (HC) including volatile organic compounds (VOC).

The SCR will have some improving effect on these, but not necessarily significantly in all cases:

- Carbon Dioxide (CO2): SCR technology is not designed to reduce CO2 emissions, as it specifically targets the reduction of NOx emissions. Therefore, the installation of SCR technology is not expected to have a significant impact on CO2 emissions.

- Particulate Matter (PM): SCR technology can reduce emissions of PM to a limited extent. However, the reduction in PM emissions is typically not as significant as the reduction in NOx emissions. Additional measures, such as the installation of diesel particulate filters (DPF), may be required to achieve significant reductions in PM emissions.

- Sulphur Dioxide (SO2): SCR technology does not directly target SO2 emissions, as it is primarily designed to reduce NOx emissions. However, the use of low-sulphur fuels can help to reduce SO2 emissions, which can have a positive impact on local air quality.

- Carbon Monoxide (CO) and Hydrocarbons (HC): SCR technology does not directly target CO and HC emissions, as it is designed to reduce NOx emissions. However, the reduction in NOx emissions can indirectly lead to reduced emissions of CO and HC, as the reduction in NOx emissions can lead to improved combustion efficiency and reduced fuel consumption.

Therefore in addition to SCR we will be exploring further measures with the selected SCR installation specialist:

- Carbon Dioxide (CO2): Increasing energy efficiency through improving insulation, and re-mapping.

- Particulate Matter (PM): reviewing feasibility of installing diesel particulate filters (DPF), i.e. devices that capture and remove PM emissions from the exhaust stream of diesel engines.

- Sulphur Dioxide (SO2): reviewing feasibility of installing scrubbers, i.e. devices that remove SO2 emissions from exhaust gases.

- Carbon Monoxide (CO) and Hydrocarbons (HC): through improving combustion efficiency and optimizing fuel-air ratios.

- Volatile Organic Compounds (VOC): V reviewing feasibility of vapor recovery systems.

All of this will be done in parallel with the implementation of the three year energy efficiency plan, which we anticipate will remove the need to use diesel generators as a power source and replace these with non-emitting power supplies.

Monitoring

A monitoring programme will be implemented with SOCOTEC to provide independent verification of the effectiveness of the SCR abatements and the emissions over time. This will be done at commissioning of each generator (with SCR fitted) and weekly for one month, and then every three months for the first twelve months of operations.

Annex 1: water emissions in dryer