REPORT

Petrojarl Rosebank FPSO – Stack Emissions Monitoring Plan

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PETROJARL ROSEBANK STACK EMISSIONS MONITORING PLAN

ENVIRONMENTAL PERMIT DOCUMENT

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DOCUMENT DESCRIPTION

The purpose of this document is to support the Pollution Prevention and Control (PPC) Subsidiary Application Template (SAT) submission for the Petrojarl Rosebank installation (PPC/352) and provides details of the monitoring programme as required under the Offshore Combustion Installations (Pollution Prevention and Control) (PPC) Regulations 2013 (as amended), which transpose the Industrial Emissions Directive 2010/75/EU (IED) and the Medium Combustion Plant Directive 2015/2193 (MCPD).

CONTENTS

Petrojarl Rosebank Stack EMissions Monitoring plan 1
Environmental Permit Document 1
Document Description 1
Abbreviations 2
1. Introduction 3
1.1. PPC Reporting 3
2. Stack Monitoring Requirements 3
2.1. Pollutants 3
2.2. Combustion Equipment 3
2.3. MCERTS 4
2.4. Measurements Standards 5
2.5. Monitoring Approach 5
2.5.1. Sampling Facilities 6
2.5.2. Frequency 6
3. References 7

ABBREVIATIONS

BS	British Standard
CEN	European Committee for Standardization
CO	Carbon Monoxide
DESNZ	Department for Energy Security and Net Zero
EEMS	Environmental Emissions Monitoring System
EA	Environment Agency
EN	European Standard
EU	European Union
FPSO	Floating, Production, Storage and Offloading
GTG	Gas Turbine Generator
ISO	International Standards Organisation
MAT	Master Application Template
MCERTS	Monitoring Certification Scheme
MW	Megawatt
MW(th)	Megawatt (thermal)
NO_x	Oxides of Nitrogen
PPC	Pollution Prevention and Control
SAT	Subsidiary Application Template
SO_2	Sulphur Dioxide
SSP	Site Specific Protocol
UHCs	Unburnt Hydrocarbons
VOC	Volatile Organic Compounds

1. INTRODUCTION

This plan supports the Pollution Prevention and Control (PPC) Subsidiary Application Template (SAT) submission for the Petrojarl Rosebank (hereafter referred to as Rosebank) Floating Production Storage and Offloading (FPSO) vessel and provides details of the monitoring programme as required under the Offshore Combustion Installations (Pollution Prevention and Control) Regulation 2013 (as amended).

The aggregated thermal input of the combustion plant on the Rosebank FPSO classes it as a large combustion installation. The main combustion plant on the FPSO (four dual fuel Solar Titan 130 Turbine Generators) are rated with a thermal input less than 50MW_{th} and are not classified as large combustion plant (LCP). Furthermore, the single dual fuel Auxiliary boiler operates under an exemption due to limited running hours (<500 hours per annum) so the monitoring requirements of the IED and MCPD (as implemented via the PPC Regulations, as amended) do not apply. However, the general principles of Best Available Techniques (BAT) apply regardless and conditions to the permit can be added by the Regulator that supplement the requirements of the IED and MCPD.

As part of the PPC permit conditions the permit holder must undertake a monitoring programme to achieve several goals:

- To determine the levels of the polluting substances in the emissions from the combustion equipment authorised under the permit;
- To determine the suitability of the emissions factors used to calculate the total annual emissions of the polluting substances;
- To determine the suitability of emissions projections that form the basis of the total permitted annual emissions; and
- To determine the efficiency of the monitored combustion equipment.

All new permit applications must have an emissions monitoring plan that clearly defines the monitoring objective, be based on standardised methods (e.g. EN standards) and a quality assurance system, e.g. in accordance with EN ISO/IEC 17025:2017 (Ref 3), to help to ensure accurate, reliable, representative, and comparable monitoring data.

Proposed plans for stack monitoring are described within Section 2 of this document. The results of the monitoring programme will be used to establish relationships between load and emissions. The emissions factors derived from monitoring data will be compared to those used for annual emissions reporting.

1.1. PPC REPORTING

The standard Environmental Emissions Monitoring System (EEMS) and PPC reporting format are used for monitoring the consumption of resources and emissions to air.

2. STACK MONITORING REQUIREMENTS

2.1. POLLUTANTS

The primary emissions to air monitored from combustion plant under offshore PPC are oxides of nitrogen (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2) and volatile organic compounds (VOCs, otherwise known as unburnt hydrocarbons, UHCs).

2.2. COMBUSTION EQUIPMENT

The main power supply is obtained by four, dual fuel Solar Titan 130 Turbine Generators, operated in a three out of four (3oo4) configuration with the load shared and preferentially operated on fuel gas. The power generation turbines selected are fitted with Solar's SoLoNO$_x^{TM}$ Dry Low-Emission (DLE) combustion technology, which is optimised to reduce emissions by tightly controlling the combustion temperature inside the turbine.

There are four diesel driven fixed speed electrical firewater pumps (FWPs), two located in the fore and aft of the vessel. When there is demand, two firewater pumps are required for full FPSO coverage, both ran at 100% load.

Upon failure of main power, the diesel engine driven essential and emergency generator will support normal conditions of habitability and essential marine/process systems. There are no routine users of diesel.

The FPSO also has an inert gas generator (IGG) which supplies safe combustion gases to cargo oil storage tanks to maintain a low-oxygen atmosphere in the event the primary blanketing gas source (fuel gas fed from the first stage suction scrubber for A and B compressors) is unavailable and facilitate maintenance activities. The IGG operates on diesel/gas oil and is expected to operate for around 48 hours per year on average during periods the primary source is unavailable. There is no sampling port fitted to the IGG so stack monitoring is not possible. However, O_2 levels will be monitored to validate that the IGG is operating as per design.

It is anticipated that following the commissioning period, the diesel engines associated with the firewater pumps and emergency generators will only be used in emergencies and furthermore, will normally operate for less than 500 hours per annum. Stack monitoring will not be carried out for these items of combustion plant.

Each of the gas turbines on the FPSO are fitted with ports in the exhaust stack to enable sampling of effluent gases with a traversing probe. Sample port details are summarised in Table 2-1.

Emissions monitoring will be carried out for all primary combustion units (electricity generation or heat generation) in continuous use.. For the Rosebank FPSO, the combustion equipment which are anticipated to satisfy the criteria for emissions monitoring are summarised in Table 2-1.

The design and location of sample points and appropriate measurement techniques are discussed in section 2.5 and follows the Department for Energy Security and Net Zero (DESNZ,2013), formerly the Department for Business, Energy and Industrial Strategy (BEIS) Offshore PPC (Combustion Plant) Emissions Monitoring Guide (DESNZ, 2013, updated Aug 2023).

Table 2-1 Rosebank FPSO Relevant Combustion Equipment to be Monitored

Emission Source Description	Tag Number	Maximum Rated Output (MW)	Maximum Thermal Input Output (MW_{th})	Sample Point	Drawing Number
Solar Titan 130 Gas Turbine Generators	80-DE-001A	14.055[1]	42.106[1]	GTG-A-SSP	PJ5-04-P-80-XB-00001-001_X03_AB
Solar Titan 130 Gas Turbine Generators	80-DE-001B	14.055[1]	42.106[1])	GTG-B-SSP	PJ5-04-P-80-XB-00001-002_X03_AB
Solar Titan 130 Gas Turbine Generators	80-DE-001C	14.055[1]	42.106[1]	GTG-C-SSP	PJ5-04-P-80-XB-00001-003_X03_AB
Solar Titan 130 Gas Turbine Generators	80-DE-001D	14.055[1]	42.106[1]	GTG-D-SSP	PJ5-04-P-80-XB-00001-001_X04_AB
AALBORGOL 39280 Auxiliary Boiler	55-FB-501	8[2]	9.061[2]	FB-SSP	PJ5-03-P-45-XB-00210-001_P01_AB

1. Gas Turbine Datasheet: Solar Predicted Engine Performance TITAN_130-20501S_New Gas Fuel_ISO Inlet Conditions.pdf

2. Auxilliary Boiler : PJ5-03-R-55-XD-00200-001_02_01 - Aux Boiler Burner GA - 55-FB-501

Note: Gas Turbine Generator Ratings based on OEM data based at ISO standard conditions i.e 15 ºC / 60% humidity and 1.013 bara which is standard atmospheric pressure at sea level

2.3. MCERTS

The Monitoring Certification Scheme (MCERTS) provides a framework of standards in relation to environmental monitoring and covers:

- The standards of performance that monitoring equipment must meet;
- The level staff must be qualified to; and

- Accrediting laboratories and inspecting sites in line with European and International standards.

Altera will use MCERTS qualified personnel and MCERTS accredited equipment and laboratories to support the Rosebank FPSO offshore stack monitoring programme. However, it is acknowledged that offshore execution of the monitoring in line with every aspect of the relevant standards indicted in the MCERTS performance standards may not be possible given the constraints on offshore facilities.

Any deviation from MCERTS will be justified and discussed with the Department.

2.4. Measurements Standards

The following hierarchy is generally applied to measurements standards:

- European Standard (EN)
- International Standard (ISO)
- National Standard (BS)
- Other recognised method

DESNZ requires monitoring to be carried out in line with MCERTS and the use of Standard CEN/ISO measurements techniques for the main pollutants. EN 15259:2007 is one of the key standards for offshore stack monitoring. EN 15259 is the standard for "Measurement Locations – Monitoring stack emissions: techniques and standards for periodic monitoring" (BS EN, 2007).

All new permit applications must have an emissions monitoring plan that clearly defines the monitoring objective, be based on standardised methods (e.g. EN standards) and a quality assurance system, e.g. in accordance with EN ISO/IEC 17025:2017, to help to ensure accurate, reliable, representative, and comparable monitoring data.

An important aspect of exhaust stack monitoring is to obtain a representative sample from the exhaust stack. To achieve this, there are requirements around ensuring homogeneous flow at the sample location and in relation to the number of samples required. EN 15259:2007 sets out appropriate sampling strategies i.e. number and positioning of sample points, for circular and rectangular ducts of different sizes.

The MCERTS specification for portable monitoring equipment sets the criteria for two equipment "types". The portable stack gas analysers will meet the Type II equipment accuracy and repeatability standards given in the Environment Agency (EA) Performance Standard (MCERTS) (EA, 2005) as far as is practicable offshore, considering structural, access, cost and safety restrictions on the platform. A Type I system would require calibration gases and is considered only semi-portable for offshore use but will obtain more accurate results.

According to MCERTS standards, monitoring should incorporate the use of on-site calibration gases to verify measurement data before and after a test run, using competent personnel & suitable test procedures.

2.5. Monitoring Approach

The methodology for the monitoring programme will comply with all relevant internal HSE standards and procedures. Altera will ensure that MCERTS qualified personnel will be appointed to conduct the stack monitoring testing. Prior to conducting the testing, a site review, followed by a site-specific protocol (SSP) shall be produced to detail the application of the techniques and methods in the standards to the specific requirements of the Rosebank FPSO.

The SSP needs to convert the scope of the monitoring being conducted (e.g. baseline survey) into a practical measurement programme reflecting issues such as access, safety requirements and the duration of the tests. The SSP shall be submitted to DESNZ for review prior to carrying out any stack monitoring testing.

During the stack monitoring, emission analyses will be undertaken over a range of operating loads. The results will be used to establish relationships between load and emissions. The emission factors derived from the monitoring data will be compared to those used for annual emissions reporting.

The monitoring programme will be used to achieve the objectives highlighted in the introduction and to carry out adequate compliance monitoring, which are the conditions of the PPC permit set out be DESNZ. The

monitoring programme will outline the approach to measure prescribed emission releases from individual release points for the main items of combustion equipment.

2.5.1. Sampling Facilities

For the sampling facilities, the key requirements (DESNZ) include; a sampling position as far away from flow disturbances (for example, bends and dampers) and joining ducts as possible to ensure homogenous flow. Grid sampling at multiple points on a grid across the stack measurement plane is used to determine if flow is homogenous.

Generally homogenous flow is achieved with at least 5 hydraulic diameters of straight duct upstream of the sampling plane and 2 hydraulic diameters downstream (5 hydraulic diameters from the top of a stack to avoid air entrainment). However, it is recognised that in the offshore context the selected locations will often be a compromise position between the 'ideal' and 'readily accessible' locations.

Sampling ports are required to access the exhaust gases and, where practicable, should be located to allow a traverse of the ducts across two diameters (to assess mixing at the sampling position). If only gaseous concentration measurements are required, then a minimum 1 inch BSP (British Standard Pipe) or NPT (National Pipe Thread, US Standard) socket and safe working access are all that are required. However, it should be noted that some test houses prefer a minimum 2 inch sockets to accommodate adequate tip prefilters when undertaking testing for diesel fuel. For gas turbines without heat recovery, a flange connection is recommended (flanges appear to be less prone to seizing). To avoid discharge of hot gases at the sampling position, an isolating valve is recommended for exhaust ducts which are at higher than ambient pressure.

The sample ports are available on the exhaust stacks of the waste heat units for the 4 x Solar Titan 130 Gas Turbine Generators as detailed in Table 2-1. It is recommended that suitability is confirmed during site review by MCERTS qualified personnel appointed to conduct the monitoring programme.

2.5.2. Frequency

An initial baseline emissions monitoring survey will be conducted within 12 months of the Rosebank FPSO combustion plant commencing operation, capturing the equipment outlined in Table 2-1 and will reflect normal and stable operating conditions. The baseline survey will serve to validate the emission estimates in the permit application. After a an initial baseline survey is undertaken, periodic routine monitoring may be required by the Regulator. Altera will adhere to the scope and frequency specified within relevant permit conditions

3. REFERENCES

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Auxilliary Boiler : PJ5-03-R-55-XD-00200-001_02_01 - Aux Boiler Burner GA - 55-HB-501