

Shell Penguins – Emissions Monitoring Plan

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PENGUINS EMISSIONS MONITORING PLAN

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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 Penguins installation (PPC/113) and provides details of the monitoring programme as required under the Offshore Combustion Installations (Pollution Prevention and Control) (PPC) Regulations 2013 (as amended) (Ref 1), which transpose the Industrial Emissions Directive 2010/75/EU (IED) and the Medium Combustion Plant Directive 2015/2193 (MCPD).

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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
SO₂	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 Penguins 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 Penguins FPSO classes it as a large combustion installation. All combustion plant on the FPSO are neither large combustion plant (LCP) nor medium combustion plant (MCP) 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. An emissions monitoring programme seeks 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 2.5 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. MONITORING OF AIR EMISSIONS

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 (SO₂) and volatile organic compounds (VOCs, otherwise known as unburnt hydrocarbons, UHCs).

2.2. COMBUSTION EQUIPMENT

The main power supply is obtained from three Taurus 70 Gas Turbine Generators in a 3 x 50% configuration. Normally two machines are running with the load shared. Gas compression is supplied via a Titan 130 gas fired compression turbine (1 x 100% configuration). Both the power generation and gas compression turbines are fitted with Solar's SoLoNO_xTM Dry Low-Emission (DLE) combustion technology, which is optimised to reduce emissions by tightly controlling the combustion temperature inside the turbine.

There are 3 diesel driven electrical firewater pumps (FWPs) which will be ran at 100% load. When there is a demand, one firewater pump is sufficient for full FPSO coverage. The design of the FWP system enables one of the FWPs to function as an essential generator (Fire pump A-7101A), providing power in a black start scenario, and can also serve as a back-up seawater lift pump. The emergency generator will switchover with auto synchronisation with the GTG's, to allow for changeover of from diesel to gas generation. There is also a diesel



fired inert gas generator (IGG) that is used to provide a low oxygen atmosphere in the cargo tanks of the FPSO to minimise the risk of explosion.

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.

The inert gas generator (IGG) consumes diesel/gas oil and is used to provide a low oxygen atmosphere in the cargo tanks of the FPSO to minimise the risk of explosion. It is not classed as MCP (Ref. 7) and is expected to operate for around 1500 hours per year. Emissions from the IGG are expected to be immaterial when compared with emissions from the gas turbines on the FPSO. There is no sampling port fitted to the IGG so stack monitoring is not possible. However, O₂ levels will be monitored to validate that the IGG is operating as per design.

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 from combustion plant on the FPSO will be monitored periodically based on surrogate information available from instrumentation on the FPSO. Suitable emission factors will be identified and applied to appropriate activity data to estimate the emissions of pollutants from the combustion plant:

- Plant run hours and/or flow instrumentation, plant data sheets, and fuel specification will be used to estimate emissions arising from the emergency generator, fire water pumps, and IGG.
- Vendor datasheets, flow instruments, turbine load and other relevant status indication, and fuel composition will be used to estimate emissions arising from the gas turbine generators and the HP compressor. As these turbines utilise Solar's SoLoNOx technology, turbine instrumentation will be used to monitor when these turbines are operating in DLE 'mode' and when they are not so that the appropriate emissions factors can be applied. Periodic stack monitoring can be undertaken to validate performance of the turbines against vendor data if required.

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

Emission Source Description	Tag Number	*Maximum Rated Input (MW)	*Maximum Thermal Rated Output (MW _{th})	Sample Point	Drawing Number
Solar Taurus 70 Gas Turbine Generators	EG8001A	7.3 ⁽¹⁾	23.84 ⁽¹⁾	41-MV-185/187	PRD-PT-TOPS-41-E-PX-2365-00003-001
Solar Taurus 70 Gas Turbine Generators	EG8001B	7.3 ⁽¹⁾	23.84 ⁽¹⁾	41-MV-189/191	PRD-PT-TOPS-41-E-PX-2365-00004-001
Solar Taurus 70 Gas Turbine Generators	EG8001C	7.3 ⁽¹⁾	23.84 ⁽¹⁾	41-MV-193/195	PRD-PT-TOPS-41-E-PX-2365-00005-001
Solar Titan 130 HP Compressor Turbine	KG-2601	15.9 ⁽²⁾	42.2 ⁽²⁾	26SC003	PRD-PT-TOPS-26-E-PX-2365-00008-001
1. Ref 5					
2. Ref 6					
*Based on vendor data (Ref 5, Ref 6) at -7 deg C.					

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.

Shell will use MCERTS qualified personnel and MCERTS accredited equipment and laboratories to support the Penguins FPSO installation offshore stack monitoring programme. However, it is acknowledged that offshore execution of the monitoring in line with every aspect of the relevant standards indicated 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” (Ref 2).

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) (Ref 8) 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 stack monitoring programme will comply with all relevant internal HSE standards and procedures. 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 Penguins 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 by 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 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.

Homogenous flow is generally 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 socket 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 3 x Solar Taurus 70 and the 1x Solar Titan 130 HP compressor power turbine exhaust stack as detailed in Table 2-1.

2.5.2. Frequency

An initial baseline emissions monitoring survey will be conducted within 12 months of the Penguins combustion plant commencing operation and will reflect normal and stable operating conditions. The baseline survey will serve to validate the emission estimates in the permit application. After a baseline survey, periodic routine monitoring may be required by the Regulator. Shell will adhere to the scope and frequency specified within relevant permit conditions.



3. REFERENCES

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6. HP Compressor Data Sheet: P3NG-4-0304-01-C08-00004
7. Frequently Asked Questions (FAQs) - Medium Combustion Plant (2023)
8. Performance Standard for Handheld Emission Monitoring Systems, Version 4, Environment Agency (2018)