



# Shell Penguins – Non-Technical Summary (NTS) Document

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## NON-TECHNICAL SUMMARY

The Penguins Field is located in the United Kingdom Continental Shelf (UKCS) Blocks 211/13 (Penguins West) and 211/14 (Penguins East), in the northern North Sea (NNS). The field is located approximately 160 km from the Scottish coastline (Northern Shetland) and runs adjacent to the UK/Norway median line.

The existing and new developments will be produced via additional subsea infrastructure to the Penguins Sevan Floating, Production, Storage and Offloading (FPSO) facility, which is approximately 430 km from the Scottish coastline (Latitude: N 61° 34' 59.27" Longitude: E 001° 32' 47.71", WGS84). Oil will be temporarily stored and exported via tanker offload. Gas is compressed, dehydrated and exported through the gas export pipeline tied into the existing FLAGS pipeline system. Gas will also be used for gas lift, fuel gas and cargo tank blanketing. When the FPSO becomes gas deficient or is shutdown, gas can be imported from the FLAGS system. Only a low rate of water production is expected. This water will be treated and discharged overboard.

The main power supply is obtained from the 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 HP gas fired compression turbine (1 x 100% configuration). Both the power generation and gas compression turbines are fitted with Solar's SoLoNO<sub>x</sub><sup>TM</sup> Dry Low-Emission (DLE) combustion technology, which is optimised to reduce emissions by tightly controlling the combustion temperature inside the turbine.

To reduce the emissions from the asset, a Vapour Recovery Unit (VRU) has been installed to recycle waste streams which would otherwise historically have been routed to flare. The Vapour Recovery Unit (VRU) compresses fuel gas which has been used for purging the vapour space in the oil cargo tanks and as stripping gas in the TEG regeneration unit and feeds it into the gas compression train.

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 diesel engines 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.

The efficiency of the Taurus 70 gas turbines themselves is only one of the factors of the total energy efficiency of the offshore installation. The Taurus 70 gas turbines are also fitted with Waste Heat Recovery Units (WHRUs) for heating crude oil and most of the heat duty for process equipment. At low power load, turbine controls prioritise a high exhaust gas temperature to ensure that there is enough heat recovery at the WHRUs to avoid process upsets. Variable speed drive has been used on the gas turbine driven compressor set. A trim cooler is used to control the temperature by rejecting excess heat to the sea via the cooling medium system. The heating demand required for the Penguins facility will be recovered from cooling down the main power exhaust gas using WHRUs. The WHRUs, heat circulating fluid (heating medium) which supplies the normal process heat duty to FPSO topsides equipment and cargo storage systems.

As the combined thermal input of the main combustion plant (3 Gas Turbine Generators (GTG) each with maximum thermal input of 23.84 MWth and HP Gas Turbine Compressor with maximum thermal input of 42.2 MWth (GTC)), the total thermal capacity of the main combustion plant being 113.72 MWth, which exceeds 50 MWth, the FPSO is considered an Large Combustion Installation (LCI).

The power requirements for the Penguins FPSO have been strategically evaluated during the Penguins Redevelopment Project. Gas turbine generators with dual fuel capability provide main electrical power to the facility and a gas - fired power turbine drives the HP compressor. All turbines are provided with state-of-the-art (DLE) dry low-emission control systems to reduce environmental discharges of NO<sub>x</sub>, SO<sub>x</sub>, CO, and unburned hydrocarbons, and waste heat is recovered from hot exhaust gases to meet the heat duty of process equipment.



The selected equipment configuration (i.e., Titan 130 and Taurus 70 turbines) balances emissions, efficiency, availability, reliability, and capital cost and as such, it represents the Best Available Technique (BAT) to provide the Penguins FPSO with power.

Reciprocating diesel engines are provided for equipment that only runs during emergency conditions and an inert gas generator supplies safe combustion gases to cargo oil storage tanks to facilitate maintenance activities.

The Penguins BAT Assessment demonstrates that BAT has been implemented and reviews the combustion operations and assesses what measures could reasonably be implemented to minimise emissions and discharges, see BAT Assessment 204226C-004-RT-6200-0037.

Small volumes of waste are generated in relation to the combustion plant and are managed in compliance with all current legislation. Drainage systems around the combustion equipment collect oil-contaminated water and free oil is separated and recovered before discharging the treated water to sea. The gas turbines are periodically washed with a detergent solution and the wash-water is discharged to the hazardous drainage system on the platform. The presence of High Efficiency Particulate Arrestance (HEPA) grade air intake filters in all three gas turbines reduces significantly the required need of water washing.

Emissions from all combustion plant will be monitored and stack sampling will be carried out for all primary combustion units (3 x Solar Taurus 70 Gas Turbine Generators and 1 x Solar Titan 130 HP Compressor Turbine), as per the Emissions Monitoring Plan 204226C-004-RT-6200-0039.

Emissions of oxides of sulphur from the combustion equipment at the installation are a function of the Sulphur content of the fuels burnt. All of the gas turbines normally operate on gas minimising the emissions of SO<sub>2</sub> from this combustion equipment. Low Sulphur diesel (< 0.1 wt.%) is also used as a back-up fuel source for gas turbines for infrequent events where enough fuel gas is not available.

Shell U.K. Limited is committed to preventing pollution, complying with legislation and improving their environmental performance. The Penguins FPSO is a new facility and has been engineered to prioritise energy efficiency. Energy consumption has been minimised by process design and equipment selection. Heat conservation insulation is provided to all process equipment operating at high temperatures and winterisation insulation is provided to all equipment susceptible to icing or freezing. This reduces the heating power required and ultimately reduces the consumption of fuel at the facility.

The equipment will be operated by technically competent operators and maintained to ensure safe and efficient operation, with planned maintenance for the single gas compression train and condition-based maintenance for power generation train. The installation of HEPA filters to all gas turbine drivers will avoid compressor fouling and hence compressor washing. Low pressure drop exhaust systems are also fitted.

Air dispersion modelling has been undertaken to assess the impacts on air quality of emissions from the Penguins FPSO. Overall, there were no predicted exceedances of any of the relevant Air Quality Standards for the pollutants of concern, for any of the modelled scenarios at any location. For pollutant concentrations that were not screened out based on their Process Contribution (PC) values, all were deemed insignificant as Predicted Environmental Concentration (PEC) is less than 70% of the relevant long term environmental standard. Furthermore, with the prevailing wind direction being broadly parallel to the median line and the relatively low pollutant concentrations that have been estimated from conservative modelling scenarios, the expected trans-boundary impacts from the Penguins FPSO is likely to be negligible.