




Client: *Altera Infrastructure LP*



Project Title <i>PPC Permit Application Support</i>	Project Ref. <i>J76086A</i>	Ref No <i>217505C-001-CN-6200-0001</i>
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CALCULATION SHEET
Emission Load Calculation - Rosebank Petrojarl FPSO

0	19-Dec-25	Issued for Client Use				
Rev No	Date	Description	Originator By	Checked By	Approved By	Client Approval

Project	PPC Permit Application Support				
Client	Altera Infrastructure LP	Project No:	J76086A		
Subject	Emission Load Calculation - Rosebank Petrojarl FPSO			CTR No.	
Calc. By	#REF!	Date	#REF!	Calc No.	217505C-001-CN-6200-0001
Checked By	#REF!	Date	#REF!	Rev	#REF!
OBJECTIVE					
<p>The objective of this calculation sheet is to estimate the emissions profiles/loads required in the PPC permit for the Petrojarl Rosebank FPSO and assess the predicted contribution to UKCS emissions of the installation for inclusion in supporting docs such as the BAT, SAT, EAJ and upload into to UK Energy Portal, etc.</p>					
BASIS					
<p>NO_x pollutant loads for the Solar Titan 130 Gas turbines Generators (GTGs) have been estimated using Original Equipment Manufacturer (OEM) information while operated in SoLoNO_xTM mode i.e. above 50% load (Ref 4). No other project specific warranted pollutant load data was available for the GTGs under normal operation i.e. operation in SoLoNO_xTM mode, therefore, all other pollutants have been determined using the default factors provided in the EEMs guidance (Ref 3). SO_x emissions have been estimated based on the default factor for turbines in the EEMs guidance (Ref 3) due to insufficient information on expected fuel gas concentration being available, this is deemed to be conservative based on the low Sulphur concentration in both import gas and associated fuel gas.</p> <p>Additional consideration has been given to "Other Than Normal Operating Conditions" (OTNOC) within the emissions calculations which may lead to increased emissions. Vendor information outlined in Solar Turbine Product Information Letter (PIL) 170 (Ref 19), provides general vendor data for the Solar Titan 130 during start-up/shutdown operations and has been used to assess NO_x, CO, and UHC emissions related to turbine switchover operations. Application of other Solar PIL's have been assessed but screened out, PIL 167 for example as the information provided for cold weather operations falls outwith the average expected ambient temperature of the Rosebank GTG's in operation and is deemed unrepresentative.</p> <p>CO₂ emissions have been estimated based on the associated fuel gas composition (Att4, Ref 2). EEMS factors (Ref 3) have been used for other sources where vendor data was not available.</p>					
ASSUMPTIONS					
<i>The following assumptions have been made:</i>					
1	Fuel gas and Diesel run hours and activity during the commissioning and production periods in 2026 have been provided by the client (Ref 1).				
2	The Petrojarl Rosebank FPSO shall enter UK waters on 16/04/2026. The offshore commissioning period shall end on 18/11/2026. More detail on the schedule is given in Att 1.				
3	Fuel gas and Diesel usage has been forecasted for 2027 and 2028 based on an assumed plant uptime of 85%. An additional 15% contingency has been added to all forecasts. Assumptions and considerations made for specific equipment in the forecast of 2027 and 2028 run hours are detailed in Att 1.				
4	There are no turnarounds are scheduled for 2027 or 2028 as confirmed by the Client.				
5	The main electrical power is provided by the SOLAR Titan 130 gas turbine in a 3oo4 configuration during normal production.				
6	When the GTGs operate in the region of 50–100% load, Solars SoLoNO _x TM DLE technology is in operation, resulting in decreased NO _x emissions. A GTG NO _x emission factor for this operational range was derived from the OEM's guaranteed emission limit of 25 ppmv (Ref 4). In this range, NO _x emissions are the only warrantable emissions, and as such other emission factors for SoLoNO _x mode were not derived. It was assumed on a conservative basis that 90% of GTG operations will be within 50-100% load.				
7	Following on from assumption 6 above, 10% of operations are assumed to be outwith SoLoNO _x DLE mode. For this case, emission factor for NO _x given in the EEMS Guidance was used (Ref 3).				
8	It is assumed that there will be 4 turbine switch over events each year, and that there will be no black start due to the ability to import gas. PIL 170 provides the mass of emissions for NO _x , CO, UHC, VOC and CO ₂ per start up or shutdown event (Att 3, Ref 19).				
9	Consumption rates for all combustion equipment have been obtained from OEM datasheets and Operations & Maintenance manuals (Att 4 through Att 13).				
10	Temporary equipment has not been included within the emissions calculations because they are in service for less than 500 hours (i.e. during commissioning activities only) and are therefore, not included on the ETS permit.				
GENERAL CONVERSION FACTORS USED					
	Methane GWP	28	<i>Ref 7</i>		
	Nitrous Oxide GWP	265	<i>Ref 7</i>		
RESULTS					
<p>The outputs to be included in the relevant permit application are presented in the in the tab "Emission Loads Calculation" which tabulates the annual emissions and pollutant loads for inclusion in the supporting docs such as the BAT, SAT, EAJ and upload into to UK Energy Portal, etc.</p>					

REFERENCES

- 1 HC Emissions to Environment.pdf (Att 1)
- 2 Rosebank Data Request 16.09.25.xlsx (Att 4)
- 3 EEMS-Atmospheric Emissions Calculations (Issue 1.810a)
- 4 PJ5-04-R-80-DS-01002-001_03_01 - Solar Turbine Performances
- 5 DUKES Calorific Values and Density of Fuels (<https://www.gov.uk/government/statistics/dukes-calorific-values>)
- 6 J7333A-Y-RT-24000 D1 Summary of EEMS Recommendations
- 7 Global Warming Potentials (https://ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf)
- 8 PJ5-03-R-80-RA-00003-001_Essential eng Test datas and FAT diesel oil spec and consumption
- 9 Em gen.pdf
- 10 Pages from PJ5-03-R-55-RD-00200-001_02_01-Aux boiler Fuel consumption data
- 11 IG Generator Specification
- 12 PJ5-03-I-71-DS-00103-001_03_01 - Fire Pump Datasheets
- 13 Email Correspondence re Temporary Equipment Datasheet Information
- 14 NP-08_en
- 15 PD Pump PP-31 Datasheet
- 16 217505C-003-RT-6200-0001 Petrojarl Rosebank FPSO -BAT Assessment
- 17 DB Email with Rosebank - Combustion Emissions Forecast
- 18 041-00076_APPL_13-3271_REVISIED
- 19 Product Information Letter (PIL) 170 - EMISSION ESTIMATES START UP SHUT DOWN (Solar Turbines)
- 20 Solar Predicted Engine Performance TITAN_130-20501S_New Gas Fuel_ISO Inlet Conditions.pdf
- 21 Solar Predicted Engine Performance TITAN_130-20501S_Desiel Fuel_10degC.pdf

ATTACHMENTS

- 1 Att 1 - Equip Runhours Estimate
- 2 Att 2 - Genesis Gas Properties
- 3 Att 3 - EF Calculations
- 4 Att 4 - Fuel Gas Comp
- 5 Att 5 - GTG Consump
- 6 Att 6 - Ess Gen Consump
- 7 Att 7 - Em Gen Consump
- 8 Att 8 - Boiler Consump
- 9 Att 9 - IGG Consump
- 10 Att 10 - Fire Pump Consump
- 11 Att 11 - N2 Pump Consump
- 12 Att 12 - MEG Pump Consump
- 13 Att 13 - Quench Pump Consump
- 14 Att 14 - Gas GT Exhaust vol

OBJECTIVE

The objective of this calculation sheet is to estimate the emissions profiles/loads required in the PPC permit for the Petrojar Rosebank FPSO and assess the predicted contribution to UKCS emissions of the installation for inclusion in supporting docs such as the BAT, SAT, EAJ and upload into UK Energy Portal, etc.

BASIS

- These will be a commissioning period from April through to November 2026. All GTGs will be commissioned on diesel prior to arrival in UK waters. 1 GTG running on diesel (90% load based on demands of installation base load) from arrival on station up to import of WsSFS gas. commissioning of all GTGs on fuel gas & auto-switch, 2 GTGs (75% load) running on fuel gas to support compressor commissioning, 3 GTGs (75% load) running on fuel gas after gas export starts, diesel contingency for trips.
- Fuel use and Diesel Usage has been forecasted for 2027 and 2028 based on an assumed plant uptime of 85% per annum. An additional 15% contingency has been added to all forecasts. No turnarounds are scheduled for 2027 or 2028.
- The CO₂ emission factor for fuel gas consumed by the turbines was estimated using the fuel gas compositions provided in At 4. Of the two samples, the one with the higher emission factor was used for a conservative approach.
- The turbines are assumed to be operating in DLE mode 90% of the time under normal operations. Under this operating mode, the NO_x emission factor has been calculated on the warrantable emissions of 25 ppmV (At 3, Ref 4). NO_x emissions are the only project specific warrantable emissions provided by the OEM, and as such all other emission factors under SO₂/NO_x mode are derived from the EME guidance (Ref 3).
- Operation in non-Solator mode (for the remaining 10% of the time in operation) use the emission factors taken from EME Guidance (Ref 3).
- Emissions related to start up and shut down events have been added to emission loads.

CALCULATION

Source	Fuel use (tonnes)	CO ₂	NO _x	N ₂ O	SO ₂	CO	CH ₄	VOC	CO ₂ e
Gas (Turbines)	45,581	127,833	113.42	10.03	0.56	274.10	42.38	1.73	131,877
Gas (Heaters/Boilers, etc)	48	138	0.12	0.01	0.00	0.03	0.00	0.00	141
Diesel (Turbines)	17,096	54,707	230.80	3.76	34.19	15.73	0.96	5.04	55,720
Diesel (Heaters/Boilers, etc)	18	51	0.04	0.00	0.03	0.01	0.00	0.00	52
Diesel Engine	2	6	0.01	0.00	0.00	0.00	0.00	0.00	6
Total	62,827	183,048	346.51	13.92	34.98	291.23	43.37	6.76	187,872
2018 UKCS CO ₂ e Emissions									
		13,200,000					43,500	50,100	14,630,000
Total fuel use CO ₂ e Emissions as a % of UKCS CO ₂ e Emissions, 2018									
		1.39%					0.10%	0.01%	1.29%

Default Emissions Factors for Gas Consumption (Ref 3)				
Emission	Turbine	Engine	Heater	Other
Gas	2.9845	2.88	2.88	2.86
CO ₂	0.00022	0.00022	0.00022	0.00022
NO _x	0.000128	0.000128	0.000128	0.000128
SO ₂	0.000128	0.000128	0.000128	0.000128
CO	0.006	0.0073	0.006	0.003
CH ₄	0.00092	0.0198	0.00099	0.00092
VOC	0.000038	0.0032	9.9E-07	0.000038

Source	Fuel use (tonnes)	CO ₂	NO _x	N ₂ O	SO ₂	CO	CH ₄	VOC	CO ₂ e
Gas (Turbines)	68,636	178,470	158.35	14.00	0.81	382.44	59.00	2.38	183,822
Gas (Heaters/Boilers, etc)	74	211	0.18	0.02	0.00	0.04	0.01	0.00	216
Diesel (Turbines)	1,049	3,355	14.16	0.23	2.10	0.98	0.03	0.31	3,417
Diesel (Heaters/Boilers, etc)	25	79	0.07	0.01	0.05	0.02	0.00	0.00	80
Diesel Engine	305	975	18.09	0.07	0.61	4.78	0.05	0.61	994
Total	65,089	193,090	190.84	14.32	3.57	388.25	59.09	3.30	188,539
2018 UKCS CO ₂ e Emissions									
		13,200,000					43,500	50,100	14,630,000
Total fuel use CO ₂ e Emissions as a % of UKCS CO ₂ e Emissions, 2018									
		1.39%					0.14%	0.01%	1.29%

Default Emissions Factors for Liquid Fuel (Ref 3)				
Emission	Turbine	Engine	Heater	Other
Gas	3.2	3.2	3.2	3.2
CO ₂	0.0155	0.0155	0.0155	0.0155
NO _x	0.00022	0.00022	0.00022	0.00022
SO ₂	0.002	0.002	0.002	0.002
CO	0.00092	0.0157	0.00071	0.00071
CH ₄	0.0000328	0.00018	7.08E-06	0.00018
VOC	0.0000265	0.0021	0.000282	0.0000265

Source	Fuel use (tonnes)	CO ₂	NO _x	N ₂ O	SO ₂	CO	CH ₄	VOC	CO ₂ e
Gas (Turbines)	68,636	178,470	158.35	14.00	0.81	382.44	59.00	2.38	183,822
Gas (Heaters/Boilers, etc)	74	211	0.18	0.02	0.00	0.04	0.01	0.00	216
Diesel (Turbines)	1,049	3,355	14.16	0.23	2.10	0.98	0.03	0.31	3,417
Diesel (Heaters/Boilers, etc)	25	79	0.07	0.01	0.05	0.02	0.00	0.00	80
Diesel Engine	305	975	18.09	0.07	0.61	4.78	0.05	0.61	994
Total	65,089	193,090	190.84	14.32	3.57	388.25	59.09	3.30	188,539
2018 UKCS CO ₂ e Emissions									
		13,200,000					43,500	50,100	14,630,000
Total fuel use CO ₂ e Emissions as a % of UKCS CO ₂ e Emissions, 2018									
		1.39%					0.14%	0.01%	1.29%

RESULT/CONCLUSIONS

NO_x and CH₄ only used in the calculation of the CO₂e emissions.
 The forecast emissions for diesel and fuel gas equate to 14.32 tonnes of N₂O emitted.
 The forecast emissions equate to 188,539.36 tonnes of CO₂e.
 The total CO₂e emissions associated with the forecast equates to approximately 1.29 % of UKCS CO₂e emissions (2018) (OGLUK, 2019).
 The total CO₂e emissions associated with the forecast equates to approximately 1.39 % of UKCS CO₂e emissions (2018) (OGLUK, 2019).
 The total CH₄ emissions associated with the forecast equates to approximately 0.14 % of UKCS CH₄ emissions (2018) (OGLUK, 2019).
 The total VOC emissions associated with the forecast equates to approximately 0.01 % of UKCS VOC emissions (2018) (OGLUK, 2019).

Equipment Name & Model	Tag No	Full year 2026 Annual Hrs	Operational Mode Assumptions
Main Gas Turbine Generator - SOLAR Titan 130 gas turbine	80-DE-001A	5950	Rated mechanical power at 10c ambient temperature, 60% humidity and 0m elevation on import fuel gas (spec as per WoSPS pipeline expected composition). All GTGs will be commissioned on diesel prior to arrival in UK waters, 1 GTG running on diesel (assumed approx 90% load based on demands of installation base load) from arrival on station up to import of WoSPS gas, commissioning of all GTGs on fuel gas & auto-switch, 2 GTGs (~70% load) running on fuel gas to support compressor commissioning, 3 GTGs (~70% load) running on fuel gas after gas export starts, diesel contingency for trips.
Main Gas Turbine Generator - SOLAR Titan 130 gas turbine	80-DE-001B	5950	
Main Gas Turbine Generator - SOLAR Titan 130 gas turbine	80-DE-001C	5950	
Main Gas Turbine Generator - SOLAR Titan 130 gas turbine	80-DE-001D	5950	
Essential Generator - MAN STX 7L27/38 diesel engine	80-DD-501	48	Commissioned before arrival in UK waters, 1 period of test run planned, contingency for unplanned events.
Emergency Generator - MTU 20V4000P63 diesel engine	84-DD-501	48	Commissioned before arrival in UK waters, 3 periods of test runs planned, contingency for unplanned events.
Auxiliary Boiler AALBORG OL 12.5T/H	55-FB-501	96	In operation before well clean up 19/10/26 thru 18/11/26 when vapour recovery in service.
Inert Gas Generator HAMWORTHY MOSS 5700m ³ /h	64-YV-501	48	
Fire Pump - CUMMINS QSK60 D(M) diesel engine	71-DD-553	12	Commissioned before arrival in UK waters, 3 periods of test runs planned for each pump
Fire Pump - CUMMINS QSK60 D(M) diesel engine	71-DD-558	12	
Fire Pump - CUMMINS QSK60 D(M) diesel engine	71-DD-564	12	
Fire Pump - CUMMINS QSK60 D(M) diesel engine	71-DD-571	12	

Run hours data for Table 4-1 in BAT Assessment and Portal SAT