

B.03.06 EMISSIONS TO AIR

Document references

ENEM-URS-FS-00-DR-ME-00056 Stack Location Drawing

P1521 Delimara Phase 1 – ADI SOx Modelling Report

P1521 Delimara Phase 2 – ADI SOx Modelling Report

As part of the development, the following guarantees for air quality and emissions to air have been provided by the contractor:

- Particulate matter emissions (PM): For the onshore section of the new facilities negligible or no PM emissions are expected, similarly negligible or no PM emissions are expected for the demobilised FSU.. When the FSU first arrives in harbour with the main boilers running on diesel oil there will be some minimal PMs.
- Sulphur oxides (SOx) emissions: Minimal SOx emissions are expected as Natural Gas from the regasification process has a low sulphur content. The concentration of total sulphur in the Natural Gas shall always be lower than 30mg/Nm³ and will on average not be greater than 5mg/kg. This sulphur content is then highly diluted with air in the GTs combustion chambers so that the concentration of sulphur in flue gases at the stacks, based on the maximum value above, shall always be lower than 10mg/Nm³ at 15% O₂ (dry basis).
- Nitrogen oxides (NOx) emissions: The emission level for NOx will be ≤30 mg/Nm³ at 15% volume O₂ dg. This value will only be guaranteed for 70-100% Gas Turbine load operating range; and
- Carbon monoxide (CO), Total Hydrocarbons (THC) & Volatile Organic Compounds (VOCs): The emission level for CO will be ≤100 mg/Nm³ at 15% volume O₂. Dg. This value will only be guaranteed for 70-100% Gas Turbine load operating range. No THC or VOC emissions are expected at normal operating conditions.

Air dispersion modelling and ambient air monitoring are currently being updated in line with the requirements for the updated Development Permit. Refer to SOx modelling report by ADI P1521 Phase 1 and P1521 Phase 2.

The CCGT has the ability to be operated in either open cycle (without the steam turbine) or in combined Cycle (with the steam turbine operating) the plant is design for base load at full CCGT output and shall generally be operate in this mode. However for the first few months whilst the steam cycle is being fully commissioned the plant will operating in open cycle. However the amount of gas required in open cycle will be the same as in combined cycle and thus the emissions will be the same, the only slight variance will be that the discharge from the bypass stacks will be at a high temperature and thus will be more buoyant.

There are three main categories of emissions relating to operations scenarios; the first being normal operating mode with the regas plant and CCGT operating; the second is as the first with an STS operation at the LNG terminal expected every six to eight weeks and the third is in an emergency case when neither the CCGT plant nor the regas plant are operational, but the relevant EGD and/or NVCC are in use.

The following table presents information on the emission sources and rated thermal input of the development in normal operation.

| Drg Ref | Flue Gas Release Point | Source | Energy Output (MWe) | NG Gross Heat Power intake at MCR (MWth) | Fuel Type | Annual Fuel Consumption (tonnes/yr) | Stack Height (m) | UTM Co-ordinates of stacks |
|---------|--------------------------------|---|---------------------|--|-------------|-------------------------------------|------------------|------------------------------|
| 1 | Main Stack 1 | GT 1 | 46 | 144 | Natural Gas | 74000 | 75 | E=459763.81; N=3965808.50 |
| 4 | Bypass stack 1 | GT1 | N/A | 144 | Natural Gas | | 30 | E=459753.82; N=3965823.29 |
| 2 | Main Stack 2 | GT 2 | 46 | 144 | Natural Gas | 74000 | 75 | E=459750.96; N=3965798.51 |
| 5 | Bypass stack 2 | GT2 | N/A | 144 | Natural Gas | | 30 | E=459739.98; N=3965813.33 |
| 3 | Main Stack 3 | GT 3 | 46 | 144 | Natural Gas | 74000 | 75 | E=459737.29; N=3965788.49 |
| 6 | Bypass stack 3 | GT 3 | N/A | 144 | Natural Gas | | 30 | E=459726.41; N=3965803.37 |
| 7 | D3 Gas reducing station boiler | D3 gas heating boilers (duty & standby) | N/A | 0.420 | Natural Gas | 78 * | 10 | E=460015.09 N= 3965653.78 |

Note * D3 GRS boilers will only be operational when there is a gas demand from D3.

During ship to ship operations, expected every six to eight weeks, and during storm mooring disconnected events the auxiliary boilers will be operational on the FSU.. During a storm mooring event the FSU auxiliary diesel genset will also operate.

| Drg Ref | Flue Gas Release Point | Source | Rated gross thermal input | Estimated running hours / yr | Fuel Type | Annual Fuel Consumption (tonnes/yr) | Stack Height (m) | UTM Co-ordinates of stacks |
|---------|------------------------|---------------------------------|---------------------------|------------------------------|-----------|-------------------------------------|------------------|-----------------------------|
| 8a | FSU Stack | FSU auxiliary boiler | 16.25 MW | 650 | NG | 1300 | 44 ASL | E=459771.98 N=3965155.31 |
| 9 | FSU Stack | Auxiliary service diesel genset | 5 MW | 120 | LSMDO | 200 | 44 ASL | E=459756.48 N=3965156.77 |

In addition to the emission sources expected during operations of the facility there are three emergency diesel generators on the site, one for the CCGT, one for the regasification plant and one on the FSU. Also in an emergency there is a non-visible combustion chamber (NVCC) in the regasification area serving the plant. None of these will be operating under normal operating regimes. Details of these emergency emissions are shown in the table below;

| Drg Ref | Flue Gas Release Point | Source | Energy Output (MWe) | Rated thermal input | Fuel Type | Estimated running hours / yr | UTM Co-ordinates of stacks |
|---------|--------------------------------------|--------------------|---------------------|---------------------|-----------|------------------------------|-----------------------------|
| 8b | FSU Spare Emergency Diesel Generator | FSU SEDG | 1.2MW | 3.6MW | Diesel | 4 | E=459767.92 3965159.89 |
| 9 | FSU Emergency Diesel Generator | FSU EDG | 150kW | 0.450 MWth | Diesel | 12 | E=459756.48 N=3965156.77 |
| 10 | CCGT Emergency Diesel Generator | CCGT EDG | 800kW | 2.60 MWth | Diesel | 12 | E=459697.65 N=3965817.67 |
| 11 | Regas Plant EDG | Regas Plant EDG | 170 kW | 0.54 MWth | Diesel | 12 | E=459991.14 N=3965291.35 |
| 12 | NVCC | 3 No. Pilot lights | N/A | 226 MWth | NG | 0 | E=459965.48 N=3965248.89 |

Note: LSMDO – Low Sulphur Marine Diesel Oil

A Natural Gas odourisation plant is not considered necessary for the proposed development as the natural gas used in the CCGT process will not be transferred to the natural gas distribution network for delivery to final consumers. Therefore, no mercaptans will be required to provide odour to the natural gas.

For details regarding fuel storage, containment and protective measures, see section B.02.03 Consumables in the Facilities of this report.

Details of the total emissions are estimated in the following table from the various emission sources.

Emissions Inventory: ElectroGas Malta LNG terminal and CCGT power plant

Template By : AECOM

Prepared by: GL

Checked by: KA

Date: 08/10/2016

| Source Name | Flue gas flow rate (kg/sec) | NOx Emissions* (mg/Nm3) | NOx Emissions (g/sec) | NOx Emissions (tn/yr) | SO2 Emissions* (mg/Nm3) | SO2 Emissions (g/sec) | SO2 Emissions (tn/yr) | CO Emissions* (mg/Nm3) | CO Emissions (g/sec) | CO Emissions (tn/yr) | PM10 Emissions* (mg/Nm3) | PM10 Emissions (g/sec) | PM10 Emissions (tn/yr) | Uncombusted HC Emissions (g/sec) | Uncombusted HC Emissions (tn/yr) | CO2 Emissions (g/sec) | CO2 Emissions (tn/yr) | Coordinates East X (METERS) | Coordinates North Y (METERS) | Stack Height (METERS) | Stack Diameter (METERS) | Stack Exhaust Temp (DEG.C) | Emission Controls DLN/SCR/FGD/ESP |
|---|-----------------------------|-------------------------|-----------------------|-----------------------|-------------------------|-----------------------|-----------------------|------------------------|----------------------|----------------------|--------------------------|------------------------|------------------------|----------------------------------|----------------------------------|-----------------------|-----------------------|-----------------------------|------------------------------|-----------------------|-------------------------|----------------------------|-----------------------------------|
| Gas Turbine Generator No. 1 | 132.6 | 30 | 3.57 | 103.56 | 1.77 | 0.190 | 5.51 | 100 | 11.90 | 345.19 | Nil | Nil | Nil | Nil | Nil | 3446.9 | 100003.5 | 459,764.81 | 3,965,808.50 | 75m a.g.l. | 2.9 | 95.3 | DLN |
| Gas Turbine Generator No. 2 | 132.6 | 30 | 3.57 | 103.56 | 1.77 | 0.190 | 5.51 | 100 | 11.90 | 345.19 | Nil | Nil | Nil | Nil | Nil | 3446.9 | 100003.5 | 459,750.96 | 3,965,798.51 | 75m a.g.l. | 2.9 | 95.3 | DLN |
| Gas Turbine Generator No. 3 | 132.6 | 30 | 3.57 | 103.56 | 1.77 | 0.190 | 5.51 | 100 | 11.90 | 345.19 | Nil | Nil | Nil | Nil | Nil | 3446.9 | 100003.5 | 459,737.29 | 3,965,788.49 | 75m a.g.l. | 2.9 | 95.3 | DLN |
| Gas Turbine Generator No. 1 Bypass Stack | 127.7 | 30 | 3.44 | Note 1 | 1.83 | 0.193 | Note 1 | 100 | 11.46 | Note 1 | Nil | Nil | Nil | Nil | Nil | - | - | 459,753.82 | 3,965,823.29 | 30m a.g.l. | 3.45 | 564 | DLN |
| Gas Turbine Generator No. 2 Bypass Stack | 127.7 | 30 | 3.44 | Note 1 | 1.83 | 0.193 | Note 1 | 100 | 11.46 | Note 1 | Nil | Nil | Nil | Nil | Nil | - | - | 459,739.98 | 3,965,813.33 | 30m a.g.l. | 3.45 | 564 | DLN |
| Gas Turbine Generator No. 3 Bypass Stack | 127.7 | 30 | 3.44 | Note 1 | 1.83 | 0.193 | Note 1 | 100 | 11.46 | Note 1 | Nil | Nil | Nil | Nil | Nil | - | - | 459,726.41 | 3,965,803.37 | 30m a.g.l. | 3.45 | 564 | DLN |
| Delimara3 GRS gas boiler No. 1 | 0.15 | 190 | 0.02 | Note 2 | 78.40 | 0.001 | Note 2 | 110 | 0.01 | Note 2 | Nil | Nil | Nil | Nil | Nil | 4 | Note 2 | 460,015.24 | 3,965,649.32 | 10m a.g.l. | 0.4 | 200 | Low NOX burners |
| Delimara3 GRS gas boilers No. 2 | 0.15 | 190 | 0.02 | Note 2 | 78.40 | 0.001 | Note 2 | 110 | 0.01 | Note 2 | Nil | Nil | Nil | Nil | Nil | 4 | Note 2 | 460,017.00 | 3,965,650.59 | 10m a.g.l. | 0.4 | 200 | Low NOX burners |
| FSU main boiler (marine oil fired)† | 5.39 | 832 | 2.34 | 0.56 | 164 | 0.44 | 0.11 | <200 | 0.50 | 0.12 | 45 | 0.16 | 0.04 | 0.01 | 0.0024 | 139 | 34 | 459,771.98 | 3,965,155.31 | 44m a.s.l | 2.1 | 167 | |
| FSU aux boiler (gas fired) (2x100) | 7.83 | 100 | 0.50 | 0.22 | 78.40 | 0.03 | 0.011 | 100 | 0.50 | 0.22 | Nil | Nil | Nil | Nil | Nil | 202 | 87 | 459,771.98 | 3,965,155.31 | 44m a.s.l | 2.1 | 330 | Low NOX burners |
| FSU Service diesel gen-set (marine oil fired)† | 3.21 | 1100 | 3.96 | 1.71 | <350 | 0.30 | 0.13 | <100 | 0.18 | 0.08 | 20 | 0.09 | 0.04 | 0.177 | 0.08 | 350 | 151 | 459,756.48 | 3,965,156.77 | 18m a.s.l | 0.52 | 465 | |
| FSU back-up Emergency diesel gen-set (marine oil fired) | 2.371 | 1931 | 6.74 | Note 4 | <350 | 0.20 | Note 4 | 416 | 1.45 | Note 4 | 277 | 0.48 | Note 4 | 0.540 | Note 4 | 258 | Note 4 | 459,771.98 | 3,965,155.31 | 44m a.s.l | 0.5 | 480 | |

Note 1: operation of the Delimara4 in open cycle is not expected after the first 6 months of commercial operation
Note 2: only when D3 is in operation
Note3: Maximum concentration of Sulphur in Natural gas is 30mg/Nm3
Note 4: It will only operate before a FSU disconnection event for about 1 hour
* Emission concentration from GTs and diesel engines are expressed at 15% O2 db. Emissions concentration from boilers are expressed at 3% O2 db.
† Estimated operating hours 120hr/yr. Emissions [Nox]~1100mg/Nm3, [Sox]<350mg/Nm3,[Dust]<20mg/Nm3 expressed at 15%O2 db
† To be decommissioned