ElectroGas Malta

ElectroGas Malta Project

Internal Emergency Plan – General Data

21st September 2016

ENEM-AEC-E0-00-RP-SE-00013 REV 02

Prepared for:
ElectroGas Malta Limited

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00	25/03/2016	First issue for comments	S Hartz Process Safety	G Cook Process/ Mechanical Team Lead	K Aplin Technical Director
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AECOM

Major Projects & PMCM
AECOM Europe, Middle East & India Region
6-8 Greencoat Place,
London,
SW1P 1PL
United Kingdom

Tel +44 (0)20 7798 5126
Fax +44 (0)20 7798 5001

www.aecom.com

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1 INTRODUCTION

1.1 Objective

Due to the large amount of LNG stored and handled (> 200 tonnes), ElectroGas' new plant is an "upper tier" establishment as defined by the Control of Major Accident Hazards Regulations that implement the Seveso Directive (Directive 2012/18/EU), so called Seveso III Directive. The Directive has been transposed into Maltese law through the Control of Major Accident Hazards (COMAH) Regulations, 2015 - L.N. 179 of 2015.

L.N. 179 of 2015, Article 10: *Every operator shall ensure that, for all upper-tier establishments:*

a) An internal emergency plan for the measures to be taken inside the establishment is drawn up;

b) The necessary information is supplied to the competent authority, to enable the Civil Protection Department to draw up external emergency plans.

[…] The emergency plans shall be established with the following objectives:

a) Containing and controlling incidents so as to minimise the effects, and to limit damage to human health, the environment and property;

b) Implementing the necessary measures to protect human health and the environment from the effects of major accidents;

c) Communicating the necessary information to the public and to the services or authorities concerned in the area;

d) Providing for the restoration and clean-up of the environment following a major accident.

Therefore, this Internal Emergency Plan (IEP) has been prepared to establish the organization, procedures and resources for responding to specific emergencies that may occur at the Delimara 4 and LNG Terminal, in order to minimise the effects of major accidents to people and the environment.

1.2 Scope

The Internal Emergency Plan is applicable to all facilities related to the Delimara 4 and LNG Terminal, the administration buildings, Employees, Contractors and Visitors. This plan is to be merged with the existing facilities of Delimara Power Station operated by Enemalta.

1.3 Distribution List

The Internal Emergency Plan is an official document and its filing, handling, replication and distribution shall be controlled by ElectroGas Malta.

The restricted distribution list is as follows:

Recipient	Contact Address	Number of copies
ElectroGas Malta Ltd (EGM)	Block D, Ta Monita Residence Piazza off St Joseph Street Marsascala	1
Armada Floating Gas Storage Malta Ltd	[TBA] Delimara Power Station Power House Marsaxlokk, Malta	1
Armada Floating Gas Services Malta Ltd	[TBA] Delimara Power Station Power House Marsaxlokk, Malta	1
ESB International	[TBA] Delimara Power Station Power House Marsaxlokk, Malta	1
Enemalta	Delimara Power Station Power House Marsaxlokk, Malta	1
Planning Authority (PA)	[TBA] Triq San Frangisk Il-Furjana, Malta	1
Occupational Health and Safety Authority (OHSA)	Edgar Ferro Street Pieta, Malta	1
Civil Protection Department (CPD)	Hal-Far Fire Station, Triq Birzebbugia Hal-Far L/O Gudja, Malta	1
Transport Malta	[TBA] Floriana, Malta	1
TOTAL		9

[TBA]: To Be Attributed

Table 1: Restricted Distribution List (CONFIDENTIAL)

1.4 General Contents

The Internal Emergency Plan consists of a suite of documents as listed in the table below:

Reference	Designation	Contents
ENEM-AEC-E0-00-RP-SE-00013	General Data	Description of the Environment Description of the Site and Installations Description of the Process Dangerous Substances
ENEM-AEC-E0-00-RP-SE-00014	Alert and Evacuation	Emergency Alert and Immediate Actions Emergency Communications Systems Alarm Systems and Procedures Escape Routes and Evacuation Procedures
ENEM-AEC-E0-00-RP-SE-00015	Containment, Detection, ESD and Fire Fighting Systems	LNG Spills Containment Systems Fire, Spill and Gas Detection Systems Emergency Shut-Down Systems Fire Fighting Systems External Fire Fighting Resources
ENEM-AEC-E0-00-RP-SE-00016	Roles and Responsibilities	Normal Operating Organization Emergency Organization Emergency Control Systems Roles and Responsibilities Off-site Emergency Organizations Incident Reporting Requirements
ENEM-AEC-E0-00-RP-SE-00019	Scenarios	Consequence Analysis Potential Domino Effects
ENEM-AEC-E0-00-RP-SE-00017	Emergency Response	Emergency Classification LNG Spill, Gas release and Fire Scenarios FSU Related Scenarios Other Scenarios (Vehicle Accident, Medical Response, Bomb Threat or Discovery of an Explosive Device, Breach of Site Security, Earthquake)
ENEM-AEC-E0-00-RP-SE-00018	Emergency Drills	Training Requirements Periodic Drills

Table 2: General Contents

1.5 Review and Update

The Internal Emergency Plan shall be submitted to review and update at least in the following cases:

- Significant modification of the installations and/or activities (facility extension, new hazardous substance, etc.);
- Incorporation of new risks analysis;
- Changes in legislative and regulation;
- Results of the different trainings and drills;
- Any subsequent amendments to improve the operability of the Internal Emergency Plan.

The HSE Manager shall implement all necessary changes and updates to the Internal Emergency Plan. He shall keep tracks and records of all changes and updates to the Internal Emergency Plan. OHSA may periodically review the Internal Emergency Plan, including any updates.

1.6 Reference Documents

The reference documents are tabulated below:

Reference	Designation	Issued by	Date
ENEM-AEC-E0-00-RP-SE-00005	Safety Report - Description of the Environment	AECOM	21/09/2016
ENEM-AEC-E0-00-RP-SE-00004	Safety Report - Description of the Installations	AECOM	21/09/2016
ENEM-AEC-E0-00-RP-SE-00003	Safety Report - Hazard Identification	AECOM	21/09/2016
ENEM-JPA-E2-00-DR-ME-00044	General Plant Layout	J&P Avax	24/03/2015

Table 3: Reference Documents

1.7 Glossary

BOG	Boil-Off Gas
CCGT	Combined Cycle Gas Turbine
CLP	Classification, Labelling, Packaging
COMAH	Control of Major Accident Hazards
CPD	Civil Protection Department
D3PP/D3PS	Delimara 3 Power Plant/Delimara 3 Power Station
D4PP/D4PS	Delimara 4 Power Plant/Delimara 4 Power Station
EGM	ElectroGas Malta Ltd
FSU	Floating Storage Unit
GRS	Gas Receiving Station
GT	Gas Turbine
HAZID	HAZard IDentification
HAZOP	HAZard and OPerability study
HP	High Pressure
HRSG	Heat-Recovery Steam Generator
HSE	Health Safety and Environment
IEP	Internal Emergency Plan
IFV	Intermediate Fluid Vaporizers
LFL	Lower Flammable Limit
LNG	Liquefied Natural Gas
LNGC	LNG Carrier(s)
MEPA	Malta Environment & Planning Authority
MMscfd	Million standard cubic feet per day
MWe	MegaWatt electric
MSDS	Material Safety Data Sheet
NG	Natural Gas
NVCC	Non Visible Combustion Chamber
OHSA	Occupational Health and Safety Authority
RGU	ReGasification Unit
RPT	Rapid Phase Transition
ST	Steam Turbine
UFL	Upper Flammable Limit
[TBA]	To Be Attributed
[TBC]	To Be Completed

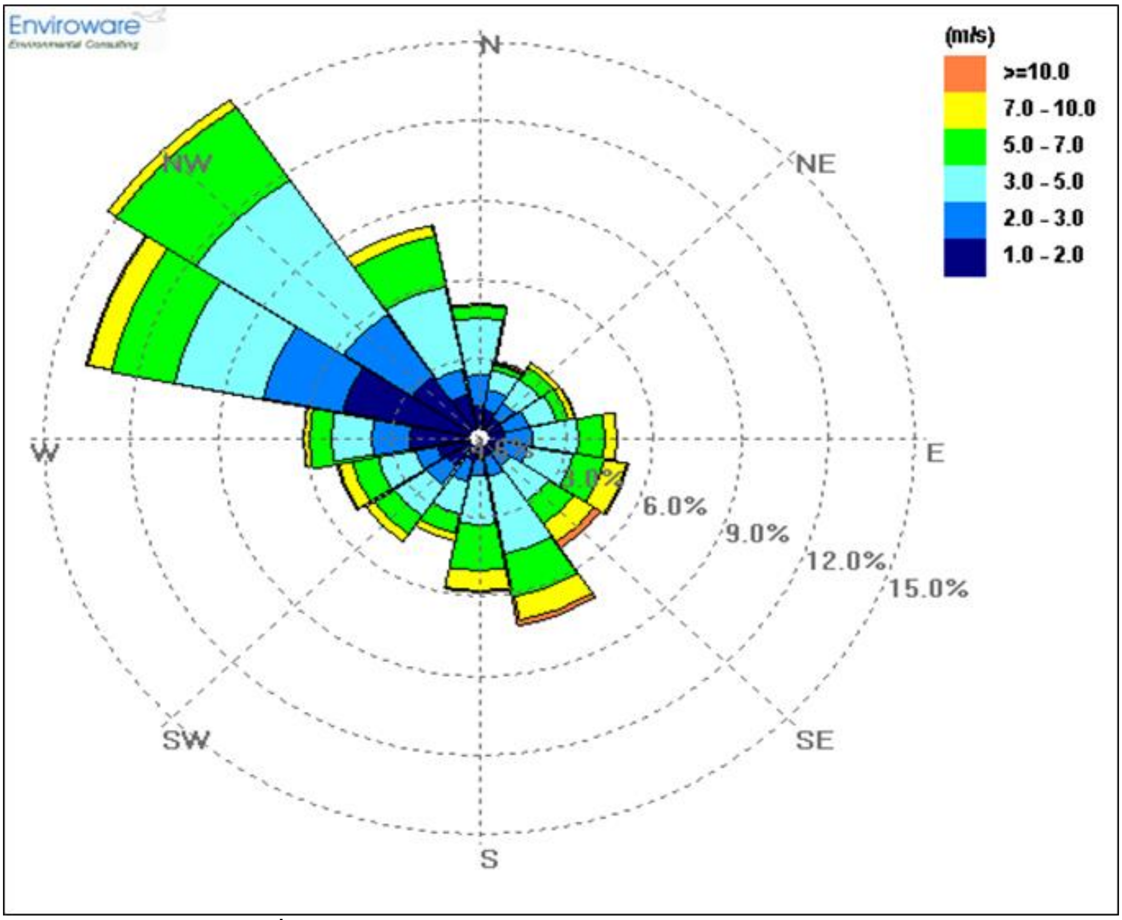
2 DESCRIPTION OF THE ENVIRONMENT

Climate data, including wind rose and weather statistics are of interest, should an incident occurs.

2.1 Climate Data

2.1.1 Wind rose

From the Żejtun meteo-station (latitude: 35.8560982, longitude: 14.5333004), which is the nearest station to the site, wind rose is reported below.



Source: Żejtun Meteo-station (2010)

Figure 1: Wind Rose

Therefore, the site is characterized by prevailing winds of medium speed with the primary direction from WNW-NW, with total occurrence of about 30% of the total on hourly basis and E-SE-SES total occurrence of more than 10% of the total on hourly basis. The other wind directions that contribute to the total are approximately 5%. The intensity of the winds is observed for higher winds from SSE with intensity more than 10 m/s. The average range is between 3.0-5.0 m/s with total occurrence of more than 30% of the total on hourly basis. The calm winds, winds with speeds less than 1m/s are recorded for approximately 5% of the annual data.

2.1.2 Weather Statistics

Weather statistics from Żejtun are tabulated in the following table, including temperatures, wind speed, humidity and air pressure values, for the last 3 year period:

Year	2014	2013	2012
Average temperature	22°C	20°C	19°C
Minimal temperature	7°C	9°C	8°C
Maximal temperature	33°C	34°C	26°C
Day average temperature	22°C	22°C	20°C
Night average temperature	13°C	18°C	17°C
Day minimal temperature	7°C	10°C	12°C
Night minimal temperature	-	9°C	8°C
Day maximal temperature	33°C	34°C	26°C
Night maximal temperature	17°C	29°C	24°C
Average wind speed	20 km/h	16 km/h	17 km/h
Maximal wind speed	50 km/h	43 km/h	37 km/h
Average humidity	61 %	65 %	68 %
Average air pressure	1001 hPa	1015 hPa	1016 hPa
Year average precipitation	569 mm		
Month with highest average precipitation	December, 109.2 mm		
Month with lowest average precipitation	May, 10.2 mm		
Average days with precipitation per annum	117.0 days		
Month with highest average days of precipitation	December, 19.0 days		
Month with lowest average days of precipitation	July, 1.0 day		

Source: Żejtun Meteo-station, Luqa meteo-station, Climatevo, weatherbase

Table 4: Weather Statistics

2.2 Land-Use

The presence of the population in the environment is important to the evaluation of scenario severity. Therefore it has been surveyed, differentiating off-site population in the Marsaxlokk Bay and on-site population within Delimara Power Plant boundaries, as shown in the following drawings.

2.2.1 Off-site Population

2.2.1.1 Residential Populations and Sensitive Buildings

The area immediately surrounding the site is mainly in agricultural use. However, few scattered residential buildings are also present close to the site, including some cottages (6), a horse farm, an historic fort and a farm in the extreme south of the Delimera peninsula.

The nearest population centre is Marsaxlokk Village which lies approximately 1 km north-west of the site, with a total area of 4.7 km^2. The village is important as a traditional Maltese fishing village. The last National Census reports that Marsaxlokk's population increased substantially after WWII, from 1,431 in 1931 to 3,366 in 2011.

The town of Birżebbuġa is located approximately 2 km west of the site, across Marsaxlokk Bay, and has a population of 10,412 persons. The town comprises a mix of residential, commercial and industrial developments.

In addition to general residential developments in Marsaxlokk and Birżebbuġa, there are a number of other sensitive buildings. These buildings mainly include primary schools and Parish churches.

2.2.1.2 Martime area

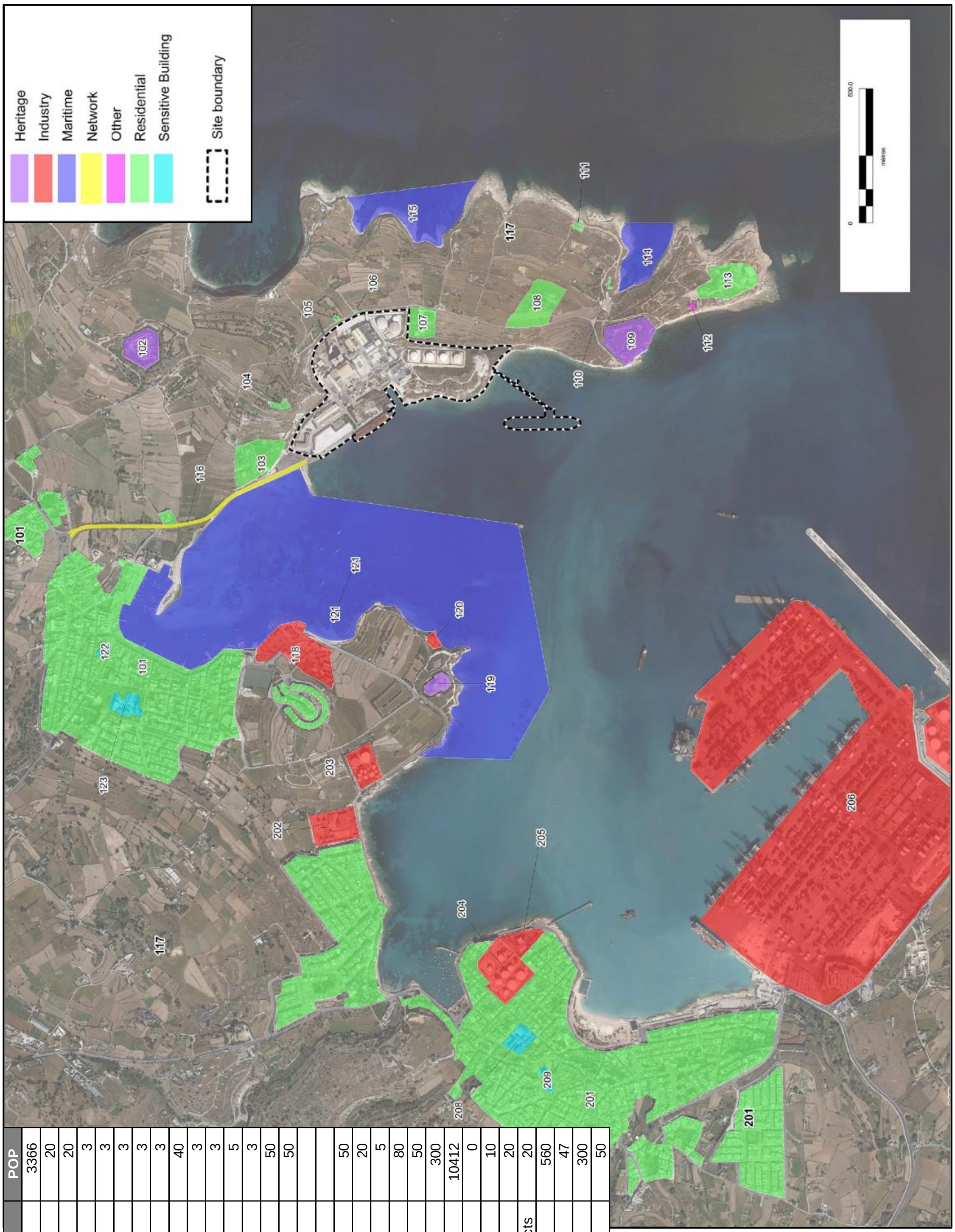
The maritime area of Marsaxlokk Bay incorporates a range of different sea uses. These include fishing with various sizes of fishing vessels operating in the area, aquaculture with a number of pens located offshore, bunkering facility and shipping and trans-shipment, with several vessels traversing the area, including vessels making use of Freeport facilities. Vessels include (in addition to fishing vessels) coasters, relatively small tankers, deep sea-going container ships, pleasure craft, and others.

2.2.1.3 Industry and COMAH Establishments

The Malta Freeport, which was set up in January 1988, is a customs free zone located around the much-developed Marsaxlokk harbour in the southern part of the Island. It lies in Birżebbuġa, on the site of the former seaplane base RAF Kalafrana.

Marsaxlokk and Birżebbuġa harbours include most of the COMAH establishments in Malta: Delimara Power Station (Marsaxlokk), 31st March 1979 Installation (Birżebbuġa), Oil Tanking Malta (Birżebbuġa, Malta Freeport), Gasco Energy (Birżebbuġa), Wied Dalam Installation (Birżebbuġa), San Lucian Oil Co. Ltd (Birżebbuġa).

The LPG storage and bottling plant at Qajjenza, previously a COMAH site, is to be dismantled in the near future.



ID	TYPE	POP
101	Marsaxlokk Village	3366
102	Historic fort	20
103	Low density residential	20
104	Low density residential	3
105	Low density residential	3
106	Low density residential	3
107	Low density residential	3
108	Horse farm	3
109	Historic fort	40
110	Low density residential	3
111	Low density residential	3
112	Light house	5
113	Farm	3
114	Swimming/craft area	50
115	Swimming/craft area	50
116	Road	
117	Agricultural land	
118	Light industry	50
119	Historic fort	20
120	Petroleum tank	5
121	Swimming/craft area	80
122	Parish church	50
123	Primary school	300
201	Birzebbugia Town	10412
202	Unused LPG storage depot	0
203	Petroleum storage tanks	10
204	Petroleum storage tanks	20
205	Importer of petroleum products	20
206	Trans shipment	560
207	Petroleum storage depot	47
208	Primary school	300
209	Parish church	50

Figure 2: Off-site Population

2.2.2 On-site Population

The Delimara Power Station is currently one of the two power stations operated by Enemalta and it is located south east of the town of Marsaxlokk along a peninsula in the southern part of Malta. The ElectroGas Malta site is located within the Delimara Power Station boundaries.

The Delimara Plant main components are:

- Two steam units with HFO-fired boiler, steam turbine and generator, for baseload operations, at 2x60 MW (called Delimara 1);
- Two open cycle gas turbines (burning diesel) and generator units at 37.5 MW, designed for peak load (called Delimara 2a);
- Two combined cycle gas turbines (burning diesel) with heat recovery steam generators and a steam turbine for midrange duties, at total capacity of 110 MW (called Delimara 2b);
- Eight medium-speed diesel engines of the Wartsila Model 18V46 as well as a steam turbine generator of the Dresser-Rand model Frame 30 (Multi Stage Impulse Condensing), designed to combust heavy fuel oil (HFO) as the main fuel and diesel fuel oil (DO) as a backup option (called Delimara 3). This installation will be converted to Natural Gas.

Fuel is delivered by tanker alongside the station and stored in the fuel tanks. The total nominal capacities of fuel storage are as follows:

- Heavy Fuel Oil: 3 tanks with a total nominal capacity of 56,710 m^3;
- Diesel: 4 tanks with a total nominal capacity of 33,884 m^3.

These are steel, fixed roof, vertical storage tanks, located towards the south of the power station.

Other HFO and Diesel day tanks are installed as a part of power plant, as buffer tanks:

- Diesel day storage tank, 140 m^3;
- HFO service tanks, 2 x 125 m^3;
- HFO buffer tanks, 2 x 125 m^3.

The HFO and Diesel facilities also comprise a combined HFO/diesel pump-house to the north of the tank farm area, and a centrifuge system where raw diesel (stored in 3 tanks) is pre-treated and transferred to the 4th tank.

Figure 3: On-site Population (within Delimara Power Station Boundaries) (CONFIDENTIAL)

3 DESCRIPTION OF THE SITE AND THE INSTALLATIONS

3.1 Location of the Site

Delimara 4 CCGT and LNG Terminal is located within the existing Delimara Power Station (DPS), approximately 1 km south east of Marsaxlokk Village, at L-Inginier, on the Delimara Peninsula. This power station is built on partly reclaimed land and commenced operations in 1991. The site is bounded to the east by a road which runs between Tas Silg Fort and Fort Delimara, at an elevation of approximately 40 m above sea level. The western boundary of the site is delineated by Marsaxlokk Bay.

The location of the site is shown in the following figures:

Figure 4: Location of the Site

Refer to **APPENDIX 1: PLANT LOCATION**.

3.2 Access to the Site for Emergency Services

In case of an incident, Emergency Services (fire brigade, ambulance, police), will access to the installation by a dedicated road which runs from outside Marsaxlokk Village, along the coast.

The default Rendezvous Point (RVP) for Emergency Services is at the Main Gate.

A second access point is provided at the south east corner of the site for emergency purposes.

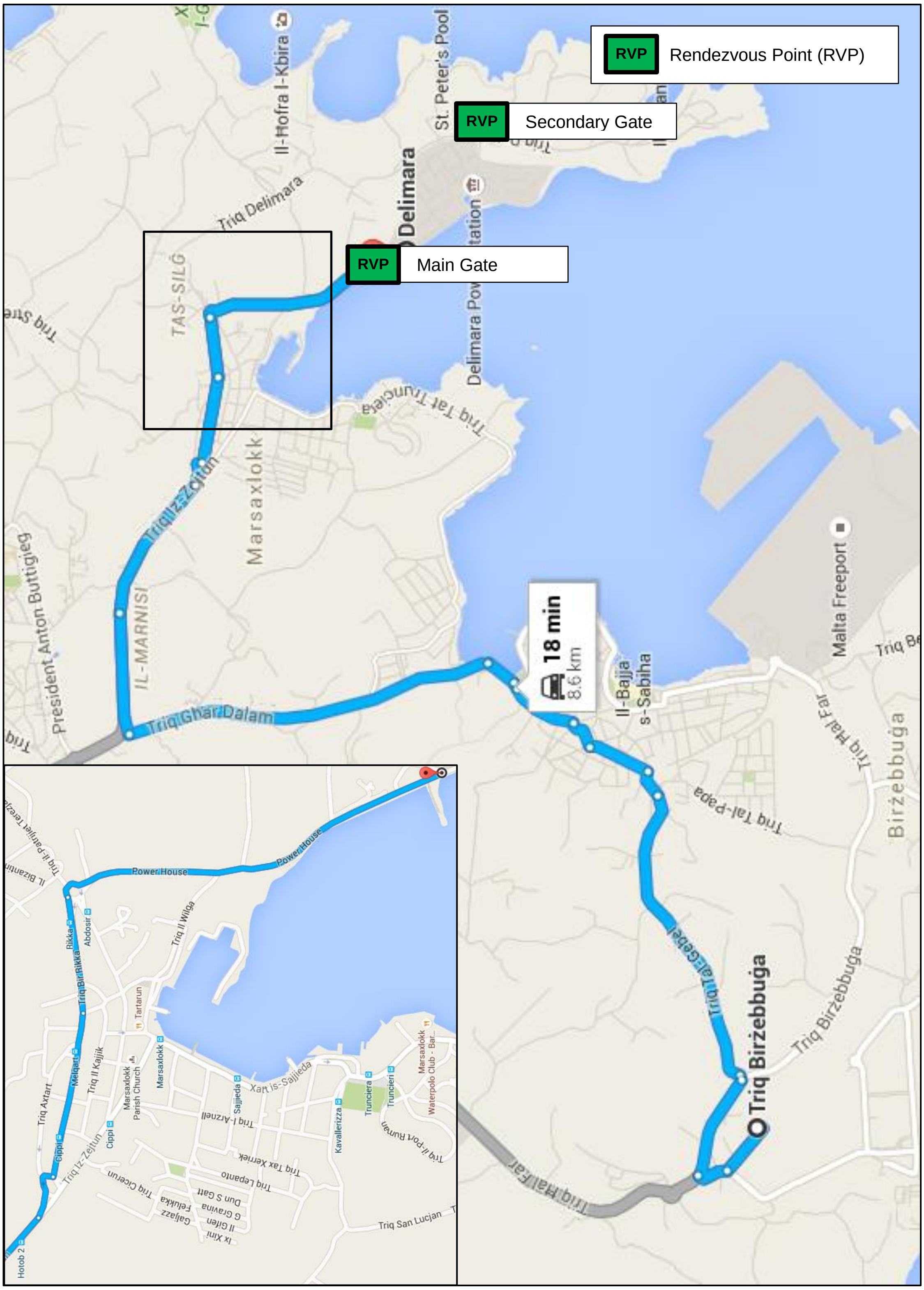


Figure 5: Access to the Site for Emergency Services (fire brigade from Hal Far Station)

3.3 Location of the Installations within the Site

The new CCGT Power Plant and LNG Terminal at the Delimara site include the following facilities, partitioned into areas:

Area	Designation	Main equipment (reference)
A1	Floating Storage Unit (FSU)	FSU cargo tanks (N°1 to 5) Existing LNG pumps (P19x, x=1 to 5) New LNG pumps (R-P29x, x=1 to 5) Spray pumps Gas compressors Existing/New liquid lines Spray line Vapour line
A2	Jetty	Jetty Central Platform: LNG unloading arm and BOG unloading hoses Jetty pier: LNG pipeline and BOG pipeline
B1	Regasification Unit (RGU)	LNG pumps suction drum (12EGA10 BB001) LNG HP pumps (12EGA20/30/40/50 AP001) Small scale LNG pumps (12EGA60/70 AP001) Intermediate Fluid Vaporizers (IFV) (12EGA80/90 AC001) LNG pumps suction/discharge lines NVCC Knock-Out drum (12EKR10 BB001) NVCC Impounding basin
B2	BOG Compressors Shelter	BOG compressors Knock-Out drum (12EKF10 BB001) BOG compressors (12EKH10/20/30 AN001) BOG compressors suction/discharge lines
B3	Regasification Control & Electrical Building and Utilities	Control & electrical building Utilites equipment: compressed air / nitrogen production BOG
C	NG Pipe Rack from Regasification to Delimara Power Plant (D3PP / D4PP)	NG pipeline WG pipeline
D	Delimara 3 Gas Receiving Station (D3PP GRS)	Filtering section, heating section, pressure reduction station and metering section
E	Delimara 4 Power Plant (D4PP)	Gas Receiving Station (CCGT GRS): pressure reduction station and metering station (50UEN01) Gas Fuel Heating System (50UEN10) Gas Turbines (51/52/53UMB01) Heat-Recovery Steam Generator (HRSG) (51/52/53UHA) Steam Turbine (50UMA) Electrical equipment: GT electrical and control modules, GT transformers, auxiliary transformers, battery modules Utility equipment: Water-glycol, demin water, closed cooling water Administration and central control building

Table 5: Location of the Installations within the Site

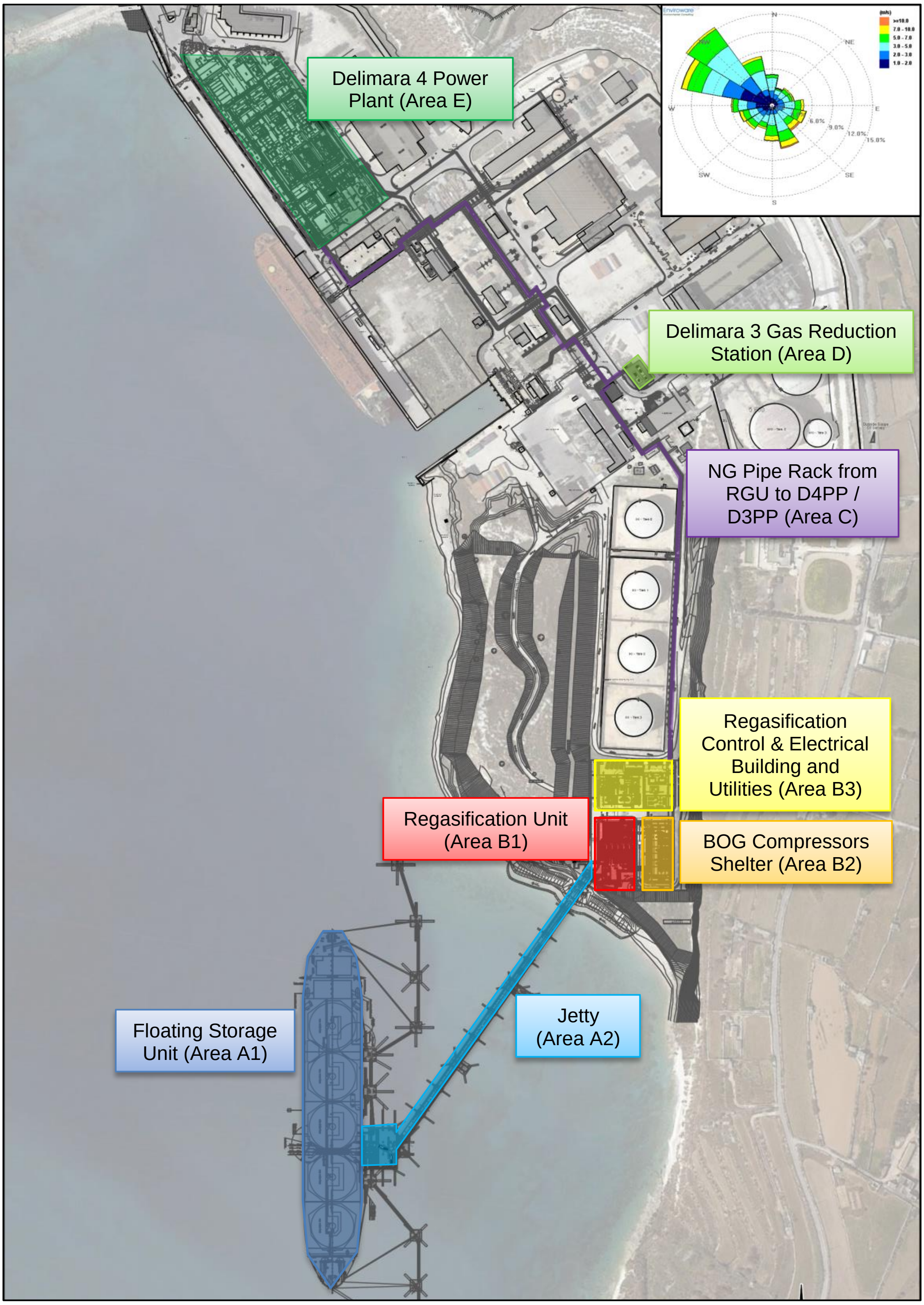


Figure 6: Installations into Partitioned Areas

Refer to **APPENDIX 2: PLANT LAYOUTS**.

4 DESCRIPTION OF THE PROCESS

4.1 General Description

4.1.1 FSU and LNG Terminal

LNG is transferred from LNG carriers (LNGC) to the new FSU through a ship-to-ship transfer system (1 LNG hose, 2 BOG hoses). The FSU is a converted LNG tanker. This tanker is consisting in 5 independent insulated Moss type tanks with a nominal storage capacity of 125 000 m^3. The tanks are made of aluminium alloy and are designed for operating at cryogenic temperatures.

The jetty provides safe berthing for the LNG carriers and the FSU in a ship-to-ship mooring configuration. The ship-to-ship mooring system will comprise 8 dolphins. This arrangement allows 180 000 m^3 capacity LNG cargo carriers to be moored alongside the FSU.

4.1.2 Regasification Plant

The LNG is transferred by in-tank pumps, as required, to the onshore regasification compound through the unloading system (1 unloading arm) where it is converted to NG for use in the new Delimara 4 CCGT and/or the converted Delimara 3 Power Plant. Since LNG is stored at cryogenic level temperature (around -160 °C), it is unavoidable that some of the LNG will evaporate during the ship-to-shore transfer process. This Boil-Off Gas is recovered, compressed and conditioned to operational pressure for use in the downstream power plants.

The regasification process includes two trains (2x100%) rated at 75.5 MMscfd each with a turndown capability of 5-100%, i.e. the regasification plant can operate at NG throughput capacities ranging from 75.5 MMscfd to 3.5 MMscfd. This turndown capability provides operational flexibility by adapting the natural gas production to the demand of the two power stations.

The heat necessary for the evaporation of the LNG is transferred from the CCGT plant and a top-up seawater heat exchanger via a propane and water-glycol closed cycle system, called Intermediate Fluid Vaporizer (2x100%). The intermediate propane closed cycle system avoids potential freezing of the water-glycol solution at all operating scenarios. The propane undergoes evaporation and condensation so as to make use of the latent heat capacity and to narrow the operating temperature window. A similar principle is adopted in conventional compressor driven refrigeration systems.

The natural gas resulting from the regasification process is clean with a high content of methane suitable for use in both the new CCGT and the converted Delimara 3 Power Plant.

4.1.3 CCGT Power Plant

The CCGT power plant includes three Siemens SGT-800 gas turbine generators which are optimized for combined cycle applications with considerable high energy exhaust resulting in high efficiency. The power plant net guaranteed power output will be 205 MWe with a net electrical efficiency of 52% at reference ambient conditions.

The working principle is common with any other state-of-the-art CCGT. Intake air is cooled and filtered in the combustion air intake system. The NG from the regasification plant is then filtered and its pressure and temperature conditioned in the CCGT GRS. The compressed air then flows to the annular-type combustor where the NG is injected and mixed with the air and the combustion takes place. The combustion gases are finally expanded in the turbine generating mechanical shaft work which is in turn converted into electricity via the generator.

The exhaust gases can be released from the gas turbines directly to the atmosphere via the 30 m high by-pass stacks during open cycle operation. This operating mode adds operational availability to the power plant and allows for flexibility.

In combined cycle operation, once the exhaust gases are expanded in the gas turbines, they are diverted to the Heat-Recovery Steam Generators (3x HRSG) where a considerable amount of the thermal energy is recovered by generating superheated steam at two different pressure levels. This steam is then expanded in a single new SST-900 Steam Turbine (ST) and additional electricity is produced in the ST generator. The ST steam outlet is finally condensed by a seawater cooling system. The exhaust gases are then discharged through the main 75 m high stacks.

4.2 Process Conditions

4.2.1 General Process Block Diagram

The general process block diagram of the Regasification Plant, comprising all main LNG and BOG/NG streams, is presented in the following figure:

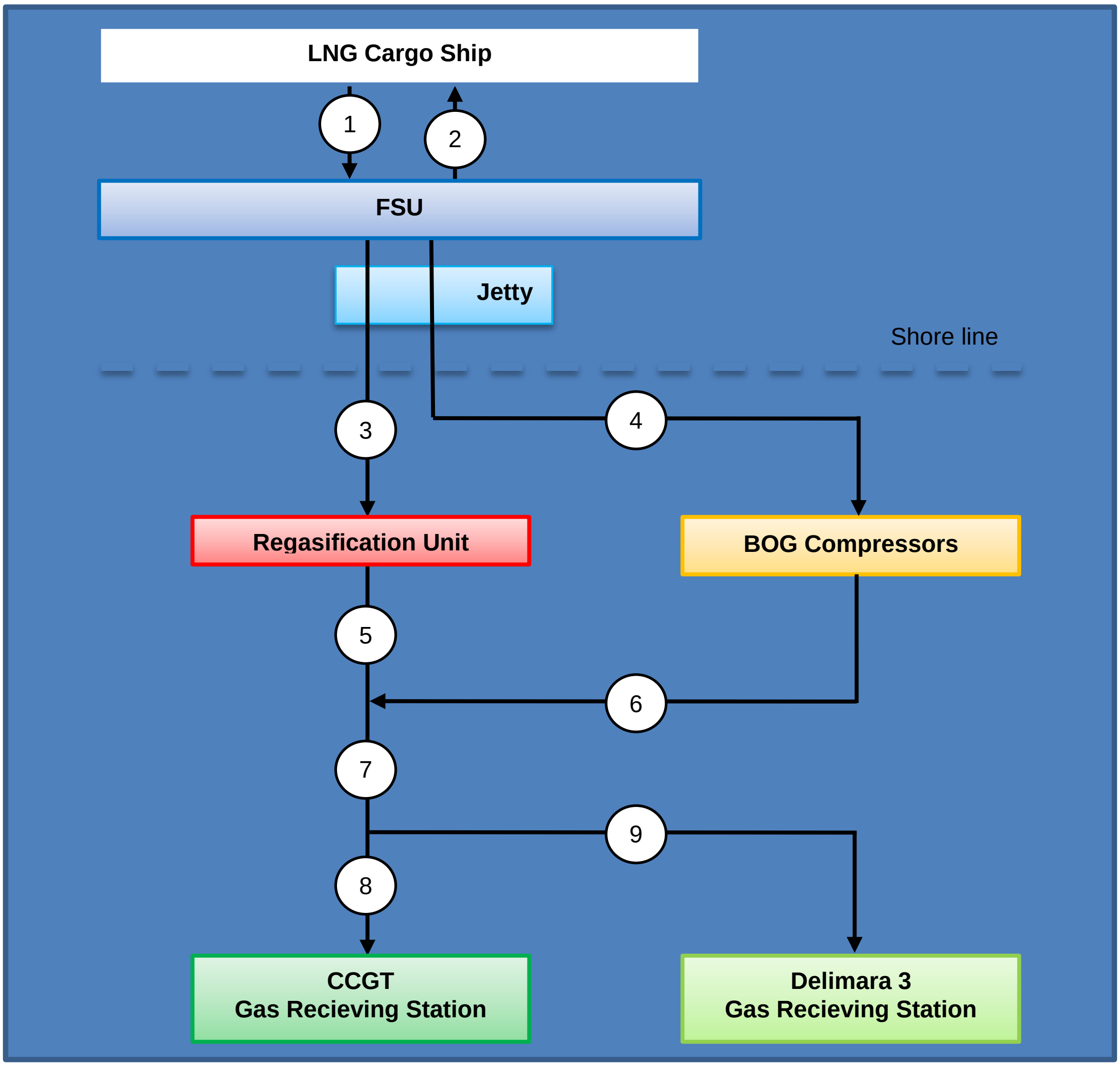


Figure 7: General Process Block Diagram

4.2.2 Material balance

The material balance, associated with the above general process block diagram, with regards to the full load operation case at ambient conditions (24°C, 65% humidity), is presented in the following table:

#	Designation	Flowrate	Operating pressure (barg)	Operating temperature (°C)
1	LNG from LNG carrier to FSU (loading operation)	4,000 - 5,000 m^3/h	-	-160
2	BOG from FSU to LNG carrier (loading operation	Depending on LNG flowrate and BOG sent to the jetty	0.12	-115
3	LNG from FSU to RGU	125 m^3/h	5	-160
4	BOG from FSU to BOG compressors	6,000 Nm^3/h (normal operation) 15,000 Nm^3/h (ship-to-ship transfer)	0.17	-115/-50
5	NG send out from RGU	69,890 Nm^3/h	37	5
6	NG send out from BOG compressors	6,000 Nm^3/h	37	15
7	Overall NG send out	75,890 Nm^3/h	37	5
8	NG to CCGT	40,370 Nm^3/h	36/31	5
9	NG to Delimara 3	35,520 Nm^3/h	36/7	5/10

Table 6: Material Balance (Regasification Plant)

4.3 LNG Compositions

The following table presents the range of LNG compositions to be received by the FSU:

Component (%mol)	Methane	Ethane	Propane	Butane	Nitrogen
Lean LNG	93.28	6.14	0.17	0.03	0.38
Rich LNG	87.53	8.34	2.18	0.78	1.17

Table 7: LNG Compositions

Out of the thirty six (36) LNG compositions provided, the above two (2) LNG compositions are selected as basis of design. The first composition (lean LNG) corresponds to the lowest possible Lower Heating Value (LHV) of LNG cargo which could be delivered to Malta, and the second composition (rich LNG) corresponding to the heaviest composition of LNG available.

4.4 Material Inventory

The material inventory, from all main equipment containing LNG, BOG/NG and propane, is presented in the following table:

Material Inventory (kg)					
#	Product	LNG	BOG/NG	Propane	
	Phase	Liquid	Gas/Vap.	Liquid	Gas/Vap.
FSU	FSU tanks	58 177 540	4 745	-	-
LNG Terminal	LNG pipeline	3 654	-	-	-
	BOG pipeline	-	101	-	-
	LNG suction drum	2 045	34	-	-
	BOG Knock-Out drum	-	26	-	-
	HP LNG pumps suction lines	997	-	-	-
	HP LNG pumps discharge lines	611	-	-	-
	IFV (E-1 Propane Vaporizer, shell side) x2	-	-	5 430	-
	IFV (E-2 LNG Vaporizer, shell side) x2	-	-	-	158
	IFV (E-2 LNG Vaporizer, tube side) x2	564	53	-	-
	IFV (E-3 NG Trim Heater, shell side) x2	-	113	-	-
	BOG compressors discharge lines	-	17	-	-
	NG pipeline to CCGT/D3PP GRS	-	1 297	-	-
	NG equipment at CCGT/D4PP GRS	-	18	-	-
	NG equipment at Delimara 3 GRS	-	23	-	-
CCGT	Fuel gas system at CCGT	-	50	-	-
	TOTAL	**55 820 786**	**12 360**	**5 430**	**158**

Table 8: Material Inventory

5 DANGEROUS SUBSTANCES

5.1 Liquefied Natural Gas and Gaseous Natural Gas

Hazards from Liquefied Natural Gas (LNG) and Gaseous Natural Gas (NG) are summarized in the following table:

Basic chemical and physical properties	LNG is Natural Gas converted to liquid form. It is liquid at approximately -160°C and atmospheric pressure. LNG is stored as a liquid only at very low temperatures and ambient pressure. It is a cryogenic liquid which means it will freeze any tissue (including a human body). LNG is odourless (if no odorising substance is added), colourless and non-corrosive. It is a mixture of methane (by far the major component), ethane, propane and butane with traces of heavier hydrocarbons and some impurities, notably nitrogen. The boiling point of LNG varies with its basic composition, but is approximately -160°C. The density of LNG varies slightly with its actual composition, from 430 to 470 kg/m^3. LNG is less than half the density of water; therefore, as a liquid, LNG will float if spilled on water. On the other hand, the specific gravity of methane in gaseous form at ambient temperature is 0.6, therefore it is lighter than air (with specific gravity of 1.0) and buoyant. As a result, natural gas will easily disperse in open or well-ventilated areas. Under ambient conditions, as LNG vaporises, the cold vapour will condense the moisture in the air, often causing the formation of a white vapour cloud until the gas warms, dilutes, and disperses. LNG vapour at the boiling point temperature and atmospheric pressure has a relative density of about 1.8, which means that when initially released, the LNG vapour is heavier than air and will remain near the ground. However as methane vapour begins to rapidly warm and reach temperatures around -110°C, the relative density of the natural gas will become less than 1 and the vapour becomes buoyant. At ambient temperatures, natural gas has a specific gravity of about 0.6, which means that natural gas vapours are much lighter than air and will rise quickly. Heat input to LNG will enhance vaporisation and dispersion. As a result, LNG vaporises up to five times more quickly on water than on land, depending upon the soil condition.
Flammability	 Natural gas is flammable but LNG (the liquid form of natural gas) is not because of the lack of oxygen in the liquid. Since LNG begins vaporising immediately upon its release from a container, the important issue is when will the vapour become flammable and for how long. The LFL for methane is 4.4% and the UFL is 16.5% both by volume in air. Outside of this range, the methane/air mixture is not flammable. Auto-ignition temperature for natural gas is approximately 600°C.
Toxicity	LNG is considered as a non-toxic substance. However, it can act as a simple asphyxiant by displacing or partially displacing the oxygen required to support life.
Stability and Reactivity	LNG is stable under normal conditions of use. Contact with heat, flames and sparks are to be avoided as natural gas may form an explosive mixture on contact with air. LNG and NG are also sensitive to static discharge: in certain circumstances these products can ignite due to static electricity.
Other specific hazards	A significant safety concern in the storage of LNG is a phenomenon called “rollover”. Rollover may occur under certain conditions as stratified LNG returns to equilibrium. Stratification occurs when the product in the tank forms into layers with different densities and at different temperatures. Sudden mixing of LNG would occur as the density of two or more of these layers approaches equality. Any heat trapped in the system is released rapidly during mixing, generating vapour to be discharged. Release of LNG into water may cause explosive boiling due to Rapid Phase Transition (RPT) where LNG is rapidly evaporated (liquid to gas).
CLP Status	Flammable gas., Category 1, Refrigerated Liquefied Gas H220: Extremely flammable gas. H281: Contains refrigerated gas; may cause cryogenic burns or injury. Not classified as a health hazard or environmental hazard under CLP criteria.

Table 9: Hazards from LNG and NG

5.2 Other Substances

Hazards from the other main substances on site are summarized in the following table:

Propane	 Propane is colourless, odourless (as no odorising substance is added) and saturated liquid under process conditions (-11.0 and 2.3 barg). It is an extremely flammable gas, with Upper / Lower Flammability Limits typically at 2.0 - 9.5 %vol. Its auto-ignition temperature is about 450°C.
Water-Glycol Solution	The water-glycol consists of 70% w/w demineralised water and 30% w/w ethylene glycol. Ethylene glycol is a colourless, practically odourless, low-volatility, low-viscosity, hygroscopic liquid. It is completely miscible with water. The freezing point of the water-glycol solution is at -13°C and the boiling point at 105°C (1 atm.). Its specific density is approximately 1.04 at process conditions. No significant hazards for health or environment are related to the water-glycol solution. No major accident scenarios are related to this preparation.
Nitrogen	 Nitrogen is not a “poison” in the traditional sense but it presents a hazard when it displaces oxygen, making the atmosphere hazardous to humans. Breathing an oxygen deficient atmosphere can have serious and immediate effects, including unconsciousness after only one or two breaths. The exposed person has no warning and cannot sense that the oxygen level is too low. No major accident scenarios are related to nitrogen.
Oils	Auxiliary transformers unit (UBE): Nytro Taurus / Insulating oil (≈ 5,3 t) Generator step up transformers (UBF): Nytro Lyra X / Insulating oil (≈ 77,5 t) Gas turbine lube oil system (UMB): MOBIL DTE 846 / Base Oil and Additives (≈ 11 m^3) Steam turbine lube oil system (UMA): MOBIL DTE 846 / Base Oil and Additives (≈ 8,5 m^3) These oils are not classified as flammable, but will burn. They are not classified as dangerous to the environment.

Table 10: Hazards from Other Substances

Refer to **APPENDIX 3: MATERIAL SAFETY DATA SHEETS**.

Figure 8: Location of Dangerous Substances (LNG and NG) (CONFIDENTIAL)

6 BIBLIOGRAPHY

#	Title	Author	Date
1	Emergency Planning for Major Accidents	Health and Safety Executive	First published 1999 Reprinted 2009

Table 11: Bibliography

APPENDIX 1: PLANT LOCATION

ENEM-AEC-E0-00-DR-SE-00005	Project Location Project Layout

APPENDIX 2: PLANT LAYOUTS (CONFIDENTIAL)

FSU

2779-90-PG-DR-00001-00	General Plant Layout (**CONFIDENTIAL**)

FSU

ENEM-FSU-FS-00-GD-MT-00001	Side by Side Arrangement (**CONFIDENTIAL**)
ENEM-BAB-FS-00-DR-MT-00004	General Arrangement (**CONFIDENTIAL**)

Delimara LNG Regasification Terminal

ENEM-JPA-E2-00-DR-ME-00057	Central Loading Platform Mechanical Arrangement Drawing (**CONFIDENTIAL**)
47067567-1022_06	Regasification (**CONFIDENTIAL**)
ENEM-JPA-E2-00-DR-CE-00177	(Delimara 3) LNG Regasification Terminal Plot Plan (**CONFIDENTIAL**)

Delimara 4 Power Plant

MT1001-UZ-CLD103-444911146_B	General Layout Arrangement Drawing (**CONFIDENTIAL**)

Note: All these drawings are to be revised "As Built".

APPENDIX 3: MATERIAL SAFETY DATA SHEETS

Liquefied Natural Gas
Propane
Ethylene Glycol
Nitrogen
Nytro Taurus (Insulating oil)
Nytro Lyra X (Insulating oil)
MOBIL DTE 846 (Turbine oil)
UNIREX N 3 (Grease)