

Brincat Anna at Parlament-MT

From: Ryan Fava <ryan.fava@enemalta.com.mt>
Sent: Tuesday, 20 June 2023 18:19
To: Brincat Anna at Parlament-MT
Cc: Darren Carabott
Subject: RE: [External] - Re: Request for information by PAC
Attachments: Papadakis.Report_1.pdf; Qualitative-Risk-Assessment - SGS Italia - 2013.pdf; EPD-Report-2.pdf

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Sinjura Brincat,

Referenza ghal- email li rcivejt qieghed naghmel anness b'referenza ghal-dokumentazzjoni relatat ma' LNG storage.

Qieghed naghmel referenza ukoll ghall-applikazzjoni ta' ippjanar kif ukoll r-riferenza ta' ERA hawn taht imsemmija:

PA File No.: PA/00021/14 and PA/00022/14

ERA Reference: EA/00014/13

Project Title: Delimara Gas and Power – CCGT (Combined Cycle Gas Turbine Power Plant) and LNG (Liquified Natural Gas) Receiving, Storage and Regasification Facilities, at, Delimara, Marsaxlokk

<https://era.org.mt/era-project/delimara-gas-and-power-Ing/>

Nittama li l-informazzjoni sottomessa hi ta' ghajnuna.

Inselli ghalik,

Ryan

Ing. Ryan Fava

Chairman | Enemalta plc

T: +356 22980555 | E: ryan.fava@enemalta.com.mt | W: www.enemalta.com.mt



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From: Brincat Anna at Parlament-MT <anna.brincat@parlament.mt>

Sent: Thursday, June 15, 2023 9:48 AM

To: Ryan Fava <ryan.fava@enemalta.com.mt>

Cc: Darren Carabott <carabottdarren@gmail.com>

Subject: [External] - Re: Request for information by PAC

Inġ. Ryan Fava
Chairman, Enemalta

Fil-laqgħa tal-Kumitat Permanenti dwar il-Kontijiet Pubbliċi, li saret nhar it-Tlieta 13 ta' Ġunju 2023, iċ-
Chairman talab sabiex Enemalta ttiprovdi kwalunkwe rapport tekniku li jindika li l-storage facility tal-LNG
kellha ssir offshore.

Din l-informazzjoni għandha tasal għand il-Kumitat sal-laqgħa li jmiss, li hija skedata għal nhar it-Tlieta 20 ta'
Ġunju.

Nirringrazzjak u nselli għalik.

Anna Brincat

Clerk for Public Accounts Committee
Standing Committee for the Environment, Climate Change and Development Planning
National Audit Office Accounts Committee

t: +356 25596308 e: anna.brincat@parlament.mt | www.parlament.mt

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HOUSE OF REPRESENTATIVES
PARLIAMENT OF MALTA
FREEDOM SQUARE, VALLETTA, MALTA

**PRELIMINARY STUDY FOR THE DEVELOPMENT OF CONSULTATION ZONES IN DELIMARA
PENINSULA**

**LNG PROJECT CONSULTATION ZONES FOR LAND USE PLANNING IN THE VICINITY OF
DELIMARA POWER STATION AND THE NEW STORAGE AND REGASIFICATION FACILITIES IN
MARSAXLOKK BAY**

LUP RISK ANALYSIS

Confidential Document

Draft Report 01, Rev.1

Issue 1, February 2014

GAP ANALYSIS S.A.

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1 Project Background

Enemalta Corporation, the main producer of electricity in Malta, plans the construction and operation of a Liquefied Natural Gas (LNG) import terminal and associated Regasification Unit in order to operate a new Combined Cycle Gas Turbine (CCGS), high efficiency Natural Gas Power Plant. The facilities will be located in Marsaxlokk Bay close to existing ENEMALTA Delimara Power Station facilities (DPS).

The final option of LNG facilities, selected by Electrogas Malta Consortium, included a Floating Storage Unit (FSU) permanently moored in the southern part of the harbour and a Regasification Unit (R/U) onshore. The plant is regarded an “Upper Tier SEVESO” establishment according to the Control of Major Accident Hazards (COMAH) Regulations¹.

For purposes of fulfilling the land-use planning and environmental permitting requirements ENEMALTA submitted a Preliminary Quantitative Risk Assessment (QRA) Report and Damage Zones Study (SGS, Dec. 2013) for the preconstruction phase of the selected proposal (Option B) for LNG facilities. Taking into account the current needs to integrate the results of submitted safety studies in planning decisions as well as in view of updating Marsaxlokk Bay Local Plan, Maltese COMAH Competent Authorities in collaboration with Enemalta launched a project for the development of a guidance document supporting planning policy framework and implementing the Land Use Planning (LUP) objectives of SEVESO II Directive.

The present study adopts a consistent and systematic risk based approach aligned with practices used by European Competent Authorities and Bodies controlling major accident hazard risks and international organizations (RIVM, HSE etc.), in EU Member States. The results of the study aim at providing advice on applications for Land use planning permission and the development of consultation zones in the vicinity of Delimara Power Station and the new LNG storage and regasification facilities in Marsaxlokk Bay.

The present report summarizes the results of the study.

¹ The latest version of the ‘Seveso’ Directive (Directive 2003/105/EC, which amended Directive 96/82/EC) is transposed into Maltese law through the Control of Major Accident Hazards (COMAH) Regulations - L.N. 37 of 2003 and as amended by L.N. 6 of 2005. The Competent Authority is the Occupational Health and Safety Authority (OHSA) together with the Malta Environment and Planning Authority (MEPA) and the Civil Protection Department of the Ministry for Home Affairs and National Security (CPD).

2 Objectives

The purpose of the present study, titled “LUP RISK ANALYSIS” (LUP RA), is to provide a risk based decision-support tool for the development of Consultation Zones (CZs) in Delimara area. The LUP RA study addresses the needs of Maltese COMAH Competent Authorities (OHSA, Environment Protection Directorate of MEPA and Civil Protection Department) as well as of Enemalta Corporation, to combine and integrate the results extracted from risk assessment studies performed for both major accident hazard establishments located in Delimara: the existing Delimara Power Station and the new LNG Storage and Regasification facilities in Marsaxlokk Bay.

The main objective is to incorporate the results of Risk Analysis performed for the new LNG project in the identification and delineation of CZs in the area.

3 Risk Analysis (RA) approach

The new LUP RA is based on data derived from Hazard Analysis performed in previous safety studies for both COMAH establishments. Consequence Assessment and Quantitative Risk Assessment are performed in the present study to assess the risk for the individuals associated with the major accident hazard industrial establishments in Delimara area.

The analysis is structured in two phases. In the initial phase a Consequence Assessment (physical effects modeling) is performed in order to evaluate the consequences of major accidents following the Loss Of Containment (LOC) of a substantial amount of dangerous substances involved in the safety critical units of the COMAH establishments.

Concerning the proposed new LNG storage and Regasification facilities, the Worst Case Scenarios (WCSs) are selected for large releases of LNG and Natural Gas, the physical effects involved are modeled and the adverse consequences of such WCSs scenarios are assessed. The LUP RA addresses major accident hazards of all the safety critical units and equipment involved in the design of the new LNG project including storage, unloading, processing and transfer of LNG in both liquid and gaseous states. At the current stage of the study, all design, technical and operational data concerning the involved safety critical equipment were drawn from previous safety studies of the LNG terminal [10] [11]. Detailed design data and operational conditions of the involved safety critical units used in the present study, are presented in Section 8 of this report.

As regards the existing establishment of Delimara Power Station, the results of the consequence assessment performed in the COMAH Safety Report for the major releases of liquid fuels and for fires, are extracted from the Safety Report and incorporated in the present analysis without any modifications or updating [1] [8]. The results of consequence assessment for both major hazard establishments have been incorporated in the QRA performed in the second phase of the present study.

In the second and concluding phase, a Quantified Risk Assessment- QRA study is performed and the Location Risk of individuals in the region is evaluated. The new QRA performed for LUP purposes, is based on the results of consequence assessment performed at the first phase of the study and the list of selected LOC frequencies and probabilities (ignition, stability classes, wind roses, etc)².

The deliverables of the current version of the study, are the plots of the Individual Risk Contours (Location Risk) on appropriate background maps of the region. The Individual Risk Contours are depicted for the WCSs of major accidents as examined for both COMAH establishments. The results could thus be combined with specific LUP criteria e.g. PADHI system [4], to support the identification and development of CZs in the region of Delimara.

The present LUP RA study can be used as a basis for future QRA studies that would take into account the “as built” technical and safety data e.g. PIDs, safety systems and procedures, operation, shut down, maintenance and emergency procedures, etc. Review and updating of the present LUP RA study should be performed when specific technical information concerning construction and operational procedures is available and at the detailed engineering phase of the LNG project.

The implemented HSE Management System of the operator should also be incorporated in future QRA studies in order to demonstrate that:

- The safety measures (preventing, controlling, and mitigation) are appropriately implemented and the major accident risks are kept as low as reasonably possible and within acceptable limits, and
- The emergency response measures are sufficient and effective to handle all major accident hazards so as the public is exposed to no extra risks due to the operations of the new LNG plant.

General limitations

As not specific QRA criteria have been established in Malta until today, the present study uses frequencies, risk assessment and risk acceptance criteria (based on individual risk) with cut off values adopted by HSE UK (PADHI system [4]), HSA Ireland [5], the Dutch authorities [9] and other relevant QRA references. The present report uses as main reference the HSE LUP methodology [4] and the Purple Book Guideline for QRA [9].

The detailed Safety and Fire protection Systems as will be implemented have not been taken into account in the present analysis. It is proposed that reliability data of safety critical equipment, detection and response time of emergency measures should also be taken into account in future versions of QRA. This will provide further risk based arguments for diminishing the risk of the LNG terminal considering the efficiency of safety and emergency measures implemented.

² Concerning the Delimara Power Station, the fire frequencies regarding the liquid fuels used in the current version of the study, have been incorporated in the present analysis without any modifications or updates, as included in the existing Safety Report of the site [1].

4 Methodological steps of the study

The practice applied for the development of the present study includes the following steps:

- Review of available technical data provided at the preconstruction phase of the LNG facilities including the Regasification Unit (R/U) and the Delimara Power Station establishment;
- Adoption and determination of available technical and design data for the LNG terminal, loading/unloading and R/U facilities;
- Collection and elaboration of regional meteorological data for the definition of weather classes;
- Identification of Worst Case Scenarios (WCSs) of major hazard accidents. Concerning the LNG terminal, the WCSs have been identified in the present study based on the design characteristic and operation conditions of the safety critical equipment involved in the LNG storage terminal, R/U and gas transmission lines. Concerning the existing Delimara Power Station, the WCSs, the consequence assessment and the event frequency data have been adopted without modification from the COMAH Safety Report of the Delimara Power Station.
- Consequence assessment of the WCSs identified for the LNG facilities using the EFFECTS 9.0/TNO software. The model parameters have been adjusted to the design and operation data of the LNG terminal.
- Quantitative Risk Assessment (QRA) performed for the LNG terminal and R/U facilities is based on the results of consequence assessment achieved in the present study and the event frequencies and probabilities adjusted to the available design features and operation conditions of the proposed LNG terminal. The ultimate output is the plot of Iso-Risk Contours on map of the region (Individual Risk). For the development of the Iso-Risk Contours plots the simulation models of Riskcurves 9.0/TNO 2012 software were used.

The results of the present QRA study can be used in parallel with risk acceptance criteria in order to develop Consultation Zones and support Land Use Planning purposes.

5 List of safety critical units and equipment

The safety critical units and equipment of the new LNG terminal are analytically presented in Section 8 of the present report. The safety critical units and equipment examined in the present study include:

- The LNG tanker (unloading to the FSU)
- The ship to ship LNG unloading arms or hoses (from Tanker to the FSU) including the Gas return arms or hoses (from FSU to the Tanker)
- The FSU (Floating Storage Unit)
- The ship to shore LNG unloading arms or hoses (from FSU to the jetty) including the Gas return arm or hose (from Jetty to FSU)
- The Jetty LNG pipeline (from unloading arm/hose to the secondary pump)
- The Regasification Unit (R/U) located onshore, including at least the following safety critical equipment and their connecting pipes :
 - Secondary pumps
 - Vaporizers
 - Compressor (including the jetty pipeline from FSU to Compressor)
 - Liquefier / absorber (including the jetty LNG return pipe to the FSU)
 - Metering station and odourization
- The Gas pipeline from RU to the Metering Station
- The Gas pipeline from the Metering Station to the Combined Cycle Gas Turbines in the Natural Gas Power Plant.

For the safety critical equipment the Worst Case Scenarios have been studied. To this end, major LNG and gas releases are examined, following the catastrophic rupture of equipment and of pipes, by considering loss of containment (LOC) at full capacity and at operational conditions.

The only dangerous substance examined for the LNG terminal and R/U is LNG and natural gas. For simulation purposes and risk assessment modeling the chemical substance used is Methane.

6 Description of the Environment

6.1 Location of the Delimara Power Station

Enemalta Power Station (P/S) is located approximately 1 km south east of Marsaxlokk Village, at Llnqinier, on the Delimara Peninsula [1]. The P/S 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 40m above sea level. The western boundary of the site is delineated by Marsaxlokk Bay. The location of the installation is shown in Figure 6.1.

The site is semi-enclosed in a crescent shaped hollow and is partly screened from Marsaxlokk Village by the Rdum-il-Bies headland, which rises to 50m. Access to the installation is provided by a dedicated road which runs from outside Marsaxlokk Village, along the coast. A second access point is provided at the south east corner of the site for emergency purposes. The power station occupies an area of approximately 184.500 m², from which approximately 103.500 m² has been reclaimed from the sea [1].

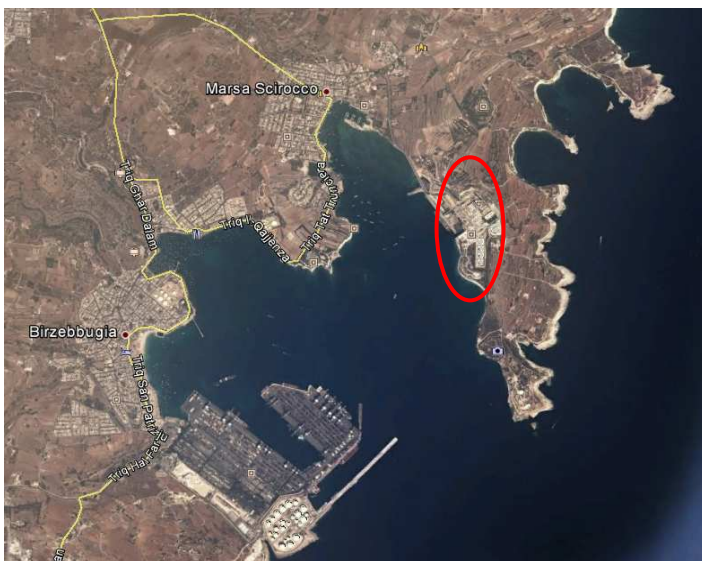


Figure 6.1: Delimara Power Station in Malta

6.2 LNG Terminal

The proposed new LNG terminal will be located in the Marsaxlokk Bay, close to the existing ENEMALTA P/S facilities in the Delimara peninsula, onshore, on reclaimed land, and offshore in the harbor. Specifically according to the approved proposal (Option B), an LNG Floating Storage Unit (FSU) will be permanently moored in the southern part of the harbour and a Regasification Plant (RU) onshore without any clearing of the hill [10].

The site is bounded on the east side by the Delimara Peninsula, on the north side by the existing facilities owned and operated by ENEMALTA and on the west by the coastline to be modified. The access to the proposed facilities is a public road that runs in a North-South direction, bordering the coastline and currently stopping at ENEMALTA entrance. In the future, this road should be enlarged up to the entrance of the LNG terminal. The area of concern, as well as the proposed site, is presented in the Figure 6.2.



Figure 6.2: The proposed location of the main units of the LNG terminal : FSU and RU [10]

6.3 Land Uses

The site proposed for the new LNG terminal is designated in the Marsaxlokk Bay Local Plan as part of the existing ENEMALTA facilities, being the adjacent area mainly dedicated to agricultural use, with a few isolated buildings. The description of land uses in the vicinity of the establishments is presented in the Figure 6.3 and the Delimara Power Station is clearly indicated with red outline [10].

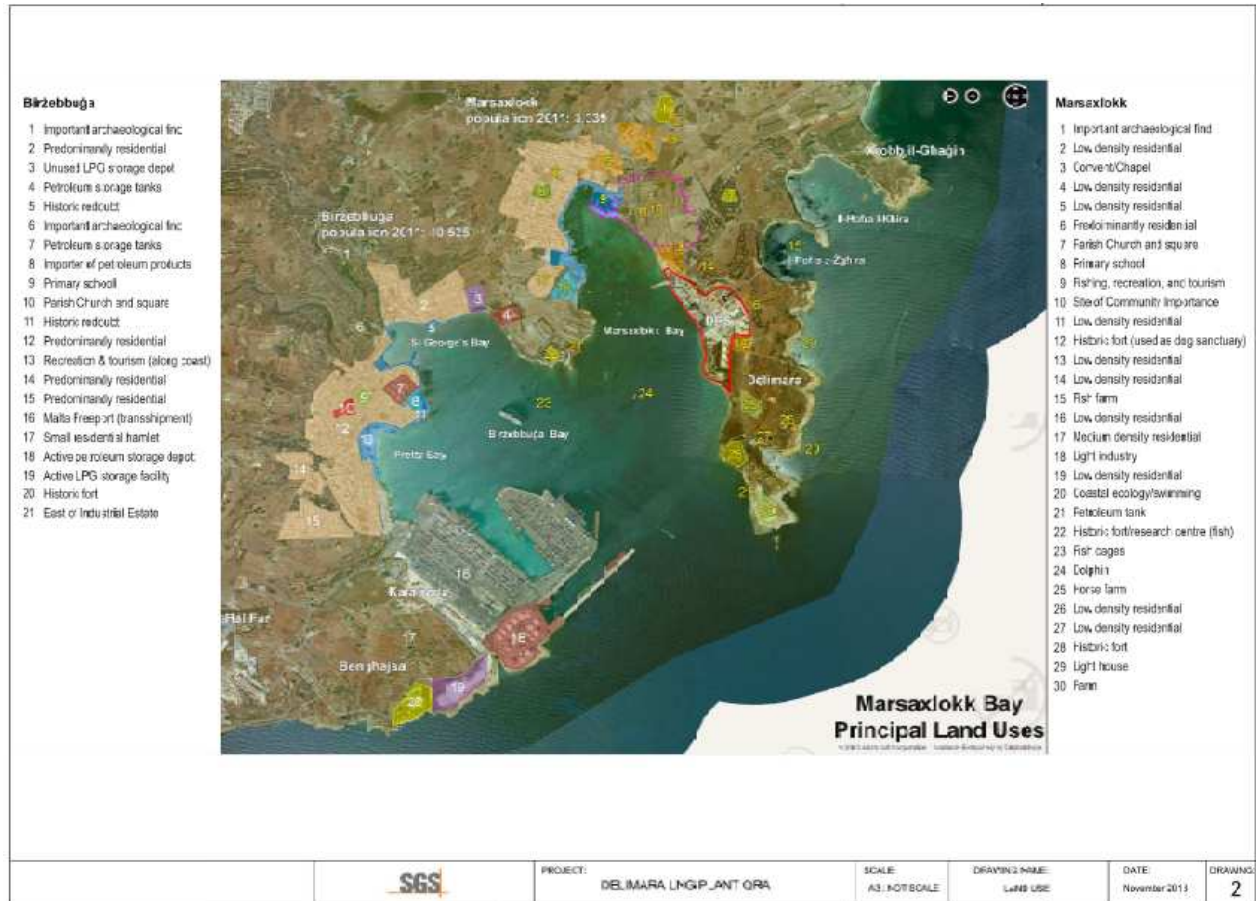


Figure 6.3: Land Uses in the vicinity of hazardous establishments [10]

7 Meteorological data

7.1 Development of Pasquill stability classes for Delimara region

Meteorological data are necessary to perform the simulation of atmospheric dispersion of gas clouds and risk assessment calculations based on wind rose data and weather stability classes. Meteorological data can be expressed in terms of Pasquill classes. The Pasquill stability classes describe the amount of turbulence Meteorological data present in the atmosphere and range from “A” to “F” class. Stability class “A” corresponds to ‘unstable’ weather, with a high degree of atmospheric turbulence, as would be found on a bright sunny day. Stability class “D” describes ‘neutral’ conditions, corresponding to an overcast sky with moderate wind. A clear night with little wind would be considered to represent ‘stable’ conditions, denoted by stability class “F”.

Stability classes “D” and “F” are commonly used in Risk Assessment and QRA studies as representative of the neutral and stable weather conditions in the site location.

The Pasquill stability classes were derived from the available meteo data of Delimara region. Meteorological data were obtained by Malta International Meteo Office (Benghajsa Station) and Enemalta Delimara Meteo Station. The data obtained from Benghajsa Meteo station, cover the area of the Freeport / Birzebbugia and refer to the period 2006 to 2012. The data obtained from Delimara Meteo Station cover the area of Delimara Peninsula and Marsaxlokk Bay and refer to the period 2010 to 2013. The meteo data include observations in terms of year, month, date, hour (24 hours), and on the wind direction and the wind speed (8760 records per year).

The analytical meteo data collected (in total 35.040 records from Delimara Meteo Station for a 4year period: 2010-2013 and 26.280 records from Benghajsa Meteo station for a 3year period: 2011-2013) were elaborated in the present study in order to produce the actual weather stability classes applicable in the region of Delimara LNG terminal. To this end, the Pasquill- Gifford stability method was applied with the following inputs (recorded data):

- Horizontal wind speed
- Cloud cover
- Ceiling height, and
- Time of observation

Data on cloud cover of the examined region were obtained by Malta International Airport (data from Luqa Station for the years 2010 to 2013). Moreover, the solar elevation angle was recorded for 24hour observations in terms of year, month and date for Malta Longitude (35° 54') and Latitude (14° 31')³.

The following matrices were used as guideline for the identification of stability classes in Delimara area based on local meteo records.

³ <http://keisan.casio.com/exec/system/1224682331>

PASQUILL- GIFFORD STABILITY CATEGORIES

Surface Wind (Measured at 10 m) (m / s)	Day Incoming Solar Radiation** (Insolation) (Strong)	Day Incoming Solar Radiation** (Insolation) (Moderate)	Day Incoming Solar Radiation** (Insolation) (Slight)	Night * (Thin Overlast or >= 4/8 cloudiness*)	Night * (<= 3/8 cloudiness*)
< 2	A	A-B	B	F	F
2 - 3	A-B	B	C	E	F
3 - 5	B	B-C	C	D	E
5 - 6	C	C-D	D	D	D
6	C	D	D	D	D

Table 7.1: Pasquill-Gifford Stability Categories

* Night is defined as the period from 1 hour before sunset to 1 hour after sunrise.

** Appropriate Insolation categories have been determined through the use of sky cover and solar elevation information according to the following matrix.

Sky Cover (Opaque or Total)	Solar Elevation Angle > 60 °	Solar Elevation Angle < 60 ° but, > 35 °	Solar Elevation Angle < 35 ° but, > 15 °
4/8 or less or, Any amount of High Thin Clouds	Strong	Moderate	Slight
5/8 to 7/8 Middle Clouds (700 ft. - 16000 ft. base)	Moderate	Slight	Slight
5/8 to 7/8 Low Clouds (Less than 700 ft base)	Slight	Slight	Slight

Table 7.2: Sky Cover-Solar Elevation matrix

In the QRA study, at least six representative weather classes should be used, covering the several stability conditions such as stable, neutral and unstable, as well as several wind speeds from low to high. The number of wind directions should be at least eight.

To limit the calculation time for QRA a number of representative groups of stability classes have been derived. To this end, the following matrix (Table 7.3) of six class groups (B_{med} , D_{low} , D_{med} , D_{high} , E_{med} and F_{low}) vs. wind speed intervals was applied to the collected meteorological data [9].

Wind speed	A	B	B/C	C	C/D	D	E	F
< 2.5 m s ⁻¹	B medium			D low			F low	
2.5 – 6 m s ⁻¹				D medium			E medium	
>6 m s ⁻¹				D high				

Table 7.3: Allocation of observation into six weather classes [9]

The available data were separated in night-time and daytime. The period of the day attributed to daytime should have the day-time and night-time statistic added accordingly. The mean average day-time fraction for Malta was considered to be 54% of total time [10].

The Pasquill-Gifford stability method and the Purple Book guidelines for allocation of observations into six weather classes, have been implemented using the collected meteo data of Delimara area.

The obtained average frequency distributions of weather classes, regarding data obtained by Delimara Meteo Station for the years 2010-2013, are presented in Table 7.4 for 12 wind directions and 6 weather classes. Direction 346-015 corresponds to wind coming from the North and is indicatively presented with Wind Sector 0 (degrees). The average wind speed per weather class equals to the average wind speed of all observations in each class.

Weather Stability Classes							
Wind Direction	B medium	D low	D medium	D high	F low	E medium	Total
0,00	1,35%	0,20%	0,74%	0,03%	3,08%	0,20%	5,61%
30,00	0,46%	0,01%	0,00%	0,00%	1,02%	0,00%	1,49%
60,00	0,34%	0,01%	0,00%	0,00%	0,75%	0,00%	1,10%
90,00	2,62%	0,24%	1,25%	0,09%	1,49%	0,45%	6,14%
120,00	5,05%	0,36%	3,31%	0,89%	1,88%	0,99%	12,48%
150,00	2,53%	0,16%	2,12%	0,68%	1,84%	0,54%	7,88%
180,00	5,15%	0,46%	1,61%	0,23%	1,57%	0,50%	9,51%
210,00	2,69%	0,31%	1,78%	0,37%	1,42%	0,39%	6,97%
240,00	0,97%	0,22%	1,37%	0,65%	1,47%	0,51%	5,18%
270,00	1,07%	0,15%	2,08%	0,80%	2,42%	0,55%	7,07%
300,00	2,60%	0,32%	5,81%	6,00%	4,80%	2,20%	21,72%
330,00	3,19%	0,42%	2,88%	1,39%	5,50%	0,00%	13,38%
Total stability contribution %	28%	3%	24%	11%	28%	6%	100%
Average Wind Speed per stability class [m/sec]	2,2 (B)	2,2(D)	4,4 (D)	7,4 (D)	0,9 (F)	3,2 (E)	

Table 7.4: Stability classes break down per wind direction and average wind speed.

In order to examine the possible changes of the derived stability classes through the years the distribution of their occurrence was evaluated for the period 2010 to 2013, and presented in the following Figure 7.1.

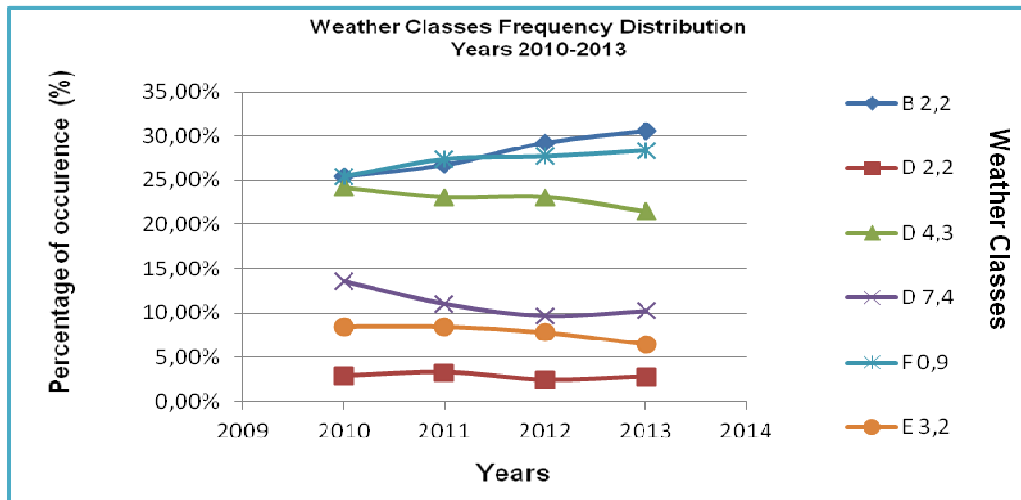


Figure 7.1: Weather Classes Frequency Distribution

According to results of the present analysis based on data derived from Delimara Meteo Station, the following conclusions can be extracted:

- Weather classes F, D and B are those with the highest occurrence in the 4 year period examined. Their mean average values are 28%, 24% and 28% respectively
- There are no substantial variation in the contribution (occurrence) of the classes through the years 2010-2013
- The average wind speeds in this period for the prevailing classes are F 0.9 m/s, D 4.3 m/s and B 2.2 m/s
- D stability class has a total contribution of 38% (D_{medium} 24% with an average wind speed of 4.3m/s, D_{high} 11% with 7,4 m/s and D_{low} 3% with 2.2 m/s). D stability class can thus be accurately represented by an overall average wind speed of 5 m/s (D5)
- F stability class has a total contribution of 28% with an average wind speed of 0.9m/s. F stability class can thus be conservatively represented by an overall average wind speed of 2 m/s (F2).

It is acceptable practice in QRA studies to consider the stability classes A to D to be represented overall by D stability class, and the stability classes E and F to be represented overall by F class. In such case, the observed meteo data can be represented overall by D class with an average wind speed of 4 m/s (D4) and by F class with an average wind speed of 1,3 m/s (F1,3).

In conclusion, the analysis above indicates that the selection of representative weather classes D5 and F2, is in consistency with the elaborated Meteo data, correctly representing the weather conditions of the region and providing an appropriately conservative approach for the risk assessment.

7.2 Verification of selected weather classes

The results of the above analysis concerning weather classes distribution, average values of wind directions and wind speeds were also compared to further data obtained from both Meteo Stations (Delimara and Benghajsa) and the consistency of the outcomes was verified.

An indicative Wind Rose from Delimara Meteo Station is presented in Figure 7.2 demonstrating that the results of Table 7.4 comply with the distributions wind speeds and wind directions, as specified in the wind rose for the year 2013.

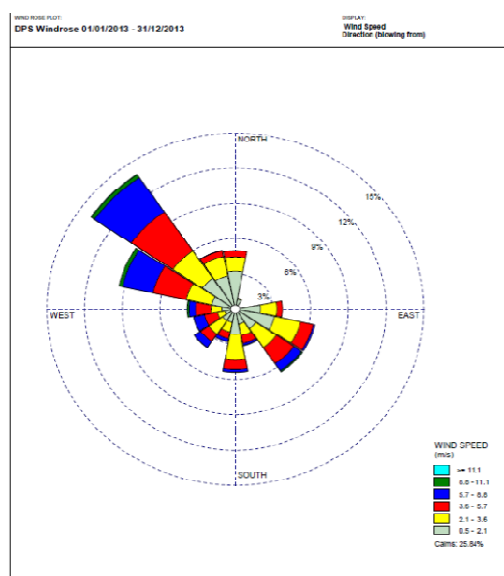


Figure 7.2: Delimara Wind Rose Year 2013

Additionally an analysis of meteorological data obtained by the Benghajsa Meteo station regarding a period of 7 years (2006-2012) was performed. The data include daily average records (observations) for wind speed and wind directions (365 days per year).

In Table 7.5 the wind speed intervals (< 2.5 m/s, 2.5 to 6m/s and > 6m/s) are presented for the 7year period examined. In Figure 7.3 the values are graphically presented in order to illustrate their variation over the years.

Wind Speed m/sec	2006	2007	2008	2009	2010	2011	2012	7 year Average %
< 2,5	37 %	35 %	45 %	44 %	24 %	38 %	38 %	38%
2,5 - 6	58 %	58 %	50 %	53 %	70 %	57 %	57 %	58%
> 6	5 %	5 %	5 %	3 %	5 %	5 %	5 %	5%

Table 7.5: Percentage of observations for all wind directions (0-360 degrees), Benghajsa Meteo Station.



Figure 7.3: Variation of selected wind speed intervals, Years 2006-2012, Benghajsa Meteo Station.

According to Figure 7.3, high wind speeds (>6m/s) remain constant and with a very low contribution (~5%) over the 7 years examined. Low and medium range wind speeds exhibit fairly constant contribution over the years with no obvious tendencies. In general, low and medium range winds show lower speeds in the years 2008 and 2009, and somehow higher speeds in 2010.

The results obtained by both Meteo stations (Benghajsa and Delimara) are in striking agreement for the examined wind speed (WS) intervals (especially for the medium range wind):

- WS < 2.5m/s (38% vs. 30%) ,
- 2,5 < WS < 6 m/s (58% vs. 59%) and
- WS > 6m/s (5% vs. 11%).

The present analysis indicates that the selection of representative wind speeds of 5 m/sec for D stability class and 2 m/sec for F stability class, is in consistency with the observations from both Meteo stations. Conclusively, the collected meteo data for the past 7 years have been elaborated and analysed so as to determine broad wind speed and weather stability classes. This allows the risk assessment to calculate risk at representative weather conditions for the LNG terminal location. It is postulated that the weather profile of the last 7 years will not exhibit substantial changes within the next years and thus can provide a solid reference to future predictions.

The results of the above analysis support the selection of representative weather classes D5 (average wind speed of 5 m/sec for D stability class) and F2 (average wind speed of 2 m/sec for F stability class) as the prevailing weather stability classes in the examined region for the coming years. For simulation modelling and Risk Assessment purposes stability classes D5 and F2 are thus considered to be consistent with the observed meteo data and to satisfy a conservative approach for all possible consequences of worst case accident scenarios examined.

7.3 Weather Classes Profile in QRA

The meteorological data set contains probabilities for typical weather classes (Pasquill stability class, wind-speed, day or night) occurring at the location of Delimara. The weather classes determine the damage definitions contained in QRA.

The weather classes profile as developed for the purposes of the LUP RA study, according to the analysis presented in section 7.1 and 7.2 above, is presented in Table 7.6 and Figure 7.4 below.

Day Probability Distribution: MALTA DELIMARA AREA YEARS 2010 2011 2012 2013					
Probability [%]	B2.2 Day	D2.2 Day	D4.4 Day	D7.4 Day	
Wind sector (from)	%	%	%	%	
0	2,49	0,37	1,08	0,04	
30	0,85	0,02	0,00	0,00	
60	0,62	0,02	0,00	0,00	
90	4,85	0,45	1,56	0,06	
120	9,34	0,66	3,76	0,92	
150	4,68	0,30	2,55	0,70	
180	9,54	0,85	2,27	0,26	
210	4,97	0,58	2,41	0,44	
240	1,79	0,41	1,74	0,73	
270	1,99	0,28	2,84	1,19	
300	4,82	0,59	7,12	7,70	
330	5,90	0,77	3,86	1,70	

Night Probability Distribution: MALTA DELIMARA AREA YEARS 2010 2011 2012 2013					
Probability [%]	D4.4 Night	D7.4 Night	F0.9 Night	E3.2 Night	
Wind sector (from)	%	%	%	%	
0	0,34	0,03	6,70	0,44	
30	0,00	0,00	2,21	0,00	
60	0,00	0,00	1,62	0,01	
90	0,88	0,12	3,25	0,98	
120	2,78	0,85	4,10	2,16	
150	1,61	0,66	4,00	1,18	
180	0,83	0,18	3,40	1,08	
210	1,05	0,29	3,08	0,85	
240	0,93	0,55	3,19	1,10	
270	1,18	0,34	5,27	1,19	
300	4,26	4,01	10,40	4,77	
330	1,73	1,14	12,00	3,25	

Other Information	
Main program	Riskcurves 9.0.17.8052

Table 7.6: Probabilities of Delimara Weather Classes (Day/Night)

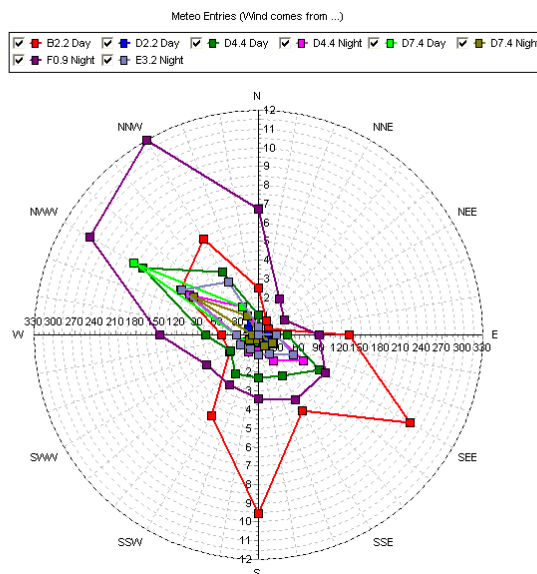


Figure 7.4: Wind Rose for Weather Classes in Delimara Area

8 Selected design and operational data of LNG terminal for the Risk Assessment

LNG Tanker

LNG sea transport is carried out with large LNG carriers with a capacity of up to 250,000 m³. Tankers of Standard class with a capacity of 125-150,000 m³ are assumed to be used for loading the FSU of the LNG terminal.

The parameters assumed for the LNG tankers are as follows [10] :

- Capacity: max. 125,000 m³ to 140,000 m³ (Moss, spherical tanks not bigger than 31250 to 35000 m³ each)
- Vapour return gas at -151°C
- LNG discharge pressure: 3 to 4 barg at ship manifold

Considering that the total Maltese consumption rate is approximately 2440 m³ LNG /day (~100/h or ~12 kg/s), the number of tanker visits and the FSU reloading is estimated to vary between 7 and 8 times per year. The visiting LNG tanker would be moored to the FSU.

Ship to ship unloading by arms or hoses (Tanker to FSU)

The LNG transfer from the visiting tanker to the FSU can be carried out through 2 LNG unloading 12'' arms each capable of unloading 4,000 m³/h of LNG and one 12'' vapour return arm, all operating at 4 barg. Total unloading rate is estimated at 8000 m³/h.

The unloading is assumed in the present study to be carried out through 4 flexible hoses, 10'' diameter, each capable of unloading ~1500 m³/h of LNG and one 10'' vapour return hose, all operating at 3 barg. Total unloading rate is estimated at approximately 6000 m³/h.

According to the above data, unloading may last for up to 24 hours. For a total 8 tanker visits per year, the probability at which the tanker is expected to be present in the port and moored to the FSU is approximately 2-3% in a year.

LNG is discharged by the visiting ship pumps to either one or more of the FSU storage tanks. The tanks BOG (boil-off gas) is sent back to the tanker via the return gas arm or hose for displacement gas supply during unloading and to the BOG compressors where it is compressed for re-condensation in the liquefier.

Floating Storage Unit (FSU)

The FSU storage capacity is assumed, for the study purposes, to be 125,000 m³ (e.g. 4 spherical tanks of 31,250 m³ each). The FSU is going to be permanently moored to the jetty (8760 hours per year).

FSU to onshore Regasification Unit

The LNG transfer from the FSU to the onshore pipelines (jetty) can be carried out through one 6" arm unloading 200 m³/h of LNG and one vapour return arm, all operating at 4 barg. Total unloading rate is estimated at 200 m³/h.

The unloading is assumed in the present study to be carried out through one flexible hoses, 10" diameter (or 8"), unloading ~145 m³/h of LNG and one 10" (or 8") vapour return hose, both operating at 3 barg. Total unloading rate is estimated at approximately 150 m³/h.

Jetty

The jetty allows permanent mooring of the FSU and provides permanent services to the ship. The LNG pipeline on the jetty connects the FSU unloading arm or hose to the onshore secondary pump. The 4" LNG pipeline operating at 4 barg is assumed to be 300m long.

Primary (LP) and secondary (HP) pumps

The LNG is pumped from the FSU storage tanks by primary or low pressure pumps located in several wells inside the tanks and submerged in the liquid. The liquid is passed, directly or indirectly through an absorber, to the high pressure pumps (HP pumps) which is assumed to feed the vaporizers at 47.5 barg.

Regasification Unit R/U

The Regasification Unit and all its equipment is assumed to be sited onshore at the indicated location to the south of the existing hill in the pathway to Delimara Power Station. The R/U includes the following safety critical equipment :

- Secondary pumps (operating at 47.5 barg with 6" connecting LNG pipes to R/U)
- Vaporizers (with 1,5 " tubes operating at 45 barg)
- Compressor (operating at 15 or 38 barg with 6" connecting Gas pipes to Liquefier)
- Liquefier (operating at 6 barg with 4" connecting LNG pipes to FSU through the jetty)
- Metering station (10" Gas pipeline from R/U to metering station operating at max 45 barg)

The battery limit conditions are assumed 35 barg with a minimum temperature of 5 °C.

Boil Off Gas treatment in the FSU

During tanker unloading a part of the vapour displaced in the FSU tanks is sent back to the tanker by means of return gas line through the boil-off header, the vapour return line and the 10" vapour arm (or 12" vapour hose) at 0,03 barg and -151 °C. Excess boil-off gas from FSU is transferred through a 6", 300m long pipe to boil-off compressors.

Metering station and odourization

Before export to the CCGT plant, the gas passes through the gas metering station at 35 barg. The exact route from the metering station to CCGT is not known at the present stage. The metering consists of two parallel metering lines. The gas is odourized at the metering station

and thus any gas leakage preceding the odourization unit cannot be detected through olfaction.

9 Consequence Assessment

9.1 LNG facilities

All the safety critical equipment of the proposed LNG terminal and R/U facilities have been examined for their major accident hazards due to their LNG and natural gas content. The Worst Case Scenarios were identified by analyzing the catastrophic failure of the safety critical equipment involved in the whole process of LNG storage, loading/unloading, vaporization and transfer including Gas process and delivery.

The potential releases of LNG and natural gas due to possible catastrophic failure of the safety critical equipment are analysed for each case separately. To this end, safety critical vessels and pipeline inventories are reviewed for their hold up. The possible LNG or gas release following catastrophic failure of equipments are analysed for the Worst Case Scenarios. All identified WCSs are presented in Section 9.2.

The main parameters, conditions and limitations of the analysis involved in the consequence assessment are presented in the following Sections 9.1.1 to 9.1.3. An overview is provided below on the main assumptions made for the examined system, the LNG and gas releases, the physical phenomena expected such as LNG pools and their evaporation on water, and the evaluation of the adverse consequences of possible Pool fires, Flash Fires and Gas explosions.

The results of consequence assessment analysis have been incorporated in the present QRA study.

9.1.1 Main Parameters of the Analysis

The main parameters involved in the analysis, include:

- The conditions of liquid and gas; operating conditions of LNG storage : -161°C at 0.03 barg; for LNG streams -161°C at 3 to 4 barg; for natural gas streams -151°C at 0.03 barg and - 5 °C to 20 °C at 15 to 45 barg;
- The volume capacity of the equipment and pipelines (diameter, length, filling degree);
- The inventory of LNG or gas in the equipment or pipe involved as calculated according to the density of LNG and of compressed gas at the operational conditions of the equipment examined e.g. 0.03 barg for storage ; 3-4 barg for unloading; and 15 or 45 barg for gas transfer.
- The hole opening and hole location on the equipment or the pipes, for which the releases of LNG and of gas have been calculated (breach size, release rates). For pipes FBR (Full bore ruptures are considered);
- The pumping rate or static head driving the release;

- The release duration; release duration for tanks assumed to be until empty, for pipe ruptures release duration assumed 2 min, and for hoses 10 s.
- The surface on which LNG is released and evaporated (sea or land);
- The evaporation rates of LNG; in large scale LNG experiments (spills on water) the evaporation rates were recorded as high as 0.15 Kg/s m²;
- The size of LNG pools; depends on the combination of release rate and evaporation rate;
- The Surface Emissive Power; in large scale Natural Gas fires was recorded higher than 200 kW/m²;
- The ignition probability of gas cloud and time to ignition; ignition probability has been derived according to the presence of ignition sources and delayed ignition of 2 min has been assumed;
- The failure frequency of equipment and pipes and the frequency of releases e.g. tanker collision, FBR of hoses/pipes, etc, have been determined for each safety critical part by application of generic frequency data. The frequency data and relevant probabilities have been derived based on the following guidelines:
 1. the Purple Book RIVM [9],
 2. the HSE FRED (Failure Rate and Event Data) contained within the Planning Case Assessment Guide [6],
 3. LNG QRA studies: LNG Delimara QRA, SGS 2013 [10] & LUP QRA Shannon Ireland, ERM 2007 [2].

All frequencies and event probabilities have been appropriately adjusted to the available design features and operation conditions of the proposed LNG terminal.

- Risks of collision of the loading Tanker and FSU have been considered based on general Marsaxlokk port traffic data [10]. A detailed analysis (marine study) should be performed with actual data e.g. vessels traffic data, routes and maneuvering, etc.

9.1.2 Releases of LNG and Gas

The Worst Case Scenarios examined for the safety critical equipment of the terminal comprise 13 sets of major accident scenarios that address the following LNG and Gas releases.

- The release of LNG to the sea from the Tanker after collision of vessel with the Tanker and hole opening in the LNG tank bottom and walls (small and medium size holes of 500 mm, 1000mm diameter). Development of LNG pool on the sea surface, LNG evaporation and development and dispersion of gas cloud;
- The release of LNG to the sea after rupture of the ship to ship unloading arms or hoses. Development of LNG pool on the sea surface, LNG evaporation and development and dispersion of gas cloud;
- The release of Gas, development and dispersion of gas cloud after rupture of the gas return arms or hoses (from FSU to the Tanker);
- The release of LNG to the sea from the FSU after collision of vessel with FSU and hole opening in the LNG tank bottom and walls (small and medium sizes: 500 mm,

- 1000mm). Development of LNG pool on the sea surface, LNG evaporation and development and dispersion of gas cloud;
- The release of LNG to the sea after rupture of the ship to shore unloading arms or hoses. Development of LNG pool on the sea surface, LNG evaporation and development and dispersion of gas cloud;
 - The release of Gas, development and dispersion of gas cloud after rupture of the gas return arm or hose (from Jetty to FSU);
 - The release of LNG to the sea after rupture of the Jetty LNG pipeline. Development of LNG pool on the sea surface, LNG evaporation and development and dispersion of gas cloud;
 - The release of LNG on land in the area of R/U (development of LNG pool, LNG evaporation and development and dispersion of gas cloud) after pipe rupture of the : Secondary pumps, Vaporizers and Liquefier
 - The release of LNG to the sea (development of LNG pool, LNG evaporation and development and dispersion of gas cloud) after the rupture of LNG return pipe to the FSU (on the jetty);
 - The release of Gas, development and dispersion of gas cloud after pipe rupture of the Compressor, of the pipeline from FSU to Compressor (on the jetty); and,
 - The release of Gas, development and dispersion of gas cloud after rupture of the Gas pipeline from R/U to the Metering Station and from the Metering Station to the Combined Cycle Gas Turbines in the proposed Natural Gas Power Plant.

9.1.3 Physical Phenomena characteristics

With reference to the Worst Case Scenarios the phenomena of POOL FIRES, FLASH FIRES and Vapour Cloud EXPLOSIONS have been examined for LUP purposes. Jet Fires have not been examined in the present study since immediate ignition of releases is a remote probability assuming that the areas within the boundaries of the Regasification Unit, the FSU location including loading/unloading, are ignition free (ATEX classified).

The consequences of POOL FIRES, FLASH FIRES and Vapour Cloud EXPLOSIONS have been evaluated using the EFFECTS 9.0 /TNO software. To this end, a number of assumptions have been made concerning the characteristics of the physical phenomena examined such as: the development of LNG pools and evaporation of LNG on water, ignition of evaporated gas and Pool fires, Gas cloud dispersion, Delayed ignition of dispersed gas cloud and Flash fires or unconfined gas cloud explosions.

LNG Pools and LNG evaporation

- LNG pools can be sustained for a reasonable time period (e.g. longer than 2 min) when the LNG release is semi-continuous and it lasts for at least 2 minutes with a release rate higher than the evolving evaporation rate.

- An instantaneous release of a large amount of LNG can also create a liquid pool. Instantaneous LNG releases on land are not expected in the area where the secondary pump and the RU is located. Instantaneous release of LNG on water is simulated as a semi-continuous liquid release at very high rates e.g. following the catastrophic rupture of an LNG tank (or even of the unloading Arms/ Hoses) at the Tanker (Unloading Vessel) or the FSU.
- LNG pools on water is likely to develop nucleate boiling due to high heat transfer rates at the free or rigid interfaces. Free interfaces are assumed to be the upper and lower boundaries of a horizontal LNG layer on water. Rigid interface are assumed to be the lower boundary of an LNG layer on ice when ice is formed at the free surface of water.
- Evaporation rates for nucleate boiling of LNG have estimated to be as high as 0.14 to 0.2 kg/m²s. Such high evaporation rates have been obtained in large scale experiments for large releases of LNG on water [12].
- For a given LNG release rate, the size of LNG pool area (before vapour ignition) heavily depends on the evaporation rate of the pool. Lower evaporation rates can sustain larger pools and vice versa.
- LNG pools on water are assumed to develop very high evaporation rates and limited pool surface areas. It is therefore postulated that the extent of LNG pools on water is controlled by the heat transfer rate at the lower interface of LNG layer.
- Very high LNG evaporation rates can also be obtained at rigid interfaces of thermally conductive materials when heat transfer is carried out at constant temperature (very high temperature difference). Simulation performed for evaporation of LNG layer on metal surfaces at constant temperature (e.g. 0° C or temp. difference of 161 ° K) provides excellent results for the inevitably high evaporation rates obtained with LNG spills on water. Such high evaporation rates have been obtained in large scale experiments with large release of LNG on water [12].
- Evaporation rates of LNG pools on soil or concrete are much lower than those on water (i.e. one order magnitude lower) and are normally controlled by the heat transfer rate established at the lower interface of the LNG layer with subsoil.

Pool Fires

- A pool fire requires the formation of an open LNG pool developed either on water surface or on land and the ignition of the evaporated cloud at concentrations higher than LFL (flammable cloud).
- Vapour ignition sources can be activated at locations either inside the maximum area of the LNG pool or within an extended area where the flammable cloud is dispersed (for a specified time period of 2 min). The ignited dispersed cloud will in turn ignite the vapour above the pool and generate a pool fire.

Gas Cloud dispersion and ignition

- A gas cloud can be generated either by evaporation of an LNG pool or by a large gas release.

- A natural gas cloud is assumed to be neutral after being well mixed with air and its dispersion is simulated as Neutral Gas at real weather conditions.
- The weather stability classes examined have been derived from elaboration of past 7 years meteo data, for Delimara region. The main outputs of the meteo data analysis are: F 1,3 m/s and D 4 m/s for weather stability classes and average wind speeds (see analysis in Section 7).
- In the present study a conservative approach has been adopted for the principal weather classes and average wind speeds. For purposes of cloud dispersion modeling the weather stability classes F2 and D5 have been considered as principal.
- The generated natural gas cloud is assumed not to be immediately ignited, since the examined release points and areas e.g. within the boundaries of the Regasification Unit, the FSU location including loading/unloading, are assumed to be “ignition free”.
- Immediate ignition is not considered in the present study and since possible jet fires at the release source are not examined.
- A natural gas cloud generated by a large LNG or gas release, if not immediately ignited, can be dispersed as far as 200-300m away from the release point within 2 min under F2 weather conditions. Larger distances can be documented when gas clouds are allowed to disperse for longer periods or at different weather conditions.
- The relief of the area (ground roughness) where the cloud is dispersed plays an important role to the resulting cloud dimensions. The present study adopts a conservative approach for the cloud dispersion and since flat terrain (open sea surface) has been assumed.
- The generated natural gas cloud is assumed to be ignited 2 min after its dispersion from release point has started. A delayed ignition is assumed based on potential ignition sources located in the vicinity of the LNG terminal at a distance of up to 700m.
- The locations and frequencies of potential ignition sources have been assumed in appropriate ignition zones around the FSU and R/U sites. The average ignition probability used in the study, $P_{\text{delayed ign}} = 0.33$ to 0.38 , was derived for an overall distance of 700m away from FSU in all directions. The derived figure for delayed ignition of natural gas clouds compares well with figures used in relevant studies [2] although conservative if compared with figures extracted from the literature (e.g. 0.02 to 0.09).
- The result of the delayed cloud ignition is a Flash Fire or an Explosion of the explosive mass of cloud. The ignited cloud is assumed in turn to ignite the vapour above the pool and to generate a Pool fire if a pool of LNG still exists. The average probability of a LNG pool ignition was derived to be $P_{\text{del ign PF}} = 0.33$ while that of clouds, $P_{\text{del ign FF}} = 0.38$.
- Given the ignition of the gas cloud the probability of Flash Fire is taken as 60% while that of an explosion as 40%. Explosions are considered to be medium strong deflagrations. This is a conservative assumption, since explosions of unconfined natural gas clouds are not, as of today, well documented in the literature.
- Extended clouds are examined as unconfined (up to 8% confinement) while clouds of limited extension as semi-confined (up to 30% confinement). This conservative assumption is taken to account for gas clouds that may get confined in the area of R/U or within the P/S units.

9.2 Worst Case Scenarios

9.2.1 LNG Terminal

The Worst Case Scenarios for the LNG terminal and R/U are identified in the present study. The potential of releases, the evaporation of LNG and the consequences of the Pool Fires, Flash Fires and Explosions for WCSs are calculated using validated computer programs (EFFECTS/TNO 9.0 and RISKCURVES/TNO 9.0).

For the evaluation of accident scenarios consequences in a consistent manner weather conditions derived by actual Delimara meteo data are used (see Section 7 of the present report).

In total 72 Worst Case Scenarios (WCSs) have been examined for the LNG terminal and R/U. An analytical list of the WCSs for LNG Facilities is presented in the following Table 9. 1.

Table 9.1: Worst Case Scenarios (WCSs), in total 72, considered in the present QRA for the safety critical equipment of the new LNG terminal

LNG 100 – FSU LNG RELEASE ON WATER/FSU (Floating Storage Unit) 2mins CLOUD DISPERSION	
1	GAP LUP_Sc100-FSU FSUSphD500mm Bottom Hole FLASH FIRE or EXPLOSION D5
2	GAP LUP_Sc100-FSU FSUSphD500mm Bottom Hole FLASH FIRE or EXPL F2
3	GAP LUP_Sc100-FSU FSUSphD500mm Bottom Hole POOLFIRE
4	GAP LUP_Sc100-FSU-s FSUSphD500 mm 20mWall Hole FLASH FIRE or EXPL D5
5	GAP LUP_Sc100-FSU-s FSUSphD500 mm 20mWall Hole FLASH FIRE or EXPL F2
6	GAP LUP_Sc100-FSU-s FSUSphD500mm 20mWall Hole POOLFIRE
7	GAP LUP_Sc101-FSU FSUSphD1000mm Bottom Hole FLASH FIRE or EXPL D5
8	GAP LUP_Sc101-FSU FSUSphD1000mm Bottom Hole FLASH FIRE or EXPL F2
9	GAP LUP_Sc101-FSU FSUSphD1000mm Bottom Hole POOLFIRE
10	GAP LUP_Sc101-FSU-s FSUSphD1000mm 20m Wall Hole FLASH FIRE or EXPL D5
11	GAP LUP_Sc101-FSU-s FSUSphD1000mm 20mWall Hole FLASH FIRE or EXPL F2
12	GAP LUP_Sc101-FSU-s FSUSphD1000mm 20mWall Hole POOLFIRE
13	GAP LUP_Sc102-FSU FSUSphD1500mm Bottom Hole FLASH FIRE or EXPL D5
14	GAP LUP_Sc102-FSU FSUSphD1500mm Bottom Hole FLASH FIRE or EXPL F2
15	GAP LUP_Sc102-FSU FSUSphD1500mm Bottom Hole POOLFIRE
16	GAP LUP_Sc102-FSU-s FSUSphD1500mm 20mWall Hole FLASH FIRE or EXPL D5
17	GAP LUP_Sc102-FSU-s FSUSphD1500mm 20mWall Hole FLASH FIRE or EXPL F2
18	GAP LUP_Sc102-FSU-s FSUSphD1500 mm 20mWall Hole POOLFIRE
LNG 100 GAS TANKER RELEASE ON WATER/TANKER (LNG UNLOADING VESSEL) 2mins CLOUD DISPERSION	
19	GAP LUP_Sc100 TKRSphD500B FLASH FIRE or EXPLOSION D5
20	GAP LUP_Sc100 TKRSphD500B FLASH FIRE or EXPL F2

21	GAP LUP_Sc100 TKRSphD500B POOLFIRE
22	GAP LUP_Sc100-s TKRSphD500H05 FLASH FIRE or EXPL D5
23	GAP LUP_Sc100-s TKRSphD500H05 FLASH FIRE or EXPL F2
24	GAP LUP_Sc100s TKRSphD500H05 POOLFIRE
25	GAP LUP_Sc101 TKRSphD1000B FLASH FIRE or EXPL D5
26	GAP LUP_Sc101 TKRSphD1000B FLASH FIRE or EXPL F2
27	GAP LUP_Sc101 TKRSphD1000B POOLFIRE
28	GAP LUP_Sc101-s TKRSphD1000H05 FLASH FIRE or EXPL D5
29	GAP LUP_Sc101-s TKRSphD1000H05 FLASH FIRE or EXPL F2
30	GAP LUP_Sc101-s TKRSphD1000H05 POOLFIRE
31	GAP LUP_Sc102 TKRSphD1500B FLASH FIRE or EXPL D5
32	GAP LUP_Sc102 TKRSphD1500B FLASH FIRE or EXPL F2
33	GAP LUP_Sc102 TKRSphD1500B POOLFIRE
34	GAP LUP_Sc102-s TKRSphD1500H05 FLASH FIRE or EXPL D5
35	GAP LUP_Sc102-s TKRSphD1500H05 FLASH FIRE or EXPL F2
36	GAP LUP_Sc102-s TKRSphD1500H05 POOLFIRE
LNG 200 TANKER to FSU UNLOADING 10" HOSES (TANKER TO FSU, LOW PRESSURE 3barg) 10s Release	
37	GAP LUP_Sc200x4-10s FBR 10" FLASH FIRE or EXPLOSION D5
38	GAP LUP_Sc200x4-10s FBR 10" FLASH FIRE or EXPLOSION F2
39	GAP LUP_Sc200x4-10s FBR 10" POOLFIRE
LNG 300 FSU TO JETTY UNLOADING 10" HOSE (LNG FSU TO JETTY, LOW PRESSURE 3barg) 10s Release	
40	GAP LUP_Sc300- 10s FBR 10" POOLFIRE
41	GAP LUP_Sc300- 10s FBR 10" FLASH FIRE or EXPLOSION D5
42	GAP LUP_Sc300- 10s FBR 10" FLASH FIRE or EXPLOSION F2
LNG 400 TANKER UNLOADING 12" HOSE-GAS RETURN	
43	GAP LUP_Sc400-2min FBR of 12in GAS pipe - 2min FLASH FIRE or EXPLOSION D5
44	GAP LUP_Sc400-2min FBR of 12in GAS pipe - 2min FLASH FIRE or EXPLOSION F2
LNG 500 PIPELINE FROM FSU TO SECONDARY PUMP JETTY LOW PRESSURE PIPE 6"	
45	GAP LUP_Sc500-2min JettySecPumpD6LPFBR FLASH FIRE or EXPLOSION D5
46	GAP LUP_Sc500-2min JettySecPumpD6LPFBR FLASH FIRE or EXPLOSION F2
47	GAP LUP_Sc500-2min JettySecPumpD6LPFBR POOLFIRE
48	GAP LUP_Sc501-s JettySecPumpD6LP2inHole FLASH FIRE or EXPLOSION D5
49	GAP LUP_Sc501-s JettySecPumpD4LP2inHole FLASH FIRE or EXPLOSION F2
50	GAP LUP_Sc501-s JettySecPumpD4LP2inHole POOLFIRE
LNG 600 SECONDARY PUMP OUTLET HIGH PRESSURE PIPE 4"	
51	GAP LUP_Sc600-2min SecPumpOutletD4HPFBR FLASH FIRE or EXPLOSION D5
52	GAP LUP_Sc600-2min SecPumpOutletD4HPFBR FLASH FIRE or EXPLOSION F2
53	GAP LUP_Sc600-2min SecPumpOutletD4HPFBR POOLFIRE

LNG 700 PIPELINE FROM SECONDARY PUMP TO RU HIGH PRESSURE 6" PIPE POINT 1 (47.5 barg)

- 54 GAP LUP_Sc700-2min SecPumptoRUD6HPFBR FLASH FIRE or EXPLOSION F2
- 55 GAP LUP_Sc700-2min SecPumptoRUD6HPFBR FLASH FIRE or EXPLOSION D5
- 56 GAP LUP_Sc700-2min SecPumptoRUD6HPFBR POOLFIRE

LNG 700 PIPELINE FROM SECONDARY PUMP TO RU HIGH PRESSURE 6" PIPE POINT 2 (47.5 barg)

- 57 GAP LUP_Sc700-s-2min SecPumptoRUD6HPFBR-s FLASH FIRE or EXPLOSION D5
- 58 GAP LUP_Sc700-s-2min SecPumptoRUD6HPFBR-s FLASH FIRE or EXPLOSION F2
- 59 GAP LUP_Sc700-s-2min SecPumptoRUD6HPFBR-s POOLFIRE

LNG 800 REGASIFICATION UNIT

- 60 GAP LUP_Sc800-2min RU 10 x 1,5" TUBES FBR (1m) - 2 min FLASH FIRE or EXPL D5
- 61 GAP LUP_Sc800-2min RU 10 x 1,5" TUBES FBR (1m) - 2 min FLASH FIRE or EXPL F2

LNG 900 PIPELINE FROM RU TO METERING STATION HIGH PRESSURE 10" [0,74 km]

- 62 GAP LUP_Sc900-2min RU 10 in Pipe FBR (1m) FLASH FIRE or EXPLOSION D5
- 63 GAP LUP_Sc900-2min RU 10 in Pipe FBR (1m) FLASH FIRE or EXPLOSION F2

LNG 1000 PIPELINE FROM FSU TANK TO COMPRESSOR MEDIUM PRESSURE 6" POINT 1

- 64 GAP LUP_Sc1000-2min FBR of 6in GAS pipe - 2min FLASH FIRE or EXPL D5
- 65 GAP LUP_Sc1000-2min FBR of 6in GAS pipe - 2min FLASH FIRE or EXPL F2

LNG 1000 PIPELINE FROM FSU TANK TO COMPRESSOR MEDIUM PRESSURE 6" [0,40 km]

- 66 GAP LUP_Sc1000-2min FBR of 6in GAS pipe - 2min FLASH FIRE or EXPL F2
- 67 GAP LUP_Sc1000-2min FBR of 6in GAS pipe - 2min FLASH FIRE or EXPL D5

LNG 1112 PIPELINE FROM COMPRESSOR TO FSU LIQUIFIER MEDIUM PRESSURE 6" POINT

- 68 GAP LUP_Sc1112-2min FBR of 6in GAS pipe - 2min FLASH FIRE or EXPL D5
- 69 GAP LUP_Sc1112-2min FBR of 6in GAS pipe - 2min FLASH FIRE or EXPL F2

LNG 1300 PIPELINE FROM LIQUEFIER TO FSU LOW PRESSURE 4" [0,40 km]

- 70 GAP LUP_Sc1300-2min RUtoFSUD4LPFBR POOLFIRE
- 71 GAP LUP_Sc700-s-2min SecPumptoRUD6HPFBR-s FLASH FIRE or EXPL D5
- 72 GAP LUP_Sc700-s-2min SecPumptoRUD6HPFBR-s FLASH FIRE or EXPL F2

9.2.2 Delimara Power Station

Hazard analysis, identification of WCSs, consequence assessment for the fuels involved in the safety critical equipment of the Delimara Power Station (DPS), have been performed in the existing DPS Safety Report [1]. The results of the analysis and reported scenarios frequencies have been incorporated in the present QRA study without any modification. Pool Fires resulting from LOCs in Diesel Tanks and HFO Tanks are considered as the worst credible scenarios that might occur in the DPS. Jet fires involving fuels such as Diesel and HFO are not taken into account since not substantiated.

In total 65 Worst Case Scenarios (WCSs) have been taken from the DPS Safety Report.

Table 9.2: Worst Case Scenarios (WCSs), in total 65, considered in the present QRA for the safety critical equipment of the existing Delimara Power Station (DPS)

PS 1 HFO STORAGE RELEASE T1	
1	Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5
2	Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2
3	Damage Definition (Poolfire) FIXED DURATION D5
4	Damage Definition (Poolfire) FIXED DURATION F2
5	Damage Definition (Poolfire) FIXED DURATION MANHOLE F2
PS 1 HFO STORAGE RELEASE T2	
6	Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5
7	Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2
8	Damage Definition (Poolfire) FIXED DURATION D5
9	Damage Definition (Poolfire) FIXED DURATION F2
10	Damage Definition (Poolfire) FIXED DURATION MANHOLE F2
PS 2 HFO RELEASE WATER DISCHARGE	
11	Damage Definition (Poolfire) LINE RUPTURE D5
12	Damage Definition (Poolfire) LINE RUPTURE F2
PS 3 HFO RELEASE INTO QUAY	
13	Damage Definition (Poolfire) FIXED DURATION F2
14	Damage Definition (Poolfire)FIXED DURATION D5
PS 4 HFO RELEASE IN TRANSFER PIPE BOILER [0,46 km]	
15	Damage Definition (Poolfire) FIXED DURATION F2
16	Damage Definition (Poolfire)FIXED DURATION D5
PS 5 HFO SERVICE BUFFER STORAGE RELEASE	
17	Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5
18	Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2

- 19 Damage Definition (Poolfire) FIXED DURATION F2
- 20 Damage Definition (Poolfire) FIXED DURATION D5
- 21 Damage Definition (Poolfire) FIXED DURATION MANHOLE F2

PS 6 HFO RELEASE IN TRANSFER PIPE TO ENGINE [0,20 km]

- 22 Damage Definition (Poolfire) FIXED DURATION D5
- 23 Damage Definition (Poolfire) FIXED DURATION F2

PS 7 DIESEL STORAGE RELEASE POINT T0

- 24 Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5
- 25 Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2
- 26 Damage Definition (Poolfire) FIXED DURATION D5
- 27 Damage Definition (Poolfire) FIXED DURATION F2
- 28 Damage Definition (Poolfire) FIXED DURATION MANHOLE D2
- 29 Damage Definition (Poolfire) FIXED DURATION MANHOLE F2

PS 7 DIESEL STORAGE RELEASE POINT T1

- 30 Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5
- 31 Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2
- 32 Damage Definition (Poolfire) FIXED DURATION D5
- 33 Damage Definition (Poolfire) FIXED DURATION F2
- 34 Damage Definition (Poolfire) FIXED DURATION MANHOLE D2
- 35 Damage Definition (Poolfire) FIXED DURATION MANHOLE F2

PS 7 DIESEL STORAGE RELEASE POINT T2

- 36 Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5
- 37 Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2
- 38 Damage Definition (Poolfire) FIXED DURATION D5
- 39 Damage Definition (Poolfire) FIXED DURATION F2
- 40 Damage Definition (Poolfire) FIXED DURATION MANHOLE D2
- 41 Damage Definition (Poolfire) FIXED DURATION MANHOLE F2

PS 7 DIESEL STORAGE RELEASE POINT T3

- 42 Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5
- 43 Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2
- 44 Damage Definition (Poolfire) FIXED DURATION D5
- 45 Damage Definition (Poolfire) FIXED DURATION F2
- 46 Damage Definition (Poolfire) FIXED DURATION MANHOLE D2
- 47 Damage Definition (Poolfire) FIXED DURATION MANHOLE F2

PS 8 DO RELEASE WATER DISCHARGE POINT T0

- 48 Damage Definition (Poolfire) LINE RUPTURE D5
- 49 Damage Definition (Poolfire) LINE RUPTURE F2

PS 8 DO RELEASE WATER DISCHARGE POINT T1

- 50 Damage Definition (Poolfire) LINE RUPTURE D5

51 Damage Definition (Poolfire) LINE RUPTURE F2

PS 8 DO RELEASE WATER DISCHARGE POINT T2

52 Damage Definition (Poolfire) LINE RUPTURE D5

53 Damage Definition (Poolfire) LINE RUPTURE F2

PS 8 DO RELEASE WATER DISCHARGE POINT T3

54 Damage Definition (Poolfire) LINE RUPTURE D5

55 Damage Definition (Poolfire) LINE RUPTURE F2

PS9 DO RELEASE INTO QUAY

56 Damage Definition (Poolfire) LINE RUPTURE F2

57 Damage Definition (Poolfire)FIXED DURATION D5

PS 10 DO SERVICE STORAGE RELEASE

58 Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5

59 Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2

60 Damage Definition (Poolfire) FIXED DURATION F2

61 Damage Definition (Poolfire) FIXED DURATION D5

62 Damage Definition (Poolfire) FIXED DURATION MANHOLE D5

63 Damage Definition (Poolfire) FIXED DURATION MANHOLE F2

PS 11 DO RELEASE IN TRANSFER PIPE TO GAS [0,48 km]

64 Damage Definition (Poolfire)FIXED DURATION D5

65 Damage Definition (Poolfire)FIXED DURATION F2

9.3 Consequence Assessment Criteria

In the present study, the evaluation of consequence zones of the Worst Case Scenarios is performed using the following criteria for Thermal Radiation of open Fires, Explosion overpressure and the extent of flammable cloud.

Consequence Assessment Criteria		
Fire - Received Thermal Radiation	37,5 kW/m ² 15 kW/m ² 13,4 kW/m ² 9,3 kW/m ² 7,3 kW/m ² 5 kW/m ²	99 % Fatalities 50 % Fatalities 40 % Fatalities 5 % Fatalities 3 % Fatalities 1% Fatalities
Cloud fires (Flash Fires)	within the LFL and UFL of the gas cloud (Methane in air)	100% fatalities
Explosion (Overpressure)	350 mbar 140 mbar	50 % Fatalities 1 % Fatalities

Table 9. 3: Consequence Zones Criteria used in the LUP RA

The above criteria are in good general agreement with the criteria proposed for consequence zoning in several EU countries considering both protected and unprotected persons. Exemplified cases are presented in the table below.

	“Inner Zone” Significant lethality	“Middle Zone” 1% Lethality	“Outer Zone” Irreversible effects
France	8 kW/m ² or 1800 TDU 200 mbar	5 kW/m ² or 1000 TDU 140 mbar	3 kW/m ² or 600 TDU 50 mbar
UK	1800 TDU	1000 TDU	500 TDU
Italy	12,5 kW/m ² 300 & 600 mbar	7 kW/m ² 140 mbar	5 kW/m ² 70 mbar
Greece	15 kW/m ² 350 mbar	6 kW/m ² 140 mbar	3 kW/m ² 50 mbar
Malta⁴	50% fatalities in normal population	1 - 5% fatalities in normal population	(1 - 5% fatalities in vulnerable population)

Table 9.4: Consequence Zones Criteria used in some EU countries

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Consequence Zones Criteria as used in Safety Reports of COMAH sites in Malta	“Inner Zone”	“Middle Zone”	“Outer Zone”
	13.4 kW/m ² for 50% fatalities in protected (clothed) persons [11]	9.3 kW/m ² for (1%) fatalities in protected (clothed) persons [11]	7.3 kW/m ² for (1%) fatalities in unprotected (unclothed) persons [11]
	13.4 kW/m ² , Damage to protected person [1]	9.3 kW/m ² , High damage to unprotected person [1]	7.3 kW/m ² , Low damage to unprotected person [1]

For reasons of comparison, the risk of fatality for people indoors and outdoors as adopted by HSA in Ireland [5], is presented below:

Overpressure (mbar)	Outdoor Risk	Indoor Risk
3000	94.10%	100%
1000	53.21%	100%
600	27.12%	70%
300	6.12%	50%
100	0.12%	5%
50	0%	1%
10	0%	0%

Table 9.5: Risk of fatality associated with various levels of Overpressure

Thermal Radiation kW/m²	Person Outdoors⁵
6.8	1%
9.23	10%
13.4	50%
Thermal Radiation kW/m²	Person Indoors⁶
< 12.7	0% People are assumed to be protected, so 0% fatality
12.7 to 25.6	People are assumed to escape outdoors, and so have a risk of fatality corresponding to that outdoors
> 25,6	100% (Building conservatively assumed to catch fire quickly and so 100% probability)

Table 9.6: Risk of fatality associated with various levels of Thermal Radiation

⁵ The probit most commonly used to determine the risk from thermal radiation is the Eisenberg et al (1975) probit, i.e. $Probit = -14.9 + 2.56 \ln(11.33 t)$ with l in kW/m² and t in seconds The Eisenberg probit relationship

⁶ Crossthaite et al (1988)

10 Risk Assessment

The Quantitative Risk Assessment (QRA) performed for the LNG terminal and R/U facilities is based on the results of consequence assessment of the present study. The event frequencies and probabilities are adjusted to the available design features and operation conditions of the proposed LNG terminal. The probabilities of ignition, weather stability classes, etc, taken into consideration in the analysis have been mentioned in Section 9.1.1 to 9.1.3 of this report.

The result of present QRA performed for LUP purposes is the Location Risk of individuals in the region. The ultimate output is the plot of Iso-Risk Contours (Individual Risk) on appropriate background maps of the region. For the development of the Iso-Risk Contours plots the simulation models of Riskcurves 9.0/TNO 2012 software is used.

The Individual Risk Contours are depicted for the WCSs of major accidents as examined for both COMAH establishments: the existing Delimara Power Station and the new LNG Storage and Regasification facilities in Marsaxlokk Bay. The results of the present study could be used in combination with specific LUP criteria e.g. PADHI system [4], to support the identification and development of CZs in the region of Delimara.

10.1 Pool Fire and Flash Fire Frequencies

The failure frequency of equipment and pipes and the frequency of releases e.g. tanker collision, FBR of hoses/pipes, etc, have been determined for each safety critical part by application of generic frequency data. The frequency data and relevant probabilities have been derived using the following guidelines:

- the Purple Book RIVM, [9],
- the HSE FRED (Failure Rate and Event Data) contained within the Planning Case Assessment Guide [6],
- LNG QRA studies: LNG Delimara QRA, SGS 2013 [10] and LUP QRA Shannon Ireland, ERM 2007 [2].

All frequencies and event probabilities have been appropriately adjusted to the available design features and operation conditions of the proposed LNG terminal.

A total of **137** accident scenarios independently of the frequency of their occurrence are taken into account in the QRA, 72 out of 137 scenarios refer to the new LNG terminal and 65 to the existing DPS.

The frequencies used in the QRA for Pool Fires and Flash Fires (including explosions) are summarized, for both the LNG terminal and the DPS, in Table 10.1 below.

Table 10.1: POOL FIRE and FLASH FIRE FREQUENCIES (DELIMARA LNG TERMINAL and POWER STATION)

SCENARIOS	POOL FIRE / FLASH FIRE
	Frequency [/year]
LNG 100 – FSU LNG RELEASE ON WATER/FSU (Floating Storage Unit)	
2mins CLOUD DISPERSION	
GAP LUP_Sc100-FSU FSUSphD500mm Bottom Hole FLASH FIRE or EXPLOSION D5	6,53E-06
GAP LUP_Sc100-FSU FSUSphD500mm Bottom Hole FLASH FIRE or EXPL F2	6,53E-06
GAP LUP_Sc100-FSU FSUSphD500mm Bottom Hole POOLFIRE	5,49E-06
GAP LUP_Sc100-FSU-s FSUSphD500 mm 20mWall Hole FLASH FIRE or EXPL D5	6,53E-06
GAP LUP_Sc100-FSU-s FSUSphD500 mm 20mWall Hole FLASH FIRE or EXPL F2	6,53E-06
GAP LUP_Sc100-FSU-s FSUSphD500mm 20mWall Hole POOLFIRE	5,49E-06
GAP LUP_Sc101-FSU FSUSphD1000mm Bottom Hole FLASH FIRE or EXPL D5	1,24E-06
GAP LUP_Sc101-FSU FSUSphD1000mm Bottom Hole FLASH FIRE or EXPL F2	1,24E-06
GAP LUP_Sc101-FSU FSUSphD1000mm Bottom Hole POOLFIRE	2,08E-06
GAP LUP_Sc101-FSU-s FSUSphD1000mm 20m Wall Hole FLASH FIRE or EXPL D5	1,24E-06
GAP LUP_Sc101-FSU-s FSUSphD1000mm 20mWall Hole FLASH FIRE or EXPL F2	1,24E-06
GAP LUP_Sc101-FSU-s FSUSphD1000mm 20mWall Hole POOLFIRE	2,08E-06
GAP LUP_Sc102-FSU FSUSphD1500mm Bottom Hole FLASH FIRE or EXPL D5	4,79E-08
GAP LUP_Sc102-FSU FSUSphD1500mm Bottom Hole FLASH FIRE or EXPL F2	4,79E-08
GAP LUP_Sc102-FSU FSUSphD1500mm Bottom Hole POOLFIRE	8,05E-08
GAP LUP_Sc102-FSU-s FSUSphD1500mm 20mWall Hole FLASH FIRE or EXPL D5	4,79E-08
GAP LUP_Sc102-FSU-s FSUSphD1500mm 20mWall Hole FLASH FIRE or EXPL F2	4,79E-08
GAP LUP_Sc102-FSU-s FSUSphD1500 mm 20mWall Hole POOLFIRE	8,05E-08
LNG 100 GAS TANKER RELEASE ON WATER/TANKER (LNG UNLOADING VESSEL)	
2mins CLOUD DISPERSION	
GAP LUP_Sc100 TKRSphD500B FLASH FIRE or EXPLOSION D5	6,53E-08
GAP LUP_Sc100 TKRSphD500B FLASH FIRE or EXPL F2	6,53E-08
GAP LUP_Sc100 TKRSphD500B POOLFIRE	1,10E-07
GAP LUP_Sc100-s TKRSphD500H05 FLASH FIRE or EXPL D5	6,53E-08
GAP LUP_Sc100-s TKRSphD500H05 FLASH FIRE or EXPL F2	6,53E-08
GAP LUP_Sc100s TKRSphD500H05 POOLFIRE	1,10E-07
GAP LUP_Sc101 TKRSphD1000B FLASH FIRE or EXPL D5	2,47E-08
GAP LUP_Sc101 TKRSphD1000B FLASH FIRE or EXPL F2	2,47E-08
GAP LUP_Sc101 TKRSphD1000B POOLFIRE	4,15E-08
GAP LUP_Sc101-s TKRSphD1000H05 FLASH FIRE or EXPL D5	2,47E-08
GAP LUP_Sc101-s TKRSphD1000H05 FLASH FIRE or EXPL F2	2,47E-08
GAP LUP_Sc101-s TKRSphD1000H05 POOLFIRE	4,15E-08
GAP LUP_Sc102 TKRSphD1500B FLASH FIRE or EXPL D5	9,58E-10
GAP LUP_Sc102 TKRSphD1500B FLASH FIRE or EXPL F2	9,58E-10
GAP LUP_Sc102 TKRSphD1500B POOLFIRE	1,61E-09
GAP LUP_Sc102-s TKRSphD1500H05 FLASH FIRE or EXPL D5	9,58E-10

GAP LUP_Sc102-s TKRSphD1500H05 FLASH FIRE or EXPL F2	9,58E-10
GAP LUP_Sc102-s TKRSphD1500H05 POOLFIRE	1,61E-09
LNG 200 TANKER to FSU UNLOADING 10" HOSES (TANKER TO FSU, LOW PRESSURE 3barg) 10s Release	
GAP LUP_Sc200x4-10s FBR 10" FLASH FIRE or EXPLOSION D5	4,66E-06
GAP LUP_Sc200x4-10s FBR 10" FLASH FIRE or EXPLOSION F2	4,66E-06
GAP LUP_Sc200x4-10s FBR 10" POOLFIRE	7,83E-06
LNG 300 FSU TO JETTY UNLOADING 10" HOSE (LNG FSU TO JETTY, LOW PRESSURE 3barg) 10s Release /6monthLC	
GAP LUP_Sc300- 10s FBR 10" POOLFIRE	9,79E-05
GAP LUP_Sc300- 10s FBR 10" FLASH FIRE or EXPLOSION D5	1,16E-04
GAP LUP_Sc300- 10s FBR 10" FLASH FIRE or EXPLOSION F2	1,16E-04
LNG 400 TANKER UNLOADING 12" HOSE-GAS RETURN	
GAP LUP_Sc400-2min FBR of 12in GAS pipe - 2min FLASH FIRE or EXPLOSION D5	9,19E-06
GAP LUP_Sc400-2min FBR of 12in GAS pipe - 2min FLASH FIRE or EXPLOSION F2	9,19E-06
LNG 500 PIPELINE FROM FSU TO SECONDARY PUMP JETTY LOW PRESSURE PIPE 6" [0,26 km]	
GAP LUP_Sc500-2min JettySecPumpD6LPFBR FLASH FIRE or EXPLOSION D5	7,66E-06
GAP LUP_Sc500-2min JettySecPumpD6LPFBR FLASH FIRE or EXPLOSION F2	7,66E-06
GAP LUP_Sc500-2min JettySecPumpD6LPFBR POOLFIRE	6,44E-06
GAP LUP_Sc501-s JettySecPumpD6LP2inHole FLASH FIRE or EXPLOSION D5	1,92E-04
GAP LUP_Sc501-s JettySecPumpD4LP2inHole FLASH FIRE or EXPLOSION F2	1,92E-04
GAP LUP_Sc501-s JettySecPumpD4LP2inHole POOLFIRE	1,61E-04
LNG 600 SECONDARY PUMP OUTLET HIGH PRESSURE PIPE 4"10s ESD 2Pumps 6months Interchange	
GAP LUP_Sc600-2min SecPumpOutletD4HPFBR FLASH FIRE or EXPLOSION D5	1,15E-05
GAP LUP_Sc600-2min SecPumpOutletD4HPFBR FLASH FIRE or EXPLOSION F2	1,15E-05
GAP LUP_Sc600-2min SecPumpOutletD4HPFBR POOLFIRE	9,66E-06
LNG 700 PIPELINE FROM SECONDARY PUMP TO RU HIGH PRESSURE 6" PIPE POINT 1 (47.5 barg)	
GAP LUP_Sc700-2min SecPumptoRUD6HPFBR FLASH FIRE or EXPLOSION F2	7,66E-08
GAP LUP_Sc700-2min SecPumptoRUD6HPFBR FLASH FIRE or EXPLOSION D5	7,66E-08
GAP LUP_Sc700-2min SecPumptoRUD6HPFBR POOLFIRE	6,44E-09
LNG 700 PIPELINE FROM SECONDARY PUMP TO RU HIGH PRESSURE 6" PIPE POINT 2 (47.5 barg) [0,03 km]	
GAP LUP_Sc700-s-2min SecPumptoRUD6HPFBR-s FLASH FIRE or EXPLOSION D5	3,83E-06
GAP LUP_Sc700-s-2min SecPumptoRUD6HPFBR-s FLASH FIRE or EXPLOSION F2	3,83E-06
GAP LUP_Sc700-s-2min SecPumptoRUD6HPFBR-s POOLFIRE	6,44E-06

LNG 800 REGASIFICATION UNIT	
GAP LUP_Sc800-2min RU 10 x 1,5" TUBES FBR (1m) - 2 min FLASH FIRE or EXPL D5	3,83E-06
GAP LUP_Sc800-2min RU 10 x 1,5" TUBES FBR (1m) - 2 min FLASH FIRE or EXPL F2	3,83E-06
LNG 900 PIPELINE FROM RU TO METERING STATION to P/S HIGH PRESSURE 10" (10s ignition /2000kg expl mass) HIGH PRESSURE 10" [0,81 km]	
GAP LUP_Sc900-2min RU 10 in Pipe FBR (1m) FLASH FIRE or EXPLOSION D5	1,32E-05
GAP LUP_Sc900-2min RU 10 in Pipe FBR (1m) FLASH FIRE or EXPLOSION F2	2,64E-05
LNG 1000 PIPELINE FROM FSU TANK TO COMPRESSOR MEDIUM PRESSURE 6" POINT 1	
GAP LUP_Sc1000-2min FBR of 6in GAS pipe - 2min FLASH FIRE or EXPL D5	7,66E-08
GAP LUP_Sc1000-2min FBR of 6in GAS pipe - 2min FLASH FIRE or EXPL F2	7,66E-08
LNG 1000 PIPELINE FROM FSU TANK TO COMPRESSOR MEDIUM PRESSURE 6" [0,40 km]	
GAP LUP_Sc1000-2min FBR of 6in GAS pipe - 2min FLASH FIRE or EXPL F2	3,83E-06
GAP LUP_Sc1000-2min FBR of 6in GAS pipe - 2min FLASH FIRE or EXPL D5	3,83E-06
LNG 1112 PIPELINE FROM COMPRESSOR TO FSU LIQUEFIER MEDIUM PRESSURE 6" POINT	
GAP LUP_Sc1112-2min FBR of 6in GAS pipe - 2min FLASH FIRE or EXPL D5	4,60E-07
GAP LUP_Sc1112-2min FBR of 6in GAS pipe - 2min FLASH FIRE or EXPL F2	4,60E-07
LNG 1300 PIPELINE FROM LIQUEFIER TO FSU LOW PRESSURE 4" [0,40 km]	
GAP LUP_Sc1300-2min RUtoFSUD4LPFBR POOLFIRE	1,61E-05
GAP LUP_Sc700-s-2min SecPumptoRUD6HPFBR-s FLASH FIRE or EXPL D5	9,58E-06
GAP LUP_Sc700-s-2min SecPumptoRUD6HPFBR-s FLASH FIRE or EXPL F2	9,58E-06
PS 1 HFO STORAGE RELEASE T1	
Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5	1,46E-07
Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2	1,46E-07
Damage Definition (Poolfire) FIXED DURATION D5	1,46E-07
Damage Definition (Poolfire) FIXED DURATION F2	1,46E-07
Damage Definition (Poolfire) FIXED DURATION MANHOLE F2	1,46E-07
PS 1 HFO STORAGE RELEASE T2	
Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5	1,46E-07
Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2	1,46E-07
Damage Definition (Poolfire) FIXED DURATION D5	1,46E-07
Damage Definition (Poolfire) FIXED DURATION F2	1,46E-07
Damage Definition (Poolfire) FIXED DURATION MANHOLE F2	1,46E-07
PS 10 DO SERVICE STORAGE RELEASE	
Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5	9,16E-09
Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2	9,16E-09
Damage Definition (Poolfire) FIXED DURATION F2	9,16E-09
Damage Definition (Poolfire) FIXED DURATION D5	9,16E-09
Damage Definition (Poolfire) FIXED DURATION MANHOLE D5	9,16E-09

Damage Definition (Poolfire) FIXED DURATION MANHOLE F2	9,16E-09
PS 11 DO RELEASE IN TRANSFER PIPE TO GAS [0,48 km]	
Damage Definition (Poolfire)FIXED DURATION D5	8,50E-08
Damage Definition (Poolfire)FIXED DURATION F2	8,50E-08
PS 2 HFO RELEASE WATER DISCHARGE	
Damage Definition (Poolfire) LINE RUPTURE D5	4,77E-12
Damage Definition (Poolfire) LINE RUPTURE F2	4,77E-12
PS 3 HFO RELEASE INTO QUAY	
Damage Definition (Poolfire) FIXED DURATION F2	5,51E-08
Damage Definition (Poolfire)FIXED DURATION D5	5,51E-08
PS 4 HFO RELEASE IN TRANSFER PIPE BOILER [0,46 km]	
Damage Definition (Poolfire) FIXED DURATION F2	7,55E-08
Damage Definition (Poolfire)FIXED DURATION D5	7,55E-08
PS 5 HFO SERVICE BUFFER STORAGE RELEASE	
Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5	9,16E-09
Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2	9,16E-09
Damage Definition (Poolfire) FIXED DURATION F2	9,16E-09
Damage Definition (Poolfire) FIXED DURATION D5	9,16E-09
Damage Definition (Poolfire) FIXED DURATION MANHOLE F2	9,16E-09
PS 6 HFO RELEASE IN TRANFER PIPE TO ENGINE [0,20 km]	
Damage Definition (Poolfire)FIXED DURATION D5	4,47E-07
Damage Definition (Poolfire)FIXED DURATION F2	4,47E-07
PS 7 DIESEL STORAGE RELEASE POINT T0	
Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5	1,19E-07
Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2	1,19E-07
Damage Definition (Poolfire) FIXED DURATION D5	1,19E-07
Damage Definition (Poolfire) FIXED DURATION F2	1,19E-07
Damage Definition (Poolfire) FIXED DURATION MANHOLE D2	1,19E-07
Damage Definition (Poolfire) FIXED DURATION MANHOLE F2	1,19E-07
PS 7 DIESEL STORAGE RELEASE POINT T1	
Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5	1,19E-07
Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2	1,19E-07
Damage Definition (Poolfire) FIXED DURATION D5	1,19E-07
Damage Definition (Poolfire) FIXED DURATION F2	1,19E-07
Damage Definition (Poolfire) FIXED DURATION MANHOLE D2	1,19E-07
Damage Definition (Poolfire) FIXED DURATION MANHOLE F2	1,19E-07
PS 7 DIESEL STORAGE RELEASE POINT T2	

Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5	1,19E-07
Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2	1,19E-07
Damage Definition (Poolfire) FIXED DURATION D5	1,19E-07
Damage Definition (Poolfire) FIXED DURATION F2	1,19E-07
Damage Definition (Poolfire) FIXED DURATION MANHOLE D2	1,19E-07
Damage Definition (Poolfire) FIXED DURATION MANHOLE F2	1,19E-07

PS 7 DIESEL STORAGE RELEASE POINT T3

Damage Definition (Poolfire) CATASTROPHIC RUPTURE D5	1,19E-07
Damage Definition (Poolfire) CATASTROPHIC RUPTURE F2	1,19E-07
Damage Definition (Poolfire) FIXED DURATION D5	1,19E-07
Damage Definition (Poolfire) FIXED DURATION F2	1,19E-07
Damage Definition (Poolfire) FIXED DURATION MANHOLE D2	1,19E-07
Damage Definition (Poolfire) FIXED DURATION MANHOLE F2	1,19E-07

PS 8 DO RELEASE WATER DISCHARGE POINT T0

Damage Definition (Poolfire) LINE RUPTURE D5	4,77E-12
Damage Definition (Poolfire) LINE RUPTURE F2	4,77E-12

PS 8 DO RELEASE WATER DISCHARGE POINT T1

Damage Definition (Poolfire) LINE RUPTURE D5	4,77E-12
Damage Definition (Poolfire) LINE RUPTURE F2	4,77E-12

PS 8 DO RELEASE WATER DISCHARGE POINT T2

Damage Definition (Poolfire) LINE RUPTURE D5	4,77E-12
Damage Definition (Poolfire) LINE RUPTURE F2	4,77E-12

PS 8 DO RELEASE WATER DISCHARGE POINT T3

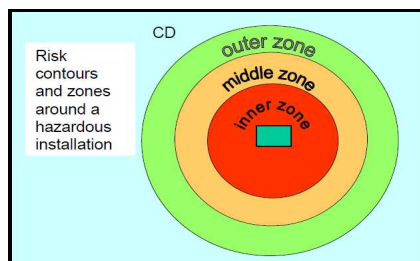
Damage Definition (Poolfire) LINE RUPTURE D5	4,77E-12
Damage Definition (Poolfire) LINE RUPTURE F2	4,77E-12

PS9 DO RELEASE INTO QUAY

Damage Definition (Poolfire) LINE RUPTURE F2	4,93E-05
Damage Definition (Poolfire) FIXED DURATION D5	4,93E-05

10.2 Risk Acceptance Criteria (examples of EU practices)

For demonstration reasons, the risk acceptance criteria and LUP practice proposed by HSE in UK (PADHI system [4]) and HSA in Ireland, are referred in this section. The application of such criteria may provide useful support to LUP authorities in identifying appropriate Consultation Zones in Delimara area.



A proposed development is classified into one of four “Sensitivity Levels”. The main factors that determine these levels are the numbers of persons at the development, their sensitivity (vulnerable populations such as children, old people) and the intensity of the development. With these two factors known, a simple decision matrix is used to give a clear ‘Advise Against’ (AA) or ‘Don’t Advise Against’ (DAA) response, as shown in Table 10.2 below.

New Developments in the vicinity of major hazard establishments	Development in Inner Zone	Development in Middle Zone	Development in Outer Zone
Risk of fatality (per year)	1×10^{-5}	1×10^{-6}	3×10^{-7}
Level of sensitivity of new Developments			
Level 1	DAA	DAA	DAA
Level 2	AA	DAA	DAA
Level 3	AA	AA	DAA
Level 4	AA	AA	AA

Table 10.2: Decision Matrix for LUP (HSE UK [4])

A similar decision matrix is proposed by HSA Ireland as shown in Table 10.3.

	Development in Inner Zone	Development in Middle Zone	Development in Outer Zone
Risk of fatality (per year) for New Developments in the vicinity of major hazard establishments and according to Levels of Sensitivity (Table 10.2)	1×10^{-5}	1×10^{-6}	1×10^{-7}
Risk of fatality for New major hazard establishments	Risk < 5×10^{-6} per year to the current non residential neighbors or Risk < 1×10^{-6} per year to the nearest residential type property		

Table 10.3: Decision Matrix for LUP (HSA Ireland [5])

DAA means **Do not Advise Against** the Development

AA means **Advise Against** the Development

Sensitivity Level 1 - Example: Factories

Sensitivity Level 2 - Example: Houses

Sensitivity Level 3 - Example: Vulnerable members of society e.g. primary schools, old people’s homes,

Sensitivity Level 4 - Example: Football ground/Large hospital.

10.3 QRA study results

The results of the present QRA concerning Individual Risk in form of “Iso Risk Contours” are presented in Figures 10.1, 10.2 and 10.3, as follows.

In Figure 10.1, the IR contour representing the Location Risk of 1×10^{-5} per year for individuals, is plotted on the background map of the new LNG terminal.

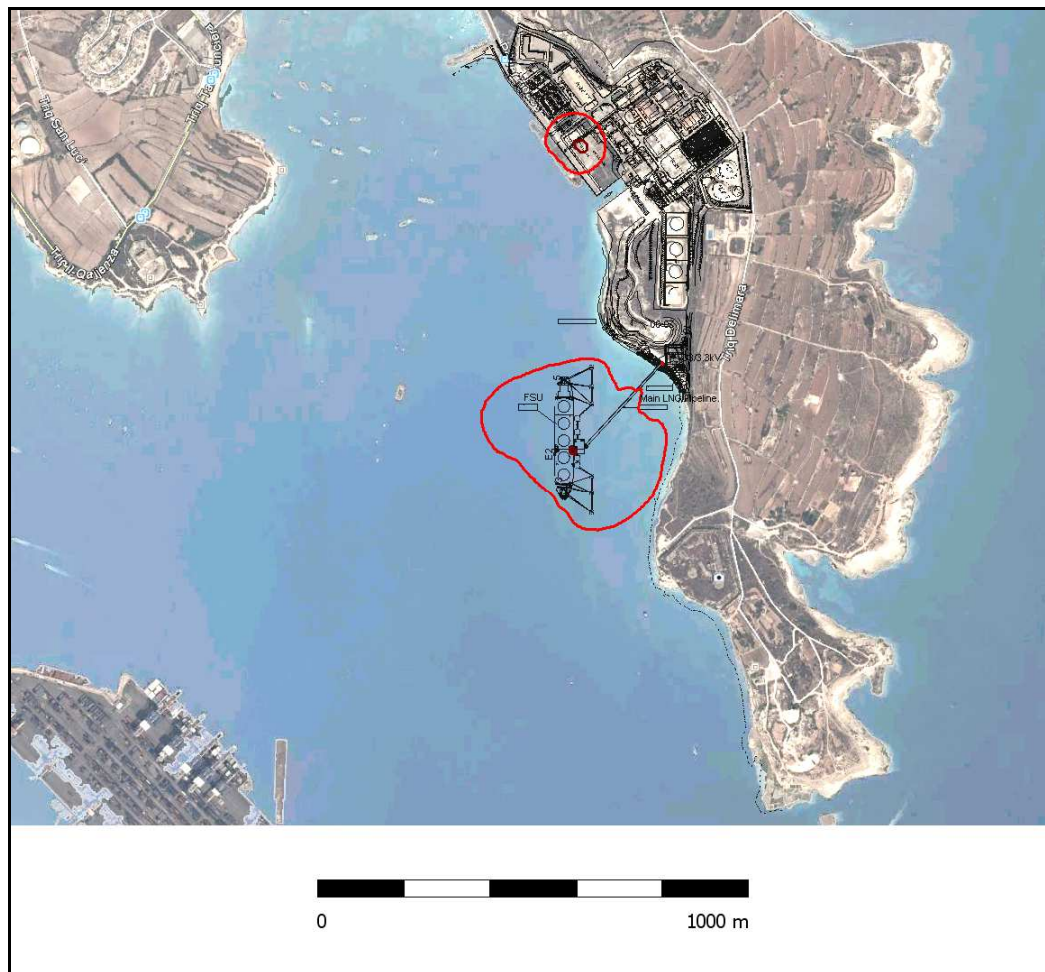


Figure 10.1: The IR contour that represents Location Risk of 1×10^{-5} per year for individuals

Following the identification of the 1×10^{-5} per year zone, the application of Risk Acceptance criteria, in case of New major hazard establishments such as the New offshore DEMIMARA LNG Terminal and the R/U, could provide support for **Advising Against** or **Not Advising Against** developments of specified sensitivity.

In the present case, the area within the **RED contour (IR > 10^{-5} per year)** is an area where the Authorities should **Advise Against** any Land Uses with the exception of working areas for specific industrial purposes. As indicated in Figure 10.1, two such areas have been identified, one in the sea around the FSU and another one on land located entirely within the boundaries of the DPS. Therefore, both such areas are by default out of scope of LUP limitations.

In Figure 10.2, the IR contours that represent Location Risk of 1×10^{-5} and 5×10^{-6} per year for individuals, are plotted on the background map of the new LNG terminal.

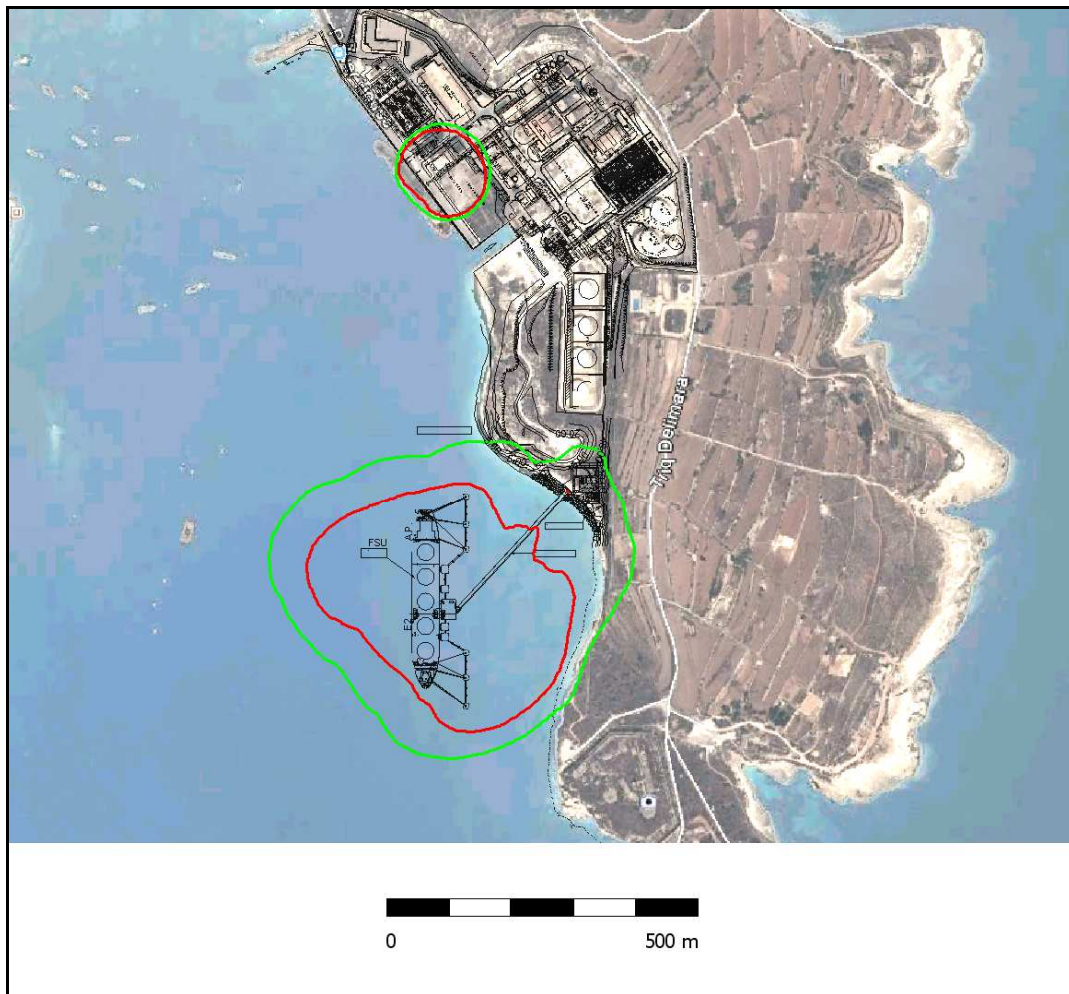


Figure 10.2: The Location Risk contours of 1×10^{-5} and 5×10^{-6} per year for individuals

In the present case, **the zone between the RED contour (IR = 10^{-5} per year) and the GREEN contour (IR = 5×10^{-6} per year)** is an area where the Authorities should **NOT Advise Against** any Land Uses with the exception of dense residential development and vulnerable sites of sensitivity higher or equal to level 3 (see Section 10.2). As illustrated in Figure 10.2, one such zone is identified along the coastline.

The major part of this zone will be occupied by the R/U and the auxiliary onshore equipment of the LNG terminal. For the rest of the area within such zone no restrictions are normally applied either for industrial land uses or non-residential developments or for residential developments of certain population density (Sensitivity Levels 1 and 2, see Section 10.2).

In Figure 10.3, the IR contours that represent Location Risk of 5×10^{-6} and 1×10^{-6} per year for individuals, are plotted on the background map of the new LNG terminal.

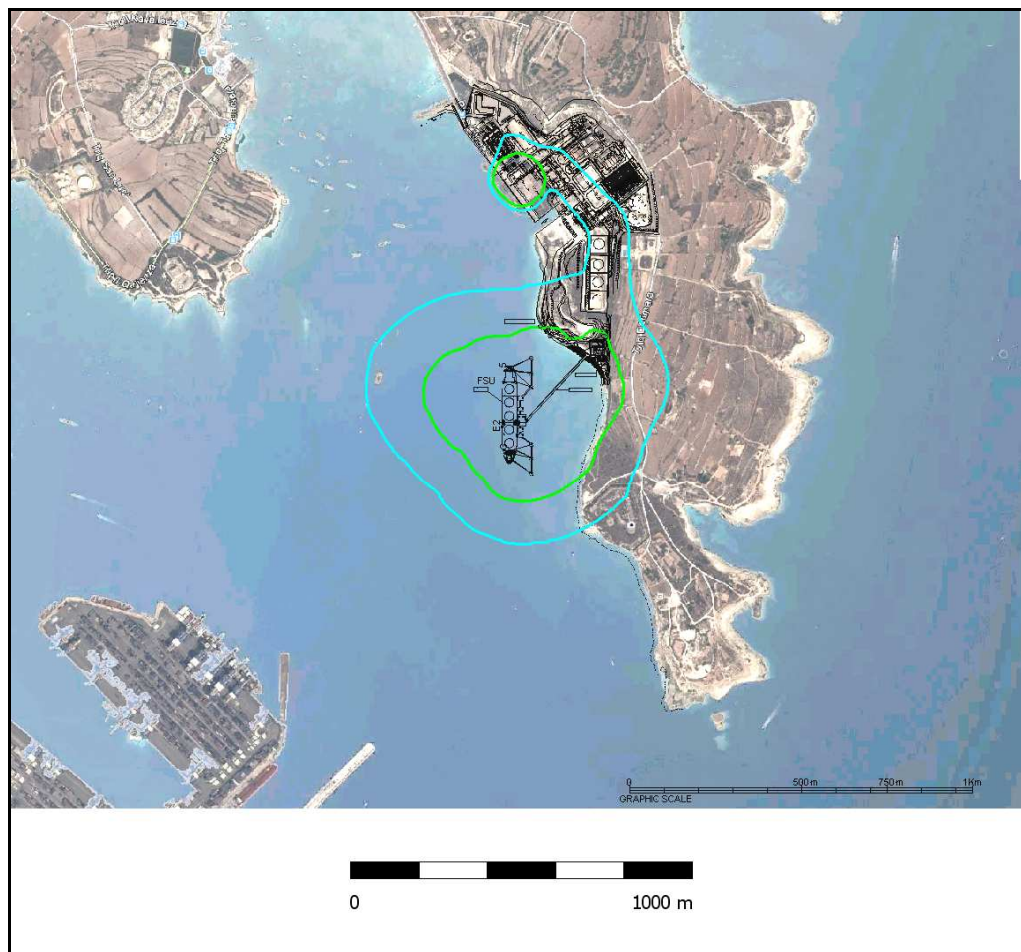


Figure 10.3: The Location Risk contours of 5×10^{-6} and 1×10^{-6} per year for individuals

At the present stage of the study this zone can also be identified drawn by the route of the gas pipeline delivering gas from R/U to the CCGS, despite the fact that pipe design and lining details are still uncertain. This zone, **between the GREEN contour (IR = 5×10^{-6} per year) and the BLUE contour (IR = 1×10^{-6} per year)** is an area where the Authorities should **NOT Advise Against** any Land Uses with the exception of dense residential development and vulnerable sites of sensitivity higher or equal to level 3 (see Section 10.2). In the present case, one such zone has been identified within the boundaries of the DPS and another one around the R/U as illustrated in Figure 10.3. For the area within such a zone and outside the DPS boundaries no restrictions are normally applied either for commercial, or non-residential development or for residential development of certain population density (Sensitivity Levels 1 and 2).

All areas outside the contour 10^{-6} per year are areas where the Authorities should **NOT Advise Against** any Land Uses with the exception of specific vulnerable sites of sensitivity higher or equal to level 4 (see Section 10.2). For all such areas outside the zone and outside the DPS boundaries no restrictions should be applied either for commercial, non-residential development or any type of residential development (Sensitivity Levels 1, 2 and 3).

11 References

- [1] Ambiente (July, 2013) Safety Report of Delimara Power Station, July 2013.
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- [3] European Council Directive 96/82 1996. On the control of major accident hazards involving dangerous substances. Official Journal of the European Communities. Luxembourg: European Commission.
- [4] Health and Safety Executive, 'PADHI – HSE's Land Use Planning Methodology', <http://www.hse.gov.uk/landuseplanning/padhi.pdf>.
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- [6] HSE, (2003), Failure Rate and Event Data for Use within Risk Assessment, Planning Case Assessment Guide.
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- [8] OHSMA-Malta (2013). Evaluation Report of Safety Report for Delimara Power Station.
- [9] RIVM (2005). The TNO Purple Book "Guidelines for quantitative risk assessment".
- [10] SGS, (Dec 2013). QRA Study for the new LNG Regasification facility in Marsaxlokk Bay.
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- [12] U.S. Department of Energy (May 2012). Liquefied Natural Gas Safety Research.

PA 00021/14: COMBINED CYCLE GAS TURBINE AND LIQUIFIED NATURAL GAS RECEIVING STORAGE AND RE-GASIFICATION FACILITIES; AND,

PA 00022/14: CONSTRUCTION OF JETTY AND ANCILLARY FACILITIES;

AT, DELIMARA POWER STATION, TRIQ IL-POWER STATION, MARSAXLOKK

1. INTRODUCTION AND DESCRIPTION OF THE PROPOSED DEVELOPMENT

The Malta Environment and Planning Authority (MEPA) requested an Environmental Impact Statement (EIS) for the developments proposed in permit applications PA 00021/14 (*Combined Cycle Gas Turbine and Liquefied Natural Gas Receiving Storage and Re-gasification Facilities, at Delimara Power Station, Triq il-Power Station, Marsaxlokk*) and PA 00022/14 (*Construction of jetty and ancillary facilities, Delimara Power Station, Triq il-Power Station, Marsaxlokk*). The applications required an EIS in accordance with Schedule IA, Category 7.3.1.1 (*Construction of thermal power station and other combustion installation with an output of more than 50MW*) and 7.6.1.1 (*Surface and underground storage of combustible gases including natural gas with a capacity of more than 100,000m³*) of the Environmental Impact Assessment Regulations, 2007 (Legal Notice 114 of 2007, as amended). The EIS was coordinated by Dr. Paul Gauci, for ERSLI Consultants Ltd.

1.1 Description of the proposed development

The proposed development consists of a 215MW natural gas fired combined cycle gas turbine (CCGT) plant together with liquefied natural gas (LNG) receiving, storage and re-gasification facilities. The proposed development consists of the following major components (Figure 1-4 of the EIS Coordinated Assessment refers):

- A combined cycle gas turbine (CCGT) plant located to the north-west of the Delimara Power Station (DPS) site;
- A jetty situated to the south-west of the DPS site against which a Floating Storage Unit (FSU) with a capacity of 125,000m³ would be berthed; and
- A re-gasification facility which is located in the southern tip of the DPS site.

The EIS notes that both the FSU and the re-gasification facilities are located at the farthest possible distance away from the existing DPS plant and the site to be occupied by the proposed CCGT.

The proposed CCGT plant shall consist of three (3) gas turbines (producing electricity using natural gas in the 'first cycle') and a steam turbine (which would be driven by steam generated in the heat recovery steam generators by the hot exhaust gases from the gas turbines in the 'second cycle'). The EIS indicates that the combined system being proposed is capable of operating at an efficiency of 54%. The CCGT facility shall include three (3) main stacks of 75m height each and three (3) by-pass stacks of 30m height each.

During the first six months of operations, the plant would be operated as an open cycle gas turbine (OCGT). The EIS estimates that the construction and installation phase for both the CCGT and the LNG facilities will be completed within a maximum period of 15 months.

In terms of decommissioning, the EIS indicates that a detailed plan is not available, however the submission of a decommissioning plan would be required as part of the IPPC process.

An overview of the planning policies and legislative framework which relate to the proposed developments is provided throughout Chapters 3 and 4 of the EIS Coordinated Assessment.

1.2 Assessment of alternatives

The EIS (Chapter 2) has considered the following aspects vis-à-vis alternatives:

- *Alternative sites:* The EIS indicates that the only site found suitable for the proposed development is the Delimara Power Station area, being located at a safe distance from the closest community, Marsaxlokk, and since over the past twenty years, the power distribution infrastructure has been organized in such a manner to preclude other areas into being considered realistically suitable for such a development.
- *Alternative technologies:* With respect to fuel alternatives, the EIS states that the adoption of a natural gas-fired CCGT facility refers to a policy decision by the Government of Malta, and is also established by the Action Plan for the Electricity Sector of the National Energy Plan, 2012. With respect to the types of power plant, the Enemalta Energy Generation Plan, 2006 indicated that the cost of electricity could be minimized through the installation of gas fuelled CCGT units. Such installations would have the potential to meet the expected emission limits of Directive 2001/81/EC on National Emission Ceilings (NEC) for certain pollutants [NEC Directive]. The emissions generated through the use of the interconnector would not have an adverse impact on the NEC Directive, 2001 whereas a gasoil fuelled CCGT plant would generate emissions that would be just within the limits of the NEC Directive by 2020, thereby making the proposed combined use of a CCGT plant and the interconnector the preferred option from a technology perspective.
- *Alternative layouts:* The EIS assessed three different options vis-à-vis the layout of the proposed CCGT and LNG facilities (Figures 2-2 to 2-7 of the EIS Coordinated Assessment refer). The preferred options for both the CCGT and the LNG were primarily based on the assessment of risk of all the elements of the proposed development and on noise impacts on sensitive receptors associated with the proposal. In terms of off-shore options (i.e. outside of the port of Marsaxlokk), the EIS notes that these were not considered for the following reasons: (i) very little sea-room available for a shallow-water platform which is fixed to the sea bed, (ii) no experience of installing a FSRU at a floating connection point to supply gas, (iii) any FSRU moored outside Marsaxlokk harbour, including its attendant pipeline is likely to represent an obstacle to shipping, and (iv) the exposure to severe adverse weather conditions (e.g. wind, waves, and swell) outside the shelter afforded by Marsaxlokk harbour would reduce the ability of the FSRU to receive fuel from supply carriers.

In this regard, the EIS notes that these conditions were considered to be too risky in terms of security of supply. The EIS concludes that the off-shore option was not completely discarded, given that potential technological developments in the future may render such option a viable solution.

- *Downscaling of the project:* The EIS indicates that the possibility of downscaling could not be considered, due to the fact that: (i) the Marsa Power Station will be decommissioned upon the installation of the interconnector; (ii) DPS 1 will be replaced by the proposed CCGT plant, and (iii) DPS 2A and 2B will be kept going for use in emergencies or as a reserve plant. Only the proposed

215MW CCGT would be capable of taking over the 200MW interconnector in case of a serious fault.

- *Zero option:* The EIS also assessed the implications of the zero option; particularly in terms of marine water bodies, air quality and noise impacts. The EIS notes that the proposed developments may lead to general improvements in the baseline situation, particularly in terms of Malta's commitments with EU targets regarding air pollution and energy management.

EPD Comment (1): *The Environment Protection Directorate (EPD) notes that the EIS has provided an overall outline of the main alternatives considered for the proposed developments and provided the main reasons for such choice, also noting the relevant environmental effects and their prevention, in line with the requirements of Section 2 of the Terms of Reference dated July 2013 and of the EIA Regulations, 2007 (Legal Notice 114 of 2007, as amended).*

EPD Comment (2): *In terms of the off-shore option associated with LNG storage facilities, the EPD notes that any future proposals are not covered by the current assessment and would need to be subject to all the required environmental assessments.*

2. EIA CONSULTATIONS

2.1 EIA Scoping

During the scoping stage, the Project Description Statement (PDS) was circulated to the following consultees and was made available for public consultation from the 4th June 2013 to the 25th June 2013:

- Marsaxlokk Local Council;
- Local Councils Association;
- Malta Resources Authority;
- Transport Malta;
- Environmental Health Directorate;
- Superintendence of Cultural Heritage;
- Civil Protection Department;
- Environmental NGOs: Din l-Art Ħelwa, Kummissjoni Ambjent, Birdlife Malta, Nature Trust Malta, Ramblers Association of Malta, Flimkien għal Ambjent Aħjar, Friends of the Earth Malta, Żminijietna, Fondazzjoni Wirt Artna, GAIA Foundation, Light Pollution Awareness Group, Moviment Graffiti, Malta Organic and Agriculture Movement, Malta Water Association, Youth for the Environment, Noise Abatement Society of Malta, Federazzjoni Birżebbuġa, Birżebbuġa Environmental Action Group.

The PDS was also circulated for internal review within MEPA.

Comments were received from Din l-Art Ħelwa (e-mail dated 21st June 2013), Birżebbuġa Local Council (e-mail dated 24th June 2013), Marsaxlokk Local Council (e-mail dated 25th June 2013) and 2 members of the public (Ing. John Pace – e-mail dated 21st June 2013; Prof. Edward Mallia - letter dated 25th June 2013). A scoping meeting with the Marsaxlokk Local Council, government entities and environmental NGOs was also held on the 19th June 2013. A copy of the submitted comments are included as Appendix I and a copy of the minutes of the scoping meeting have been included in Appendix II to this report.

The final Terms of Reference were issued to the applicant and architect on 10th July 2013.

2.2 EIA Review

The draft EIS was submitted to MEPA on 2nd September 2013 and was circulated for review to the same consultees consulted during the scoping stage (see Para 2.1 above). The EIS was also circulated for internal review within MEPA.

Within the stipulated consultation period, comments were received from Din I-Art Helwa (e-mail dated 7th September 2013), Birżebbuġa Environmental Action Group (letter dated 25th September 2013), Civil Protection Department (letter dated 26th September 2013), Marsaxlokk Local Council (e-mail 30th September 2013), Environmental Health Directorate (e-mail dated 1st October 2013), Birżebbuġa Local Council (e-mail dated 2nd October 2013), Malta Resources Authority – Competence, Licensing and Enforcement (e-mail dated 2nd October 2013) and Superintendence of Cultural Heritage (e-mail dated 14th October 2013). Comments made by MEPA and its consultees during the review stage were forwarded to the EIA Coordinator, the developer and the architect on 3rd October 2013. These comments were addressed by the EIA Coordinator and responses were included in Volume 6 of the EIS Coordinated Assessment Report submitted to MEPA. Comments received during the public consultation period are inserted in Appendix III to this report.

2.3 EIA Certification, Public Consultation and Public Hearing

The EIS was certified on the 23rd December 2013 and was published for a three-week public consultation period, with a deadline for submissions being the 24th January 2014. A public hearing was held on the 27th January 2014, with a deadline for comments by the 3rd February 2014 (included in Appendix IV to this report). Minutes of the meeting are also included as Appendix V. Overall, comments were received from the Birżebbuġa Sailing Club (letter dated 20th January 2014), Din I-Art Helwa (e-mail dated 1st February 2014), the Marsaxlokk and Birżebbuġa Local Councils (letter dated 20th January 2014), members of the public (Ing. John Pace – e-mail dated 24th January 2014, Mr. Alfred Falzon – e-mail dated 28th January 2014, Birżebbuġa Environmental Action Group (letter dated 3rd February 2014), Environmental Health Directorate (e-mail dated 3rd February 2014) and Mr. Kees de Jong – e-mails dated 4th and 7th February 2014).

3. EIA FINDINGS

The characteristics of the site, assessment of impacts and mitigation measures were identified in the EIS as follows:

3.1 Land Cover and Land Uses

The Power Station site is located on the westernmost side of the Delimara peninsula, which in terms of topography, incorporates a ridge running along the centre of the peninsula, with land sloping down to the coast on both the western and eastern aspects. The site is characterised by a variety of different geomorphological landforms with a varying and diverse topography. The principal land use in the Delimara peninsula is agricultural, together with the presence of some isolated residential units. Moreover, areas of natural and semi-natural habitats, and areas with historical elements are also present. Figures 3-5 to 3-8 in the EIS Coordinated Assessment illustrate the land cover and land-use in the area.

Il-Port ta' Marsaxlokk, where the FSU and the ancillary infrastructure are proposed to be located, harbours a range of different uses with the most important being fishing, aquaculture, bunkering, shipping and trans-shipment operations.

IMPACT SIGNIFICANCE AND PREDICTIONS

The EIS indicates that the proposed development is expected to have the following effects:

- Changes to the existing land use arrangements and land take-up within the power station site during both construction and operation: *Insignificant*, given that the existing land uses are expected to remain essentially unchanged. A higher proportion of the power station site will be built-up however DPS 1 will be decommissioned while DPS 2A and 2B will be used for back-up only.
- Changes to the existing land use arrangements and land take-up in the surroundings during both construction and operation: *No impact on the surrounding land uses is expected.*
- Changes to existing arrangements with respect to sea uses in relation to the jetty and the FSU locations during construction: Albeit highly likely to occur, the EIS indicates that impact significance is considered to be *low if Transport Malta is kept informed of planned vessel movements or marine engineering works.* During operations, impacts on sea uses are identified as inevitable, however of *low significance* since the location of the jetty was discussed with Transport Malta after the risk assessment indicated the area in the harbour within which the loading arms should be located and the current/wave study indicated that the proposed location was not expected to have a significant impact on wave and current patterns.
- Changes to existing arrangements with respect to sea uses in Il-Ħofra ż-Żgħira during operations: Impact is considered to be of *moderate significance*, particularly on swimmers using the area.

PROPOSED MITIGATION MEASURES

- Good communication with Transport Malta and all the stakeholders involved in the process (for example: fishermen, Malta Freeport, Oil Tanking Malta).
- The possibility of the use of a pipe through which the discharge of cooling water could by-pass Il-Ħofra ż-Żgħira, as proposed by the Marsaxlokk Local Council.

RESIDUAL IMPACTS

No significant residual impacts were identified by the EIS.

3.2 Landscape and Visual Amenity

The landscape character and visual amenity assessment was based on the identification of the zone of visual influence (ZVI) and critical viewpoints for the baseline photographs and a 3D model of the proposed development. The ZVI for the proposed development is presented in Figure 3-9 of the EIS Coordinated Assessment.

GENERAL LANDSCAPE DESCRIPTION

The present-day landscape of the area is characterised by a high diversity and a mosaic of land uses, including industrial, agricultural, residential and recreational elements. Natural habitat coverage is somewhat limited within the area, and there has been significant land conversion in the Marsaxlokk/Delimara area primarily for four purposes: agriculture, residential development, industrial development, tourism and commerce. Il-Port ta' Marsaxlokk has several historical/archaeological features of interest, including 17th-19th century harbour fortifications (Il-Fortizza ta' Delimara, It-Torri ta' San Luċjan and Il-Forti ta' San Luċjan around it, Il-Forti tas-Silġ, and the Wolseley Battery), a landmark lighthouse, (Il-Fanal ta' Delimara), and archaeological sites such as Borġ in-Nadur and Tas-Silġ. In this regard, the Delimara peninsula and the embayments around Marsaxlokk and Birżebbuġa, together with the surrounding sea area, are strongly characterised by a high density and diversity of land and sea uses.

VISUAL AMENITY

Six viewpoints (VPs) (Figures 3-14 to 3-19 of the EIS Coordinated Assessment) were identified to assess the visual impact of the proposed development:

- *Viewpoint 1:* Located within Delimara peninsula, in relatively close proximity to the DPS site. This viewpoint affords a relatively expansive view in several directions; with the exception of the views towards the east, south-east and south.
- *Viewpoint 2:* Located at the junction between Triq tas-Silġ and Triq il-Power Station (Marsaxlokk), with the position affording a view of the Delimara headland to the south and south-east, together with partial views of Marsaxlokk harbour and the San Luċjan headland, and partial long-distance views of parts of Birżebbuġa and parts of the Freeport at Kalafrana. Views from this location are more enclosed, bounded by the Delimara headland to the west, with visibility in other directions is more limited.
- *Viewpoint 3:* Located on the Marsaxlokk seafront, along Xatt is-Sajjieda, with the viewshed delimited by the Delimara and San Luċjan headlands. This position provides a good view of the Marsaxlokk seafront promenade, with views bounded by the two headlands to the south-east and south-west and by existing buildings close to the seashore to the north and north-west.
- *Viewpoint 4:* Located on the Marsaxlokk seafront along Xatt is-Sajjieda, at a point closer to the San Luċjan peninsula. The viewpoint lies directly opposite the Delimara peninsula; the view of the south is limited by the lie of the San Luċjan peninsula and the view of the sea is limited due to the site topography.
- *Viewpoint 5:* Located on the San Luċjan peninsula along Triq it-Trunciera (Marsaxlokk), directly opposite the power station complex, with the latter dominating the view. The view incorporates much of the Delimara headland, though its southernmost extent is obscured by the San Luċjan peninsula itself. The marine area visible in this viewpoint includes the stretch of sea between the two peninsulae, although the innermost part of Id-Daħla ta' Marsaxlokk is not visible.
- *Viewpoint 6:* Located along Triq San Patrizju on the Birżebbuġa seafront; where much of the Delimara headland is visible except for the southernmost tip, and also parts of the seafront along Ir-Ramla ta' Birżebbuġa (Pretty Bay) and parts of the San Luċjan peninsula. The sea also forms part of the view.

IMPACT SIGNIFICANCE AND PREDICTIONS

Impacts on landscape character

The EIS indicates that the proposed development shall lead to the following impacts in terms of landscape character:

- Presence of construction machinery in the landscape, in contrast with the predominantly rural character of the Delimara peninsula, during construction works: *Low to moderate significance.*
- Increase in industrial elements with the predominantly rural context of Delimara peninsula during operations: *Moderate significance.*
- Weakening of the 'traditional' landscape character of Marsaxlokk Bay, as a result of a stronger industrial presence in the visible landscape: *Moderate significance.*
- Weakening of the residential/recreational values of the landscape at Birżebbuġa, as a result of the increased industrial presence in the landscape: *Moderate to low significance.*

Impacts on visual amenity

The EIS identified the following as key sensitive receptors in terms of the proposed development:

- (i) Farmers cultivating land in proximity to VP1 elsewhere on the Delimara peninsula, particularly in areas with a direct view of the power station complex;
- (ii) Farmers cultivating land within the Marsaxlokk/Birżebbuġa areas, with a view of the power station complex opposite;
- (iii) Residents living close to the area of the power station (on the Delimara peninsula);
- (iv) Residents living along the Marsaxlokk and Birżebbuġa seafronts, or further inland but with a direct view of the power station complex;
- (v) Drivers passing through the area, as well as casual passers-by;
- (vi) Tourist and local patrons of the Marsaxlokk market, and of Marsaxlokk and Birżebbuġa catering establishments;
- (vii) Commercial operators of catering/tourism and other establishments;
- (viii) Operators at the Freeport complex;
- (ix) Individuals out at sea, on pleasure craft or industrial vessels (including fishermen); and
- (x) Bathers and other recreational users of the seafronts at Marsaxlokk and Birżebbuġa.

Impacts for each of the viewpoints analysed in the EIS are as follows:

- Viewpoint 1: *High significance*
- Viewpoint 2: *Moderate significance*
- Viewpoint 3: *Moderate significance*
- Viewpoint 4: *Low significance*
- Viewpoint 5: *High significance*
- Viewpoint 6: *High significance*

PROPOSED MITIGATION MEASURES

A good landscaping plan for the Delimara peninsula can mitigate the impact, though not substantially.

RESIDUAL IMPACTS

The EIS notes that the impacts on landscape and the visual scene from the proposed development are unavoidable and thus residual visual impacts of *high significance* would remain.

EPD Comment (3): *The Environment Protection Directorate (EPD) agrees with the conclusions of the EIA Coordinator in terms of impacts on landscape character and visual amenity. Whilst having no significant concerns from a landscape and visual amenity point of view vis-à-vis the location of the CCGT plant (including the location of the three primary stacks and the three by-pass stacks) and the onshore re-gasification facility, the introduction of the FSU shall lead to an additional significant impact in the landscape character and visual amenity of the port of Marsaxlokk which is difficult to eliminate completely. Nevertheless, the EPD is requesting a detailed landscaping plan (e.g. camouflaging, design of structures and materials, colour treatments and textural finishes to aid integration with surroundings and thus minimise impacts) to be submitted, also taking into consideration any requirements arising from both the Industrial Emissions Directive and the Seveso Directive.*

3.3 Geo-environment (geology – geomorphology – hydrology – hydrogeology)

3.1.1 Geology

The DPS site is located on Middle Globigerina Limestone, overlain by the Upper Globigerina Limestone (Figure 3-43 of the EIS Coordinated Assessment Report refers).

In terms of Middle Globigerina Limestone, the EIS indicates that this rock unit is well exposed in the cliff section forming the eastern boundary of the DPS and is over 50m thick, consisting of a bedded sequence of marls and marly limestone. On the other hand, the Upper Globigerina Limestone consists of two beds of a cream fine, soft, massive, bio-turbated, moderately weak limestone beds each about 8m thick and a middle marly bed, about 5m thick, with it being entirely composed of tests of benthonic and planktonic foraminifera, some echinoid spines, echinoids and scattered whole or fragmented bivalve shells. The EIS states that the power station site *per se* is located on Middle Globigerina Limestone while the Area of Study is mostly located on the Upper Globigerina Limestone.

3.1.2 Mineral resource assessment

The EIS included a mineral resource assessment of the site and was undertaken through:

- A field survey of the site;
- Fieldwork comprising the drilling of 7 boreholes (Figure 3-46 in the EIS Coordinated Assessment refers);
- Offshore holes drilled to investigate the geology of the seabed; and
- Previous *in situ* testing close the DPS site.

The laboratory tests on the samples collected through the boreholes indicate that the rock is moderately strong, having an uniaxial compressive strength¹ that varied from 6.2 to 20.6N/mm² and an average uniaxial compressive strength of 13.5N/mm². Petrographic examination reveals that the rock is a marly limestone.

In terms of quality of the resource, the EIS indicates that such rock would be suitable for cement manufacture and may be suitable for filling of trenching works and screed.

Offshore subsurface investigations were also carried out in the EIS and analysed seabed soft-sediment thickness, depth to bedrock and rock core sample recovery. The identified maximum depths to the bedrock were 33m, 32m and 20.5m respectively at each of the profiles analysed.

3.1.3. Geomorphology

The following geomorphologic features were identified within and around the area of study:

- Middle Globigerina Limestone slopes at Il-Ballut – an exposed marl which weathers very easily to form a rather gentle slope;
- Cuesta-like ridge (*i.e.* ridge which possesses both scarp and dig slopes) marking the north-eastern boundary of the site, formed at the up-dip axis of the Upper Globigerina Limestone strata which dip to the northeast;
- Cliff margin at Delimara – the DPS site (L-Ingernier) and the rest of the west-facing slope of Delimara forms a steep cliff as a result of wave erosion of the weaker strata exposed at sea level;
- Shingle beach at Is-Sarċi, near the northern side of Fort Delimara;
- Serrated coastline forming the northeast margin of the Delimara peninsula;
- Circular amphitheatre-like bays of Il-Ħofra l-Kbira and Il-Ħofra ż-Żgħira on the north-east coastline; and
- The DPS site lies inside a deep excavation initially cut into Rdum il-Bies in the early-1990s to accommodate the DPS, producing a steep near-vertical rockface up to about 40m high.

3.1.4. Hydrology and hydrogeological features

The EIS indicates that area of study for the hydrology and the hydrogeology includes a number of surface hydrological features in the form of water wells, small reservoirs and a disused canal irrigation system. No

¹ The capacity of a material or structure to withstand loads tending to reduce size, which can be measured by plotting applied force against deformation in a testing machine. Compressive strength is a key value for design of structures.

well-developed watercourses are located within the area of study. Overland flow is discharged in a diffuse manner along the coastline. No mean sea level aquifer is developed in the area of study, as the Middle Globigerina Limestone is impermeable and extends well below sea level. The actual sites to be developed as part of the proposal have a total catchment area of 15,000m². The site also incorporates the remnants of a system of surface concrete canals dating back to the 1980s; the system has been abandoned and whole sections been removed.

In terms of ground water protection, the site lies outside the groundwater protection zone and no public boreholes are located within the area of influence.

IMPACT SIGNIFICANCE AND PREDICTIONS

The proposed development is not expected to have any significant impact on the geology, geomorphology, hydrology and hydrogeology of the area. The proposed development does not involve major excavation works, and the DPS site is located within an artificially-excavated area, thus making the overall impact on geology *low to insignificant*, while that on geomorphology would be *insignificant*.

The EIS notes that there is the remote possibility for wave and sea current action to affect the stability of the rubble mound in Area B during both construction and operation, with an impact of *high significance*, in terms of destabilisation of the proposed re-gasification plant.

PROPOSED MITIGATION MEASURES

Protection of the coastal margin through rock armour to protect the area around the re-gasification plant, which would need to be inspected regularly and after major storms.

RESIDUAL IMPACTS

The above mitigation measure should effectively mitigate the impacts associated with stability of slope in Area B, subject to regular monitoring, reducing the impact to *low significance*.

3.4 Marine Water Bodies

The study of the marine water bodies focused on the following two main elements:

- A review of the current seawater and sediment quality within the relevant parts of Il-Port ta' Marsaxlokk (including the Delimara headland in particular) and Il-Ħofra ż-Żgħira, to establish the current sources of marine contaminants in the area and subsequently, establish the current risk profile to the marine environmental quality; and
- Changes to the marine environmental quality risk profile.

The EIS establishes the following main sources of marine pollution in Marsaxlokk (Figure 3-50 in the EIS Coordinated Assessment): (i) sewage overflows and other sources; (ii) maritime and fuel handling; (iii) fish-farming; (iv) Delimara Power Station; and (v) land runoff. The study focused most on the effects on Il-Port ta' Marsaxlokk and Il-Ħofra ż-Żgħira.

IL-PORT TA' MARSAXLOKK

The EIS notes that some water stratification is evident during the summer months; however no anoxic conditions were reported in the bottom waters, though occasional low levels of dissolved oxygen were recorded at surface waters off the power station. Water transparency in general is very good except occasionally due to runoff events, and decreases rapidly with depth. Total suspended solids as monitored in Marsaxlokk and Il-Ħofra ż-Żgħira were comparable to those found in other local coastal waters. Nutrient and chlorophyll levels indicate that, as a whole, Marsaxlokk is the least exposed to eutrophic risks when

compared to other local harbours. Levels of heavy metals were found to be generally lower than annual average-environmental quality standards (AA-EQS and MAC-EQS) set by the Water Framework Directive (Directive 2000/60/EC) and the Environmental Quality Standards Directive (Directive 2008/105/EC). Mercury often features prominently in surface waters, with an annual average being estimated at above the set standards (Table 3-22 of the EIS Coordinated Assessment refers). Levels of petroleum hydrocarbons and most other organic contaminants, including pesticides, solvents and antifouling agents were below detection limits within the coastal waters. In sediments, such hydrocarbons were found in various locations in the port, with their levels ranging from low to moderate. Other organic compounds were found to be below the detection limit.

IL-HOFRA Ż-ŻGHIRA

Currently, Il-Hofra ż-Żghira receives up to 43,000m³/h of cooling waters at temperatures up to +8°C above ambient. Aside from the thermal pollution, the EIS indicates no major impacts on the normal marine water quality parameters, most likely due to the rapid diffusion of contaminants.

IMPACT SIGNIFICANCE AND PREDICTIONS

The EIS indicates that the proposed development shall have the following effects on the quality of the waters within the Marsaxlokk harbour through:

- The release of particulate matter, and increased turbidity during construction, due to coastal engineering works: *Moderate to low significance.*
- Increased nutrients in the water body during construction, due to coastal engineering works: *Moderate to low significance.*
- Releases of oil/fuel and other contaminants during construction, due to land-based activities and increased maritime activities related to coastal engineering works: *Moderate to low significance.*
- Discharge of re-gasification waters during operation, due to re-gasification of LNG: *Low significance.*
- The discharge of other wastewater streams from CCGT and LNG facilities during operation: *Moderate to low significance.*
- Atmospheric fallout of gases emitted by the development at the Delimara Power Station, into the water column, during operation of the re-gasification plant and storage facilities: *Low significance.*
- Increased maritime traffic and increased potential operational releases of pollutants (e.g. fuel lubricating oils) during operation: *Low significance.*
- Changes in the hydrodynamics of the water body, in relation to construction of jetty leading to reduced diffusivity of marine contaminant, during operation: *Low significance.*

PROPOSED MITIGATION MEASURES

- Good practice of coastal engineering works (e.g. the deployment of strategically-placed geo-textile curtains along the DPS shoreline and jetty works) through the submission of a detailed Construction Management Plan (CMP).
- Strict compliance with all discharge regulations for all wastewater streams.
- Good workmanship and strict supervision of all operations including water treatment.
- Minimisation of all gaseous emissions.
- Proper supervision of harbour and maritime activities.
- Full compliance with regulations controlling the discharge of solid and liquid wastes from ships in harbours.
- Proper supervision of DPS operations to avoid any oil spills in the immediate vicinity of the cooling water intake.
- Prompt contingency planning to control minor spills, should they occur.

- An integrated liquid waste management programme (within the whole of the DPS), which would include the management of any ballast waters, bilge oils, sanitary liquid wastes, and other effluents generated by the LNG facilities.
- Bunded storage areas should be properly supervised to minimise contamination of any surface runoff which may be generated within them. Drainage from such areas should be controlled through the provision of valved outlets which should normally be in the closed position. The contents of bunds ancillary to bulk chemical tanks should be chemically monitored prior to their release.
- Delivery of bulk chemicals should be permitted only in a designated area, draining from which should be directed to the neutralisation system of a water treatment plant.
- Detailed monitoring programme related to marine water bodies, which should include monitoring of water turbidity, nutrient levels, spatial extent of cool plume, and the chemical profiles of the various waste streams to be discharged into the marine environment.
- Detailed hydrodynamic survey to identify the current regime as it changes with different seasons in the area of influence assessed in the EIS. Water stratification and surface and sub-surface currents in the area would also be identified.
- Monitoring and surveillance monitoring during operations.

RESIDUAL IMPACTS

Residual impacts are expected to range from *none* (specifically where impacts are temporary) to *low significance*, mainly in cases of discharges of treated waters into the sea, additional sea-craft movements in the harbour (maximum 10 additional trips per annum to the current 2,700 per annum), the discharge of pollutants such as oils and fuels, and the anticipated changes to hydrodynamics.

EPD Comment (4): *The Environment Protection Directorate recommends that the mitigation measures listed in the above section, including monitoring, are included as development permit conditions and the IPPC permit conditions.*

3.5 Terrestrial Ecology

The area of study for terrestrial ecology assessed in the EIS (Figure 3-55) encompasses three distinct ecological units, all of which represent different stages in the recolonisation of former agricultural areas by natural communities.

The agricultural land in the area of study has been subject to recent cultivation and is colonised by herbaceous ruderal species that may generally be considered as 'weeds' exploiting the recently-released habitat-space. The margins of agricultural land provide corridors for dispersal and have been colonised by species characteristic of greater ecological stability. The presence of rubble wall remnants in the southern portions of the area of study suggests that these areas were also cultivated in the past.

Vertical faces in the area of study were all colonised by a rupestral community dominated by the Maltese Salt Tree (*Darniella melitensis*). The composition of these rupestral assemblages was similar across the area of study and there was little detectable difference in community composition between 'recent' and 'non-recent' rock faces. 'Recent' faces were artificially created following excavation works to accommodate the DPS whilst 'non-recent' faces are essentially the natural cliffs that have been available for colonisation for much longer periods of time. The relatively homogenous community composition across rock faces of different ages suggests that the time required to achieve a local climax in these habitats is less than 25 years.

The species composition of the 'plantation' in the southern sector of the area of study suggests a complex ecological history. The area is characterised by remnants of ruderal communities from agricultural areas, various trees and large shrubs that were presumably introduced for embellishment, and species characteristic of early-pioneer and later-pioneer stages of secondary ecological succession. The lower parts of the slopes, closer to the shoreline, were characterised by ruderals characteristic of coastal communities.

VERTEBRATE FAUNA

A study of the terrestrial fauna (birds, mammals including bats, amphibians and reptiles) was also undertaken.

In terms of bird species, the EIS notes that the Delimara peninsula is known to hold no less than seven breeding species, namely: Blue Rock Thrush (*Monticola solitarius*), Great Short-toed Lark (*Calandrella brachydactyla*), Zitting Cisticola (*Cisticola juncidis*), Sardinian Warbler (*Sylvia melanocephala*), Spectacled Warbler (*Sylvia conspicillata*), Tree Sparrow (*Passer montanus*) and Spanish Sparrow (*Passer hispaniolensis*). In terms of seabirds, no such species are known to breed in the area of influence and the closest colonies are situated at Bengħisa with both Scopoli's and Yelkouan Shearwaters breeding along the cliff-faces.

Bats and other vertebrate fauna were also noted, however the EIS indicates that considering that the area is already very much disturbed especially due to the construction of the Delimara Power Station and by the roads leading to it, the current project is not likely to affect much of the vertebrate fauna of the area. Minor disturbance may occur during the construction phase, especially to birds breeding in the immediate vicinity of the site. One issue of concern listed in the EIS is related to light pollution, which may negatively affect the behavioural patterns of birds and other vertebrate species.

IMPACT SIGNIFICANCE AND PREDICTIONS

Impacts on terrestrial ecology

The EIS indicates that the main impact associated with terrestrial ecology is the obliteration of biological communities during excavation, stabilisation and construction phases in the CCGT site and the re-gasification facility, which may lead to an impact of *high significance* in the area.

Other impacts listed in the EIS, which however are not of high significance include:

- Disturbance arising from noise and vibration during construction;
- Effects of windblown limestone dust on habitats and biota during construction;
- Obliteration of biological communities in possible storage sites due to storage of excavated material;
- Redistribution of particulates during storage of excavated material;
- Proliferation of ruderal species during storage of excavated material;
- Degradation of biological communities due to leakages from the storage of excavated material and construction materials and wastes;
- Disturbance of susceptible fauna due to site illumination during the night; and
- Possible damage to vegetation due to emissions of primary and secondary pollutants.

Impacts on vertebrates

The EIS indicates that the proposed development will have the following impacts on vertebrate fauna:

- Light spillage during construction and operation, leading to the disruption of normal behaviour in vertebrate fauna: *Moderate to high significance*.
- Noise impacts throughout all phases: *Moderate significance*.

PROPOSED MITIGATION MEASURES

- Damping mechanisms to reduce effects of vibrations on terrestrial fauna.
- Dust suppression measures to minimise wind-blown dispersion (e.g. collection of fine particulates generated during onsite working of stone, covering of stored material, water-spraying of active areas).
- Stockpiles of excavated material should be either removed or underlain with porous bedding and covered with a tarpaulin in order to minimise redistribution by wind and water. Onsite storage should be as brief as possible. Height and slope should be limited in order to reduce wind erosion and wet suppression of dust.
- Siting of stockpiles away from the rupestral habitats characterising the western perimeter of the DPS complex should be considered.
- Insulation of stockpiles to minimise dispersal of propagules of invasive species.
- Containment of spillages through secure storage and confinement of loads in vehicles.
- Secure storage of potential pollutants (including oils and cement) with secondary containment and fire-prevention systems.
- A contingency plan to clean up any spills should also be established.
- Use of downward-facing lights (although such lights may still cause light pollution that may negatively influence wildlife) and low-intensity lighting is recommended wherever possible. Fixtures that are acceptable to the International Dark Sky Association should be used.
- Appropriate noise control.

RESIDUAL IMPACTS

Residual impacts with respect to terrestrial ecology are considered to be *insignificant to low*, based on the observation of recolonisation by shrub formations in areas impacted by construction of the current Delimara PS complex in the early 1990s.

3.6 Marine Ecology

The marine ecological study was undertaken using direct observation by scientific SCUBA divers, with the main aim of producing maps showing the distribution of the main benthic habitats and to establish the presence of any habitats and species that are protected and/or have a high conservation value. The 2013 studies built upon the work carried out, with respect to both Il-Ħofra ż-Żgħira and the Marsaxlokk side of the peninsula by the marine ecology consultants who prepared the EIS for the 2011 extension to the DPS. The 2009 studies consisted of: (i) benthic surveys aimed at mapping the distribution of main benthic habitats in the study areas; and (ii) the collection of samples of biota from hard substrata and soft sediments to characterise the flora and fauna present (Figures 3-60 to 3-62 in the EIS Coordinated Assessment refers).

The following biocoenoses and mosaics were recorded from the infralittoral zone at Il-Ħofra ż-Żgħira and Marsaxlokk-side study areas as follows (Figure 3-65 in the EIS Coordinated Assessment):

- Biocoenosis of infralittoral algae;
- Biocoenosis of infralittoral stones and pebbles;
- Biocoenosis of well-sorted fine sands;
- Biocoenosis of superficially muddy sand in sheltered waters;
- Biocoenosis of polluted harbour mud and sandy mud; and
- Biocoenosis of *Posidonia oceanica* meadows.

The EIS indicates that, overall, the shore and benthic biotic assemblages and the demersal and pelagic fauna (including fish) recorded from the two areas of study are typical of those occurring in local bays and

inlets. The type of benthic assemblages and habitat types that occurred was influenced by the physical features of the seabed and water quality characteristics. In parts of the areas of study, a mosaic of different assemblage types was present, which results from the heterogeneous physical characteristics of the seabed. In terms of status, the benthic assemblages and demersal fauna appeared to be in a better state at Il-Hofra ż-Żgħira compared to the waters along the power station site, particularly in relation to the case of seagrass (*Cymodocea nodosa* and *Posidonia oceanica*) habitats.

A number of species and habitats have been recorded to occur in the areas of study. These include:

- *Posidonia* beds (listed in Schedule I and Schedule III of the Flora, Fauna and Natural Habitats Protection Regulations, 2006; Appendix I of the Bern Convention and Annex II of the Barcelona Convention);
- The lesser Neptune Grass, *Cymodocea nodosa* (Appendix I of the Bern Convention, Annex II of the Barcelona Convention and Appendix I of the Bern Convention);
- *Cystoseria foeniculacea* (listed in Schedule III of the Flora, Fauna and Natural Habitats Protection, Regulations, 2006); and
- The Rock Urchin, *Paracentrotus lividus* (listed in Schedule VIII of the Flora, Fauna and Natural Habitats Protection Regulations, 2006 and Annex III of the Barcelona Convention and Appendix III of the Bern Convention).

IMPACT SIGNIFICANCE AND PREDICTIONS

The EIS indicates that the proposed development is expected to have the following effects on marine life:

- Release of particulate matter and increased turbidity due to construction-phase coastal engineering works: *Moderate to low significance*;
- Releases of oil/fuel and other contaminants from land-based activities and increased maritime activities due to construction-phase coastal engineering works: *Low significance*;
- Increases in sea vessel traffic during construction: *Low significance*;
- Physical alteration of the sea-bed due to construction-phase coastal engineering works: *Moderate significance*;
- Construction of rock armour for construction-phase coastal engineering works: *Low significance*;
- Changes in the hydrodynamics of the water body due to construction of the jetty, leading to reduced diffusivity of marine contaminants: *Insignificant*;
- Discharge of other wastewater streams from the CCGT and LNG facilities during operation: *Moderate to low significance*;
- Atmospheric fallout of LNG into the water column, via the re-gasification plant and LNG storage facilities during operation: *Low significance*;
- Disturbance and pollution through vessel activity during operation: *Low significance*;
- Thermal and chemical pollution via the re-gasification plant and LNG storage facilities during operation: *Low significance*.

PROPOSED MITIGATION MEASURES

- Good practice during coastal engineering works, adhering to a detailed Construction Management Plan (CMP).
- Measures to reduce the introduction of toxic substances and contaminants into the marine environment.
- Good operational procedures and supervision with adherence to the relevant standards, guidelines and conventions.
- Monitoring of water quality and benthic assemblages.

RESIDUAL IMPACTS

The residual impacts identified in the EIS are of *low significance* and are related to the following:

- Effects on marine life through the release of particulate matter and increased turbidity during construction;
- Effects on marine life, through changes in the hydrodynamics of the water body during construction and operation;
- Effects on marine life, through the discharge of other wastewater streams;
- Effects through atmospheric fallout of LNG into the water column;
- Effects through disturbance; and
- Thermal and chemical pollution during operation.

3.7 Agricultural Land and Soils

AGRICULTURAL LAND

The agriculture area of study (Figure 3-67 to Figure 3-70) assessed in the EIS is largely characterised by small-sized terraced dry land farm parcels located on shallow soils over a parent bedrock of Globigerina Limestone. The larger part is utilised for the production of a single winter crop, namely wheat. The edaphic conditions in the area, namely the shallowness of the soil and adverse climatic conditions (lack of rainwater and sea spray-laden winds) prohibit the successful completion of a single crop cycle. The EIS notes that the primary agricultural land use is the growing of wheat, with a few instances where legumes were sown to enhance crop rotation. A degree of crop rotation is still being practiced within the study area, which includes fallow land as well as a small number of vineyards and a few olive groves.

The main agricultural system is that of low-intensity traditional agricultural farming that is primarily influenced by limited soil depth and by prevailing salt-laden winds. Accessibility is also an issue in some of the areas within the area of study.

SOILS

The EIS indicates that the soils in the area of study can be mostly categorised as Terra soils from the upper range to the west and lower xerorendzinas to the east. Soils located in the area are typical of a hot, dry climate, particularly arid and semi-arid areas. Such soils are effectively weakly developed with typical ochric colour, of medium texture and well-drained, leading to low water-holding capacity and high permeability. Soil depth is variable, ranging between 10cm and 60cm, and is likely to reflect previous farming practices and erosion patterns.

IMPACT SIGNIFICANCE AND PREDICTIONS

In terms of agricultural land, the EIS indicates that the proposal shall not lead to any direct agricultural loss as a result of construction and operation of the DPS. Impacts on agricultural land due to dust generated during construction works during construction was determined to be of *low to no significance*.

PROPOSED MITIGATION MEASURES AND RESIDUAL IMPACTS

The EIS indicates that good construction site practices would effectively mitigate any impacts on agricultural land, leading to no residual impacts.

3.8 Cultural Heritage: Coastal and Marine

The study carried out to assess marine archaeology and coastal and marine cultural heritage was carried out through a marine magnetometer survey with an accompanying sub-bottom profiler survey. Single beam bathymetric data was derived from the first seafloor reflector as recorded by the sub-bottom profiler. Furthermore, a desk-top study, a diver survey and an analysis of remote sensing data was also carried out.

The marine archaeology study covered the site illustrated in Figure 3-73 and 3-74 in the EIS Coordinated Assessment and was based on the following:

- *Disturbance factors in Maltese bays and harbours:* Dredging, anchoring, propeller wash, World War II bombs and local fishing habits.
- *Discoveries from an underwater context:* Over the past decades, a number of archaeological objects have been discovered and raised from the seabed at Il-Port ta' Marsaxlokk, including (non-exhaustive list): one partial amphora of the late Roman period; a ceramic artefact dating back to the Arab period and other ceramic fragments; a large bronze cannon; and pottery fragments.
- *Diver survey:* The EIS indicated that there are no significant archaeological deposits present on the seabed in the area of study.
- *Sub-bottom survey targets:* 9 sub-bottom targets were located, varying in size from 6m to 20m, and it was determined that the objects detected in this survey do not coincide with any known archaeological sites or objects but may still be of cultural heritage value.
- *Magnetometer survey targets:* The quantity of targets identified by the magnetometer survey indicates that many pieces of modern debris may be lying on the seabed in the study area.

IMPACT SIGNIFICANCE AND PREDICTIONS

The EIS notes that the significance of impacts associated with damage and obliteration of cultural heritage on the seabed during the construction works for the jetty may vary from *high to low*, for the above-mentioned reasons.

PROPOSED MITIGATION MEASURES

Proposed mitigation measures include exploration of the seabed and sediment, together with monitoring of works.

RESIDUAL IMPACTS

The EIS indicates that further exploration and monitoring would effectively mitigate any impacts on marine archaeology, leading to no residual impacts.

3.9 Cultural Heritage: Terrestrial

A cultural heritage study was carried out as part of the EIS, after the quantitative risk assessment report prepared as part of the same EIS indicated that in case of a major accident, some cultural heritage features located close to the Delimara Power Station site may be affected. The study consisted of both desk-top and field research, and covered the two terrestrial sites (Areas A and B) that could be potentially affected by the proposed development (Figure 3-109 of the EIS Coordinated Assessment refers).

The historical importance of the area dates back to the prehistoric period, with the multicultural site of Tas-Silġ located approximately one kilometre north of the Delimara Power Station. The strategic importance of Tas-Silġ continued throughout the Classical period, particularly during the Phoenician and Roman periods and also in the medieval period, through the Paleochristian and Arab era. During the Knights' Period, the vulnerability of the Marsaxlokk area to attacks by the Ottoman Turks led to the decision by the Grandmaster Alof de Wignacourt to commission a set of coastal towers, including It-Torri ta' San Luċjan in 1610, as a first step to defend the coast of Marsaxlokk Bay. In 1658, smaller coastal towers were commissioned by Grandmaster De Redin, including the ones built at Xifer l-Infern (Delimara) and Xrobb l-Għaġin. Furthermore, throughout the 18th Century, three harbour batteries were constructed: the San Luċjan battery (in front of It-Torri ta' San Luċjan, subsequently demolished and replaced by Fort San Luċjan in the 19th Century), the battery known as It-Trunciera tal-Wilġa (still largely extant near the main road

leading to the power station, albeit in a bad state of repair) and the battery at Ras it-Tumbrell (of which only vestiges survive). The strategic importance of Marsaxlokk was further acknowledged during the British period, where a number of forts were built, including: Il-Fortizza ta' Delimara, Il-Forti San. Luċjan, Il-Forti Tas-Silġ, St. Paul's Battery (also known as Il-Fortizza taż-Żebbuġ), Wolseley Battery (also known as Il-Fortizza tal-Basal) and Il-Fortizza ta' Bengħisa which lies well away from the area of influence of the proposal. Other complementary elements that needed to be erected included: Tal-Bies Position Finding Station, a lighthouse (Il-Fanal ta' Delimara) near the tip of the Delimara peninsula which included a Fresnel lantern, a number of pill boxes, beach posts and Heavy Anti-Aircraft batteries.

Within the area of study (Figure 3-111 in the EIS Coordinated Assessment), a list of recorded cultural features and their proposed protection is provided in Table 3-50. Such features include vernacular features such as farmhouses and field rooms (DLM13/001, DLM13/003, DLM13/005 and DLM13/006). In terms of rubble walls (Figure 3-112 in the EIS Coordinated Assessment), 39 per cent of those surveyed were considered to be in good condition (Grade A). With respect to military features, the area of study included the following features: Tal-Wilġa battery (DLM 13/002), the Tal-Bies Position Finding Station (DLM13/007), a circular stone-clad pillbox (DLM 13/009) and parts of Wolseley Battery (DLM13/010).

IMPACT SIGNIFICANCE AND PREDICTIONS

The EIS indicates that since the proposed development is within the footprint of the already-existing power station, and the areas earmarked for development are located on already developed land, the possibility of uncovering new archaeological material is minimal and thus the impact on cultural heritage in this scenario is considered to be *insignificant*. In terms of the worse-case scenario, the EIS notes that in the event of ignition points from the DPS igniting the gas cloud (as indicated by the preliminary risk assessment report), the area covering all the cultural sites from DLM13/002 to DLM13/10 to Delimara Lighthouse and Fort Delimara may be significantly affected.

PROPOSED MITIGATION MEASURES AND RESIDUAL IMPACTS

In light of the above, the EIS indicates no mitigation measures are being proposed and no residual impacts are envisaged.

3.10 Air Quality

The air quality report was based on air dispersion modelling, utilising the following models:

- AERMOD for the long term annual runs (hourly resolution), point sources and including the local background;
- AERMOD/TRAFFIC for high resolution line sources/traffic;
- CAM_x nested grid for the regional background (starting with a 2,400km domain around Malta); and
- MM5, 3D prognostic non-hydrostatic meteorological model.

The runs generated by the above-mentioned models compared the relative and absolute changes which would be created by the proposed CCGT plant in various combinations of assumptions regarding emissions. These include the switch to gas at the DPS and the decommissioning of specific components of the plants at both the Marsa power station and the Delimara power station. The baseline scenario and the results from the numerical air quality simulation models were also taken into account.

The air quality study was based on scenario analysis, using simulation models, with more than 350 annual model runs executed as hourly resolution runs. These runs were performed with detailed hourly and distributed (1km resolution) meteorological data for five years (2008 – 2012), together with a range of measures and indices of air quality and regulatory compliance, based on the Air Quality Directive (Directive

2008/50/EC). The EIS states that the study utilised worst-case assumptions and explored various ranges of assumptions.

BASELINE SCENARIO

The baseline scenario analysed by the EIS considered the following point, area and line sources:

- The Marsa Power Station and OCGT;
- The Delimara Power Station steam turbines, and CCGT plants (DPS 1, DPS 2A and DPS 2B), together with the recently installed medium speed diesel engines and steam turbine of DPS 3 running on gasoil or heavy fuel oil (HFO);
- Minor point sources: Malta Waste Incinerator, Oil Tanking Malta, 31st March 1979 installation in Birżebbuġa, the Wied Dalam fuel depot and a number of stone crusher operations;
- Area sources, namely Malta International Airport, the Grand Harbour, the Malta Freeport Terminal and San Luċjan Oil Company Ltd; and
- The road network, for traffic generated emissions.

The EIS notes that the annual average for the baseline scenario in terms of total emissions² for NO_x is estimated at 397g/s while that for PM₁₀ is 145g/s. However in order to provide more realistic estimates, the study provided load-corrected emission estimates³, based on Tier 2 estimates (EEA/EMEP emission factors) and the 2012/2013 load factors for the energy sector point sources. In this regard, the annual averages for the baseline scenario are estimated as 275g/s NO_x and 27.2g/s PM₁₀.

Tables 3-35 and 3-36 of the EIS Coordinated Assessment provide a yearly assessment (2008–2012) of both the NO_x and PM₁₀ values. The air quality model indicates that there are few exceedances of the hourly maxima in terms of NO_x at the sensitive receptor points⁴ for most years, all below the regulatory maximum of 18 annual exceedances, except for 2008. In terms of PM₁₀, the corresponding values yield an annual average maximum within 15km impact radius of 17.4µg/m³, which is below the EU limit value of 40µg/m³. The EIS also provides an analysis of the baseline scenario for the energy sector only, including sources from the Marsa power station and the Delimara power station, excluding all other point, area and line sources.

IMPACT SIGNIFICANCE AND PREDICTIONS

In terms of air quality impacts, the EIS considers the latest proposal by the applicant, viz. the plant having three gas turbines plus a steam turbine and three 75m-high stacks and another three 30m-high by-pass stacks. A number of scenarios/combinations have been simulated for the three stack configuration, over a five year period (2008 – 2012) as follows:

- DPS/CCGT – 3 stacks – base emissions – background levels;
- DPS/CCGT – 3 stacks – base emissions – no background readings;
- DPS/CCGT – 3 stacks – load corrected emissions – background levels;
- DPS/CCGT – 3 stacks – load corrected emissions – no background readings; and
- DPS/CCGT – 3 stacks – incremental contributions.

² Base set emission estimates are based on measured flue gas concentrations and estimated (reported) flue gas volumes. Base set emissions estimates are based on stack monitoring (pollutant concentrations and gas flow). The availability of such data is limited and characterized by high temporal variability.

³ Load corrected emissions refer to estimates based on capacity (thermal or electrical power rating, efficiency), fuel and boiler burner technology corrected by the actual, average load (actual power generation as a fraction of design capacity) of the sources.

⁴ Table 3.38 in the EIS Coordinated Assessment provides a list of the 23 sensitive receptor locations, while Figure 3-87 illustrates the location for each of the sensitive receptors.

The EIS notes that the final configuration of the proposed development (with three stacks) has no significant impact on the estimated ambient concentrations in terms of compliances with the respective national and EU legislation, and if anything, the results indicate improvements over the original configuration (one stack) and emission data. The indicated NO_x concentrations remain more or less the same (and within the range of the inter-annual variability) and with the revised stack and emission data provided by the applicant, yield very closely the same NO_x emission as that communicated previously and used for the original single stack configuration simulations (9.18g/s versus 10.15g/s).

The incremental contributions from the three stack configuration (limit value of 3% of the annual average NO₂ concentration or 1.2µg/m³) estimated are well below that limit value for the reported stack (75m) and emission data. No violations of the 1.2µg/m³ target are predicted at any of the sensitive receptor locations, but also there is no increase in the hourly exceedances in the immediate vicinity of the stacks.

Impacts from the alternative CCGT configurations in terms of PM₁₀ are negligible, well below the impacts from the original single stack configuration. The alternative three-stack configuration has no negative impacts in terms of PM₁₀.

During the first six months of commissioning of the new power plant, this would be operated as an OCGT (Open Cycle Gas Turbine), with emissions passing through the 30m-high by-pass stacks. Two scenarios were analysed in the study:

- DPS/OCGT – Three 30m stacks – Natural gas; and
- DPS/OCGT – Three 75m stacks – Natural gas.

The EIS indicates that the two configurations (OCGT and CCGT) differ in terms of physical stack height, stack-emission parameters and the resulting dispersion patterns. Whilst assuming identical operational/load conditions, the dispersion-related differences are the stack heights for the OCGT and CCGT (30 and 75m, respectively) and flue gas temperatures and velocities, the latter being considerably higher for the OCGT configuration. This mostly compensates for the lower physical stack height. The EIS notes that physical stack height and the plume rise (the virtual stack) influence dispersion in opposite ways, and are subject to the meteorological conditions, which makes the combined effect non-intuitive.

Based on the balance between the effects of the different (higher CCGT) physical stacks and the (higher OCGT) virtual stack height or plume rise due to higher temperature and flue gas velocities for the OCGT configuration, the comparison of the scenarios indicates that:

- Average NO_x concentration values are lower (up to 50%) for the OCGT configuration (30m, hotter, faster); and
- Maxima of the NO_x concentrations are lower (close to 10%) for the CCGT configuration (75m, cooler, slower).

This generally suggests 'better' overall, long-term dispersion from the OCGT, but at the same time a higher sensitivity to extreme weather situations that can lead to maxima of short-term concentrations and suggests that the (very small absolute) differences expected between the two configurations may also depend on, and vary with, the period of implementation.

For both configurations, all values are well below any applicable air quality standard or limit value, including the 1.2µg/m³ incremental contribution limit.

Impacts associated with air quality can be summarised as follows:

- Impact on air quality due to dust generated during the construction works: *Low to insignificant*.
- Impacts on air quality due to emissions of pollutants and greenhouse gases (GHG) during operations: *High beneficial significance*.

PROPOSED MITIGATION MEASURES

- Good construction site practices through the implementation of a detailed Construction Management Plan (CMP).

- Minimise the use of gasoil at a national level and focus on gas and renewables.
- Regular on-site inspections.
- Detailed air quality monitoring programme, based on continuous (hourly) multi-parameter minimally monitoring of the pollutants addressed by Directive 2008/50/EC on Ambient Air Quality and a Cleaner Air for Europe, air quality modeling, air quality simulation and an operational real-time monitoring, data management and simulation system.

RESIDUAL IMPACTS

In terms of residual impacts, a *low beneficial* residual impact was identified in terms of emissions of pollutants and greenhouse gases (GHGs) during operations.

EPD Comment (5): *The Environment Protection Directorate agrees with the EIA Coordinator's proposal with respect to the requirement for a detailed air quality monitoring programme during operation of the new plant. Such programme would include air quality modelling, air quality simulation and an operational real-time monitoring, data management and simulation system.*

3.11 Climate Change

In terms of impacts on climate change, the EIS notes that it is expected that the proposed CCGT plant and LNG facilities will aid Malta into lowering its greenhouse gas (GHG) emissions. The high efficiency of a CCGT plant and the possibility of one of the gas turbine (GT) units being switched off in times of lower electricity demand would also contribute to a reduction of CO₂ emissions from the site:

- The expected net heat rate of the proposed CCGT plant operated on gas is 6865MJ/MWh;
- The expected net heat rate of the converted engine operated on gas is equivalent to 47.6% net efficiency;
- By comparison, the net heat rate of the existing un-converted engine operated on HFO is equivalent to 48.1% net efficiency; and
- The CO₂ emissions per MWh for the various plants are: (i) new CCGT plant: 0.38t/MWh; (ii) the converted DPS 3 on gas: 0.42t/MWh; and (iii) existing unconverted DPS 3 on HFO are 0.58t/MWh.

3.12 Noise

BASELINE NOISE SURVEY

The noise assessment (Figure 3-88 of the EIS Coordinated Assessment) carried out in the EIS was based on the construction of a 3-dimensional spatial model of the area of concern in order to simulate the propagation of individual noise sources inside the Delimara Power Station. The model was based on the following: (i) geo-spatial data; (ii) calculation methods for the model set to ISO 9613-2:1996 with an assessment period of an L_{Day} 07:00 to 23:00 and an L_{Night} 23:00 to 07:00; and (iii) BS 4142. The preferred measurement approach for the proposed development was determined to be ISO 9614-2:1996.

The noise sources that were measured within the DPS boundary were identified as follows:

- DPS Phase 1 complete with sheds, doors left open, fan assisted transformer and stacks;
- Extra high voltage (EHV) section – fan-assisted transformers and air-conditioning external units;
- Phase 2A OCGTs – emergency units and their fan-cooled systems;
- Phase 2B complete with stacks;
- Phase 3 complete with engine shed, auxiliary building door openings and stacks;
- Fuel pumping area – openings and shed;
- VOC/Urea pump areas;
- Seawater cooling pumps; and
- Pumps at rear of demineralization shed and water storage.

In terms of sensitive receptor locations, the EIS identified three locations for measurements (Figure 3-91 in the EIS Coordinated Assessment):

- PM1 and PM2, referred to as *noise sensitive positions* (located to the north and south of the DPS site respectively). These noise sensitive points were selected given that the said locations have the most exposed façades and are the nearest and most exposed noise sensitive positions/receptors. One such noise sensitive point is an area where there are at least five family groups living in proximity to the DPS area boundary (within 200m). The EIS also notes that the measurement locations were considered to be optimal in terms of validation of the noise model; and
- SM1 as *secondary measurement position* located to the west of the roundabout between Triq il-Power Station and Triq Tas-Silġ.

In terms of the current situation, the results indicate that at a two-metre height, parts of Marsaxlokk (mainly the waterfront to the south-west of il-Magħluq) are presently subject to noise levels between 35 to 40 dB L_{Aeq} over a day or night period. Such levels are not audible outside during the day but will be heard under the right conditions at night time (Figures 3-107 and 3-108 in the EIS Coordinated Assessment refer).

With the existing situation, no residence is currently being affected during the day except for the residence in the vicinity of DPS to the south (PM2). The EIS indicates that during night-time, the possibility of DPS being heard along the waterfront is likely but the level is not sufficiently significant to disturb residents inside their homes. However, the situation would be significantly different under emergency conditions at night, whereby the areas of Il-Wilġa and Il-Kavallerizza would be affected with a noticeable change in noise levels with a moderate impact.

IMPACT SIGNIFICANCE AND PREDICTIONS

The EIS notes that the noise profile, in terms of the final configuration of the proposed development, would have an impact on receptors in the following locations:

- The Marsaxlokk waterfront, with the EIS indicating that there is a high probability of introducing audible tonal components into the local environment, similar to the smaller-scale localised situation when the emergency turbines are used;
- The DPS administration building and entrance gate, workshop and office building;
- Parts of Birżebbuġa; and
- Residents in the vicinity of the DPS.

In terms of the Environmental Noise Directive (Directive 2002/49/EC), the EIS concludes that the scenario with the final configuration of the proposed development would be well within limits for both façade protection to the residents in Marsaxlokk and within the existing noise profile.

In this regard, impacts associated with noise can be summarised as follows:

- Impacts from noise generated by construction equipment, mainly during excavations: *Moderate significance*.
- Impacts from noise generated by CCGT and LNG during normal operations: *Low to insignificant significance*, depending on the location of sensitive receptors.

PROPOSED MITIGATION MEASURES

- Submission of a detailed Construction Management Plan (CMP).
- Use of enclosures around the gas turbines (GTs) and heat recovery steam generator (HRSG) and silencers as per BREF document regarding Large Combustion Plants. The EIS also proposes that the re-gasification unit be enclosed in a shed-like structure, in order to maintain small or no changes in level at the nearest property building.

- Monitoring noise generation in locations determined by the EIS Coordinated Assessment (carried out pre- and post- installation of the CCGT).

RESIDUAL IMPACTS

In terms of residual impacts, a *low to insignificant* impact was identified in terms of noise generated by the CCGT and LNG operations, following the use of noise-abatement measures such as enclosure and silencers.

3.12 Environmental Risk

The aim of the preliminary quantitative risk assessment (QRA) is the following:

- Comparison of the risk level of the different initial alternative options regarding the location within the DPS site of the CCGT plant and the LNG facilities; and
- In the event that the risks of major accidents of one or more of these options were found to be unacceptable, make alternative proposals.

The EIS notes that the focus of the QRA was the location of the LNG receiving, storage and re-gasification facilities. Table 4-100 in the EIS Coordinated Assessment indicates the main differences between the LNG facilities as tested in the first draft EIS and those tested in the third draft EIS. The options originally studied are as follows:

- Option A (Figure 2-2): Location of a CCGT in Area A and an onshore natural gas storage;
- Option B (Figure 2-3): Location of a CCGT in Area A and an alternative between an FSU and FSRU; and
- Option C (Figure 2-4): Location of the CCGT plant in the southern side of the DPS site (Area B) with an FSU/FSRU adjacent to it.

The results from the preliminary QRA noted the following main aspects: (i) maximum extension of the gas clouds; (ii) individual risk contours; and (iii) societal risk FN curves (where F is the cumulative frequency of accidents with N or more deaths). The main points arising from the preliminary QRA are as follows:

- The alternative options evaluated earlier in the process were engineered as a first step in order to carry out the preliminary QRA and such options are based on general risk assumptions. The EIS notes that final configuration of the proposal may vary significantly with respect to engineering the assumptions made in the initial part of the EIS process.
- The comparison between the three alternative options using the risk contours shows that Option A presents the largest individual risk to some of the scattered houses near the power station. Option C was considered the best option in terms of minimising risks to the population. Option B could also be adopted as long as the re-gasification unit is relocated as far as possible from the DPS and as close as possible to the unloading facilities.
- The comparison between the three options using the extension of the gas cloud contour, demonstrates that for the three options a flammable gas cloud can travel to the DPS and possibly find an ignition point.
- The possibility to locate both Options B and C in the inner part of the harbour was taken into account and a suitable location for the jetty is presented in the final configuration of the proposal in order to remove most of the possible flash-fires which may be generated from the ignition of the flammable gas cloud.
- An FSRU (Option C) or a FSU plus a re-gasification unit located in the recommended zone (i.e. Option B plus the location of the re-gasification unit as per Option A) is the preferred choice in order to minimise the individual risk to the population as well as to minimise the damage to the DPS in case of flash-fire. However, the risk assessment indicates that such locations may have problems

from a nautical perspective given that such a location may lead to an increase in the probabilities of a collision with a manoeuvring ship or for damage in the FSRU or FSU itself due to high waves, storms and other atmospheric phenomena, against which the tanker would not be protected.

In summary, the EIS notes that:

- The data related to the detailed specifications of the plant and its final layout as provided by the applicant suggest that the projected plant fits into the data and layout originally assessed and proposed by the risk assessment consultant;
- The location of the jetty and the FSU proposed by the applicant fits in the recommended area in order to minimise ignition of gas cloud in the existing DPS;
- The required recalculation of scenarios has been carried out when required with negligible impact on the result of the risk contour estimation; and
- Introduction of hoses instead of arms is not quantifiable in the risk contour due to lack of evidence in the comparison of frequencies in their respective sources of information.

EPD Comment (6): *In terms of environmental risk, the EPD notes that issues related to the risk from the proposed development on the different environmental aspects were dealt separately in the different sections of the EIS, and therefore any comments related to worse-case scenarios are discussed in the previous sections.*

EPD Comment (7): *The Environment Protection Directorate (EPD) takes note of the conclusions of the preliminary quantitative risk assessment and agrees with the EIA Coordinator in that both a nautical risk assessment and a harbour risk assessment are to be carried out by the applicant, to the satisfaction of the relevant competent authorities. Furthermore, a more detailed quantitative risk assessment (QRA) would also be required to enable the determination of the following:*

- *The establishment of risk zones around the Delimara Power Station complex;*
- *The prevention and minimisation of risks in connection with the requirements of both the Industrial Emissions Directive (Directive 2010/75/EU) and the Seveso Directive (Directive 2012/18/EU); and*
- *The drawing up of contingency measures required to ensure a state of readiness in case of emergencies of different types, including major accidents with reference to the Seveso Directive and the drawing up of the necessary harbour management plans and emergency procedures.*

3.13 Impacts on Human Populations

3.13.1. Health impacts

The assessment of health impacts carried out as part of the EIS takes note of the findings of the air quality, noise, quality of the marine environment and social impact, while taking into consideration both the current situation regarding known hazards and their health effects, together with any new hazards arising from the proposed development. The study assessed the benefits and potential hazards following the proposed conversion to a natural gas-based power plant. The EIS identifies the following as the expected changes and health impacts of the proposal:

- *Air pollution:* The EIS envisages a general positive effect on health and reduced respiratory illnesses (including mortality) should be expected, especially when considering the energy sector as an individual contributor to air pollution in Malta.
- *Greenhouse gas emissions:* The EIS discusses that the move towards a cleaner source of fuel would lead to both environmental and health benefits.
- *Noise pollution:* Noise pollution studies have indicated that there will be a negligible increase in noise pollution levels but this is within recognised safe EU health limits. In turn, in the 2015+

scenario, noise levels are not expected to increase significantly, subject to effective mitigation as proposed in the EIS. Moreover, during construction no negative health impacts are anticipated.

- *Water pollution:* Water quality changes are expected to be minimal, with low to negligible health impact.
- *Waste:* In terms of waste, the EIS predicts a positive health impact on both the local population and the workers on site, particularly during operations, given that: (i) the new plant shall be reducing the risk of a toxic waste spill from hazardous waste arising from HFO plants; and (ii) natural gas is a cleaner fuel which is expected to generate no solid waste. During transportation, transfer of LNG and overall operations, as long as adequate health and safety precautions are duly taken, no negative health effects should be expected. During construction, no significant impacts are expected as long as the necessary mitigation measures are effectively implemented.
- *Risk assessment:* The EIS notes that the following LNG hazards may occur, albeit highly unlikely: (i) cryogenic burns; (ii) asphyxiation; (iii) explosions and spill risk; and (iv) leakage and gas cloud.

The risk associated with natural disasters was also considered and indicated the major hazards as being: earthquakes, tsunamis and fires. The EIS notes that, however remote or unlikely such eventuality actually is, personnel on site should be adequately trained to tackle such situations.

3.13.2. Social Impacts

In terms of social impacts, the EIS indicates that the majority of the stakeholders perceive that the proposed new power plant is not expected to have a drastic and harsh impact on the communities in question. Most of the stakeholders interviewed as part of this EIS, particularly residents, welcomed the construction of the new power plant on the basis that they perceived the new construction as a 'greener' and 'eco-friendlier' option compared to the present power station, albeit objections, resistance and concerns still remained.

With respect to the preferred building options, the majority of the stakeholders interviewed expressed a preference for the storage facility to be situated on board a floating vessel rather than a land storage facility on the basis that this option would be visually more acceptable. Furthermore, a large majority of respondents (those from Marsaxlokk) preferred having the storage and re-gasification facility outside the port (and therefore unseen from land) given that such possibility would be safer, less visually intrusive, and less in the way of fishermen vessels. In terms of mitigation, a number of possibilities were provided by the respondents: maintaining access to the boats, sustainable security plans, planning gains (e.g. creating a national family park, day centre for older persons, residential/nursing home for older persons, enclosure of the water polo pitch), local management committee and detailed health/safety plans.

3.14 Infrastructure and Utilities

The EIS notes that the DPS infrastructural network (both internal, external and distribution) will not be affected by the new CCGT plant. The electricity produced by the new plant will be distributed through the existing network, which is continuously being upgraded in order to minimise losses through the distribution system.

3.15 Public Access

The EIS indicates that the DPS is not, and should not, be accessible to the public except when interested members of the public apply for access for educational purposes.

4. ENVIRONMENT PROTECTION DIRECTORATE COMMENTS AND CONCLUSIONS

The Environment Protection Directorate acknowledges that the main justification for the proposed development is based on: (i) the National Energy Policy for the Maltese Islands, 2012, (ii) the economic considerations, and (iii) commitments with reference to EU environmental and energy policies. The Directorate also notes that the proposal was made in response to a policy decision made by the Government of Malta that, as from spring 2015, base-load electricity should be sourced by Enemalta from an independently owned, high-efficiency power plant powered by natural gas. The proposal is intended to contribute towards an overall reduction in air pollution and is expected to function more efficiently in terms of fuel use and energy efficiency.

As discussed in the above sections, the EIS has predicted a number of potential impacts on the environment as a result of the proposed development, some of which are potentially of *high significance*. The mitigation measures proposed in the EIS are aimed at minimising the predicted impacts, however despite the mitigation measures, impacts on the landscape character and visual amenity of the Delimara peninsula, Marsaxlokk and Birżebbuġa are of high significance and cannot be effectively mitigated. The Environment Protection Directorate (EPD) agrees with these conclusions of the EIA Coordinator. Whilst there are no significant concerns from a landscape and visual amenity point of view vis-à-vis the location of the CCGT plant (including the location of the three primary stacks and the three by-pass stacks) and the onshore re-gasification facility, the introduction of the FSU shall lead to an additional significant impact in the landscape character and visual amenity of the port of Marsaxlokk which is difficult to eliminate. Nevertheless, the EPD is requesting a detailed 'landscaping' scheme (e.g. camouflaging, design of structures and materials, colour treatments and textural finishes to aid integration with the surroundings and thus minimise impacts), also taking into account any requirements arising from both the Industrial Emissions Directive and the Seveso Directive.

In terms of overall risk implications, the Environment Protection Directorate (EPD) notes that these are largely beyond the Directorate's remit, and in this regard takes note of the conclusions of the preliminary quantitative risk assessment and agrees with the EIA Coordinator's recommendation in that both a nautical risk assessment and a harbour risk assessment need to be carried out by the applicant, to the satisfaction of the relevant competent authorities (e.g. Transport Malta, Operational Health and Safety Authority and the Civil Protection Department). Furthermore, a more detailed quantitative risk assessment (QRA) is also required to enable the determination the following:

- The establishment of risk zones around the Delimara Power Station complex;
- The prevention and minimisation of risks in connection with the requirements of both the Industrial Emissions Directive (Directive 2010/75/EU) and the Seveso Directive (Directive 2012/18/EU); and
- The drawing up of contingency measures required to ensure a state of readiness in case of emergencies of different types, including major accidents with reference to the Seveso Directive and the drawing up of the necessary harbour management plans and emergency procedures.

Moreover, aside from mitigation measures emerging from the EIS which should be included as part of the development permit application, the Environment Protection Directorate is also including additional recommendations in terms of monitoring, with respect to: air quality (including air quality modelling, air quality simulation and an operational real-time monitoring, data management and simulation system), noise and the marine environment (marine ecology, marine water bodies and marine archaeology). A comprehensive construction management plan (CMP) is also being requested to holistically address the entire range of issues relevant to the construction-phase works. Such requirements, along with other permit conditions can be found in the attached document.

With respect to alternatives, the EPD notes that the EIS has provided an overall outline of the main alternatives considered for the proposed developments and has provided the main reasons for such choice,

also noting the relevant environmental effects and their prevention, in line with the requirements of Section 2 of the Terms of Reference dated July 2013 and of the EIA Regulations (Legal Notice 114 of 2007, as amended). In this regard, the EPD would also like to clarify that, since any future proposals associated with an offshore location of the FSU are not incorporated into the currently proposed plans, they would need to be subject to all the required environmental assessments.

The Environment Protection Directorate's assessment as summarized in this report is primarily concerned with the *environmental* implications of the proposal, and is without prejudice to any other potentially relevant considerations (e.g. evaluation of safety risks, navigation and port management issues, etc.) falling within the competence of other authorities.



EIA Projects

PA File No.: PA/00021/14 and PA/00022/14

ERA Reference: EA/00014/13

Project Title: Delimara Gas and Power – CCGT (Combined Cycle Gas Turbine Power Plant) and LNG (Liquified Natural Gas) Receiving, Storage and Regasification Facilities, at, Delimara, Marsaxlokk

Location: Delimara, Marsaxlokk

Project Description Statement: N/A

EIA Screening Report: N/A

Status: Concluded

EIA Terms of Reference Consultation Period: 04/06/2013 - 25/06/2013

Terms Of Reference: [EIA Terms of Reference](#)

EIA Report: [EIA Report](#)

[Coordinated Assessment Part 1](#)

[Coordinated Assessment Part 2](#)

[Coordinated Assessment Part 3](#)

[Coordinated Assessment - Drawing 1](#)

[Coordinated Assessment - Drawing 2](#)

[Coordinated Assessment - Photomontages](#)

[Coordinated Assessment - Summary of Impacts](#)

[Coordinated Assessment - Comments & Responses](#)

[Coordinated Assessment - Comments & Responses following Public Hearing](#)

[Appendix TORs](#)

[Qualitative Risk Assessment](#)

[Appropriate Assessment](#)

Consultation Dates on EIA Report: 23/12/2013 - 24/01/2014

Public Hearing Date: 27/01/2014

Public Hearing Location: Primary School, St. Thomas More College, Marsaxlokk

Deadline for Comments: 03/02/2014

Minutes of Public Hearing: [Minutes - 2014](#)

ERA's assessment & recommendation: [EPD Report - 2014](#)

EIA Report Addendum 2016: [EIA Report Addendum 2016](#)

Public Hearing Date: 18/11/2016

Public Hearing Location: Primary School, St. Thomas More College, Marsaxlokk

Final EPD Report - 2016: [Final EPD Report - 2016](#)

Coordinator Statement following changes to project: [EA/00014/13 - Coordinator Statement](#)

ERA Correspondence: [EA/00014/13 - ERA Correspondence](#)

Responsible authorities and nature of decisions:

- the authority responsible for the Environmental Impact Assessment process: ERA
- the nature of the decisions to be taken: development consent decision
- the authorities responsible for the development consent decisions: Planning Authority

The Environment and Resources Authority shall safeguard the environment to achieve a sustainable quality of life.

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 Environment and Resources Authority
Hexagon House
Spencer Hill
Marsa, MRS 1441

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