----ENEMALTA DPS IPPC APPLICATION - FORM C----

APPENDIX E – Enemalta Safety Report - Part 1

0466 – Enemalta DPS IPPC Application

Enemalta plc.
Ing. Fredrick Azzopardi,
Central Administration Offices,
Church Wharf,
Marsa.

Date of Version Issue	*11/10/16*
Report Version number	*Rev 01*

Revision History

Version	Revision	Date	Purpose/Status
01	01	11/10/2016	Submission for consultation

Appendices Reference

Reference	Document Title
Appendix A	Reference Drawings
Appendix B	Best-Available-Technology Conclusions
Appendix C	Material Safety Data Sheets
Appendix D	Maintenance of Tank Bunds
Appendix E	Enemalta Safety Report
Appendix F	Enemalta Safety Management System
Appendix G	Enemalta Emergency Response Plan
Appendix H	Coordinated Safety Report
Appendix I	Coordinated Safety Management System
Appendix J	Coordinated Emergency Response Plan
Appendix K	Sewer Discharge Permit
Appendix L	VOC Abatement System Report
Appendix M	Enemalta DPS - Noise Monitoring Method Statement
Appendix N	DPS Noise Monitoring Reports 2014 & 2015
Appendix O	NEC Emissions Calculations Letter
Appendix P	Technically Competent Person - CV
Appendix Q	Decommissioning Plan
Appendix R	Expenditure Plan
Appendix S	EMS Documentation & ISO Certification
Appendix T	Environmental Impact Assessment

SAFETY REPORT

ENEMALTA PLC

AS REQUIRED BY LN179/2015 CONTROL OF MAJOR ACCIDENT HAZARDS

Barcelona, October 10th, 2016

Report nº.: 02-901-200560-15958

Review 0.4

Prepared for:

Enemalta plc

Prepared by:	Reviewed by:	Approved by:
Ms. Andrea Silva Process Safety Senior Consultant SGS Tecnos SA	Mr. Roberto Vaccari Process Safety Development Manager SGS Tecnos SA	Sylvana Scicluna Enemalta plc

DISCLAIMER

Unless otherwise agreed, orders are executed in accordance with the latest version of the SGS' General Conditions. Upon request the conditions will again be sent to you. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any holder of this document is advised that information contained herein reflects the company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

CONTENTS

SCOPE

This Safety Report identifies the hazards, assesses the risk and lists the safeguards available in order to provide protection for people and the environment from major accidents which could arise from the activities carried out at the ENEMALTA facilities in Delimara, Malta.

The scope of this review of the Safety Report includes all the facilities, considering several phases of operation, according to the planning for the conversion of the facilities for combustion of natural gas as the principal source of energy.

In other words, the scope of this document includes the loading, unloading, storage and transfer operation in the power plant, both for gas oil and fuel oil, as it happens in the current situation, but also the use of diesel oil only in the power plant and storage of both HFO and gasoil fuels, as it will happen in the future. Hazards associated to the transitory construction activities that will be carried out at the facilities have been specifically detected during the HAZOP and HAZID workshops prior to the preparation of the Safety Report and have also been considered in the document. The report assesses the hazards normally due to standard operations. Commissioning, start-up, shut-down and switch from one mode of operation to others have not been taken specifically into account and are not specifically mentioned in the report, but are fully included in the overall risk assessment. In fact, in this kind of power plant, the start-up, shut-down and switch from one mode to another is part of the standard operation and is carried out on a daily basis.

The handling of natural gas has been considered out of scope of the report, both for the current and the future situation, being the natural gas facilities not owned nor operated by ENEMALTA, even if the pipelines will cross the ENEMALTA site. The natural gas handling will be covered by the Safety Report prepared and submitted by the owner of the pipelines. Of course, the presence of new natural gas pipelines within the facilities will introduce an additional risk of gas leakage and gas fire and, more important, the possibility for a domino effect to happen within the facilities. This domino effect shall be understood as external domino effect and shall be assessed in cooperation between the different stakeholders. For this reasons, this domino effect is considered out of scope of this document and will be assessed in the Coordinated Safety Report.

Other existing facilities, handling other chemicals or the turbine cycles handling water / steam are also considered out of scope, being these substances not included in the Seveso III Directive.

This document complies with the requirements of the Seveso III Directive[1], which has been implemented into the Maltese law as the Control of Major Accident Hazard Regulations 2015 ("COMAH"). The enforcing body for this law is the Competent Authority ("CA") set up jointly by the Occupational Health and Safety Authority ("OHSA"), the Malta Environment and Planning Authority ("ERA") and the Civil Protection Department of the Ministry for Justice and Home Affairs ("CPD"). The Seveso III Directive has been implemented into the Maltese law by the L.N. 179 of 2015. For this reason, this Safety Report has been prepared in compliance with the requirements of the Directive and the local legislation, in particular addressing the new requirement for Fuel oil. ENEMALTA facility is an upper tier site under COMAH and, as required by article 8, the objective of this Safety Report is to demonstrate that the site has a policy with respect to prevention of major accidents that is designed to guarantee a high level of protection for persons and the environment. This is to be achieved by:

- Taking appropriate measures, in connection with the various activities involved in the establishment, to prevent major accidents, and
- Providing appropriate means for limiting the consequences of major accidents, both on-site and off-site.

In accordance with COMAH Schedules II and III, this Safety Report comprises the following elements:

- A summary of ENEMALTA's Major Accident Prevention Policy ("MAPP") and Safety Management System ("SMS");
- A description of the site activities, environment and surroundings;
- Identification and analysis of major accident risks to the environment and people at the site;
- Measures of protection and intervention to limit the consequences of an accident.

This Safety Report for the ENEMALTA facility has been prepared on behalf of ENEMALTA plc by SGS and has been reviewed and approved by ENEMALTA prior to the submission to the authorities.

The revision 0.2 of this document includes the amendment of some disconformities detected by the Evaluator of the Report (Gap Analysis SA)[2], as well as the calculation of the Full Bore Rupture scenarios and the application of a common risk matrix for the entire site, in agreement with the other stakeholders[3] [4].

The revision 0.3 of this document includes the amendment of those disconformities detected by the Evaluator of the Report (Gap Analysis SA)[5], as well as the revision of the population data, the addition of a new scenario due to jet fire domino effect from Electrogas Malta facilities. The text added or amended has been highlighted in orange. Tables have been amended with the updated data and not highlighted.

GLOSSARY

1% lethality distance	The distance to the location where an unprotected person has a 1% probability of dying for a given scenario and weather class
Atmospheric storage tank	Storage tank in which the maximum permitted pressure is less than or equal to 0.5 bar of overpressure Generally the overpressure is a maximum of 70 mbar.
BLEVE	Boiling Liquid Expanding Vapour Explosion; results from the sudden failure of a vessel containing liquid at a temperature well above its normal (atmospheric) boiling point. A BLEVE of flammables results in a large fire ball (if ignited)
Blocking system	Suppression system to isolate (part of) an installation to prevent (further) outflow
Competent authority	Authority responsible for law enforcement
Compressed liquefied gas	Gas that is compressed to a pressure that is equal to the saturation vapour pressure at storage temperature, so that the majority is condensed into its liquid phase
Containment system	One or several devices, any parts of which are permanently in open contact with one another, and which are intended to contain one or multiple substances. A Loss of Containment in one containment system will not lead to the release of significant quantities of hazardous substance from other containment systems
Dispersion	Mixing and spreading of substances in the air
Domino effect	The effect that Loss of Containment in one installation leads to Loss of Containment in other installations
Dose	A measure of integral exposure; a function of concentration and exposure time

Establishment	The whole area under the control of an operator where dangerous substances are present in one or more installations, including common or related infrastructures or activities
Event tree	A diagram of success and failure combinations are used to identify event sequences leading to all possible consequences of a given initiating event
Explosion	A sudden release of energy that causes a blast.
Explosive substances	Explosive substances are: a. 1°. Substances and preparations that present an explosion hazard due to shock, friction, fire or other causes of ignition(risk phrase R2); 2°. Pyrotechnic substances. A pyrotechnic substance is understood to be a substance or mixture of substances with the purpose of producing heat, light, sound, gas or smoke or a combination of these phenomena by means of non-explosive, self-propagating exothermic chemical reactions; 3°. Explosive or pyrotechnic substances and preparations that are contained in objects; b. substances and preparations that present a serious danger of explosion as a result of shock, friction, fire or other ignition causes (risk phrase R3)
Fault tree analysis	The evaluation of an unwanted event, the top event in the fault tree. Given a top event, a fault tree is drawn up using a deduction method (top-down), which can be used to determine the cause (or causes) of the unwanted event
Fire ball	A fire, burning rapidly enough for the burning mass to rise into the air as a cloud or ball

Flammable (hazardous) substances	Flammable (hazardous) substances are: -flammable substances (category 0, 1 and 2) -category 3 and 4 substances if the process temperature is higher than the flash point
Flash	Part of a superheated liquid that evaporates rapidly due to a relatively rapid depressurization, until the resulting vapor/liquid mixture has cooled to below boiling point at the end pressure. Superheat is the extra heat of a liquid made available by decreasing the liquid's temperature, for instance, by vaporization, until the vapor pressure equals that of the surroundings
Flash fire	The combustion of a flammable vapor and air mixture in which the flame passes through the mixture at a rate less than sonic velocity so that negligible damaging overpressure is generated
FN curve	Log-log graph: the X-axis represents the number of deaths and the y-axis the cumulative frequency of the accidents, with the number of deaths equal to N or more
Frequency	The number of times an outcome is expected to occur in a given period of time (see also probability)
Ignition source	A thing able to ignite a flammable cloud, e.g. due to the presence of sparks, hot surfaces or open flames
Installation	A technical unit within an establishment where hazardous substances are produced, used, handled or stored
Jet fire	Combustion of materials emitted from an opening with great force
LEL / LFL	Lower flammability limit; below this concentration too little flammable gas is present in the air to maintain combustion

Limit value	Measure of the dangerous properties of a substance based on both the physical and the toxic/explosive/flammable properties of the substance
LOC	See Loss of Containment event
Loss of Containment	Event resulting in the release of material to the atmosphere, water and ground
Nominal pumping rate	Normal flow of material through a pump
Operator	Any natural person or corporate entity who operates or holds an establishment or installation or, if provided for by national legislation, has been given decisive economic power in the technical operation thereof
Operator	Any individual operating technical equipment
Pasquill class	Classification to qualify the stability of the atmosphere, indicated by a letter ranging from A, for very unstable, to F, for stable
Pool fire	The combustion of material evaporating from a layer of liquid.
Probit	Number directly related to probability by a numerical transformation
Pressure vessel	Pressurized storage vessel in which the maximum permitted pressure is more than 0.5 bar of overpressure

Probability	Measure of the likelihood of an occurrence, expressed as a dimensionless number between 0 and 1 Risk is defined as the probability that within a fixed time period, usually one year, an unwanted effect occurs. Consequently, risk is a dimensionless number. However, risk is often expressed in units of frequency, ‘per year’. Since failure frequencies are low, the probability that an unwanted effect will occur within a fixed time period of one year is, practically speaking, equal to the frequency of occurrence per year. In this Reference Manual, frequency is used to denote the risk
Process vessel	Vessel in which a change in the physical properties of the substance occurs, e.g. temperature or phase
QRA	See Quantitative Risk Analysis
Quantitative Risk Analysis	A numerical evaluation of probabilities, effects and consequences of incidents and their combination into measures of risk
Reactivity	Measure for the flame acceleration in a gas/air mixture
Reactor vessel	Vessel in which a chemical change of the substances occurs
Repression system	System to limit the release of substances into the environment given a certain event
Risk	The combination of probability and effect.
Risk contour	Line on a map connecting points having equal risk

Roughness length	Artificial length scale appearing in relationships describing the wind speed over a surface and characterising the roughness of the surface. The roughness length of a pipeline determines the resistance in the pipe, the roughness length of the surroundings determines the wind speed at ground level
Safety Report	Report on the safety of an establishment
Safety valve	Valve (or here also rupture disk) designed to automatically vent excess pressure
Vapour cloud explosion	The explosion resulting from ignition of a cloud of flammable vapour, gas or spray mixed with air, in which flames accelerate to significantly high velocities to produce significant overpressure
Weather class	Combination of Pasquill stability and wind speed. Weather class D5 means Pasquill category D and wind speed 5 m/s

1 MANAGEMENT SYSTEM AND ORGANISATION OF THE ESTABLISHMENT FOR MAJOR ACCIDENT PREVENTION

This section of the Safety Report fulfils the requirements of the LN 179/2015, Article 8, sub-regulation (a) and Schedule III.

It includes the Major Accident Prevention Policy, which describes the systems in place at ENEMALTA facilities, in order to provide protection to the people and the environment against dangerous incidents that could arise from activities at the site.

1.1 Major Accident Prevention Policy (MAPP)

The Major Accident Prevention Policy (MAPP) is the commitment of the company with the prevention of the accidents related to the handling of the hazardous materials included in the Seveso Directive. The MAPP shall be signed by the company management and updated whenever required. For this reason, the MAPP has been published separately

1.2 Safety Management System (SMS)

The Safety Management System (SMS) is a set of procedures that require continuous improvement in order to be implemented. For this reason, the SMS has been published separately.

2 DESCRIPTION OF THE ENVIRONMENT OF THE ESTABLISHMENT

This section of the Safety Report fulfils the requirements of the LN 179/2015, Schedule II Paragraph 2.

2.1 Site description

The Delimara Power Station was established in 1991, and is currently the main provider of electricity generation in the Maltese Islands.

Throughout the years, Enemalta has been instrumental and pioneering the usage of new technology to reach its corporate objectives together with offering better products and the best service to its customers. Enemalta continues to invest in all areas of its operations making best use of technological developments and is committed to continue to improve its service delivery through a pro-active approach, to meet an ever-growing and diversified demand for energy.

The facilities are limited in its east side by a road that runs between Fort Tas-Silg and Fort Delimara. On the west side, the boundary of the site is delineated by the Marsaxlokk Bay.

The 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 m^2, approximately 103,500 m^2 of which reclaimed from the sea.

The UTM and geographic coordinates of the installation are provided in the table below:

UTM coordinates	
X	459,662
Y	3,965,642

The position of the Power Station is shown in the drawings in the Annexure #2.

The nearest town to the facilities is Marsaxlokk.

TOWN	DISTANCE FROM DPS (m)	POPULATION [1]
Marsaxlokk	1,200	3,200
Birzebuggia	2,500	8,800

The corporate name of the establishment is:

COMPANY NAME	
Denomination	Delimara Power Station
Street address	Triq il-Powerstation
City	Marsaxlokk, Malta
CONTACT IN CASE OF EMERGENCY	
Name	Ing. Ismail D'Amato
Position	Manager Generation
Address	Power House
City	Marsaxlokk, Malta
Telephone number	[redacted]
Mobile number	[redacted]
Email	ismail.damato@enemalta.com.mt

[1] Population according to GeoNames database. Website: http://www.geonames.org

2.2 Environment of the establishment

2.2.1 Geographical Location

Delimara Power Station is located in the Marsaxlokk Bay, which has an approximate surface of 7.7 km^2. The latitude and longitude of Marsaxlokk are 35.84 degrees North and 14.54 degrees east.

Delimara Power station is located approximately 1 km south east of Marsaxlokk Village, at the area known as L-Inginier, on the Delimara Peninsula. The site is bounded to the east by a road which runs between Fort Tas Silg and Fort Delimara, at an elevation of approximately 40 m above sea level. The western boundary of the site is delineated by Marsaxlokk Bay. The location of the installation is shown in the following figures.
The site is semi-enclosed in a crescent shaped hollow and is partly screened from Marsaxlokk Village by the cliffs known as Rdum-il-Bies headland, which rises to 50 m.

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 m^2, from which approximately 103,500 m^2 has been reclaimed from the sea.

Nearby cities and towns of Marsaxlokk are: Birzebbuga at 2.68 km, Zejtun at 3.28 km, Marsaskala at 3.45 km, Ghaxaq at 3.95 km, Tarxien at 5.44 km, Gudja at 5.17 km, Zabbar at 5.21 km, Luqa at 6.77 km.

2.2.2 Meteorology

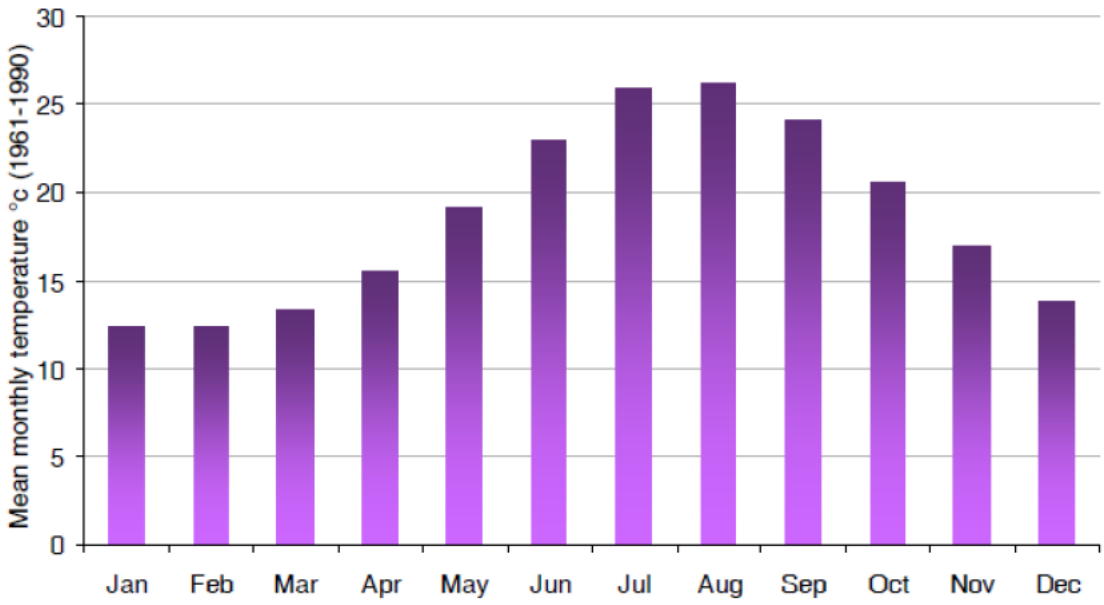
The seasonal features of the Mediterranean can be traced from the motion and development of the pressure systems over the Atlantic, Eurasia and Africa [6]. While the Mediterranean spring is often a period of indecisive weather, summer is characterised by the intensification of the Azores High Pressure which tends to extend up to the Central Mediterranean, giving general weather conditions consisting of light surface winds ranging from the northwest to northeast. Autumn is relatively short and leads to wintry conditions in a fairly decisive and quick way. During this season, Atlantic depressions move eastwards across northern Europe into the Mediterranean bringing with them waves of cold air. In its path, this cold air comes into contact with warm moist air causing vertical instability, the development of vigorous depressions, rainfall and frequent gales. From time to time the eastward march of travelling depressions is interrupted by cold air coming from the Arctic via the Norwegian Sea or Russia. This great thermal contrast leads to very active depressions.

In the Central Mediterranean region both Sicily and the Tunisian peninsula may play an important part on the local weather. Under certain prevailing conditions Sicily can act as a barrier against strong low-level northerly winds. This Italian island can also create local instabilities due to land heating effects or heat lows which may be advected towards the Maltese Islands depending on the prevailing winds.

Transient North African low pressure systems have the potential to produce strong winds over the Central Mediterranean. When for example North African lows occur south of the Atlas Mountains, strong easterly to south-easterly winds are likely over the Central Mediterranean resulting in high seas.

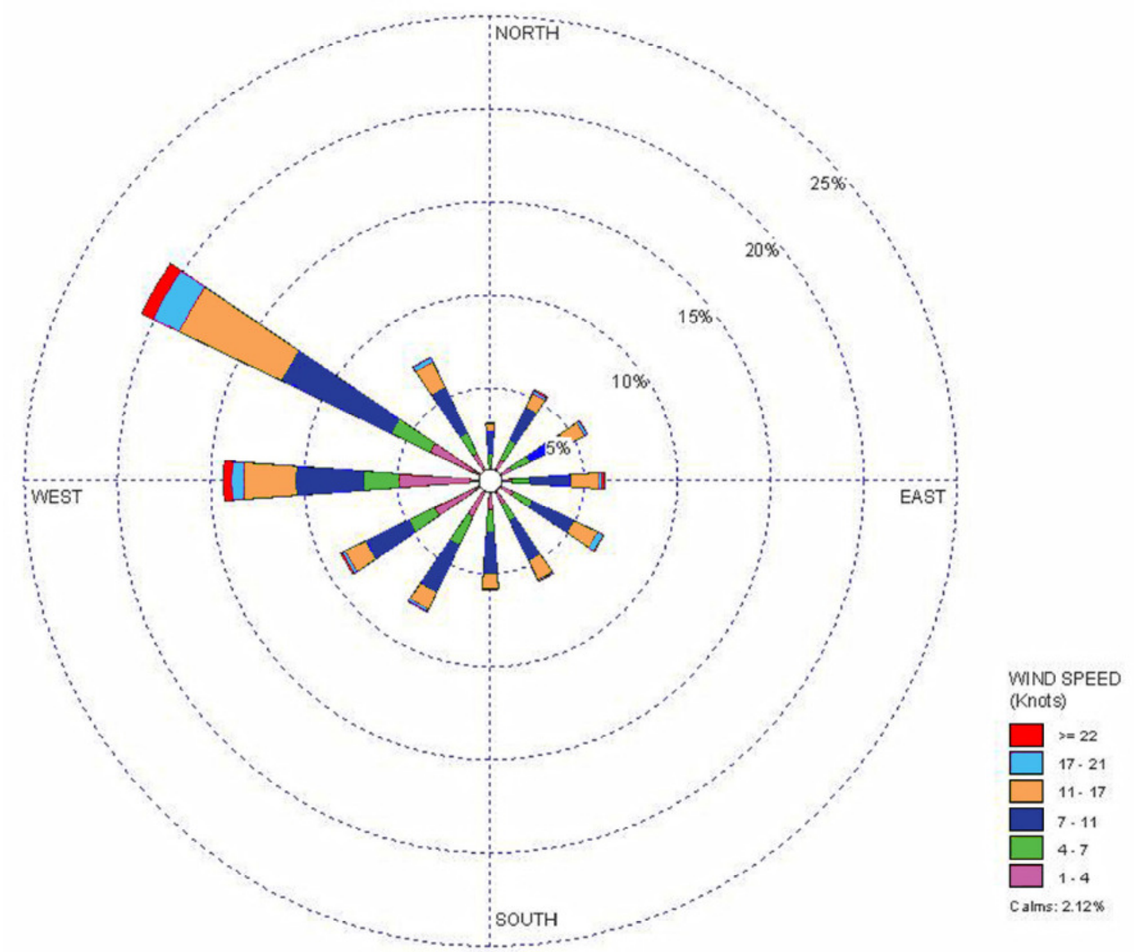
The presence of the surrounding water mass significantly shapes the climate of the Maltese Islands. The general weather is often cooler and more humid than what is experienced in inland areas of larger land masses. The high thermal capacity of the sea also reduces large fluctuations in the ambient temperature of the islands. But the presence of surrounding warm waters during the end of the summer season is a source of major weather instability when colder air migrates into the Central Mediterranean, thus creating areas with heavy thunderstorms and intense precipitation [6].

Variable	Value	Unit
Ambient Temperature	19	ºC
Ambient Humidity	75	%
Cloud cover	75	%
Average wind speed	4.52	m/s



The prevailing wind is from the northwest, and approximately 20% of annual average recorded winds come from this direction.

In the following figure, the wind rose is shown.



In the risk analysis, 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 [7].

In the table shown below there are presented the day/night probabilities of Delimara Weather Classes, based on [7] study.

Day	Wind direction	B2.2	D2.2	D4.4	D7.4
	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	**Wind direction**	**D4.4**	**D7.4**	**F0.9**	**E3.2**
	0	1.08	0.04	6.70	0.44
	30	0.00	0.00	2.21	0.00
	60	0.00	0.00	1.62	0.01
	90	1.56	0.06	3.25	0.98
	120	3.76	0.92	4.10	2.16
	150	2.55	0.70	4.00	1.18
	180	2.27	0.26	3.40	1.08
	210	2.41	0.44	3.08	0.85
	240	1.74	0.73	3.19	1.10
	270	2.84	1.19	5.27	1.19
	300	7.12	7.70	10.40	4.77
	330	3.86	1.70	12.00	3.25

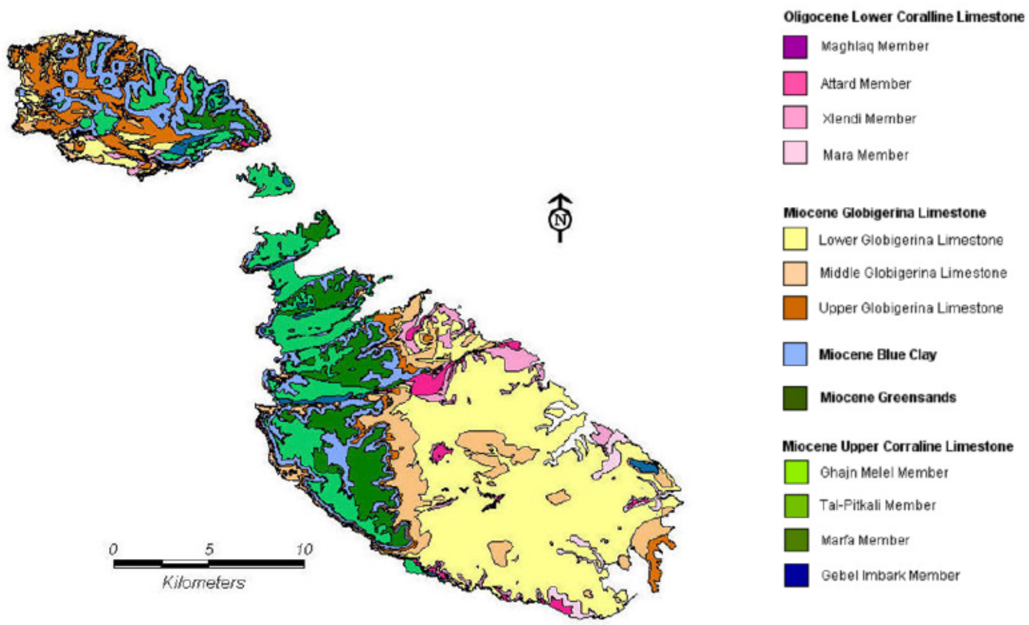
2.2.3 Geology

Geology and geomorphology are two of the key characteristics of land, influencing archaeological and industrial heritage, water, flora, fauna and soil, as well as having economic value for tourism and agriculture. The conservation of geological heritage, besides being important because of the intrinsic value of geology itself, is essential for the conservation of biodiversity, as well as resources such as water, soil and minerals.

The Maltese Islands are composed of Tertiary limestone and marls with subsidiary Quaternary deposits [8]. The strata consist of layers of Lower and Upper Coralline Limestone with intervening soft Globigerina Limestone and Blue Clay. The stratigraphy of the Maltese Islands is generally in accordance with the following table.

Formation	Approx. Age	Max. Thickness (m)
Upper Coralline Limestone	12-7.5 Ma	104-175
Greensand	12-7.5 Ma	0-16
Blue Clay	13-12 Ma	0-175
Upper Globigerina Limestone	15-13 Ma	5-20
Middle Globigerina Limestone	20-15 Ma	0-110
Lower Globigerina Limestone	20-15 Ma	5-110
Lower Coralline Limestone	--	140-236
Clays and dolomitised limestone	--	>3000

These rocks are sporadically overlain by terrestrial, Aeolian and alluvial deposits, laid down following the emergence of the Maltese Islands above sea level. Most of the central and south eastern sections of Malta comprise outcrops of Globigerina Limestone, whilst in the north and north western sections, Coralline Limestone predominates.



Lower Coralline Limestone [8] is the oldest exposed rock in the Maltese Islands, outcropping to a height of 140 m in the vertical cliffs near Xlendi, Gozo. It is mainly composed of the tests of coralline algae indicating deposition in a shallow gulf environment. Globigerina Limestone outcrops in over 70% of the Maltese Islands. It erodes to form a rolling landscape and varies in thickness from 23 m near Fort Chambray to 207m around Marsaxlokk. Blue Clay overlays the Globigerina Limestone formation. This material erodes easily when wet and flows out over underlying formations leading to wide variations in thickness of the deposit.

Greensand is made up of bioclastic limestone, rich in glauconite. It is generally less than 1m thick.

Upper Coralline Limestone is the youngest tertiary formation in the islands and reaches a thickness of approximately 160m in the Bingemma area.

Geologically, the south of Malta is important for soft stone quarries, which are mainly located in Mqabba and Qrendi. The area is mainly made up of gently undulating Globigerina plains. It forms part of the South Horst, which is a tilted structural block, bounded on the North West by the Victoria Lines Fault and on the south by the Maghlaq Fault.

The typical lithology, thickness and hydrogeological characteristics of these formations are presented in table below.

Formation	Typical lithology	Thickness (m)	Hydrogeological unit	Type of aquifer
Upper Coralline Limestone	Algal reef limestone with scattered corals, mainly in the west, changes to more dense chalky and marly limestone in the lower parts	7 to 82	Upper phreatic aquifer	Perched aquifer drained by springs
Greensand	Marly dense limestone with green gluconitic grains, filling pockets and depression on the blue clay	2 to 12	Aquiclude	
Blue Clay	Blue-grey and marl that weathers to brown-yellow	18 to 75	Aquitard transmits water from surface into regional lower aquifer along joints and fractures	
Globigerina Limestone	Fine-grained white calcarenite in the lower part, chalky and marly white or blue limestone in the middle and fine-grained yellow limestone and marl at the top	30 to 70	Regional lower aquifer	Local phreatic aquitared (permeability through fissures)

Formation	Typical lithology	Thickness (m)	Hydrogeological unit	Type of aquifer
Lower Coralline Limestone	Algal coarse grained, grey to yellowfish limestone, with corals, that changes to massive marly limestone and mudstone at the base	over 100		Regional phreatic aquifer (commonly referred to as the Mean Sea Level Aquifer)

The geology of the Maltese Islands has played an important role in shaping the landscape character of the islands. The characteristic coastline, distinctive rural landscape and agricultural setting, fresh water sources, and the yellow colour of globigerina limestone in Malta's urban setting, are the result of a geology originating approximately 26-27 million years ago, during the Oligocene and Miocene epochs of the Tertiary age. The importance of conserving geological heritage lies in the fact that geology is a fossil, or historical record, representing the earth's history, and thus also Malta's history. Once damaged, geological formations cannot be replaced, and this fact has provided the impetus towards geoheritage conservation. The importance of understanding geological setting does not only lie in its heritage value, but also contributes to better urban planning, reducing any potential geological risks a site might be exposed to.

There is a growing international awareness of the importance of protecting geological diversity for its intrinsic value, and this has been presented through the Recommendation (2004) of the Council of Europe on conservation of geological heritage and areas of special geological interest. The manifesto seeks to establish European Geoparks and to promote the intrinsic, educational, touristic, and recreational values of geological sites.

Despite this awareness, geological heritage is often threatened by development that is insensitive to the geological potential of a site or an area. Coastal development, for example, often results in coastal protection engineering in order to protect anthropogenic structures that do not respect geological value and mechanisms. Mineral extraction that is not monitored is another potential threat to geological heritage, as it may contribute to the loss of important features, and in such a case unmonitored land filling is considered a threat to geoheritage. Mineral extraction may however uncover some geological features.

Conservation of geological and geomorphological sites in Malta is part of the statutory responsibilities of MEPA and the Superintendence of Cultural Heritage. By end 2008, 21 of the 73 scheduled Areas of Ecological Importance and Sites of Scientific Importance have been scheduled for their geological or geomorphological value. The Special Area of Conservation designation process also provides a means through which sites in Malta are assessed in terms of their geological and geomorphological value.

In terms of positive measures to promote geological conservation, there are two principal directions: the adoption of geology-sensitive measures within the context of management plans for areas of geological and geomorphological importance, such as in the case of the Dwejra/Qawra project; and, the sensitive restoration of spent quarries where geological value is evident. Practices in countries such as the United Kingdom show that geological features in both active and disused quarries may be conserved through the sensitive management of the quarry.

Managing the location of spoil tips, controlling and directing vegetation growth, removing rock debris, sensitive refilling, and restricting development adjacent to and within the quarry, are a few of conservation techniques that may be applied.

Soil

Soil is a primary resource for agriculture, which in the Maltese Islands is a highly sensitive industry, as well as being a fundamental element of natural ecosystems.
Various mechanisms have been adopted to protect and enhance soil in the Maltese Islands. Legal means such as the Fertile Soil (Preservation) Act, and the legal notice on the conservation and preservation of rubble walls and rural structures, through the assessment of soil quality, are also in place. There is however no legal instrument for regulating non-agricultural soils or for remediating contaminated industrial soils.

Principal threats to soil in Malta

Soil is threatened by a range of human activities that undermine its long-term availability and viability. The European Thematic Strategy for Soil Protection identifies eight key threats to soils: erosion; decline in organic matter; soil contamination (local and diffuse); soil sealing; soil compaction; decline in soil biodiversity; salinisation; and, flood and landslides. Increasing urbanization and development in Malta, together with the intensification of agricultural practices, have accentuated the pressures on land, and thus on soil. Although data on the extent and severity of soil threats, and on the economic and environmental implications of soil degradation, are lacking, the principal threats to soils in Malta may be described as erosion, decline in organic matter, soil contamination, and salinisation, arising out of contamination, soil sealing and land abandonment. The then-National Soils Unit of the Agriculture Department carried out monitoring of key soil quality indicators during 2004-2006, the results of which are presented below.

Soil organic matter

Soil organic carbon content is one of the primary indicators of soil quality. Organic material in the soil is derived from residual plant and animal matter synthesized by microbes, and decomposed under external influences such as temperature, moisture and ambient soil conditions. Soil organic matter plays a major role in maintaining soil quality, because of its influence on the exchange of nutrients, water retention, soil structure and its stability, soil ecology and biodiversity, but also as a source of plant nutrients. Topsoil organic carbon content gives an indication of the evolution in organic matter volumes, since changes in organic matter status are usually greater in the surface layers.

Organic content in the soil is influenced by: natural factors (climate, soil parent material, land cover and/or vegetation and topography), and human-induced factors (land use, management and degradation). One of the main causes of the decline in soil organic matter in Malta is human activity, principally intensive cultivation. It is widely believed that a major threshold is two percent soil organic carbon, below which potentially serious decline in soil quality will occur. In 2006 the average organic matter in sampled topsoil was 2.1 percent, 0.2 percent more than the average in 2002, with the highest percentage (4 percent) recorded at Mellieha.

Soil contamination

Soil contamination is still an emerging issue for Malta, and data in this area remains scanty. Specific waste streams, some industrial activities, military activities, the storage of certain substances, nuclear operations, agricultural activities, and some recreational activities (e.g. shooting ranges) may contribute to the contamination of land and soil. This contamination can pose immediate or long term risks to human health in terms of behavioural problems and learning disabilities, as well as soil function, and the wider environment. Contaminants may escape from the sites, resulting in further land and soil contamination, but also in air and water contamination. Contaminants may also be the cause of damage to buildings and underground services, or the cause of the contamination of the food chain.

Information on lead concentrations in Maltese top soils provides insights into soil contamination in the Islands. The Maltese population is known to have high mean blood lead levels. Whilst soil lead levels is not considered as one of the main reasons behind high lead blood levels in Malta, its monitoring is useful since there is a noted correlation between soil lead levels and distance of the field from the road. The monitoring of lead levels in soils is thus important in terms of understanding and controlling potential health risks from contaminated food and water sources.

The average content of lead in monitored sites was found to have increased from 78 milligrams per kilogram (mg/kg) in 2002 to 125 mg/kg in 2006. The site monitored in Paola recorded the highest concentration, that of 451 mg/kg, up from 266 mg/kg in 2002. Lead concentrations generally exceed 100 mg/kg in South and central Malta (Map above), the part of the island that is more densely populated.

Soil contamination can be from either diffuse or local sources. Diffuse contamination is caused by one or more point sources, however emission, transformation and dilution make the relationship between the pollution source and the soil contamination difficult to trace. This type of contamination is usually associated with atmospheric deposition, certain farming practices and inadequate waste and wastewater recycling and treatment. Local soil contamination is originally caused by point sources and usually affects high-density urban areas, those with a long tradition of heavy industry, or those in the vicinity of former military installations. In the Maltese context, possible causes of lead in soil may be remnants from car exhaust, paint, used pellets from hunting or emissions from industrial activities.

Other than the above, there is little data on soil contamination in Malta, and the information provided below is based on estimates of the potential sources of land contamination. Malta has identified the main sources of soil contamination as agriculture (both the animal husbandry and the arable sectors), sites used for waste disposal, storage facilities for oil and other fuels, scrap metal yards, and sites subject to illegal dumping of wastes.

The monitoring of contaminated sites is also important in the light of groundwater protection, and the identification of potential contaminants, and the application of the necessary means to control them, is essential. The future disassembling of these sites, and their reuse for other purposes, requires the sensitive surveying of the site in order to propose suitable alternative uses, and ensure their appropriate rehabilitation, as has been carried out with respect to the Maghtab and Wied Fulija ex-waste dump sites. Guidance needs to be prepared and legislation enforced in this regard.

Soil salinity

Soil salinisation, or the excessive increase of soluble salts in the soil, is among the most important and widespread of soil degradation processes. The salinisation of soil, and thus the accumulation of salts on or near the soil surface, may result in unproductive soils. The soils of Malta are vulnerable to soil salinisation, due to its small island nature. The main cause of salinisation is the use, for irrigation, of groundwater that is rich in salts (mainly sodium chloride). Between 2002 and 2006, average soil conductivity (indicating salinity in soil) increased by 30 percent, from 581 micro Siemen per centimetre (µS/cm) to 756 µS/cm at the sites monitored.

Highest values were recorded in coastal areas where salt from sea spray is deposited, such as in Mgarr in the north of Malta, where in 2006 there was a concentration of 1.580 μS/cm.

Soil sealing

The increase of sealed soil areas translates into loss of uses such as agriculture and forestation. Sealed soils result in the impairment of a soil system, affecting ecological soil functions and thus disrupting the potential of the soil working as a buffer and filter system, or as a carbon sink. Sealing of soils also influences the change of water flow patterns, whilst potentially contributing to the fragmentation of habitats. Current studies suggest that soil sealing may be irreversible. One of the main mechanisms contributing to soil sealing is that of urbanization, and land development has been identified as an indicator of soil sealing. However other activities also contribute to soil sealing, these include: trapping, recreational, creation of informal car parks, off-roading, and the creation of new roads or road widening.

This review of the pressures on and status of Malta's soil resources indicates that they are important for the maintenance of ecosystem health, agriculture and water management. However soils are threatened by a range of factors including contamination, soil sealing and land abandonment. There is a need for Malta to update national legislation, and build capacity in this area for monitoring and enforcement.

In conclusion, geology and soil are discussed, highlighting that Malta's soil resources are important for the maintenance of ecosystem health, agriculture and water management. However it is noted that soils remain threatened by a range of factors such as contamination, soil sealing and land abandonment. There is a need for Malta to update national legislation, and build capacity in this area for monitoring and enforcement.

2.2.4 Seismic Activity

The Maltese Islands lie in the middle of an extensive fault system affecting the central Mediterranean from Tunisia to Sicily. The faults are potential earthquake sources and are expressions of the stress field that has created the system of grabens in the central Mediterranean, known as the Pantelleria Rift. Some of the faults are still active whilst others are believed to be stable [9].

Detailed historical data for earthquake events affecting the Maltese Islands have not been published. However, some records of previous earthquakes are available and can be used to assess possible risks from a major seismic event.

The maximum intensity of any earthquake recorded for Malta since 1500 was a level VII on the European Macroseismic Scale (EMS), which corresponds to a “damaging” earthquake. Widespread damage to buildings was reported in many parts of Malta during this event. Earthquakes of lesser intensity (EMS VI) have been reported on four occasions between 1743 and 1923. An event also occurred in 1972, about 50 km south east of Malta which produced a local EMS of V.

The University of Malta operates a digital seismograph which has been recording small scale seismic events since 1995. About 20 minor events are recorded on average per year within a radius of 100 km of Malta, the majority of which are not noticed by the general population and have no effect on structures.

It is considered that the Maltese Islands have a low to moderate risk of being affected by a significant seismic event. Within a 100km radius of the islands, seismic activity is generally low or diffuse, with a magnitude not exceeding 5 on the Richter Scale.

2.2.5 Hydrography and hydrogeology

The geological structure of the Maltese Islands permits the division of the islands into several distinct aquifer blocks with limited communication of the groundwater. The main source of groundwater is the Mean Sea Level Aquifer, which provides about 76% of Malta's groundwater resource. The main aquifer bearing rocks are the Upper and Lower Coralline Limestone. The Globigerina Limestone, which overlays the main aquifer over most of central and southern Malta, has very low permeability and average porosity. It is only locally important as a groundwater resource. The freshwater is in the form of a lens (Ghyben-Herzberg lens) with the thicker part situated in the central part of Malta, thinning towards the coast. The aquifer floats on top of the sea water, due to the density differential [8].

Replenishment of the aquifer is by rainwater. Percolation of rainwater into the Sea Level Aquifer is through fissures or other discontinuities. However, in some areas, the Globigerina Limestone is fractured below the water table and it becomes part of the Lower Coralline Limestone aquifer.

Because of the presence of fissures and other recharge pathways, such as fault lines, the Sea Level Aquifer is susceptible to surface derived contamination.

Perched aquifers are present in the Upper Coralline Limestone, sustained by the underlying impervious Blue Clay. These perched aquifers have only a small potential for water extraction but are used extensively for agricultural purposes.

Public supply is abstracted from a network of around 100 boreholes. In addition there are over 5,000 privately registered boreholes and an un-quantified number of unregistered ones.

At Delimara station, the top of the Lower Coralline Limestone is thought to be more than 100 m below sea level. The area of recharge is limited and there are no known public or private abstraction boreholes on the peninsula, the main Lower Coralline

Limestone aquifer being located several kilometres inland. Therefore activities at the power station do not therefore present a risk to potable groundwater resources.

With regard to coastal hydrography, Marsaxlokk Bay is generally characterized by a gently sloping shoreline formed from the erosion of the Upper Coralline Limestone. The currents in the bay are slow moving, entering the Bay from the west, moving round Fort San Lucian and leaving along the western side of Delimara Peninsula. This current movement causes deposition of solids at Rdum Il-Bies and along the west side of the peninsula.

2.3 Identification of installations and other activities that could present a Major Accident Hazard

This section of the Safety Report fulfils the requirements of the LN 179/2015, Schedule II of COMAH. This information has been developed in details in the following chapters. All the installations which can cause a major accident have been also identified in the drawings attached in the Annexure #2.

2.4 Areas where a Major Accident can occur

2.4.1 Neighbouring land uses

As exposed in the last review of the Safety Report [10], the area immediately surrounding the Delimara Power Station is mainly in agricultural use, with a few scattered residential buildings. The greater part of the Delimara Peninsula itself is designated as National Park, in accordance with Structure Plan Policy RC014. It has a considerable tourist potential and its conservation, protection and improvement has been designated as a priority in the Marsaxlokk Bay Approved Local Plan (1995). Forts are located at Tas-Silg and Delimara, north and south of the power station respectively. These forts are regarded as important features of the landscape and have major tourist potential. The Local Plan envisages rehabilitation of the forts with possible use as a hotel, visitor centre/museum, field study centre or craft centre.

The nearest population centre to the power station is Marsaxlokk Village which lies approximately 1.1 km north west of the site. Marsaxlokk village is important as a tourist traditional Maltese fishing village. The resident population of Marsaxlokk Village is 3534 people.

The town of Birzebbugia is located approximately 2.5 km west of the Power Station, across Marsaxlokk Bay, and has a population of 9,736 people. The town comprises a mix of residential, commercial and industrial developments.

The coastal areas adjoining Birzebbugia, Pretty Bay and St Georges Bay, are important from an economical point of view as they have fishing, fish farming, boating and tourism activities.

In addition to general residential developments in Marsaxlokk and Birzebbugia, there are a number of other sensitive buildings. These buildings include schools and churches. There are also a number of sites of archaeological importance on the outskirts of Birzebbugia and Marsaxlokk.

The Freeport is located approximately 2 km south west of Delimara Power Station and is a major container port and shipping facility.

Other land uses in the surroundings include the Petroleum Installation at Birzebbugia (run by Enemed) and the San Lucjan Oil Company.

The distance from these sites is sufficient so that a “Domino effect” scenario is not considered likely.

2.4.2 Environmentally sensitive areas

For the purposes of this report, environmentally sensitive areas are defined as those areas/sites which could be adversely affected by the consequences of a major accident at the establishment. This includes natural environmental features, land in agricultural production, archaeological/cultural resources and the built environment. Direct impacts on people are considered separately in Section 4.1 of this report.

Environmentally sensitive areas are defined as those areas/sites which could be adversely affected by the consequences of a major accident at the establishment. This includes natural environmental features, land in agricultural production, archaeological/cultural resources and the built environment.

The environmentally sensitive areas identified in the vicinity of Delimara Power Station are listed below:

- Forts and sites of archaeological interest
- Ecologically important areas
- Recreation/tourist areas
- Conservation areas/national park
- Natura 2000 sites
- Landscape sensitivity areas

Forts and Sites of Archaeological Importance

The most important elements of these characteristics identified in the surroundings of the Delimara Power Station are:

- St Lucian Tower
- Batteries
- Ghar Dalam
- Bronze age village;
- Roman villa

- Neolithic temple

Due to the existence of fossils of diverse variety and archaeological vestiges, the surrounding areas of Ghar Dalam and Borg in-Nadur have been declared as Heritage Park.

Cultural heritage

An international legal framework has been developed in the Maltese Islands, with the purposes of the protection of buildings and places with high cultural importance, based on a series of agreements signed by Malta, such as:

- the 1954 European Cultural Convention;
- the 1969 European Convention for the Protection of the Archaeological Heritage;
- the Paris Convention of 1972 on the Protection of the World Cultural and Natural Heritage;
- the 1985 European Convention on offenses relating to cultural property;
- 1985 Granada Convention for the protection of the architectural heritage of Europe;
- Valletta 1992 European Convention on Protection of Archaeological Heritage (revised) and
- the European Landscape Convention 2000.

Ecologically Important Areas

In the vicinity of the property there is a designated area as Natura 2000[2]: Il-Ballut. This area supports a rare type of marshland which supports specialist biota able to withstand the hypersaline water and seasonal droughts. Additionaly, this site supports a species of gastropod called Alexia kobelti, which is only known from this site.

The marine coastal ecosystem of Marsaxlokk Bay comprises gently sloping shores of Middle Globigerina Limestone. These shallow waters support prairies of the

[2] EU Directive 92/43 / EEC (Habitats Directive)

angiosperm Cymodocea nodosa accompanied by the alga Caulerpa prolifera. In deeper water, these are replaced by Posidonia oceanica. These plants provide the basis of an extensive food web and a highly productive and diverse ecosystem.

Marsaxlokk Bay also supports some specialist immigrant species which have colonised the Mediterranean from elsewhere. Halophila stipulcea, for example, is a native of the Red Sea, but is found in Marsaxlokk Bay, near Marsaxlokk Village. Another immigrant is the free floating alga Acanthophora delilei, also from the Red Sea.

Planning Policy MDO8 of the Marsaxlokk Bay Local Plan refers to the designation of the area off the Delimara Peninsula as a Marine Conservation Area (MCA). This designation has not so far been applied and is subject to detailed study and consultation with interested parties.

The cooling water outfall from the power station passes across the peninsula in a tunnel to a discharge point at Il-Hofra z-Zghira, on the east coast. Policy MDO8 refers to the outfall from Delimara Power Station as a factor to be resolved, before the declaration of a MCA.

The terrestrial plant communities of the area are dominated by common halophytic species such as Deniella melitensis, a succulent which is endemic to the Maltese Islands. However, the area also supports one locally rare species – Halimione portulacoides. This plant has been decreasing in abundance on the Maltese Islands in recent years and is now only recorded from the marsh area known as Ras ic-Caghaq, on the east coast of Marsaxlokk Bay.

As noted above, the Delimara Peninsula is designated as a National Park and is protected for conservation reasons. It also has high value as a touristic resource. The whole of the peninsula must therefore be considered to be environmentally sensitive.

Natural areas designated

Malta protects its important habitats through the designation of Special Areas of Conservation (SACs) in line with the EC Habitats Directive and Special Protection Areas (SPAs) in line with the EC Birds Directive. In 2011, 3 additional marine SACs were designated (and 1 marine site was changed from national to international importance), such that Malta had a total of 3967 SACs (including 5 marine areas), 32 of international and 7 of national importance, by the end of that year. The 5 marine SACs, which are all of international importance, covered 190.8 km2 of territorial waters in 2011, up from 10.8 km2 in 2010. As at end 2011, terrestrial SACs covered 42 km2 or 13.3% of land area. By end 2011, there were 13 SPAs covering 16.5 km2 or 5.2% of land area. Furthermore, in 2011, 3 more Areas of Ecological Importance and Sites of Scientific Importance were scheduled, bringing the total to 73. In these areas specific policies guide the type of development that can take place. In 2011, the boundaries for 30 tree protection areas were published, covering 5.35 km^2, with the aim of enhancing protection of one of Malta's important ecosystems.

Malta also has 3 Nature Reserves affording protection to islets, as well as 26 Bird Sanctuaries. In addition, since 2007, all beaches and swimming areas in close proximity to urban areas or major roads, including 11 specifically named beaches, were afforded legal protection from hunting. As of end 2011, the Maltese Islands had a total of 21.5% of land area under some form of legal protective designation.

Sites proposed or designated as part of the Natura 2000 network

The EU Natura 2000 Network is a network of protected sites across the EU, designated under the Habitats and Birds Directives, which merit special conservation measures since they support habitats and species of community interest. This network is one of the tools used by the EU to assist with halting the loss of biodiversity. A number of areas in Malta have been designated as part of the EU Natura 2000 network. As of end 2011 Malta had 27 terrestrial sites covering 41.8 km^2 or 13.1% of land area, and 1 marine area of 8.5 km^2 forming part of the network. 4 additional marine sites were submitted to the European Commission in 2011 to form part of the Natura 2000 network, and are expected to form part of this network shortly. The 5 marine sites in all cover an area of 190.8 km^2. Some amendments to selected terrestrial sites were also considered, which will lead to 13.3% of land area being covered once accepted. Sites designated in line with the obligations of the Birds Directive are referred to as SPAs, and by December 2011 Malta had designated 13 SPAs covering 16.5 km^2 or 5.2% of land area, which are automatically Natura 2000 sites. In some cases the areas designated under the two Directives overlap.

Landscape sensitivity areas

While Malta's landscape is physically determined by its limestone geomorphology and dry climate, it has also been heavily influenced by over 7,000 years of human presence, particularly during the last few decades. Malta's natural landscape is characterized by karstic rock and relatively inconspicuous Mediterranean biodiversity in terms of vegetation and fauna. The Maltese landscape may be characterized as a cultural landscape with a combination of elements that give it a distinct character that is unique in the world.

Malta's draft Landscape Assessment Study provides a summary of the principal changes to the Maltese landscape in the period between 1990 and 2000. It concludes that there has been a limited but noticeable improvement in townscapes in terms of architectural quality and public amenities, with more attention to landscaping, treatment of facades and public open space. Overall, however, landscape is threatened by increasing built up area, industrial and coastal development, taller buildings on urban fringes obstructing views of historical centres, modern agricultural practices, increasing vehicular access, littering, poor standards of design and work, and lack of maintenance.

Public perceptions of landscape value favour hilly coastal areas with lush vegetation, including fortifications, churches and traditional buildings, and view industrial areas, quarries and landfills negatively.

A recent study indicates that landscapes with varied rural topography and steeper slopes were more appreciated than plains. Settlements were generally perceived to be of neutral value, scoring very highly when churches were in the centre, and lower when modern buildings on settlement edges dominated skylines. Industrial areas, quarries and landfills were judged to detract significantly from scenic value.

The least favored landscape was that containing the Maghtab dump site, despite the sea and fields surrounding the feature. This illustrates the importance of prior knowledge in public perceptions of landscape quality.

Malta signed (but has not yet ratified) the European Landscape Convention in 2000 and its provisions relating to legal recognition, participatory procedures, protective policies, and integrating landscape into land-use planning are already implemented. In line with provisions regarding landscape characterization and monitoring, MEPA has carried out a national landscape assessment, which mapped out landscape sensitivity areas, of which Very High and High Landscape Sensitivity areas (see Map below) cover 51 percent of the Islands.

The Landscape Assessment Study has provided a firm foundation for better landscape protection in strategic and subsidiary land-use plans.

The planning system's principal tool for landscape protection is statutory designation. Areas of High Landscape Value (AHLVs) were designated in 1996 and 2000, and cover 12 percent of the territory. There is a certain level of convergence between the findings of the Landscape Assessment Study and AHLVs (see Map below), however some important areas of landscape quality, particularly in Gozo and inland Malta, have not yet been afforded statutory protection. The emergent land-use policy on tall buildings has also taken landscape sensitivity on board. Other protective designations such as the Special Areas of Conservation that protect biodiversity also help to protect the Maltese landscape. On the scale of individual projects, the land-use planning system imposes landscaping conditions on permissions for major development projects. For smaller developments in urban areas, small plot sizes and parking conditions often do not allow for much landscaping. In rural areas landscaping aims to screen development from long- and medium-distance views.

The Environmental Landscapes Consortium, a public-private partnership launched in 2001, has improved the appearance of many of Malta's public areas and gardens. In addition, MRAE's Tree for You (34U) afforestation campaign will create woodland recreational areas integrated with national and regional parks at Delimara, Xrobb l-Ghagin, Ta' Qali, Salina and Mellieha, although some public woodlands that are not being actively managed, such as the Tas-Silg area, are seriously degraded and suffering from vandalism. The Rural Development Plan is another key tool for landscape protection; one of its medium-term objectives is to maintain cultural landscapes to generate positive externalities. Its agri-environment measure provides financial incentives for rubble wall repair on the basis of which, together with Pre-accession project, 0.26 km^2 rubble walls were subject to application for restoration.

Population data [5]

The areas with public presence in the surroundings of the establishment are presented in the table below, including the total population in each one.

ITEM	DAY	NIGHT
	TOTAL POPULATION PER AREA	TOTAL POPULATION PER AREA
101. Marsaxlokk Village	3,366	3,366
102. Historic Fort	20	20
103. Low density residential	20	20
104. Low density residential	3	3
105. Low density residential	3	3
106. Low density residential	3	3
107. Low density residential	3	3
108. Horse Farm	3	3
109. Historic Fort	40	4
106. Low density residential	3	3
107. Low density residential	3	3
108. Horse farm	3	3
109. Historic fort	40	4
110. Low density residential	3	3
111. Low density residential	3	3

ITEM	DAY	NIGHT
112. Light house	5	5
113. Farm	3	3
114. Swimming/craft area	50	10
116. Road	1	1
118. Light industry	50	50
119. Historic fort	20	20
121. Swimming/craft area	80	80
Dolphin	5	4

The land use plan for Marsaxlokk is shown in drawings in Annexure #2.

3 DESCRIPTION OF INSTALLATIONS

3.1 Description of the main activities and products

In this chapter the installations of Delimara Power Station are described, highlighting the following items:

- **Plant installations**, including a general description of the facilities.
- **Storage tanks**, listing the main characteristics of fixed storage equipment**.**
- **Prevention system**, based on standard operation procedures, permit to work, training of the employees and safeguards installed on field.
- **Detection system**, based on detectors and alarms on field, they are focused on the early detection of any emergency.
- **Fire fighting facilities** are the standard facilities designed, installed and maintained in order to quickly extinguish any incipient fire.
- **Other resources** are all the resources available for the solving of specific situations apart from fire, including spillages.
- **Warning systems** are the resources available for the communication of the emergency situation inside the terminal and among the employees.
- **External communications systems** are the resources available for the communication of the emergency to the public authorities, the general public and other agencies, as well as to other stakeholders at the site.

3.1.1 Plant installations

The activity of Delimara Power Station in Marsaxlokk is to guarantee the energy supply of the island. The main components in the Delimara Power Station are:

- **PHASE 1 (D1)**: Two HFO steam units with boiler, steam turbine and generator, for baseload operations, 2 x 60 MW
- **PHASE 2a (D2A)**: Two DO open cycle gas turbines and generator units at 37.5 MW, designed for peak load

- **PHASE 2b (D2B)**:Two DO combined cycle gas turbines with heat recovery steam generators and a steam turbine for midrange duties, with a total capacity of 110 MW
- **PHASE 3 (D3)**: Eight medium-speed diesel engines of the Wartsila Model 18V46 as well as a steam turbine generator of the Dresser-Rand model Frame 30 (Multi Stage Impulse Condensing), designed to combust heavy fuel oil as the main fuel and diesel fuel oil as a backup option.

The thermal power station of the plant is resumed in the table below:

Construction Phase	Source	Total Thermal Rating MWTH	Fuels
Phase 1	Steam Boilers (phase 1A and phase 1B)	332	Heavy Fuel oil (HFO)
Phase 2A	CCGT1	121	Gasoil (DO)
	CCGT2	121	
Phase 2B	CCGT3A	121	Gasoil (DO)
	CCGT3B	121	
Phase 3	Diesel engines 41 & 42	77	HFO & DO
	Diesel engines 43 & 44	77	
	Diesel engines 45 & 46	77	
	Diesel engines 47 & 48	77	

The total nominal capacities of fuel storage are as follows:

Fuel Type	No. Of Storage Tanks	Total Nominal Capacity, m^3
Heavy Fuel Oil	3	56,710
Gasoil	4	33,884

3.1.2 Storage tanks

The fuel stored at the power station is heavy fuel oil (HFO) and diesel (DO). It is contained within steel, fixed roof, vertical storage tanks which are located towards the south of the power station. Fuel storage operations are controlled from the Central Control Room; however, tank and transfer valves are manually operated.

For heavy fuel there are two main heavy fuel oil tanks located in the same bunded area and a smaller service tank intended for daily operation of the plant.

There is a combined HFO/diesel pump-house to the north of the tank farm area.

For diesel storage, four diesel tanks are situated in separate bounded compounds: raw diesel is stored in Tanks 0, 1 and 2 and is transferred to tank 3 after receiving a pre-treatment through a centrifuge system. The centrifuge is fed by a series of three transfer pumps.

The following table lists total storage capacity for each tank previously mentioned:

Tank No.	Product	Capacity m^3
Fuel Oil Tank 1	Heavy fuel oil	25,540
Fuel Oil Tank 2	Heavy fuel oil	25,540
Fuel Oil Tank 3 (Service)	Heavy fuel oil	5,630
Diesel Tank 0	(Raw) Diesel	8,600
Diesel Tank 1	(Raw) Diesel	8,428
Diesel Tank 2	(Raw) Diesel	8,428
Diesel Tank 3	(Treated) Diesel	8,428

Other HFO and Diesel day tanks are installed as a part of Diesel power plant, as buffer tanks; the following table lists the additional storage tanks.

Tank No.	Product	Capacity m^3
Gasoil day storage tank	Diesel	140
Service tank	Heavy fuel oil	2 x 125
Buffer tanks	Heavy fuel oil	2 x 125

With reference to fuel storage facilities it can be detailed that:

- HFO and gasoil are delivered via ships which berth at the quay at Delimara station; a steel pipeline connects the unloading facility on the quay to the HFO Tanks and another steel pipeline connects the unloading arm of the gasoil to the DO tanks;
- The high pressure hose connecting the steel pipe to the ship is tested annually in the presence of a third party inspector;
- The fuel-unloading pipeline is also tested annually;
- All fuel tanks are contained within an enclosed bund wall; the bunds have 110% capacity of largest inventory in a single tank. Rainwater collected in the bund area is manually discharged through a valve to two oil interceptors connected in series before being discharged to the sea;
- HFO flows by gravity to a fuel oil pumping station where the oil is further heated and then transported in above ground pipes to the respective boilers;
- Gasoil received from the ship is stored in three tanks (0, 1, 2): these tanks are called raw Diesel tanks. From these tanks gasoil is treated by means of centrifuge separators and the gasoil is collected in DO tank (3). The drain system of the centrifuges is collected and piped through an oil interceptor;
- Gasoil from Tank 3 called treated diesel is then pumped to the gas turbines or the diesel engines day tanks in aboveground steel pipes;
- For the diesel engines, fuel from the storage tanks is transferred to smaller 2 HFO buffer tanks, 2 HFO service tanks, and 1 day GDO service tank which are all included within this same Phase 3 installation (in order to reduce the handling of the product); in the case of HFO, this is centrifuged prior use by the diesel engines;
- All fuel tanks have a foam injection system for applying foam to the tank, either above the fuel or below the surface (there are separate foam stations for the HFO and diesel tanks) and have water cooling rings around the outside of the tanks (shell cooling);
- Fire hydrants in the tank areas are fed by two sea water fire pumps; if necessary, these may be connected to a separate fresh water system for the purposes of exercises or wash-down and as a backup.

3.1.3 Prevention system

Most Preventive Measures are based on a proper management of the safety related issues and are described in the Safety Management System.

Other measures which can prevent or minimize the consequences of the accidents identified in the following chapter are summarized hereafter.

Electric installation

Several high voltage electric installations are located at the site. The electric installation in the terminal is designed, installed and maintained according to the international standards and legal obligations in Malta. The system is protected by standard protection systems.

Lightning protection

Chimneys, stacks and high structures, as well as building are suitably earthed in order to prevent lightning and the associated effects.

Collection system for waste and rain waters

Rain water is, in general, collected in reservoirs and used for irrigation purposes within the site itself. Rain water falling onto areas which could, potentially, be contaminated with oil (like fuel tank bunded areas), are directed to oily water interceptors, where the oil part is separated from the water part by virtue of the difference in densities between the two fluids, prior to be discharged to the sea.

There is installed on the site a foul water system which is connected to the main public sewer.

Security System

The perimeter of the site is secured by fencing. Gates are manned 24/7 by security officers. There is CCTV monitoring in key areas. All areas are adequately lit.

3.1.4 Detection system

All areas are equipped with automatic fire detection (smoke or heat) and manual call points. Fire alarms are transmitted to the Central Control Room which is manned 24/7.

The Fire Detection System is subject to a suitable system of maintenance.

3.1.5 Fire fighting systems

The always activated fire protection system, the presence of a dedicated cooling system to the storage tanks and the immediate activation of the emergency procedures, allows to limit, if not exclude, the possibility that domino effects occur.

There are two 100% duty fire water pumps (one electric, the other diesel drive) and a jockey pump. Suction is from the inlet after the main screens for circulating water. Fire water can be pumped from the sea into a firewater main which circulates throughout the power station complex. The fire main is kept pressurised and the fire pumps start automatically on demand.

The fire main terminates at the foam station adjacent to the HFO tanks. There are fire hydrants at the fuel oil pump-house. There is a separate foam installation and monitor at the fuel import jetty head.

A sea water fire hydrant system at Delimara Power Station provides outlet points for the facility which enable firewater to be applied in the event of a fire either through sprinklers in arrays around the tanks or through fire monitors attached to the hydrants.

Fire fighting equipment at the Delimara Power Station fuel storage area consists of the following items:

- Hydrant main fed by pumped seawater;
- Hydrants (for Diesel tank and for HFO tanks common bund);
- Bulk Foam systems at diesel oil (base injection);
- A fixed foam station to apply foam to the HFO tanks (top pouring);
- Foam sprinklers on the diesel centrifuge and fuel oil pumps;
- Tank cooling deluge system is fitted to the HFO and diesel tanks.

The HFO tanks are also fitted with a foam pouring system; the diesel tanks are fitted with a base injection (semi-subsurface) foam system.

The tanks are fitted with a fire alarm. Operation of the fire systems is manually, in all cases from outside the bunds.

There are foam spray systems installed in the diesel centrifuge house and the HFO and DO pumps.

External Hydrant main – Seawater

The system is always pressurised at 10 bar; working pressure is typically at 8 bar depending on load. The fire pumps start automatically on pressure drop; suction is direct from the sea.

The fire main runs around the entire plant and is mostly underground. There are:

- 1 Fire Pump Electric Nijhuis 820m^3/h @ 9bar;
- 1 Fire Pump Diesel Nijhuis 820m^3/h @ 9bar;
- 53 Hydrants BS 336 – 2 ½”.

Internal Deluge / Sprinkler Hydrant Systems (Fresh Water)

The system is always pressurised at 10 bar; the working pressure is typically at 8 bar depending on load. The fire pumps start automatically on pressure drop. There is a 330 m^3 reserve, continuous filled from evaporators. The Reserve is based on 30 minutes for highest demand.

A cross connection is provided between the FFI and FFE systems in case of an emergency. There are:

- 1 Fire Pump Electric Nijhuis 630m^3/h @ 8bar;
- 1 Fire Pump Diesel Nijhuis 630m^3/h @ 8bar;
- Jockey pump / pressure tank – system always pressurized;
- Internal hydrant main – 43 hydrants BS336 2½" (Some with foam capability).

A water spray protection (Deluge or sprinklers) is installed in the following locations:

- All oil-filled transformers;
- All cable flats;
- Boiler fronts (conventional boilers; the HRSG's are not fired);
- Turbine lubricating oil tanks;
- Fuel oil heaters / pumps trays;
- Fixed water spray (cooling) on all fuel tanks (HFO & DO) (From FFE).

Foam systems

In the plant there are foam system located as below:

- Fixed foam pourers / base injection on all fuel tanks. (20000 litres foam in 4 tanks);
- Fixed foam monitor on loading quay (3000 litres foam);
- Phase 3 – Foam on all FOT tanks + bund area. (1000 litres foam).

The storage of foam is:

- 2 x 5000 litre HFO;
- 2 x 5000 litre DO;
- 1 x 3000 litre Quay (tanker unloading protection);
- 1 x 1000 litre Phase 3 FOT;
- 5000 litres reserve (IBC's).

Foam is also present in sprinklers in:

- HFO pumping / heating shed;
- DO centrifuge (Phase 2);

- FOT pumping / centrifuge (Phase 3).

Other fire systems

There is a water mist fire suppression system for Steam Turbines 1 & 2 (Phase 1) – 120 bar @ 120 l/min.

In the plant is also present a CO_2 fixed systems at service of all gas turbines (Phase 2, Phase 2A).

Only for Phase 3 there is a Argonite flood systems is for all engine cells (x8) and all switchgear rooms.

In addition, everywhere are present portable equipment, about 450 various portable extinguishers mainly powder / CO_2. Cabinets situated close to most hydrants, with equipment including hoses, branches. Several foam trolleys in high risk areas and for bund protection.

A system of checklists is used to inspect and maintain the fire safety systems.

Fire Detection & Alarm

A fire alarm system covers the entire plant incorporating smoke & heat detectors, manual callpoints inside & outside the plant buildings, and sirens. The alarm system incorporates monitoring of the fire systems. The main alarm panel is in the Central Control Room (CCR).

A Wide Area Warning system is also installed; this is intended to warn the surrounding population of a serious incident.

3.2 Description of processes and operating procedures

The delivery and the handling of HFO and diesel are the most important activities from the point of view of safety as it is in those activities where we can identify the initiating event that could originate a major accident.

Other activities carried out in other parts of the installation, such as the cooling system and the water treatment system, are not directly correlated to a major accident but they can affect and determine the extension of its consequences, hence the following description of the plant activities have been carried out.

3.2.1 Handling heavy fuel oil and gas oil

These activities include all the steps from the delivery of the fuel at the quay until its final combustion in the boilers, diesel engines and gas turbines of the plant. HFO and diesel are delivered by sea tankers to the quay which has been built for that purpose inside the station area. On average the following shipments are delivered annually:

- 12 of HFO shipments;
- 2 of diesel shipments

After the arrival of the fuel, a high pressure hose is used to unload the HFO and pump it through steel pipes to one of the three HFO storage tanks.

In the case of diesel, the fuel is unloaded from the sea tanks by coupling an unloading arm at the quayside and transferred afterwards to one of the three diesel storage tanks located at the southern boundary by steel pipework.

In the quay, in order to prevent leakage due to movements of ships or pressure failure of the piping system, there is a breakaway valve on HFO and Diesel Unloading Arm Lines.

Before the diesel is used in the gas turbines, the raw fuel receives a previous treatment by pumping it to centrifuges. As a result from this pre-treatment, traces of water are removed from the raw diesel and the purified diesel is stored in another storage tank (number 3). Afterwards it is directly pumped from this tank to the gas turbine through a series of above ground steel pipework. Diesel is circulated to the combined cycle gas turbines using a series of three transfer pumps. To the open cycle gas turbines Diesel is also circulated using another series of two transfer pumps.

In the case of HFO, prior to being transfer to the boilers at the phase 1, it is pre-treated in the fuel oil pumping station by means of heat. Afterwards two transfer pumps circulate HFO to the boilers in phase 1 using three screw pumps.

3.2.2 Fuel Transfer Preparation

As important as it is the fuel transfer from a safety point of view, a specific protocol has been established in order to avoid operational mistakes which could result in accidents.

Once the recipient date and the fuel quantity to be received has been confirmed, the Responsible Engineer shall ensure that by the scheduled date, the unloading quay is free from any other activities or obstacles that might hinder a successful fuel transfer operation. Also the designated receiving shore tank and its immediate ancillaries should be available and completely functional. Furthermore, any operation on the receiving tank, and adjacent unloading lines as well as any "Work Permits" ought to be terminated, postponed or retrieved. In the case of the HFO unloading line, the trace heating circuits are checked and switched on 24 hours prior arrival of the fuel in order to establish the necessary temperatures for a smooth fluid flow through the all the unloading line sections.

The Responsible Engineer must also ensure that oil-spill response materials for land or sea spills, such as booms, spill kits, absorbent rolls, aggregate and waste disposal containers, are readily available and easily accessible in case of any spillages. He shall also forward instructions to the Generation Officer to prepare the pipeline configuration (Diesel/HFO) in such a way that ensures that no fuel enters or leaves the Receiving tank/s during the transfer and the transferred fuel enters only in the designated tank/s (diesel consignments are usually transferred into more than one tank simultaneously). In addition the engineer shall ensure the availability of the fire fighting system, particularly at the tank farm and the unloading point, the regular maintenance of the diesel unloading line and that the anchorage and mechanism of the HFO quick release valve is in order. Before the delivery date of the fuel, the Responsible Engineer shall endorse and issue a "*Fuel Transfer Form*" indicating the Receiving Shore tank/s and the required pipeline and tank/s valve status necessary for the forthcoming transfer.

When the fuel finally arrives at the quayside, it is the Unloading Master who performs the supervision tasks. Upon berthing, he/she shall board the vessel and together with ship's assigned officer, conduct a joint inspection to ensure ship adheres to safety regulations as indicated in "*Ship/shore safety check list*". Before unloading he/she shall refer the observed quantities to Responsible Engineer and await confirmation of available storage space before authorising the initiation of the transfer. The surveyor on the other hand, performs the following tasks: he shall confirm the correct configuration and seal, tag and record the status of all valves adjacent to receiving tank in the presence of Enemalta representative. Afterwards, the surveyor shall proceed to sound the shore tank and take samples to establish the initial tank contents, witnessed by customs and Enemalta personnel. On their behalf, the Pump-house operators shall make a final site inspection to confirm that the Receiving Tank/s bunds' drains are closed and the area is safe. All parties are to endorse and record these initial conditions in the "*Fuel Transfer Form*".

If the safety conditions are met and the vessel chief confirms that the unloading can start, the Unloading Master shall authorise the connection of the station's unloading flexible hosing to the ship's manifold. During this stage the Unloading Master will coordinate with the Pump-house operators in order to release the padlocks on the unloading line isolation valves and to indicate the ship's crew to start pumping the fuel at a reduced rate. Then the pressure ought to be slowly incremented until check valves at the unloading point and at the tank inlet are lifted. Once the pump-house operator signals the 'all clear' signal the Unloading Master will instruct the ship's officer to reach a pre-established line pressure.

The pump – house operators will walk along the unloading line inspecting every valve, seal or joint checking for evidence of any leaks. These visual checks are repeated every 2 hours for the duration of the transfer. The Responsible Engineer shall follow the transfer progress from the station's Distributed Control System, and Control Room Operators who are constantly monitoring the system alarms shall draw the Responsible Engineer's attention if any Fuel tank level alarm ensues. There should be no leakages on the hoses, flanges, valves or unloading arm and the Unloading Master shall be responsible to ensure that there are no contaminations to the port waters caused by discharges. Such incidents are to be reported to the responsible authorities for remedial action and contained or cleaned before leaving the site. In the event of a leak the Unloading Master shall stop pumping and proceed to isolate the pipeline immediately to contain the spill until assistance from the Emergency Response Team arrives.

Once the Fuel transfer operation is complete the connecting flexible hoses are purged from the vessels manifold towards the shore tank using compressed air and the station's unloading line isolation valve is closed and padlocked. The hoses are disconnected from the vessel's manifold and the blanking flange is replaced. The hoses are lowered down to the quay and coiled properly.

The Surveyor checks for any water content and then proceeds to sound the tank/s, witnessed again by Customs and Enemalta representative as per procedure, and endorses the recorded data.

The consigned fuel is left to settle in the receiving tank/s for at least 24 hours or until the fluid movement is abated and any water content settles to the bottom. Fuel samples are drawn from the tank/s to establish the resulting density of the fuel mixture.

The layout of the Power Station is shown in the drawings in the Annexure #2.

3.2.3 Steam plant

In the steam plant, the fuel is burnt in the boilers to produce steam to power the turbines. The gas resulting from the combustion is discharged to the atmosphere through two flues in a single concrete windshield.

Three seawater evaporators produce distillate water for the boilers using seawater and discharge the concentrated brine into the seawater outlet. The distillate is further treated in a demineralisation plant.

The water production and storage plant is then constituted by:

- Evaporated storage facilities, consist of 2 tanks of 700 m^3 each and 3 tanks of 600 m^3 each;
- Evaporated water is treated to make demineralised water; the resin of the demineralised water plant is regenerated using sulphuric acid and caustic soda;
- Demineralised storage facilities, consist of 2 tanks of 600 m^3 each and 5 tanks of 700 m^3 each;
- Sulphuric acid is stored in a steel tank of 6.5m^3, inside the plant itself within a contained area; caustic soda is received in sacks and mixed with water inside the plant itself and stored in a tank, which is situated within a contained area;
- All drains are directed to a neutralizing pit where the ph of the effluent is tested and neutralized before it is discharged with the outfall.

3.2.4 Steam plant cooling system

From the turbines the steam is exhausted into the condensers, which are cooled by seawater drawn from Marsaxlokk Bay. The cooling water is then discharged through a tunnel to the other side of the peninsula. This cooling water, which is also used for the combined cycle plant and the seawater evaporator, is treated with the addition of anti-fouling chemical to prevent the accumulation of marine growths in the water passages. Anti-fouling is done by means of chlorine dioxide. Chlorine dioxide is generated on site by mixing two chemicals Sodium Chlorite and hydrochloric acid under water.

The amount of seawater passing through the system is approximately 21,000 m^3 per hour for Phase 1 turbines and approximately 8,500 m^3 per hour for Phase 2b.

Anti-fouling is done by means of chlorine dioxide. Chlorine dioxide is generated on site by mixing two chemicals Sodium Chlorite-Biocaf 1320 and hydrochloric acid under water.

3.2.5 Gas turbine plant

For the gas turbine plants the fuel is burnt in the gas turbines that provide the motive power for the generators. In the case of the combined cycle plant the exhaust gas delivers its heat energy to the heat recovery steam generators and is then emitted through one chimney for each gas turbine / HRSG unit. The open cycle gas turbines exhaust directly to atmosphere each through its own chimney.

3.2.6 Environmental outputs

Air emissions

Stack emissions are all continuously monitored using a Continuous Emissions Monitoring Systems on each stack, except on the OCGT plants since the stack height does not permit the installation of such equipment; the gases that are monitored are SO_2, NO_X, CO, CO_2, and dust.

Discontinuous monitoring of stack emissions are carried out regularly, as per IPPC permit conditions, for dioxins and furans, polyaromatic hydrocarbons, and a number of heavy metals.

Waste water

From the five outfall points that the plant discharges to the marine environment one of them, the Discharge Point No.4 (oil separator drain), is the only one relevant from the point of view of possible hazard. The point is shown in the drawings in Annexure #2.

The Point 4 discharges comprise waters from the HFO heater manifold building and when required, drainage from the HFO and gas oil (diesel) tank farm bunds. However, it should be noted that the bund drains are typically kept locked down and no water from these areas normally passes through the system.

The discharges from Point 4 pass through two oil separators prior to disposal to the sea; the system actually comprises five oil separators known as:

- Heater Drain Cooler;
- Cool Drain Interceptor;
- Diesel Bund Interceptor;
- HFO Bund Interceptor;
- Polishing Interceptor.

Waste oils generated on the site are normally collected inside a settling tank and pumped to the HFO tanks for eventual disposal by as hazardous waste. The amount of generated waste oil is considered to be a very minute amount compared with the amount of HFO burned.

In addition, the following effluents are discharged into the sea:

- Cooling water after passing through condensers and heat exchangers;
- Brine discharged from the seawater evaporator;
- Boiler blowdown;
- Surface runoff water, discharged through oil interceptors to remove any contamination by oil.

Solid waste

Solid wastes are industrial wastes such as lagging, sheet metal, scrap metal etc. Regarding general maintenance, waste is contracted out to separate permitted waste contractors as necessary for disposal or recycling:

- Scrap metal is normally sold for recycling;
- Wood, plastics, and packaging materials are disposed for recycling;
- Spent florescent tubes, scrap ac's are collected and disposed as WEEE;
- All batteries, both domestic and industrial, are collected and disposed for recycling;
- Municipal waste is also collected and disposed;
- hazardous and non-hazardous wastes are separated and disposed of as required by law.

3.2.7 Maintenance and inspection carried out in the installation

Plant maintenance is essential for the prevention of major accidents as it allows to monitor the functionality of the equipment and to check the connectors tightness. Regarding the frequencies of the maintenance operations stated in this document allows to maintain the levels of safety and reduce the probability of accident occurrence together with the extension of its possible consequences.

Diesel pipelines are generally welded lines running bare and supported mostly on trestles above ground, however at road crossings they laid in channels below the surface. Heavy Fuel Oil pipelines are also distributed but cladded in fibre wool and aluminium sheeting for thermal insulation. The cladding is vital for the pipeline's condition, especially at support points.

Below the actions taken by the company to ensure proper maintenance of the plant.

Diesel Lines inspections:

- Diesel pipelines in Area 6 (Fuel Pump House) and Area 7 (Diesel Tank Farm), including the piping lying inside the tank bounds, are visually inspected daily for any evidence of leaks or potentially hazardous conditions on pipe-works, welds, flanges, valve glands, pump seals or any other fixture;
- Observations are recorded in the daily operations log sheet and in case of incidents, reported immediately to Generation Officer for further remedial action, according to urgency;
- The Responsible Engineer (a warranted engineer) shall conduct a detailed weekly visual inspection of all the diesel pipelines, with special attention to parts running in culverts, line vents and line drains, recording any visible deterioration or conditions to be rectified;
- Pump House Operators inspect the diesel Unloading Line from coupling arm to receiving tank every 4 hours during a ship to shore transfer procedure as requested in Diesel Unloading Procedure. Quay personnel attend the unloading arm continuously for the duration of the transfer;
- The Maintenance Engineer shall coordinate with the Responsible Engineer to ensure the annual hydrostatic testing of the Diesel unloading line, to be certified by an accredited third party auditing engineer as requested by Transport Malta regulations. All the other diesel pipelines shall be certified leak proof by a third party, once every three years.

HFO lines inspections:

- Cladded HFO lines in Area 6 (Fuel Pump House) and Area 8 (HFO tank Farm) are visually inspected on a daily basis for any evidence of leaks on pump seals, valves, flanges and lines; observations are recorded and in case of incidents, reported immediately to Generation Officer for further remedial action, according to urgency;

- The Responsible Engineer shall conduct a detailed weekly visual inspection of all the HFO cladded pipelines, with special attention to parts running in culverts, line vents and drains, signs of rusting parts and missing or misplaced aluminium cladding, recording any visible deterioration or potentially hazardous conditions;
- The HFO Unloading line is inspected every 3 hours during fuel transfer procedures. The operation is stopped immediately if any appreciable leaks which could develop into uncontainable situations are detected. Emergency Response procedures for oil spills are initiated as described in the emergency plan;
- The Maintenance Engineer shall coordinate with the Responsible Engineer to ensure the annual hydrostatic testing of the HFO unloading line, to be certified by an accredited third party auditing engineer as requested by Transport Malta regulations. All the other HFO pipelines shall be certified leak proof by a third party;
- On a yearly basis the Responsible Engineer shall coordinate with the Maintenance Engineer to schedule a number of checks on bare pipelines at strategic locations, intended to map the condition of the lines and determine whether further investigative and remedial actions are required. The findings are reported.

Other important checks carried out at the plant are bund wall inspection.

Responsible Engineer (a warranted engineer) is responsible to conduct weekly visual inspections of the fuel stocks bunded areas, checking for the following elements:

- Check whether the bund is holding rainwater during/ after episodes of rain;
- Check condition of wall perforation glands;
- Check for the presence of any damp patches which could indicate cracks;
- Check walls for any physical damages or breeches;
- Check satisfactory operation of surface water drain valve;

- Check that surface water valve has lockable attachment in place and is in the normally closed position;
- Check that surface water sump is cleared from all debris, waste, rags or other solids which might affect the satisfactory operation of the valve;
- Check and inspect fuel transfer pumps (tank to tank) for oil leaks; if present to investigate action with maintenance department and record details;
- Sludge deposits in the bund must be reported and action taken for their removal / treatment.

Any faults identified during the inspection must be followed by immediate action to remedy the situation. Such inspections are recorded, including a description of the maintenance interventions requested and those performed.

Responsible Engineer ensure that on a yearly basis, all bund walls and floors are inspected for the presence of cracks that might be present in the bund walls / floors by a warranted civil engineer.

De-watering process

Another operation performed periodically in order to maintain a proper quality of the products (Diesel and Raw Fuel Oil – RFO) and preserve safe equipments is represented by the de-watering process.

Water deposits can occur in fuel tanks from various processes (such as water acquired through transportation means, water as condensation during repeated thermal cycles in the tank proper, water condensate from fuel heating piping leaks inside the tanks); water having a greater density than the fuels stored, separates from suspension and settles at the bottom over an extended period of time.

The water fuel interface in a diesel tank is an ideal environment for the rapid breeding of certain bacteria whose skeletal remains are the cause of heavy filter fouling; maintaining a water free tank bottom is the most efficient way to avoid such instances. HFO with a high content of water droplets will cause unstable pumping and firing in the boilers; keeping a service tank at temperatures in the range of 40 degrees helps to facilitate water separation from possible fuel /water suspensions forming at the low level tank outlet.

Tank bottoms are structured in such a way (either domed or concaved) to divert and concentrate water deposits at the tanks' outer bottom rim or to a middle collection sump. The tanks' drain valves draw out the water from these areas.

Procedure for de-watering HFO tanks are:

- Ensure there is enough space in the 80 m^3 Settling Tank to hold the contents of a de-watering procedure;
- The draining line from 1 m^3 HFO drains break tank down to the Settling Tank is warmed up by passing auxiliary steam through it for some minutes. This should ensure the flow of fuel /water mixture which typically have high Pour Point temperatures;
- Throttle the Fuel Tank double isolation drain valves and let the drains run into the Break Tank by controlling the quarter turn inlet valve to fill break tank. Visually inspect drains for water content;
- Close the warming steam valve and slightly throttle the break tank's outlet valve taking care to avoid excessive steam back pressure spurts;
- Once the tank drains, close the tank's quarter turn discharge valve and introduce steam into the draining line to aid the flow and warm the line through again, ready for another draining cycle;
- Repeat points 3, 4, 5 until the water content of the drains issuing from the HFO tank is drastically reduced;
- Clearing the draining line thoroughly for the last time using auxiliary steam;
- Close and padlock Fuel Tank's drain isolation valves.

Procedure for De-Watering Diesel Tanks are:

- Ensure that the 2 m^3 Diesel Tanks' de-watering break tank in Settling Tank bunds is empty. If not, transfer its contents to the Settling Tank using the 'Fuel Recovery Pump' located in the same bunds;

- Throttle the two tank drains isolation valves and run drains in a slight stream to fill up funnel;
- Close Diesel tank drain and open funnel drain valve to discharge drains into the 'Diesel Drains Break Tank';
- Those steps are to be repeated until drains are practically from water. Filling a transparent clean container and leaving to settle until water separates from the fuel should help determine when water deposits are removed;
- Sometimes, especially after new consignments, water deposits are considerable and drains are discharged to break tank straight away by leaving the funnel isolation valve open continuously. In such cases an operator is to monitor the break tank level and transfer contents to Settling Tank as required;
- When a satisfactory condition is reached Diesel Tank drain isolation valves and the funnel drain isolation valve are all padlocked in closed position;
- Diesel drains break tank contents are transferred to Settling Tank for further processing.

3.3 Description of the dangerous substances

3.3.1 Inventory

In line with LN 179/2015 definitions, the ENEMALTA installation falls under the scope of this directive as an upper tier establishment.

The regulation defines dangerous substance as:

> *a substance or mixture covered by Part 1 or listed in Part 2 of Schedule I, including in the form of a raw material, product, by-product, residue or intermediate*

Following this definition, the following types of substances and preparations are considered:

Categories of dangerous substances: Substances included in Schedule 1, Part 1 of L.N. 179 of 2015

Named Dangerous Substances: Substances included in Schedule 1, Part 2 of L.N. 179 of 2015

Some ***Categories of dangerous substances*** are stored and handled at Delimara Power Station facilities in small quantities. They are listed in the table below:

CATEGORIES OF SUBSTANCES NOT SPECIFICALLY NAMED (part 1, Schedule 1, LN 179 of 2015)	SUBSTANCES	MAXIMUM QUANTITY (tones)	LOWER THRESHOLD (column 2)	UPPER THRESHOLD (column 3)
E2 Hazardous to the Aquatic Environment in Category Chronic 2	Sodium Chlorite	40	200	500

The upper tier classification is due to the presence of the following named substances:

Hazard categories in accordance with Regulation (EC) No 1272/2008	MAXIMUM QUANTITIES (t)	LOWER THRESHOLD (t)	UPPER THRESHOLD (t)
Petroleum products and alternative fuels (a) gasolines and naphthas, (b) kerosenes (including jet fuels), has gas oils (including diesel fuels, home heating oils and gas oil blending streams) (d) heavy fuel oils (e) alternative fuels serving the same purposes and with similar properties as regards flammability and environmental hazards as the products referred to in points (a) to (d)	 0 0 29,140.3 52,740.3 0	2 500	25 000

Additionally some other chemical are used on site:

NO.	MATERIAL	DETAILS	QTY STORED ON SITE	UNITS	REMARKS
1	Sodium Bicarbonate (SBC)	Flue gas desulphurisation agent for Phase 3 plant	120	tonnes	6 containers of 20 Tonnes each
2	Urea	Part of the SCR agent to reduce Nox in the phase 3 plant	120	tonnes	6 containers of 20 Tonnes each
3	Fuel oil additives	Magnesium Oxide (MgO) slurry emulsifier (FireMag / PentoMag 2000)	16	tonnes	16 IBC at storage site
4	Sea water treatment chemical	Chemical 31% Sodium Chlorite to generate Chlorine Dioxide in situ	35	tonnes	35 IBCs
5		Ferrous Sulphate	1,300	kg	
6	Boiler water intake treatment chemical	Tri Sodium Phosphate	250	kg	
6		Ammonia solution	3,000	litres	
7	Evaporators chemical treatments	Anti-scaling chemical (Aquamax)	4,000	litres	
8		Sulfamic Acid	2,000	kg	
9		Corrosion Inhibitor (Dizsolve)	100	kg	

NO.	MATERIAL	DETAILS	QTY STORED ON SITE	UNITS	REMARKS
10	Demineralisation plant regeneration chemicals + Boiler washes	Sulphuric Acid 98%	12	tonnes	
11		Caustic soda flakes	10	tonnes	
12	Gas turbine compressor cleaning	Industrial Detergent (Zok 27)	1,200	kg	
13	Acid spills	Sodium Bicarbonate (Acid neutralizer)	1,000	kg	
14	Aquabreak	Aquatic based Degreaser for engine cleaning	3,000	L	
15	SAF Acid by Drew Marine	Descaling compound used for cleaning of Titanium HPE in phase 3	2,000	L	
16	Altreat Engine water treatment	Water treatment for Des	1,000	L	
17	HCl	For production of Chlorine Dioxide as antifouling.	4,000	L	

3.3.2 Physical, chemical and toxicological characteristics and chemical behaviours

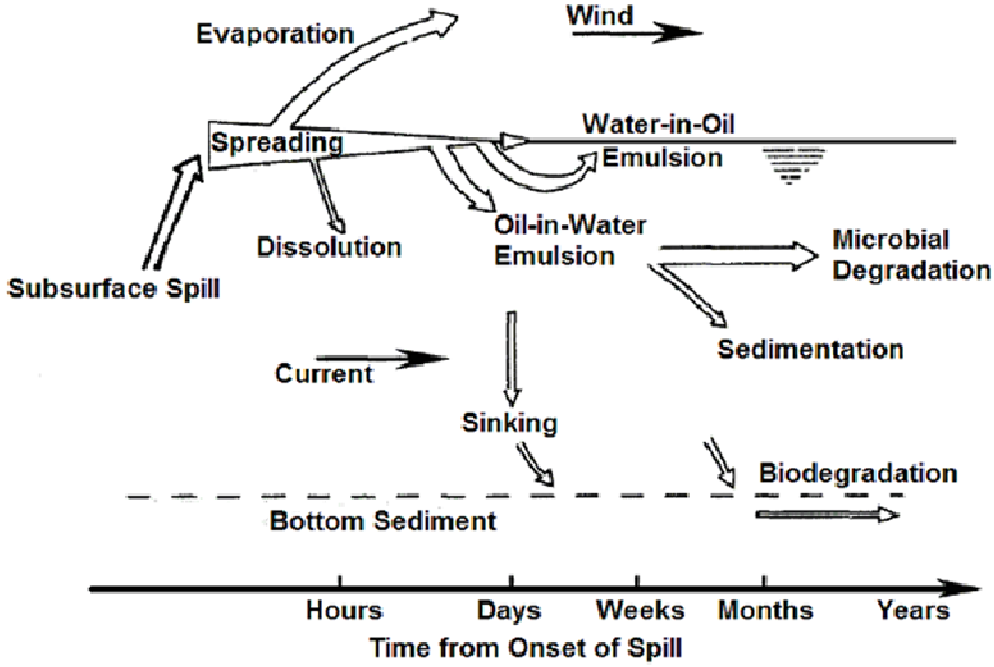
A first step in the assessment of the potential risk arising from the handling of a chemical substance is to identify the physical, chemical and toxicological characteristics of the substance. The most common hazards and behaviours are summarized in the following tables for Gasoil (Diesel) and Heavy Fuel Oil, considering that any other substance aforementioned is not relevant, being handled in small quantities.

Gasoil	
General Description: Liquid. Colourless to various colours. Petroleum odour.	
Incompatibilities & Reactivities: Stable under recommended storage and handling conditions. Reactive or incompatible with the following materials: oxidizing materials, acids and alkalis. Halogenated compounds.	
Exposure Routes: Dermal contact. Eye contact. Inhalation. Ingestion.	
Physical and chemical properties	
Liquid density @ 288K (kg/m^3)	820-950
Average molecular weight (kg/kmol)	200
Boiling point (K)	670-740
Critical temperature (K)	Not available
Critical pressure (bar)	Not available
Upper flammability limit (%)	1
Lower flammability limit (%)	6
Toxic and ecotoxic properties	
Acute toxic effects	Moderate to severe skin irritant.[11]
Long-term toxic effects	Middle distillates have caused skin cancer in laboratory animals [11]
Ecotoxicity	Acute aquatic toxin. “Dangerous for the environment” R51/53 [12]
Bioaccumulation	May not biodegrade rapidly [12]

Heavy fuel oil	
General Description: Heavy fueloil (HFO) is the residue of crude oil distillation that still flows (the quasi-solid residue is asphalt); waste oil from other industries are often added. It is the fuel used in large marine vessels because of price (about half the price of distillates)	
Incompatibilities & Reactivities: Not available	
Exposure Routes: Dermal contact. Eye contact. Inhalation. Ingestion.	
Physical and chemical properties	
Liquid density @ 288K (kg/m^3)	930
Average molecular weight (kg/kmol)	Not available
Boiling point (K)	670-740
Critical temperature (K)	Not available
Critical pressure (bar)	Not available
Upper flammability limit (%)	5
Lower flammability limit (%)	0,5
Toxic and ecotoxic properties	
Acute toxic effects	Moderate to severe skin irritant.[11]
Long-term toxic effects	Middle distillates have caused skin cancer in laboratory animals [11]
Ecotoxicity	Acute aquatic toxin. "Dangerous for the environment" R51/53 [12]
Bioaccumulation	May not biodegrade rapidly [12]

The hazard for the environment in case of a spillage of these products onto the sea is highly relevant in any risk analysis. The most frequent effect of a spillage is the formation of a continuous patch on the water's surface. This thin layer of oil spreads over the surface waves resulting in an area with a smoother appearance compared to the surrounding water. As the hydrocarbons layer becomes thinner, it is broken up by waves and current movements into smaller patches.

Physical, chemical and biological processes affect the spreading and the persistence of the oil patch. In general, for any oil spillage, low molecular weight fractions may dissolve in water or evaporate to the atmosphere, whereas the remaining constituents may float or sink depending on density relationships and become incorporated into soils/sediments.



Gasoil and fuel oil, when spilled into the water, spread quickly and create a rainbow or silvery thin layer (less than 0.005 mm) floating on the water's surface. A few litres of oil can cover more than a square km of water.

Light oils like diesel and light fuel oil evaporate or dissipate quickly from the surface of the water and are easily mixed into the water column. In turbulent waters some of the oil could become emulsified and disperse into the water column as suspended droplets. Light oil is not heavy enough to sink and settle down to the seafloor, but it can remain in the environment when it is absorbed into sediments or when it is dispersed into small droplets that stay suspended in the water. Current and waves will also drive oil onto the beaches, where it may eventually be dissipated through microbial biodegradation and photodegradation. The rate of consumption by microbes depend upon physical factors associated with weathering to aid in dispersion as well as the availability of nutrients and oxygen for the microbial communities.

While a light oil spill might seem like it would disappear quickly, it can take months for the last traces of the oil to leave the environment.

Direct contact with diesel oil is toxic to fish, and it has been known to bioaccumulate within crabs and other shellfish, making then unsafe for human consumption.

Birds and mammals are affected by making direct contact with their feathers and fur or by ingesting the oil when they engage in preening. Even very thin sheens can do great harm to these animals.

4 IDENTIFICATION AND ANALYSIS OF MAJOR ACCIDENT RISKS AND PREVENTATIVE MEASURES

This section of the Safety Report responds to Schedule 3 Paragraph 4 of COMAH.

4.1 Risk Assessment methodology

A Risk Assessment is used to make decisions about the acceptability of risk in relation to developments for a company or in the area surrounding an establishment or transport route. The criteria for assessing the acceptability of risks are set in internationally recognised guidelines and regulations.

The first step in a risk assessment is to identify all hazards. Once a hazard has been identified, it is necessary to evaluate it in terms of the risk it presents to the neighbouring community, environment and facilities. Both probability and consequence should be considered but there are situations in which, if either the probability or the consequence can be shown to be sufficiently low or sufficiently high, decisions can be made on just one factor.

For proper hazard identification, a HAZID methodology has been applied. A HAZID is a systematic, multidisciplinary, team-oriented exercise. It requires the presence of a group of experts to evaluate hazards and the probable consequences, should an incident occur. The HAZID methodology asks participants to identify credible causes of incidents based on knowledge of similar infrastructures, facilities and products.

The generation of a major accident is associated with the loss of containment (LOC) of equipment with a hazardous substance or the release of energy from them. In the first case spills or leaks with consequent formation of a toxic or flammable cloud or direct concern to the environment can be generated.

To identify these scenarios, it is necessary to study the physical and chemical characteristics of the substances handled at the facility, along with the conditions of loading / unloading, transfer, storage and handling in general. It is also necessary to consider all possible operations performed at the establishment, the experience shows that many major accidents occur in situations of stop / start of the facilities, maintenance, etc.

In Delimara Power Plant case of study, additionally to the HAZID study, the hazard identification has been performed also by a Hazard and Operability Analysis (HAZOP), issued as a stand-alone document.

The HAZOP process is based on the critical and systematic analysis of a process from the deviations that can occur in certain parameters, identifying the causes, consequences and possible detection mechanisms.

In order to be able to use the results of a Risk Assessment for decisions, they must be verifiable, reproducible and comparable. Consequently the risk assessment must be completed based upon the same assumptions, models and basic information.

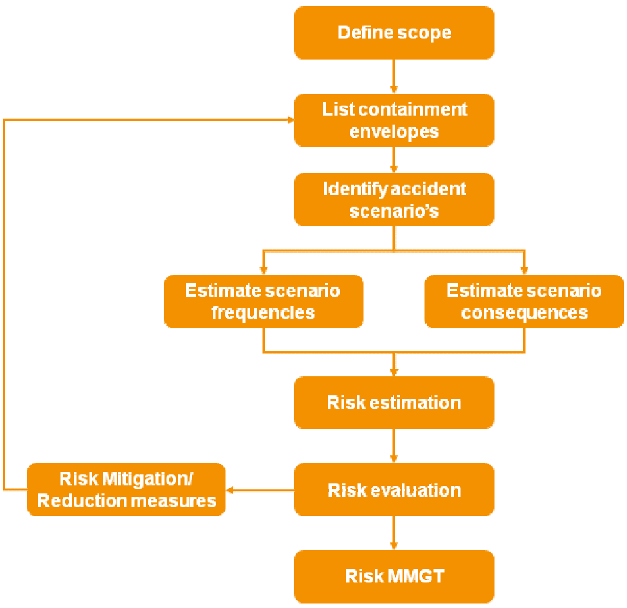
The general Health and Safety Executive (HSE) [13], [14], [15], [16], [17] or BEVI [18] [19] calculation method can be followed to carry out the risk calculations. This calculation method can in principle be used in all situations that present themselves within the scope of the project.

A number of choices have been made in the development of the project. In so doing in each case, an evaluation was made between making the calculation method as clear as possible, for which parameters need to be set, and enabling location-specific modelling, for which some freedom of choice needs to be given to the user. The result of this evaluation is that, within the available framework of the calculation method, the user always has the option to modify specific information. For this the precondition applies that all risk calculations must be worked out using properly substantiated and fully documented evaluations and choices.

The general steps are as follows:

- Data Compilation – The first step is to compile all pertinent data for the risk analysis.
- Hazard identification – The equipment must be characterized in sufficient detail to formulate potential accident scenarios and to permit subsequent evaluation of accident probability, likely release amount, and nature and magnitude of resulting impacts.
- Consequence analysis – Consequence analysis examines the severity of the potential physical impacts and derivative consequences of an equipment failure and accidental release of product. All the consequence calculation criteria used are strictly according to the Yellow Book [10].

The general approach is illustrated in the flowchart below. This scope definition (internal, external, domino-effects) will have an influence on the selection of the relevant installations.



All relevant equipment will be listed and studied in the next steps. A first step is to determine the accident scenario's related to the equipment using i.e. Purple Book [19], Handbook Failure Frequencies [20], PERD, HSE FRED [21].

The results of a risk assessment are the Damage Zones.

4.2 Major Hazards Identification

The HAZID & HAZOP workshops have allowed the identification of a large list of possible hazards for the installation, some of them resulting in a possible loss of containment. The hazards in detail may be read in the HAZID & HAZOP reports, while the summary of the possible major accident scenarios is included in the following paragraph.

Any Loss of Containment scenario can result in a number of different final consequences which may affect the people, the environment and the facilities. The developing of one or other effect depends in great measure on environmental conditions, such as the wind velocity, the weather stability, the temperature, the released quantity or the presence of ignition points.

The COMAH regulation specifies the acceptable methods for identification and accidental risk analysis:

- Detailed description of the possible major accident scenarios and their probability or the conditions under which they occur including a summary of the events which may play role in triggering each of these scenarios, the causes being internal or external to the installation.
- Assessment of the extent and severity of the consequences of identified major accidents
- Description of technical parameters and equipment used for the safety of installations.

The regulation does not prescribe any particular approach to risk analysis. Consequently, SGS considers that the methodology established in the Reference Manual BEVI Risk Assessments [18] is according to the needs of the hazard identification.

For that reason, BEVI [18] is focused on the parts of the system where there is a possibility of losing containment. The Reference Manual BEVI [18] considers different events of loss of containment in the equipment, from catastrophic failure to minor leakage.

The scenarios selected in this study are presented in the table shown below:

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-001	G2	HFO Unloading hose	HFO	Leak in unloading hose with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm.	ENE	Current, transient and future
HFO-001 FBR	G1	HFO Unloading hose	HFO	Rupture of the unloading hose.	ENE	Current, transient and future
HFO-002	G2	HFO Unloading pipeline from vessel to tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm. Pipeline from unloading point to tanks	ENE	Current, transient and future

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-002 FBR	G1	HFO Unloading pipeline from vessel to tank	HFO	Rupture in the pipeline	ENE	Current, transient and future
HFO-003	G3	HFO Storage tank n. 1 and 2	HFO	Continuous release from a hole with an effective diameter of 10 mm of the HFO storage tank	ENE	Current, transient and future
HFO-003 CF	G1	HFO Storage tank n. 1 and 2	HFO	Instantaneous release of the entire contents of the HFO storage tank	ENE	Current, transient and future

SGS

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-004	G3	HFO Storage tank n. 3	HFO	Continuous release from a hole with an effective diameter of 10 mm of the HFO storage tank	ENE	Current, transient and future
HFO-004 CF	G1	HFO Storage tank n. 3	HFO	Instantaneous release of the entire contents of the HFO storage tank	ENE	Current, transient and future
HFO-005	G2	HFO pipelines from storage tank to D3 transfer pump	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	Current, transient and future

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-005 FBR	G1	HFO pipelines from storage tank to D3 transfer pump	HFO	Rupture of the pipeline. Pipeline from unloading point to tanks	ENE	Current, transient and future
HFO-006	G2	HFO D3 Transfer Pumps	HFO	Leak (10 % diameter). Discharge line	ENE	Current, transient and future
HFO-006 CF	G1	HFO D3 Transfer Pumps	HFO	Catastrophic failure. Discharge line	ENE	Current, transient and future

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-007	G2	HFO pipelines from D3 transfer pump to D3 buffer tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	Current, transient and future
HFO-007 FBR	G1	HFO pipelines from D3 transfer pump to D3 buffer tank	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	ENE	Current, transient and future
HFO-008	G3	HFO D3 buffer tanks	HFO	Continuous release from a hole with an effective diameter of 10 mm. HFO service storage tanks	ENE	Current, transient and future

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-008 CF	G1	HFO D3 buffer tanks	HFO	Instantaneous release of the entire contents. HFO service storage tanks	ENE	Current, transient and future
HFO-009	G2	HFO pipelines from D3 buffer tank to D3 centrifuges supply pump	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	Current, transient and future
HFO-009 FBR	G1	HFO pipelines from D3 buffer tank to D3 centrifuges supply pump	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	ENE	Current, transient and future

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-010	G2	HFO D3 centrifuges supply pumps	HFO	Leak (10 % diameter). Discharge line of the supply pumps	ENE	Current, transient and future
HFO-010 CF	G1	HFO D3 centrifuges supply pumps	HFO	Catastrophic failure. Discharge line of the supply pumps	ENE	Current, transient and future
HFO-011	G2	HFO pipelines from D3 centrifuges supply pump to D3 centrifuges	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	Current, transient and future

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-011 FBR	G1	HFO pipelines from D3 centrifuges supply pump to D3 centrifuges	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	ENE	Current, transient and future
HFO-012	G3	HFO D3 centrifuges	HFO	Continuous release from a hole with an effective diameter of 10 mm. Centrifuges	ENE	Current, transient and future
HFO-012 CF	G1	HFO D3 centrifuges	HFO	Catastrophic failure. Centrifuges	ENE	Current, transient and future

SGS

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-013	G2	HFO pipelines from D3 centrifuges to D3 service tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	Current, transient and future
HFO-013 FBR	G1	HFO pipelines from D3 centrifuges to D3 service tank	HFO	Rupture in the pipeline	ENE	Current, transient and future
HFO-014	G3	HFO D3 service tanks	HFO	Continuous release from a hole with an effective diameter of 10 mm. HFO service storage tanks	ENE	Current, transient and future

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-014 CF	G1	HFO D3 service tanks	HFO	Catastrophic failure. HFO service storage tanks	ENE	Current, transient and future
HFO-015	G2	HFO pipelines from service tanks to D3 engines	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	Current, transient and future
HFO-015 FBR	G1	HFO pipelines from service tanks to D3 engines	HFO	Rupture in the pipeline	ENE	Current, transient and future

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-016	G2	HFO pipelines from storage tank to D1 HFO pumphouse	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	Current, transient and future
HFO-016 FBR	G1	HFO pipelines from storage tank to D1 HFO pumphouse	HFO	Rupture in the pipeline	ENE	Current, transient and future
HFO-017	G2	HFO D1 HFO Pumps	HFO	Leak (10 % diameter). Discharge line	ENE	Current, transient and future

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-017 CF	G1	HFO D1 HFO Pumps	HFO	Catastropic failure. Discharge line	ENE	Current, transient and future
HFO-018	G2	HFO pipelines from D1 HFO pumphouse to heaters	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	Current, transient and future
HFO-018 FBR	G1	HFO pipelines from D1 HFO pumphouse to heaters	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	ENE	Current, transient and future

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
HFO-019	G2	HFO pipelines from D1 heaters to D1 boilers	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	Current, transient and future
HFO-019 FBR	G1	HFO pipelines from D1 heaters to D1 boilers	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	ENE	Current, transient and future
DO-001	G2	DO Unloading arm	DO	Leak in unloading hose with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm.	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-001 FBR	G1	DO Unloading arm	DO	Rupture of the unloading arm.	ENE	All
DO-002	G2	DO Unloading pipeline from vessel to raw tanks	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All
DO-002 FBR	G1	DO Unloading pipeline from vessel to raw tanks	DO	Rupture in the pipeline	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-003	G3	DO Raw tank n. ½/3	DO	Continuous release from a hole with an effective diameter of 10 mm	ENE	All
DO-003 CF	G1	DO Raw tank n. ½/3	DO	Instantaneous release of the entire contents of the DO Raw tank n. ½/3	ENE	All
DO-004	G2	DO pipelines from raw tank to transfer pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-004 FBR	G1	DO pipelines from raw tank to transfer pumps	DO	Rupture in the pipeline	ENE	All
DO-005	G2	DO Transfer Pumps	DO	Leak (10 % diameter). Discharge line	ENE	All
DO-005 CF	G1	DO Transfer Pumps	DO	Catastrophic failure. Discharge line	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-006	G2	DO pipelines from transfer pumps to centrifuges	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All
DO-006 FBR	G1	DO pipelines from transfer pumps to centrifuges	DO	Rupture in the pipeline	ENE	All
DO-007	G2	DO centrifuges	DO	Continuous release from a hole with an effective diameter of 10 mm. Centrifuges	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-007 CF	G1	DO centrifuges	DO	Catastrophic failure. Centrifuges	ENE	All
DO-008	G3	DO pipelines from centrifuges to treated tank	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All
DO-008 FBR	G1	DO pipelines from centrifuges to treated tank	DO	Rupture in the pipeline	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-009	G3	DO Treated tank n. 4	DO	Continuous release from a hole with an effective diameter of 10 mm	ENE	All
DO-009 CF	G 1	DO Treated tank n. 4	DO	Instantaneous release of the entire contents of the DO Treated tank n. 4	ENE	All
DO-010	G3	DO return pipelines from centrifuges to raw tank nr 0, nr 1	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-010 FBR	G1	DO return pipelines from centrifuges to raw tank nr 0, nr 1	DO	Rupture in the pipeline	ENE	All
DO-011	G3	DO return pipelines from centrifuges to raw tank nr 2	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All
DO-011 FBR	G1	DO return pipelines from centrifuges to raw tank nr 2	DO	Rupture in the pipeline	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-012	G2	DO pipelines from treated tank to D2A forwarding pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All
DO-012 FBR	G1	DO pipelines from treated tank to D2A forwarding pumps	DO	Rupture in the pipeline	ENE	All
DO-013	G2	DO pipelines from treated tank to D2B forwarding pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-013 FBR	G1	DO pipelines from treated tank to D2B forwarding pumps	DO	Rupture in the pipeline	ENE	All
DO-014	G2	DO D2A forwarding pumps	DO	Leak (10 % diameter). Discharge line of the supply pumps	ENE	All
DO-014 CF	G1	DO D2A forwarding pumps	DO	Catastrophic failure. Discharge line of the supply pumps	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-015	G2	DO D2B forwarding pumps	DO	Leak (10 % diameter). Discharge line of the supply pumps	ENE	All
DO-015 FBR	G1	DO D2B forwarding pumps	DO	Rupture in the pipeline	ENE	All
DO-016	G2	DO pipelines from forwarding pumps tank to D2A	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-016 FBR	G1	DO pipelines from forwarding pumps tank to D2A	DO	Rupture in the pipeline	ENE	All
DO-017	G2	DO pipelines from forwarding pumps tank to D2B	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All
DO-017 FBR	G1	DO pipelines from forwarding pumps tank to D2B	DO	Rupture in the pipeline	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-018	G2	DO pipelines from raw tank to D3 transfer pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All
DO-018 FBR	G1	DO pipelines from raw tank to D3 transfer pumps	DO	Rupture in the pipeline	ENE	All
DO-019	G3	DO D3 Transfer Pumps	DO	Leak (10 % diameter). Discharge line	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-019 CF	G1	DO D3 Transfer Pumps	DO	Catastrophic failure. Discharge line	ENE	All
DO-020	G2	DO pipelines from D3 transfer pump to D3 service tank	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All
DO-020 FBR	G1	DO pipelines from D3 transfer pump to D3 service tank	DO	Rupture in the pipeline	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-021	G3	DO D3 Service tank	DO	Continuous release from a hole with an effective diameter of 10 mm	ENE	All
DO-021 CF	G1	DO D3 Service tank	DO	Instantaneous release of the entire contents of the DO D3 Service tank	ENE	All
DO-022	G2	DO pipelines from D3 service tank to supply pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	OPERATOR	STAGE
DO-022 FBR	G1	DO pipelines from D3 service tank to supply pumps	DO	Rupture in the pipeline	ENE	All
DO-023	G2	DO pipelines from D3 supply pumps to engines	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	ENE	All
DO-023 FBR	G1	DO pipelines from D3 supply pumps to engines	DO	Rupture in the pipeline	ENE	All

It is important to state that all the HFO related scenarios are expected to be less likely after the commissioning of the new gas turbines and the conversion of the existing engines, but will remain part of the Safety Report as long as the HFO will be stored handled at Delimara.

4.3 Determination of the likelihood of final events – Event Tree and Fault Tree Analysis.

In general, the most common effects of a loss of containment are well known, typified and modelled. For a liquid release of gasoil or fuel oil, the following effects are considered:

Final events

- Pool Fire
- Explosion
- Environmental damage

A brief description of these effects is provided in the following paragraphs.

Pool Fire

A pool fire is the combustion of a substance in a liquid phase, while accumulated in a basin or spreading on the ground or water. A pool fire can be a continuous effect if the released quantity is enough and can burn over a very large period of time, until all the quantity is gone or the pool is properly covered with fire fighting foam.

Physical Explosion

Physical explosions occurs due to the accumulation of vapours in the container (closed) resulting in an overpressure explosion associated with rupture of the container.

Environmental damage

Environmental damage encompasses events with the potential to cause severe, widespread, long-term or even permanent damage to ecosystems. These accidents can pose considerable threats to the terrestrial as well as the aquatic environment.
Spills into superficial water are likely to lead to chemicals being transported rapidly away from the original site spreading over a wide surface of water. The effects of spills would then be related to the degree of dispersion of chemical in the water body.

4.3.1 Event Tree Analysis

The goal for the Event Tree Analysis is to quantify the probability of intermediate events that determine the evolution from the initial event (i.e a leakage) and end up causing the final damage (i.e. a fire). This can be done using the event tree technique.

The event tree is an inductive method that describes in a qualitative and quantitative mode, the evaluation from an initial event up to the final accident depending on the characteristics of the initiator, the environmental and the protection systems, where known.

From the initial failure or initiator and considering the conditioning factors involved, the tree describes the accident sequences leading to possible events. The construction and evaluation of the tree begins by identifying the conditions and their probabilities of occurrence of each of them.

Each starting point, based on the initial event, is identified in the tree as N. The tree has to be systematically raised in two branches: the one at the top reflecting success or the occurrence of the event (with probability P) and the one below representing the failure or non-occurrence of the event (probability 1-P).

The frequencies of each accident scenario were obtained from tabulated standard frequencies from referenced guidelines ([21][18]) and have been adapted to the facilities.

Taking into account the physical and chemical characteristics of the substances involved in each scenario, some specific frequencies have been estimated on the basis of the following discussions.

In the case of heavy fuel oil and gasoil releases, the frequency of each final event scenario depends on the ignition probability.

The probability of direct ignition depends on the substance category. Heavy Fuel oil is a substance with a flash point of 60 ºC and gasoil flash point is greater than 55 ℃ and less than or equal to 100 ℃. Therefore, these substances are classified under WMS category 3.

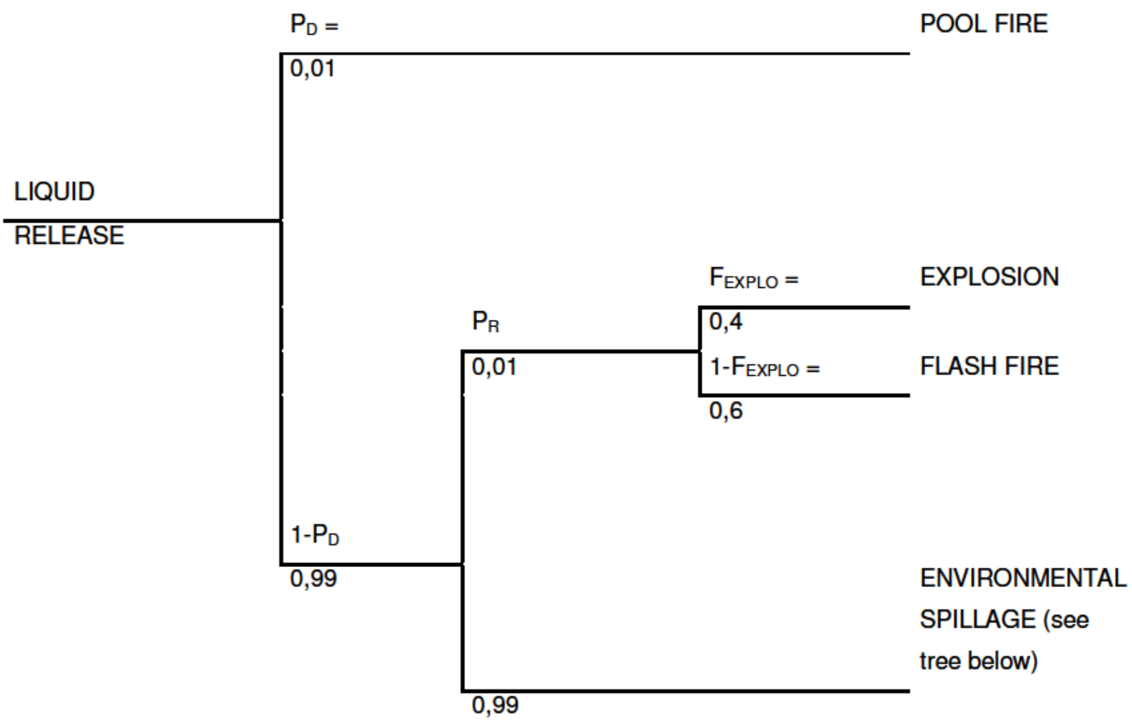
As it is stated on BEVI [18]:
"... even if a category 3 substance does not have a WMS classification, it satisfies the definition in the BEVI for a flammable substance. Gasoil has a flash point greater than 55ºC and therefore falls under category 3 and under category LF1 in the S3b method. A probability of ignition of 0,01 is therefore used for category 3. It is now proposed to attribute no probability of ignition to category 3 (and therefore not to include it in the QRA), because the substance does not have a WMS classification. The substance must only be included if the process temperature is greater than the combustion temperature."

In this study, a direct ignition probability of 0.01 is applied for heavy fuel oil in those parts of the facilities in which the process temperature can exceed the combustion temperature, such as in the pump room, centrifuges and the associated pipelines. In case of gasoil, this ignition probability is applied when the identified scenarios are caused by domino effect due to a fire impinging on a tank, nevertheless, this phenomenon has not been identified in the facility.

The resulting event trees are shown below.

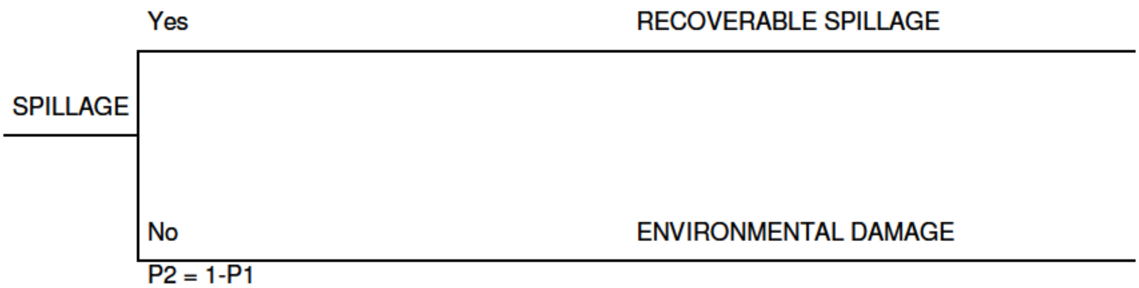
Event tree for heavy fuel oil releases

Release	Direct ignition	Delayed ignition	Explosion	Final event



Event tree for liquid release (gasoil and fuel oil)

Top Event	Immediate and effective barrier	Final Event



4.3.2 Fault Tree Analysis

A fault tree analysis can be simply described as an analytical technique, whereby an undesired state of the system is specified (usually a state that is critical from a safety standpoint), and the system is then analyzed in the context of its environment and operation to find all credible ways in which the undesired event can occur. The fault tree itself is a graphic model of the various parallel and sequential combinations of faults that will result in the occurrence of the predefined undesired event. The faults can be events that are associated with component hardware failures, human errors, or any other pertinent events which can lead to the undesired event. A fault tree thus depicts the logical interrelationships of basic events that lead to the undesired event- which is the top event of the fault tree.

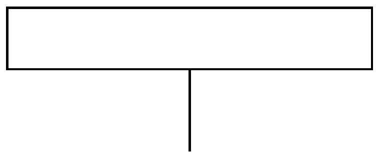
A fault tree is tailored to its top event which corresponds to some particular system failure mode, and the fault tree thus includes only those faults that contribute to this top event. Moreover, these faults are not exhaustive-they cover only the most credible faults as assessed by the analyst.

It is also important to point out that a fault tree is not in itself a quantitative model. It is a qualitative model that can be evaluated quantitatively and often is.

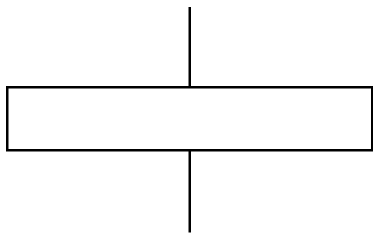
A fault tree is a complex of entities known as “gates” which serve to permit or inhibit the passage of fault logic up the tree. The gates show the relationships of events needed for the occurrence of a “higher” event. The “higher” event is the “output” of the gate; the “lower” events are the “inputs” to the gate. The gate symbol denotes the type of relationship of the input events required for the output event.

The development of the tree is to systematically break down a complex event called “TOP Event” into intermediate events to reach basic events.

TOP Event: It occupies the top of the logical structure that represents the fault tree. It is the complex event which is represented by a rectangle. It has to be clearly defined (conditions ...)



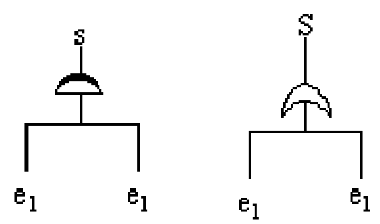
Intermediate events: are the intermediate events that are found in the decomposition process, these events can be decomposed again. They are represented in the fault tree into rectangles.



Basic events: They can represent any type of event : Event “failures” human error .... or events ‘success’: occurrence of a certain event. Are represented in circles in the tree structure.

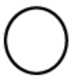
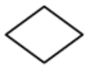
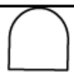
In the decomposition process of the tree is used to gate array representing the event algebra operators. The two basic types correspond to AND and OR gates whose symbols are given below. The OR gate is used to indicate a logic “0”: means that the S logic output will always occur and when they occur at least one of the two logic inputs e1 and e2.

The AND gate is used to indicate a “Y” logical. For the logic output S needs to happen together the two logic inputs e1 and e2.



Undeveloped events. There are events in the decomposition process fault tree whose decomposition process is not followed, either for lack of information or because it is not considered necessary. They are represented by a diamond and are treated as basic events.

When all the causes and sub-causes have been identified, the next stage is to construct the fault tree. In designing the tree, a set of symbols, shown in. Are used

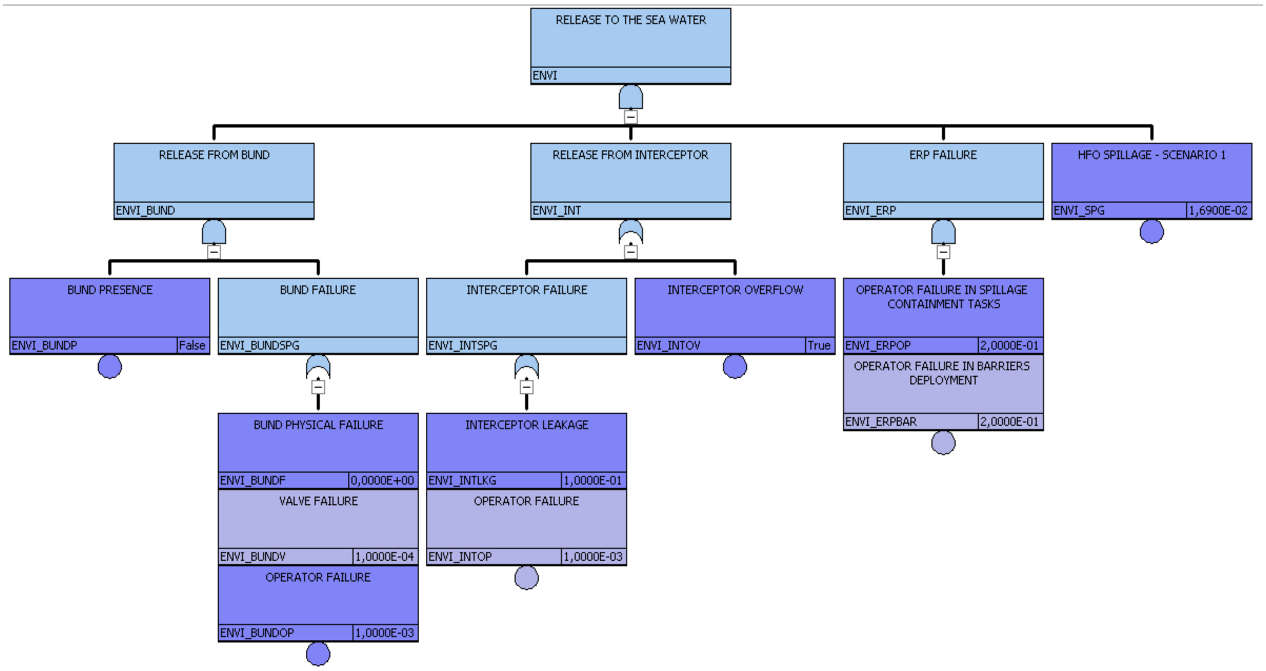
Symbol	Designation	Function
	EVENT / CAUSE	Causes or events that can be developed further
	BASIC EVENT/ CAUSE	Basic or Root Causes or events that cannot be developed further
	UNDEVELOPED EVENT/ CAUSE	Causes are not developed due to lack of information or significance.
	AND gate	Output event occurs only if all input events occur
	OR gate	Output event occurs if any one of the input events occurs

In this report the FTA technique has been applied in order to estimate the probability of a release to the environment, being this scenario not directly associable to a standard frequency. Such a release has been considered to be the result of several mechanical or human failures inside the facilities. Using basic standard frequencies and logical calculation of the events required for the release, a frequency for each environmental scenario is proposed.

The FTA technique has been developed for the totality of the environmental scenarios identified at the Delimara Power Station facilities taking into account that the scenarios may occur inside the bunds, outside the bund but in a partially contained area or at the quay during the unloading activities.

All the spillages outside the bunds will be conducted to the correspondent interceptor through the existing drainage routes in the facilities. However, depending on the release magnitude, the release could not be completely contained into the interceptor, leading to an environmental damage.

The resulting fault tree regarding environmental spillages of HFO or DO is shown below:



For all the releases occurred inside a bund, the spillage will be contained, being the potential for a leakage outside the bund associated to a human error in the drainage valve, which must be kept closed all the time, but may be open in case of omission or due to a valve failure.

The corresponding description of each basic event, the likelihood obtained and failure rates used are shown in the table below:

Basic Event	**Description**	**Probability (y-1)**	**Failure rate**	**Reference**
ENVI_SPG	SPILLAGE HFO or DO spillage	Depending on each scenario[3].	-	BEVI See table on pages below
ENVI_BUNDV	VALVE FAILURE Valve failure to close not including human error	-	0.0001	FRED
ENVI_BUNDOP	VALVE OPEN DUE TO OPERATOR FAILURE Human failure. Procedures without checklist taking into consideration less than 10 items	-	0.001	NUREG/CR -1278
ENVI_ERPOP	OPERATOR FAILURE IN SPILLAGE CONTAINMENT TASKS Human failure working under stress conditions is considered.	0.2	-	KLETZ, T.
ENVI_ERPBAR	OPERATOR FAILURE IN BARRIERS DEPLOYMENT Human failure working under stress conditions is considered.	0.2	-	KLETZ, T.

[3] In the presented FTA is shown the probability of a spillage of HFO corresponding to the scenario n. 1

4.4 Final occurrence frequencies of the identified scenarios

The final frequencies proposed for each scenario, considering the results obtained in the application of the event and fault tree analysis, are shown in the table below:

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
HFO-001	G2	HFO Unloading hose	HFO	Leak in unloading hose with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm.	Table 50 BEVI v.3.2	4,00E-05	h-1	1 hose N vessels = 18 N transfer operations = 18 t operation = 24 h	1,73E-02	y-1	PFIRE	1,73E-04	y-1
											EXPLOSION	6,84E-05	y-1
											FLASHFIRE	1,03E-04	y-1
											HFO SPILLAGE	7,46E-04	y-1
HFO-001 FBR	G1	HFO Unloading hose	HFO	Rupture of the unloading hose.	Table 50 BEVI v.3.2	4,00E-06	h-1	1 hose N vessels = 18 N transfer operations = 18 t operation = 24 h	1,73E-03	y-1	PFIRE	1,73E-05	y-1
											EXPLOSION	6,84E-06	y-1
											FLASHFIRE	1,03E-05	y-1
											HFO SPILLAGE	7,46E-05	y-1
HFO-002	G2	HFO Unloading pipeline from vessel to tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm. Pipeline from unloading point to tanks	Table 27 BEVI v.3.2	5,00E-07	m-1·y-1	D = 16" L = 500m	5,00E-04	y-1	PFIRE	5,00E-06	y-1
											EXPLOSION	1,98E-06	y-1
											FLASHFIRE	2,97E-06	y-1
											HFO SPILLAGE	2,16E-05	y-1
HFO-002 FBR	G1	HFO Unloading pipeline from vessel to tank	HFO	Rupture in the pipeline	Table 27 BEVI v.3.2	1,00E-07	m-1·y-1	D = 16" L = 500m	1,00E-04	y-1	PFIRE	1,00E-06	y-1
											EXPLOSION	3,96E-07	y-1
											FLASHFIRE	5,94E-07	y-1
											HFO SPILLAGE	4,32E-06	y-1
HFO-003	G3	HFO Storage tank n. 1 and 2	HFO	Continuous release from a hole with an effective diameter of 10 mm of the HFO storage tank	Table 17 BEVI v.3.2	1,00E-04	y-1	N tanks = 2	2,00E-04	y-1	PFIRE	2,00E-06	y-1
											EXPLOSION	7,92E-07	y-1
											FLASHFIRE	1,19E-06	y-1
											HFO SPILLAGE	9,50E-09	y-1
HFO-003 CF	G1	HFO Storage tank n. 1 and 2	HFO	Instantaneous release of the entire contents of the	Table 17 BEVI v.3.2	5,00E-06	y-1	N tanks = 2	1,00E-05	y-1	PFIRE	1,00E-07	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
				HFO storage tank							EXPLOSION	3,96E-08	y-1
											FLASHFIRE	5,94E-08	y-1
											HFO SPILLAGE	4,75E-10	y-1
HFO-004	G3	HFO Storage tank n. 3	HFO	Continuous release from a hole with an effective diameter of 10 mm of the HFO storage tank	Table 17 BEVI v.3.2	1,00E-04	y-1	N tanks = 1	1,00E-04	y-1	PFIRE	1,00E-06	y-1
											EXPLOSION	3,96E-07	y-1
											FLASHFIRE	5,94E-07	y-1
											HFO SPILLAGE	4,75E-09	y-1
HFO-004 CF	G1	HFO Storage tank n. 3	HFO	Instantaneous release of the entire contents of the HFO storage tank	Table 17 BEVI v.3.2	5,00E-06	y-1	N tanks = 1	5,00E-06	y-1	PFIRE	5,00E-08	y-1
											EXPLOSION	1,98E-08	y-1
											FLASHFIRE	2,97E-08	y-1
											HFO SPILLAGE	2,37E-10	y-1
HFO-005	G2	HFO pipelines from storage tank to D3 transfer pump	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	5,00E-07	m-1·y-1	DN200 L = 200	2,00E-04	y-1	PFIRE	2,00E-06	y-1
											EXPLOSION	7,92E-07	y-1
											FLASHFIRE	1,19E-06	y-1
											HFO SPILLAGE	7,92E-07	y-1
HFO-005 FBR	G1	HFO pipelines from storage tank to D3 transfer pump	HFO	Rupture of the pipeline. Pipeline from unloading point to tanks	Table 27 BEVI v.3.2	1,00E-07	m-1·y-1	DN200 L = 200	4,00E-05	y-1	PFIRE	4,00E-07	y-1
											EXPLOSION	1,58E-07	y-1
											FLASHFIRE	2,38E-07	y-1
											HFO SPILLAGE	1,73E-06	y-1
HFO-006	G2	HFO D3 Transfer Pumps	HFO	Leak (10 % diameter). Discharge line	Table 35 BEVI v.3.2	5,00E-05	y-1	N pumps = 2 t use = 8606 h	9,82E-05	y-1	PFIRE	9,82E-07	y-1
											EXPLOSION	3,89E-07	y-1
											FLASHFIRE	5,84E-07	y-1
											HFO SPILLAGE	5,23E-10	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
HFO-006 CF	G1	HFO D3 Transfer Pumps	HFO	Catastrophic failure. Discharge line	Table 35 BEVI v.3.2	1,00E-05	y-1	N pumps = 2 t use = 8606 h	1,96E-05	y-1	PFIRE	1,96E-07	y-1
											EXPLOSION	7,78E-08	y-1
											FLASHFIRE	1,17E-07	y-1
											HFO SPILLAGE	8,56E-11	y-1
HFO-007	G2	HFO pipelines from D3 transfer pump to D3 buffer tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN150 L = 110m	4,40E-04	y-1	PFIRE	4,40E-06	y-1
											EXPLOSION	1,74E-06	y-1
											FLASHFIRE	2,61E-06	y-1
											HFO SPILLAGE	1,74E-06	y-1
HFO-007 FBR	G1	HFO pipelines from D3 transfer pump to D3 buffer tank	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	DN150 L = 110m	6,60E-05	y-1	PFIRE	6,60E-07	y-1
											EXPLOSION	2,61E-07	y-1
											FLASHFIRE	3,92E-07	y-1
											HFO SPILLAGE	2,85E-06	y-1
HFO-008	G3	HFO D3 buffer tanks	HFO	Continuous release from a hole with an effective diameter of 10 mm. HFO service storage tanks	Table 17 BEVI v.3.2	1,00E-04	y-1	N tanks = 2	2,00E-04	y-1	PFIRE	2,00E-06	y-1
											EXPLOSION	7,92E-07	y-1
											FLASHFIRE	1,19E-06	y-1
											HFO SPILLAGE	8,63E-06	y-1
HFO-008 CF	G1	HFO D3 buffer tanks	HFO	Instantaneous release of the entire contents. HFO service storage tanks	Table 17 BEVI v.3.2	5,00E-06	y-1	N tanks = 2	1,00E-05	y-1	PFIRE	1,00E-07	y-1
											EXPLOSION	3,96E-08	y-1
											FLASHFIRE	5,94E-08	y-1
											HFO SPILLAGE	4,32E-07	y-1
HFO-009	G2	HFO pipelines from D3 buffer tank to D3 centrifuges supply pump	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN100 L = 30m	1,20E-04	y-1	PFIRE	1,20E-06	y-1
											EXPLOSION	4,75E-07	y-1
											FLASHFIRE	7,13E-07	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
											HFO SPILLAGE	4,75E-07	y-1
HFO-009 FBR	G1	HFO pipelines from D3 buffer tank to D3 centrifuges supply pump	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN100 L = 30m	1,20E-04	y-1	PFIRE	1,20E-06	y-1
											EXPLOSION	4,75E-07	y-1
											FLASHFIRE	7,13E-07	y-1
											HFO SPILLAGE	5,18E-06	y-1
HFO-010	G2	HFO D3 centrifuges supply pumps	HFO	Leak (10 % diameter). Discharge line of the supply pumps	Table 35 BEVI v.3.2	5,00E-05	y-1	N pumps = 6 t use = 49,158 h	1,68E-03	y-1	PFIRE	1,68E-05	y-1
											EXPLOSION	6,67E-06	y-1
											FLASHFIRE	1,00E-05	y-1
											HFO SPILLAGE	6,67E-06	y-1
HFO-010 CF	G1	HFO D3 centrifuges supply pumps	HFO	Catastrophic failure. Discharge line of the supply pumps	Table 35 BEVI v.3.2	1,00E-05	y-1	N pumps = 6 t use = 49,158 h	3,37E-04	y-1	PFIRE	3,37E-06	y-1
											EXPLOSION	1,33E-06	y-1
											FLASHFIRE	2,00E-06	y-1
											HFO SPILLAGE	1,45E-05	y-1
HFO-011	G2	HFO pipelines from D3 centrifuges supply pump to D3 centrifuges	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN100 L = on same skid	2,00E-05	y-1	PFIRE	2,00E-07	y-1
											EXPLOSION	7,92E-08	y-1
											FLASHFIRE	1,19E-07	y-1
											HFO SPILLAGE	7,92E-08	y-1
HFO-011 FBR	G1	HFO pipelines from D3 centrifuges supply pump to D3 centrifuges	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	DN100 L = on same skid	3,00E-06	y-1	PFIRE	3,00E-08	y-1
											EXPLOSION	1,19E-08	y-1
											FLASHFIRE	1,78E-08	y-1
											HFO SPILLAGE	1,29E-07	y-1
HFO-012	G3	HFO D3 centrifuges	HFO	Continuous release from a hole with an effective diameter of 10 mm. Centrifuges	Table 31 BEVI v.3.2	1,00E-04	y-1	N separators = 3	3,00E-04	y-1	PFIRE	3,00E-06	y-1
											EXPLOSION	1,19E-06	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
											FLASHFIRE	1,78E-06	y-1
											HFO SPILLAGE	1,19E-06	y-1
HFO-012 CF	G1	HFO D3 centrifuges	HFO	Catastrophic failure. Centrifuges	Table 31 BEVI v.3.2	5,00E-06	y-1	N separators = 3	1,50E-05	y-1	PFIRE	1,50E-07	y-1
											EXPLOSION	5,94E-08	y-1
											FLASHFIRE	8,91E-08	y-1
											HFO SPILLAGE	5,94E-08	y-1
HFO-013	G2	HFO pipelines from D3 centrifuges to D3 service tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN150 L = 30m	1,20E-04	y-1	PFIRE	1,20E-06	y-1
											EXPLOSION	4,75E-07	y-1
											FLASHFIRE	7,13E-07	y-1
											HFO SPILLAGE	4,75E-07	y-1
HFO-013 FBR	G1	HFO pipelines from D3 centrifuges to D3 service tank	HFO	Rupture in the pipeline	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	DN150 L = 30m	1,80E-05	y-1	PFIRE	1,80E-07	y-1
											EXPLOSION	7,13E-08	y-1
											FLASHFIRE	1,07E-07	y-1
											HFO SPILLAGE	7,13E-08	y-1
HFO-014	G3	HFO D3 service tanks	HFO	Continuous release from a hole with an effective diameter of 10 mm. HFO service storage tanks	Table 17 BEVI v.3.2	2,00E-06	y-1	N tanks = 2	4,00E-06	y-1	PFIRE	4,00E-08	y-1
											EXPLOSION	1,58E-08	y-1
											FLASHFIRE	2,38E-08	y-1
											HFO SPILLAGE	1,73E-07	y-1
HFO-014 CF	G1	HFO D3 service tanks	HFO	Catastrophic failure. HFO service storage tanks	Table 17 BEVI v.3.2	2,00E-06	y-1	N tanks = 2	4,00E-06	y-1	PFIRE	4,00E-08	y-1
											EXPLOSION	1,58E-08	y-1
											FLASHFIRE	2,38E-08	y-1
											HFO SPILLAGE	1,73E-07	y-1
HFO-015	G2	HFO pipelines from service tanks to D3	HFO	Leak with an effective diameter of 10% of the	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN150 L = 300m	1,20E-03	y-1	PFIRE	1,20E-05	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
		engines		nominal diameter, up to a maximum of 50 mm							EXPLOSION	4,75E-06	y-1
											FLASHFIRE	7,13E-06	y-1
											HFO SPILLAGE	4,75E-06	y-1
HFO-015 FBR	G1	HFO pipelines from service tanks to D3 engines	HFO	Rupture in the pipeline	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	DN150 L = 300m	1,80E-04	y-1	PFIRE	1,80E-06	y-1
											EXPLOSION	7,13E-07	y-1
											FLASHFIRE	1,07E-06	y-1
											HFO SPILLAGE	7,13E-07	y-1
HFO-016	G2	HFO pipelines from storage tank to D1 HFO pumphouse	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN200 L = 200m	8,00E-04	y-1	PFIRE	8,00E-06	y-1
											EXPLOSION	3,17E-06	y-1
											FLASHFIRE	4,75E-06	y-1
											HFO SPILLAGE	3,17E-06	y-1
HFO-016 FBR	G1	HFO pipelines from storage tank to D1 HFO pumphouse	HFO	Rupture in the pipeline	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	DN200 L = 200m	1,20E-04	y-1	PFIRE	1,20E-06	y-1
											EXPLOSION	4,75E-07	y-1
											FLASHFIRE	7,13E-07	y-1
											HFO SPILLAGE	5,18E-06	y-1
HFO-017	G2	HFO D1 HFO Pumps	HFO	Leak (10 % diameter). Discharge line	Table 35 BEVI v.3.2	5,00E-05	y-1	N pumps = 2 t use = 11,672 h	1,33E-04	y-1	PFIRE	2,00E-07	y-1
											EXPLOSION	7,92E-08	y-1
											FLASHFIRE	1,19E-07	y-1
											HFO SPILLAGE	8,63E-07	y-1
HFO-017 CF	G1	HFO D1 HFO Pumps	HFO	Catastropic failure. Discharge line	Table 35 BEVI v.3.2	1,00E-05	y-1	N pumps = 2 t use = 11,672 h	2,66E-05	y-1	PFIRE	2,66E-07	y-1
											EXPLOSION	1,06E-07	y-1
											FLASHFIRE	1,58E-07	y-1
											HFO SPILLAGE	1,15E-06	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
HFO-018	G2	HFO pipelines from D1 HFO pumphouse to heaters	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN150 L = heaters are in HFO pumphouse buiding	2,00E-05	y-1	PFIRE	1,64E-05	y-1
											EXPLOSION	1,71E-07	y-1
											FLASHFIRE	2,57E-07	y-1
											HFO SPILLAGE	7,08E-05	y-1
HFO-018 FBR	G1	HFO pipelines from D1 HFO pumphouse to heaters	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	DN150 L = heaters are in HFO pumphouse buiding	3,00E-06	y-1	PFIRE	3,00E-08	y-1
											EXPLOSION	9,74E-07	y-1
											FLASHFIRE	1,46E-06	y-1
											HFO SPILLAGE	1,29E-07	y-1
HFO-019	G2	HFO pipelines from D1 heaters to D1 boilers	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN150 L = 410m	1,64E-03	y-1	PFIRE	4,32E-07	y-1
											EXPLOSION	1,71E-07	y-1
											FLASHFIRE	2,57E-07	y-1
											HFO SPILLAGE	1,86E-06	y-1
HFO-019 FBR	G1	HFO pipelines from D1 heaters to D1 boilers	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	DN150 L = 410m	2,46E-04	y-1	PFIRE	2,46E-06	y-1
											EXPLOSION	9,74E-07	y-1
											FLASHFIRE	1,46E-06	y-1
											HFO SPILLAGE	1,06E-05	y-1
DO-001	G2	DO Unloading arm	DO	Leak in unloading hose with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm.	Table 50 BEVI v.3.2	3,00E-07	h-1	1 arm N vessels = 9 N transfer operations = 9 t operation = 16 h	4,32E-05	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	1,75E-07	y-1
DO-001 FBR	G1	DO Unloading arm	DO	Rupture of the unloading arm.	Table 50 BEVI v.3.2	3,00E-08	h-1	1 arm N vessels = 9 N transfer operations = 9 t operation = 16 h	4,32E-06	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
											DO SPILLAGE	1,90E-07	y-1
DO-002	G2	DO Unloading pipeline from vessel to raw tanks	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	5,00E-07	m-1·y-1	D = 12" L = 570m	5,70E-04	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	2,51E-05	y-1
DO-002 FBR	G1	DO Unloading pipeline from vessel to raw tanks	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	1,00E-07	m-1·y-1	D = 12" L = 570m	1,14E-04	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	5,02E-06	y-1
DO-003	G3	DO Raw tank n. ½/3	DO	Continuous release from a hole with an effective diameter of 10 mm	Table 17 BEVI v.3.2	1,00E-04	y-1	N tanks = 3	3,00E-04	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	1,45E-08	y-1
DO-003 CF	G1	DO Raw tank n. ½/3	DO	Instantaneous release of the entire contents of the DO Raw tank n. ½/3	Table 17 BEVI v.3.2	5,00E-06	y-1	N tanks = 3	1,50E-05	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	7,27E-10	y-1
DO-004	G2	DO pipelines from raw tank to transfer pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	5,00E-07	m-1·y-1	D = 10" L = 210m	2,10E-04	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	9,25E-06	y-1
DO-004 FBR	G1	DO pipelines from raw tank to transfer pumps	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	1,00E-07	m-1·y-1	D = 10" L = 210m	4,20E-05	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	1,70E-07	y-1
DO-005	G2	DO Transfer Pumps	DO	Leak (10 % diameter). Discharge line	Table 35 BEVI v.3.2	5,00E-05	y-1	N pumps = 2 t use = 836 h	9,54E-06	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	4,20E-07	y-1
DO-005 CF	G1	DO Transfer Pumps	DO	Catastrophic failure. Discharge line	Table 35 BEVI v.3.2	1,00E-05	y-1	N pumps = 2 t use = 836 h	1,91E-06	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	7,71E-09	y-1
DO-006	G2	DO pipelines from transfer pumps to centrifuges	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	5,00E-07	m-1·y-1	D = 6" L = 100m	1,00E-04	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	4,40E-06	y-1
DO-006 FBR	G1	DO pipelines from transfer pumps to centrifuges	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	1,00E-07	m-1·y-1	D = 6" L = 100m	2,00E-05	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	8,08E-08	y-1
DO-007	G2	DO centrifuges	DO	Continuous release from a hole with an effective diameter of 10 mm. Centrifuges	Table 31 BEVI v.3.2	1,00E-04	y-1	N separators = 4	4,00E-04	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	1,76E-05	y-1
DO-007 CF	G1	DO centrifuges	DO	Catastrophic failure. Centrifuges	Table 31 BEVI v.3.2	5,00E-06	y-1	N separators = 4	2,00E-05	y-1	PFIRE	**0**	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	8,08E-08	y-1
DO-008	G3	DO pipelines from centrifuges to treated tank	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	5,00E-07	m-1·y-1	D = 6" L = 260m	2,60E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	1,15E-05	y-1
DO-008 FBR	G1	DO pipelines from centrifuges to treated tank	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	1,00E-07	m-1·y-1	D = 6" L = 260m	5,20E-05	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	2,10E-07	y-1
DO-009	G3	DO Treated tank n. 4	DO	Continuous release from a hole with an effective diameter of 10 mm	Table 17 BEVI v.3.2	1,00E-04	y-1	N tanks = 1	1,00E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	4,84E-09	y-1
DO-009 CF	G 1	DO Treated tank n. 4	DO	Instantaneous release of the entire contents of the DO Treated tank n. 4	Table 17 BEVI v.3.2	5,00E-06	y-1	N tanks = 1	5,00E-06	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	2,42E-10	y-1
DO-010	G3	DO return pipelines from centrifuges to raw tank nr 0, nr 1	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	5,00E-06	m-1·y-1	D = 2" L = 170m	1,70E-03	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	7,49E-05	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
DO-010 FBR	G1	DO return pipelines from centrifuges to raw tank nr 0, nr 1	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	1,00E-06	m-1·y-1	D = 2" L = 170m	3,40E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	1,37E-06	y-1
DO-011	G3	DO return pipelines from centrifuges to raw tank nr 2	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	D = 4" L = 250m	1,00E-03	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	4,40E-05	y-1
DO-011 FBR	G1	DO return pipelines from centrifuges to raw tank nr 2	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	D = 4" L = 250m	1,50E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	6,06E-07	y-1
DO-012	G2	DO pipelines from treated tank to D2A forwarding pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	5,00E-07	m-1·y-1	D = 10" L = 260m	2,60E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	1,05E-06	y-1
DO-012 FBR	G1	DO pipelines from treated tank to D2A forwarding pumps	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	1,00E-07	m-1·y-1	D = 10" L = 260m	5,20E-05	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	2,10E-07	y-1
DO-013	G2	DO pipelines from treated tank to D2B forwarding pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	5,00E-07	m-1·y-1	D = 10" L = 260m	2,60E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
											DO SPILLAGE	1,05E-06	y-1
DO-013 FBR	G1	DO pipelines from treated tank to D2B forwarding pumps	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	1,00E-07	m-1·y-1	D = 10" L = 260m	5,20E-05	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	2,10E-07	y-1
DO-014	G2	DO D2A forwarding pumps	DO	Leak (10 % diameter). Discharge line of the supply pumps	Table 35 BEVI v.3.2	5,00E-05	y-1	N pumps = 4 t use = 435 h	9,93E-06	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	4,01E-08	y-1
DO-014 CF	G1	DO D2A forwarding pumps	DO	Catastrophic failure. Discharge line of the supply pumps	Table 35 BEVI v.3.2	1,00E-05	y-1	N pumps = 4 t use = 435 h	1,99E-06	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	8,02E-09	y-1
DO-015	G2	DO D2B forwarding pumps	DO	Leak (10 % diameter). Discharge line of the supply pumps	Table 35 BEVI v.3.2	5,00E-05	y-1	N pumps = 3 t use = 6,161 h	1,05E-04	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	4,26E-07	y-1
DO-015 FBR	G1	DO D2B forwarding pumps	DO	Rupture in the pipeline	Table 35 BEVI v.3.2	1,00E-05	y-1	N pumps = 3 t use = 6,161 h	2,11E-05	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1
											FLASHFIRE	**0**	y-1
											DO SPILLAGE	8,52E-08	y-1
DO-016	G2	DO pipelines from forwarding pumps tank to D2A	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	D = 4" L = 272m	1,09E-03	y-1	PFIRE	**0**	y-1
											EXPLOSION	**0**	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
											FLASHFIRE	0	y-1
											DO SPILLAGE	4,40E-06	y-1
DO-016 FBR	G1	DO pipelines from forwarding pumps tank to D2A	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	D = 4" L = 272m	1,63E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	6,59E-07	y-1
DO-017	G2	DO pipelines from forwarding pumps tank to D2B	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	D = 4" L = 290m	1,16E-03	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	5,11E-05	y-1
DO-017 FBR	G1	DO pipelines from forwarding pumps tank to D2B	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	D = 4" L = 290m	1,74E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	7,03E-07	y-1
DO-018	G2	DO pipelines from raw tank to D3 transfer pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN125 L = 220m	8,80E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	3,56E-06	y-1
DO-018 FBR	G1	DO pipelines from raw tank to D3 transfer pumps	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	DN125 L = 220m	1,32E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	5,81E-06	y-1
DO-019	G3	DO D3 Transfer Pumps	DO	Leak (10 % diameter). Discharge line	Table 35 BEVI v.3.2	5,00E-05	y-1	N pumps = 2 t use = 836 h	9,54E-06	y-1	PFIRE	0	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	3,86E-08	y-1
DO-019 CF	G1	DO D3 Transfer Pumps	DO	Catastrophic failure. Discharge line	Table 35 BEVI v.3.2	1,00E-05	y-1	N pumps = 2 t use = 836 h	1,91E-06	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	8,41E-08	y-1
DO-020	G2	DO pipelines from D3 transfer pump to D3 service tank	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN100 L = 30m	1,20E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	4,85E-07	y-1
DO-020 FBR	G1	DO pipelines from D3 transfer pump to D3 service tank	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	DN100 L = 30m	1,80E-05	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	7,27E-08	y-1
DO-021	G3	DO D3 Service tank	DO	Continuous release from a hole with an effective diameter of 10 mm	Table 17 BEVI v.3.2	1,00E-04	y-1	N tanks = 1	1,00E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	4,04E-07	y-1
DO-021 CF	G1	DO D3 Service tank	DO	Instantaneous release of the entire contents of the DO D3 Service tank	Table 17 BEVI v.3.2	5,00E-06	y-1	N tanks = 1	5,00E-06	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	2,20E-07	y-1

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	REFERENCE	BASE FREQUENCY	UNITS	NOTES	FREQUENCY	UNITS	FINAL EVENT	FINAL FREQUENCY	UNITS
DO-022	G2	DO pipelines from D3 service tank to supply pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN100 L = 30m	1,20E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	4,85E-07	y-1
DO-022 FBR	G1	DO pipelines from D3 service tank to supply pumps	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	DN100 L = 30m	1,80E-05	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	7,93E-07	y-1
DO-023	G2	DO pipelines from D3 supply pumps to engines	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	Table 27 BEVI v.3.2	2,00E-06	m-1·y-1	DN100 L = 215m	8,60E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	3,47E-06	y-1
DO-023 FBR	G1	DO pipelines from D3 supply pumps to engines	DO	Rupture in the pipeline	Table 27 BEVI v.3.2	3,00E-07	m-1·y-1	DN100 L = 215m	1,29E-04	y-1	PFIRE	0	y-1
											EXPLOSION	0	y-1
											FLASHFIRE	0	y-1
											DO SPILLAGE	5,68E-06	y-1
NOTES	SF = Safety factor. Pipelines frequency has been incremented in a factor of 2 in order to take into account the transitory risk arising from the construction activities at the site, according to the potential hazard detected in the HAZID.												

4.5 Calculation criteria

The following criteria have been used in the calculation of the damage zones:

Release Duration

Release duration is a variable that depends on the organizational and technology structure of the equipment installed on site. For leakages from pipelines and vessels the estimated release duration are based on estimation of the closing time of emergency and operational valves. The detection systems installed at the facility would enable leaks to be detected rapidly.

The release duration time is generally considered:

- 2 minutes when an automatic detection and acting system is installed.
- 10 minutes when an automatic detection and acting system is not installed but the operation are constantly supervised by the operator.
- 30 minutes when an automatic detection and acting system is not installed and no continuous supervision is installed.

Releases on sea and on land

The unloading activities and the pipeline from the facilities to the sea are located in places where a spillage may fall into the water, so the calculation is done in both locations.

Whenever there are bunds, and can ensure that they are tight or lead to safety places, it will be considered effective in spill containment.

To determine the extent of the unconfined puddles, a maximum of 1,500 m^2 in the case of releases in land surface and 10,000 m^2 for releases into the sea are considered [19].

Surface Roughness Parameters

The surface roughness parameters are related to the type of subsoil on which the pool is spreading. Several different classes are supplied here where the type determines the heat transfer rate.

In practical situations the pool will spread until it reaches some minimum thickness which is related to the surface roughness. As typical values a lower limit of 5 millimetres for smooth surfaces, and for very rough surfaces several centimetres are used.

The classification provided here is based on table 3.1 from the Yellow Book [22]:

SUBSOIL	AVERAGE ROUGHNESS
flat sandy soil, concrete, tiles, plant-yard	0.005 m
relatively flat sandy soil, gravel	0.010 m
rough sandy soil, arable land, meadows	0.020 m
very rough overgrown sandy soil with holes	0.250 m

The roughness length is an artificial length-scale appearing in relations describing the wind speed over a surface, and which characterizes the roughness of the surface. Note that the sizes of the elements causing the roughness can be more than ten times larger than the roughness length.

Heavy Fuel Oil Emissive Power

The relationship between the emissive power and the diameter of the pool for flammable substances is defined by the following equation[4]:

$$E_{av} = E_m e^{-SD} + E_S\left(1 - e^{-SD}\right)$$

[4] Mudan, K.S. y Croce, P.A. (1995). Fire Hazard Calculations for Large Open Hydrocarbon Fires. In: DiNenno, P.J.; Beyler, C.L.; Custer, R.L.P.; Douglas Walton, W.; Watts, J.M.; Drysdale, D.; Hall, J.R. (eds.). *SFPE Handbook of Fire Protection Engineering*, Quincy, MA: NFPA y Boston, MA: SFPE, pp. 3-197-3-240.

where:

E_{av} = average emissive power

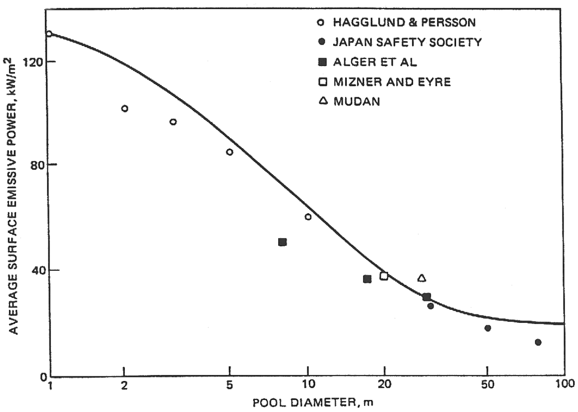
E_m = maximum emissive power of the pool (kW/m^2).

E_s = combustion emissive power (kW/m^2).

S = constant (= 0,12 m^{-1})

D = pool diameter (m)

The relationship between emissive power of the flame and the diameter of the pool is defined by the following graph:



Average surface emissive power for gasoline, kerosene, and JP-4 pool fires.[8]

4.5.1 Modelling software

For this report, the suite models incorporated into the EFFECTS 8.1.8 has been used.

EFFECTS examine the progress of a potential incident from the initial release to far-field dispersion including modelling of pool spreading and evaporation, and flammable and toxic effects. The mathematical models introduced in the EFFECTS Software fulfil the Dutch Yellow Book [22].

EFFECTS contain models organize in the next sections:

- Release (Gas, liquefied gas, liquid): discharge from a vessel or a pipe of gas, liquid or pressurized liquefied gas: vapour, liquid, two-phases and spray release.
- Pool evaporation: from land or water surfaces of a boiling or a non-boiling liquid.
- Atmospheric dispersion: neutral gas, heavy gas and turbulent free jet.
- Heat Radiation and combustion: Jet fire, pool fire, BLEVE
- Explosion
- Damage models

EFFECTS can link different models in order to organize the information in a matrix structure to simplify the calculations. For every EFFECTS model, a Yellow Book reference [22] is given for the complete description of the model.

4.6 Human vulnerability determination

The analysis of physical effects and consequences consists in determination of the consequences of particular physical effects in hazard zones. A hazard zone is the region in which physical effect of the hazard exceeds critical threshold values and induces negative effects for people, environment and property.

The estimation of the damage zones is based on the use of meteorological data, software models and acceptability criteria.

ERA has established a planning policy with reference to the control of major accident hazards. For the development in the vicinity of hazardous installations, consultation zones have to be defined according to HSE – UK Health and Safety Executive "risk based approach" [23]. These zones are based on the number of individuals likely to be affected by an accident and set at levels of:

99% fatalities in a normal population,

50% fatalities in a normal population (Inner zone),

40% fatalities in a normal population,

1 to 5% fatalities in a normal population (Middle Zone),

1 to 5% fatalities in a vulnerable population (Outer Zone).

Threshold values for the each zone to be used in this document are summarized in the following table.

RISK ZONES [24]			
EVENT	**OUTER ZONE**	**MIDDLE ZONE**	**INNER ZONE**
Pool fire	Low damage UPP=7.3 kW/m^2	High damage UPP=9.3 kW/m^2	Damage UPP=13.4 kW/m^2
Blast overpressure	0,17 barg	0,17 barg	0,90 barg

For the calculation of the threshold value for heat radiation effects, the thermal radiation is required to give a percentage of fatality for a 30 seconds exposure, calculated using 3 different Probit equations:

7.3 kW/m^2 for 1% fatalities for unprotected (unclothed) persons,

9.3 kW/m^2 for 1% fatalities for protected (clothed) persons,

13.4 kW/m^2 for 50% fatalities for protected (clothed) persons

The probit most commonly used to determine the risk from thermal radiation is the Eisenberg et al (1975) Probit.

$$\text{Probit} = -14.9 + 2.56 \ln (I^{1.33t})$$ with I in kW/m2 and t in seconds.

This relationship applies to people exposed outdoors. Consequently, this relationship can be used for most exposed population indoor and outdoor. The value t is related to the averaging time. The value proposed in the Yellow Book [25] is 18.75 s. But, according to the HSE, the value proposed for long duration fires is 75 s. Taking into account that this time is related to the human reaction in front of fire, it is considered more reasonable the value proposed by Yellow Book [25].

For some types of major hazard installation, damage contours associated with various levels of harm to property and buildings will be produced and provided to the planning authority, showing the maximum possible extent of any particular level of damage.

4.7 Domino Effect determination

Domino effects resulting from the Delimara Power Station and with effects on the vicinity are evaluated in this chapter.

The article no. 8 of the European Communities Council Directive on the Control of mayor hazards involving hazardous substances states:

> *Member States shall ensure that the competent authority, using the information received from the operators in compliance with Article 6 and 9, identifies establishments and groups of establishments or where the likelihood and the possibility of consequences of a mayor accident may be increased because of the location and the proximity of such establishments, and their inventories of dangerous substances.*

In order to address these issues the Health and Safety Executive (HSE) reviewed the previous work on domino effects and edited the document "*Development of methods to assess the significance of domino effects from major hazard sites*" which collects the methodologies for determining the additional risks from domino effects between sites and summarizes the values considered to be most appropriate for use in a Domino Assessment.

The scope of this chapter is to define the domino effect zones generated by the considered scenarios. Only the internal domino effect will be treated in details, while for the external domino effect, distances will be published for further evaluation of the effect in the Coordinated Safety Report.

In the framework of domino effect analysis, the risk of explosion and fire, characterized by the possibility of an accident in an industrial site may lead to serious consequences for the surrounding process equipment, people, goods and environment. These latter can generate four main events that may affect and/or cause the failure of the surrounding process equipments/units:

- Fire
- Explosion
- Toxic Release
- Other hazardous releases

In Delimara Power Station case, the relevant mechanism by which a potential domino effect could take place is fire; its main characteristics are described below:

Effect of fire depends on:

- Passive fire protection
- Fire walls
- Line of sight effects (blocking by others structures, vessels, walls)
- Active fire protection
- Fire load
- Flaring/dump tanks to reduce the inventory of the escaping material

Careful consideration needs to be deserved to whether "fire spread" events should be classified as domino events. A fire may spread due to a burning liquid flowing from one plant area to another, where it causes further hazardous events, or else a fire could spread via combustion of intervening combustible material.

Fire spread depends on:

- Availability of a route for the fire/burning material/gas/liquid to spread along (such as open ground, roads, natural or manmade drainage channels, drains, etc...
- Proximity of combustible material
- Fire walls

- Ditches, dikes, slopes, bunds, kerbs to prevent spread of burning liquid (topographic effects)
- Flashover effects
- Active fire prevention may possible if fire spread is gradual
- Effect of wind spreading fire
- Communication between plants

4.7.1 Domino Effect Damage Criteria

The events previously described can lead to domino effects depending on the resistance of materials. In this chapter, several thresholds for thermal radiation effects are discussed and final threshold for the project is presented.

When considering process plant, most studies in the past have considered only the intensity and neglected the exposure duration. In case of process plant that is subjected to steady thermal radiation intensity, the temperature of the material exposed will increase until a steady state temperature is reached. In order to define an allowable radiation intensity, some criteria are generally used which are derived from avoidance of unacceptable effects which would occur at higher temperature (loss of structural properties of materials).

In conclusion of the exposed by HSE, the damage criteria for the domino effect derived from thermal radiation scenarios are shown below:

THERMAL RADIATION DAMAGE CRITERIA	
ITEM	**THERMAL RADIATION FLUX (kW / m^2)**
Pressure vessels	37.5
Atmospheric Storage Tanks	37.5
Pipework	37.5
Water deluged pipework and vessels	-
Buildings	12.5
Control Buildings	25
People	1000 tdu

As a conservative approach, domino effects should be studied where the thermal flux can exceed 37.5 kW/m^2.

During the evaluation process additional criteria have been agreed with the stakeholders at the site for a detailed evaluation of possible domino effect, not only on the basis of the radiation or overpressure at which critical equipment is exposed, but also on the basis of the exposure duration.

VCE may provoke catastrophic rupture of affected pressurised, elongated and small equipment with a probability higher than 80%, and of atmospheric equipment with a probability higher than 95% at overpressure exceeding 700 mbar. [application of Probit functions (Mingguang& Juncheng 2008, Cozzani et al 2006) ref. Kardell & Loof 2014].

Pool Fires and Jet Fires with duration of more than 10 minutes may generate structural damage and loss of inventory of exposed pressurized equipment (of volume > 1 m3) with a probability higher than 50%, and of atmospheric equipment with a probability higher than 85% at heat radiation exceeding 37.5 kW/m2 [application of Probit functions (Landucci et al 2009, Antonioni et al 2009, Cozzani et al 2006) ref. Kardell & Loof 2014] .

Additionally it will be considered that no domino effect to pressurized equipment can be realistically sustained from Pool Fires or Jet Fires with a duration of less than 10 minutes, for all phenomena engulfing pressurized equipment (of volume > 1 m3) in flame, specifically for HFO/DO flames since heat emission level of HFO/DO flame is not expected to surpass 50kW/m2.

The same circumstance can also apply to the atmospheric equipment (up to a volume of 28000 m3) when engulfed in flame with the condition that the fraction of heat radiated to the atmospheric equipment is lower than the 30-50% of the heat emitted by the flame.

4.8 Major Accident to the Environment (MATTE). Effects determination

The Seveso III Directive requires operators to assess the potential for a major accident with the potential for creating a major impact on the environment. These accidents are described as Major Accidents to the Environment (MATTE). In addition to impacts on the natural environment, indirect impacts on the human population also need to be considered, such as effects on agricultural produce and water supplies.

The important factors that need to be considered in determining what constitutes a Major Accident to the Environment are [26]:

- The extent of the contamination or damage to habitats, species or communities.
- The severity of the effects
- The likely duration of any effects.
- Potential indirect impacts on human health through contamination of food or drinking water.

It is also important to take into account the intrinsic sensitivity of the environment surrounding the installation, as this is of direct relevance to the assessment of the significance of any consequence of a major accident.

The criteria to assist in the evaluation of a MATTE have been developed by the UK Department of the Environment, Transport and Regions (DETR) [26]. A summary of these criteria and threshold is provided below:

ENVIRONMENTAL MEDIUM	RECEPTOR	CRITERIA/THRESHOLD
Land/water (inter-tidal/near shore, subtidal)	National Nature Reserves, Sites of Special Scientific Interest, Marine Nature Reserves	Greater than 0.5 ha adversely affected, or greater than 10% of the area of the site affected (whichever is lesser) Greater than 10% of an associated linear feature adversely affected. Greater than 10% of a particular habitat or population of individual species affected.
Land/water	Natura 2000 sites, Special Protection Area, Special Areas of Conservation, Ramsar sites	Greater than 0.5 ha or 5% of the area of the site adversely affected (whichever is the lesser). Greater than 5% of an associated linear feature adversely affected. Greater than 5% of a particular habitat or population of individual species adversely affected.
Land	National Parks, Local Nature Reserves, Environmentally Sensitive Areas etc	Greater than 10 ha or 10% of land damaged, whichever is the lesser.

ENVIRONMENTAL MEDIUM	RECEPTOR	CRITERIA/THRESHOLD
Land/water	Scarce Habit (e.g. Biodiversity Action Plan Habitats, geological features, caves, fossil beds, mineral veins, moraines etc)	Damage to 10% of the area or 2ha, whichever is the lesser.
Widespread Habitat (Land/water)	Agricultural land, forestry	Contamination of 10ha or more of land which, for one year or more, prevents growing of crops or the grazing of domestic animals or renders the area in accessible to the public because of possible skin contact with dangerous substances, or, Contamination of any aquatic habitat which prevents fishing or aquaculture or which similarly renders it inaccessible to the public.
Aquifers or Groundwater	Water resources in or under the soil	Any incident likely to require large-scale and long term remedial measures. Any incident of contamination/pollution occurring within an area requiring a high level groundwater protection.

ENVIRONMENTAL MEDIUM	RECEPTOR	CRITERIA/THRESHOLD
Soil or Sediment	Soil or sediment to a depth of 1m	Contamination such that planned present or future uses of the site could be compromised. Deterioration in the biological quality of the soil/sediment such that common organisms are eliminated, the structure of the biological community altered for periods in excess of a single season, or normal ecosystem function is severely impaired for a period in excess of one year.
Built Environment	Listed/Scheduled Buildings, sites of archaeological importance	Damage to a listed/scheduled building such that it no longer possesses its architectural, historic or archaeological importance and which would require remedial/restorative work to remain listed/scheduled. Damage to an area of archaeological importance or to a conservation area resulting in a loss of importance.
Water	Various: groundwater, drinking water, fish and shellfish water, bathing waters	Post accident remediation and restoration work should ensure limits specified in various EU Directives for discharges and environmental quality are not exceeded
Particular Species	Common species, species listed under national or European legislation, Red Data Book species	For common species, death or serious sub-lethal effects within 1% of any species is significant. For common plant species, death or serious sub-lethal effects within 5% of the ground cover. Any loss of a Red Data Book Species or loss of a Red Data Book species habitat.

ENVIRONMENTAL MEDIUM	RECEPTOR	CRITERIA/THRESHOLD
Marine Waters	Marine waters, littoral, sub-littoral zone, benthic communities adjacent to the coast, fish spawning grounds.	An area of 2 ha or more of the littoral or sub littoral zone, or coastal benthic community, or benthic community of any fish spawning ground. An area of 100 ha or more of the open sea benthic community, or 100 or more dead seabirds (excluding gulls) 500 dead seabirds of any species 5 dead or significantly injured marine mammals.
Freshwater and Estuarine Habitats	Stream, river, canal, reservoir, lake, pond or estuary	A lowering of the chemical quality of the water course for a length of 10 km or 10% of the length of the water course, whichever is the lesser for more than one month, or a lowering of the biological quality for more than one year, or cause long term (>3 years) damage to the habitat. For estuaries and ponds, the area of impact for significance is 2ha or 10% of the area, whichever is the lesser.

The approach for assessing the potential MATTE at Delimara Power Station facilities is based on the guidance issued by the UK Government Environment Agency and The Department of Environment, Transport and the Regions [26],[27], [28] and in accordance with established scientific principles of environmental risk assessment. This approach comprised the following stages:

1. An assessment of the environmental sensitivity of the area surrounding the installation, based on a review of published data, land use planning policies, a review of base maps and a site inspection.
2. Identification of environmentally sensitive receptors.
3. Identification of possible pollution pathways which would allow environmentally hazardous substances to enter the environment following a major accident.
4. An initial screening of environmental risks, through the identification of possible source-pathway-receptor linkages.
5. Detailed assessment of those hazards which could result in a MATTE.
6. Assessment of environmental risks of a MATTE and risk management requirements to prevent or limit the consequences of a MATTE.

The types of environmental receptors that should be considered are as follows:

- Terrestrial habitats
- Freshwater habitats
- Marine habitats
- Groundwater bodies

When reviewing habitats the following points should be considered:

- Small areas within the larger overall area of a receptor may be significant, depending on the flora / fauna that inhabits them, reference should be made to the DETR 1999 guidance table 10 and Appendix 4 for further details.
- Any review of receptors should include migratory species which could be transient in the habitat
- Individual species (where appropriate) should be considered in the assessment, regardless of the pathway to the receptor.

The thresholds that should be used when determining the potential for a MATTE to each of the receptors have been developed with regard to the Major Accident EC reporting thresholds in the Seveso Directive and the DETR 1999 Guidance on MATTE. Thresholds are presented in two dimensions: Extent and Severity, and Duration of harm. The thresholds for both dimensions must be exceeded for the scenario to be considered to be a potential MATTE.

The severity level thresholds regarding the receptors in the surroundings of an establishment are established as shown in the table below:

ITEM	RECEPTOR TYPE	SEVERITY OF HARM			
		SIGNIFICANT[5]	SEVERE[6]	MAJOR	CATASTROPHIC
	SEVERITY LEVEL	1	2	3	4
1	Designated Land/Water Sites (Nationally important)	<0.5ha or <10%	>0.5 ha or 10-50% of site area, associated linear feature or population	>50% of site area, associated linear feature or population	*N/A*
2	Internationally important)	<0.5ha or <5% (<5% LF/Pop)	>0.5 ha or 5-25% of site area or 5-25% of associated linear feature or population	25-50% of site area, associated linear feature or population	>50% of site area, associated linear feature or population
3	Other designated Land	<10ha or <10%	10-100 ha or 10-50% of land	>100ha or >50% of land	*N/A*
4	Scarce Habitat	<2 ha or <10%	2-20ha or 10-50% of habitat	>20ha or >50% of habitat	*N/A*

[5] *While this level of harm might be significant pollution, it is not considered a MATTE.*

[6] *DETR Criteria - the lowest level of harm that might be considered MATTE.*

ITEM	RECEPTOR TYPE	SEVERITY OF HARM			
		SIGNIFICANT[5]	SEVERE[6]	MAJOR	CATASTROPHIC
	SEVERITY LEVEL	1	2	3	4
5	Widespread Habitat – Non-designated Land	<10ha	Contamination of 10100ha of land, preventing growing of crops, grazing of domestic animals or renders the area inaccessible to the public because of possible skin contact with dangerous substances. Alternatively, contamination of 10ha or more of vacant land.	100-1000ha (applied as per text under 'Severe')	>1000ha (applied as per text under 'Severe')
6	Widespread Habitat – Non-designated Water	Contamination of aquatic habitat which prevents fishing or aquaculture or renders is inaccessible to the public.	*N/A*	*N/A*	Widespread Habitat – Non-designated Water

ITEM	RECEPTOR TYPE	SEVERITY OF HARM			
		SIGNIFICANT[5]	SEVERE[6]	MAJOR	CATASTROPHIC
	SEVERITY LEVEL	1	2	3	4
7	Source of Public or Private Drinking Water (Groundwater or Surface Water)	Interruption of drinking water supply <1000 person-hours or For England & Wales only <1ha SPZ	Interruption of drinking water supplied from a ground or surface source (where persons affected x duration in hours [at least 2] > 1,000) or For England & Wales only 1-10ha of SPZ where drinking water standards are breached	>1 x 107 person-hours interruption of drinking water (a town of ~100,000 people losing supply for month) or For England & Wales only 10-100ha SPZ drinking water standards breached	>1 x 109 person-hours interruption of drinking (~1 million people losing supply for 1 month) or For England & Wales only >100ha SPZ drinking water standards breached
8	Groundwater Body (non- Drinking Water Source)	<1ha	1-100ha of groundwater body where the WFD status has been lowered	100-10,000ha	>10,000ha
9	Other Groundwater (outside of groundwater bodies)	Groundwater not a pathway to another receptor.	*Where the groundwater is a pathway for another receptor assess against relevant criteria for the receptor.*		

ITEM	RECEPTOR TYPE	SEVERITY OF HARM			
		SIGNIFICANT[5]	SEVERE[6]	MAJOR	CATASTROPHIC
	SEVERITY LEVEL	1	2	3	4
10	Soil or sediment (i.e. as receptor rather than purely a pathway)	Contamination not leading to environmental damage (as per ELD), or not significantly affecting overlying water quality.	Contamination of 10100ha of land etc. As per Widespread Habitat; Contamination sufficient to be deemed environmental damage (Environmental Liability Directive)	Contamination of 100-1000ha of land, as per Widespread Habitat; Contamination rendering the soil immediately hazardous to humans (e.g. skin contact) or the living environment, but remediation available.	Contamination of >1000ha of land, as per Widespread Habitat; Contamination rendering the soil immediately hazardous to humans (e.g. skin contact) or the living environment and remediation difficult or impossible.
11	Built environment	Damage below a level at which designation of importance would be withdrawn.	Damage sufficient for designation of importance to be withdrawn.	Feature of built environment subject to designation of importance entirely destroyed.	*N/A*
12	Various receptors. Should not be used to identify and assess MATTE.	*N/A*	*N/A*	*N/A*	

ITEM	RECEPTOR TYPE	SEVERITY OF HARM			
		SIGNIFICANT[5]	SEVERE[6]	MAJOR	CATASTROPHIC
	SEVERITY LEVEL	1	2	3	4
13	Particular species (Note – these criteria apply nationally – i.e. England, Wales, Scotland)	Loss of <1% of animal or <5% of plant ground cover in a habitat.	Loss of 1-10% of animal or 5-50% of plant ground cover.	Loss of 10-90% of animal or 50-90% of plant ground cover.	
14	Marine	<2ha littoral or sub-littoral zone, <100ha of open sea benthic community, <100 dead sea birds (<500 gulls), <5 dead/significantly impaired sea mammals	2-20ha littoral or sublittoral zone, 100-1000ha of open sea benthic community, 100-1000 dead sea birds (500-5000 gulls), 5-50 dead/significantly impaired sea mammals	20-200ha littoral or sub-littoral zone, 100-10,000ha of open sea benthic community, 1000-10,000 dead sea birds (5,000-50,000 gulls), 50-500 dead/significantly impaired sea mammals	

ITEM	RECEPTOR TYPE	SEVERITY OF HARM			
		SIGNIFICANT[5]	SEVERE[6]	MAJOR	CATASTROPHIC
	SEVERITY LEVEL	1	2	3	4
15	Fresh and estuarine water habitats	Impact below that of Severity level 2	WFD Chemical or ecological status lowered by one class for 2-10km of watercourse or 2-20ha or 10-50% area of estuaries or ponds. Plus interruption of drinking water supplies, as per DETR Table 6	WFD Chemical or ecological status lowered by one class for 10-200km of watercourse or 20200ha or 50-90% area of estuaries and ponds. Plus interruption of drinking water supplies, as per DETR Table 6	WFD Chemical or ecological status lowered by one class for >200km of watercourse or >200ha or >90% area of estuaries and ponds. Plus interruption of drinking water supplies, as per DETR Table 6

For most scenarios it should be considered the opportunity for clean-up and remediation as a post-incident measure which will reduce the environmental harm. In order to assign a duration/recovery category, the following criteria have been used:

DESCRIPTION	**SHORT TERM**[7]	**MEDIUM TERM**	**LONG TERM**	**VERY LONG TERM**
HARM DURATION CATEGORY	**1**	**2**	**3**	**4**
Land	≤ 3 years	> 3 years or > 2 growing seasons for agricultural land	> 20 years	> 50 years
Surface water (all except public or private drinking water source)	≤ 1 year	> 1 year	>10 years	>20 years
Groundwater body or surface water public or private drinking water source	*N/A*	Harm affecting non-public drinking water source.	Harm affecting public drinking water source or SPZ.	*N/A*
Built environment	Can be repaired in < 3 years, such that its designation can be reinstated	Can be repaired in > 3 years, such that its designation can be reinstated	Feature destroyed, cannot be rebuilt, all features except world heritage site	Feature destroyed, cannot be rebuilt, world heritage site

For a proper consideration of the persistence of the HFO and DO in the marine environment, a few additional characteristics of the substances should be taken into account.

[7] Harm with such short recovery is not considered a MATTE.

First, a distinction should be made between “light” and “heavy” oils. Fuel oils, such as gasoline and diesel fuel, are very “light” oils. Light oils are very volatile (they evaporate relatively quickly), so they usually don’t remain for long in the aquatic or marine environment (typically no longer than a few days). If they spread out on the water, as they do when they are accidentally spilled, they will evaporate relatively quickly.

In contrast, very “heavy” oils (like bunker oils, which are used to fuel ships) look black and may be sticky for a time until they weather sufficiently, but even then they can persist in the environment for months or even years if not removed. While these oils can be very persistent, they are generally significantly less acutely toxic than lighter oils. Instead, the short-term threat from heavy oils comes from their ability to smother organisms whereas over the long-term, some chronic health effects like tumors may result in some organisms.

Also, if heavy oils get onto the feathers of birds, the birds may die of hypothermia (they lose the ability to keep themselves warm). This same effect can be observed if sea otters become oiled. After days or weeks, some heavy oils will harden, becoming very similar to an asphalt road surface. In this hardened state, heavy oils will probably not harm animals or plants that come in contact with them.

In between light and heavy oils are many different kinds of medium oils, which will last for some amount of time in the environment and will have different degrees of toxicity. Ultimately, the effects of any oil depend on where it is spilled, where it goes, and what animals and plants, or people, it affects.

Returning to the MATTE evaluation, the following stage is the determination of the tolerability boundaries to identify the consequence level, defined as A, B, C or D, according to the following matrix:

SEVERITY LEVEL	4		C	D	D
	3		B	C	D
	2		A	B	C
	1				
		1	2	3	4
		HARM DURATION CATEGORY			

Once the severity of harm, the duration of harm and the consequences level has been determined, is possible to assess each scenario-specific risk, taking into account also the scenario frequency and the acceptability criteria defined in the table below:

Frequency at which the CDOIF consequence level is reached or exceeded	Frequency per receptor per establishment per year	
	Intolerable (greater than)	Broadly Acceptable (less than)
A	1.0 E-02	1.0 E-04
B	1.0 E-03	1.0 E-05
C	1.0 E-04	1.0 E-06
D	1.0 E-05	1.0 E-07

4.9 Consequence Calculation Results

In the following three chapters, the results for damage zones, domino effect zones and MATTE are presented for each scenario.

4.9.1 Damage zones

According to MEPA requirements, the damage zones obtained for the scenarios identified in this study are presented in the table shown in the pages below:

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-001	G2	HFO Unloading hose	HFO	Leak in unloading hose with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm.	PFIRE	1,73E-04	y-1	34	34	18	18	15	15	30	30	27	27	20	20
					EXPLOSION	6,84E-05	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,03E-04	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	7,46E-04	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-001 FBR	G1	HFO Unloading hose	HFO	Rupture of the unloading hose.	PFIRE	1,73E-05	y-1	110	110	63	63	57	57	96	96	87	87	69	69
					EXPLOSION	6,84E-06	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,03E-05	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	7,46E-05	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-002	G2	HFO Unloading pipeline from vessel to tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm. Pipeline from unloading point to tanks	PFIRE	5,00E-06	y-1	48	48	26	26	22	22	42	42	38	38	29	29
					EXPLOSION	1,98E-06	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	2,97E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	2,16E-05	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-002 FBR	G1	HFO Unloading pipeline from vessel to tank	HFO	Rupture in the pipeline	PFIRE	1,00E-06	y-1	48	48	24	24	22	22	42	42	38	38	26	26
					EXPLOSION	3,96E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	5,94E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	4,32E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-003	G3	HFO Storage tank n. 1 and 2	HFO	Continuous release from a hole with an effective diameter of 10 mm of the HFO storage tank	PFIRE	2,00E-06	y-1	42	42	22	22	52	52	38	38	52	52	24	24
					EXPLOSION	7,92E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,19E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	9,50E-09	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-003 CF	G1	HFO Storage tank n. 1 and 2	HFO	Instantaneous release of the entire contents of the HFO storage tank	PFIRE	1,00E-07	y-1	79	79	42	42	39	39	69	69	62	62	44	44
					EXPLOSION	3,96E-08	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	5,94E-08	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	4,75E-10	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-004	G3	HFO Storage tank n. 3	HFO	Continuous release from a hole with an effective diameter of 10 mm of the HFO storage tank	PFIRE	1,00E-06	y-1	42	42	22	22	52	52	38	38	52	52	26	26
					EXPLOSION	3,96E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	5,94E-07	y-1	NA	NA	NA	NA	0		NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	4,75E-09	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-004 CF	G1	HFO Storage tank n. 3	HFO	Instantaneous release of the entire contents of the HFO storage tank	PFIRE	5,00E-08	y-1	79	79	42	42	39	39	69	69	62	62	13	29
					EXPLOSION	1,98E-08	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	2,97E-08	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	2,37E-10	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-005	G2	HFO pipelines from storage tank to D3 transfer pump	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	2,00E-06	y-1	31	31	15	15	13	13	26	26	23	23	16	16
					EXPLOSION	7,92E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,19E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	7,92E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-005 FBR	G1	HFO pipelines from storage tank to D3 transfer pump	HFO	Rupture of the pipeline. Pipeline from unloading point to tanks	PFIRE	4,00E-07	y-1	48	48	24	24	22	22	42	42	38	38	26	26
					EXPLOSION	1,58E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	2,38E-07	y-1	NA	NA	NA	NA	0		NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	1,73E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2 STAB. D	STAB. F	LETHALITY 50% 15 kW/m2 STAB. D	STAB. F	LETHALITY 99% 37,5 kW/m2 STAB. D	STAB. F	Low Damage 3% 7,3 kW/m2 STAB. D	STAB. F	High Damage 5% 9,3 kW/m2 STAB. D	STAB. F	Damage 40% 13,4 kW/m2 STAB. D	STAB. F
HFO-006	G2	HFO D3 Transfer Pumps	HFO	Leak (10 % diameter). Discharge line	PFIRE	9,82E-07	y-1	13	13	6	6	5	5	11	11	10	10	7	7
					EXPLOSION	3,89E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	5,84E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	5,23E-10	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-006 CF	G1	HFO D3 Transfer Pumps	HFO	Catastrophic failure. Discharge line	PFIRE	1,96E-07	y-1	41	41	22	22	18	18	35	35	31	31	24	24
					EXPLOSION	7,78E-08	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,17E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	8,56E-11	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		RISK ZONES: LETHALITY 50% 15 kW/m2		RISK ZONES: LETHALITY 99% 37,5 kW/m2		RISK ZONES: Low Damage 3% 7,3 kW/m2		RISK ZONES: High Damage 5% 9,3 kW/m2		RISK ZONES: Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-007	G2	HFO pipelines from D3 transfer pump to D3 buffer tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	4,40E-06	y-1	21	21	10	10	8	8	18	18	16	16	11	11
					EXPLOSION	1,74E-06	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	2,61E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	1,74E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-007 FBR	G1	HFO pipelines from D3 transfer pump to D3 buffer tank	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	6,60E-07	y-1	48	48	24	24	22	22	42	42	38	38	26	26
					EXPLOSION	2,61E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	3,92E-07	y-1	NA	NA	NA	NA	0		NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	2,85E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-008	G3	HFO D3 buffer tanks	HFO	Continuous release from a hole with an effective diameter of 10 mm. HFO service storage tanks	PFIRE	2,00E-06	y-1	48	48	24	24	22	22	42	42	38	38	26	26
					EXPLOSION	7,92E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,19E-06	y-1	NA	NA	NA	NA	0		NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	8,63E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-008 CF	G1	HFO D3 buffer tanks	HFO	Instantaneous release of the entire contents. HFO service storage tanks	PFIRE	1,00E-07	y-1	48	48	24	24	22	22	42	42	38	38	26	26
					EXPLOSION	3,96E-08	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	5,94E-08	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	4,32E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

SGS

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-009	G2	HFO pipelines from D3 buffer tank to D3 centrifuges supply pump	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	1,20E-06	y-1	21	21	10	10	8	8	18	18	16	16	11	11
					EXPLOSION	4,75E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	7,13E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	4,75E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-009 FBR	G1	HFO pipelines from D3 buffer tank to D3 centrifuges supply pump	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	1,20E-06	y-1	63	63	41	41	23	23	57	57	53	53	44	44
					EXPLOSION	4,75E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	7,13E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	5,18E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-010	G2	HFO D3 centrifuges supply pumps	HFO	Leak (10 % diameter). Discharge line of the supply pumps	PFIRE	1,68E-05	y-1	21	21	10	10	8	8	18	18	16	16	11	11
					EXPLOSION	6,67E-06	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,00E-05	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	6,67E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-010 CF	G1	HFO D3 centrifuges supply pumps	HFO	Catastrophic failure. Discharge line of the supply pumps	PFIRE	3,37E-06	y-1	48	48	24	24	22	22	42	42	38	38	26	26
					EXPLOSION	1,33E-06	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	2,00E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	1,45E-05	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-011	G2	HFO pipelines from D3 centrifuges supply pump to D3 centrifuges	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	2,00E-07	y-1	21	21	10	10	8	8	18	18	16	16	11	11
					EXPLOSION	7,92E-08	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,19E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	7,92E-08	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-011 FBR	G1	HFO pipelines from D3 centrifuges supply pump to D3 centrifuges	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	3,00E-08	y-1	42	42	22	22	52	52	38	38	52	52	24	24
					EXPLOSION	1,19E-08	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,78E-08	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	1,29E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-012	G3	HFO D3 centrifuges	HFO	Continuous release from a hole with an effective diameter of 10 mm. Centrifuges	PFIRE	3,00E-06	y-1	11	11	5	5	4	4	9	9	8	8	6	6
					EXPLOSION	1,19E-06	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,78E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	1,19E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-012 CF	G1	HFO D3 centrifuges	HFO	Catastrophic failure. Centrifuges	PFIRE	1,50E-07	y-1	33	33	18	18	14	14	29	29	25	25	19	19
					EXPLOSION	5,94E-08	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	8,91E-08	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	5,94E-08	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-013	G2	HFO pipelines from D3 centrifuges to D3 service tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	1,20E-06	y-1	17	17	9	9	6	6	15	15	13	13	10	10
					EXPLOSION	4,75E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	7,13E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	4,75E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-013 FBR	G1	HFO pipelines from D3 centrifuges to D3 service tank	HFO	Rupture in the pipeline	PFIRE	1,80E-07	y-1	48	48	26	26	22	22	42	42	38	38	29	29
					EXPLOSION	7,13E-08	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,07E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	7,13E-08	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-014	G3	HFO D3 service tanks	HFO	Continuous release from a hole with an effective diameter of 10 mm. HFO service storage tanks	PFIRE	2,00E-06	y-1	48	48	26	26	22	22	42	42	38	38	29	29
					EXPLOSION	7,92E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,19E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	8,63E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-014 CF	G1	HFO D3 service tanks	HFO	Catastrophic failure. HFO service storage tanks	PFIRE	1,00E-07	y-1	48	48	24	24	22	22	42	42	38	38	26	26
					EXPLOSION	3,96E-08	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	5,94E-08	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	4,32E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-015	G2	HFO pipelines from service tanks to D3 engines	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	1,20E-05	y-1	18	18	9	9	7	7	15	15	13	13	10	10
					EXPLOSION	4,75E-06	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	7,13E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	4,75E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-015 FBR	G1	HFO pipelines from service tanks to D3 engines	HFO	Rupture in the pipeline	PFIRE	1,80E-06	y-1	48	48	26	26	22	22	42	42	38	38	29	29
					EXPLOSION	7,13E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,07E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	7,13E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-016	G2	HFO pipelines from storage tank to D1 HFO pump house	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	8,00E-06	y-1	18	18	9	9	7	7	15	15	13	13	10	10
					EXPLOSION	3,17E-06	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	4,75E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	3,17E-06	y-1	48	48	26	26	22	22	42	42	38	38	29	29
HFO-016 FBR	G1	HFO pipelines from storage tank to D1 HFO pump house	HFO	Rupture in the pipeline	PFIRE	1,20E-06	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					EXPLOSION	4,75E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					FLASHFIRE	7,13E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	5,18E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-017	G2	HFO D1 HFO Pumps	HFO	Leak (10 % diameter). Discharge line	PFIRE	2,00E-07	y-1	17	17	10	10	5	5	14	14	14	14	11	11
					EXPLOSION	7,92E-08	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,19E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	8,63E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-017 CF	G1	HFO D1 HFO Pumps	HFO	Catastrophic failure. Discharge line	PFIRE	2,66E-07	y-1	41	41	22	22	18	18	35	35	31	31	24	24
					EXPLOSION	1,06E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,58E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	1,15E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-018	G2	HFO pipelines from D1 HFO pump house to heaters	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	1,64E-05	y-1	26	26	16	16	8	8	23	23	22	22	17	17
					EXPLOSION	1,71E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	2,57E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	7,08E-05	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-018 FBR	G1	HFO pipelines from D1 HFO pump house to heaters	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	3,00E-08	y-1	48	48	24	24	22	22	42	42	38	38	26	26
					EXPLOSION	9,74E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,46E-06	y-1	NA	NA	NA	NA	0		NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	1,29E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
HFO-019	G2	HFO pipelines from D1 heaters to D1 boilers	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	4,32E-07	y-1	21	21	10	10	8	8	18	18	16	16	11	11
					EXPLOSION	1,71E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	2,57E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	1,86E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
HFO-019 FBR	G1	HFO pipelines from D1 heaters to D1 boilers	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	2,46E-06	y-1	63	63	41	41	23	23	57	57	53	53	44	44
					EXPLOSION	9,74E-07	y-1	--	--	--	--	--	--	--	--	--	--	--	--
					FLASHFIRE	1,46E-06	y-1	NA	NA	NA	NA	0		NA	NA	NA	NA	NA	NA
					HFO SPILLAGE	1,06E-05	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-001	G2	DO Unloading arm	DO	Leak in unloading hose with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm.	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	1,75E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-001 FBR	G1	DO Unloading arm	DO	Rupture of the unloading arm.	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	1,90E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2 STAB. D	LETHALITY 1% 5 kW/m2 STAB. F	LETHALITY 50% 15 kW/m2 STAB. D	LETHALITY 50% 15 kW/m2 STAB. F	LETHALITY 99% 37,5 kW/m2 STAB. D	LETHALITY 99% 37,5 kW/m2 STAB. F	Low Damage 3% 7,3 kW/m2 STAB. D	Low Damage 3% 7,3 kW/m2 STAB. F	High Damage 5% 9,3 kW/m2 STAB. D	High Damage 5% 9,3 kW/m2 STAB. F	Damage 40% 13,4 kW/m2 STAB. D	Damage 40% 13,4 kW/m2 STAB. F
DO-002	G2	DO Unloading pipeline from vessel to raw tanks	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	2,51E-05	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-002 FBR	G1	DO Unloading pipeline from vessel to raw tanks	DO	Rupture in the pipeline	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	5,02E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-003	G3	DO Raw tank n. 1/2/3	DO	Continuous release from a hole with an effective diameter of 10 mm	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	1,45E-08	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-003 CF	G1	DO Raw tank n. 1/2/3	DO	Instantaneous release of the entire contents of the DO Raw tank n. 1/2/3	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	7,27E-10	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-004	G2	DO pipelines from raw tank to transfer pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	9,25E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-004 FBR	G1	DO pipelines from raw tank to transfer pumps	DO	Rupture in the pipeline	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	1,70E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-004 FBR DE	G1	DO pipelines from raw tank to transfer pumps	DO	Rupture in the pipeline	PFIRE	1,00E-07	y-1	58	58	28	28	22	22	49	49	43	43	31	31
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	2,10E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-005	G2	DO Transfer Pumps	DO	Leak (10 % diameter). Discharge line	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	4,20E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-005 CF	G1	DO Transfer Pumps	DO	Catastrophic failure. Discharge line	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	7,71E-09	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-006	G2	DO pipelines from transfer pumps to centrifuges	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	4,40E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-006 FBR	G1	DO pipelines from transfer pumps to centrifuges	DO	Rupture in the pipeline	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	8,08E-08	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-007	G2	DO centrifuges	DO	Continuous release from a hole with an effective diameter of 10 mm. Centrifuges	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	1,76E-05	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-007 CF	G1	DO centrifuges	DO	Catastrophic failure. Centrifuges	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	8,08E-08	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-008	G3	DO pipelines from centrifuges to treated tank	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	1,15E-05	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-008 FBR	G1	DO pipelines from centrifuges to treated tank	DO	Rupture in the pipeline	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	2,10E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-009	G3	DO Treated tank n. 4	DO	Continuous release from a hole with an effective diameter of 10 mm	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	4,84E-09	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-009 CF	G 1	DO Treated tank n. 4	DO	Instantaneous release of the entire contents of the DO Treated tank n. 4	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	2,42E-10	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-010	G3	DO return pipelines from centrifuges to raw tank nr 0, nr 1	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	7,49E-05	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-010 FBR	G1	DO return pipelines from centrifuges to raw tank nr 0, nr 1	DO	Rupture in the pipeline	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	1,37E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-011	G3	DO return pipelines from centrifuges to raw tank nr 2	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	4,40E-05	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-011 FBR	G1	DO return pipelines from centrifuges to raw tank nr 2	DO	Rupture in the pipeline	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	6,06E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-012	G2	DO pipelines from treated tank to D2A forwarding pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	1,05E-06	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-012 FBR	G1	DO pipelines from treated tank to D2A forwarding pumps	DO	Rupture in the pipeline	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	2,10E-07	y-1	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA
DO-013	G2	DO pipelines from treated tank to D2B forwarding pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	1,05E-06	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

SGS

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-013 FBR	G1	DO pipelines from treated tank to D2B forwarding pumps	DO	Rupture in the pipeline	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	2,10E-07	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DO-014	G2	DO D2A forwarding pumps	DO	Leak (10 % diameter). Discharge line of the supply pumps	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	4,01E-08	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-014 CF	G1	DO D2A forwarding pumps	DO	Catastrophic failure. Discharge line of the supply pumps	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	8,02E-09	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DO-015	G2	DO D2B forwarding pumps	DO	Leak (10 % diameter). Discharge line of the supply pumps	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	4,26E-07	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2 STAB. D	LETHALITY 1% 5 kW/m2 STAB. F	LETHALITY 50% 15 kW/m2 STAB. D	LETHALITY 50% 15 kW/m2 STAB. F	LETHALITY 99% 37,5 kW/m2 STAB. D	LETHALITY 99% 37,5 kW/m2 STAB. F	Low Damage 3% 7,3 kW/m2 STAB. D	Low Damage 3% 7,3 kW/m2 STAB. F	High Damage 5% 9,3 kW/m2 STAB. D	High Damage 5% 9,3 kW/m2 STAB. F	Damage 40% 13,4 kW/m2 STAB. D	Damage 40% 13,4 kW/m2 STAB. F
DO-015 FBR	G1	DO D2B forwarding pumps	DO	Rupture in the pipeline	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	8,52E-08	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DO-016	G2	DO pipelines from forwarding pumps tank to D2A	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	4,40E-06	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-016 FBR	G1	DO pipelines from forwarding pumps tank to D2A	DO	Rupture in the pipeline	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	6,59E-07	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DO-017	G2	DO pipelines from forwarding pumps tank to D2B	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	5,11E-05	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2 STAB. D	LETHALITY 1% 5 kW/m2 STAB. F	LETHALITY 50% 15 kW/m2 STAB. D	LETHALITY 50% 15 kW/m2 STAB. F	LETHALITY 99% 37,5 kW/m2 STAB. D	LETHALITY 99% 37,5 kW/m2 STAB. F	Low Damage 3% 7,3 kW/m2 STAB. D	Low Damage 3% 7,3 kW/m2 STAB. F	High Damage 5% 9,3 kW/m2 STAB. D	High Damage 5% 9,3 kW/m2 STAB. F	Damage 40% 13,4 kW/m2 STAB. D	Damage 40% 13,4 kW/m2 STAB. F
DO-017 FBR	G1	DO pipelines from forwarding pumps tank to D2B	DO	Rupture in the pipeline	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	7,03E-07	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DO-018	G2	DO pipelines from raw tank to D3 transfer pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	3,56E-06	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-018 FBR	G1	DO pipelines from raw tank to D3 transfer pumps	DO	Rupture in the pipeline	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	5,81E-06	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DO-019	G3	DO D3 Transfer Pumps	DO	Leak (10 % diameter). Discharge line	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	3,86E-08	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-019 CF	G1	DO D3 Transfer Pumps	DO	Catastrophic failure. Discharge line	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	8,41E-08	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DO-020	G2	DO pipelines from D3 transfer pump to D3 service tank	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	4,85E-07	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-020 FBR	G1	DO pipelines from D3 transfer pump to D3 service tank	DO	Rupture in the pipeline	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	7,27E-08	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DO-021	G3	DO D3 Service tank	DO	Continuous release from a hole with an effective diameter of 10 mm	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	4,04E-07	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-021 CF	G1	DO D3 Service tank	DO	Instantaneous release of the entire contents of the DO D3 Service tank	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	2,20E-07	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DO-022	G2	DO pipelines from D3 service tank to supply pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	4,85E-07	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-022 FBR	G1	DO pipelines from D3 service tank to supply pumps	DO	Rupture in the pipeline	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	7,93E-07	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DO-023	G2	DO pipelines from D3 supply pumps to engines	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	0	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	3,47E-06	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES: LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
DO-023 FBR	G1	DO pipelines from D3 supply pumps to engines	DO	Rupture in the pipeline	PFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					EXPLOSION	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	**0**	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	5,68E-06	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DO-024 DE	G1	DO Raw tank n. 1/2/3	DO	Catastrophic failure of the DO Raw tank n. 1/2/3 due to a jet fire domino effect from EGM	PFIRE	7,81E-05	y-1	74	74	36	36	29	29	62	62	54	54	40	40
					EXPLOSION	NA	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					FLASHFIRE	NA	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					DO SPILLAGE	3,41E-09	y-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NOTES																			

ITEM	LOC	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK ZONES											
								LETHALITY 1% 5 kW/m2		LETHALITY 50% 15 kW/m2		LETHALITY 99% 37,5 kW/m2		Low Damage 3% 7,3 kW/m2		High Damage 5% 9,3 kW/m2		Damage 40% 13,4 kW/m2	
								STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F	STAB. D	STAB. F
NA	Not applicable. Value not consistent with the scenario definition																		
--	Distance not achieved																		
	Review 0.3.- Distances have been updated due to the adjustment of the emissive power for HFO pool fires																		

4.9.2 Domino Effect

The distances obtained for determining the Domino Effect zones are presented in the table below for those scenarios which may introduce a domino effect:

					DOMINO EFFECT																		
					37,5 kW/m2		15 kW/m2		TARGETS														
SCENARIO	FINAL EVENT	FINAL FREQ.	UNITS	POOL FIRE DURATION (s)	STAB. D	STAB. F	STAB. D	STAB. F	QUAY	PIPE RACK	ENE PUMP HOUSE	CENTRIF.	SERVICE TANKS BUND	DO BUND	HFO BUND	FSU	EGM JETTY	REGAS AREA	IFV Propane in shell side	NG Pipe Rack	EGM Metering Station	D4 Gas turbines	COMM.
Leak in unloading hose with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm.	PFIRE	1,73E-04	y-1	144	15	15	18	18															NO domino effect on adjacent HFO / DO pipelines and unloading facilities, with duration < 10 minutes
Rupture of the unloading hose.	PFIRE	1,73E-05	y-1	144	57	57	63	63															NO domino effect on adjacent HFO / DO pipelines and unloading facilities, with duration < 10 minutes
Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm. Pipeline from unloading point to tanks	PFIRE	5,00E-06	y-1	968	22	22	26	26															Probable domino effect on the NG pipeline and metering station, depending on the location of the spillage and fire and the duration of the fire. Duration can be > 10 minutes
Rupture in the pipeline	PFIRE	1,00E-06	y-1	14524	22	22	24	24															Probable domino effect on the NG pipeline

SCENARIO	FINAL EVENT	FINAL FREQ.	UNITS	POOL FIRE DURATION (s)	DOMINO EFFECT																		COMM.
					37,5 kW/m2		15 kW/m2		TARGETS														
					STAB. D	STAB. F	STAB. D	STAB. F	QUAY	PIPE RACK	ENE PUMP HOUSE	CENTRIF.	SERVICE TANKS BUND	DO BUND	HFO BUND	FSU	EGM JETTY	REGAS AREA	IFV Propane in shell side	NG Pipe Rack	EGM Metering Station	D4 Gas turbines	
																							and metering station, depending on the location of the spillage and fire and the duration of the fire. Duration can be > 10 minutes
Continuous release from a hole with an effective diameter of 10 mm of the HFO storage tank	PFIRE	2,00E-06	y-1	343950	52	52	22	22															Probable domino effect on the adjacent tank, depending on the location of the spillage and fire and the duration of the fire. Duration can be > 10 minutes
Instantaneous release of the entire contents of the HFO storage tank	PFIRE	1,00E-07	y-1	156370	39	39	42	42															Probable domino effect on the adjacent tank, depending on the location of the spillage and fire and the duration of the fire. Duration can be > 10 minutes

					DOMINO EFFECT																		
					37,5 kW/m2		15 kW/m2		TARGETS														
SCENARIO	FINAL EVENT	FINAL FREQ.	UNITS	POOL FIRE DURATION (s)	STAB. D	STAB. F	STAB. D	STAB. F	QUAY	PIPE RACK	ENE PUMP HOUSE	CENTRIF.	SERVICE TANKS BUND	DO BUND	HFO BUND	FSU	EGM JETTY	REGAS AREA	IFV Propane in shell side	NG Pipe Rack	EGM Metering Station	D4 Gas turbines	COMM.
Continuous release from a hole with an effective diameter of 10 mm of the HFO storage tank	PFIRE	1,00E-06	y-1	78111	52	52	22	22															Probable domino effect on the adjacent tank, depending on the location of the spillage and fire and the duration of the fire. Duration can be > 10 minutes
Instantaneous release of the entire contents of the HFO storage tank	PFIRE	5,00E-08	y-1	34487	39	39	42	42															Probable domino effect on the adjacent tank, depending on the location of the spillage and fire and the duration of the fire. Duration can be > 10 minutes
Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	2,00E-06	y-1	231550	13	13	15	15															Probable domino effect on adjacent facilities depending on the location of the accident: other HFO / DO pipelines, transfer

					DOMINO EFFECT																		
					37,5 kW/m2		15 kW/m2		TARGETS														
SCENARIO	FINAL EVENT	FINAL FREQ.	UNITS	POOL FIRE DURATION (s)	STAB. D	STAB. F	STAB. D	STAB. F	QUAY	PIPE RACK	ENE PUMP HOUSE	CENTRIF.	SERVICE TANKS BUND	DO BUND	HFO BUND	FSU	EGM JETTY	REGAS AREA	IFV Propane in shell side	NG Pipe Rack	EGM Metering Station	D4 Gas turbines	COMM.
																							pumps. Duration can be > 10 minutes
Rupture of the pipeline. Pipeline from unloading point to tanks	PFIRE	4,00E-07	y-1	3810	22	22	24	24															Probable domino effect on adjacent facilities depending on the location of the accident: other HFO / DO pipelines, transfer pumps and closer HOF tank. Duration can be > 10 minutes
Leak (10 % diameter). Discharge line	PFIRE	9,82E-07	y-1	449	5	5	6	6															No domino effect on adjacent HFO/ DO pipelines and pumps. Duration < 10 minutes
Catastrophic failure. Discharge line	PFIRE	1,96E-07	y-1	288	18	18	22	22															No domino effect on adjacent HFO/ DO pipelines and pumps. Duration < 10 minutes

					DOMINO EFFECT																		
					37,5 kW/m2		15 kW/m2		TARGETS														
SCENARIO	FINAL EVENT	FINAL FREQ.	UNITS	POOL FIRE DURATION (s)	STAB . D	STAB . F	STAB . D	STA B. F	QUAY	PIPE RACK	ENE PUMP HOUSE	CENTRIF.	SERVICE TANKS BUND	DO BUND	HFO BUND	FSU	EGM JETTY	REGAS AREA	IFV Propane in shell side	NG Pipe Rack	EGM Metering Station	D4 Gas turbines	COMM.
Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	4,40E-06	y-1	288	8	8	10	10															NO domino effect on adjacent HFO/ DO pipelines, HFO buffer tank, pump house. Duration < 10 minutes
Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	6,60E-07	y-1	576	22	22	24	24															NO domino effect on adjacent HFO/ DO pipelines, HFO buffer tank, pump house. Duration < 10 minutes
Continuous release from a hole with an effective diameter of 10 mm. HFO service storage tanks	PFIRE	2,00E-06	y-1	1733	22	22	24	24															Probable domino effect on the adjacent tanks and centrifuges , and on the NG pipeline, depending on the location of the spillage and fire and the duration of the fire. Duration can be > 10 minutes
Instantaneous release of the entire contents. HFO service storage tanks	PFIRE	1,00E-07	y-1	2401	22	22	24	24															Probable domino effect on the adjacent tanks and centrifuges

SCENARIO	FINAL EVENT	FINAL FREQ.	UNITS	POOL FIRE DURATION (s)	DOMINO EFFECT																		
					37,5 kW/m2		15 kW/m2		TARGETS														COMM.
					STAB. D	STAB. F	STAB. D	STAB. F	QUAY	PIPE RACK	ENE PUMP HOUSE	CENTRIF.	SERVICE TANKS BUND	DO BUND	HFO BUND	FSU	EGM JETTY	REGAS AREA	IFV Propane in shell side	NG Pipe Rack	EGM Metering Station	D4 Gas turbines	
																							, and on the NG pipeline, depending on the location of the spillage and the fire and the duration of the fire. Duration can be > 10 minutes
Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	1,20E-06	y-1	288	8	8	10	10															No domino effect on adjacent tanks and cetrifuges. Duration < 10 minurtes
Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	1,20E-06	y-1	576	23	23	41	41															No domino effect on adjacent tanks and cetrifuges. Duration < 10 minurtes
Leak (10 % diameter). Discharge line of the supply pumps	PFIRE	1,68E-05	y-1	283	8	8	10	10															No domino effect on adjacent tanks and cetrifuges. Duration < 10 minurtes
Catastrophic failure. Discharge line of the supply pumps	PFIRE	3,37E-06	y-1	576	22	22	24	24															No domino effect on adjacent tanks and cetrifuges. Duration < 10 minurtes

					DOMINO EFFECT																		
					37,5 kW/m2		15 kW/m2		TARGETS														
SCENARIO	FINAL EVENT	FINAL FREQ.	UNITS	POOL FIRE DURATION (s)	STAB. D	STAB. F	STAB. D	STAB. F	QUAY	PIPE RACK	ENE PUMP HOUSE	CENTRIF.	SERVICE TANKS BUND	DO BUND	HFO BUND	FSU	EGM JETTY	REGAS AREA	IFV Propane in shell side	NG Pipe Rack	EGM Metering Station	D4 Gas turbines	COMM.
Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	2,00E-07	y-1	283	8	8	10	10															No domino effect on adjacent tanks and cetrifuges. Duration < 10 minurtes
Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	3,00E-08	y-1	576	52	52	22	22															No domino effect on adjacent tanks and cetrifuges. Duration < 10 minurtes
Continuous release from a hole with an effective diameter of 10 mm. Centrifuges	PFIRE	3,00E-06	y-1	143	4	4	5	5															No domino effect on adjacent tanks and cetrifuges. Duration < 10 minutes
Catastrophic failure. Centrifuges	PFIRE	1,50E-07	y-1	144	14	14	18	18															No domino effect on adjacent tanks and cetrifuges. Duration < 10 minurtes
Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	1,20E-06	y-1	144	6	6	9	9															No domino effect on adjacent tanks and cetrifuges. Duration < 10 minurtes
Rupture in the pipeline	PFIRE	1,80E-07	y-1	176	22	22	26	26															No domino effect on adjacent tanks and cetrifuges. Duration <

SCENARIO	FINAL EVENT	FINAL FREQ.	UNITS	POOL FIRE DURATION (s)	DOMINO EFFECT																		
					37,5 kW/m2		15 kW/m2		TARGETS														
					STAB. D	STAB. F	STAB. D	STAB. F	QUAY	PIPE RACK	ENE PUMP HOUSE	CENTRIF.	SERVICE TANKS BUND	DO BUND	HFO BUND	FSU	EGM JETTY	REGAS AREA	IFV Propane in shell side	NG Pipe Rack	EGM Metering Station	D4 Gas turbines	COMM.
																							10 minurtes
Continuous release from a hole with an effective diameter of 10 mm. HFO service storage tanks	PFIRE	2,00E-06	y-1	1683	22	22	26	26															Probable domino effect on the adjacent tanks and centrifuges, and on the NG pipeline, depending on the location of the spillage and fire and the duration of the fire. Duration can be > 10 minutes
Catastrophic failure. HFO service storage tanks	PFIRE	1,00E-07	y-1	2401	22	22	24	24															Probable domino effect on the adjacent tanks and centrifuges, and on the NG pipeline, depending on the location of the spillage and fire and the duration of the fire. Duration can be > 10 minutes

SCENARIO	FINAL EVENT	FINAL FREQ.	UNITS	POOL FIRE DURATION (s)	DOMINO EFFECT 37,5 kW/m2 STAB. D	STAB. F	15 kW/m2 STAB. D	STAB. F	TARGETS QUAY	PIPE RACK	ENE PUMP HOUSE	CENTRIF.	SERVICE TANKS BUND	DO BUND	HFO BUND	FSU	EGM JETTY	REGAS AREA	IFV Propane in shell side	NG Pipe Rack	EGM Metering Station	D4 Gas turbines	COMM.
Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	1,20E-05	y-1	288	7	7	9	9															NO domino effect on pipelines, centrifuges, pump house, buffer tank and other facilities depending on the location of the spillage and fire. Duration < 10 minutes
Rupture in the pipeline	PFIRE	1,80E-06	y-1	389	22	22	26	26															NO domino effect on pipelines, centrifuges, pump house, buffer tank and other facilities depending on the location of the spillage and fire. Duration < 10 minutes
Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	8,00E-06	y-1	288	7	7	9	9															No domino effect on pipelines. Duration < 10 minutes
Rupture in the pipeline	PFIRE	1,20E-06	y-1	389	--	--	--	--															No domino effect on pipelines. Duration < 10 minutes

SCENARIO	FINAL EVENT	FINAL FREQ.	UNITS	POOL FIRE DURATION (s)	DOMINO EFFECT																		COMM.
					37,5 kW/m2		15 kW/m2		TARGETS														
					STAB. D	STAB. F	STAB. D	STAB. F	QUAY	PIPE RACK	ENE PUMP HOUSE	CENTRIF.	SERVICE TANKS BUND	DO BUND	HFO BUND	FSU	EGM JETTY	REGAS AREA	IFV Propane in shell side	NG Pipe Rack	EGM Metering Station	D4 Gas turbines	
Leak (10 % diameter). Discharge line	PFIRE	2,00E-07	y-1	449	5	5	10	10															No domino effect on pipelines and pump house. Duration < 10 minutes
Catastrophic failure. Discharge line	PFIRE	2,66E-07	y-1	288	18	18	22	22															No domino effect on pipelines and pump house. Duration < 10 minutes
Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	1,64E-05	y-1	288	8	8	16	16															No domino effect on pipelines and pump house. Duration < 10 minutes
Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	3,00E-08	y-1	576	22	22	24	24															No domino effect on pipelines and pump house. Duration < 10 minutes
Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	4,32E-07	y-1	288	8	8	10	10															No domino effect on pump house and adjacent HFO / DO pipelines. Duration < 10 minutes
Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	2,46E-06	y-1	576	23	23	41	41															No domino effect on pump house, centrifuges and adjacent HFO/ DO pipelines.

SCENARIO	FINAL EVENT	FINAL FREQ.	UNITS	POOL FIRE DURATION (s)	DOMINO EFFECT																		
					37,5 kW/m2		15 kW/m2		TARGETS														COMM.
					STAB . D	STAB . F	STAB . D	STA B. F	QUAY	PIPE RACK	ENE PUMP HOUSE	CENTRIF.	SERVICE TANKS BUND	DO BUND	HFO BUND	FSU	EGM JETTY	REGAS AREA	IFV Propane in shell side	NG Pipe Rack	EGM Metering Station	D4 Gas turbines	
																							Duration < 10 minutes
Rupture in the pipeline	**PFIRE**	**1,00E-07**	**y-1**	**140**	**22**	**22**	**28**	**28**															**NA**
Catastrophic failure of the DO Raw tank n. 1/2/3 due to a jet fire domino effect from EGM	PFIRE	7,81E-05	y-1	46283	29	29	36	36															Probable domino effect on adjacent HFO/DO pipeline and service tanks. Duration > 10 minutes
Review 0.3.- Domino Effect has been reviewed according to last revision of EGM Safety Report [29]																							

4.9.3 Environmental Damage MATTE

The major hazard scenarios identified in the previous chapter could result in environmental damage according to the information listed below:

The spillage of fuel oil or gasoil to the seawater is the result of:

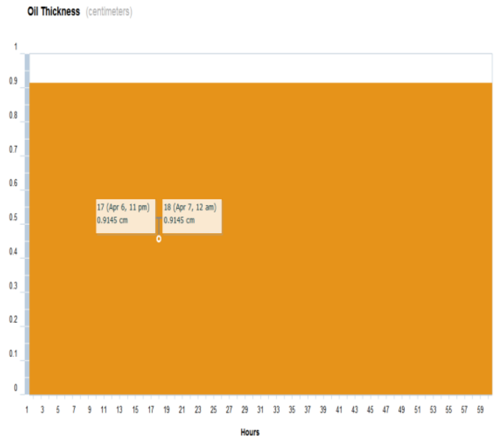
- A leakage of the unloading arm or hose in the quay.
- A spillage from the pipelines, pumps, centrifuges or tanks inside the facilities not contained into the interceptors.

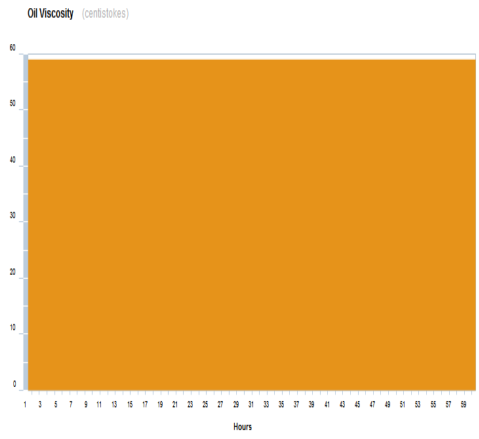
In the first case, the spillage is directly associated to the flowrate flowing through the hose and considering that the spillage will not exceed the 2 minutes of duration due to the direct supervision and vessel pump stopping automatically in case of quick depressurization.

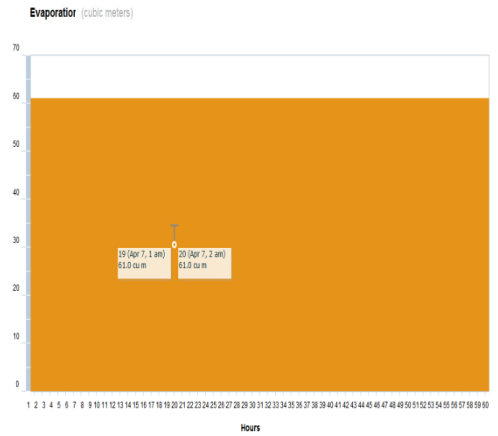
In the second case, the spillage is associated to the spillage duration onshore and the capacity of the interceptor at which the spillage will flow. In some cases, the entire quantity spilled will be contained, while in other cases, an overflow is possible.

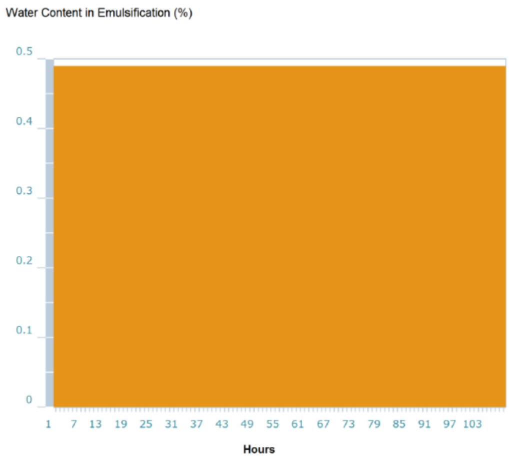
For minor pipe ruptures, large detection times have been considered, in view of the fact that a product transfer may take place and the spillage may not be directly detected if it takes place along the pipeline in unmanned areas.

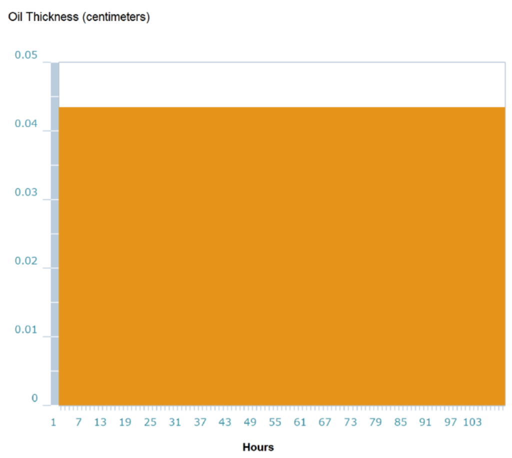
Shorter detection times have been considered for HFO FBR releases, given the higher probability of early detection by alarms, supervision and even external alarm in case of interceptor overflow to the sea. In this case, the maximum amount spilled to the seawater is expected to be approximately 229 m^3 with a flow rate of 25 m^3/min, correspondent to scenario no. HFO-002 FBR. This release has been modelled with ROC program [30] in order to determine parameters of the spillage.

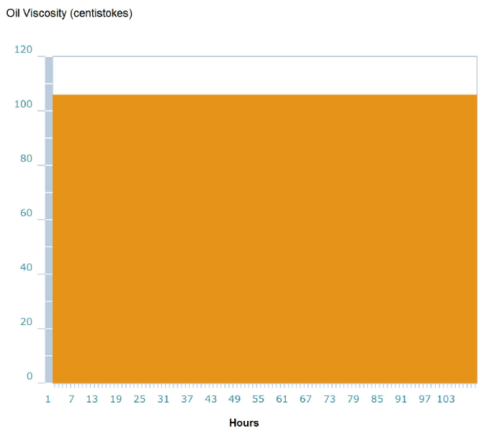

Oil Thickness (centimeters)
17 (Apr 6, 11 pm) 0.9145 cm
18 (Apr 7, 12 am) 0.9145 cm
Hours

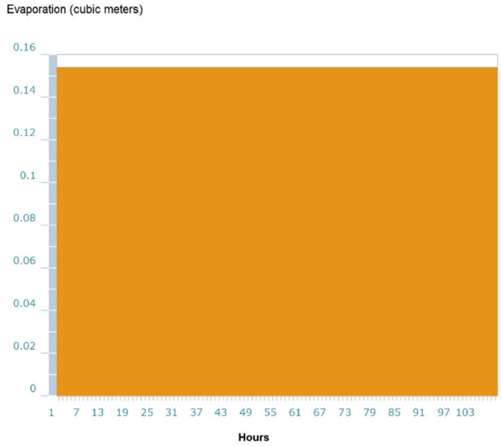

Oil Viscosity (centistokes)
Hours

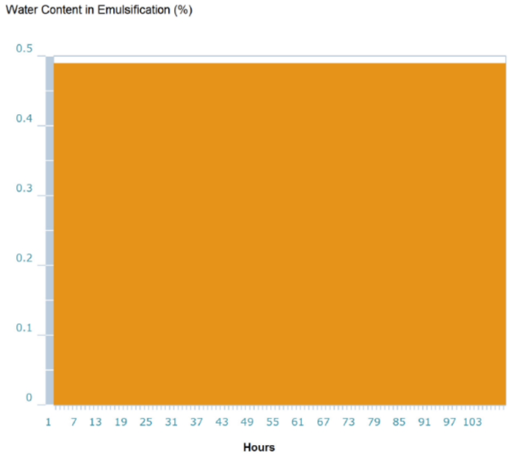

Evaporation (cubic meters)
19 (Apr 7, 1 am) 61.0 cu m
20 (Apr 7, 2 am) 61.0 cu m
Hours

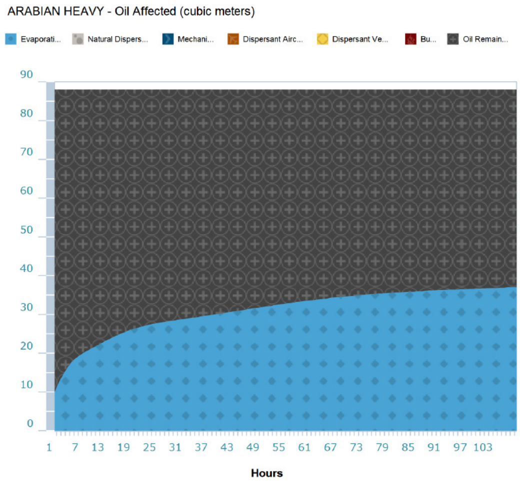

Water Content in Emulsification (%)
0.5
0.4
0.3
0.2
0.1
0
1 7 13 19 25 31 37 43 49 55 61 67 73 79 85 91 97 103
Hours


Oil Thickness (centimeters)
0.05
0.04
0.03
0.02
0.01
0
1 7 13 19 25 31 37 43 49 55 61 67 73 79 85 91 97 103
Hours


Oil Viscosity (centistokes)
120
100
80
60
40
20
0
1 7 13 19 25 31 37 43 49 55 61 67 73 79 85 91 97 103
Hours







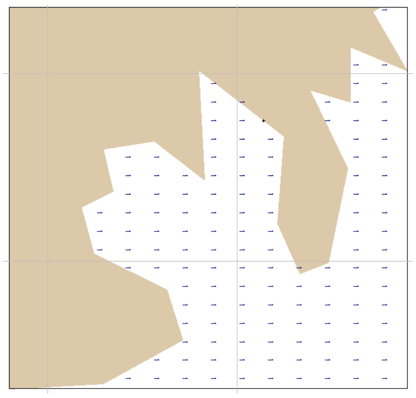
Then, taking into account a pool thickness of 0.45 mm, the maximum expected surface covered by the spillage approximately 16 ha.

Additionally, for each scenario identified in which exists a spillage onto the sea, the environmental consequences have been analysed by the calculation software GNOME [31], developed by Hazardous Materials Response Division (HAZMAT) of the National Oceanic and Atmospheric Administration Office of Response and Restoration (NOAA OR&R). The software models allow performing a "best guess" of a spill's trajectory and the associated uncertainty in that trajectory.

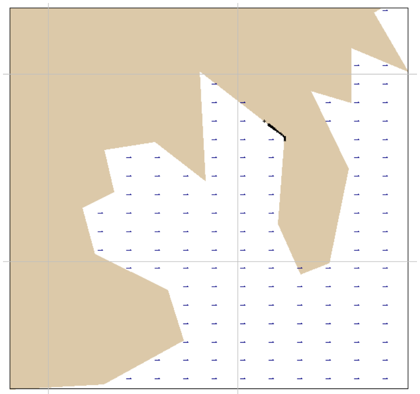
The results of GNOME can be useful to:

- Predict how winds, currents, and other processes might move and spread oil spilled on the water.
- Learn how predicted oil trajectories are affected by inexactness ("uncertainty") in current and wind observations and forecasts.
- See how spilled oil is predicted to change chemically and physically ("weather") during the time that it remains on the water surface.

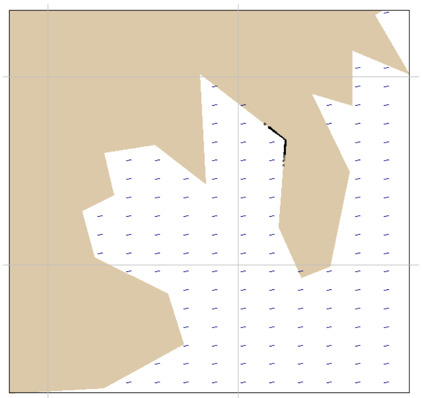
The HFO scenario has been simulated in order to determine the evolution of the release in the marine environment surrounding the Delimara Power Station with non-concluding results due to the lack of data.



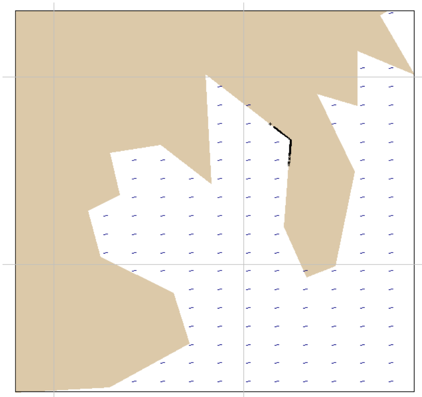
Date and time: 10/23/2015 00:00



Date and time: 10/23/2015 04:00



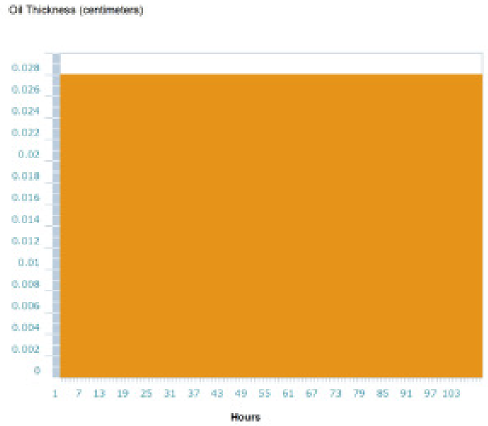
Date and time: 10/23/2015 16:00

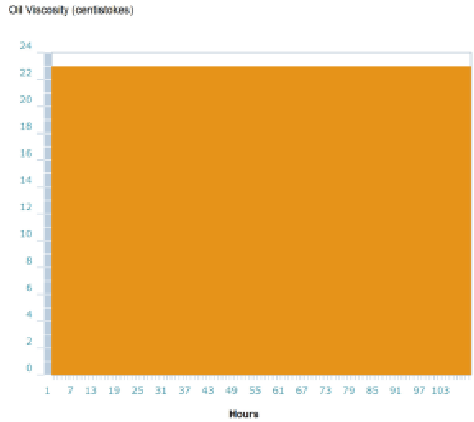


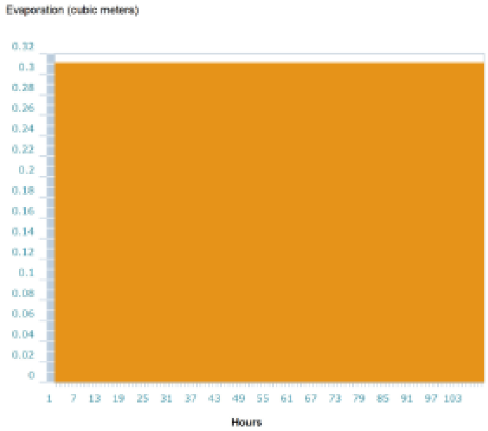
Date and time 10/24/2015 00:00

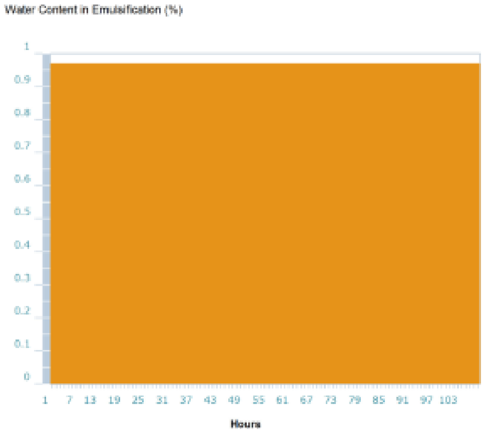
For DO, the maximum amount spilled to the seawater is expected to be approximately 104 m^3 with a flow rate of 1.85 m^3/h, correspondent to scenario no.

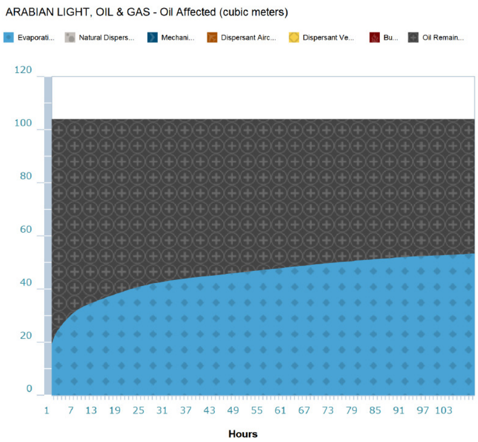
DO-021. Similarly to the HFO spillage, the release has been modelled with ROC program [30] :



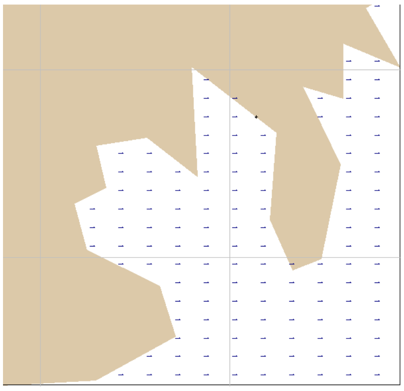




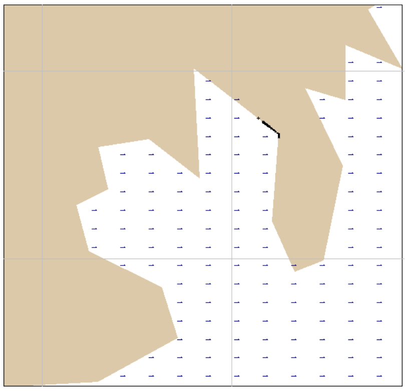




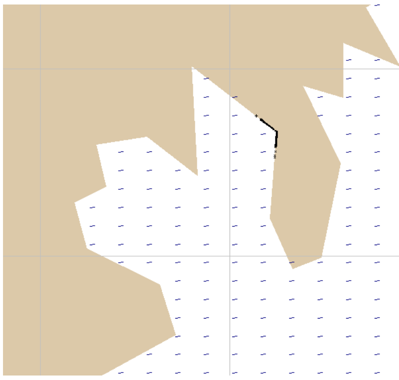
Then, taking into account a pool thickness of 0.27 mm, the maximum expected surface covered by the spillage is approximately 39 ha. For DO, the scenario modelled with GNOME program [31]:



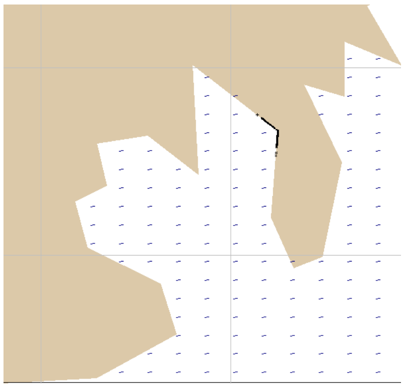
Date and time: 10/23/2015 00:00



Date and time: 10/23/2015 04:00



Date and time: 10/23/2015 16:00



Date and time 10/24/2015 00:00

All the possible spillages have been calculated. The total quantities spilled in each case are listed in the table on pages below.

ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	ENVIRONMENTAL DAMAGE							
					VOLUME RELEASED TO THE SEA WATER (m3)	EXTENT (ha)	DAMAGE	SEVERITY OF HARM	HARM DURATION CATEGORY	MATTE CONSEQUENCE LEVEL	FREQUENCY y-1	RISK
HFO-001	HFO Unloading hose	HFO	Leak in unloading hose with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm.	HFO SPILLAGE	3	7	Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	2	A	7,46E-04	Tolerable if ALARP
HFO-001 FBR	HFO Unloading hose	HFO	Rupture of the unloading hose.	HFO SPILLAGE	50	56	Release in Marsaxlokk Bay in a approximately extension lower than 200 ha	3	2	B	7,46E-05	Tolerable if ALARP
HFO-002	HFO Unloading pipeline from vessel to tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm. Pipeline from unloading point to tanks	HFO SPILLAGE	27	59	Release in Marsaxlokk Bay in a approximately extension lower than 200 ha	3	2	B	2,16E-05	Tolerable if ALARP
HFO-002 FBR	HFO Unloading pipeline from vessel to tank	HFO	Rupture in the pipeline	HFO SPILLAGE	27	30	Release in Marsaxlokk Bay in a approximately extension higher than 200 ha	3	2	C	4,32E-06	Tolerable if ALARP
HFO-003	HFO Storage tank n. 1 and 2	HFO	Continuous release from a hole with an effective diameter of 10 mm of the HFO storage tank	HFO SPILLAGE	10	21	Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	2	A	9,50E-09	Sub-MATTE
HFO-003 CF	HFO Storage tank n. 1 and 2	HFO	Instantaneous release of the entire contents of the HFO storage tank	HFO SPILLAGE	128	285	Release in Marsaxlokk Bay in a approximately extension higher than 200 ha	4	2	C	4,75E-10	Sub-MATTE
HFO-004	HFO Storage tank n. 3	HFO	Continuous release from a hole with an effective diameter of 10 mm of the HFO storage tank	HFO SPILLAGE	6	12	Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	2	A	4,75E-09	Sub-MATTE

					ENVIRONMENTAL DAMAGE							
ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	VOLUME RELEASED TO THE SEA WATER (m3)	EXTENT (ha)	DAMAGE	SEVERITY OF HARM	HARM DURATION CATEGORY	MATTE CONSEQUENCE LEVEL	FREQUENCY y-1	RISK
HFO-004 CF	HFO Storage tank n. 3	HFO	Instantaneous release of the entire contents of the HFO storage tank	HFO SPILLAGE	128	285	Release in Marsaxlokk Bay in a approximately extension higher than 200 ha	4	2	C	2,37E-10	Sub-MATTE
HFO-005	HFO pipelines from storage tank to D3 transfer pump	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor E: Fuel Heaters' Drains Interceptor	-	2	-	7,92E-07	Sub-MATTE
HFO-005 FBR	HFO pipelines from storage tank to D3 transfer pump	HFO	Rupture of the pipeline. Pipeline from unloading point to tanks	HFO SPILLAGE	171	380	Release in Marsaxlokk Bay in a approximately extension higher than 200 ha	4	2	C	1,73E-06	Tolerable if ALARP
HFO-006	HFO D3 Transfer Pumps	HFO	Leak (10 % diameter). Discharge line	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor E: Fuel Heaters' Drains Interceptor	-	2	-	5,23E-10	Sub-MATTE
HFO-006 CF	HFO D3 Transfer Pumps	HFO	Catastrophic failure. Discharge line	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor E: Fuel Heaters' Drains Interceptor	-	2	A	8,56E-11	Sub-MATTE
HFO-007	HFO pipelines from D3 transfer pump to D3 buffer tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor D: Fuel Heaters' Drains Cooling Pit	-	2	-	1,74E-06	Sub-MATTE
HFO-007 FBR	HFO pipelines from D3 transfer pump to D3 buffer tank	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	HFO SPILLAGE	9	19	Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	2	A	2,85E-06	Broadly Acceptable

					ENVIRONMENTAL DAMAGE							
ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	VOLUME RELEASED TO THE SEA WATER (m3)	EXTENT (ha)	DAMAGE	SEVERITY OF HARM	HARM DURATION CATEGORY	MATTE CONSEQUENCE LEVEL	FREQUENCY y-1	RISK
HFO-008	HFO D3 buffer tanks	HFO	Continuous release from a hole with an effective diameter of 10 mm. HFO service storage tanks	HFO SPILLAGE	69	154	Release in Marsaxlokk Bay in a approximately extension lower than 200 ha	3	2	B	8,63E-06	Broadly Acceptable
HFO-008 CF	HFO D3 buffer tanks	HFO	Instantaneous release of the entire contents. HFO service storage tanks	HFO SPILLAGE	104	231	Release in Marsaxlokk Bay in a approximately extension higher than 200 ha	4	2	C	4,32E-07	Broadly Acceptable
HFO-009	HFO pipelines from D3 buffer tank to D3 centrifuges supply pump	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor D: Fuel Heaters' Drains Cooling Pit	-	2	-	4,75E-07	Sub-MATTE
HFO-009 FBR	HFO pipelines from D3 buffer tank to D3 centrifuges supply pump	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	HFO SPILLAGE	9	19	Release expected to be contained by the interceptor D: Fuel Heaters' Drains Cooling Pit	-	2	-	5,18E-06	Sub-MATTE
HFO-010	HFO D3 centrifuges supply pumps	HFO	Leak (10 % diameter). Discharge line of the supply pumps	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor D: Fuel Heaters' Drains Cooling Pit	-	2	-	6,67E-06	Sub-MATTE
HFO-010 CF	HFO D3 centrifuges supply pumps	HFO	Catastrophic failure. Discharge line of the supply pumps	HFO SPILLAGE	9	19	Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	2	A	1,45E-05	Broadly Acceptable
HFO-011	HFO pipelines from D3 centrifuges supply pump to D3 centrifuges	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor D: Fuel Heaters' Drains Cooling Pit	-	2	-	7,92E-08	Sub-MATTE
HFO-011 FBR	HFO pipelines from D3 centrifuges supply pump to D3 centrifuges	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	HFO SPILLAGE	9	19	Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	2	A	1,29E-07	Broadly Acceptable

SGS

ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	ENVIRONMENTAL DAMAGE								
					VOLUME RELEASED TO THE SEA WATER (m3)	EXTENT (ha)	DAMAGE	SEVERITY OF HARM	HARM DURATION CATEGORY	MATTE CONSEQUENCE LEVEL	FREQUENCY y-1	RISK
HFO-012	HFO D3 centrifuges	HFO	Continuous release from a hole with an effective diameter of 10 mm. Centrifuges	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor D: Fuel Heaters' Drains Cooling Pit	-	2	-	1,19E-06	Sub-MATTE
HFO-012 CF	HFO D3 centrifuges	HFO	Catastrophic failure. Centrifuges	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor D: Fuel Heaters' Drains Cooling Pit	-	2	-	5,94E-08	Sub-MATTE
HFO-013	HFO pipelines from D3 centrifuges to D3 service tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor D: Fuel Heaters' Drains Cooling Pit	-	2	-	4,75E-07	Sub-MATTE
HFO-013 FBR	HFO pipelines from D3 centrifuges to D3 service tank	HFO	Rupture in the pipeline	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor D: Fuel Heaters' Drains Cooling Pit	-	2	-	7,13E-08	Sub-MATTE
HFO-014	HFO D3 service tanks	HFO	Continuous release from a hole with an effective diameter of 10 mm. HFO service storage tanks	HFO SPILLAGE	73	161	Release in Marsaxlokk Bay in a approximately extension lower than 200 ha	3	2	B	8,63E-06	Broadly Acceptable
HFO-014 CF	HFO D3 service tanks	HFO	Catastrophic failure. HFO service storage tanks	HFO SPILLAGE	110	244	Release in Marsaxlokk Bay in a approximately extension higher than 200 ha	4	2	C	4,32E-07	Broadly Acceptable
HFO-015	HFO pipelines from service tanks to D3 engines	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor D: Fuel Heaters' Drains Cooling Pit	-	2	-	4,75E-06	Sub-MATTE

					ENVIRONMENTAL DAMAGE							
ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	VOLUME RELEASED TO THE SEA WATER (m3)	EXTENT (ha)	DAMAGE	SEVERITY OF HARM	HARM DURATION CATEGORY	MATTE CONSEQUENCE LEVEL	FREQUENCY y-1	RISK
HFO-015 FBR	HFO pipelines from service tanks to D3 engines	HFO	Rupture in the pipeline	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor D: Fuel Heaters' Drains Cooling Pit	-	2	-	7,13E-07	Sub-MATTE
HFO-016	HFO pipelines from storage tank to D1 HFO pump house	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	HFO SPILLAGE	0	0	Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	2	-	3,17E-06	Sub-MATTE
HFO-016 FBR	HFO pipelines from storage tank to D1 HFO pump house	HFO	Rupture in the pipeline	HFO SPILLAGE	5	11	Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	2	A	5,18E-06	Broadly Acceptable
HFO-017	HFO D1 HFO Pumps	HFO	Leak (10 % diameter). Discharge line	HFO SPILLAGE	1	1	Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	2	A	8,63E-07	Broadly Acceptable
HFO-017 CF	HFO D1 HFO Pumps	HFO	Catastrophic failure. Discharge line	HFO SPILLAGE	10	22	Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	2	A	1,15E-06	Broadly Acceptable
HFO-018	HFO pipelines from D1 HFO pump house to heaters	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	HFO SPILLAGE	2	4	Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	2	A	7,08E-05	Broadly Acceptable
HFO-018 FBR	HFO pipelines from D1 HFO pump house to heaters	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	HFO SPILLAGE	30	67	Release in Marsaxlokk Bay in a approximately extension lower than 200 ha	3	2	B	1,29E-07	Broadly Acceptable
HFO-019	HFO pipelines from D1 heaters to D1 boilers	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	HFO SPILLAGE	2	4	Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	2	A	1,86E-06	Broadly Acceptable

					ENVIRONMENTAL DAMAGE							
ITEM	**EQUIPMENT / PROCESS**	**SUBSTANCE**	**SCENARIO**	**FINAL EVENT**	**VOLUME RELEASED TO THE SEA WATER (m3)**	**EXTENT (ha)**	**DAMAGE**	**SEVERITY OF HARM**	**HARM DURATION CATEGORY**	**MATTE CONSEQUENCE LEVEL**	**FREQUENCY y-1**	**RISK**
HFO-019 FBR	HFO pipelines from D1 heaters to D1 boilers	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	HFO SPILLAGE	30	67	Release in Marsaxlokk Bay in a approximately extension lower than 200 ha	3	2	B	1,06E-05	Tolerable if ALARP
DO-001	DO Unloading arm	DO	Leak in unloading hose with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm.	DO SPILLAGE	2	9	Spreading pool on closed waters in port environment, with possibilities to be contained and dispersed, minimum impact on sea life	2	1	Sub-MATTE harm	1,75E-07	Sub-MATTE
DO-001 FBR	DO Unloading arm	DO	Rupture of the unloading arm.	DO SPILLAGE	35		Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	1	Sub-MATTE harm	1,90E-07	Sub-MATTE
DO-002	DO Unloading pipeline from vessel to raw tanks	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	19		Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	1	Sub-MATTE harm	2,51E-05	Sub-MATTE
DO-002 FBR	DO Unloading pipeline from vessel to raw tanks	DO	Rupture in the pipeline	DO SPILLAGE	508		Release in Marsaxlokk Bay in a approximately extension higher than 200 ha	4	1	Sub-MATTE harm	5,02E-06	Sub-MATTE
DO-003	DO Raw tank n. 1/2/3	DO	Continuous release from a hole with an effective diameter of 10 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	1,45E-08	Sub-MATTE
DO-003 CF	DO Raw tank n. 1/2/3	DO	Instantaneous release of the entire contents of the DO Raw tank n. 1/2/3	DO SPILLAGE	131		Release in Marsaxlokk Bay in a approximately extension higher than 200 ha	4	1	Sub-MATTE harm	7,27E-10	Sub-MATTE
DO-004	DO pipelines from raw tank to transfer pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor I: Station Oily Water Drains	-	1	-	9,25E-06	Sub-MATTE

					ENVIRONMENTAL DAMAGE							
ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	VOLUME RELEASED TO THE SEA WATER (m3)	EXTENT (ha)	DAMAGE	SEVERITY OF HARM	HARM DURATION CATEGORY	MATTE CONSEQUENCE LEVEL	FREQUENCY y-1	RISK
							Interceptor					
DO-004 FBR	DO pipelines from raw tank to transfer pumps	DO	Rupture in the pipeline	DO SPILLAGE	0		Release expected to be contained by the interceptor I: Station Oily Water Drains Interceptor	-	1	-	1,70E-07	Sub-MATTE
DO-005	DO Transfer Pumps	DO	Leak (10 % diameter). Discharge line	DO SPILLAGE	0		Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	1	-	4,20E-07	Sub-MATTE
DO-005 CF	DO Transfer Pumps	DO	Catastrophic failure. Discharge line	DO SPILLAGE	0		Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	1	-	7,71E-09	Sub-MATTE
DO-006	DO pipelines from transfer pumps to centrifuges	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	1	-	4,40E-06	Sub-MATTE
DO-006 FBR	DO pipelines from transfer pumps to centrifuges	DO	Rupture in the pipeline	DO SPILLAGE	0		Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	1	-	8,08E-08	Sub-MATTE
DO-007	DO centrifuges	DO	Continuous release from a hole with an effective diameter of 10 mm. Centrifuges	DO SPILLAGE	0		Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	1	-	1,76E-05	Sub-MATTE

					ENVIRONMENTAL DAMAGE							
ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	VOLUME RELEASED TO THE SEA WATER (m3)	EXTENT (ha)	DAMAGE	SEVERITY OF HARM	HARM DURATION CATEGORY	MATTE CONSEQUENCE LEVEL	FREQUENCY y-1	RISK
DO-007 CF	DO centrifuges	DO	Catastrophic failure. Centrifuges	DO SPILLAGE	0		Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	1	-	8,08E-08	Sub-MATTE
DO-008	DO pipelines from centrifuges to treated tank	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	1,15E-05	Sub-MATTE
DO-008 FBR	DO pipelines from centrifuges to treated tank	DO	Rupture in the pipeline	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	2,10E-07	Sub-MATTE
DO-009	DO Treated tank n. 4	DO	Continuous release from a hole with an effective diameter of 10 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	4,84E-09	Sub-MATTE
DO-009 CF	DO Treated tank n. 4	DO	Instantaneous release of the entire contents of the DO Treated tank n. 4	DO SPILLAGE	131		Release in Marsaxlokk Bay in a approximately extension higher than 200 ha	4	1	Sub-MATTE harm	2,42E-10	Sub-MATTE
DO-010	DO return pipelines from centrifuges to raw tank nr 0, nr 1	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	7,49E-05	Sub-MATTE
DO-010 FBR	DO return pipelines from centrifuges to raw tank nr 0, nr 1	DO	Rupture in the pipeline	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	1,37E-06	Sub-MATTE
DO-011	DO return pipelines from centrifuges to raw tank nr 2	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	4,40E-05	Sub-MATTE

ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	ENVIRONMENTAL DAMAGE: VOLUME RELEASED TO THE SEA WATER (m3)	EXTENT (ha)	DAMAGE	SEVERITY OF HARM	HARM DURATION CATEGORY	MATTE CONSEQUENCE LEVEL	FREQUENCY y-1	RISK
DO-011 FBR	DO return pipelines from centrifuges to raw tank nr 2	DO	Rupture in the pipeline	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	6,06E-07	Sub-MATTE
DO-012	DO pipelines from treated tank to D2A forwarding pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor H: Polishing Interceptor	-	1	-	1,05E-06	Sub-MATTE
DO-012 FBR	DO pipelines from treated tank to D2A forwarding pumps	DO	Rupture in the pipeline	DO SPILLAGE	0		Release expected to be contained by the interceptor H: Polishing Interceptor	-	1	-	2,10E-07	Sub-MATTE
DO-013	DO pipelines from treated tank to D2B forwarding pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	1,05E-06	Sub-MATTE
DO-013 FBR	DO pipelines from treated tank to D2B forwarding pumps	DO	Rupture in the pipeline	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	2,10E-07	Sub-MATTE
DO-014	DO D2A forwarding pumps	DO	Leak (10 % diameter). Discharge line of the supply pumps	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	4,01E-08	Sub-MATTE
DO-014 CF	DO D2A forwarding pumps	DO	Catastrophic failure. Discharge line of the supply pumps	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	8,02E-09	Sub-MATTE
DO-015	DO D2B forwarding pumps	DO	Leak (10 % diameter). Discharge line of the supply pumps	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	4,26E-07	Sub-MATTE

					ENVIRONMENTAL DAMAGE							
ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	VOLUME RELEASED TO THE SEA WATER (m3)	EXTENT (ha)	DAMAGE	SEVERITY OF HARM	HARM DURATION CATEGORY	MATTE CONSEQUENCE LEVEL	FREQUENCY y-1	RISK
DO-015 FBR	DO D2B forwarding pumps	DO	Rupture in the pipeline	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	8,52E-08	Sub-MATTE
DO-016	DO pipelines from forwarding pumps tank to D2A	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	4,40E-06	Sub-MATTE
DO-016 FBR	DO pipelines from forwarding pumps tank to D2A	DO	Rupture in the pipeline	DO SPILLAGE	0		Release expected to be contained by the interceptor F: Diesel Interceptor	-	1	-	6,59E-07	Sub-MATTE
DO-017	DO pipelines from forwarding pumps tank to D2B	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	1	-	5,11E-05	Sub-MATTE
DO-017 FBR	DO pipelines from forwarding pumps tank to D2B	DO	Rupture in the pipeline	DO SPILLAGE	0		Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	1	-	7,03E-07	Sub-MATTE
DO-018	DO pipelines from raw tank to D3 transfer pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	1	-	3,56E-06	Sub-MATTE
DO-018 FBR	DO pipelines from raw tank to D3 transfer pumps	DO	Rupture in the pipeline	DO SPILLAGE	15		Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	1	Sub-MATTE harm	5,81E-06	Sub-MATTE
DO-019	DO D3 Transfer Pumps	DO	Leak (10 % diameter). Discharge line	DO SPILLAGE	0		Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	1	-	3,86E-08	Sub-MATTE

ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	ENVIRONMENTAL DAMAGE							
					VOLUME RELEASED TO THE SEA WATER (m3)	EXTENT (ha)	DAMAGE	SEVERITY OF HARM	HARM DURATION CATEGORY	MATTE CONSEQUENCE LEVEL	FREQUENCY y-1	RISK
DO-019 CF	DO D3 Transfer Pumps	DO	Catastrophic failure. Discharge line	DO SPILLAGE	15		Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	1	Sub-MATTE harm	8,41E-08	Sub-MATTE
DO-020	DO pipelines from D3 transfer pump to D3 service tank	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	0		Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	1	-	4,85E-07	Sub-MATTE
DO-020 FBR	DO pipelines from D3 transfer pump to D3 service tank	DO	Rupture in the pipeline	DO SPILLAGE	0		Release expected to be contained by the interceptor J: Block 4 Oily Water Effluent Pit	-	1	-	7,27E-08	Sub-MATTE
DO-021	DO D3 Service tank	DO	Continuous release from a hole with an effective diameter of 10 mm	DO SPILLAGE	104		Release in Marsaxlokk Bay in a approximately extension lower than 200 ha	3	1	Sub-MATTE harm	4,04E-07	Sub-MATTE
DO-021 CF	DO D3 Service tank	DO	Instantaneous release of the entire contents of the DO D3 Service tank	DO SPILLAGE	125		Release in Marsaxlokk Bay in a approximately extension lower than 200 ha	4	1	Sub-MATTE harm	2,20E-07	Sub-MATTE
DO-022	DO pipelines from D3 service tank to supply pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	1		Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	1	Sub-MATTE harm	4,85E-07	Sub-MATTE
DO-022 FBR	DO pipelines from D3 service tank to supply pumps	DO	Rupture in the pipeline	DO SPILLAGE	22		Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	1	Sub-MATTE harm	7,93E-07	Sub-MATTE
DO-023	DO pipelines from D3 supply pumps to engines	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	DO SPILLAGE	1		Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	1	Sub-MATTE harm	3,47E-06	Sub-MATTE

ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	ENVIRONMENTAL DAMAGE								
					VOLUME RELEASED TO THE SEA WATER (m3)	EXTENT (ha)	DAMAGE	SEVERITY OF HARM	HARM DURATION CATEGORY	MATTE CONSEQUENCE LEVEL	FREQUENCY y-1	RISK
DO-023 FBR	DO pipelines from D3 supply pumps to engines	DO	Rupture in the pipeline	DO SPILLAGE	22		Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	1	Sub-MATTE harm	5,68E-06	Sub-MATTE
DO-024 DE	DO Raw tank n. 1/2/3	DO	Catastrophic failure of the DO Raw tank n. 1/2/3 due to a jet fire domino effect from EGM	DO SPILLAGE	22		Release in Marsaxlokk Bay in a approximately extension lower than 20 ha	2	1	Sub-MATTE harm	3,41E-09	Sub-MATTE

4.9.4 Risk matrix

The application of a common Risk Matrix to all the Safety Reports submitted by the operator at Delimara site has been proposed during the evaluation process by the evaluator and approved by the authorities.

The risk matrix has been developed identical to the French Assessment Grid (Risk Matrix officially established in France). The Proposed Risk Matrix outlines three accidental risk areas (red, yellow and green) identical to the three risk areas of the French Assessment Grid :

- Red for "high-risk area"
- Yellow for "intermediate risk area"
- Green for "lesser risk area"

The proposed risk matrix is shown below:

		Seriousness of Consequences (see Table 3 for scale)				
Probability	**Per year**	**1 Moderate**	**2 Serious/ Medium**	**3 Major/ Significant**	**4 Catastrophic**	**5 Disastrous/ Extreme**
A Likely	Greater than or equal to 10^{-2}	Yellow	Red	Red	Red	Red
B Unlikely	Greater than or equal to 10^{-3} and less than 10^{-2}	Green	Yellow	Red	Red	Red
C Very Unlikely	Greater than or equal to 10^{-4} and less than 10^{-3}	Green	Yellow	Yellow	Red	Red
D Extremely Unlikely	Greater than or equal to 10^{-5} and less than 10^{-4}	Green	Green	Yellow	Yellow	Red
E Remote	Less than 10^{-5}	Green	Green	Yellow	Yellow	For New Establishments (*Yellow for Existing Plant*)

The seriousness of the consequences shall be estimated in accordance with the following table and related criteria:

Severity of Consequences	Significant lethal effect	First lethal effect	Irreversible effect
Extreme	PE > 10	PE > 100	PE > 1000
Catastrophic	1 < PE ⩽ 10	10 < PE ⩽ 10 100	100 < PE ⩽ 1000
Significant	PE < 1	1 < PE < 10	10 < PE ⩽ 100
Medium	0	PE ⩽ 1	1 < PE ⩽ 10
Moderate	No lethal effects outside the facility		PE ⩽ 1
NOTE: PE = Persons Exposed			

Interpretation criteria:

- The above scale shall be applied exclusively for persons exposed outside the boundaries of the SEVESO establishment.
- The intensity of the effects (consequence) of dangerous phenomena (accident scenarios) is defined in comparison with reference values expressed in form of thresholds (threshold values /end point values) of toxic effects, effects of overpressure, thermal effects and effects linked to the impact of projectiles on persons and structures.
- The Effects are defined according to the following Threshold/End Point Values:

Effects		Significant Lethal Effects	First Lethal Effects	Irreversible
	Hazard Zones : Threshold / End point values			
	Domino Zone 99% fatality	**Inner Zone** (Very Serious Hazard) **50% fatality**	**Middle Zone** (Serious Hazard) **1% fatality**	**Outer Zone** (Significant Hazard) **No fatality**
Thermal Radiation Thermal Dose	37.5 kW/m²	**15 kW/m²** **1800** (*to 2000*) **TDU** ([8])	**5 kW/m2** **500** (*to 1000*) **TDU** for short duration effects	3 KW/m²
Overpressure	700 mbar	**300** (*to 350*) **mbar**	**140 mbar**	40-50 mbar
Toxic	-	**LC50 : Lethal concentration for 50% lethality**	**LC1 : Lethal concentration for 1% lethality**	IDLH

Further Hazard Zones with Significant Lethal effects may also be defined according to the Threshold/End Point Values defined.

Effects	**Significant Lethal Effects**	**Significant Lethal Effects**	**Significant Lethal Effects**	**Lethal Effects**	**First Lethal Effects**
	Hazard Zones : Threshold / End point values				
	Inner Zone (Very Serious Hazard) 50% fatality	40% fatality	5% fatality	3% fatality	Middle Zone (Serious Hazard) 1% fatality
Thermal Radiation **Thermal Dose**	15 kW/m² 1800 (*to 2000*) TDU	13.4 kW/m²	9.3 kW/m²	7.3 kW/m²	kW/m² 500 (*to 1000*) TDU for short duration effects
Overpressure	300 (*to 350*) mbar	-	170-200 mbar	-	140 mbar
Toxic	LC50 : Lethal concentration for 50% lethality	-	LC5	-	LC1 : Lethal concentration for 1% lethality

[8] TDU : Thermal Dose Units in $((kW/m^2)^{4/3})$sec

Specifically considering ENEMALTA scenarios, only the thermal radiation is applicable as a criterion for lethal effects and only in those cases in which a pool fire is possible according to the event tree.

The following table shows the result of the application of the risk matrix to each scenario.

							RISK MATRIX		
ITEM	**EQUIPMENT / PROCESS**	**SUBSTANCE**	**SCENARIO**	**FINAL EVENT**	**FINAL FREQUENCY**	**UNITS**	**LIKELYHOOD LEVEL**	**EXTERNAL SEVERITY**	**RISK RANKING**
HFO-001	HFO Unloading hose	HFO	Leak in unloading hose with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm.	PFIRE	1,73E-04	y-1	C – Very Unlikely	1 – Moderate	
				EXPLOSION	6,84E-05	y-1	D – Extremely Unlikely	1 – Moderate	
				FLASHFIRE	1,03E-04	y-1	C – Very Unlikely	1 – Moderate	
				HFO SPILLAGE	7,46E-04	y-1	NA	NA	NA
HFO-001 FBR	HFO Unloading hose	HFO	Rupture of the unloading hose.	PFIRE	1,73E-05	y-1	D – Extremely Unlikely	1 – Moderate	
				EXPLOSION	6,84E-06	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,03E-05	y-1	D – Extremely Unlikely	1 – Moderate	
				HFO SPILLAGE	7,46E-05	y-1	NA	NA	NA
HFO-002	HFO Unloading pipeline from vessel to tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm. Pipeline from unloading point to tanks	PFIRE	5,00E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	1,98E-06	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	2,97E-06	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	2,16E-05	y-1	NA	NA	NA
HFO-002 FBR	HFO Unloading pipeline from vessel to tank	HFO	Rupture in the pipeline	PFIRE	1,00E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	3,96E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	5,94E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	4,32E-06	y-1	NA	NA	NA
HFO-003	HFO Storage tank n. 1 and 2	HFO	Continuous release from a hole with an effective diameter of 10 mm of the HFO storage tank	PFIRE	2,00E-06	y-1	E – Remote	3 – Major / Significant	
				EXPLOSION	7,92E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,19E-06	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	9,50E-09	y-1	NA	NA	NA
HFO-003 CF	HFO Storage tank n. 1 and 2	HFO	Instantaneous release of the entire contents of the HFO storage tank	PFIRE	1,00E-07	y-1	E – Remote	3 – Major / Significant	
				EXPLOSION	3,96E-08	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	5,94E-08	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	4,75E-10	y-1	NA	NA	NA
HFO-004	HFO Storage tank n. 3	HFO	Continuous release from a hole with an effective diameter of 10 mm of the HFO storage tank	PFIRE	1,00E-06	y-1	E – Remote	3 – Major / Significant	
				EXPLOSION	3,96E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	5,94E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	4,75E-09	y-1	NA	NA	NA
HFO-004 CF	HFO Storage tank n. 3	HFO	Instantaneous release of the entire contents of the HFO storage tank	PFIRE	5,00E-08	y-1	E – Remote	3 – Major / Significant	
				EXPLOSION	1,98E-08	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	2,97E-08	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	2,37E-10	y-1	NA	NA	NA

ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK MATRIX		
							LIKELYHOOD LEVEL	EXTERNAL SEVERITY	RISK RANKING
HFO-005	HFO pipelines from storage tank to D3 transfer pump	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	2,00E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	7,92E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,19E-06	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	7,92E-07	y-1	NA	NA	NA
HFO-005 FBR	HFO pipelines from storage tank to D3 transfer pump	HFO	Rupture of the pipeline. Pipeline from unloading point to tanks	PFIRE	4,00E-07	y-1	E – Remote	1 – Moderate	
				EXPLOSION	1,58E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	2,38E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	1,73E-06	y-1	NA	NA	NA
HFO-006	HFO D3 Transfer Pumps	HFO	Leak (10 % diameter). Discharge line	PFIRE	9,82E-07	y-1	E – Remote	1 – Moderate	
				EXPLOSION	3,89E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	5,84E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	5,23E-10	y-1	NA	NA	NA
HFO-006 CF	HFO D3 Transfer Pumps	HFO	Catastrophic failure. Discharge line	PFIRE	1,96E-07	y-1	E – Remote	1 – Moderate	
				EXPLOSION	7,78E-08	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,17E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	8,56E-11	y-1	NA	NA	NA
HFO-007	HFO pipelines from D3 transfer pump to D3 buffer tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	4,40E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	1,74E-06	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	2,61E-06	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	1,74E-06	y-1	NA	NA	NA
HFO-007 FBR	HFO pipelines from D3 transfer pump to D3 buffer tank	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	6,60E-07	y-1	E – Remote	1 – Moderate	
				EXPLOSION	2,61E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	3,92E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	2,85E-06	y-1	NA	NA	NA
HFO-008	HFO D3 buffer tanks	HFO	Continuous release from a hole with an effective diameter of 10 mm. HFO service storage tanks	PFIRE	2,00E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	7,92E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,19E-06	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	8,63E-06	y-1	NA	NA	NA
HFO-008 CF	HFO D3 buffer tanks	HFO	Instantaneous release of the entire contents. HFO service storage tanks	PFIRE	1,00E-07	y-1	E – Remote	1 – Moderate	
				EXPLOSION	3,96E-08	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	5,94E-08	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	4,32E-07	y-1	NA	NA	NA
HFO-009	HFO pipelines from D3 buffer tank to D3 centrifuges supply pump	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	1,20E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	4,75E-07	y-1	E – Remote	1 – Moderate	

ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK MATRIX		
							LIKELYHOOD LEVEL	EXTERNAL SEVERITY	RISK RANKING
				FLASHFIRE	7,13E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	4,75E-07	y-1	NA	NA	NA
HFO-009 FBR	HFO pipelines from D3 buffer tank to D3 centrifuges supply pump	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	1,20E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	4,75E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	7,13E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	5,18E-06	y-1	NA	NA	NA
HFO-010	HFO D3 centrifuges supply pumps	HFO	Leak (10 % diameter). Discharge line of the supply pumps	PFIRE	1,68E-05	y-1	D – Extremely Unlikely	1 – Moderate	
				EXPLOSION	6,67E-06	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,00E-05	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	6,67E-06	y-1	NA	NA	NA
HFO-010 CF	HFO D3 centrifuges supply pumps	HFO	Catastrophic failure. Discharge line of the supply pumps	PFIRE	3,37E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	1,33E-06	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	2,00E-06	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	1,45E-05	y-1	NA	NA	NA
HFO-011	HFO pipelines from D3 centrifuges supply pump to D3 centrifuges	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	2,00E-07	y-1	E – Remote	1 – Moderate	
				EXPLOSION	7,92E-08	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,19E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	7,92E-08	y-1	NA	NA	NA
HFO-011 FBR	HFO pipelines from D3 centrifuges supply pump to D3 centrifuges	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	3,00E-08	y-1	E – Remote	1 – Moderate	
				EXPLOSION	1,19E-08	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,78E-08	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	1,29E-07	y-1	NA	NA	NA
HFO-012	HFO D3 centrifuges	HFO	Continuous release from a hole with an effective diameter of 10 mm. Centrifuges	PFIRE	3,00E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	1,19E-06	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,78E-06	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	1,19E-06	y-1	NA	NA	NA
HFO-012 CF	HFO D3 centrifuges	HFO	Catastrophic failure. Centrifuges	PFIRE	1,50E-07	y-1	E – Remote	1 – Moderate	
				EXPLOSION	5,94E-08	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	8,91E-08	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	5,94E-08	y-1	NA	NA	NA
HFO-013	HFO pipelines from D3 centrifuges to D3 service tank	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	1,20E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	4,75E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	7,13E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	4,75E-07	y-1	NA	NA	NA

SGS

ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK MATRIX LIKELYHOOD LEVEL	RISK MATRIX EXTERNAL SEVERITY	RISK MATRIX RISK RANKING
HFO-013 FBR	HFO pipelines from D3 centrifuges to D3 service tank	HFO	Rupture in the pipeline	PFIRE	1,80E-07	y-1	E – Remote	1 – Moderate	
				EXPLOSION	7,13E-08	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,07E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	7,13E-08	y-1	NA	NA	NA
HFO-014	HFO D3 service tanks	HFO	Continuous release from a hole with an effective diameter of 10 mm. HFO service storage tanks	PFIRE	4,00E-08	y-1	E – Remote	1 – Moderate	
				EXPLOSION	1,58E-08	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	2,38E-08	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	1,73E-07	y-1	NA	NA	NA
HFO-014 CF	HFO D3 service tanks	HFO	Catastrophic failure. HFO service storage tanks	PFIRE	4,00E-08	y-1	E – Remote	1 – Moderate	
				EXPLOSION	1,58E-08	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	2,38E-08	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	1,73E-07	y-1	NA	NA	NA
HFO-015	HFO pipelines from service tanks to D3 engines	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	1,20E-05	y-1	D – Extremely Unlikely	1 – Moderate	
				EXPLOSION	4,75E-06	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	7,13E-06	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	4,75E-06	y-1	NA	NA	NA
HFO-015 FBR	HFO pipelines from service tanks to D3 engines	HFO	Rupture in the pipeline	PFIRE	1,80E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	7,13E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,07E-06	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	7,13E-07	y-1	NA	NA	NA
HFO-016	HFO pipelines from storage tank to D1 HFO pumphouse	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	8,00E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	3,17E-06	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	4,75E-06	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	3,17E-06	y-1	NA	NA	NA
HFO-016 FBR	HFO pipelines from storage tank to D1 HFO pumphouse	HFO	Rupture in the pipeline	PFIRE	1,20E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	4,75E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	7,13E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	5,18E-06	y-1	NA	NA	NA
HFO-017	HFO D1 HFO Pumps	HFO	Leak (10 % diameter). Discharge line	PFIRE	2,00E-07	y-1	E – Remote	1 – Moderate	
				EXPLOSION	7,92E-08	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,19E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	8,63E-07	y-1	NA	NA	NA
HFO-017 CF	HFO D1 HFO Pumps	HFO	Catastropic failure. Discharge line	PFIRE	2,66E-07	y-1	E – Remote	1 – Moderate	
				EXPLOSION	1,06E-07	y-1	E – Remote	1 – Moderate	

ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK MATRIX LIKELYHOOD LEVEL	EXTERNAL SEVERITY	RISK RANKING
				FLASHFIRE	1,58E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	1,15E-06	y-1	NA	NA	NA
HFO-018	HFO pipelines from D1 HFO pumphouse to heaters	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	1,64E-05	y-1	D – Extremely Unlikely	1 – Moderate	
				EXPLOSION	1,71E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	2,57E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	7,08E-05	y-1	NA	NA	NA
HFO-018 FBR	HFO pipelines from D1 HFO pumphouse to heaters	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	3,00E-08	y-1	E – Remote	1 – Moderate	
				EXPLOSION	9,74E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,46E-06	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	1,29E-07	y-1	NA	NA	NA
HFO-019	HFO pipelines from D1 heaters to D1 boilers	HFO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	4,32E-07	y-1	E – Remote	1 – Moderate	
				EXPLOSION	1,71E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	2,57E-07	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	1,86E-06	y-1	NA	NA	NA
HFO-019 FBR	HFO pipelines from D1 heaters to D1 boilers	HFO	Rupture in the pipeline. Pipeline from unloading point to tanks	PFIRE	2,46E-06	y-1	E – Remote	1 – Moderate	
				EXPLOSION	9,74E-07	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	1,46E-06	y-1	E – Remote	1 – Moderate	
				HFO SPILLAGE	1,06E-05	y-1	NA	NA	NA
DO-001	DO Unloading arm	DO	Leak in unloading hose with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm.	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	1,75E-07	y-1	NA	NA	NA
DO-001 FBR	DO Unloading arm	DO	Rupture of the unloading arm.	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	1,90E-07	y-1	NA	NA	NA
DO-002	DO Unloading pipeline from vessel to raw tanks	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	2,51E-05	y-1	NA	NA	NA
DO-002 FBR	DO Unloading pipeline from vessel to raw tanks	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	5,02E-06	y-1	NA	NA	NA

							RISK MATRIX		
ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	LIKELYHOOD LEVEL	EXTERNAL SEVERITY	RISK RANKING
DO-003	DO Raw tank n. ½/3	DO	Continuous release from a hole with an effective diameter of 10 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	1,45E-08	y-1	NA	NA	NA
DO-003 CF	DO Raw tank n. ½/3	DO	Instantaneous release of the entire contents of the DO Raw tank n. ½/3	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	7,27E-10	y-1	NA	NA	NA
DO-004	DO pipelines from raw tank to transfer pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	9,25E-06	y-1	NA	NA	NA
DO-004 FBR	DO pipelines from raw tank to transfer pumps	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	1,70E-07	y-1	NA	NA	NA
DO-004 DE	DO pipelines from raw tank to transfer pumps	DO	Rupture in the pipeline due to a jet fire domino effect from EGM	PFIRE	3.47E-5	y-1	E – Remote	1 – Moderate	
				PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	4,20E-07	y-1	NA	NA	NA
DO-005 CF	DO Transfer Pumps	DO	Catastrophic failure. Discharge line	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	7,71E-09	y-1	NA	NA	NA
DO-006	DO pipelines from transfer pumps to centrifuges	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	4,40E-06	y-1	NA	NA	NA
DO-006 FBR	DO pipelines from transfer pumps to centrifuges	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	8,08E-08	y-1	NA	NA	NA
DO-007	DO centrifuges	DO	Continuous release from a hole with	PFIRE	0	y-1	E – Remote	1 – Moderate	

							RISK MATRIX		
ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	LIKELYHOOD LEVEL	EXTERNAL SEVERITY	RISK RANKING
			an effective diameter of 10 mm. Centrifuges	EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	1,76E-05	y-1	NA	NA	NA
DO-007 CF	DO centrifuges	DO	Catastrophic failure. Centrifuges	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	8,08E-08	y-1	NA	NA	NA
DO-008	DO pipelines from centrifuges to treated tank	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	1,15E-05	y-1	NA	NA	NA
DO-008 FBR	DO pipelines from centrifuges to treated tank	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	2,10E-07	y-1	NA	NA	NA
DO-009	DO Treated tank n. 4	DO	Continuous release from a hole with an effective diameter of 10 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	4,84E-09	y-1	NA	NA	NA
DO-009 CF	DO Treated tank n. 4	DO	Instantaneous release of the entire contents of the DO Treated tank n. 4	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	2,42E-10	y-1	NA	NA	NA
DO-010	DO return pipelines from centrifuges to raw tank nr 0, nr 1	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	7,49E-05	y-1	NA	NA	NA
DO-010 FBR	DO return pipelines from centrifuges to raw tank nr 0, nr 1	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	1,37E-06	y-1	NA	NA	NA
DO-011	DO return pipelines from centrifuges to raw tank nr 2	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	

ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK MATRIX LIKELYHOOD LEVEL	EXTERNAL SEVERITY	RISK RANKING
				DO SPILLAGE	4,40E-05	y-1	NA	NA	NA
DO-011 FBR	DO return pipelines from centrifuges to raw tank nr 2	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	6,06E-07	y-1	NA	NA	NA
DO-012	DO pipelines from treated tank to D2A forwarding pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	1,05E-06	y-1	NA	NA	NA
DO-012 FBR	DO pipelines from treated tank to D2A forwarding pumps	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	2,10E-07	y-1	NA	NA	NA
DO-013	DO pipelines from treated tank to D2B forwarding pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	1,05E-06	y-1	NA	NA	NA
DO-013 FBR	DO pipelines from treated tank to D2B forwarding pumps	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	2,10E-07	y-1	NA	NA	NA
DO-014	DO D2A forwarding pumps	DO	Leak (10 % diameter). Discharge line of the supply pumps	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	4,01E-08	y-1	NA	NA	NA
DO-014 CF	DO D2A forwarding pumps	DO	Catastrophic failure. Discharge line of the supply pumps	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	8,02E-09	y-1	NA	NA	NA
DO-015	DO D2B forwarding pumps	DO	Leak (10 % diameter). Discharge line of the supply pumps	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	4,26E-07	y-1	NA	NA	NA
DO-015 FBR	DO D2B forwarding pumps	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	

ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK MATRIX		
							LIKELYHOOD LEVEL	EXTERNAL SEVERITY	RISK RANKING
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	8,52E-08	y-1	NA	NA	NA
DO-016	DO pipelines from forwarding pumps tank to D2A	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	4,40E-06	y-1	NA	NA	NA
DO-016 FBR	DO pipelines from forwarding pumps tank to D2A	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	6,59E-07	y-1	NA	NA	NA
DO-017	DO pipelines from forwarding pumps tank to D2B	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	5,11E-05	y-1	NA	NA	NA
DO-017 FBR	DO pipelines from forwarding pumps tank to D2B	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	7,03E-07	y-1	NA	NA	NA
DO-018	DO pipelines from raw tank to D3 transfer pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	3,56E-06	y-1	NA	NA	NA
DO-018 FBR	DO pipelines from raw tank to D3 transfer pumps	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	5,81E-06	y-1	NA	NA	NA
DO-019	DO D3 Transfer Pumps	DO	Leak (10 % diameter). Discharge line	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	3,86E-08	y-1	NA	NA	NA
DO-019 CF	DO D3 Transfer Pumps	DO	Catastrophic failure. Discharge line	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	

SGS

							RISK MATRIX		
ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	LIKELYHOOD LEVEL	EXTERNAL SEVERITY	RISK RANKING
				DO SPILLAGE	8,41E-08	y-1	NA	NA	NA
DO-020	DO pipelines from D3 transfer pump to D3 service tank	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	4,85E-07	y-1	NA	NA	NA
DO-020 FBR	DO pipelines from D3 transfer pump to D3 service tank	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	7,27E-08	y-1	NA	NA	NA
DO-021	DO D3 Service tank	DO	Continuous release from a hole with an effective diameter of 10 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	4,04E-07	y-1	NA	NA	NA
DO-021 CF	DO D3 Service tank	DO	Instantaneous release of the entire contents of the DO D3 Service tank	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	2,20E-07	y-1	NA	NA	NA
DO-022	DO pipelines from D3 service tank to supply pumps	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	4,85E-07	y-1	NA	NA	NA
DO-022 FBR	DO pipelines from D3 service tank to supply pumps	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	7,93E-07	y-1	NA	NA	NA
DO-023	DO pipelines from D3 supply pumps to engines	DO	Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E – Remote	1 – Moderate	
				DO SPILLAGE	3,47E-06	y-1	NA	NA	NA
DO-023 FBR	DO pipelines from D3 supply pumps to engines	DO	Rupture in the pipeline	PFIRE	0	y-1	E – Remote	1 – Moderate	
				EXPLOSION	0	y-1	E – Remote	1 – Moderate	
				FLASHFIRE	0	y-1	E - Remote	1 - Moderate	
				DO SPILLAGE	5,68E-06	y-1	NA	NA	NA

ITEM	EQUIPMENT / PROCESS	SUBSTANCE	SCENARIO	FINAL EVENT	FINAL FREQUENCY	UNITS	RISK MATRIX		
							LIKELYHOOD LEVEL	EXTERNAL SEVERITY	RISK RANKING
DO-024 DE	DO Raw tank n. 1/2/3	DO	Catastrophic failure of the DO Raw tank n. 1/2/3 due to a jet fire domino effect from EGM	PFIRE	7,81E-05	y-1	D - Extremely Unlikely	1 - Moderate	

5 MEASURES FOR THE PREVENTION, CONTROL AND MITIGATION OF RISKS

This section provides information on technical parameters and suitable technological safeguards to prevent and mitigate the consequences of each of the major accidents mentioned in this Safety Report. These measures have been specifically listed for each hazard in the HAZID & HAZOP reports.

6 FINDINGS AND CONCLUSIONS

The complete Safety Report for Delimara Power Station facilities in Delimara has been carried out according to the requirement of the L.N. 179/2015. The Safety Report includes the description of the facilities and the environment surrounding the facilities, the identification of the hazards, and the estimation of the damage zones. Damages to the people, to the installations and to the environment (MATTE) have been presented.

The following findings should be highlighted:

- The hazards identified in the facilities are relatively familiar for the process safety experts and for the Delimara Power Station personnel, being the operation similar to the ones carried out at the facilities submitted to hundreds of risk assessment worldwide each year.
- The characteristic of the substances have been studied; the ignition of the gasoil is not considered possible due to the high flash point. The only cases in which the heavy fuel oil has been considered flammable are that equipment in the facilities where the process temperature is higher or closer to the combustion temperature.
- The scenarios have been proposed according to the hazards identified; several scenarios involving a MATTE may happens, most of them associated to the interceptors failure (inside the facilities) or the a leakage in the unloading arm/hose (in the quay).
- The damage areas have been calculated for the scenarios identified, delivering results compatible with the low density in the Delimara Peninsula.
- The MATTE analysis have highlighted that most of the possible spillages inside the power plant are contained in the bunds or the drainage systems and that the probability for a human error or an interceptor failure resulting in a spillage to the sea is unlikely. It has also highlighted the probability for a spillage to occur in the quay due to the failure of the unloading hose or arm.
- The ultimate conclusion is that the Delimara Power Station facilities is absolutely compatible with the surrounding activities and the presence of private houses, the risk for the population is acceptable and the risk for the environment is acceptable, provided that all the safeguards considered or

recommended in the HAZOP & HAZID reports are implemented and properly maintained.

7 REFERENCES

[1] *Directive 2003/105/EC of the European Parliament and of the Council of 16 December 2003 amending Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances..*

[2] G. A. SA, «Assessment of Safety Reports for the Delimara Power Station Malta (FSU, LNG/BOG systems, RGU and NG pipelines to CCGT GRS & D3PP GRS) ENEMALTA / ELECTROGAS / D3 PG ltd - 1st ASSESSMENT (SCL 1-5),» 12 February 2016.

[3] MEPA, «MEPA technical meetings (12 – 16 February 2016) Agreement Template,» 23 march 2016.

[4] G. A. SA, «Risk Matrix Ref. No. 766_1-3-2016,» 3 March 2016.

[5] GAP ANALYSIS, A.E. SAFETY & ENVIRONMENT CONSULTANTS ENGINEERS, "Control of Major Accident Hazards Assessment Report - ENEMALTA Safety Report - ENEMALTA Safety Management System - ENEMALTA Emergency Response Plan," 2016.

[6] C. Galdies, The climate of Malta: statistics, trends and analysis 1951-2011, National Statistics Office, Malta.

[7] Gap Analysis, S.A., "Preliminary Study for the Development of Consultation Zones in Delimara Penynsula - 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," 2014.

[8] "Malta National Focal Point," EMWIS: Euro-Mediterranean Information System on know-how in the Water sector, [Online]. Available: http://www.emwis-mt.org/documentation/context/physical%20factors_files/Geology.htm. [Accessed June 2013].

[9] P. Galea, "Seismic history of the Maltese islands and considerations on seismic risk," *Annals of Geophysics,* vol. 50, no. 6, pp. 725-740, December 2007.

[10] Ambiente, s.c., "Safety Report - Delimara Power Station," 2013.

[11] *CONCAWE "gas oils (diesel fuels/heating oils)" Product Dossier no. 95/107 September 1996.*

[12] *CONCAWE "Environmental classification of petroleum substances - summary data and rationale" Report no. 01/54, October 2001.*

[13] Health and Safety Authority (HSA), Policy & Approach of the Health & Safety Authority to COMAH Risk-based Land-use Planning, 07 September 2009.

[14] A. Franks, «A Review of HSE's Risk Analysis and Protection - Based Analysis Approaches for Land-Use Planning,» Health and Safety Executive (HSE), 2004.

[15] Health And Safety Executive (HSE), "Offshore Installations (Safety Case) Regulations 2005 Regulation 12 Demonstrating compliance with the relevant statutory provisions".

[16] Health and Safety Executive (HSE), «Fire, Explosion and Risk Assessment,» February 2003.

[17] Health and Safety Executive (HSE), «Application of QRA in operational safety issues,» 2002.

[18] RIVM, Reference Manual Bevi Risk Assessment version 3.2, 2009.

[19] VROM, Publication Series on Dangerous Substances (PGS 3) - Guideline for quantitative risk assessment 'Purple book' CPR 18E., 2005.

[20] Flemish Government, LNE Department, Environment, Nature and Energy Policy Unit, Safety Reporting Division, «Handbook Failure Frequencies,» 2009.

[21] HSE, Failure Rate and Event Data for use within Risk Assessment.

[22] VROM, Publication Series on Dangerous Substances (PGS 2) - Methods for the calculation of physical effects - due to releases of hazardous materials (liquids and gases)- "Yellow Book, CPR 14E".

[23] Malta Environment & Planning Authority (MEPA) , Supplementary Planning Policy Guidance, November 2004.

[24] Health and Safety Executive (HSE), Methods of approximation and determination of human vulnerability for offshore major accident hazard assessment.

[25] TNO, "TNO innovation for life," [Online]. Available: http://www.tno.nl/index.cfm?Taal=2.

[26] *UK Department of the Environment, Transport and Regions. Guidance on the Interpretation of Major Accident to the Environment for the Purposes of COMAH Regulations. HMSO, London. 1999.*

[27] *COMAH Competent Authority. Guidance on the Environmental Risk Assessment Aspects of COMAH Safety Reports. Environment Agency, 1999.*

[28] Chemical and Downstream Oil Industries Forum (CDOIF), «Guideline - Environmental Risk Tolerability for COMAH Establishments».

[29] AECOM, “Electrogas Project - Safety Report. Rev. 01,” London - United Kingdom, 15th March 2016.

[30] Genwest Systems, Inc., "Response Options Calculator," 2011.

[31] NOAA Office of Response and Restoration, “General NOAA Operational Modeling Environment GNOME”.