ENVIRONMENTAL IMPACT ASSESSMENT

PROJECT:

NEPTUN DEEP

PROJECT TITLEHOLDERS:

OMV Petrom S.A

Romgaz Black Sea Limited

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

CHAPTER 9 – DESCRIPTION OF THE PROJECT'S ANTICIPATED SIGNIFICANT NEGATIVE EFFECTS ON THE ENVIRONMENT, DETERMINED BY THE PROJECT'S VULNERABILITY TO THE RISKS OF MAJOR ACCIDENTS AND/OR DISASTERS RELEVANT TO THE PROJECT IN QUESTION

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CHAPTER 9 DESCRIPTION OF ANTICIPATED SIGNIFICANT NEGATIVE EFFECTS OF THE PROJECT ON THE ENVIRONMENT, DETERMINED BY THE VULNERABILITY OF THE PROJECT TO THE RISKS OF MAJOR ACCIDENTS AND/OR DISASTERS RELEVANT TO THE PROJECT IN QUESTION

Operating in the oil and gas industry today is challenging due to the increased focus on costs and increased requirements for operational availability, but more than that, society has become intolerant to major accidents, demanding increased requirements for safety.

Therefore, after the catastrophic oil pollution experiences (Alaska, 1989; Gulf of Mexico, 2010), the safety procedures in the offshore oil and gas industry have been revised. The previous experiences of the industry have shown that most major accidents can be attributed to one way or another to human error. Understanding the factors that influence human performance is therefore a key characteristic in reducing error and increasing safety, as major accidents in the oil and natural gas industry can have significant effects on the environment as well as on personnel engaged in operations.

A number of regional conventions and agreements have been signed at the international level in order to provide the legal framework for the Black Sea riparian countries to participate and/or intervene in removing the effects of serious sea pollution. In this way, where there is a potential for pollution to become transboundary, or it is necessary for human resources and/or equipment to be transported across borders, these agreements mean that the reaction time is rapid, and the resources are provided as soon as the situation demands it.

Although, in the Romanian sector of the Black Sea EEZ, an incident of a magnitude comparable to those exemplified above did not occurred, at the national level a series of IMO[1] conventions, regional agreements and European Directives are transposed and applied in national legislation, thus creating the legal framework for cooperation and intervention in case of serious pollution of the Black Sea.

Moreover, in accordance with Law no. 165/2016 on the safety of offshore oil operations for development projects - exploitation of natural gas deposits in the Romanian sector of the Black Sea, it is necessary to draw up the a Design Notification, Report on Major Hazards (RoMH), Independent Verification Plan, Independent Verification Scheme and appoint an Independent Verification body in order to ensure that risks are managed t and ALARP level during in order to obtain the approval issued by the Competent Authority for the Regulation of Offshore Petroleum Operations in the Black Sea (ACROPO).

Beyond all these institutional regulations, every company that develops projects in the offshore oil and gas industry, whether exploration or exploitation projects of natural gas resources, has implemented a major accident risk management system and plans intervention in case of emergency

[1] IMO – International Maritime Organization

situations, and are systematically audited by international audit bodies for the verification and validation of the management and safety systems.

In this context, reducing the risk of a major accident associated with the construction and operations of the Neptun Deep project, to the lowest possible level, represents the foundation of the accident prevention policy, as part of the design and operational procedures within the project.

9.1 VULNERABILITY OF THE PROJECT TO NATURAL HAZARDS

Natural risk areas on the territory of Romania have been geographically delimited, based on specific studies and research developed by specialized institutions, the delimitation materializing through natural risk maps, approved by competent public authorities.

Natural risk areas are those areas within which there is a potential for destructive natural phenomena, which can affect the population, human activities, the natural and the built environment and can cause damage and human casualties.

According to *Law no. 575/2001 on the approval of the National Territorial Development Plan - Section V - Natural risk areas,* in the natural risk areas, geographically delimited and declared as such according to the law, specific measures are established regarding the prevention and mitigation of risks, the realization constructions and land use, which are included in urban planning and land development plans, also constituting the basis for drawing up disaster protection and intervention plans.

When defining natural risk areas, according to Law no. 575/2001, flood, landslide and seismic risks are taken into account.

9.1.1 Project vulnerability to flooding

The onshore portion of the project is in the Dobrogea - Littoral hydrographic space, which is characterized by a small hydrographic network, with excessively torrential specifics that create floods with extremely short propagation time.

In 2001, according to *Law no. 575/2001 - Annex 5 - Administrative-territorial units affected by floods*, the administrative territory of Tuzla commune was included in the category of localities at risk of torrential floods. However, the revision of the flood hazard and risk maps based on the analysis of the relevant data regarding the urban areas affected in the period 2010-2016 by cumulative torrential rains and with increases in flows, exclude the territorial-administrative area of the Tuzla commune from the risk of floods (figure 9.1).

Although the onshore project location area is in the vicinity of Costinești commune, classified as a flood risk area from rainwater (figure 9.1), its flood risk is very unlikely.

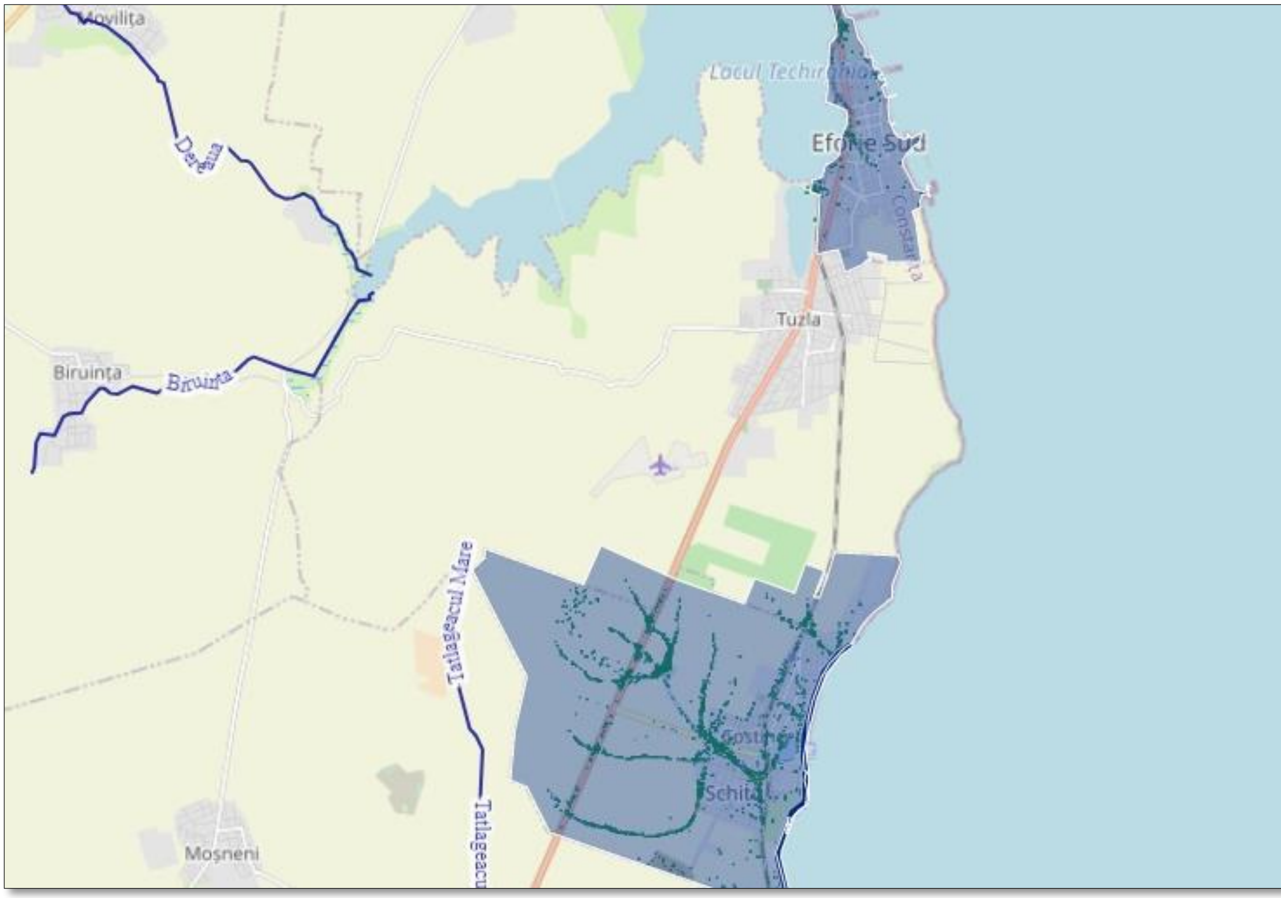


Figure 9.1– Positioning of the commune of Tuzla on the flood hazard and risk map, the location of the project on land in the vicinity of the commune of Costinești, classified as at risk of flooding from rainwater (source: www.inundatii.ro)

9.1.2 Vulnerability of the project to landslides

The relief of Tuzla commune is generally flat with slopes towards the sea (East) and North (towards Lake Techirghiol) with a maximum altitude of 60.00 m (Băldean Hill) in the eastern part, the limit is the cliff that has the highest height in the Cap Tuzla area and descends to the North (Eforie) and to the South (Costinești) where it ends with the beach.

The risk profile regarding landslides is low for the administrative territorial area of Tuzla commune.[2] Based on the field studies carried out in the land area of the project, it was concluded that there is no risk of landslides.[3]

[2] Annex 7 – Territorial administrative units affected by landslides, Law no. 575/2001.
[3]Neptun Deep s oil and water investigation study, Jacobs June 2019.

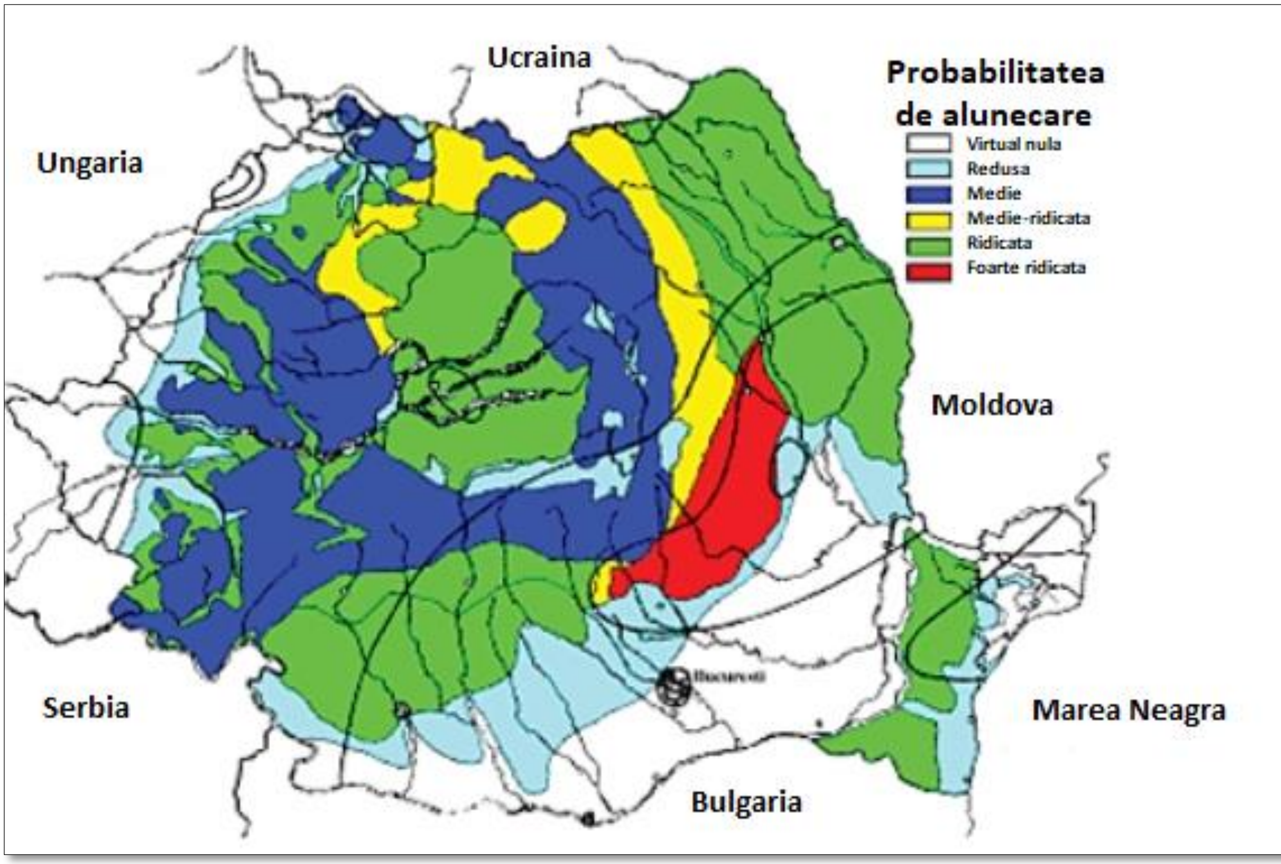


Figure 9.2– Zoning of regions in Romania at risk of landslides

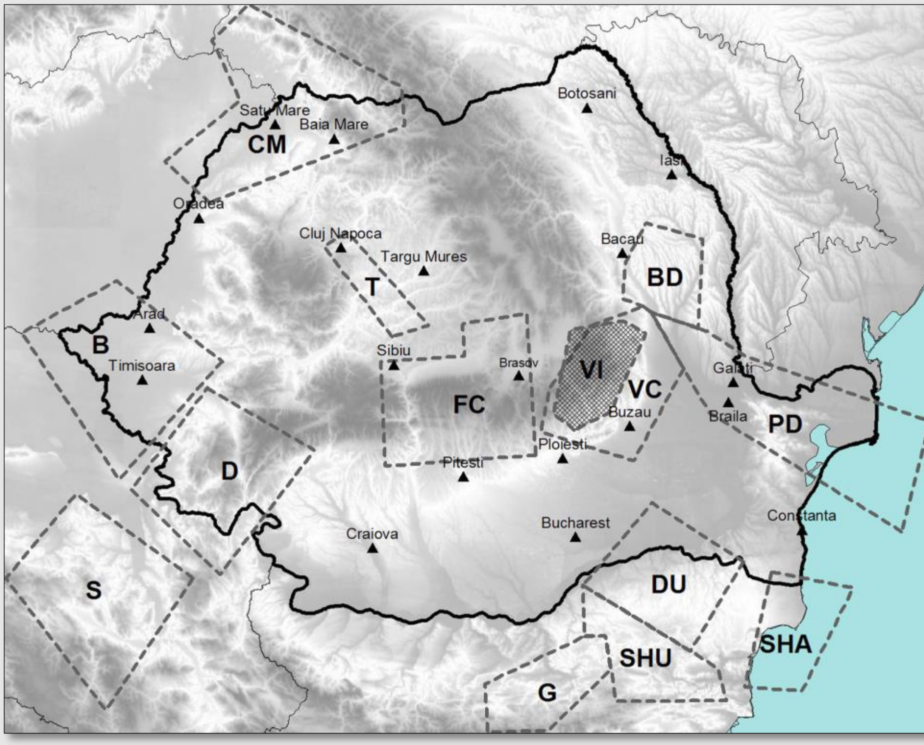
9.1.3 Vulnerability of the project to earthquakes

9.1.3.1 Onshore

According to the National Seismic Risk Reduction Strategy (SNRRS) [4], Romania's seismicity is due to a combination of the subcrustal seismic source of intermediate depth Vrancea and 15 crustal (superficial) seismic sources, among which is the Pre-Dobrogean Depression (DP) located in the North Dobrogea, being the closest superficial source on the territory of our country to the project location.

The current configuration of potential seismic sources is presented in figure 9.3, including the following sources: Vrancea intermediate depth (VRI), Vrancea normal (VN), Bârlad depression (BD), Intramoesica fault (IMF), North Dobrogea (PD), North Dobrogea Black Sea (BS1), Central Dobrogea (BS2), Shabla (BS3), Istanbul (BS4), N Anatolian Fault (BS5), Georgia (BS6), Novorossjsk (BS7), Crimea (BS8), Western Black Sea (BS9) and the centre of the Black Sea (BS10).

[4] in relation to the Plan national disaster risk management plan 2020-2027, approved by the Decision no. 13/2021 of the Committee National for Emergency situations _



Legenda:

B = Banat;
BD = Depresiunea Bârlad;
CM = Crișana Maramureș;
D = Dunărea;
DU = Dulovo;
FC = Făgăraș Câmpulung;
G = Gorna;
PD = Depresiunea pre-dobrogeană;
S = Serbia;
SHA = Shabla;
SHU = Shumen;
T = Transilvania;
VC = Vrancea de suprafață;
VI = Vrancea adâncime intermediară.

Figure 9.3– Seismic sources in Romania (according to INFP, http://tsunami.infp.ro/seismic.php)

The epicentre of the high-magnitude earthquakes is in Vrancea (VI, VC), the characteristics of the shallow sources in the southeast area being as follows:

Table 9.1– Characteristics of seismic sources (according to INFP, http://tsunami.infp.ro/seismic.php)

Seismic source		Minimum expected magnitude	Maximum Expected Magnitude	Average number of earthquakes of magnitude greater than or equal to the minimum magnitude in 25 years
The pre-Dobrogean depression		4.5	5.7	2
Shabla		4.5	7.8	3
Vrancea surface		4.5	6.3	3
Vrancea intermediate depth	60–90 km	4.9	7.0	4
	90–120 km	4.9	8.0	16
	120–150 km	4.9	8.1	30
	150–180 km	4.9	6.6	6

According to the Seismic Design Code of Buildings *P 100-1/2013, approved by Order of the Minister of Regional Development and Public Administration no. 2465/2013*, with subsequent amendments and additions, the zoning of the seismic hazard is given by the distribution of the peak values of the ground acceleration for the design (ag), with an average recurrence interval of the seismic action of 225 years (probability of exceeding 20% in 50 years). This zoning is based on a seismic hazard analysis in which the catalogue of the 20th century Vrancea earthquakes and a set of 80 accelerograms recorded in 1977, 1986 and 1990 were used.

Seismic hazard zoning on the national territory is divided into 3 zones:

- **low seismic** hazard includes regions exposed to ag values ≤150 cm/s^2 (≤0.15g);
- **medium seismic** hazard area includes regions exposed to 150 cm/s^2 (0.15g) < ag ≤350 cm/s^2 (≤0.35g);
- **high seismic** hazard area includes regions exposed to ag >350 cm/s^2 (>0.35g).

From the perspective of seismic hazard zoning, the administrative territory of the Tuzla commune falls within the VII MSK seismic intensity level, being considered minimal, according to *Annex 3 - Urban administrative-territorial units, located in areas for which the seismic intensity, according to Law no. 575/2001.*

At the Constanta County level, **the Risk Analysis and Coverage Plan** (PARR) is approved, which establishes the mode of action and the necessary resources in case of earthquakes, as well as other natural hazard events, which would lead to economic losses or endanger the health of the population.

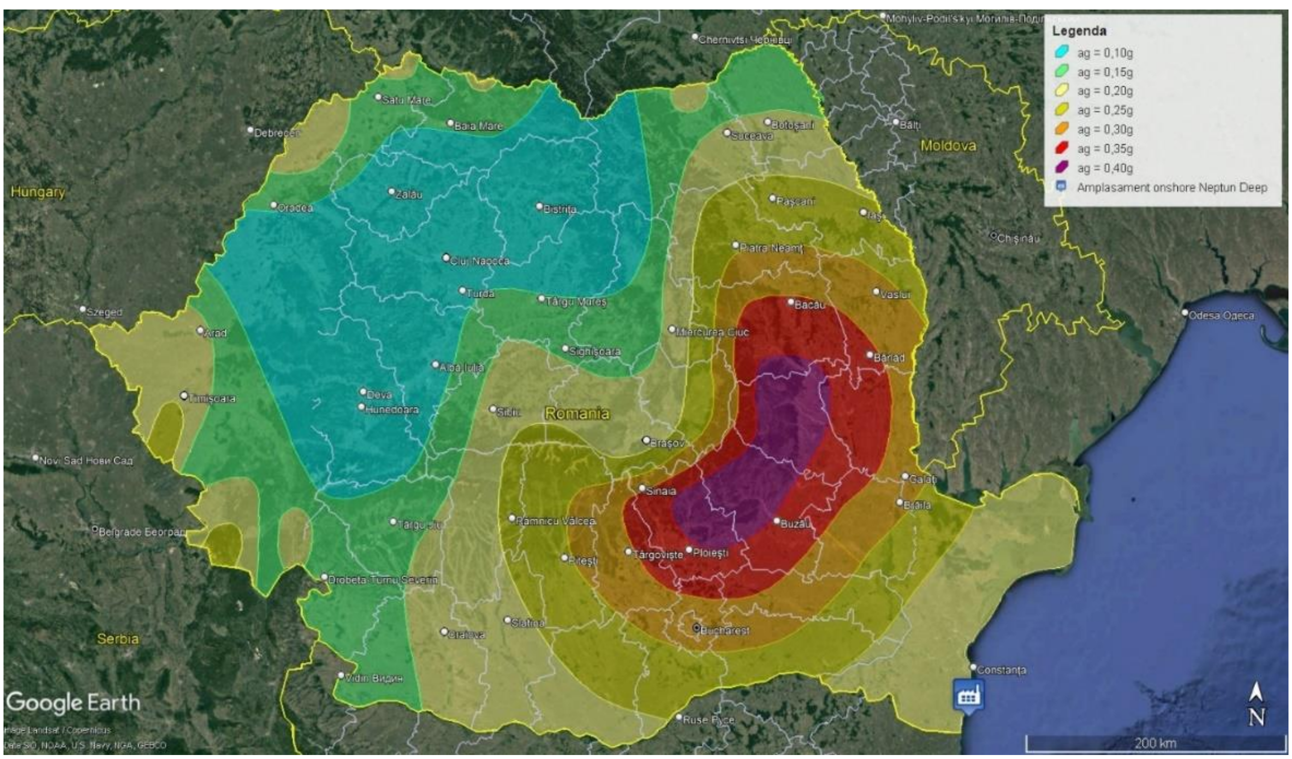


Figure 9.4– Map with the zoning of the territory of Romania in terms of peak values of land acceleration for ag design with IMR = 225 years and 20% probability of exceeding in 50 years (source: http://ccers.utcb.ro/http://ccers.utcb.ro/

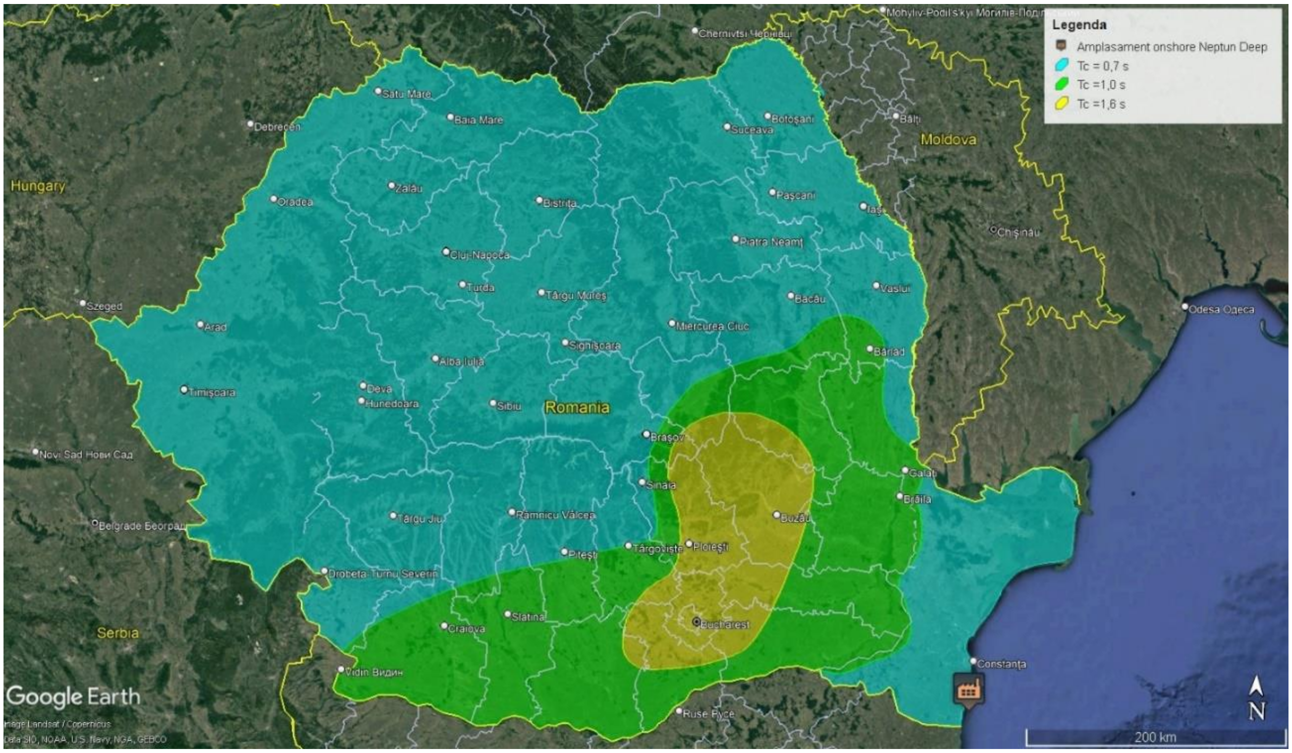


Figure 9.5– Map with the zoning of the territory of Romania in terms of control period (corner), Tc of the response spectrum (source: http://ccers.utcb.ro/)

9.1.3.2 Offshore

Researchers from the National Institute for Earth Physics (INFP) assessed the seismic hazard in the Black Sea, using the probabilistic method.

In order to obtain a reliable and homogeneous seismic data set, European-scale seismic catalogues were used[5], covering historical seismicity and the instrumental period, up to the present, but also the INFP database, which includes the history of surface earthquakes and deep earthquakes from the Black Sea and SE Romania.

The seismic zoning of the Eastern part of Romania and the Black Sea was obtained using the distribution of earthquakes and the map with the tectonically active areas (Radulian et al., 2000; Moldovan, 2008, 2013, 2016)[6].

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[5]ANSS- Advanced National Seismic System -USA, NEIC - National Earthquake Information Centre, World Data for Seismology Denver-USA, ISC-International Seismological Centre-UK, cited by INFP.
Source: http://tsunami.infp.ro/seismic.php - accessed 21.09.2023

[6]Seismic zoning of the Black Sea, INFP, Source: http://tsunami.infp.ro/seismic.php - accessed 21.09.2023

Zoning of the Black Sea was obtained using the map with the distribution of earthquakes and the map with active zones (figure 9.6). Numerous studies related to seismic zoning, carried out within various national and international projects, were taken into account[7].

The current configuration of the active seismic sources places the area of interest of the project at sea between the following sources: central Dobrogea (BS2), Shabla, Bulgaria (BS3) and the central Black Sea (BS10) (figure 9.5).

In the table below are presented the input parameters describing each source, necessary for a probabilistic assessment of the seismic hazard in the Black Sea area.

Table 9.2– Seismic sources in the Black Sea and seismological parameters (M.Radulian el al, 2008)

Seismic source	Average depth (km)	M min (MW)	M max (MW)	Seismic activity rate (a)
Central Dobrogea (BS2)	11	3.0	5.0	0.11
Shabla, Bulgaria (BS3)	16.4	3.0	7.2	0.16
Central Black Sea (BS10)	26.9	3.0	3.9	0.25

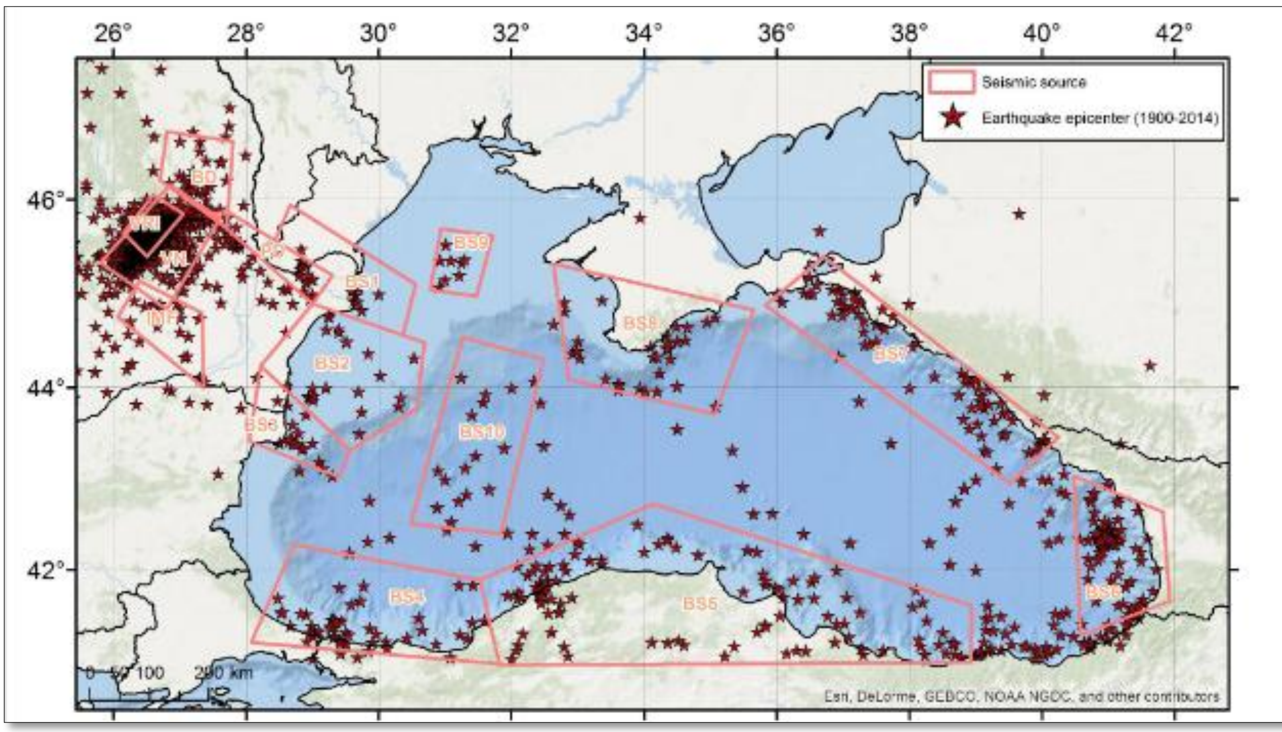

Figure 9.6– Seismic zoning for the E part of Romania and the Black Sea area (source: INFP http://tsunami.infp.ro/seismic.php)

[7]SHARE project - http://www.share-eu.org, MARINEGEOHAZARD project - www.geohazard-blacksea.eu, DARING project - http://daring.infp.ro/ and ASTARTE RO project -astarte-ro.infp. ro BIGSEES project - http://infp.infp.ro/bigsees/default.htm , cited by INFP, Source: http://tsunami.infp.ro/seismic.php - accessed 21.09.2023.

9.1.4 Vulnerability of the project to climate change

The vulnerability of the project to climate change was detailed in Chapter 6, Section 6.1.7.6.

9.1.5 Control and prevention measures

The project is designed according to all relevant codes and standards, presented in the previous sections, to withstand seismic events and potential impacts due to climate change, as well as physical hazards (floods, landslides, extreme storms).

A potential vulnerability is noted for the offshore section of the project, from the perspective of submarine structures.

To protect underwater structures, the following mitigation methods are considered:

- Bury the pipeline using dredging or trenching equipment capable of operating at a water depth of approximately 1,000 m;
- Protecting the pipeline by placing rocks, using a specialized chute vessel capable of operating at a water depth of approximately 1,000 m;
- Independent seismic analysis has been conducted by the Operator and confirmation that the design loading within the applicable ISO codes is valid.

9.1.6 Intervention and response plans in case of natural hazards

All potential risks (including natural hazards) associated with the Neptun Deep Project are identified and evaluated, and measures to prevent and/or reduce the risks and implementation methods are proposed. A description of the Emergency and Crisis Response Plan is presented in **Section 9.3**.

9.2 DESCRIPTION OF THE SIGNIFICANT NEGATIVE EFFECTS ON THE ENVIRONMENT DETERMINED BY THE VULNERABILITY OF THE PROJECT TO THE RISKS OF MAJOR ACCIDENTS

9.2.1 Identification of major hazards associated with the Neptun Deep project

Hazard identification and risk assessment is a necessary tool for accident prevention and control. The framework and minimum requirements for risk management are defined in the OMV Group's HSSE risk management standard.

The Neptun Deep project team will demonstrate a commitment to risk management by ensuring that risks are reduced to the lowest possible level (ALARP).

The design of project components must ensure that project-specific safety hazards are identified during process hazard analysis (PHA) sessions and that risk mitigation measures are put in place. The results of these assessments are recorded in the project's HSSE risk register. Process safety is an integral part of all design elements through the rigorous application of established processes and procedures, which includes the following tools:

- Design safety assessment
- Hazard Identification (HAZID)
- Environmental (Hazard) Identification (ENVID)
- Hazard and operability (HAZOP) studies
- Safety Integrity Level (SIL)
- Layer of Protection Analysis (LOPA)
- Gas dispersion modelling studies
- Bow tie analysis
- Failure mode effect analysis (criticality) (FMEA/ FMECA)
- Simultaneous Operations (SIMOP)
- Matrix of Permitted Operations (MOPO)
- Event tree / error tree
- Quantitative Risk Assessment (QRA)
- Project safety reviews
- Safety culture assessment

In terms of major environmental incidents, given that Neptun Deep is a natural gas development, there is less potential for a significant environmental incident (as defined by the EU Environmental Liability Directive 2004/35/C) following a process loss or event.

The HAZID study identified those potential hazards that have environmental consequences.

Primary disturbance conditions and hazardous events with significant environmental incident potential occurring offshore and onshore during drilling, construction, commissioning and operations include, but are not limited to:

Table 9.3– Categories of major accident hazards by onshore/offshore sections and project stages

Project stage	Location	Risk of major accident
Construction	Offshore	Release of unlit gas due to well blowout
Construction/ process	Offshore	Spill due to ship collision or fuel transfer activities
Process	Offshore	Release of unlit gas due to pipe rupture
Process	Onshore	Leakage of unlit gas at the measuring station
Process	Offshore	Fire and explosion at the Neptun Alpha production platform
Process	Onshore	Fire and explosion at the gas measuring station
Construction/ process	Offshore/ Onshore	Natural hazards (earthquake, extreme storms, floods/landslides)

Major accidents are those considered to have a significant impact on people or the environment. The term major accident is defined in *Law no. 165/2016 on the safety of offshore oil operations,* Article 2, point 3 as follows:

> "*Major accident means, in relation to an installation or a connected infrastructure*:
>
> *a) an incident involving an explosion, fire, loss of control of the well or a spill of oil, gas or hazardous substances which involves or has a significant potential to cause death or serious bodily injury;*
>
> *(b) an incident causing serious damage to the facility or connected infrastructure, involving or having a significant potential to cause death or serious bodily injury;*
>
> *c) any other incident leading to the death or serious injury of five or more persons who are on the offshore installation where the source of danger occurs or who are engaged in an offshore oil and gas operation in connection with the installation or connected infrastructure;*
>
> *(d) any major environmental incident resulting from the incidents referred to in points (a), (b) and (c).*
>
> *For the purposes of determining whether an incident constitutes a major accident under subparagraphs (a), (b) or (d), an installation that is normally unattended shall be treated as if it were supervised.''*

The Neptun Deep project demonstrates the owner's commitment to control and manage all potential risks by identifying hazards, assessing their likelihood and consequences, analysing their causes and implementing control measures to ensure that risks are eliminated or reduced to the lowest possible level (ALARP).

Elimination and/ or minimization of hazards are relevant approaches to risk management whenever technically, operationally, and economically feasible.

The hierarchy of risk control decision analysis and OMV Group's guiding principles for risk management are:

- All hazards can be identified, and all risks can be assessed;
- Eliminating a hazard is preferable to managing it;
- Prevention of a dangerous situation is preferable to its mitigation
- All risks can be managed so that they are reduced to a reasonable minimum;
- Risk management is everyone's responsibility.

The Neptun Deep facilities are designed to safely support the range of activities anticipated to take place there. Facility design has been incorporated to manage risks associated with operations towards ALARP.

The project implemented safety and environmental critical elements (SECE), which are safety barriers, as defined in Directive 2013/30/EU, "the purpose of which is to prevent or limit the consequences of a major accident *or whose failure could cause or substantially contribute to a major accident*".

SECEs fall into different categories depending on the type of functionality they provide:

- Prevention – System, structure, or equipment for the primary containment (pressure envelope) of inventories that have the potential for major accidents or for the primary support of other SECE. Measures designed to reduce the likelihood of a major accident event occurring (e.g. structural and/or containment integrity);
- Detection – System or equipment to detect that primary protective measures have failed, e.g. fire/gas/leakage detection;
- Control – Measures that are designed to minimize the consequences of the major accident event. Their role is to limit the escalation of the hazard and to control the extent, intensity or duration of the hazard (e.g. ESD, purge system, ignition source control);
- Containment – measures designed to mitigate the effects or consequences of the major accident event against personnel, the facility or environmental receptors (e.g. drains, PFP);
- Emergency response – Primary and secondary collateral damage minimization systems, e.g. local alarms, life protection systems including emergency communications and emergency power;
- Lifesaving – Systems that assist evacuation, evacuation, and rescue during an emergency; and
- Environmental Protection – Systems and equipment used to disperse and/or contain and recover releases that could cause major environmental damage.

9.2.2 Independent Verification

To meet the requirements of the EU Safety Directive, Laws 256/2018 and 165/2016 OMV Petrom (OMVP) appointed an independent verification body to ensure that the facilities are designed, built, commissioned, and operated in accordance with SECE and performance for onshore and offshore, thus ensuring major accident risks are properly managed, mitigated and independently verified to be ALARP.

- The independent verification plan includes the following elements of the Neptun Deep project:
- Domino and Pelican subsea production wells;
- Pipes, umbilicals, columns and flow lines (PURF);
- Subsea Production System (SPS);
- Neptun Alpha production platform;
- 30" Export Gas Production Pipeline (GPP) to shore;
- Onshore Natural Gas Metering Station (NGMS).

9.2.2.1 Verification limits

The regulatory requirement for independent verification applies to offshore installations, including associated pipelines. The requirements are mainly regulated by Law 165/2016 on the safety of offshore oil operations, which is based on the *European Directive 2013/30/EU on the safety of offshore oil and gas operations.*

The independent project verification requirement was proactively and voluntarily extended to include onshore installations under *Law no. 50/ 1991 on civil constructions and compliance verification,* which includes the Central Control Room (CCR) and NGMS up to the custody transfer station in the Transgaz network.

The independent project verification plan and verification scheme will apply to the entire integrated Neptun Deep facility.

9.2.2.1.1 Offshore

It is OMVP's policy to fully comply or, where appropriate, go beyond legal requirements, compliance requirements with national, European Union and international regulations. The requirement for independent verification of offshore installations, including associated pipelines, is mainly regulated by Law 165/2016 on the safety of offshore oil and gas operations, which is based on the European Directive 2013/30/EU on the safety of offshore oil and gas operations.

The following regulations apply to the design, construction, operation, and verification of offshore installations:

- Law 165/2016 Offshore Oil and Gas Operations. Note, this law represents the implementation in Romania of European Directive 2013/30/EU on the safety of offshore oil and gas operations.
- Law 256/2018 regarding some measures necessary for the implementation of oil operations by licensees in the offshore perimeter.
- Law 238/2004 regarding oil (including Order no. 8 of 12.10.2011 for wells)
- ACROPO Guidelines and Procedures.
- European Directive 2013/30/EU

The above regulations require the operator of an offshore facility to establish and implement an independent verification scheme (IVS) to ensure that safety and environmental critical elements (SECE) and the "production facility", i.e. a fixed installation of offshore gas production, as provided by Law 165/2016, meet the specified design and functional intent. Also, the above regulations specify that the IVS is implemented by a competent independent verifier.

9.2.2.1.2 Onshore

Seveso III Directive 2012/18/EU implemented under Law 59/11.04.2016 on the control of the dangers of major accidents involving dangerous substances establishes the rules for the prevention of major industrial accidents involving dangerous substances and for limiting the consequences of such accidents on human health and on the environment.

Under the Seveso III Directive, establishments carrying out industrial processes involving hazardous substances are subject to reporting requirements to the relevant national authorities of the Member States.

The total hazardous inventory, i.e., natural gas within the site's battery boundaries, is expected to be less than 50 tonnes, therefore the project does not fall under the SEVESO regulations. This mass criterion provided in Annex I, Part II to Law no. 59/11.04.2016 serves to identify dangerous units of lower level.

OMVP has decided to include onshore installations in an independent verification scheme against a set of SECE and performance standards to ensure a complete and robust verification of onshore installations, thus ensuring that there are no gaps between onshore installations and offshore.

Other pieces of legislation that have been identified as applicable to onshore installations include:

- Law no. 50/1991 ("Construction Law");
- Law no. 238/2004 ("Petroleum Law");
- GD no. 1043/2004 – for the approval of the Access Regulation to the National Natural Gas Transportation System and the Access Regulation to the Natural Gas Distribution Systems;
- Decision no. 1271/06.10.2004 of the former ANRGN (National Agency for Regulation in the Field of Natural Gases) - regarding the approval of the Framework Conditions of validity of the natural gas distribution license, the natural gas supply license and the operating authorization of installations/systems natural gas distribution, modified and completed by ANRE (National Agency for Energy Regulation);
- ACROPO guidelines and procedures (only onshore elements affected by the offshore installation);
- ANRE standards and guidelines;
- EU Directive 2013/30/EU.

9.2.2 Description of major accident scenarios

The exposures in this chapter focus primarily on the consequences and severity to environmental and public health receptors caused by potential accidental or unplanned events that have the potential to occur during the construction or operational phases, either onshore or offshore.

9.2.2.1 Release of unlit gas due to blowout at the probe

9.2.2.1.1 Scope

A sudden, uncontrollable release of well gas at reservoir temperature and pressure. A well blowout can occur at Neptun Deep wells during three different phases of operations:

- Production
- Well intervention
- Drilling

Production breakouts may occur at the Domino and Pelican subsea drilling centres, which are located approximately 36.5 km and 1.6 km from Neptun Alpha platform, respectively. An undersea blow-out can lead to the release of gaseous hydrocarbons (natural gas).Given the separation between the drilling centres and Neptun Alpha, any gas cloud will not reach the platform.

9.2.2.1. 2 Significance of potential impact

A blow out will result in the release of gaseous components into the marine environment and into the atmosphere. An analysis by gas plume modelling was performed for both drill centres as presented below.

a) Pelican gas plume dispersion modelling.

In the dynamic gas flow modelling for the Pelican, the following inputs were used:

Table 9.4– Gas plume dispersion modelling input data in case of an eruption at the Pelican well

Pelican Modelling Input Data
Water depth: 126 m
Flow rate at flare: 693.9 MMSCFD gas (693.9 MMSCFD ≈ 24,522,398.5 m³ of natural gas per day)
The gas release area and elevation assume the blowout is through the top of the BOP (ID - 18.75" and 10 m high)
Wind speed: 2 m/s, 5 m/s and 10 m/s
Water temperature at the surface – 10.3˚C
Water temperature at the bottom of the sea - 8 ˚C
Air temperature -12 ˚C

Results

- The first gas will come to the surface after 25.5 seconds. This means that the average vertical rise velocity of the gas in the water column is 4.5 m/s.
- The marine current is not expected to be a factor in moving the well centre plume due to the high gas rise rate and relatively shallow water depth.
- About 6.5% of the released gas will dissolve in the water column before reaching the surface.
- Concentrations 10% lower than the Explosive Limit (LEL) will spread over a radius of 45 m above the sea surface.

- Significant surface boiling is expected for modelled conditions extending to ~20m from the well centre with any operations conducted outside of any surface boils and continuous gas monitoring will occur.
- For relief well planning, the location of the platform surface will be at a radius outside the flammable exclusion zone, i.e., 1850 m from the centre of the well.

Modelling results for Pelican are illustrated in Figure 9.7 and Figure 9.8 below.

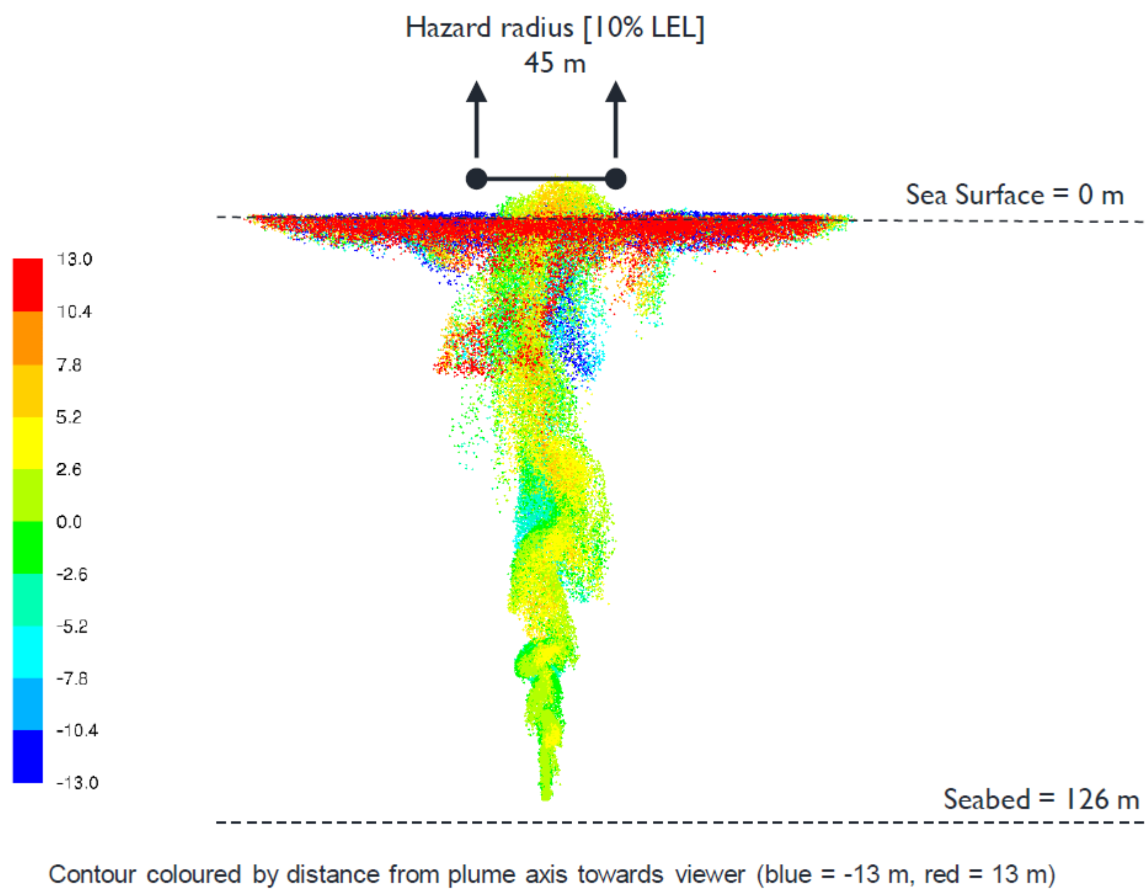

Figure 9.7– Pelican, Modelling of the gas plume as a result of an eruption at the probe (in the vertical column)

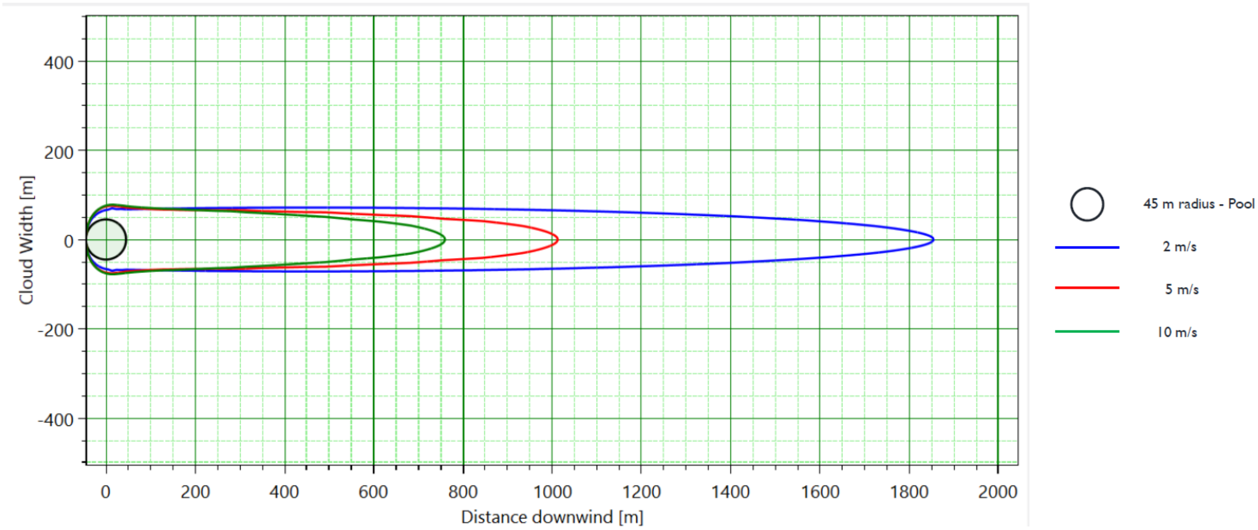

Figure 9.8– Pelican, Imprint of the gas bubble after the eruption, at the sea surface for the three wind speeds (2m/s; 5m/s; 10m/s)

b) <u>Domino gas plume dispersion modelling</u>

In dynamic gas flow modelling for Domino, the following inputs were used:

Table 9.5– Gas plume dispersion modelling input data in case of an eruption at the Domino well

Domino modelling input data
Water depth: 978m
Flow rate at flare: 1098.8 MMSCFD gas (1098.8 MMSCFD ≈ 38,765,192.2 m³ of natural gas per day)
The gas release area and elevation assume the blowout is through the top of the BOP (ID - 18.75" and 10m high)
Wind speed: 2 m/s, 5 m/s and 10 m/s
Water temperature at the surface – 10.3˚C
Water temperature at the bottom of the sea - 8 ˚C
Air temperature -12 ˚C

<u>Results</u>

- The first gas will come to the surface after 508 seconds. This means that the average vertical rise velocity of the gas in the water column is 1.9 m/s.
- About 95.3% of the released gas will dissolve in the water column before reaching the surface.
- Concentrations 10% lower than the explosion limit (LEL) will spread over a radius of 10 m above the sea surface; lower concentrations spread over a larger radius.

- For relief well planning, the location of the platform surface will be at a radius outside the flammable exclusion zone, i.e. 250 m from the centre of the well

The modelling results for Domino are illustrated in Figure 9.9 and Figure 9.10 below.

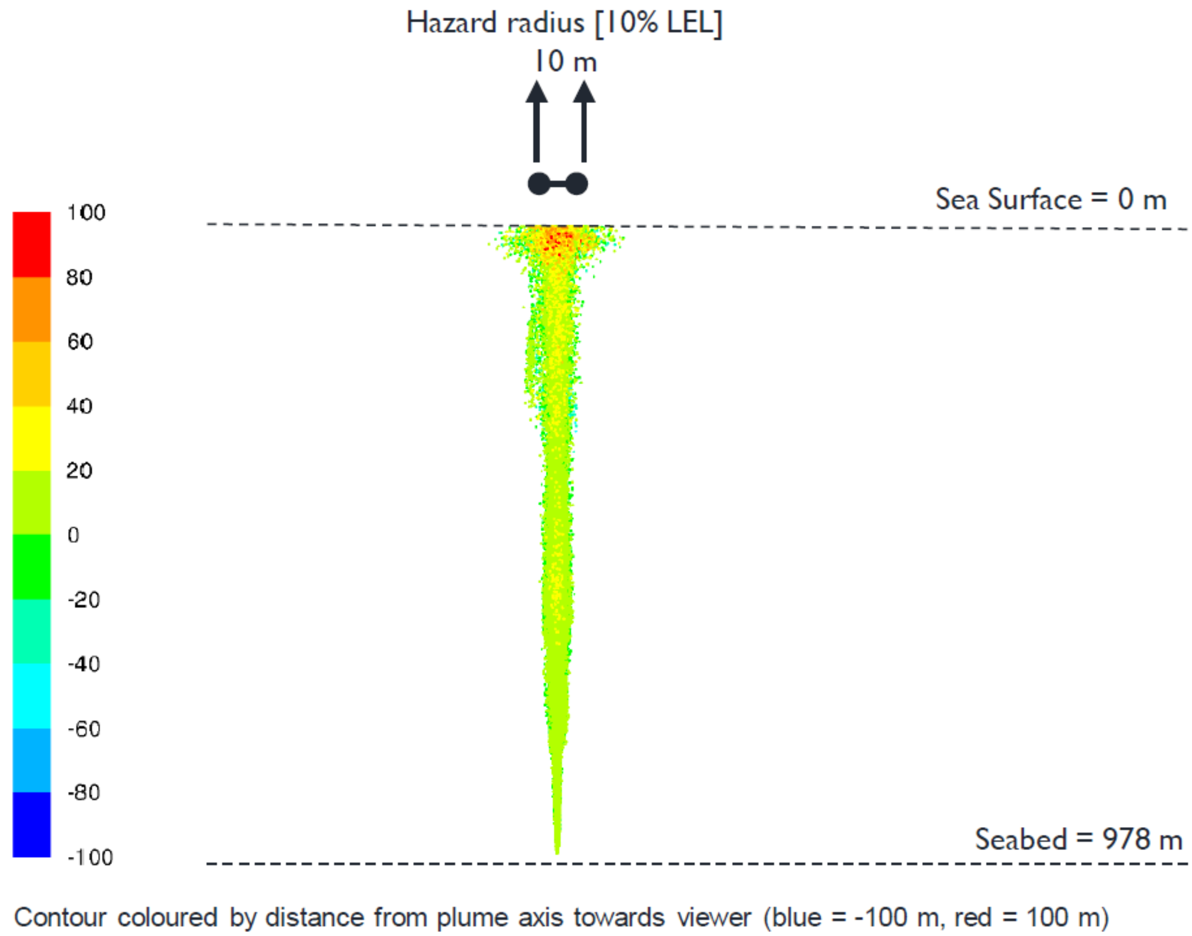

Figure 9.9– Domino, Modelling of the gas plume following an eruption at the well

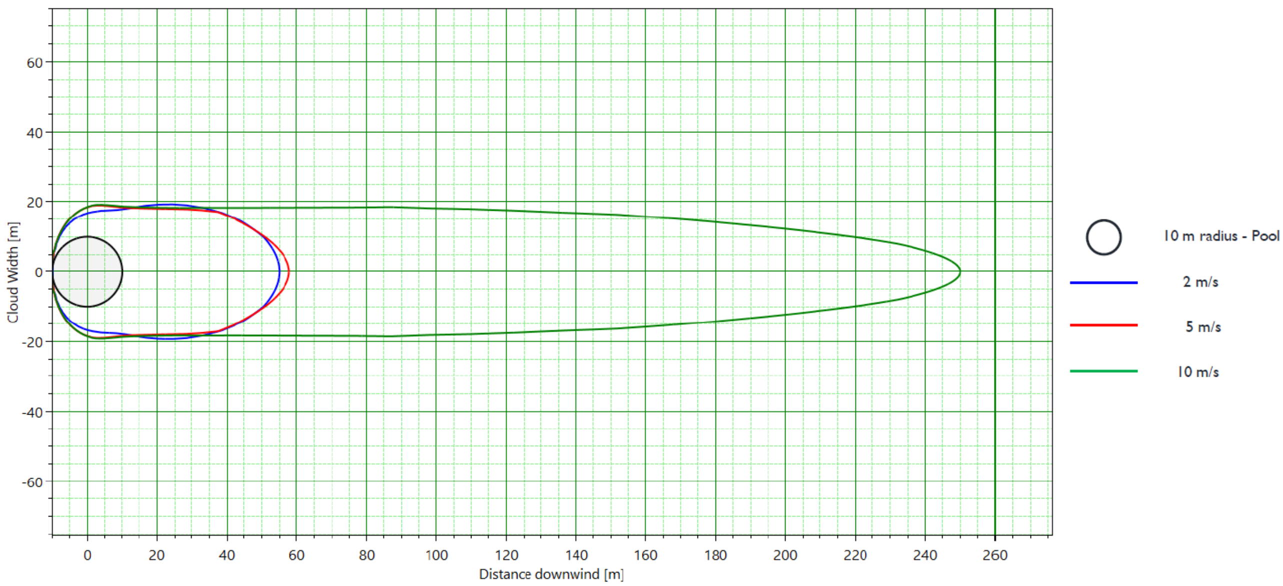

Figure 9.10– Domino, The imprint of the gas bubble after the eruption, at the surface of the sea for the three wind speeds (2m/s; 5m/s; 10m/s)

9.2.2.1.3 Effects on the environment as a result of a well blowout with unlit gas release

Because the Pelican and Domino subsea drilling centres are located at a distance from Neptun Alpha Platform, it is unlikely that the event will escalate beyond a large release of hydrocarbons. Thus, in the event of such an event, the structure, and possible staff at Neptun Alpha will not be affected.

The impact on the environment in case of an uncontrolled gas leak from the well, in the hypothetical case of loss of control over it, would be felt with negative effects on the marine ecosystem, located at the level of the water column. In general, the geometry of the gas bubble has a conical profile, with the tip positioned at the sea floor.

In the deep zone within the Domino drilling centre, most of the released gas quantity will dissolve in seawater, respectively 95.3% (Figure 9.5) compared to the shallow water zone in the Pelican South drilling centre, where only 6.5% will dissolve in seawater (Figure 9.3).

Adverse effects on water quality

Considering the water depth, pressure and temperature conditions of the water, any gas release in combination with the water may form hydrates localised around the release location - an ice-like solid substance. After formation, these hydrates rise through the water column and, upon reaching shallower water depths (depths above the hydrate formation line), decompose into methane and water. Because methane is highly soluble in water, it quickly dissolves in the water column after the hydrate breaks down. Most of the gas will freely disperse into the water column and will dissolve in water. Dissolved methane will biodegrade, while gaseous methane will continue to rise to the sea surface and be carried away by surface winds. The water produced by the dissociation of hydrates will disperse in the water column.

In a case study, water and sediment monitoring, as well as Eco toxicological analyses of fish, after the gas leak incident from the Elgin platform, North Sea, in 2012, led to unexpected results, i.e. no trace of contamination with hydrocarbons above the reference limits of the state before the incident[8].

Due to the pressure difference between the gas and the water column, contamination of the water column or sediment as a result of a loss of well control incident and uncontrolled release of hydrocarbons from the well is expected to be minimal and without long-term consequences.

Negative effects on marine species

Adverse effects will be felt by marine fauna differently depending on the area and time of exposure. Laboratory studies have shown that at concentrations of 0.02 - 0.05 mg/l, the gas will be sensed by fish and they will move away. Exposure of fish to concentrations higher than 1 mg/l leads to an increased sensitivity within a few seconds of contact, showing a behaviour of disorientation and immobility. Tests have shown that within 15 - 20 minutes, fish exposed to such concentrations show signs of acute intoxication and die within 1-2 days of exposure, juveniles being more sensitive than adult fish. Fish also become more sensitive if repeatedly exposed to low concentrations of the gas. Fish are more vulnerable when water temperatures are high (during summer) or when oxygen concentrations are low (as in a eutrophic estuary in summer). It has been found that species of zooplankton and phytoplankton can tolerate higher gas concentrations than can fish or crustaceans (i.e. they die at 2 - 5 mg/l) [9].

Field and experimental research on marine biota following the 1982 and 1985 incidents in the Sea of Azov, resulting from loss of control of gas wells followed by oil rig explosions, supports the previously described general pattern of fish response to the presence of methane and its counterparts in the aquatic environment.[10]

The results of these observations indicate the existence of a cause-effect relationship between the mass mortality of fish and the large amounts of natural gas introduced into the water after the accidents in the Sea of Azov (Patin, 1999, p.235-6).

It was found that fish from the accident areas developed significant pathological changes. In particular, they showed movement coordination disorders, weakened muscle tone, organ and tissue pathologies, damaged cell membranes, blood formation disorders, changes in protein synthesis, radical increase in total peroxidase activity and other abnormalities typical of acute fish poisoning.

[8]Webster, L., Russle, M., Hussy, I., Packer, G., Dalgarno, EJ, Craig, A., Moore, DC, Jaspars, M., Moffat, CF - Environmental Assessment of the Elgin Gas Field Incident – **Report 5,** Fish and Sediment Update; - **Report 4,** Fish muscles; **Report 3,** Water Update. – Marine Scotland Science Report

[9]Dr. Irene Novaczek " Environmental Impact of the Offshore Oil and Gas Industry," Watershed Sentinel, 2012, https://watershedsentinel.ca/articles/natural-gas-marine-environment/ accessed 09/12/2023

[10] Patin, Stanislav – Impact of Natural Gas on Fish and Other Marine Organisms, EcoMonitor Publishing, New York, 1999.

These pathological changes were found even in fish collected at a considerable distance from the accident site (Patin, 1999, p.233-9)

In addition to ichthyo-toxicological data, studies on the accidental blowout of gas wells in the Sea of Azov, provide an idea of methane pollution of the aquatic environment and the possible impact on benthic and pelagic communities. Methane accounted for more than 95% of the released gas. It was present in water in concentrations of 4-6 mg/1 directly near the well that lost containment control, and in concentrations of 0.07-1.4 mg/1 at a distance of 200 meters from the platform. These results suggest that methane and its counterparts can remain in the aquatic environment for quite a long time and can spread over considerable distances (Patin, 1999, 220-2, 224-31, 249).

More recent research [11], carried out in 2012 by Marine Scotland Science - Marine Laboratory, had as its object the sampling of 7 species of fish (*Gadus morhua, Melanogrammus aeglefinus, Pleuronectes platessa, Merlangius whiting, Microstomus kitt, Clupea Haringus, Scomber scombrus)* obtained from 6 sample locations located at a distance of 2 nautical miles (3.7 km) from the site of the gas loss incident from the Elgin platform, North Sea.

The aim of the study was to determine the concentration of PAHs and aliphatic hydrocarbons (including n-alkanes) in fish tissues by the GS-MS (Gas Chromatography Mass Spectrometry) method

The test results were compared to reference values, which were the results of tissue analyses from fish samples collected in the same area, in the year 1993.

The result of the samples analysed from the tissues of the fish taken around the exclusion zone of the Elgin platform, after the gas escape incident from the well, showed no evidence of a petrogenic contamination, with n-alkane and PAH concentrations, the values of the resulting concentrations being typical of reference samples. Benzo [a] pyrene was below the CE food safety level in all fish muscle samples and therefore there is no concern for human health. Aliphatic profiles showed no evidence of petrogenic contamination.[12]

Adverse effects on air quality

An uncontrolled release of gases in the shallow area of the Neptun Deep project, in the area of the South Pelican drilling centre, would have negative effects on the marine ecosystem in the surface water horizon. In such a hypothesis, gas discharged uncontrolled at the seabed, at a depth of 120 m, would rise to the sea surface, quickly reaching the surface water horizon (Figure 9.3).

In addition to the effects on the marine ecosystem described above, since natural gas consists mainly of methane, a negative effect on the atmosphere with an impact on climate change can also be considered in this scenario. The extent to which air quality could be affected, and implicitly the

[11]Webster, L., Russle, M., Hussy, I., Packer, G., Dalgarno, EJ, Craig, A., Moore, DC, Jaspars, M., Moffat, CF - Environmental Assessment of the Elgin Gas Field Incident – **Report 4,** Fish muscles; – Marine Scotland Science Report

[12]Webster, L., Russle, M., Hussy, I., Packer, G., Dalgarno, EJ, Craig, A., Moore, DC, Jaspars, M., Moffat, CF - Environmental Assessment of the Elgin Gas Field Incident – **Report 4,** Fish muscles; – Marine Scotland Science Report

contribution to the global climate crisis, depends on the total amount of gas ultimately released into the atmosphere.

In another case study, namely the major accident that occurred in September, 2022 at the Nord Stream 1 and 2 pipelines located in the Baltic Sea, it was estimated that more than 115,000 tons of natural gas escaped from the damaged pipeline in just six days, with a greenhouse gas contribution of about 15 million tons of CO_2 - or the amount of carbon that can be absorbed by about 580 million trees in a year.

According to the Leibniz Institute for Baltic Sea Research Warnemünde (IOW), the influence of the Nord Stream gas pipeline leaks on climate change is relatively small[13].

9.2.2.1.4 Proposed control measures

Inherent safeguards are based on a philosophy: 1) prevention, 2) detection, and 3) control.

In terms of preventing a major blowout accident, the well barrier envelope is defined by its pressure containment boundary and identifies a primary and secondary barrier to all potential flow paths.

Barrier casings for primary and secondary wells comprise several barrier elements as follows:

- Critical valves that include surface-controlled, retrievable underground safety valves (TRSCSSSV) conforming to API 14A and wellhead valves, remotely controlled, conforming to API 14D and IOGP S561.
- During production, the Well Integrity Management System specifies the well's critical barriers, their components, test criteria and revalidation period;
- The drill strings and tubing are a critical part of the well barrier. They are designed according to the OMV technical requirements for the design of casing pipes and are in accordance with the Drilling Manual developed for Neptun Deep.
- Primary cements are designed and executed in accordance with OMV technical requirements for cementing engineering, which are aligned with relevant international standards.
- All borehole barrier elements are tested in accordance with the OMV Borehole Engineering Technical Standard.
- The well design and drilling program will be independently verified and approved by an independent well expert certified by ANRM.
- The subsea wellhead equipment is designed to ensure that pressure build-up in the *A-ring* (thermal expansion, etc.) can be safely removed without the risk of hydrate formation. The well design ensures that either there are no trapped fluid volumes or that the design of the drill strings is adequate to control the worst-case pressure build-up.
- Equipment and drill string/tubing containing process hydrocarbons are fully evaluated for operating conditions (pressure and temperature) and have undergone rigorous design.
- Equipment and drill string/tubing were selected based on process fluids and operating conditions, including the use of corrosion resistant alloy as required.

[13]Sanderson H. et al – Environmental impact of Nord Stream pipelines, Research Square, February 2023

- External corrosion protection (cathodic) and coatings are provided for outfitting seabed wells where required.
- Routine inspection, maintenance, and monitoring programs according to the Well Integrity Management System (WIMS) and the Subsea Systems Integrity Management Strategy (SSIMS), including the well examination scheme.
- Effective standard operating procedures and trained/experienced operators are used in operations.
- The well head will be equipped with independent sensors and controllers. This includes temperature and pressure monitoring and provides for operator action in the event of an emergency.
- Well capping stack will be available during the drilling/well construction phase for well control contingencies.

Regarding gas leak detection:

- Detection of low pressure (leaks) in upstream XMT with automatic action.
- ROV to locate and determine the size of any suspected leak will be undertaken.
- Real-time monitoring (pressure, temperature, flow, water content, composition, etc.) will be performed to ensure operations remain within prescribed limits. Deviations from the prescribed limits can and should initiate various actions, from individual well shutdown to total shutdown of the field(s).

9.2.2.2 Accidental fuel pollution as a result of a collision event / or refuelling of ships

9.2.2.2.1 Scope of the assessment

The transport and traffic of several vessels associated with the project could create a hazard for maritime traffic. In total, a maximum of 14 vessels will be used during offshore drilling and construction activities. However, the ships will not be present in the same area at the same time.

A moderate leakage of hydrocarbons could occur as a result of the movement of ships and/or support barges for various activities during the course of the project, resulting in:

- Drilling/Construction/Installation Support: Fuel spills from support vessels.
- Field Support: Fuel spills from activities involving field support or construction vessels.

A 500m safety zone will be maintained around the drilling rig and construction areas, therefore a collision with a vessel not associated with the project is considered unlikely.

During the drilling phase, drilling chemicals are temporarily stored on the MODU for use in drilling fluids and cement, with mixing taking place in on-board mud tanks. Chemicals will be stored on board the drilling rig in closed tanks and therefore the risk of chemical spills is kept to a minimum.

However, the risk of spillage of hazardous materials/chemicals into the sea may occasionally occur while chemicals are being mixed or due to improper storage and handling practices.

Other potential sources of spills may occur during chemical transfer, storage and use activities. This scope also covers all phases of the project and mitigation measures will be applicable for the duration of the project.

9.2.2.2.2 Significance of potential impact

For the case of marine fuel pollution, two credible scenarios were analysed, consisting of the following:

- an accidental pollution from the installation vessel, which led to the release of 300 m^3 of marine diesel oil (MGO); and
- a MODU leak that resulted in the release of 165m^3 MGO.

Two simulations were run for each of the 2 accidental pollution scenarios (table 9.8), with a total of 150 individual trajectories post-processed for each season, to create a stochastic output. Each trajectory started with different starting data, so each simulation has a different set of wind and current conditions as input data.

A summary of the results is presented in the table below:

Table 9.6– Summary of stochastic scenario modelling data

Script references	Scenario 1	Scenario 2
Description	Accidental pollution from the platform installation ship	Accidental pollution from the drilling rig (MODU) – the worst credible scenario
Location	44° 02' 51" N 030° 35' 14" E	44° 03' 19" N 030° 35' 56" E
Period/ season	Winter – October – May; Summer – June – September	Winter – October – May; Summer – June – September
Discharge depth	0m (surface horizon)	0m (surface horizon)
Discharge rate	300 m^3/hour	41.25 m^3/hour
Duration of discharge	1 hour	4 hours
The total volume of the spill	300 m^3 -	165 m^3
Total spilled mass	264 MT	146 MT
Total run time	14 days	14 days
The diameter of the hole	N/A	N/A

Script references	Scenario 1	Scenario 2
Gas/oil mixture (GOR)	N/A	N/A
MGO temperature	in winter - 11.6°C summer - 23.6°C	in winter - 11.6°C summer - 23.6°C
Total number of trajectories	150	150
Time between trajectories	8 days, 2 hours	4 days, 1 hour
Nearest shore	~117 kilometres, Sf. Gheorghe, Romania	~117 kilometres, Sf. Gheorghe, Romania

Metocean data

Five sets of hydrodynamic data were used as input to the modelling, as shown in the table below:

Table 9.7– Metoceanic data included in the modelling

ice data		
datasets	**Sea currents** - Black Sea Physics Reanalysis	**wind** - CFSR
Resolution space	3 km	16 km
Temporal resolution	24 hours	1 hour
Period	May 2015 – May 2020	May 2015 – May 2020
Number of vertical layers	31	1

Black Sea dataset ***Physics Reanalysis*** for ocean currents was selected as the most suitable option for modelling. Covering only the Black Sea, this hydrodynamic model is optimized for the local area, which provides more confidence in the data, providing an accurate representation of real-world conditions.

Establishing thresholds

Thresholds define the point below which the data is no longer informative. For example, when the thickness of the surface emulsion is less than 0.04 µm, the hydrocarbon film is no longer visible to the naked eye, so it can be considered insignificant. The thresholds applied to this simulation are shown in the table below.

Table 9.8– Thresholds included in modelling

Threshold	Value	Description
Surface	0.04 µm	The Bonn Agreement on the Hydrocarbon Colour Code (BAOAC) defines five oil layer thicknesses based on their optical effects and actual colours. 0.04 µm is the minimum thickness that can be seen with the naked eye.
Shore line	0.1 litres/m^2	The lowest threshold for light oil shore coverage. According to the ITOPF

Threshold	Value	Description
		document "Recognition of oil on shorelines"[14]. It is assumed that a concentration of 0.1 litres per square meter is the lethal threshold for invertebrates on hard substrates and sediments in intertidal habitats. Shore coverage greater than 0.1 litres/m^2 would be sufficient to cover individuals of the invertebrate species and affect its survival and reproductive capacity[15]

To highlight the thickness of the emulsion layer on the sea surface, the colour code according to the Bonn Agreement was used. At the same time, the colour code regarding the shoreline maps derives from the ITOPF Technical Information Document (TIP) no. 6 "Onshore Oil Reconnaissance" (ITOPF, 2011b). Slight landfall of the film is considered insignificant to ITOPF6, no practical response is required for a very lightly landfall, other than monitoring the oil spill.

Results and discussion

All model outputs were created with thresholds applied. Thresholds are used to present information that is significant, either in terms of spill response or environmental impact.

For ease of reading, the discussion below focuses on scenario 1, many of the comments are applicable to scenario 2 as well.

Scenario 1 - Accidental discharge from the platform installation vessel (conservative case)

The results of the stochastic modelling show that, in most situations, the impact on surface waters will remain in Romanian waters. About ¼ of the simulations (winter 25%, summer 21%) also resulted in surface oil passing over the sea border to Bulgaria.

The surface film could be found up to about 100 km away in most directions, apart from a small number of situations where environmental conditions allow the surface film to persist long enough to be transported to the southwest. This is more pronounced in the summer season.

The oil slick is expected to reach the Bulgarian sea border in about 1 day at the earliest. It should be noted that this is the fastest impact among the 150 simulations per season performed. Other simulations will either not affect at all or take more than 1 day to reach the sea border of Bulgaria.

In most simulations, there is no hydrocarbon film on the water surface, present after 7 days. Only a few simulations show that the hydrocarbon film persists beyond 7 days, these are the ones moving to the southwest.

[14]ITOPF 2011b, The International Tanker Owners Pollution Federation Limited (ITOPF) (nd.) ' Technical Information Paper 06: Recognition of oil on shorelines ', accessible online via: https://www.itopf.org/fileadmin/uploads/itopf/data/Documents/TIPS_TAPS_new/TIP_6_Recognition_of_Oil_on_Shorelines. pdf

[15] French-McCay, Deborah. (2009). State-of- the - Art and Research Needs for Oil Spill Impact Assessment Modeling. Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response. 2.

As one moves away from the immediate release zone, the thickness of the hydrocarbon layer is expected to spread to layers of metal thickness (5-50 µm) or less.

Surface waters near the Canionul Viteaz, protected natural area, are affected in 71% of the simulations. The simulation results show that in the winter season scenario, the hydrocarbon film reaches the Canionul Viteaz area in approximately 3 hours.

The impact on this site was further explored with additional trajectory simulations. It should be remembered that "impact" is considered to occur when the surface hydrocarbon film exceeds the silver gloss threshold - 0.04µm.

A small number of south-westerly impinging simulations reached the shoreline when the simulation was run for more than 14 days. However, it should be noted that this modelling assumes that no intervention or response actions are used. In reality, actions would have been taken to mitigate the effects of the spill during the intervening 14 days.

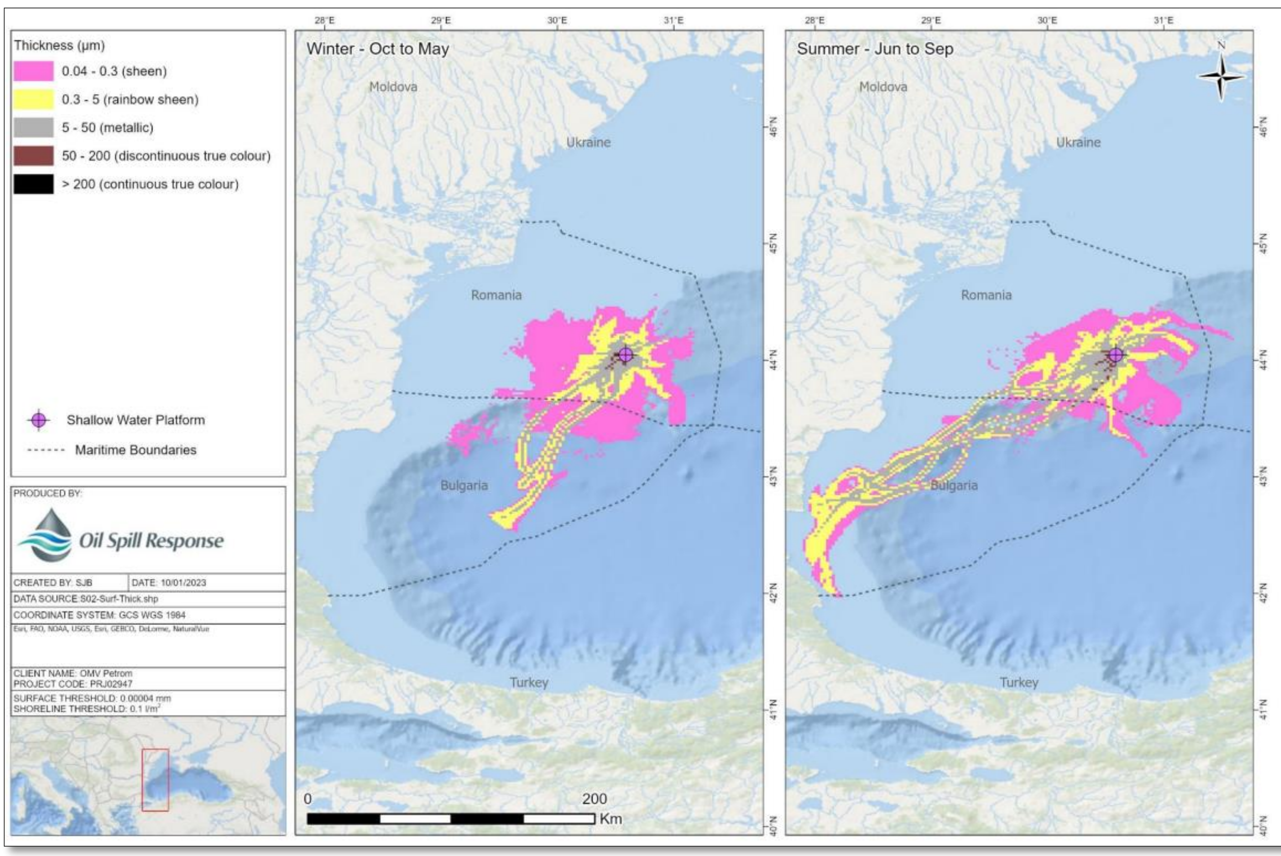

Figure 9.11– Scenario 1 modelling (conservative case) the winter period (left), and the summer period (right), without intervention of response procedures in case of accidental pollution (no metoceanic influence considered)

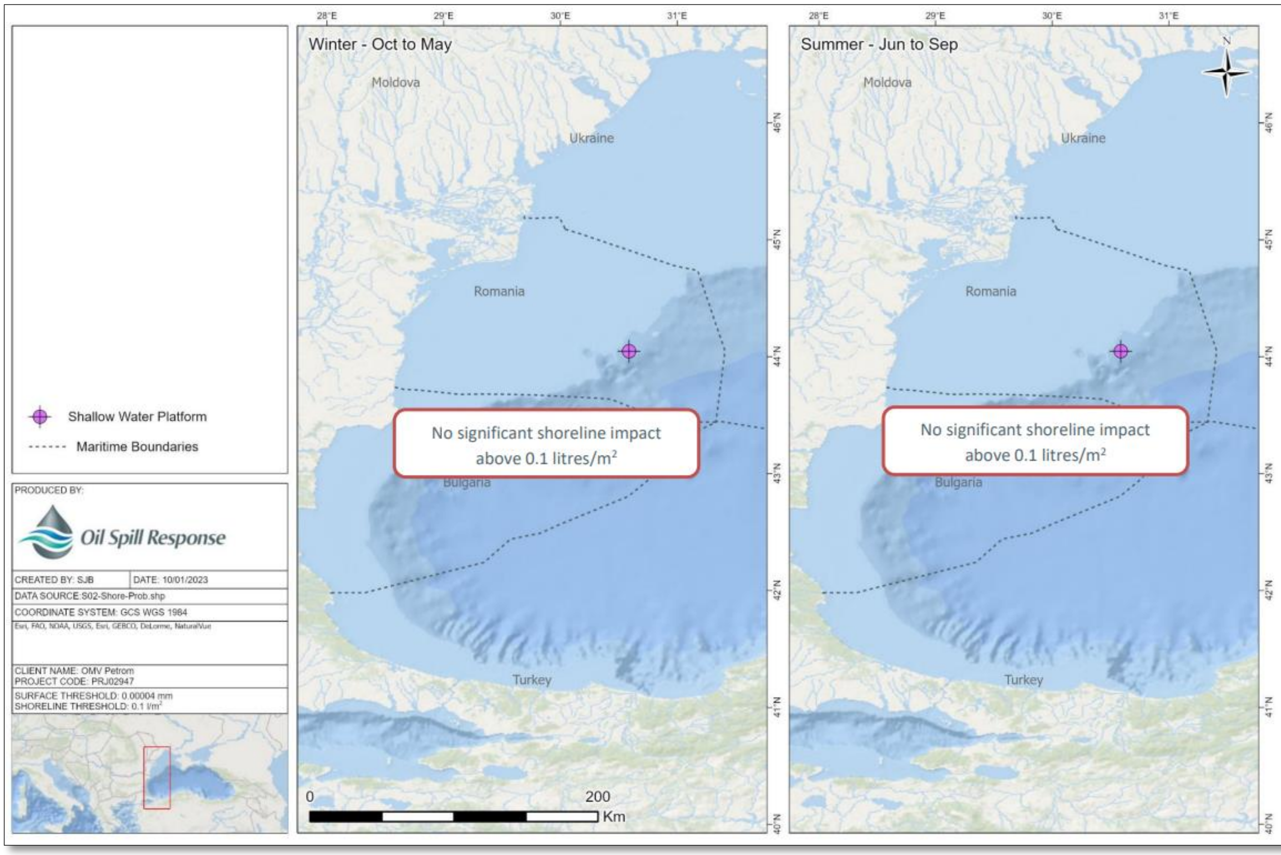

Figure 9.12– Modelling <u>(conservative case)</u> of the condition of the fuel film in winter (left) and summer (right)

<u>Scenario 2 – Accidental spill from drilling rig</u>

Scenario 2 simulates a similar but smaller release of MGO from the drilling rig. The overall results of the stochastic models are very similar to those of scenario 1. The above discussion of the effects of a spill in scenario 1 are also applicable to scenario 2.

<u>9.2.2.2.3 Negative effects on the environment</u>

Accidental fuel pollution as a result of mishandling during navigation, docking or refuelling of the drilling unit or platform installation vessel can lead to a greater or lesser imbalance in marine ecosystems, depending on the type and quantity of hydrocarbons accidentally spilled.

Marine Gas Oil (MGO) is a non-persistent fuel oil and contains a small proportion of heavy components (or low volatility components) that tend to be physically entrained in the upper water column in the presence of moderate winds (i.e. >12 knots) and of breaking waves, but may float to the surface if these conditions are reduced. In the case of a substantial spill, heavier components may be entrained or remain on the sea surface for a long time (no more than 7 days, as indicated by film condition modelling).

MGO spreads rapidly and forms a very thin film, with most volatile components typically evaporating in less than a day. About 41% of the spilled mass is estimated to evaporate in the first two days, depending on prevailing wind conditions, with subsequent evaporation slowing over time. The heavier (low volatility) components of the oil tend to be entrained into the upper water column due to wind waves but may reappear later depending on conditions[16].

Adverse effects on water quality

Studies[17]on the effects of accidental hydrocarbon spills have concluded that the extent of damage caused by a spill accident in seawater depends on the extent and area of the spill, the chemical composition of the spilled fuel, the climatic conditions, the remedial measures and the response time.

Commonly used accidental pollution response methods include mechanical containment and recovery, in- *situ incineration,* use of absorbent materials, bioremediation, and application of dispersants, as appropriate.

Within the water column, small hydrocarbon droplets undergo further processes such as biodegradation, dissolution and eventually sedimentation, if the biodegradation phenomenon predominates[18].

The opinion of the authors of a study [19]on the physical and chemical processes of hydrocarbons in the seawater column is that, given the nature of the petroleum hydrocarbon, which has a relatively high content of paraffin wax (29.32%Wt), it tends to be in the form of small droplets, forming a film on the surface of water and does not mix or dissolve in water. Biodegradation can reduce up to 60% of the spilled volume. The photochemical process can transform the spilled volume of hydrocarbons by up to 50%. Of the total amount spilled, in exceptional situations, when the spill involves a very large amount of hydrocarbons, some of the weathering hydrocarbon film on the surface of the water can be washed along the coast (Passow and Overton, 2021). High air temperatures and sea breeze speeds can increase oil degradation (Lindgren and Lindblom, 2004). This natural process can reduce the volume of oil spilled into seawater (Wang et al., 2016).

[16]RPS 2019d. WEL Scarborough development Quantitative Spill Risk Assessment – Preliminary Results. Prepared for Advisian on behalf of Woodside Energy Ltd. RPS Group.

[17] Gracia, A., Murawski, SA, Vázquez-Bader, AR (2020). Impacts of Deep Oil Spills on Fish and Fisheries. In: Murawski, S., et al. Deep Oil Spills. Springer, Cham. https://doi.org/10.1007/978-3-030-11605-7_25

[18]Emmanuel Sunday Okeke, Charles Obinwanne Okoye, Timothy Prince Chidike Ezeorba, Guanghua Mao, Yao Chen, Hai Xu, Chang Song, Weiwei Feng, Xiangyang Wu, " Emerging bio-dispersant and bioremediation technologies as environmentally friendly management responses towards marine oil spill " A comprehensive review, Journal of Environmental Management, Volume 322, 2022, 116123, ISSN 0301-4797, https://doi.org/10.1016/j.jenvman.2022.116123 .

[19] Daly, KL; Passow, U.; Chanton, J.; Hollander, D. Assessing the impacts of oil-associated marine snow formation and sedimentation during and after the Deepwater Horizon oil spill. Anthropocene **2016,** 13, 18–33.

At the same time, microbial degradation is added to these processes, which is a natural process by which microorganisms consume and degrade hydrocarbons. These microorganisms, such as bacteria, are present in all areas of the water column in unlimited numbers, but their growth rate may be limited by the nutrients available in the water column (Adofo et al., 2022).

Although a spill of any type of oil into the sea can cause irreversible damage to the environment, the consequences of oil pollution depend largely on its specific properties.

Thus, distillate fuels, such as MGO, tend to evaporate and dissolve faster than marine fuel with a predominant fuel oil content (Heavy Fuel Oil – HFO) and does not emulsify on the surface of the ocean[20]. In contrast, HFO demonstrates a strong tendency to rapidly solidify and form tar clumps in marine waters. This not only results in a significant increase in the volume of waste to be handled in the event of a spill, but also makes HFO more persistent in the environment[21].

For example, a study commissioned by the Arctic Council determined that while 90% of HFO remains in the ocean after 20 days, MGO can take up to three days to disappear from the surface[22].

In a case study[23], the evolution in the marine environment of an accidental diesel spill (1000 litres) from the Faraday Research Station, Galindez Island, Antarctica was monitored in March 1992. On the day following the incident, water concentrations of high reached a maximum of 540µg 1-1 for *n-alkanes* and 222µg 1-1 for polycyclic aromatic hydrocarbons (PAH). However, concentrations returned to local background levels within a week. The diesel spill itself had a very minor, localized and short-term impact on the Antarctic marine environment.

The opinion of researchers in another case study from the coast of Karawang, Indonesia (2022) [24], based on investigations and laboratory tests, is that, in general, seawater quality is not affected in the long term by hydrocarbon spill events, conclusion based on results of offshore and coastal water monitoring during a period of four months after the pollution event (July – October 2019). Based on the results of the laboratory analyses at the sampling site located 1km away from the spill area, at an interval of 3 weeks from the date of the event, it was possible to appreciate that the presence of a slight film on the surface of the sea does not have a significant effect on the general state of water quality, because all parameters related to hydrocarbons, such as PAH, TPH, phenols, detergents (MBAS), petroleum product, comply with the quality standards and even the concentration is below

[20] Det Norske Veritas, Heavy fuel in the Arctic (Phase 1), Report No./DNV Reg No.: 2011-0053/ 12RJ7IW-4 Rev 00, 2011-01-18, at 38 (2011

[21] Deere -Jones, T., Ecological, Economic and Social Impacts of Marine/ Coastal Spills of Fuel Oils (Refinery Residuals), at 7 (2016)

[22] Det Norske Veritas, Heavy fuel in the Arctic (Phase 1), Report No./DNV Reg No.: 2011-0053/ 12RJ7IW-4 Rev 00, 2011-01-18, at 38-39 (2011)

[23] Cripps, GC, Shears, J. The Fate in the Marine Environment of a Minor Diesel Fuel Spill from an Antarctic Research Station. Environment MONITORING Assess 46, 221–232 (1997). https://doi.org/10.1023/A:1005766302869

[24] Hefni Effendi, Mursalin Mursalin and Sigid Hariyadi, Rapid water quality assessment as a quick response of oil spill incident in Coastal area of Karawang, Indonesia, Front. Environment. Sci., 20 May 2022, Sec. Conservation and Restoration Ecology, Volume 10 - 2022 | https://doi.org/10.3389/fenvs.2022.757412 , accessed on 23.09.2023.

the detection limit. This situation can be attributed to the rapid response efforts in the form of prevention through the installation of dams and skimmers, in the shortest time after the occurrence of the accidental spill of hydrocarbons. The consequence of this effort significantly reducing the volume of hydrocarbons reaching coastal waters.

Negative effects on sediments

Due to the depth of the water in the area of the drilling centres, based on the modelling predictions, a change in the quality parameters of the sediments in the offshore project area, as a result of the release of hydrocarbons to the surface, is unlikely.

However, a potential spill originating in the shallower waters of the project area could result in entrained hydrocarbons contacting marine sediments, although this is unlikely given that MGO is typically entrained in the surface horizon, respectively ~10m of the water column, subject to the action of waves and wind.

The result of a small number of south-westward impact simulations from the modelling undertaken for the Neptun Deep project shows that, in the absence of any intervention, there could be the potential for exposure to shallow waters and contact with the Bulgarian shore. Contact with the Bulgarian shore could take place after 14 days, but without impact, the surface hydrocarbon film being below the silver sheen threshold - 0.04µm.

However, where film exposure to sediments may occur, hydrocarbon compounds may accumulate in marine sediments. As these will be at low levels over relatively small areas, this will not lead to changes in sediment quality such that there are adverse effects on biodiversity, ecological integrity, social integrity, or human health.

Negative effects on marine biodiversity

In case of an operational pollution in the offshore location area of the project, the immediate impact would be felt on the aquatic organisms that populate the area where the hydrocarbon film moves.

As a result of the change in water quality, it is expected that the fauna with increased mobility will undergo changes in behaviour, in the sense of avoiding the area affected by the spill, an aspect that leads to the exclusion of the affected surface from the area of feeding, reproduction, migration, etc., for the period of the pollution will persist.

At the same time, the sudden change in water quality can lead to additional effects on receptors, which include injury or mortality of marine fauna, as a result of two routes of exposure:

- exposure in water to entrained or dissolved hydrocarbons for marine fauna present in the water column
- exposure to surface hydrocarbons for those species that breathe, feed or are otherwise present at the sea surface

Several marine species in the water and on the shore (migratory, threatened and/or listed in the standard forms of coastal natural protected areas), have the potential to be present within the area estimated to be affected by surface oil, being exposed to different impact thresholds, depending on the specific sensitivity to exposure to hydrocarbons.

Exposure to the surface film poses the greatest risk to wildlife and seabirds as a result of contact with the hydrocarbon film or inhalation of VOCs. The result can lead to skin and eye irritation or damage to the respiratory systems (Etkins, 1997; Kirwan and Short, 2003), or fouling of the feathers of seabirds (O'Hara and Morandin, 2010).

As such, particular values and sensitivities with the potential to be affected by surface hydrocarbon exposures are:

- planktonic communities (phytoplankton and zooplankton)
- pelagic fish species
- seabird species, as a result of affecting the specific food
- marine mammals

Moderate doses of hydrocarbons have been shown to decrease the photosynthetic activity of algae and phytoplankton. Laboratory studies attest to the fact that a percentage of mortality of 100% can occur at a concentration of 0.0001-1 ml/l, the degree of resistance being different from one species to another, conditioned by the exposure time and the type of oil product.

Some zooplankton species, various microorganisms, bacteria, etc., can consume or absorb certain amounts of hydrocarbons from polluted areas. Laboratory studies attest to the fact that in concentrations of 0.001ml/l, oil and oil products can accelerate the death of zooplankton organisms or lead to a reduction of their survival capacity in proportion to 20% of the tested echelon.

Thus, the influence of an operational pollution could be felt at the level of the change in the species component of the planktonic populations and the reduction of their biomass, but the change is temporary, taking into account the ability of the planktonic communities to reproduce and repopulate the affected areas with species from neighbouring, unaffected areas.

It has been proven that the tissues of many marine organisms can retain some fractions of spilled hydrocarbons for a long time. In the body of fish and other marine organisms, these fractions are transformed into various substances by metabolic processes (Schneider 1976; Neff and Anderson, 1981). The concentration of hydrocarbons in their body increases more when these creatures feed on microorganisms contaminated with hydrocarbons, in such cases a higher mortality rate is recorded.

Mortality in fish due to accidental marine fuel pollution has rarely been observed (Lopez et al., 2021)[25]. This fact has been attributed to the ability of pelagic fish species to detect and avoid surface waters below oil spills, swimming in deeper waters, or away from affected areas. Fish that have been exposed to dissolved aromatic hydrocarbons are able to eliminate toxic substances introduced into seawater, therefore individuals exposed to a spill are likely to recover (King et al., 1996).

Where fish mortality has occurred, spills (resulting from the 1978 Amoco Cadiz and 1969 Florida tank spill incidents) have occurred in sheltered bays. In addition, laboratory studies have shown that adult fish can detect hydrocarbons in water at very low concentrations, and large numbers of dead fish have rarely been reported following oil spills (Hjermann et al., 2007). This suggests that juvenile and adult fish may avoid water contaminated with high concentrations of hydrocarbons.

Hydrocarbons entrained in the water mass as dispersed insoluble droplets pose a hazard to marine life (e.g., juvenile fish, larvae, and plankton) through direct ingestion or consumption of contaminated prey. Therefore, following the trophic chain, they can feel influential also on marine mammals, but specialist studies have not indicated a demonstrated effect (Geraci, 1990). Given the mobility of marine mammals, no chronic impacts or risks are expected as this fauna is unlikely to suffer prolonged exposure.

Although the potential for acute exposure is widespread, the interaction of mobile marine fauna with surface oil is expected to be limited, as wave action and temperature will limit the duration of exposure.

Potential effects, which could include mortality or sub-lethal injury/disease to pelagic fish, are expected to affect a small proportion of the resident and transient population given the characteristics of hydrocarbons (especially MGO), rapid film weathering below impact thresholds, as well as the degradation of the entrained fractions, along with the transient mobile nature of the fish. As such, unplanned oil spills are not expected to have a substantial adverse effect on the population or spatial distribution of fish or substantial alteration, destruction, or isolation of an area of important habitat for migratory species.

Potential exposures in an accidental liquid hydrocarbon pollution event are therefore expected to have acute effects on a small number of individuals but are unlikely to affect the viability of local populations.

Since the worst-case scenario modelling result shows that the hydrocarbon film that would reach the shore is below the 0.04 µm threshold, being below the minimum thickness that can be seen with the naked eye, no exposure to feeding species is expected, they breed, nest or are otherwise present on shore.

Effects on seabird and migratory bird species

[25] Jose Ramon Bergueiro López, José Manuel Calvilla Quintero, Kevin Soler Carracedo, Eloy Calvilla Quintero, George Zodiatis, Chapter 9 - Decision support tools for managing marine hydrocarbons spills in the island environments, Editor(s): Oleg Makarynskyy, Marine Hydrocarbon Spill Assessments, Elsevier, 2021, Pages 289-356, ISBN 9780128193549, https://doi.org/10.1016/B978-0-12-819354-9.00008-9 .

Alteration of water and sediment quality indicators as a result of accidental pollution may result in a change in behaviour or injury/mortality of waterfowl. Birds are particularly vulnerable to contact with hydrocarbons, due to the impregnation of the plumage, which leads to hypothermia as a result of the loss of insulation, but also intoxication as a result of the ingestion of hydrocarbons when they try to clean their plumage. Both situations can lead to the mortality of the affected birds[26].

Biological exposure routes that may have an impact may occur through ingestion of contaminated fish (nearshore waters) or invertebrates (intertidal foraging areas such as beaches) Ingestion may also result in internal damage to sensitive membranes and organs[27].

Whether the toxicity of ingested hydrocarbons is lethal or sub-lethal will depend on the stage of film disintegration and its inherent toxicity. Exposure to hydrocarbons can have long-term effects, impacting population numbers due to reduced reproductive performance, malformed eggs and chicks, as well as affected survival and loss of adult birds.

When first released, MGO has a higher toxicity due to the presence of volatile components, so birds that encounter the source of the spill at the time of the spill may be affected.

The presence of birds is more concentrated in the coastal area, than in the offshore area where the Pelican Sud, Domino drilling centres and the Neptun Alpha production platform are located. Therefore, in the hypothetical case of accidental oil pollution as a result of a major accident in the offshore area of the project, the potential to affect birds is limited, and it is possible to have a greater impact if the accident occurs in the coastal area.

Although the presence of birds may occur throughout the Neptun Deep project area, it is unlikely that large numbers of birds will be affected at the sea surface, above the impact thresholds, because in most simulations, there is no hydrocarbon film on the water surface, the presence after 7 days.

Potentially affected nearshore waters are used by waterfowl. Although seabird species may travel long distances offshore to feed, during the breeding/nesting season they tend to feed in nearshore waters near breeding colonies. In this case, exposure of beaches to hydrocarbons as a result of accumulation in sediments may also affect nesting females, hatching eggs and emerging chicks through direct contact with the hydrocarbon.

The conservative modelling carried out in the case of Scenario 1 (worst case scenario) presented previously, predicts reaching the shore in a non-representative number of simulations, out of the 150 run, after 14 days in the hypothesis in which no means of response is intervened. However, the contact with the shore will be below the impact threshold, respectively the film below the 0.04 µm threshold, and the amount of hydrocarbons below the 0.1l/m ^{2} threshold.

[26]Hassan, A., Javed, H. 2011. Effects of Tasman Spirit oil spill on coastal birds at Clifton, Karachi coast, Pakistan. Journal of Animal and Plant Sciences 21: pp333–339.

[27]International Petroleum Industry Environmental Conservation Association. 2004. A guide to oiled wildlife Response planning (IPIECA Report Series No. 13). International Petroleum Industry Environmental Conservation Association, London.

Negative effects on the integrity of protected natural areas

The trajectory modelling performed for Scenario 1 (worst case scenario) shows that the plume moves initially to the southwest and then curves to the northwest, affecting the surface ROSCI0311 Canionul Viteaz, 75% of the surface of the protected natural area will be affected by surface layer film at any given time during this simulation.

Closer examination of the pattern shows moderate northerly winds at the time of release, combined with a strong current pushing the initial oil south towards the protected natural area.

This combines to create a situation where the surface film is moved quickly to the sensitive area, but the winds are not strong enough to disperse the film before it gets there. Natural dispersion continues to reduce the amount of oil on the sea surface and after 36 hours very little surface oil remains.

It must be remembered, on the one hand, that in a real situation of accidental production of hydrocarbon pollution, their level will not persist in the sea water at the experimental critical concentrations, intervening with immediate actions to clean the affected area, according to the procedures of intervention established in the Accidental Pollution Intervention Plan.

9.2.2.2.4 Proposed control measures

Inherent control measures are based on the philosophy of: 1) Prevention, 2) Detection and 3) Control.

- Develop and implement safe fuel transfer procedures
- Establishing operational procedures for boats/ships affected by the Project in the work area, avoiding ship collisions.
- Enforcement of safety zones around project facilities and activities
- Development of a maritime traffic management plan to reduce the risk of accidents (isolation of areas for moving vessels, speed limit and one-way vessel routes)
- Ships and offshore installations are equipped with navigation aids
- Proposing a schedule and an adequate number of vessels for the transport of construction materials and equipment to avoid congestion in the area, if possible
- Implementation of adequate personnel training and field exercises for oil spill prevention, containment and response.
- Ensuring that spill response and containment equipment is regularly inspected and maintained, operationally checked and tested, and used during activities or available as required for the response
- Documenting and reporting all spills, as well as those situations constituting "borderline misses" of a pollution
- Notification to the relevant maritime and port authority of all permanent offshore installations, as well as of the safety zones and routine shipping routes to be used by vessels related to the project. Permanent locations of facilities will be marked on nautical charts. Maritime authorities should be notified of the schedule and location of activities when there will be a significant increase in vessel movement, such as during installation, platform movements, etc.

- The design of the facility must include considerations to withstand ship collision and layout considerations relating to the approach and currents of the support ship;
- Develop procedures for storage and transfer of hazardous materials to be strictly followed by related workers.
- Project dedicated to marine construction and field SIMOPS management process and procedures during the construction and operation phase of the asset.
- Preparation of written Standard Operating Procedures (SOPs) for the filling of tanks or containers or other containers or equipment, and for transfer operations performed by personnel trained in the safe transfer and filling of hazardous materials, and the prevention spills and emergency intervention.
- Prepare the PSO to manage the secondary containment structures, particularly the removal of any accumulated liquid such as precipitation.

9.2.2.3 Release of unburnt gases due to pipeline damage

9.2.2.3.1 Scope

Should a rupture/damage occur in the offshore pipeline, this will lead to gas leakage into the water column and emissions to the atmosphere, as well as the potential formation of gas hydrates due to high hydrostatic pressure in deep seawater areas.

A pipe break (leakage) could occur due to:

- Dropped object/oscillating load caused by lifting device failure
- Structural failure caused by extreme environmental loads
- Fishing vessel interactions

9.2.2.3.2 Significance of potential impact

A potential gas leak due to damage to the submarine pipeline would affect the environment in the area where the gas plume is located in the water column, and the leakage of the greenhouse gas methane into the atmosphere would have a detrimental impact on the climate.

Installations will be protected with SSIV and ESDV valves that will close to protect these installations.

9.2.2.3.3 Negative effects on the environment

The effects on the environment in case of gas leaks are similar to the effects described in **Section 9.2.2.1.4 Effects on the environment following an eruption at the well with the release of unlit gas,** with the note that the impact will be felt in proportion to the amount and pressure at release of gases from the pipe crack/rupture.

Taking into account the September 2022 incident at the Nord Stream 1 and 2 pipelines, the authors of a study [28]on the effects of methane on the environment, performed gas plume modelling, taking into account the estimated amount of gas leakage of 225kt. Initially, the gas leak formed a "fountain" in the water, having a height of approx. 4m above sea level, with a diameter of 11-31m. The modelling carried out took into account a diameter of 100-750 square meters, as a result of satellite data according to which it was observed that the plume stretched horizontally in a diameter of 500m [2.] The authors concluded that 94.9% of the methane that leaked from the Nord Stream pipelines entered the atmosphere immediately, and 5.0% through volatilization (3.6%) or biodegradation (1.3%) in the next 35 days of at the incident. Methane that dissolved in the sea (~11 kt) increased concentrations up to 5 orders of magnitude above reference in the area, and despite an initial rapid decline, significantly elevated concentrations (>10 times) remained present at the end of the simulation period. Long-term consequences could exist due to changes in microbial populations resulting from the massive growth of methanogens in highly ecologically sensitive areas.

There are opinions of researchers [29]who appreciate that methane emissions in the atmosphere as a result of this incident have a relatively small contribution of greenhouse gases.

9.2.2.3.4 Proposed control measures

Inherent control measures are based on the philosophy of: 1) Prevention, 2) Detection and 3) Control.

- Design codes and material specifications for all pipelines will comply with relevant Romanian (ANRE) and international standards (DNV).
- Hydro testing will be performed prior to commissioning to ensure pipeline integrity.
- Pipelines will be stabilized and protected by trenching and burial as necessary as determined by risk studies and engineering.
- Pipeline integrity will be managed in accordance with the Asset Integrity Management Plan
- Periodic monitoring and inspections of the pipeline will be carried out according to the pipeline integrity management plan
- Inspection approximately every 5 years to monitor for potential corrosion and pipe damage.
- Emergency pipe repair clamping system shall be purchased and available prior to operation.

[28] Anusha et al, 2023 – Fate of Methane from the Nord Stream Pipeline Leaks *Environ. Sci. Technology. Lett.* 2023, Publication Date: September 7, 2023; https://doi.org/10.1021/acs.estlett.3c00493 , accessed 24.09.2023

[29]Sanderson H. et al – Environmental impact of Nord Stream pipelines, Research Square, February 2023; Leibniz Institute for Baltic Sea Research Warnemünde (IOW).

9.2.2.4 Unlit gas release from NGMS

9.2.2.4.1 Scope of the assessment

An onshore unlit process gas release from process systems at NGMS. NGMS's process facilities include purge, metering, filtration and piping systems. A release from these hydrocarbon inventories may have the potential to accumulate and form an unlit gas cloud in confined/congested areas of facilities.

Potential causes of a leak include:

- Maintenance/drainage activities
  Loss of integrity of process pipelines

It is noted that a release of onshore pipeline section –is not considered credible as:

- The pipeline is completely buried outside the NGMS site boundaries (2 m depth).
- No third-party activities are allowed on the pipeline route (corridor).
- Periodic monitoring and inspections of the pipeline will be carried out according to the pipeline integrity management plan
- Design codes and material specifications for all pipelines will comply with relevant Romanian (ANRE)
- Hydro testing will be performed prior to commissioning to ensure pipeline integrity.
- Pipeline integrity will be managed in accordance with the Asset Integrity Management Plan
- Inspection approximately every 5 years to monitor for potential corrosion and pipe damage.

9.2.2.4.2 Significance of potential impact

No risks to third parties are foreseen in case of unignited release due to the composition and behaviour of the released material. The only potential impact in this case will be on the air environment (local airshed).

9.2.2.4.3 Negative effects on the environment

In the event of an unlit gas leakage event from the NGMS installations, the effects will be on the atmosphere, by contributing to GHG emissions.

9.2.2.4.4 Proposed control measures

Inherent control measures are based on the philosophy of: 1) Prevention, 2) Detection and 3) Control.

- Fully assessed and certified design
- Routine Inspection and Maintenance (PSO)
- Material selection (e.g. resistant to internal corrosion)
- External corrosion protection (e.g. coatings)
- Temperature/pressure monitoring + operator action
- Gas detection with self-isolation
- Isolation by ESD

- The location of the site and the fence minimize the impact on the public

9.2.2.5 Fire and explosion at Neptun Alpha Platform

9.2.2.5.1 Scope of the assessment

A release of flammable process gas on Neptun Alpha platform from the process or fuel gas system may result in a fire or explosion.
OMVP conducted a fire and explosion risk assessment for the offshore installations that covered the following discharges, taking into account the fluid phase and safety barriers (isolation and venting):

- Process equipment on superstructure including primary separator, TEG contactor and export, launchers and pigging station, methanol storage and pumps, methanol injection pumps, fuel gas system, diesel storage.
- Riser and pipelines including Domino and Pelican import pipeline and gas production pipeline.

9.2.2.5.2 Significance of potential impact

Production/processing facilities and fuel gas systems are located on the upper and lower decks of Neptun Alpha. Gas released from these hydrocarbon inventories can accumulate and form a flammable atmosphere in confined/congested areas of facilities.

Potential sources of ignition will be located away from production and process facilities. The power generation equipment will be located downwind of the facility on the upper deck and the flare tower will be located in the cantilever east of the platform to minimize the ignition potential of any accidental gas releases on the platform.

If a leak were to ignite immediately, given the high process gas pressure, a jet fire of significant flame length and thermal radiation would be sustained even at small hole sizes. Delayed ignition of a flammable gas cloud may result in a fire or explosion.

Early detection of the release and identification of the location of the leak is important for isolating the source and venting the leak system to stop the leak and reduce the potential for escalation.

Neptun Alpha is not normally manned, so the likelihood of human exposure is low. However, if manned operations are in progress, there is a threat to the personnel on the platform and any adjacent vessel.

9.2.2.5.3 Negative effects on the environment

The scenario regarding the fire followed by an explosion at the Neptun Alpha platform is considered a major accident, and the occurrence of such an event would have particularly serious consequences for both the environment and material assets, the image and reputation of the company.

The vulnerability of the project to the risks of major accidents caused by an explosion or fire is determined based on the quantitative and qualitative analysis of the risks of explosion and fire at the offshore and onshore facilities of the Neptun Deep Project. The assessment of the risks in case of a major accident has been evaluated and it is deemed to be improbable for the Neptun Deep project[30].

In the event of the occurrence of such an event, the expected negative effects on the environment will lead to increases in the level of emissions in the atmosphere, an increase in GHG emissions being expected.

The dispersion of flammable leaks and the size of the flammable gas cloud that could form in the worst-case scenario depend on the ventilation status of the facility, the magnitude of the leak, the location and direction of the leak.

In the event of such an incident will lead to significant changes in the water quality indicators, as a result of the release of gases in the water column, fuels and chemicals used in the operation process, stored in the storage spaces on the platform, as well as solid hazardous waste – pieces of the structure, contaminated materials, which reaching the sea water will cause a local increase in toxicity.

Changing water quality will have immediate and long-term effects on marine life. A detailed description of the effects of methane and liquid hydrocarbons (MGO fuel) on water quality, sediments and marine fauna is presented in **Section 9.2.2.1.4 and Section 9.2.2.2.4.**

A massive release of gas followed by an explosion can have significant negative effects on marine fauna. According to ACOBAMS data, as a result of the major gas rig accident event that occurred in the Sea of Azov in August 1982, resulting in the explosion of the gas rig, more than 2,000 dead porpoises washed ashore as a result of this event.[31]

At the same time, marine fauna, including fish, birds, marine mammals, can suffer a significant impact as a result of ingestion or entanglement in various materials/objects (such as nets, fabrics, etc.) as a result of exposure to toxic chemicals.

Ingestion of chemicals toxic to the marine environment may have the potential for physical injury, or may limit feeding/foraging behaviour, which inevitably leads to mortalities.

Given the positioning of the Neptun Alpha platform at a distance of 160km offshore, a fire and/or explosion incident will not affect the material assets and/or the health of the population in the onshore area.

9.2.2.5.4 Proposed control measures

- Corrosion inhibitor is continuously injected into the Domino manifold to reduce the likelihood of potential leakage due to corrosion.

[30] Neptun Deep – Fire and Explosion Risk Assessment, OMV Petrom 2023
[31]ACCOBAMS, 2021. Conserving Whales, Dolphins and Porpoises in the MEDITERRANEAN Sea, Black Sea and adjacent areas: an ACCOBAMS status report, (2021). By: Notarbartolo di Sciara G., Tonay AM Ed. ACCOBAMS, Monaco. 160 p. Layout by: ©le naturographe, 2021 Available from: October 2021 ISBN: 978-2-9579273-1-9

- Equipment and pipelines containing process hydrocarbons are fully evaluated and undergo rigorous design. This includes optimizing for minimal crew and to minimize the risk of incorrect operator intervention, e.g. locks, isolable spares, etc.
- Process piping and equipment materials were selected based on process fluids and operating conditions, including the use of corrosion-tolerant carbon steel and corrosion-resistant alloy as required
- Implementation and compliance with routine inspection, maintenance and monitoring programs
- Effective standard operating procedures and trained/experienced operators are used in operations
- The installations are designed to withstand the accidental loads defined by fire and explosion design
- In the event of a loss of primary containment, the platform is equipped with Fire and Gas detection systems
- Fire and gas detection system will automatically initiate process shutdown and blowdown to reduce the released inventories and dispose them safely via the flare
- In case the loss of primary containment occurs while the platform is manned, dedicated temporary refuge, designed to withstand to fire and explosion scenarios, is provided
- Several means to abandon the platform are provided: TEMPSC (Totally Enclosed Motor Propelled Survival Craft), inflatable life rafts and escape evacuation chute.

9.2.2.6 Fire and explosion at NGMS

9.2.2.6.1 Scope

If a leak were to ignite immediately, the duration of jet fires is short and the risk can be controlled. Delayed ignition of a flammable gas cloud may result in a fire or explosion.
Common causes of flare-ups include:

- Exposed electrical connections or cables
- Hot surfaces, including exhaust pipes
- Electrostatic discharge
- Working with open fire

The dominant hazards for the NGMS area are jet fire and fire hazards from filter separators and metering equipment. Although the hazard ranges for the pig receiver and the intake pipe are comparable, the frequency of leaks in these sections is less than 1% of the total frequency.

9.2.2.6.2 Significance of potential impact

A risk assessment was carried out to estimate the risk posed by the onshore NGMS to both the operators and third parties. The assessment takes into account all types of hazards that can lead to the release of gases in the event of loss of containment in the installation.

These include scenarios such as the immediate release of fire (jet fires), dispersals of unignited gases, as well as the slow dispersion of ignited gases that could lead to explosions or flash fires.

The results showed that the risks are at a tolerable level of acceptability, considering the the location of the proposed NGMS in the vicinity to agricultural land and that, currently, there are no permanent full-time activities of third parties near to the property boundary of the NGMS.

9.2.2.6.3 Negative effects on the environment

In the unlikely event of the occurrence of a fire or explosion at the NGMS, the expected negative effects on the environment will lead to increases in the level of emissions in the atmosphere, an increase in GHG emissions being expected.

The dispersion of flammable leaks and the size of the flammable gas cloud that could form in the worst-case scenario depend on the ventilation status of the facility, the magnitude of the leak, the location and direction of the leak.

In the event of a major accident as a result of a fire/explosion, there will also be effects on the soil in the NGMS location area, due to ash sedimentation, impregnation with chemical substances used in fire-fighting foam.

9.2.2.6.4 Proposed control measures

Early detection of the release and identification of the location of the leak is important for isolating the source and venting the leak system to end the leak and reduce the potential for escalation.

Prevention/detection/control measures:

- Corrosion and/or erosion shall not cause loss of insulation from any equipment containing flammable fluids during the design life of the plant/installation.
- Equipment and piping containing process hydrocarbons are fully evaluated and rigorously designed. This includes optimizing for minimal crew and to minimize the risk of incorrect operator intervention, e.g. locking systems, isolable spares etc.
- Process piping and equipment materials were selected based on process fluids and operating conditions
- The installations are designed to withstand the accidental loads defined by fire and explosion design.
- The vents were designed for the controlled release of hydrocarbon gas and were located away from potential ignition sources.
- Routine inspection, maintenance and monitoring programs
- Effective standard operating procedures and trained/experienced operators are used in operations
- Public access to the NGMS facility is restricted
- The process system is equipped with independent controllers (alarms, SIS trips, PSV, etc.) according to HAZOP/SIL assessment requirements. This includes temperature and pressure monitoring and provides for operator action in the event of an emergency.

- Fire and gas detection is provided throughout the facility interacting with the ESD system. Detection of Transgaz equipment alerts NGMS and ensures communication with Transgaz.
- ESD is initiated upon confirmed fire and gas detection to isolate hydrocarbon inventories and shutdown equipment in accordance with the ESD hierarchy
- The NGMS is located away from staffed areas to minimize impact on site personnel and equipped with a perimeter fence to reduce general public access to the area

9.3 Emergency Response Plans

The major accident risk management strategy developed for the Neptun Deep project provides for how major accident hazards are managed to reduce risks to the ALARP level[32]. The ALARP principle is applicable in all the scenarios analysed above for the Neptun Deep installations, both onshore and offshore.

9.3.1 Environmental Management Plan

The effective application of the Preparedness and Response Plans provided for the Neptun Deep Project will be demonstrated through the implementation of the Environmental Management Plan. The environmental performance objectives associated with the planned impacts will generally be demonstrated through the successful implementation of controls, environmental performance standards and associated measurement criteria specific to the activity for which an Environmental Management Plan is developed.

If an unplanned event (for example, an oil spill or other spill) results in the potential for environmental damage, the incident reporting and investigation process will identify whether there is potential for environmental impact. This process will provide sufficient information to determine whether the environmental objectives have been achieved.

9.3.2 The preparation and response plan in case of accidental hydrocarbon pollution

A response and Intervention Plan (OSCP) has been developed that provides directions for action during a potential hydrocarbon spill from project activities.

This Plan respects international good practices in the oil and gas industry[33], being aligned with the requirements regulated by:

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[32] ALARP stands for "As Low As Reasonably Practicable," and is a concept used in the oil and gas industry, as well as various other high-risk industries, to assess and manage the risks associated with operations and activities. The purpose of the ALARP principle is to ensure that risks are reduced to a level as low as possible, taking into account factors such as feasibility, costs and available technology.

[33]1 IPIECA, ITOPF and IOGP. OSCP Roadmap 2 International Standard (ISO) 15544, first edition 2000-09-15, Oil and natural gas industry – Offshore production facilities – Requirements and guidelines for emergency response 3 International Maritime Organization; 2010 4th Edition International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC '90

- MAPPM order no. 278/1997 for the approval of the Framework Methodology for the development of plans to prevent and combat accidental pollution,
- Romania's National Plan for preparation, response and cooperation in case of offshore pollution with hydrocarbons and other harmful substances, approved by GD. No. 893/2006,
- Standard SR EN ISO 15544:2000 - Petroleum and natural gas industries — Offshore production facilities — Requirements and guidelines for emergency response and
- IMO Oil Spill Risk Assessment and Preparedness Manual.

The sequential preparedness and response framework is consistent with the International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC).

The OSCP provides guidance to spill response personnel in relation to development and operating operations at the Neptun Deep project.

Specifically, this OSCP establishes the following:

- Providing guidance to the Incident Response Team (IRT) and Incident Management Team (IMT) for the response and control of an oil spill.
- Defines internal and external alerting and notification requirements.
- Establishes the roles and responsibilities of key personnel following a spill incident.
- Provides guidance in assessing spills and selecting IMT response strategy to protect sensitive areas and mitigate adverse impacts.
- Identifies internal and external resources available to implement a spill response and how they should be mobilized

9.3.3 The Neptun Deep emergency and crisis preparedness and response plan

At the level of the OMV Group as well as OMV Petrom, emergency response and crisis management procedures are established for the project developed in Romania, as well as for the entire global activity of the OMV Group. The Neptun Deep emergency and crisis response plan will be managed and supported by OMV Petrom, with the support of OMV Group's emergency and crisis response systems.

The main strategic objectives established in the Crisis/Emergency Management Plan in case of unplanned events are:

- Lifesaving with a focus on the ability to manage people's safety (attendance, location, work tasks),
- Minimizing environmental damage.
- Protecting material assets from further damage.

OMV Petrom defines incidents, emergency and crisis situations as follows:

- An incident is a physical action that threatens human life, the environment or property. These events can be controlled using readily available local facilities and office resources (facility). Incidents are classified as **level 1.**
- An emergency is the situation resulting from an incident that has already occurred, but which has the potential to escalate and cause further damage to human life, the environment, assets, investments and the reputation of the OMV Group. These events cannot be controlled by the facility (IMT) and require additional resources or management support (EMT). Emergencies are classified as **level 2.**
- A crisis is an actual or potential threat to the company's long-term ability to operate because of the impact on reputation, legal/financial obligations, and ability to operate. These events cannot be controlled by IMT and EMT and require significant external resources or management support from the OMV Group. Seizures are classified as **level 3.**

The OMV Group has a three-tier crisis and emergency management system, which is applied through the Group. Incident management teams are established for each location, office, unit or asset.

Oil and gas facilities must have subordinate incident response teams made up of trained first-line responders. Non-oil and gas facilities have guards and first aid responders and can call local emergency services.

There are emergency management teams in each country established at the country office. The Group Crisis Management Team is physically based in Vienna. The team can meet at headquarters, virtually via phone and video conference, or off-site (figure 9.14)

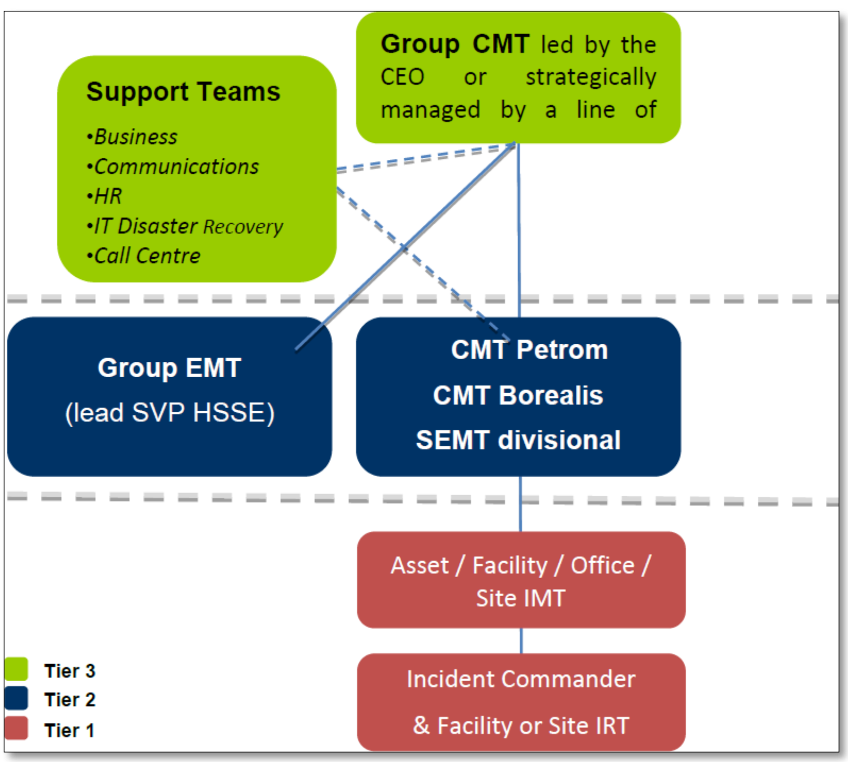

Figure 9.13– Structure of the OMV Emergency Response Group (level 1, 2, 3)

The Emergency Response Plan has been developed for Neptun Deep to describe how the project identifies credible emergencies and what arrangements are in place to minimize the effects of these emergencies. The intention is to provide an organizational framework so that all Neptun Deep Project facilities can comply with the project's requirements for emergency planning, resources, roles and responsibilities.

Prior to the start of site works at the relevant locations, as well as for the period of operation of the Neptun Deep facilities, an emergency response liaison document will be created between the Neptun Deep Project and the relevant contractors to establish a joint emergency response plan emergency situation (ERP). The document will establish:

- Assignment of Responsibilities
- Emergency contacts
- Incident reporting
- Incident command
- Injury management
- Audits and exercises
- Investigation of incidents
- Media – Public Relations – Communications

In the event of an incident, the appropriate initial response (e.g. first aid, firefighting, spill response, etc.) shall be implemented first. As soon as possible after an incident is identified, it should be reported to the appropriate supervisor, who can then initiate the joint ERP through the duty manager (DM).

At the same time, the personnel involved in the project must respect the processes and procedures of the Neptun Deep Project. In some cases, it may be necessary for staff to be part of a project-level emergency team. In this situation, all training necessary to fulfil this role will be provided.