# A RISK MANAGEMENT APPROACH FOR THE ROMANIAN OFFSHORE ACTIVITIES FOR THE EXPLORATION OF HYDROCARBONS

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**ABSTRACT**

Offshore economic activities are part of and deeply integrated into the worldwide economy, a fact that increase in the last decades with the present globalization. The success of the industry depends on the increasingly advanced technological development in this field, but also on maintaining the trust of many stakeholders, namely employees, suppliers, consumers, etc. It is obvious, however, that offshore operations are high-risk operations. These offshore activities include oil drilling, processing and supply, taking into account the fact that the fiscal growth / deficit index of a nation's economy is also controlled by the oil price. The present study will use a risk-based approach to exploration and production of hydrocarbons using a similar approach used in studies conducted for the European Commission. In this respect, sub-stages and processes were identified for each stage of economic activity. The approach to offshore operations was based on the assessment of 8 environmental aspects. So we used a risk assessment system, taking into account the consequences and probabilities of the occurrence of the risks. The evaluation was conducted using data collected from the offshore oil industry.

**Keywords:** *Romanian offshore, hydrocarbons, risk management, offshore oil industry*.

## 1. INTRODUCTION

The structures located in the offshore area are built in deep and ultra-deep waters and aim to exploit oil and natural gas. These structures are created taking into account their flexibility, robustness and safety, to protect the environment.

New and innovative materials are used for the construction of structures, with mechanical properties specific to the location conditions, but environmentally friendly.

However, the environmental challenges are not fully known, with atmospheric conditions, hydrodynamic conditions, ice loads in cold weather, submarine seismic conditions, etc. Analysis of these environmental conditions can reduce the uncertainties in the planning, analysis, design and construction stages of the offshore structure.

The offshore oil and gas industry involves companies around the world that develop state-of-the-art technologies. However, there is a risk of major accidents with devastating consequences on the environment. We can mention here the fire on the Piper Alpha platform in the UK, the event on the Norwegian platform Alexander Kielland, Exxon Valdez in 1989, etc.

Accidents that have taken place attract public attention and cause concern for safety measures, having disastrous effects on environmental pollution. The risk taken by the offshore industry tends to be as low as possible but will never be zero. It should be noted that risk reduction is an important and costly process in any investment, and the petroleum industry is no exception. However, petroleum companies operating and wishing to develop offshore installations in Romania are globally competitive and the implementation of technologies that significantly reduce risks are part of the procedures of these companies.

Several terminologies are important to note in this article:

- Accident: An unplanned accident or a series of unplanned incidents
- Danger: A feature of the system / process facility that is potential for an accident that causes damage to persons, property and / or the environment.
- Risk: A measure of potential economic loss or injury in terms of the likelihood of loss or damage and the extent of loss or damage occurring if it occurs.
- Explosion: a sudden release of energy accompanied by an explosion wave.
- Fire: A burning process that is characterized by heat or flame smoke or any combination of these.

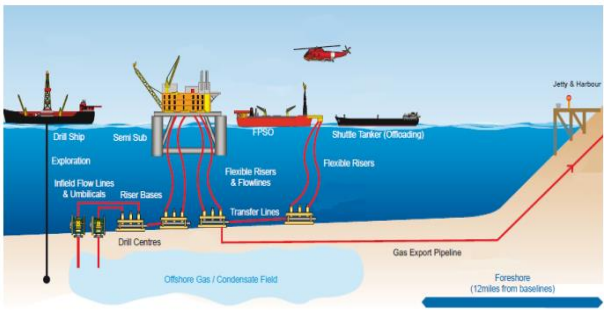


Figure 1 Example of subsea network for offshore and oil gas installations [1]

The objective of this article is to identify and assess the need for actions in the field of environmental impact management and the risks of oil and gas exploitation in the Romanian offshore sector.

We propose through this study to:

- Identify technologies and processes used in industry and clarify the risks and the impact on the environment;

- Develop measures to mitigate risks and mitigate the impact;
- Propose relevant measures.

The European Commission has taken into account the environmental impact generated by the extraction of unconventional hydrocarbons from both the onshore and offshore areas. At European level, procedures were in place to create a risk management framework that was primarily focused on shale gas, but it was extended to other unconventional instruments such as leak gas, oil and methane coal or other unconventional hydrocarbons.

Romania started offshore activity for the exploration of hydrocarbons in the low depth in 1969. The first breakthrough was made in 1980 and production began in 1987, without exceeding a modest level.

In 2008 the partnership between OMV Petrom and ExxonMobil was established in order to map the crude oil and gas reserves in the deep waters of the Black Sea. Between 2010 and 2013 a large campaign to acquire 3D seismic data in the Romanian territorial unit's waters. In September 2011, ExxonMobil and OMV Petrom began drilling at the Domino-1 probe, 170 km from the shore, at a depth of 930 meters. Drilling - the first of deep water in the Black Sea - reached a total depth of 3,615 meters at the end of February 2012 and was concluded in March 2012, confirming the presence of natural gas in an estimated volume of between 42 and 84 mmc, which could provide half of the national demand for 6-13 years at the current consumption rate.

OMV Petrom is the largest owner of marine perimeters: two blocks – XIX Neptune (the shallow water part of 100% owned, and the deep water part owned 50% -50% by ExxonMobil) and XVI II Istria - with a total area of 12,321 km2. In November 2012, Romgaz joined Lukoil Overseas Atash B.V. and Vanco International Ldt. in a participation quota d is 10% at EX-29 Rhapsody East and EX-30 Trident - 2000 km2, with a depth of between 90 and 1,000 meters. Then, ExxonMobil and OMV Petrom acquired from the Canadian Sterling Company Resources and PetroVentures participations in the deep water area of the 15th perimeter Midia. Romgaz has the option of acquiring 10% of this joint venture.

The Black Sea Basin seems to have the potential to become one of the most significant natural gas producing areas in the European Union.

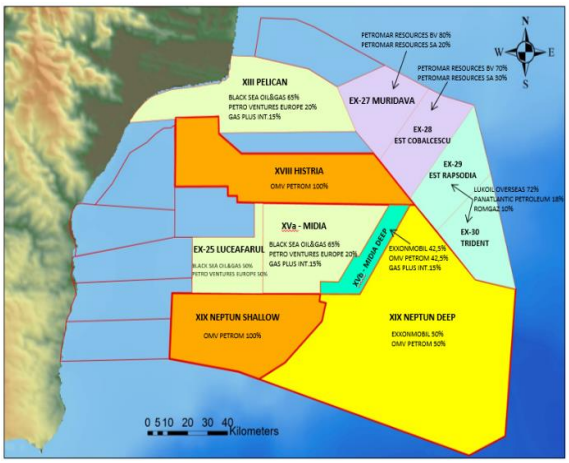


Figure 2 Romanian offshore activity for the exploration of hydrocarbons [3]

## 2. METHODOLOGIES

As I said earlier, evidence has been found of exploring offshore gas and their production in the Black Sea since March 2012. Offshore reserves were considered to be substantially higher than coastal reserves, and offshore issues were reported to be the same as onshore.

Taking into account the reserves' analysis and the current and planned exploration in offshore, the assessment focused on the potential risks this activity faces. It should be noted that potential environmental effects and offshore gas and offshore risks should be incorporated into a document on environmental impact assessment and management and on the risks of exploration and exploration production of hydrocarbons.

As regards the risk and impact analysis approach, to identify the specific risks and impacts in the offshore sector, the following approach has been developed:

1. The identified risks and impacts associated with conventional offshore exploration and gas development have been considered to be fully relevant and fully available measures for exploring offshore unconventional development;

2. In the case of offshore activities, actions that are relevant in the area of activity are excluded, excluding matters that are not applicable in the offshore area (e.g. groundwater contamination, land and road traffic impact). Instead, the impact of marine traffic on drilling operations has been taken into account, considering the risk assessment in the relevant sections of this document;

3. For issues that have not been examined, an assessment has been made whether or not they are associated with the risks and impacts associated with the different stages of the life cycle are comparable to offshore conventions;

4. These risks and impacts that were not comparable to offshore conventions have been submitted for further assessment, in particular to review the adequacy and proportionality of measures already identified for land-use. Those issues for which there was insufficient evidence to do so have been highlighted but have not been taken into account for a review of the measures.

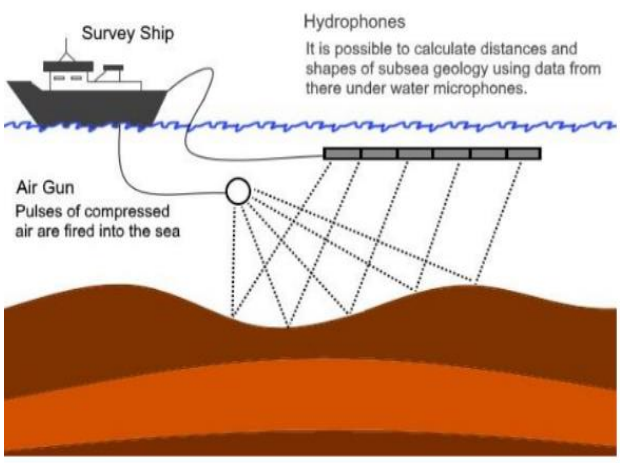


Figure 3 Illustration of Seismic Survey [1]

## 3. RESULTS, TABLES AND FIGURES

The results from the process of risk identification and impact are presented below. The identification of risks associated with conventional edge operations relevant to offshore collapse can be summarized below, adapting an European Union study methodology about management of environmental impacts and risks of conventional oil and gas in the offshore area.

Please note that the tables below include both mitigated risks and undefined risks. Environmental risks in offshore activities may be higher if the installation is located in deep waters, strong winds, low temperatures or sudden climate changes.

Table 1. Risk Matrix

| Likelihood of Incident | | | Consequence of Incident | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | |
| | | | Slight | Minor | Moderate | Major | Catastrophic | No Data |
| | 1 | Extremely Rare | 1 | 2 | 3 | 4 | 5 | Not classifiable |
| | 2 | Rare | 2 | 4 | 6 | 8 | 10 | |
| | 3 | Occasional | 3 | 6 | 9 | 12 | 15 | |
| | 4 | Likely | 4 | 8 | 12 | 16 | 20 | |
| | 5 | Highly Likely | 5 | 10 | 15 | 20 | 25 | |
| | | No data | Not classifiable | | | | | |

| Legend | | |
|---|---|---|
| **Color** | **Level of Risk** | **Score** |
| | Low | 1 – 4 |
| | Moderate | 5 – 8 |
| | High | 9 – 2 |
| | Very High | 15 – 25 |

The next two, tables 2 and 3, analyze the first stage in the life cycle, identifying potential sites for offshore oil and gas production. Information on sea bed status is analyzed using gravimetric analysis and detailed information on submarine geology using its seismic analysis.

Table 2. Risks and impacts of marine transport

| **Main Environmental Aspects** | **Impacts** | **Risk Level** |
|---|---|---|
| Releases to air (local air quality) | The use of shipping for offshore oil and gas installations is a necessity, which will generate emissions to air from fuel use of vessels. | 3 |
| Releases to air (contribution to international greenhouse gas emissions) | | 5 |

Table 3. Risk and impacts of seismic surveys

| **Main Environmental Aspects** | **Impacts** | **Risk Level** |
|---|---|---|
| Underwater noise in the marine environment (potential to cause physical injury) | Seismic surveys require the use of compressed air guns to fire pulses into the seabed to gather information about subsea geology. | 4 |
| Underwater noise in the marine environment (potential to cause disturbance to marine life) | The distinction between physical injury and disturbance that potentially causes behavioural change is important. | 4 |

Table 4. Summary environmental hazards and risk for stage 1 site identification and preparation

| **Processes/ technologies** | **Environmental Aspect** | **Risk characterisation** (**with** expected management measures in place) | | | **Risk characterisation** (**without** expected management measures in place) | | |
|---|---|---|---|---|---|---|---|
| | | **Likelihood** | **Consequence** | **Risk** | **Likelihood** | **Consequence** | **Risk** |
| 1. Identification of resource (desktop study) | | | | | | | |
| 1.1 Identifying target area for favourable geological conditions and licensing | Desk based task - no specific risks identified so not considered further. | | | | | | |
| 2.1 Gravimetric and seismic surveys of seabed to develop identification of leads | Releases to air (local air quality impacts) | Occasional | Slight | 3 | Occasional | Slight | 3 |
| | Releases to air (contribution to global emissions for greenhouse gas) | Highly Likely | Slight | 5 | Highly Likely | Slight | 5 |
| | Underwater noise in the marine environment (injury to animals) | Rare | Minor | 4 | Occasional | Minor | 6 |
| | Underwater noise in the marine environment (disturbance to animals) | Likely | Slight | 4 | Highly likely | Slight | 5 |

Table 4 presents the impact and risk of drilling activity. The probability of accidental discharge increases when the platform is placed in deeper and steeper waters.

Table 5. Summary environmental hazards and risk for stage 1 site identification and preparation

| **Processes/ technologies** | **Environmental Aspect** | **Risk characterisation** (with expected management measures in place) | | | **Risk characterisation** (without expected management measures in place) | | |
|---|---|---|---|---|---|---|---|
| | | **Likelihood** | **Consequence** | **Risk** | **Likelihood** | **Consequence** | **Risk** |
| **Well design (desktop study)** | | | | | | | |
| Planning and design for well, including rig type and logistics | Desk based task - no specific risks identified so not considered further. | | | | | | |
| **Installation of drilling rig (also covers exploratory wells)** | | | | | | | |
| Transport of drilling rig, supply vessels | Releases to air (local air quality impacts) | Occasional | Slight | 3 | Occasional | Slight | 3 |
| | Releases to air (contribution to global emissions for greenhouse gas) | Highly Likely | Slight | 5 | Highly Likely | Slight | 5 |
| | Discharges to sea (containment failure on shipping) | Occasional | Minor | 6 | Occasional | Moderate | 9 |

| **Processes/ technologies** | **Environmental Aspect** | **Risk characterisation** (with expected management measures in place) | | | **Risk characterisation** (without expected management measures in place) | | |
|---|---|---|---|---|---|---|---|
| | | **Likelihood** | **Consequence** | **Risk** | **Likelihood** | **Consequence** | **Risk** |
| | Discharges to sea (containment failure on rig) | Rare | Slight | 2 | Rare | Minor | 4 |
| **Well drilling (also covers exploratory wells)** | | | | | | | |
| Positioning of apparatus on seabed for exploratory drilling | Seabed disturbance | Highly Likely | Slight | 5 | Highly likely | Minor | 10 |
| | Underwater noise in the marine environment (disturbance to animals) | Likely | Slight | 4 | Highly likely | Slight | 5 |
| | Marine biodiversity impacts (introduce foreign species) | Rare | Moderate | 6 | Likely | Moderate | 12 |
| Drilling using water based mud (WBM)/oil based mud (OBM) | Seabed disturbance | Occasional | Slight | 3 | Occasional | Slight | 3 |
| | Releases to air (local air quality impacts) | Occasional | Slight | 3 | Likely | Minor | 8 |
| | Releases to air (contribution to global emissions for greenhouse gas) | Likely | Slight | 4 | Highly likely | Minor | 10 |
| | Underwater noise in the marine environment (disturbance to animals) | Rare | Slight | 2 | Occasional | Slight | 3 |
| | Discharges to sea (planned) – impacts to marine ecosystems | Occasional | Slight | 3 | Occasional | Minor | 6 |
| | Discharges to sea (planned) – impacts to water quality | Occasional | Slight | 3 | Occasional | Minor | 6 |
| | Discharges to sea (planned) – fouling seabed | Occasional | Minor | 6 | Occasional | Moderate | 9 |
| | Discharges to sea (accidental) – Tier III* – Major incident – impacts to marine environment | Rare | Catastrophic | 10 | Likely | Catastrophic | 20 |
| | Discharges to sea (accidental) – Tier III* – Major incident – impacts to coastal environment | Rare | Catastrophic | 10 | Likely | Catastrophic | 20 |
| | Discharges to sea (accidental) – Tier III* – Major incident – impacts to water quality | Rare | Catastrophic | 10 | Likely | Catastrophic | 20 |

| **Processes/ technologies** | **Environmental Aspect** | **Risk characterisation** (with expected management measures in place) | | | **Risk characterisation** (without expected management measures in place) | | |
|---|---|---|---|---|---|---|---|
| | | **Likelihood** | **Consequence** | **Risk** | **Likelihood** | **Consequence** | **Risk** |
| Drilling using water based mud (WBM)/oil based mud (OBM) | Discharges to sea (accidental) – Tier III* – Major incident – fouling seabed marine environment | Rare | Moderate | 6 | Occasional | Major | 12 |
| | Discharges to sea (accidental) – Tier II* – Moderate incident – impacts to marine environment | Rare | Major | 8 | Likely | Major | 16 |
| | Discharges to sea (accidental) – Tier II* – Moderate incident – impacts to coastal environment | Rare | Major | 8 | Likely | Catastrophic | 20 |
| | Discharges to sea (accidental) – Tier II* – Moderate incident – impacts to water quality | Rare | Major | 8 | Likely | Major | 16 |
| | Discharges to sea (accidental) – Tier II* – Moderate incident – fouling seabed | Rare | Minor | 4 | Occasional | Moderate | 9 |
| | Discharges to sea (accidental) – Tier I* – Minor incident – impacts to marine environment | Occasional | Minor | 6 | Likely | Moderate | 12 |
| | Discharges to sea (accidental) – Tier I* – Minor incident – impacts to coastal environment | Rare | Minor | 4 | Rare | Minor | 4 |
| | Discharges to sea (accidental) – Tier I* – Moderate incident – impacts to water quality | Occasional | Slight | 3 | Occasional | Minor | 6 |
| | Discharges to sea (accidental) – Tier I* – Minor incident – fouling seabed | Rare | Slight | 2 | Rare | Minor | 4 |
| Handling of drill cuttings | Discharges to sea (planned) – impacts to marine ecosystems | Occasional | Slight | 3 | Occasional | Minor | 6 |
| | Discharges to sea (planned) – impacts to water quality | Occasional | Slight | 3 | Occasional | Minor | 6 |

| Processes/ technologies | Environmental Aspect | Risk characterisation (with expected management measures in place) | | | Risk characterisation (without expected management measures in place) | | |
|---|---|---|---|---|---|---|---|
| | | Likelihood | Consequence | Risk | Likelihood | Consequence | Risk |
| | Discharges to sea (planned) – fouling seabed | Occasional | Minor | 6 | Occasional | Moderate | 9 |
| Cementing and casing | Discharges to sea (accidental) – impacts to marine ecosystems | Occasional | Slight | 3 | Occasional | Minor | 6 |
| | Discharges to sea (accidental – impacts to water quality5 | Occasional | Slight | 3 | Occasional | Minor | 6 |
| | Discharges to sea (accidental) - fouling seabed | Occasional | Minor | 6 | Occasional | Moderate | 9 |
| | Underwater noise in the marine environment (disturbance to animals) | Rare | Slight | 2 | Occasional | Slight | 3 |
| **Well completion** | | | | | | | |
| Well-bore clean up | Releases to air – flaring of gas (local air quality impacts) | Likely | Slight | 4 | Highly likely | Minor | 10 |
| | Releases to air – flaring of gas (contribution to global emissions for greenhouse gas) | Likely | Slight | 4 | Highly likely | Minor | 10 |
| | Discharges to sea – drop-out from flaring – impacts to marine ecosystems | Occasional | Slight | 3 | Occasional | Minor | 6 |
| | Discharges to sea – drop-out from flaring - impacts to water quality | Occasional | Slight | 3 | Occasional | Minor | 6 |
| | Discharges to sea – drop-out from flaring - fouling seabed | Occasional | Minor | 6 | Occasional | Moderate | 9 |
| | Discharges to sea (accidental) – leak from well - impacts to marine ecosystems | Occasional | Slight | 3 | Occasional | Minor | 6 |
| Well-bore clean up | Discharges to sea (accidental – leak from well - impacts to water quality | Occasional | Slight | 3 | Occasional | Minor | 6 |
| | Discharges to sea (accidental) – leak from well -fouling seabed | Occasional | Minor | 6 | Occasional | Moderate | 9 |

| Processes/ technologies | Environmental Aspect | Risk characterisation (with expected management measures in place) | | | Risk characterisation (without expected management measures in place) | | |
|---|---|---|---|---|---|---|---|
| | | Likelihood | Consequence | Risk | Likelihood | Consequence | Risk |
| Introduction of completion fluids | Discharges to sea (accidental) – leak from well - impacts to marine ecosystems | Occasional | Slight | 3 | Occasional | Minor | 6 |
| | Discharges to sea (accidental – leak from well - impacts to water quality | Occasional | Slight | 3 | Occasional | Minor | 6 |
| | Discharges to sea (accidental) – leak from well -fouling seabed | Occasional | Slight | 3 | Occasional | Minor | 6 |

## 4. DISCUSIONS

For the risks and impacts that have been identified in the Romanian offshore area, these must be analyzed adequately and proportionately. Where risks and impacts have been identified as likely, the identified measures should be reviewed to examine whether they are appropriate and proportionate to the risks and impact on the offshore area. Proportionality, was then considered to be "over-specified", "proportionate" or "unspecified".

For the action “discharges into seas” all measures considered were appropriate and proportionate to offshore extractions.

All measures considered to deplete water resources were considered appropriate and proportionate to offshore extractions. As for further measures, further measures can be beneficial to address the logistical aspects of fresh water supply remote offshore locations, while addressing the depletion of water resources. After further action is taken: Seismic measures (all measures) were considered appropriate and proportionate for offshore.

## 5. CONCLUSIONS

Upon completion of the previous steps to assess conventional oil and gas processes and risk and impact activities, an additional task was undertaken to examine the situation of the unconventional offshore oil and gas sector. This paper is based on previous studies conducted by the European Commission to assess risks and environmental impacts.

The results concluded that following this review, the following environmental aspects were identified as relevant and additional to those for conventional offshore processes:

o Discharges into the sea (for example due to the need to treat increased flow quantities);
o Exhaustion of water resources (only if fresh water is used in fracturing; shipped from the shore); and
o Seismicity due to fracture (in the case of a reduced / improved hydraulic fracture) recovery is not used in conventional probes).

In addition, there are controversial issues (due to contradictory evidence) if the risks differ for unconventional wells compared to conventional wells, for the following aspects:

- Discharges into the sea (due to long-term loss of probe integrity behind closure and abandonment) and
- Release into the air (due to fugitive methane emissions during production).

The risks and impacts associated with environmental aspects that have been identified as relevant and additional to those for conventional onshore processes have then been compared with current management measures used by the conventional offshore oil and gas industry to assess whether they are appropriate to manage these additional risks and impacts. Based on the conclusion of this review, which was conducted using an expert opinion and where possibly underlined with industry-accessible data, the measures to be taken are already available and are likely to be applied offshore are considered capable to reduce the risks identified as a result of offshore gas extraction in a level comparable to that of other offshore activities. This conclusion excludes those issues for which there is contradictory evidence of the existence of risks having increased unconventional activities compared to conventional ones, in particular fugitive methane fractions and long-term wellbore failure.

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