TÜRKİYE PETROLLERİ ANONİM ORTAKLIĞI

OTC OFFSHORE TECHNOLOGY CENTER

SAKARYA GAS FIELD DEVELOPMENT PROJECT – ENHANCEMENT OF SUBSEA PRODUCTION CAPACITY AND FLOATING PRODUCTION UNIT

Chapter 8 Offshore Risk of Accidental Releases

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Information Classification

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8.0 OFFSHORE RISK OF ACCIDENTAL RELEASES

8.1 Introduction

Accidental releases may include unplanned releases of hydrocarbons, chemicals and wastes during construction, operation, and decommissioning phases of the Project. Accidental releases may result from several sources including:

- Spillage or discharge of Potentially Hazardous Substances from vessels and FPU (including vessel collision).
- Gas Leakages and Fire.
- Chemical Leakage from pipeline and cable.

Accidental hydrocarbon and other chemical releases have the potential to impact various receptors in the marine and coastal environment including marine flora and fauna, especially seabirds and marine mammals, marine habitats, and ecosystem services such as fisheries.

As concerns the onshore risks, indications and comments about the most appropriate technical solutions are included in the Chapter 3 (Project Description) and Chapter 4 (Alternative Analysis).

8.2 Regulation and Guidance

The Project is subject to applicable Turkish Regulatory requirements and to those of international conventions ratified by Türkiye. It will also follow good international industry practice and meet the requirements of International Finance Corporation (IFC).

Key legislation relating to offshore hydrocarbon spill risk assessment and response planning includes:

- Law Pertaining to Principles of Emergency Response and Compensation for Damages in Pollution of Marine Environment by Oil and Other Harmful Substances (No. 5312), Official Gazette date/no: 11.03.2005/25752.
- Regulation on Sea and Inland Waters Hydrographic Survey, Official Gazette date/no: 09.08.2016/29796.
- Implementation Regulation on Law Pertaining to Principles of Emergency Response and Compensation for Damages in Pollution of Marine Environment by Oil and Other Harmful Substances, Official Gazette date/no: 21.10.2006/26326.
- Regulation on Prevention of Major Industrial Accidents and Mitigation of Resulting Impacts, Official Gazette Date/No: 02.03.2019/30702.
- Communiqué Concerning the Major Accident Scenario Document to be issued for Major Industrial Accidents, Official Gazette date/no: 30.06.2020/31171.
- Communiqué of Insurance Tariff and Instruction on Obligatory Financial Liability for Sea Pollution of Coastal Facilities, Official Gazette date/no: 25.04.2018/30402.
- IFC – Environmental, Health, and Safety Guidelines.
- IFC – Environmental, Health, and Safety Guidelines for Offshore Oil and Gas Development.

- International Convention for the Prevention of Pollution from Ships (MARPOL-73 Convention), as modified by the Protocol (MARPOL-78 Protocol) (1983) (Ratification date: 24 June 1990). This includes: Annex I, Annex II and Annex V (Ratification date: 24 June 1990); Annex III and Annex IV (Ratification date: 14 January 2015); MARPOL 1997 Protocol – Annex VI (Ratification date: 4 February 2014);
- The Convention on the Protection of the Black Sea against Pollution (Bucharest Convention), (Ratification Date: 21 April 1992).
- International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM, 2004) (Ratification date: 14 October 2014).
- International Convention on Civil Liability for Bunker Oil Pollution Damage (BUNKERS, 2001) (Ratification date: 26 February 2013).
- International Convention on the Establishment of an International Fund for Compensation of Oil Pollution (FUND 1992) (Ratification date: 17 August 2002).
- The 2003 Protocol to the International Convention on the Establishment of an International Fund for Compensation of Oil Pollution (FUND 2003) (Ratification date: 25 November 2011).
- International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC 1990) (Ratification date: 11 June 2003).
- Protocol on Preparedness, Response and Cooperation to Pollution Incidents by Hazardous and Noxious Substances (OPRC-HNS 2000), (Ratification date: 27 June 2013).
- International Convention on Civil Liability for Oil Pollution Damage (CLC 1992) (Ratification date: 27 July 2001).
- International Convention on Salvage (SALVAGE 1989), (Ratification date: 24 May 2014)**.**

During SGFD Phase 1 ESIA, a risk analysis study for the offshore and coastal transition section was conducted in comply with the Law Pertaining to Principles of Emergency Response and Compensation for Damages in Pollution of Marine Environment by Oil and Other Harmful Substances. This Law and its related Regulation obliges coastal facilities, including pipelines, to prepare a Risk Assessment and Emergency Response Plan. In this context, since there are coastal facilities in the Project, the Emergency Response Plan has been prepared by an organization authorized by Republic of Türkiye Ministry of Environment, Urbanisation and Climate Change.

The Emergency Response Plan includes a spill response plan. According to the IFC – Environmental, Health, and Safety Guidelines for Offshore Oil and Gas Development (2015), a spill response plan should include:

"Oil spill trajectory modelling supported by internationally recognized models (in accordance with the relevant regulatory jurisdiction prescriptions, if any), for the prediction of oil fate and relevant environmental impacts for a number of spill simulations (including worst-case scenario, such as blowout from an oil well), with the ability to input local current and wind data."

8.3 Spill Spreading Modelling

During the Phase 1 ESIA process, a spill spreading modelling study was performed in July 2021 by Prof. Dr. Ersan Başar from the Black Sea Technical University. This study simulated the spatial and temporal dynamics

of an oil spill for the SGFD offshore operations and the Emergency Response Plan for the TPAO Coastal Logistics Center at the Filyos Port. The study utilized meteorological and oceanographic data to model current patterns and provided a basis for simulating various spill scenarios. The spill scenarios included different fuel types under calm and windy conditions during ship berthing activities, and the results informed emergency response strategies.

For Phase 2, a similar spill spreading modelling study will be conducted to assess potential risks related to the new offshore facilities, including the Floating Production Unit (FPU). The methodology and assessment approach will be consistent with that used in the Phase 1 study. However, the study will specifically focus on the offshore spill risks associated with the FPU and the newly installed subsea production system (SPS), Subsea Umbilicals, Risers, and Flowlines (SURF), and export pipeline.

8.3.1 Offshore Oil Dispersion

The study performed for Phase 1 simulated different oil spill scenarios using models that considered surface runoff and current behaviours. In the offshore oil dispersion study, the Princeton Ocean Model (POM) was used to simulate the current movements and the General NOAA Oil Modelling Environment (GNOME™) model was used to analyze how oil spills might spread under different wind conditions. Two hypothetical ship accident locations were considered where one is within the Sakarya Gas Field area and the other one at the phase-2 pipeline route, with wind directions from the Northeast (NE) and Northwest (NW), and intensity of both at 5 m/sec. Spill scenarios were created for diesel (10MT, 100MT) and Fuel Oil No. 4 (100MT, 1000MT), and simulations modelled the movement of the oil spill over time.

The results showed that wind direction and intensity play a significant role in determining the spread and eventual shoreline contact of spilled oil, with spills reaching the shore between 6 to 36 hours, depending on the scenario (i.e. wind conditions, location of accident and amount of oil spilled).

The modelling results revealed that oil evaporation rates varied between 21% and 37%, with the remainder of the oil reaching the shore or spreading along the coastline. For example, in the NE wind scenario, fuel spread toward the south-southwest before turning northeast and making contact with the shore after 24 to 36 hours. In the NW wind scenario, the fuel moved more rapidly toward the shore due to the combined effect of wind and currents, with up to 30% of the fuel evaporating before reaching the coast. These findings help to determine emergency response methods, such as deploying containment booms to control the spread of the spill.

Response strategies after fuel spillage offshore

According to spill modelling conducted, wind direction and intensity are critical factors in oil spill behaviour in offshore. In the event of a spill, the fuel moves towards the shore following the dominant wind directions. For example, in northeast winds, the fuel tends to move southwest initially, later shifting southeast. The study showed that in some cases, contact with the shore could occur within 6 to 20 hours, depending on the spill location. Quick response is essential to control the spread of spilled fuel, especially using response booms at the initial stages. To facilitate rapid intervention, oil spill response materials, including booms, must be readily available and easy to deploy. Boats with sufficient engine capacity should also be prepared to carry and tow booms for effective containment of the spill.

Emergency response strategies will be reassessed in the scope of Phase 2 for the expanded offshore infrastructure.

8.3.2 Oil Dispersion in the coastal area – port

In the oil spill dispersion modelling for the coastal area-port, surface runoff was identified as a critical factor in determining the spread of oil after ship accidents. Using the Princeton Ocean Model (POM) to simulate current movements and the NOAA Oil Modelling Environment (GNOME™) model, the study assessed how oil spills might spread based on changing wind directions and intensities. Two locations within the port area were identified as potential spill sites (M1 location is for ships entering the port, and M2 location is for docking scenarios). Scenarios were simulated using different wind conditions, with wind speeds ranging from 2 m/sec to 20 m/sec. Four different fuel spill amounts were considered: 10MT and 100MT for diesel, and 700MT and 75MT for Fuel Oil No. 4.

The results of the simulations revealed that the wind plays a significant role in directing the spill toward the shore or open sea. In some scenarios, the fuel reached the shore within 30 minutes, while in others, it took several hours depending on where the accidents happen. The evaporation rate of the fuel varied between 0.5% and 14%, depending on the wind and fuel type. These findings are essential for determining effective response strategies and highlight the importance of rapid intervention with containment booms and other spill response equipment.

A similar assessment for coastal spills related to Phase 2 logistics will be conducted, focusing on the potential impact of increased offshore activity and the expanded export pipeline network.

Response Strategies After Fuel Spillage in The Coastal Area-Port

In the coastal area, wind direction plays an equally important role in oil spill dispersion, especially within port areas. Modelling simulations show that fuel tends to accumulate in the dock area under the influence of dominant winds, quickly reaching the shore. High wind intensity can drive the fuel towards the shore in a short amount of time. Immediate response is crucial to contain the spill using response booms, which help to prevent further dispersion within the port. Oil spill response equipment and materials must be kept in easily accessible locations at the terminal, ready for deployment. It is also important that boats with sufficient towing capacity are available to assist in positioning and managing the booms effectively to minimize spill impacts.

8.4 Accidental Releases

Accidental releases may result from several sources including:

- Spillage or discharge of Potentially Hazardous Substances from vessels or FPU.
  - Vessel collisions resulting in release of vessel fuel to sea.
  - Spillage or Discharge of Potentially Hazardous Substances other than Fuel/Oil from vessels or FPU.
- Gas leakages and Fire.
- Chemical Leakage from the submarine cable and pipelines.

Spillage or discharge of Potentially Hazardous Substances from vessels or FPU: The main chemicals onboard include fuel, lubrication oil and hydraulics for the maintenance of equipment and machines. Coating products, all detergents, solvents, and hydro chemical products (chloride, corrosion inhibitor, oxygen cleaner, ethylene glycol, methanol, paint) are other types of chemicals, which can be found on vessels and are stored in barrels and/or bulk containers. In addition to vessels, FPU will include storage of rich and lean MEG, TEG, methanol, sodium carbonate (Na_2CO_3), sodium hydroxide (NaOH), oxygen scavenger, scale inhibitor, and corrosion

inhibitor via storage tanks. In case of spillage of these chemicals into the sea, firstly, the source of the spillage must be isolated. Then, the spread of the spillage must be prevented by placing a sorbent barrier around the spillage depending on the size of the spilled chemicals.

To prevent hazards from the operations mentioned above, a safety cordon of 2 km is necessary around the vessels and FPU operating offshore and minimum 500 m around the vessels operating at the coastal transition zone during the operation of the vessels. The construction and operation vessels, and FPU will notify Turkish Naval Forces, Office of Navigation, Hydrography and Oceanography (ONHO) of their locations and working schedules and the sailors of the third-party vessels will be required to cruise from a distance designated for the Project construction vessels with announcements.

In addition, the actions to prevent these spills are:

- Ensuring that the operations are carried out in accordance with the MARPOL, Convention on the Protection of the Black Sea Against Pollution (Bucharest Convention), and national regulations.
- Ensuring that the operations including the supply chain are carried out in accordance with the COLREG, Convention of International Regulations for Preventing Collisions at Sea (1972).
- All the contractors and operators working under the Project develop and efficiently implement Ship Oil Pollution Emergency Plans as per MARPOL 73/78 Convention and related guides for each vessel.
- Protection of chemicals onboard by keeping them inside packages in very small amounts so that they will not leak from the vessels.
- Regular inspection of the storage tanks and associated equipment on FPU to identify and address potential wear, corrosion, or damage. Implementation of maintenance schedule for replacing seals, gaskets, and valves to prevent leaks.
- Use of automated leak detection systems (including overflow of the chemicals) on FPU, such as sensors for liquid and gas leaks, and ensure the system is linked to an alarm that triggers a quick response.
- Prevention of uncontrolled reactions between stored materials/chemicals that could results subsequent leak and releases by applying relevant regulatory applications in storage.

Gas Leakages and Fire: The risk foreseen in the operating phase of the Project is natural gas leakage because of any possible damage on the submarine cable and pipelines. A natural gas leakage from a minor puncture or tear over the lines does not cause any danger over the sea surface. A wind at a minimum velocity easily disperses the natural gas which is lighter than the air to the atmosphere. Since natural gas will mix directly into the atmosphere, there is no risk of polluting the sea and it does not harm the marine species because it is not poisonous.

Chemical Leakage from pipeline and cable: Liquid chemicals will be transported in the submarine cable and pipelines (within the SPS and SURF area) during the operating phase of the Project. Chemical leakage may occur because of any possible damage to this line. The impact of these chemicals on the aquatic life and their behaviour in the marine water are critical. The behaviour of a substance poured into the sea changes during the first couple of hours after the contact with water. Being able to predict this behaviour is one of the most important steps to develop an intervention strategy. Therefore, the behaviours of the chemicals will be evaluated

according to SEBC-Standard European Behaviour Classification principles and appropriate intervention methods will be determined.

The likelihood of the possible hazards from the operations mentioned above to damage the submarine cable and pipelines is very low but it exists, and such a situation may result in gas leakage from the damaged submarine cable and pipeline. Engineering design standards and quality assurance throughout construction, combined with the high external pressure above the pipeline at a water depth of 2,200 m, it is extremely unlikely for such an incident to occur.

For a fire incident to impact the receivers, an ignition over the sea surface must jump onto a cruising vessel following a submarine cable and pipeline failure and gas leakage. The highest probability of such an incident occurring is that an object such as a container or the vessel itself causes an impact on the pipeline, as described above. Such an incident was considered negligible since it is not observed statistically either offshore or in the coastal regions.

The mitigating measures to be implemented to minimize the likelihood of any chemical spill/leakage and to minimize possible adverse effects potentially affected aquatic species and habitats include:

- In addition to the Emergency Response Plan, the number of personnel, quantity of materials and equipment required to be kept in the coastal facilities for preparedness and response, within the scope of Article 23 of the "Implementation Regulation of the Law on the Principles of Emergency Intervention and Compensation of Damages in Pollution of the Marine Environment with Petroleum and Other Harmful Substances" are determined based on the risk assessment and the tools, supplies, materials, and equipment to be used will be provided as per the national and internationally accepted standards. The employees will be provided with training on preparedness and response to oil and other harmful substances as well as equipment and materials to minimize the risk of accident during the construction and operation phases.
- Communiqué No. 2009/4 on the Election of the Companies/Institutions/Organizations that can be charged with Response in Emergencies in the Pollution of the Marine Environment with Petroleum and Other Harmful Substances, and the Working Procedures of the Companies/Institutions/Organizations and Coastal Facilities with Authorization Certificates states that service procurement or keeping the personnel, material, and equipment available on-site is mandatory for Level 1 risks. In addition, contract will be signed with the company/institution/organization authorized as per this Communiqué for the Level 2 or 3 risks identified and this contract will be kept in the site.
- As per Article 19 of Circular No. 2010/4 on “Procedures and Principles of Training Seminars and Practice Programs on Preparedness and Response to Pollution Caused by Petroleum and Other Harmful Substances”, coastal facility needs to fulfil the requirements of this Circular within latest six months following the date of approval of emergency response plans by the Ministry. Thus, facility personnel will receive their training from the companies authorized to hold emergency response training seminar and develop exercise program as per this Circular.
- As per Article 8 (Guarantees of financial liability) of the Law No. 5312 on the Principles of Emergency Intervention and Compensation of Damages in Pollution of the Marine Environment with Petroleum and Other Harmful Substances entered into force by being published in the Official Gazette No. 25762 on 11.03.2005, “Coastal facilities shall be obliged to take financial liability insurance against the damages under this Law. “Coastal Facilities Marine Pollution Compulsory Liability Insurance” will be taken out as per the statement “Coastal facilities that fail to comply with the requirement to take insurance shall not be allowed

to operate" before the facility is put into service. As per Article 41 of the "Implementation Regulation of the Law on the Principles of Emergency Intervention and Compensation of Damages in Pollution of the Marine Environment with Petroleum and Other Harmful Substances, coastal facilities will be insured by the insurance companies designated by T.R. Ministry of Treasury and Finance since liability insurance against the damages specified under the Law is compulsory and the facilities must be insured by these companies.

The mitigating measures mentioned above will minimize the likelihood of an oil and other harmful substance spill/leakage therefore possible adverse effects on the aquatic life will have been mitigated.