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Report on Major Hazards Design notification

N05-A Offshore Platform

Report

Client	ONE-Dyas B.V.
Reference	N05A-1-40-0-12530-01
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Document info

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Summary

ONE-Dyas B.V intends to develop the newly discovered N05 field located partly in Dutch territorial waters and partly in German territorial waters. For this purpose, a new platform will be constructed, named N05-A.

The design notification provides a high-level description of the installation design and how the installation will be operated. Furthermore, the design notification reflects the alternatives and choices made in the design of the installation. It describes the Major Accident Hazards and their mitigations. The design notification describes the justification that the selected option will present the lowest overall risks, or alternatively, shows that the cost and effort to adopt the lowest risk option is grossly disproportionate to the benefit.

The design notification is a forerunner report of the combined Report on Major Hazards[1], which has to be prepared and approved by State Supervision of Mines (Staatstoezicht op de Mijnen-SodM) before start-up.

Several concepts have been evaluated. The selected concept is a standalone platform designed for gas, condensate and production water processing. The treated gas and condensate will be exported via a tie-in on the existing main gas pipeline (NGT-line) to the mainland. The required energy for the platform operations will be supplied (as electricity) from the nearby offshore windfarm (Riffgat).

The platform will be designed as a not normally manned installation and will be controlled from an onshore control room. The platform will be visited for maintenance purposes and for process upsets as required. The living quarters will support overnight stay of maintenance staff during maintenance periods and shutdowns. The platform will be equipped with a helideck for personnel transfer.

During the basic design of the installation, safety studies which analyse the hazards and risks related to the operation of the installation have been carried out. Amongst others a HAZID, a HAZOP, a Scenario Based Risk Assessment and a Major Accident Hazard Identification have been carried out. Furthermore, Safety and Environmental Critical Elements have been identified. The exiting studies will be updated in case relevant in the upcoming detailed design phase and will be presented in the Report on Major Hazards (which is prepared for the operational phase). The Report on Major Hazards will also include additional Safety Studies, such as the Quantitative Risk Assessment.

Part of the permitting process for the development of the N05 field, is to execute an Environmental Impact Assessment (Milieu Effect Rapportage-MER). In the MER the potential effects on nature and environment from drilling wells, installation of platform and pipeline and production operations are described in an integrated, objective and systematic way.

A Health, Safety, Environment and Quality Management System is used by ONE-Dyas. Application of this system allows ONE-Dyas to manage all risks within design, construction, and operations (including abandonment) as well as quality of services. Furthermore, the management system aims to improve performance of the organisation continuously.

[1] In Dutch known as 'Rapport inzake Grote Gevaren' or in short 'RiGG'

1. Introduction

1.1 General

A joint venture consisting of Hansa Hydrocarbons Limited, EBN B.V. and ONE-Dyas B.V has discovered potentially recoverable natural gas in the GEMS area. On August 2017, ONE-Dyas discovered the N05-A field located partly in Dutch territorial waters and partly in German territorial waters. Since April 2018, ONE-Dyas is the field operator and plans to develop the N05-A field with a NNMI (Not Normally Manned Installation) gas / condensate production platform.

The development of the N05-A block is in line with the objective of the Dutch Small Fields Policy, which is to develop the natural gas reserves from the small fields to the maximum extent possible. The proposed gas extraction from field N05-A is in line with the objectives of the Dutch energy policy.

Five main activities that are planned on the N05-A field are as follows:

- Drilling and completion of the N05-A wells;
- Construction and installation of the platform,;
- Construction and installation of the export pipeline and of the electric power cable;
- Production, treatment and export of gas and condensate;
- Abandonment and decommissioning.

The three possible export routes to export the recovered gas are via a:

- Pipeline to Eemshaven: The wet gas and condensate will be treated at a new Eemshaven facility;
- Pipeline to a hot tap in the NGT: Gas/condensate is dehydrated at the N05-A platform and directly exported to the NGT and;
- Pipeline to AWG: Wet gas is exported to AWG where it is dehydrated and exported via the NGT to shore.

In the current design, the N05-A platform is designed as a gas treating facility where the gas is treated to meet the specifications of the NGT-line. The NGT-line is an existing gas main transporting line that enables offshore production facilities to export gas and condensate to shore for further treatment.

1.2 Objective

This design notification has been drafted to meet the following objectives:

- Demonstrate that N05-A platform has been designed and can be operated in compliance with all relevant legal HSE requirements;
- Hazards with the potential to severely injure people, cause negative impact to the environment, and/or create significant damage to the installation, have been identified and where possible eliminated. The risks and effects have been evaluated and will be minimized to a level that is ALARP;
- All reasonable measures have been provided to enable safe escape, evacuation and rescue in the event of fire or other severe incidents;
- ONE-Dyas' general goals and acceptance criteria with respect to HSE will be met.

These objectives are in line with the Labour Conditions legislation as stated in article 2 of the Labour Conditions Act and article 45m of the Mining Law. The legislation stipulates that an HSE document (Veiligheid en Gezondheid document) for fixed mining installations must be prepared and submitted.

Oil and gas producing installations are mining installations under the Dutch law. The Dutch legal framework requires that an HSE document is developed at various stages in the life cycle of any mining installation. For this purpose, a preliminary Health Safety and Environment Case, i.e. design notification, is prepared during the DEFINE phase of the N05-A project.

ONE-Dyas values the workforce involvement in all its activities. To ensure workforce involvement in the design stage of the project, ONE-Dyas's Offshore Installation Manager (OIM) and operators are involved and engaged in the design and risk assessments of N05-A.

This report furthermore follows the Offshore Safety Directive 2013/30/EU (OSD) standards and the underlying national implementing regulations such as the Mijnbouwwet,-besluit,en-regeling and ARBO-wet,- besluit,en-regeling. The OSD outlines the requirement of a Report on Major Hazards (RoMH), also known as "Rapport inzake Grote Gevaren" (RIGG) in Dutch. The RoMH is combined with the HSE Case (VG document in Dutch).

The RoMH/RiGG describes:

- The identified Major Hazards;
- The Safety and Environmental Management System (SEMS);
- A policy of control of major accident prevention (CMAPP);
- A description of the independent verification process.

2. HSE management system

The following elements are addressed in this chapter:

Policy
ONE-Dyas's commitment to health, safety and the environment and major accident prevention is set out in the Policy Statement, see Chapter 2.1.

System
The Health, Safety, Environment and Quality Management System (HSEQ MS) manual described in Chapter 2.2 presents a general overview and a short description of policies, procedures, practices and instructions related to HSEQ management system.

ONE-Dyas Organisation
Chapter 2.3 addresses the organisational structure for the ONE-Dyas.

Planning and implementation
Chapter 2.4, 2.6, 2.7 outline the general HSEQ MS processes that control the risks associated with the N05-A activities, including:

- The approach to workforce participation in health, safety and environmental matters and communication of HSEQ-related information to personnel;
- Risk Assessment and risk management, including the management of major accident hazards;
- Management of emergency response.

2.1 Policy

Regarding this document, the following policies are applicable:

Health, Safety & Environmental Policy (HSE Policy): The ONE-Dyas HSE Policy is the highest-level document of the ONE-Dyas HSEQ MS set out and endorsed by the CEO. The ONE-Dyas HSE policy has been included as Appendix 1. The policy provides a high level of goals and objectives that have to be realised to fully meet the stated commitments. The HSEQ management provides the tools and systems required to support the realisation of the goals and objectives.

Corporate Major Accident Prevention Policy (CMAPP): The CMAPP (ref. 10) establishes the overall actions for mitigating the risk of a major accident and describes the arrangements that have been put into effect. The CEO has overall accountability for the prevention of major accidents and ensuring the CMAPP is suitable, implemented and operating as intended.

The document also demonstrates that the role of safety and environmental protection standards, in maintaining management and control of major accident hazards, is recognised and fully understood by the management.

Appropriate measures are in place to ensure that, as far as reasonably practicable, there are no unplanned loss of containment incidents of hazardous substances from pipelines, vessels and systems. In addition, there are measures in place to prevent failure of a single containment barrier leading to a major accident.

The CMAPP outlines the reliability and integrity requirements of all safety and environmental-critical systems and bases inspection and maintenance systems on achieving the required level of safety and environmental integrity.

2.2 System

To support execution of activities in compliance with the HSE policy, ONE-Dyas has a Health, Safety, Environment and Quality management system (HSEQ MS). Application of this system enables ONE-Dyas to manage the risks associated with ONE-Dyas' activities. such as construction, production and abandonment.

The HSEQ MS reflects the principles of the latest versions of the (inter-)national management system standards ISO 9001, OHSAS 18001, ISO 14001 and NTA 8620 to ensure that health, safety, environment, quality and asset management issues are systematically identified, controlled, and monitored. Since 2015 the NL and UK operations are certified for ISO 14001. In 2017, the HSE management system is reviewed against NTA 8620.

The HSEQ MS enables ONE-Dyas to control its HSE risks and the quality of its services and improve the HSEQ performance. With its HSEQ MS, ONE-Dyas strives to:

- To eliminate or minimize risk to ONE-Dyas and stakeholders who may be exposed to HSE risks associated with its activities and provide a safe workplace for all employees and contractors;
- Protect the environment from unnecessary impact and degradation from its operations and minimize waste;
- Maintain compliance with all applicable laws and regulations and assure itself of its conformance with its stated Health, Safety, Environmental and Quality policies;
- Demonstrate such conformance to others and maintain the social license to operate and establish a Quality Management System to optimize stakeholder satisfaction;

ONE-Dyas believes that these objectives can best be achieved by:

- Developing and implementing a comprehensive and documented HSEQ MS and by ensuring that each of the Company's business entities (including 'one-off' projects) operate to the HSEQ MS standards;
- Conducting its business to meet or exceed the higher of ONE-Dyas or local HSE regulatory requirements in all jurisdictions in which we operate.

The HSEQ MS enables a structured, efficient and integrated way of working with the help of several working agreements written down in (work-) processes, procedures, (work-) instructions, standards, guidelines, etc.

To address the commitment to establish, document, implement, maintain and improve an HSEQ MS, ONE-Dyas has developed a system that follows the Deming-cycle (Plan-Do-Check-Act). This four-phase structure, as described below, provides a continuous improvement, feedback cycle consistent with the management system concepts that underlie the various international management system standards and has been translated into the HSEQ Management System documentation structure.

Plan: Identification of risks and regulations; ensuring the necessary planning is carried out and measures (technical / organizational) are in place to control risks and impacts.
Do: Implementing the planned activities.
Check: Monitoring whether the activities are performed according to plan and measures as taken are adequate.
Act: Take corrective and preventive actions if necessary.

2.3 ONE-Dyas Organisation

The ONE-Dyas organisational structure is described as part of the implementation of the HSEQ MS. The overall management organisation and the structure for the operation and support of ONE-Dyas operational installations is shown in Figure 1.

Figure 1: Organogram ONE-Dyas B.V

2.4 Planning and Implementation

2.4.1 Workforce involvement

ONE-Dyas promotes a positive safety culture amongst its employees. It is expected that personnel will intervene when any unsafe acts are observed. Strong leadership will support and enhance the safety culture within the organisation and focus on continuous safe operation.

The ONE-Dyas COO is responsible for promoting the Company HSE culture by communicating the emphasis on HSE through safety meetings and workshops. Clear and consistent messages on the high priority of safety are continuously reinforced during all communications from senior leadership to all levels of the workforce.

It is an expectation to all employees, contractors and visitors to comply with and promote good health, safety and environmental practices as the minimum standard when working directly or indirectly at any ONE-Dyas location.

Offshore personnel is furthermore involved in the preparation of the Report on Major Hazards. Input of offshore personnel has been used to identify the Major Hazards and to evaluate the consequences of potential incidents.

Workforce participation: Key offshore personnel, such as OIMs and supervisors, are involved in the preparation, review and update of the HSE document. Relevant parts of the HSE document will be discussed and explained to the offshore crews.

Offshore impact on compliance with the HSE document is largely via ensuring that process activities are exercised within defined operating envelopes and instrumental setting and the integrity of installations is maintained; next to the general HSE behaviours. These roles have to be explained to staff offshore.

Stakeholder consultations: ONE-Dyas regularly engages with business partners and stakeholders; a list of stakeholders is controlled in a stakeholder register [Ref. 5] This helps to determine the level of engagement and the frequency of meetings required. Meetings are held with the Competent Authority Staatstoezicht op de Mijnen (SodM) when and where required.

Whistle-blowers: ONE-Dyas has a Speak up policy. The policy allows for reporting of workplace-related concerns and describes roles and responsibilities as well as rights and obligations. The policy explains how concerns or issues can be reported, is it a serious one or one that may seem less serious, but nevertheless requires attention. The policy describes how reports of concerns and issues are handled and which rights and obligations apply. ONE-Dyas will take every reasonable effort to ensure a fair and objective handling of all reports.

Safety programmes: All locations receive automatic alerts from “UK Stepchange” concerning any safety related issue of other Oil and Gas operators. Where relevant, ONE-Dyas will make alerts on own experiences and share those when relevant to outside parties as well.

Information on Major Hazards and Control Measures: Information on major hazards and control measures is communicated to personnel via participation in HSE document roll out sessions and face-to-face discussions with HSE department and access to the HSE document.

The Maximo CMMS contains all the information for operations technicians regarding what equipment needs to be tested, how to test it and references to the relevant performance standards and other key documents. Safety and Environmental Critical Elements (SECEs) are highlighted in the system, hence personnel are aware when equipment they are testing/maintaining is a key prevention or mitigation measure for a major accident. Performance indicators are available to give insight in performance over time. The Verification and Examination Scheme (VES) is also available to all operations technicians and includes information highlighting how major hazards are controlled.

2.5 Risk assessment and Risk management

The HSE management system aims to identify the hazards of ONE-Dyas’ activities. ONE-Dyas carries out Major Hazard identification for all its assets. Each asset has a hazard register listing the foreseeable hazard scenarios, ranked according to risk. The asset hazard registers also detail the prevention and mitigation barriers in place. The hazards will be periodically reviewed when the HSE document is updated (minimum every 5 years) and verified as part of the HSE document thorough review process.

By means of risk assessments and the risk matrix, risks are evaluated, mitigating measures identified and, if required, additional measures are identified to minimise risk levels to acceptable levels. See chapter 6 for the process of risk assessment and risk management for N05-A.

2.6 Management of Major Accident Hazards

2.6.1 General

The management of Major Accident Hazards is divided in different processes. These processes are combined to provide a full assessment of the hazards identified on the installation, an estimate of the risks associated with the installation, the assurance of the established levels of safety with respect to major accident hazards, environmental protection from Major

Environmental Incidents (MEI) and demonstration of the ALARP status of the installation via the preparation of installation scenarios.

The activities involved in this process are as follows:
1. Major Accident Hazard Identification (including Major Environmental Incidents, see section 6.4);
2. Assessment of Major Accident Hazards combined with Control and Recovery Measures in the safety studies, see section 6.5;
3. Integrity Management, the process by which SECEs are assured as suitable to manage the Major Accident Hazards, see the following paragraph.

2.6.2 Verification and Examination Scheme

The ONE-Dyas verification process is part of the overall ONE-Dyas methodology for the management of Major Accident Hazards. The N05-A Verification and Examination Scheme will be in place in order to comply with the requirements of Article 45l of the Mijnbouwwet and is set-up conform the NOGEPA standards 48 and 49.

The objectives of the ONE-Dyas Verification and Examination Scheme (VES) are:
1. To set in place independent and competent scrutiny of those parts of the installations operated by ONE-Dyas, which are critical to safety and environment, in order to obtain assurance that those parts of the aforementioned installations remain in a satisfactory condition;
2. To ensure throughout the life cycle of the ONE-Dyas installations, that appropriate examinations of SECE are performed and independent confirmation that they are suitable for their intended purpose is carried out.

2.6.2.1 Safety and Environmental Critical Elements

A Safety & Environmental Critical Element (SECE) is any part of a facility or plant that has the purpose of preventing or limiting the effect of a major accident.

SECEs are identified based on a review of the measures to prevent, detect, control or mitigate the N05-A Major Accident Hazards. The following Safety and Environmental Critical Elements have been identified [Ref. 15]:

#	SECE	Applicable for N05-A
01-P-HYC-a	Containment of Hydrocarbons Facilities	Yes
01-P-HYC-b	Containment of Hydrocarbons Wells	Yes
02-P-HYC	Pipeline Systems	Yes
03-P-STR	Structure	Yes
04-P-CPR	Collision Prevention	Yes
05-P-LIFT	Lifting and Dropped Objects	Yes
06-D-F&G	Fire and Gas Detection	Yes
07-P-IGN	Prevention of Ignition	Yes
08-C-ESD	ESD & Isolations and blowdown	Yes
09-P-PR	Pressure Relief	Yes
10-M-VEN	Ventilation Systems	Yes
11-M-FES	Fixed Fire Extinction Systems	Yes
12-M-FEP	Fire and Explosion Protection	Yes
13-M-POF	Portable Fire Prevention	Yes
14-C-EPS	Emergency Power systems	Yes
15-C-COM	Emergency Communications	Yes
16-E-MUS	Muster Stations	Yes
17-E-E&E	Evacuation and Escape	Yes

18-E-LIG	Emergency Lighting	Yes
19-E-PSE	Personal Survival Equipment	Yes
20-E-ESS	Escape by Sea	Yes
21-E-R&R	Rescue and recovery Systems	Yes

2.6.2.2 Performance standards

For each SECE maintenance frequencies, instructions, inspections and performance standards are defined. Performance standards are defined as:

- "The stated level of performance of a Safety Environmental Critical Element, piece of Personal Protective Equipment or Plant, compliance with the standards which will ensure its suitability throughout the Lifecycle of the Installation. Suitable means being appropriate for intended use, dependable and effective when required and capable of performing as intended. This suitability may be expressed in terms of functionality, availability, reliability and survivability and can be either qualitative or quantitative."

Setting up the schemes, instructions and performance standards are executed by various parties including vendors. The Responsible Engineer for the relevant discipline has to approve the scheme within the ONE-Dyas organisation and instructions in view of integrity management.

In case of a significant change in the design and/or performance of a SECE, the engineering package is submitted to the Independent Competent Verifier (ICV) for approval. The MoC database with all the MoCs is accessible for the ICV.

2.7 Emergency response

An Emergency Response Policy [Ref. 6] has been prepared which explains the emergency response organisation and its tasks, roles and responsibilities.

Based on the Emergency Response policy an Emergency Response Plan (ERP) has been prepared [Ref. 7]. The purpose of the ERP is to outline the Emergency Response Organisation (on- and offshore) and provide information that is needed to respond to emergencies in a safe, rapid, effective and efficient manner. The ERP is in line with the EU Directive 1112/2014/EU and NOGEPA standard 52.

Other ONE-Dyas emergency response documents that are in place are:
- Comprehensive Source Control Emergency Response Plan (Well Control & Blow Out Contingency Plan);
- Offshore Oil Spill Emergency Response Guideline;
- Pipeline Emergency Procedure;
- Crisis Communication Guideline.

2.7.1 Emergency response organisation

The ONE-Dyas Emergency Response Organisation (NL) consists of three levels that correspond with the incident level. Incident levels are grouped into three categories, tier 1, tier 2 and tier 3, as shown in Figure 2.

Level 1 /Tier 1 incident: Minor incidents on an installation with no potential for escalation, e.g. an accident requiring a MEDEVAC. A minor incident can be managed locally by the On Site Team (OST) under the command of the On Site Coordinator (onshore location supervisor or offshore installation manager). The OST will try to secure the situation on site, or together with external emergency services.

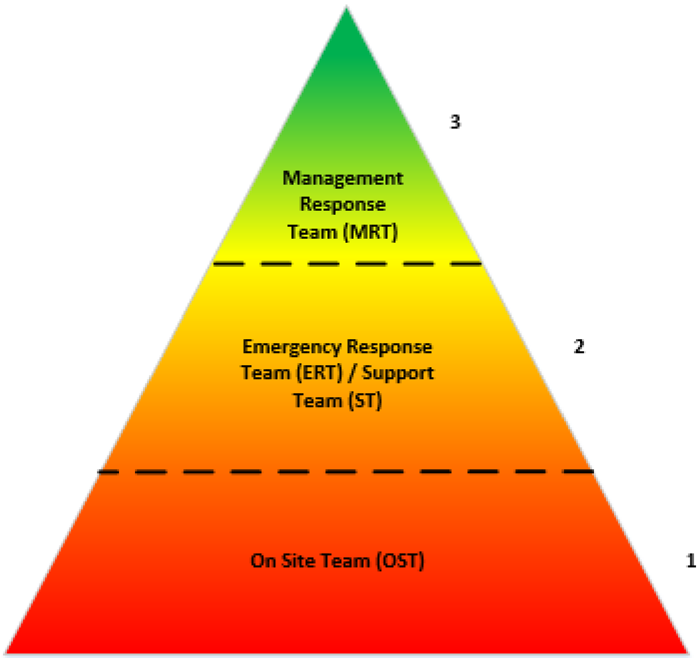

Figure 2: Emergency Response Organisation - schematic

Level 2 / Tier 2 Incident: Moderate incident that requires a more involved response such as relative and media communications. A moderate incident can be managed by activating the Emergency Response Team (ERT) in the ONE-Dyas office in Amsterdam who are under the direct command of the Emergency Coordinator (EC). The ERT is supported by the Support Team (crisis communications, relative response, financial and legal). The ERT provides overall coordination of all activities involved that are needed to support the On Site Team.

Level 3 / Tier 3 Incident: Major - These incidents have a broad impact on the safety of personnel, the environment, physical assets, and especially the company's reputation. A major incident requires the activation of the Management Response Team (MRT) led by the Crisis Manager (strategic level). The MRT has the same responsibilities as the ERT and additionally deals with strategic aspects such as long term effects and support, reputation and business continuity.

ONE-Dyas has a 24/7 contract with external communication professionals and a trauma support team for dealing with next of kin, platform crew and post trauma situations. The ONE-Dyas ERP includes a detailed description of the Emergency Organisation [Ref. 7].

2.7.2 Local emergency response plan

The goal of the Local Emergency Response Plan (LERP) is to assure that in case of an emergency, actions can be carried out swiftly, structured and efficiently in order to prevent and limit the consequences. Furthermore, it also supports the On-Site Team by:

- Describing the installed fire protection, firefighting and rescue equipment;
- Describing the local organisation, the responsibilities, the action plans and the communication schedules;
- Using it for scenario-based drills and training.

The LERP will be prepared for the operational phase of the installation.

2.7.3 Training

Offshore personnel that fulfil an emergency response role are trained as according to NOGEPA training handbook. Personnel with new emergency response responsibilities receive induction training in their role to get acquainted with emergency and rescue equipment and operating procedures. The crew, including the cook, is multi-skilled and trained.

2.7.4 Drills and exercises

To ensure that the emergency response procedures are executed efficiently, regular drills and exercises are necessary. In case the platform is manned for a significant period (more than a couple of days), drills will be scheduled offshore.

Onshore-based emergency exercises are also held to test the onshore emergency response organisation, arrangements and procedures. Annual one or two exercises are held with the ERT.

3. Facility Description

In this chapter, a description of the facility is given, which has been based on the Basis of Design document for N05-A [Ref. 1].

3.1 Installation

The N05-A topsides will be developed to accommodate 10 wells. 8 wells are planned to be drilled initially. Each of these wells will be drilled in different time intervals. The remainder of the well slots are to accommodate possible future wells. The platform will be operated as a NNMI and will have living quarters to accommodate planned overnight stay.

3.1.1 Location

The N05-A field is located about 20 km north of Schiermonnikoog and Borkum. Water depth at the location is approximately 25 m [Ref. 14].

The N05-A platform location will be:

N05-A coordinates (WGS84)

N05-A	Coordinate
Latitude	53°41'03.718
Longitude	6°21'32.188

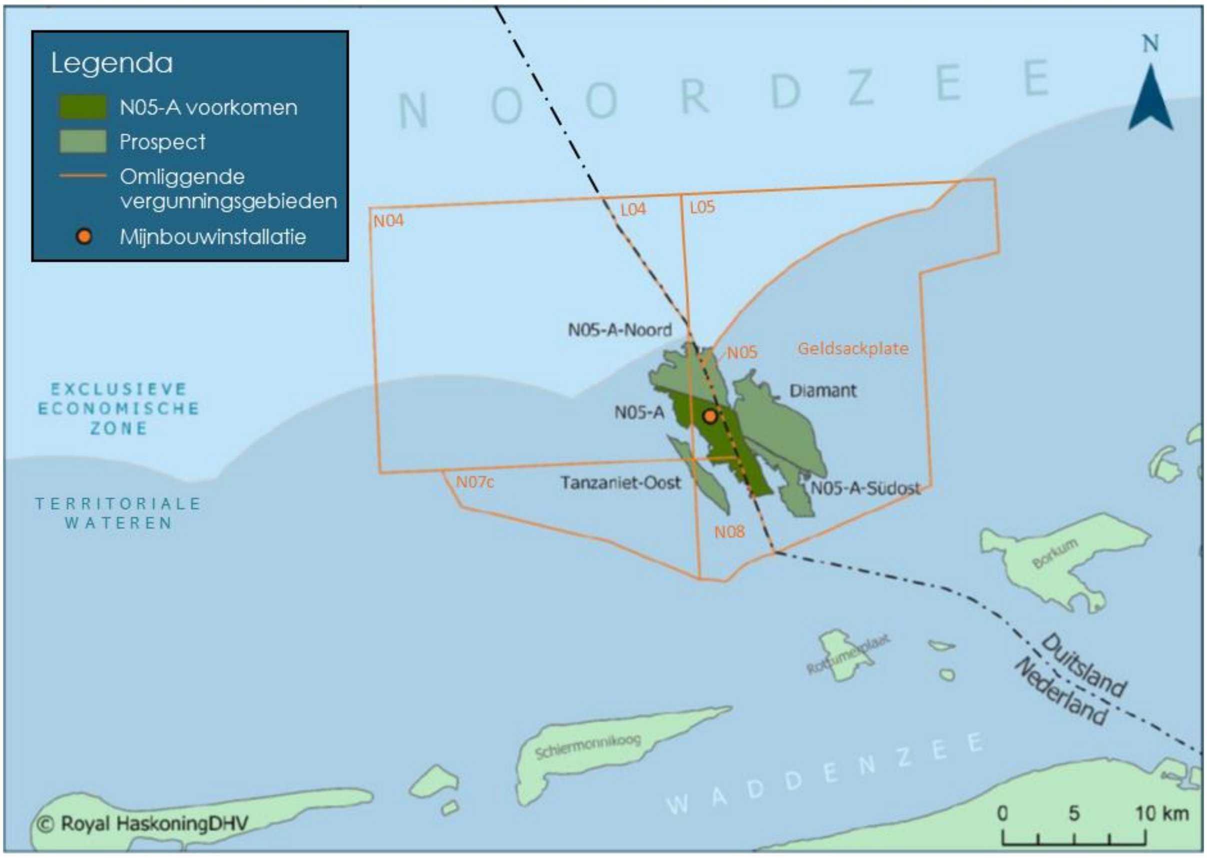

Figure 3: N05-A Field Layout

3.1.2 Process Design Data

The composition of reservoir fluids are given in the table below.

Table 3.1:Composition of reservoir fluids in N05-A

Component	Mole %
CO_2 – Carbon dioxide	1.288
N_2 – Nitrogen	23.995
C1 Methane	69.600
C2 Ethane	3.455
C3 Propane	0.864
iC4 i-Butane	0.135
nC4 n-Butane	0.220
Others	<0.1

The condensate to gas ratio (CGR) is relatively low (5-20 m^3 / MM Nm^3 gas). The produced water to gas ratio (WGR) is 5 - 10 m^3 / MM Nm^3. The export gas will meet the NGT specification at system entry.

3.1.3 Design intent

The production capacity is initially 4 MM Nm^3/d. The capacity can be extended to 6 MM Nm^3/d without large/complex modifications. The platform facilities will have a design life of 25 years. The platform will be a Not Normally Manned Installation (NNMI). The N05-A Platform will be electrically powered by a power cable from/via the adjacent wind park facility Riffgat.

3.1.4 Structural design

The sub-structure will be a six-legged jacket, which will be secured to the seabed by means of pile through or skirt piles. Preliminary plot plans are given in Appendix 2. The platform will be accessed by helicopter or by motion compensated gangways (such as Ampelmann or an equivalent system) e.g. W2W vessel.

N05-A will have four deck levels:

- Cellar deck at approximately +21.8 m LAT
- Mezzanine deck at approximately +25.8 m LAT
- Main deck at approximately +29.8 m LAT
- Helideck at approximately +34.75 m LAT

A future module (12 x 25.5 m) can be added to the westside of the platform, enlarging the surface of cellar deck, mezzanine deck and main deck. Preliminary plans indicate two suction scrubbers, a production separator and a slug catcher on the cellar deck level. On the main deck the module can house two HP Discharge coolers and two future compression trains. In the following descriptions of the decks the size and equipment of the future module is not considered.

3.1.4.1 Cellar Deck

The cellar deck will be approximately 24.5 x 47.5 m and will house:

- 10 well slots;
- Gas metering;
- Riser manifold;
- Gas/condensate/water separation vessels V-1200, V-1210, V-1300 and V-2500;

- Glycol contactor and regeneration package;
- Production skimmer tank T-6000 and pump;
- Water drain facilities, deck skimmer pump and tank;
- Electrical driven firewater pump;
- Sweet water tank & pumps and seawater lift pumps;
- Vent knock out drum;
- Lifeboat;
- Control & Radio room;
- Wellhead Control Panel (WHCP);
- Laydown area;
- Living Quarters / temporary refuge.

3.1.4.2 Mezzanine (intermediate) Deck

The mezzanine deck will be approximately 24.5 x 38.9 m and will house:

- Glycol-gas heat exchanger;
- Closed drain vessel V-6500;
- Instrument room;
- Recreation & mess room plus accommodation / temporary refuge;
- Motor Control Center (MCC) room.

With the following equipment present, that rises up from the cellar deck:

- Glycol contactor and regeneration;
- Production separators, V-1200 V-1210;
- Inlet scrubber V-1300;
- Future suction scrubbers;
- Vent knock out drum.

3.1.4.3 Main (top) Deck

The main deck is approximately 24.5 x 47.5 m and will house:

- Platform crane;
- Gas cooler equipment with room for future expansion;
- Emergency diesel generator;
- HVAC facilities;
- Corrosion inhibitor and methanol injection packages;
- Nitrogen systems;
- Glycol contactor and regeneration (elevated from cellar deck).

The main deck will also include a battery room and a medium voltage switchgear room, which will contain a control & protection panel along with several electrical components.

3.1.4.4 Helideck

The helideck will have a 22 m diameter helicopter landing area with a capacity of 12.6 ton. The helideck will be equipped with markings, drainage, access routes, a Fire Fighting System, portable firefighting equipment and helideck lighting.

3.1.4.5 Pipelines

The platform will be connected to the NGT pipeline via a 20” pipeline and a hot tap. The gas and condensate are exported to shore via the 36” NGT system.

Pipeline	Medium	Diameter, Length
Export pipeline to NGT pipeline	Gas and Condensate	20”, approx. 14.6 km

3.1.5 Process description

The process is illustrated in Process Flow Diagrams (PFDs) in Appendix 3. The wet gas from the wells is routed through the choke valves to the production manifold(s) via dedicated flowlines. The gas and liquids are separated in the 3-phase production separator, after which the gas is cooled by the air-cooled gas coolers.

At the bottom of the separator, the produced water is discharged to the produced water degasser vessel and the condensate is discharged to the condensate flash vessel. The condensate will then be injected into the gas export line.

During the initial years of production, the gas from the production separators is directly routed to the dehydration system under free flow. In later years of operation, as the flowing tubing head pressures of the wells decrease below the export pressure, the gas will be routed to the depletion compressor prior to dehydration and export.

Gas depletion compression (future): A 2-stage compressor with associated scrubbers and coolers is included in the depletion compressor unit. Initially, the two compressor stages run parallel, later the stages will run in series. The gas enters the suction scrubbers, separating the liquid entry. The gas is routed to the LP / HP compressor suction, while the liquids are routed to the condensate flash vessel. In coolers, hot gas from the discharge of the LP / HP compressor is cooled down.

Dehydration system: Gas dehydration is performed through the process of absorption of triethylene glycol (TEG). In the contactor, glycol absorbs the water where it is brought to contact with the wet gas. The glycol is regenerated via the TEG regeneration system where water is boiled off at atmospheric pressure.

Condensate treatment: Along with the condensate from the 3-phase production separator, the liquids from the closed drains and skimmer pumps are collected in the condensate flash vessel. The separated water is routed to the production skimmer while the condensate is routed to the condensate storage tank. The flash gas is recompressed by the off-gas compressor and re-injected in the export pipeline. The condensate storage tank is blanketed with nitrogen. Condensate is fiscally measured and pumped into the export pipeline.

Produced water treatment: The produced water from 3-phase separator and inlet scrubber is collected and degassed in the produced water degasser. Any separated hydrocarbons can be drained manually to the production skimmer's condensate compartment, whereas vented gases are routed to the LP vent.

The water is routed to the production skimmer, here again the condensates are collected in the production skimmer condensate compartment and the water (with maximally 30-ppm non-dissolved oil in water in average) is dumped overboard. The collected condensate is pumped to the condensate flash vessel.

Flash Gas re-compression system: A flash gas compressor will be installed to compress any gas from the condensate flash vessel and will re-inject this gas in the system.

3.1.6 Selected materials

The well heads and associated flowlines are constructed from duplex stainless steel while the gas export pipelines are carbon steel. The production separator is made of corrosion resistant alloy. No sand production is expected, when required sand filters can be installed in the individual flowlines.

3.1.7 Utilities

3.1.7.1 Power supply

In order to reduce air emissions, the N05-A platform will be electrically powered by a power cable from/via the Riffgat windfarm (traditionally offshore platforms are powered by gas driven engines and turbines). In case the windfarm cannot provide power from the windmills, the system can supply shore power as well.

An emergency diesel generator will be installed as an independent backup. The emergency generator will not be suitable to provide power for production and treatment. It will be rated approximately 600 kWe to meet emergency loads such as emergency lighting, UPS and Fire water pump loads. For the required drilling platform to operate electric, a rig power connection for 5 MW is included on the platform.

Main elements power supply:

- No power generators for main power;
- Emergency diesel generator;
- Electric heated TEG reboiler;
- Compressor(s) will be electric driven (including VSD);
- Crane will be electrically driven (emergency generator is able to deliver sufficient power for crane operations);
- Drill rig will be powered electrically via platform (5MW);
- Medium Voltage (33kV) switchgear will be installed;
- Transformers 33/0,4kV will be installed to power the auxiliary systems.

3.1.7.2 Drain system

Several drain systems will be installed on the platform:

- Open drain (hazardous & non hazardous);
- Closed drain.

Open drain (hazardous): The system consists of a collection system and a deck skimmer tank. The collected dirty water will be routed through the deck skimmer - where oil and water are separated - and water disposed overboard. The drain piping will be partially routed underneath the lowest deck level because the deck skimmer is integrated into the cellar deck.

Open drain (non-hazardous): The open non-hazardous consists of open drains (largely rainwater) from non-hazardous areas. Drains from the helideck will be routed directly overboard.

Closed drains: The closed drain system is used to collect all types of contaminated fluids from pressurized sources. The fluid will be routed to the closed drain vessel, which will have a combined function as produced water degassing vessel. Flash gas will be routed to the flash gas re-compressor and separated hydrocarbon liquids will be drained to the Condensate flash vessel. Water will be drained to the production skimmer T-6000 by gravity.

3.1.7.3 Vent system

The vent system will be used to safely dispose the hydrocarbons during a mechanical relief of excessive pressure (emergency blowdown), manual break down and start-up. The vent system is categorized into two systems:

- HP vent system;
- LP Vent system.

HP vent system: The HP vent header is routed to the HP vent KO drum, where the collected liquids are drained manually. The HP vent KO drum is designed on the maximum expected relief rate and for knock out of droplets larger than 600μm in diameter as per industry standards. During concurrent operations, the rig vent system will be used for HP venting and hence a rig connection swivel will be provided on the main deck level.

LP vent system: The flash-gas re-compressor will convert all continuous atmospheric vent gas and vapours to export pressure.

The vent systems will be designed such that air ingress will be mitigated (with for example a nitrogen purge flow).

Spurious gas releases from PSVs (for example due to poor re-seating of the valves) will be prevented by the installation of rupture disks. Pressure in the cavity between rupture disk and PSV will be monitored to ensure the integrity of the rupture disk.

3.1.7.4 Methanol and Corrosion Inhibitor injection facilities

Methanol can be injected into the wellheads and flowlines to prevent hydrate formation. Furthermore, Corrosion Inhibitor (CI) will be injected to prevent corrosion in the export pipeline. CI and methanol are stored in tote tanks on the platform.

3.1.7.5 Potable Water

The potable water will be supplied from a potable water maker. The water will be distributed to the consumers in the living quarters by potable water pumps. The design for potable water is made such that it includes a water maker with a supply to the DIFFS (Deck Integrated Fire Fighting System).

The potable water tank and downstream consumers will be flushed frequently in order to avoid legionnaires' growth and to maintain water quality. 12 to 24 hours before a visit to the platform this flushing procedure will be carried out.

3.1.7.6 Firewater

The firewater system consists of two electrical driven firewater pumps, which feed the firewater ring main upon detection of fire by the Fire and Gas detection System (FGS). The firewater pumps are fed by the main power, however the emergency generator is sized for operation of the two firewater pumps in parallel, whereas each firewater pump is rated to supply 100% of the firewater demand. The firewater demand is based on cooling (deluge) of all HC containing process equipment according NFPA guidelines.

The sweet water tank T-9300 allows for the required Deck Integrated Fire Fighting System (DIFFS) water volume of 5 m^3.

3.1.7.7 Pedestal Crane

The crane lifting capacity is determined to be maximally 25,000 kg. The outer most radius of the crane will be 38 m and the minimum radius 4 m (see Appendix 2.). The pedestal crane is a fully revolving fixed-boom type with electrically driven hydraulic power pack. Crane operations can also be performed using the emergency generators. Cranes will be provided with obstruction lights [Ref. 2].

3.1.7.8 Communication systems

The platform will communicate with shore by means of fibreoptic radio communication link. The platform is designed to be fully autonomous and operate in fail-safe mode. The platform (is monitored and) can be remotely controlled from the onshore control room.

Radio systems: Both handheld and desktop-based stations will be deployed on the platform. The radio systems will consist of UHF Radio, VHF FM Marine radio and VHF AM Aeronautical Radio.

Phone System: Different types of telephones will be installed on the platform (including a satellite telephone).

Meteorological System: The meteorological system will provide the platform with live weather data. The system will be designed and installed to provide mean wind speed, wind direction, barometric pressure, air temperature, dew point, humidity, visibility etc.

Automatic Identification System: The platform will be equipped with an Automatic Identification System (AIS) sender and receiver that will provide AIS information for display on the Intelligent Display System. The AIS will have a 360 degrees full coverage of the area surrounding the platform. The system(s) will automatically alert the platform operator of shipping activities within a specified area. The AIS information monitoring is conducted from a 24/7 manned onshore location.

CCTV System: An integrated Closed-Circuit Television (CCTV) system will be provided on the platform for the surveillance.

3.1.8 Process control

Distributed Control System (DCS): The DCS will enable the control room operator to safety start production of any well and monitor subsequent production, provides displays and operator interface facilities to enable full remote monitoring and control of the facilities to the CCR operator, DCS interface will provide full audible and visual alarm functions to alert the operator to any production upset or condition requiring attention.

Fire and Gas system (FGS): The FGS system will be able to sense possible hazardous situations and undertake corrective actions via the ESD system when required.

Safeguarding system (SGS): SGS system will be able to sense critical parameters and take shutdown and protective actions. Venting and blowdown are limited to ALARP. Pressure protection systems are selected such that the emissions are minimal.

3.1.9 Safety systems

3.1.9.1 ESD systems

A dedicated safeguarding system independent from the control and monitoring system will be installed to bring the installation to a safe status if required. N05-A will be equipped with an Emergency Shutdown (ESD) system, which can be activated manually at location by push buttons, remote from the Remote Control Room or automatic by process upsets or by confirmed fire and/or gas detection. The ESD system will be fail-safe.

There will be four levels of shutdown [Ref. 16 & 21]:

1. WSI (Well Shut-In);

2. TSI (Train Shut-In);
3. PSI (Process Shut-In);
4. ESD (Emergency Shut Down).

Furthermore, the installation will be equipped with an Emergency Blow Down (EBD) system.

WSI

This shutdown isolates the individual well by closing the wing, choke and methanol injection valve.

TSI

TSI initiates a shut down for all separation trains. Additionally, it will start WSI for all the connected wells.

PSI

The PSI will initiate TSI along with closing the gas export riser valve. This isolates all incoming and outgoing lines and stops the condensate injection pumps.

ESD

ESD is triggered by an abnormal process situation, during a confirmed gas/fire situation or manually. In case of an ESD, production and utility systems are stopped immediately by closing the ESD valves (ESDVs) and the Subsurface Safety Valves (SSSVs), to provide isolation of hydrocarbons. In addition, the methanol injection will be stopped if in operation and PSI will be initiated. All running equipment (pumps, heaters and cooler fans) will be tripped except for the emergency generator.

EBD

The EBD is an ESD combined with the opening of the installation blow down valves and starting up the firewater pumps. An EBD will be automatically generated with delay in case of a confirmed process fire. The time delay of 2 minutes upon confirmed fire enables manual operator intervention in case of false alarm. An EBD can also be initiated manually:

1. From the central control room when platform is unmanned.
2. Locally on the platform when platform is manned. The remote initiation will be overridden in case platform becomes manned, by means of "platform manned switch" located on the helideck access platform.

3.1.9.1.1 HIPPS and PSVs

A High Integrity Pressure Protection System (HIPPS) will be installed in production manifolds A/B, before the production separator. The HIPPS will protect downstream equipment from overpressure by closing its valves when instrumentation detects a pressure exceeding a set value.

The relief valve or Pressure Safety Valve (PSV) is an independent mechanical device that opens when a set pressure is reached in the upstream. The opened path lets gas/liquid pass into another system (e.g. a vent system to atmosphere), which will reduce the pressure in the upstream and protect equipment.

3.1.9.2 Fire and explosion protection

3.1.9.2.1 Segregation of hazardous and safe area

The basic philosophy is to segregate the hazardous and safe area on the platform, as much as practicable [Ref. 17]. Fire and blast walls will provide physical protection of safe areas, accommodation (muster area and lifeboat) and utility rooms with safety critical equipment, against possible fire and explosion events in the well area, process area, diesel generator and storage rooms. The safe area is made up by the living quarter, the technical room, the locker room, the lifeboat and the embarkation point.

3.1.9.2.2 Passive fire protection

The above-mentioned fire/blast wall functions as passive fire protection. A fire/blast wall will be positioned between the well and process area of the platform and the emergency shelter, the technical room and diesel generator. The fire wall (also with a blast rating) runs from east to west across the platform and stands from the bottom of Cellar deck to the top of the Main Deck (bottom of Heli Deck). It will protect the safe area from overpressures (explosion impact) caused by an explosion in the process area. The blast and fire rating will be subject to study during the detailed design phase.

The external walls around the utilities and accommodation area that are not facing the process area will have fire rating of A60 [Ref. 18]. Additional passive fire protection measures will be determined on the requirement of protection of specific equipment or areas.

The N05-A design will ensure sufficient natural ventilation across the cellar deck and mezzanine deck to disperse potential gas releases and to minimize potential overpressures caused by explosions. At the top and bottom of the weather sheeting will be a gap of approximately 0,5 m for ventilation.

3.1.9.2.3 Active fire protection

Early fire and gas detection system will enable safe shutdown of process systems, to warn personnel and to activate active fire protection systems. Fixed fire protection systems include area deluge for the process and wellhead areas. Portable fire extinguishers will be available throughout the platform. Fit for purpose firefighting system will be provided for diesel generator room and glycol area. Gaseous extinguishing systems will be provided in electrical rooms. The helideck will be provided with a Deck Integrated Fire Fighting System (DIFFS).

3.1.9.2.4 Hazardous area classification

Electrical equipment on the platform will be ATEX-rated according to its hazardous zone classification. This reduces the likelihood of ignition sources in the event of a gas leak. Hazardous area classification will be conducted in line with the NPR 7910-1 - Classification of hazardous areas with respect to explosion hazard-Part 1: Gas explosion hazard, based on NEN-EN-IEC 60079-10:2003.

3.1.9.3 Living Quarter and TR

Living quarters will be provided to accommodate planned and unplanned overnight stay. A Temporary Refuge (TR) will be provided in the living quarters for mustering, monitoring of incidents and preparation for evacuation and are designed to withstand the effects of an incident for at least 60 minutes.

3.1.9.4 Fire and gas detection

The main objectives of the fire & gas detection system are to:

- Detect a fire and gas as early as possible;
- Enables preventive actions at an early stage to reduce the consequences of the fire;
- Enables preventive actions at an early stage to reduce hydrocarbon leakages and eliminate ignition sources.

The location and number of the detectors will be based on the fire and gas mapping study. The fire and gas detection system interfaces with the ESD system.

All areas of the installation where a fire may occur will be provided with a suitable fire detection system. Smoke detectors will be provided in the accommodation and in other rooms. The gas detection system will monitor accidental releases and accumulation of combustible gases. The number and type of detectors will be based on the required reliability and availability.

All decks, rooms and air intakes/outlets will be equipped with either fire, smoke, heat and gas detectors in order to provide a full coverage. In areas that are prone to higher risks, a combination of these detectors will be installed to provide optimal coverage.

Manual Alarm Call points (MACs) will be provided at strategically located points as e.g. escape routes, staircases, ladders etc.

3.1.10 Escape, evacuation and rescue

3.1.10.1 Rescue provisions

The philosophy is to muster and, if required, to evacuate the installation in the event of a major incident. The Temporary Refuge (located in the living quarters is equipped and designed to protect people in case of unexpected event.

The primary and preferred means of evacuation will be by a helicopter (or by W2W vessel, in case the crew has been transferred by the W2W vessel). The secondary mean of evacuation will be by a davit launched lifeboat, located on southside of the cellar deck. Tertiary means of escape will be by life rafts via the descenders.

The lifeboat has a capacity of 24 persons. Lifejackets and survival suits are provided at the embarkation points of the life rafts and lifeboats.

Three life rafts are provided, one on the southwest corner of the platform, one on the northwest corner and the other on the east side. These life rafts will be provided at strategic locations for a credible POB. In total, the POB of life rafts will be at least 150% of the maximum platform POB. Lifebuoys will be installed at various locations at the platform.

All rescue provisions are depicted in the safety layout drawings, (Appendix 4.)

3.1.10.2 Escape and evacuation routes

In general, two escape routes by stairways (on the east and west side) will be provided from both decks to the muster point located in the hall area of the living quarters on cellar deck level. The embarkation station is present near the living quarters adjacent to the lifeboat. Two Walk-to-Work (W2W) vessel embarkation points are located on the northeast and on the southwest corners of the cellar deck [Ref. 19]. The W2W enables personnel transfer between vessel and platform using a motion compensated bridge.

The TR will be accessible via the two doors at the west and east side of the installation on both the Mezzanine and Cellar decks. Inside the TR is an internal stairway, to provide access between the decks. The evacuation routes from the TR towards the embarkation point will be via these doors. For detailed routes see Appendix 4.

3.2 Operation and Maintenance

3.2.1 Operational philosophy

N05-A will be remote controlled from the CCR (Central Control Room) by means of a fibre optic with a backup Line Of Sight (LOS) communication and the onshore communication network. The platform is equipped with a local control room and manned/unmanned switch which can be activated during manned situations.

3.2.2 Maintenance and manning philosophy

N05-A will be a Not Normally Manned Installation. Personnel transfer is normally conducted by helicopter. Personnel can also be transferred by motion compensated gangways from a W2W vessel.

The maximum persons onboard (POB) will be 24 persons, identical to the lifeboat capacity.

Accommodation for overnight stay is however provided on the installation. The installation will only be manned for intervention, maintenance, inspection and testing. This happens approximately 12 times a year for the duration of a week each trip. The living quarter will have an “overnight stay capacity“ of 12 POB. Any additional personnel more than 12 will be day trippers.

Materials, fuel and waste will be supplied and/or carried off with the aid of supply vessels.

3.3 Norms and standards

Design, construction and maintenance of the platform conforms to the requirements of applicable Dutch legislation and is, as far as is reasonably practicable, based on recognised national and international standards. See table below for the design codes which are applied during the design of the platform.

Table 3.2: Codes and standards

Code	Title
API 14	Specification for Subsurface Safety Valve Equipment
API 520	Sizing, Selection, and Installation of Pressure-relieving Devices
API 521	Pressure-relieving and DE pressuring Systems
IEC-61508	Functional safety of electrical/electronic/programmable electronic safety-related systems
IEC-61511	Functional safety - Safety instrumented systems for the process industry sector
EN 12464	Light and lighting - Lighting of work places
EN 50172	Emergency escape lighting systems
ISO 14122	Safety of machinery — Permanent means of access to machinery
CAP437	CAA Criteria for Offshore Helicopter Landing Areas
NOGEPA guideline 04	First aid on mining Installations
EN 12845	Fixed firefighting systems - Automatic sprinkler systems
NEN 1073	Automatische sprinklerinstallaties
EN 13565	Fixed firefighting systems - Foam systems
EN 14792	Fixed firefighting systems - Watermist systems
NEN 2535	Brandmeldinstallaties EN 3 Portable fire extinguishers
NEN 3656	Eisen voor stalen buisleidingsystemen op zee
ISO 13702	Petroleum and natural gas industries - Control and mitigation of fires and explosions on offshore production installations — Requirements and guidelines
EN 45544	Workplace atmospheres. Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours
EN 54	Fire detection and fire alarm systems
NFPA -codes	National Fire Protection Association codes
NFPA 10	Standard for Portable Fire Extinguishers
NFPA 11	Standard for Low, Medium and High Expansion Foam
NFPA 12	Standard on Carbon Dioxide Extinguishing Systems
NFPA 13	Installation of Sprinkler Systems
NFPA 15	Standard for Water Spray Fixed Systems for Fire Protection
NPFA 16	Standard for Installation of Foam-Water Sprinkler and Foam-Water Spray Systems
NFPA 17	Standard for Dry Chemical Extinguishing Systems
NFPA 20	Standard for the Installation of Stationary Fire Pumps for Fire Protection
NFPA 750	Standard on Water Mist Fire Protection Systems
NFPA 2001	Standard for Clean Agent Fire Extinguishing Systems
IMO SOLAS	IMO International Convention for the Safety of Life at Sea (SOLAS), 1974 and amendments
IMO FSS code	IMO International Code for Fire Safety Systems
IMO LSA code	IMO Life-Saving Appliances Code
IMO MARPOL protocols	IMO International Convention for the Prevention of Pollution from Ships (MARPOL) and protocols
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
IEC 60079	Explosive atmospheres. Electrical installations inspection and maintenance
SOLAS	Safety Of Life At Sea Convention
ISO-8385	Ergonomics criteria

4. Environment

The main impacts of gas production activities on the offshore environment include operational and accidental discharges of chemicals, produced water containing small concentrations of hydrocarbons, production chemicals plus heavy metals and a variety of natural components from the reservoir, atmospheric emissions, potential low level Naturally Occurring Radioactive Material (NORM), noise, and the placement of installations and pipelines on the seabed and the drilling of the wells.

4.1 Environmental effects

An Environmental Impact Assessment (EIA), in Dutch "Milieu-Effect Rapport (MER)", has been compiled and submitted to The Dutch Authorities for approval and as part of the request for an Environmental Permit [Ref. 3]. The EIA is a legal requirement for the realization of activities ("potentially significant adverse effects") can have on the environment. As such, for a detailed description of environmental effects and potential impact, reference is made to the EIA.

An overview of the expected emissions is given here below, using information from the Emissions Summary Report N05-A [Ref. 20].

4.1.1 Water emissions

Water emissions are induced by a discharge of the production, sanitary and rainwater. Rainwater will be directed to sea (via drains systems).

Based on the total expected environmental effects and operability considerations, it is decided to dispose the produced water overboard at the N05-A platform. For further details, reference is made to the EIA [Ref. 3].

Water treatment on N05-A and water disposal: Produced water is discharged under level control to the produced water degasser vessel. Here the hydrocarbons are separated. The water is finally treated in the production skimmer. The water is then finally dumped overboard. The maximum produced water discharge quality is 30-ppm non-dissolved oil in water.

Treated sewage (black water) is collected and discharged overboard after treatment. Other sanitary water (grey water) is disposed directly to sea. Food waste is macerated to contain solids not greater than 25 millimetres and is released overboard. Other solid waste (hazardous and non-hazardous) will be returned to shore for disposal. No chemical agents will be released to the environment under normal circumstances during production.

4.1.2 Air Emissions

Traditionally, the emissions to the atmosphere on an offshore platform are induced by vented natural gas, combustion (burning) gases, off-gases from the gas production process and maintenance. For N05-A these emissions have been avoided and/or minimised in the design of the installation. The platform will be electrically powered by a neighbouring windfarm. Furthermore, the vent installation is designed such that there is no continuous venting of natural gas.

Combustion gases from the platform, which contain CO2, NOx, unburned hydrocarbon and soot, can only be generated by the emergency generator. This generator will be used only in case the main power supply is not available. No other sources of exhaust gases is present on N05-A. However, exhaust gases will be produced from the helicopters and vessels that visit the platform.

For conventionally designed platform, natural gas emissions are largely caused by continuous vent emissions. When produced water is routed to the skimmer tank (after the pressure is reduced by a choke valve), dissolved gas is freed from the water and is safely routed to the platform vent. For N05-A, a flash gas compressor will be used to collect and re-inject waste gas streams into the export line, to minimize emissions to the atmosphere. The installation is designed to minimise natural gas emissions to fugitive emission levels during normal operation.

4.1.3 Noise

The main noise sources are the emergency diesel generator (when in use), compressors, and gas flowing through pipelines, choke valves, fittings and equipment.

Noise caused by helicopters are a large, but short-term source. Noise and vibrations can be transferred to the marine environment during production activities, but these are relatively small in comparison to other sources. The main source of underwater noise is induced by visiting (supply) vessels.

Underwater noise will be caused during the drilling of the wells. Noise sources caused during installation of the jacket, is mainly caused by pile driving of jacket legs. Suitable and sufficient mitigating measures will be determined during the detailed design and construction phase.

4.1.4 Light

The platform will emit light: the mandatory navigation lights and normal lighting of the installation for personnel. During unmanned operation the lighting will be minimized. The navigation lights consist of lights placed on each side of the platform. Normal lights are installed throughout the installation. Escape lighting will be provided on all escape routes, muster stations, life raft stations and closed areas. LED fixtures will be used for lighting system. Aircraft obstruction lighting will be provided for tall structures, like the crane boom in accordance with CAP 437.

4.1.5 Waste disposal

The waste materials are carried off with the aid of ships. Most of the waste will be released during the maintenance activities. The waste will mostly consist of domestic waste such as packaging material and waste scrap. In addition, hazardous waste such as used lubricant oil, batteries and oil containing materials are released. In accordance with the applicable legal requirements, waste will be efficiently collected, packed, labelled and transported to an authorized treatment facility.

The sludge containing oil / water mixtures may be released during the cleaning of process equipment. In addition to hydrocarbons, this sludge may contain traces of mercury or radioactive material (NORM), which occurs naturally in low concentrations in the geological formations. In some cases, metallic mercury can accumulate in the process equipment.

During opening of equipment (breaking of containment) a check is done on NORM as offshore equipment is suspected by default. Presence for mercury is also always checked. Contaminated materials are packed according to existing regulations, stored, and periodically transported to shore for processing.

5. Concept Selection

ONE-Dyas has carried out several studies to find out how the natural gas reserves can be developed efficiently. The chosen alternative is a production platform, with an export pipeline to the NGT system, power supplied by a neighbouring wind park. The paragraphs here below describe the different concept alternatives.

5.1 Concept alternatives

5.1.1 Location of the platform

The optimal location of the gas treatment or satellite platform is located on the north side of the field N05-A. This is because the planned location provides the best opportunity to tap into multiple gas fields from a single production platform and ensures minimum visibility from the Dutch and German Wadden. The planned location of the platform is located about twenty kilometres from Schiermonnikoog and the German island of Borkum.

The main drawback impact of this location is that Smaragd cannot be part of the phase-1 scope due to its distance to this surface location, see figure below.

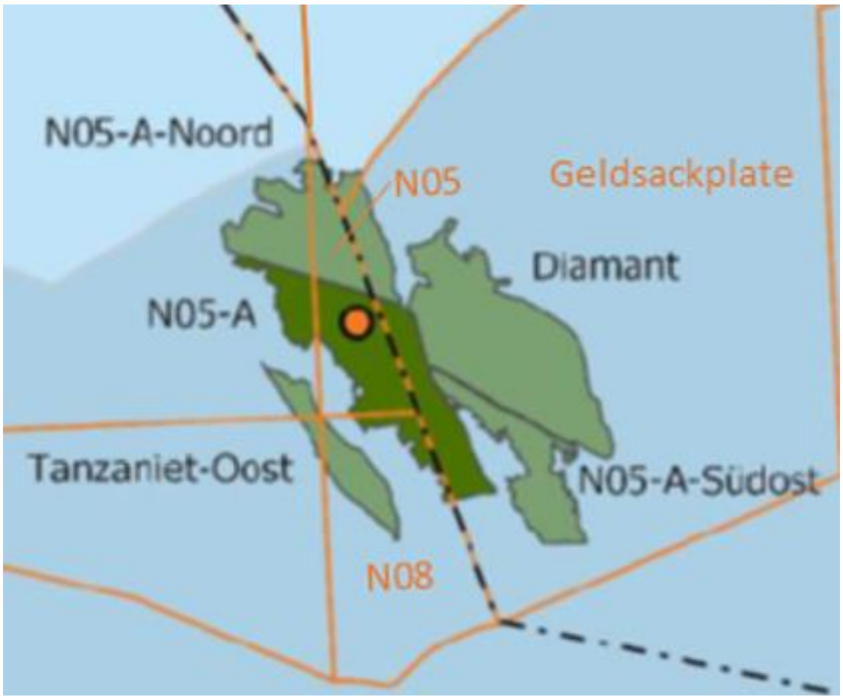

Figure 4: Selected location of N05-A

5.1.2 Production system

This section describes the various choices of production facilities that can be used for gas production in N05-A fields. The gas production from the N05-A fields can either be done using a satellite platform or subsea installations or using an production platform.

In the current design stage, it was decided to develop the gas reserves with a production platform, where the wet gas is dehydrated to meet export conditions and transported to shore.

5.1.2.1 Production platform with processing facilities

Utilization of a production platform with processing facilities, will make it possible to transport gas directly to mainland (via the NGT system). Gas will be processed more extensively to remove water. This is done to prevent hydrate formation and to meet the NGT specification

5.1.2.2 Satellite Platforms

Satellite platforms will only facilitate the recovery of the wet gas. The concept of a satellite platform will consist of installations to remove the free water present in the well stream. When this water meets the legal discharge standards (maximum 30 ppm of non-dissolved HC), then it can be discharged to the North Sea. The recovered wet gas is transported by means of a pipeline to an offshore treatment platform. Hydrate inhibitor injection will be required to prevent hydrate formation and CI injection will be required to prevent corrosion if a carbon steel pipeline is used.

The closest offshore gas treatment platform is the existing AWG (Ameland-WestGat platform). However, the required new pipeline from N05-A platform to the AWG platform will have a length of approximately forty kilometres and would run approximately five kilometres through the Natura 2000 site (Noordzeekustzone).

5.1.2.3 Subsea Installation

Here the gas is recovered by subsea installations and transported by pipeline to an offshore treatment platform. The subsea completion is the preferred option in case of a limited size field requiring only one or maximum two wells for economic development. For N05-A, multiple wells are foreseen. Furthermore, the closest existing platform is too far away (AWG with 40 km distance) for a subsea development.

5.1.3 Processing and Gas Export Pipelines

The recovered gas can be exported in three possible routes via pipeline. The choice of production facilities go hand in hand with the choice of pipeline used for export. Depending on the choice of pipeline routes, certain types of production facilities are not applicable.

The processing and export systems can be assigned into the following groups:

- Satellite platform with a pipeline to AWG;
- Production platform (with processing facilities) with gas export to NGT pipeline;
- Satellite platform with a pipeline to an onshore terminal.

In the current design, the N05-A platform is designed as a production platform with processing facilities where the gas is pre-treated to meet the specifications of the NGT-line. The NGT-line is an existing gas main pipeline connecting a variety of offshore gas production platforms to the mainland. The new pipeline, connecting the N05-A platform to the NGT line, will have a length of approximately 15 km. The route of the new pipeline runs about a possible length of less than a kilometre through the Natura 2000 site (Noordzeekustzone).

5.1.4 Power Supply

In the current design, the main source of power supply is electric power supplied via single cable from a neighbouring offshore windfarm (Riffgat). This design will greatly reduce the emissions by the engines/turbine drivers of compressors and electricity generators on the platform. In case the windfarm cannot provide power from the windmills, the system can supply shore power as well.

This concept supports the drive for sustainability and limits consumption of fossil fuel for power generation. The environmental emissions are therefore minimized without compromising on safety, e.g. power availability for safety systems. Maintenance costs are lower in comparison to traditional gas driven energy generation solutions. Furthermore, the reliability is higher for this concept which reduces visits to the platform.

5.1.5 Re-Use of existing platform

Due to the depletion of offshore gas fields in the North Sea, gas platforms are often available for possible reuse in other new developments. The existing F16-A process platform (Wintershall) was investigated for this purpose. The condition and maintenance history was examined and a budget quote was received for removal, transport and installation on a new jacket at the N05-A location.

Compared to a new build the upfront costs are significantly reduced, however these savings are outweighed by:

- Higher operational costs: € 3 million higher per year due to more maintenance and manning needed in comparison to a new built situation;
- Lower platform uptime: 90% assumed vs 95% for new build;
- Less drilling efficiency: less, smaller and more compactly spaced well slots;
- More emissions to the environment (not using the latest best available techniques and platform is continuously manned;
- Others: Electrification requires challenging modifications on F16-A platform, future emission reduction projects required, limited lifetime etc.

Given the above mentioned limitations this option is deemed less viable than a newly built station.

6. Hazard and Risk analysis

6.1 Risk Assessment

The risk assessment consists of a summary of the carried-out health, safety and environmental studies (both design studies and reviews), a definition of the acceptance criteria, identification of hazards, assessment of the risks associated with the operation of the N05-A platform and evaluation of the identified risks with the acceptance criteria and risk management measures.

The purpose of the risk assessment is to demonstrate that the design of the N05-A matches the acceptance criteria and that the risks related to the platform are ALARP (As Low As Reasonably Practicable) level.

The ALARP principle allows to verify whether the resulting risk is as low as reasonably practicable, taking also into account criteria beyond the risk matrix, such as time, investment and feasibility of additional measures.

Additional requirements on Major Accident Hazards (MAHs) are also identified and described, due to the implementation of the OSD (EU directive 2013/30/EU) and underlying national implementing regulations. The Report on Major Hazards will be implemented for the operational phase. Initial identification of MAHs and barriers and the control of Major Accident Prevention is part of the design notification and is outlined in chapter 6.4 and 6.5.

6.1.1 Process of risk assessment and risk management

In general, in the process of Risk Assessment and Risk Management the following steps can be distinguished:

- Hazard Identification using the generic hazards list and hazard identification techniques (such as HAZID and HAZOP);
- Assessment of the probabilities of a hazard being released and the consequences when a hazard is released using specific study techniques;
- Assessment of the risk involved using a Risk Assessment Matrix;
- Determining the (required) control measures (preventive and mitigating) using bow-tie diagrams and specific study techniques;
- Evaluation of the residual risk using the Acceptance Criteria.

The first step in risk management is the hazard identification. The result of the hazard identification is a list of specific hazards and the potential effect.

The second step in risk management is to evaluate the identified hazards using the ONE-Dyas Risk Assessment Matrix (RAM). From the previous step the risks are divided in high risks, medium risks and low risks for the likelihood of happening and the potential effect. The RAM matrix and risk criteria are further outlined in section 6.4.1 and is part of the identification of Major Accident Hazards (high risks).

Risks levels must be reduced to at least an ALARP level with (additional) mitigating measures. These mitigating measures can be identified and visualized with the Bow-tie model. The Bow-tie model helps in the qualitative assessment of the hazards to assess whether the hazards are sufficiently controlled to an ALARP level. It gives a structured overview of the hazards, the preventive measures in place and the mitigating measures in case an incident takes place.

Eventually, the risks are assessed according to the ONE-Dyas acceptance criteria. The risk management process is depicted in the figure below.

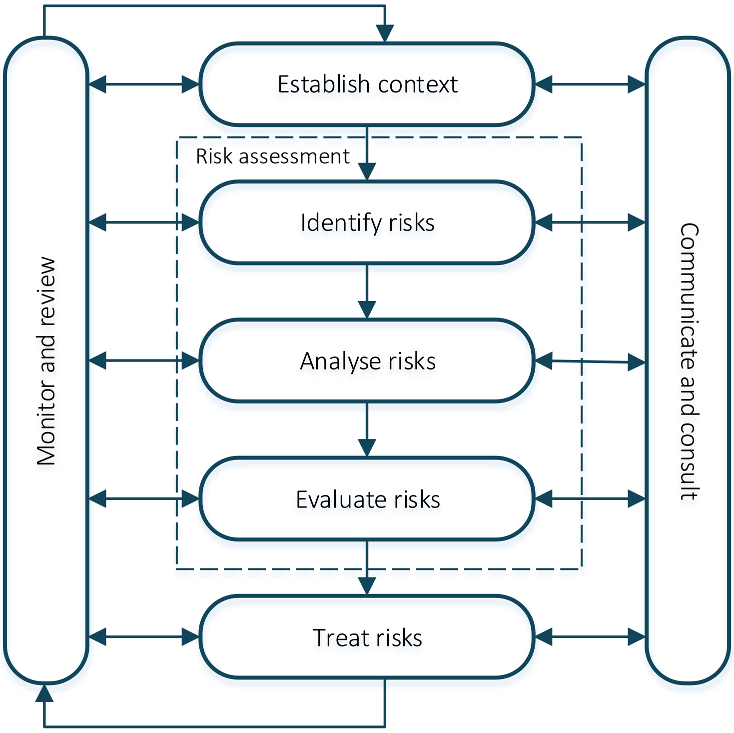

Figure 5: The Risk Management process

The specific process of Risk Assessment for the N05-A follows the same lines as the generic process. First Hazards are identified, followed by identification of probabilities and consequences. Required control measures are based on the identified risk and the residual risk is evaluated using the Acceptance Criteria and Performance Standards. The following steps are distinguished:

- Hazard identification;
- Consequence assessment tools;
- Probability assessment;
- Risk reduction and measurement;
- HSE Risk Assessment Matrix;
- Acceptance Criteria and Performance standards (including risk evaluation).

The process of hazard identification during the design and operation stages of a facilities life cycle is captured by hazard identification processes such as HAZID and HAZOP studies.

The process of consequence assessment is captured by (amongst others):

- Fire and Explosion Hazard Assessment (FEHA);
- Smoke and Gas Ingress Assessment (SGIA);
- Emergency Systems Survivability Assessment (ESSA);
- Evacuation, Escape, Rescue and TR Assessment (EERTA);
- Other specific studies involving technical evaluations of certain equipment systems and safety systems.

The process of probability and risk assessment is captured by (amongst others):

- Historical data both E&P operators (WOAD, World Offshore Accident Databank and EP-forum);
- ONE-Dyas Risk Assessment Matrix;
- Quantitative Risk Assessment (QRA);
- Expert Judgement.

6.2 Risk Acceptance Criteria

6.2.1 Qualitative risk evaluation criteria

The ONE-Dyas Qualitative risk criteria for the HSE document are summarized below.

Acceptance criteria 1: Compliance with all relevant legal requirements and guidelines

- Legislation: Mining legislation, Labour Conditions legislation, permit requirements.
- Guide Lines: e.g. Nederlandse Emissie Richtlijnen (NER), Publicatiereeks Gevaarlijke stoffen (PGS).
- Covenants and other agreements: Meerjaren Afspraak (MJA).

Acceptance criteria 2: The residual risk is tolerable when the following criteria are met:

- External risks are in line with criteria set in the 'Besluit externe veiligheid inrichtingen (Bevi)' – this is not relevant for offshore locations.
- All safety studies related to the RoMH have been prepared and all actions have been followed-up and closed-out.
- At least one way to escape shall not be impaired and thus remain function from areas subject to an incident, to enable personnel from escaping from the area and to reach a safe location.
- Emergency systems survive severe accidental events and function adequately when required.

Acceptance criteria 3: The design, operations and maintenance of the installation met the following criteria:

- The installation is maintained and operated in line with all applicable procedures and instructions.

6.2.2 Quantitative risk evaluation criteria

In addition to the identification and qualitative evaluation of hazards it is required to quantify the risk to personnel. Quantitative risk evaluation for the N05-A facility is achieved through a Quantitative Risk Assessment (QRA).

The QRA is designed to determine the Individual Risk per Annum (IRPA), the Individual Risk per Day (IRPD), the Temporary Refuge Impairment Frequency (TRIF) and the Potential Loss of Life (PLL) based on industry standard data and the findings of underlying risk studies. The QRA accounts for process, structural, occupational and transportation risks. The level of risk calculated is reviewed against the Risk Acceptance Criteria of ONE-Dyas.

In the Quantitative Risk Analysis (QRA) hazardous scenarios related to normal operation of the production platforms are quantified. The QRA will be conducted in the next project phase (during detailed design) and presented in the operational Safety Case / Report on Major Hazards.

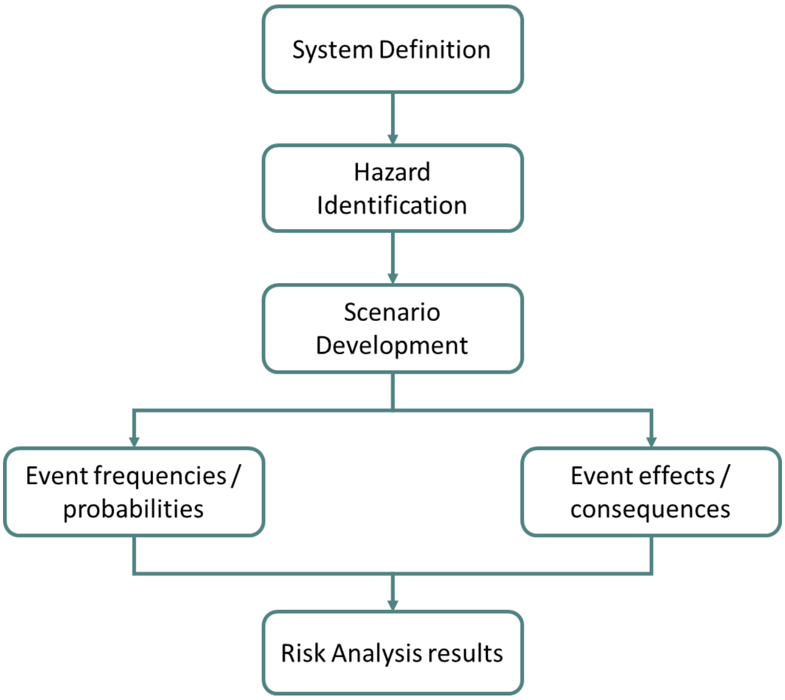

Figure 6: General structure of QRA study

Quantified risk is a numerical measure formed by the mathematical product of the likely frequency of an accidental event and its predicted consequence (in terms of statistical fatalities). Measurements of risk used in the current HSE document are described below:

Fatal Accident Rate (FAR):	The total number of potential fatalities in a certain area per 100 million (10^8) exposure hours
Individual Risk Per Annum (IRPA):	The frequency per year, of a fatal injury to an individual personnel member
Individual Risk Per Day (IRPD):	Individual risk 'dose' assuming that on average a person works 1800 hours a year on an offshore installation, based on IRPA levels
Potential loss of life (PLL):	The potential number of fatalities per year of platform operation
TR Impairment Frequency (TRIF):	The frequency per year that the defined TR and evacuation route integrity are impaired within the specified endurance period.

ONE-Dyas adopts a framework, commonly used for IRPA criteria, that divides assessed IRPA into three regions (Fig. 7):

- An upper ('intolerable') region, in which risk is considered to be unacceptable and further risk reduction measures must be taken;
- A lower ('broadly acceptable') region, in which risk is considered 'broadly acceptable' and there is generally no need to consider further risk reduction measures;
- An intermediate ('ALARP') region (between the upper and lower regions) in which risk may be tolerable, but it must be demonstrated that all practicable means of risk reduction have been employed to the extent that further risk reduction would incur disproportionate cost. That is, the risk is ALARP (As Low As Reasonably Practicable).

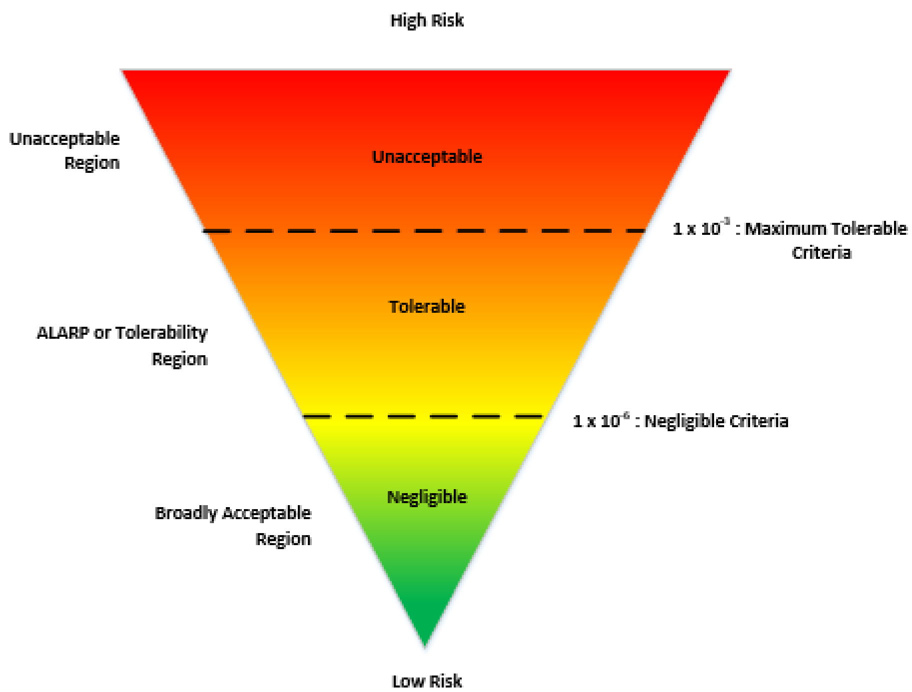

Figure 7: HSE Framework for decision on the tolerability of risk

Risks are classified as ALARP when either

- Activities are essential and cannot be omitted;
- There is no (safer) alternative way of working;
- It can be demonstrated that no further, technically feasible improvements can be implemented, or
- A Cost Benefit Analysis shows that the costs of further improvements are disproportionate to the benefits gained.

ONE-Dyas has defined the following quantitative criteria:

Table 6.1: ONE-Dyas quantitative risk acceptance criteria

Parameter	Criteria
Individual Risk Per Annum (IRPA)	Acceptable: IRPA < 10^{-6} / year ALARP: 10^{-6} < IRPA < 10^{-3} / year Not acceptable: IRPA > 10^{-3} / year
Individual Risk Per Day (IRPD)	Not acceptable: IRPD > 5.6 x 10^{-6} /year

6.3 Hazard identification

Hazards are identified using the generic Hazards List from the international standard ISO 17776:2000. The table below specifies which hazards are applicable for the N05-A installation during normal operations (excluding major modifications).

Table 6.2: Identified hazard for N05-A

#	Hazard Description	Applicable
01	Hydrocarbons	Yes
02	Refined Hydrocarbons	Yes
03	Other flammable material	Yes

#	Hazard Description	Applicable
04	Explosives	No*
05	Pressure Hazards	Yes
06	Hazards associated with differences in height	Yes
07	Objects under induced stress (spring loaded devices, hydraulic operated equipment)	Yes
08	Dynamic situation hazard (boat transport, helicopter transport, road transport)	Yes
09	Environmental hazards (weather, sea state)	Yes
10	Hot surfaces	Yes
11	Hot fluids	No
12	Cold surfaces	Yes
13	Cold fluids	No
14	Open flame	No
15	Electricity	Yes
16	Electromagnetic radiation (welding, flare, microwaves, lasers, etc.)	No
17	Ionizing radiation – Open source	No
18	Ionizing radiation – Closed source	Yes
19	Asphyxiation (confined spaces, use of CO_2 and N_2)	Yes
20	Toxic gas (H_2S, benzene, exhaust fumes)	Yes
21	Toxic liquid (mercury, chemicals such as methanol, glycol, additives	Yes
22	Toxic solid	Yes
23	Corrosive substances	Yes
24	Biological hazards (legionella)	Yes
25	Ergonomic hazards (noise, heat/cold stress, physical activities, etc.)	Yes
26	Psychological hazards (stress, fatigue, living on platform, etc.)	Yes
27	Security related hazards (vandalism)	Yes
28	Use of natural resources	Yes
29	Medical	No
30	Noise	Yes
31	Entrapment	Yes

** Applicable when drilling activities are performed.*

6.4 Major Accident Hazard identification

6.4.1 Process of Major Accident Hazard Identification

The EU directive 2013/30/EU defines major accidents as:

a) an incident involving an explosion, fire, loss of well control, or release of oil, gas or dangerous substances involving, or with a significant potential to cause, fatalities or serious personal injury;
b) an incident leading to serious damage to the installation or connected infrastructure involving or with a significant potential to cause, fatalities or serious personal injury;
c) any other incident leading to fatalities or serious injury to 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; or
d) any major environmental incident resulting from incidents referred to in points (a), (b) and (c)

ONE-Dyas has implemented a guideline on the identification of Major Hazards [Ref. 9]. ONE-Dyas considers the following pre-defined major hazards as major accident hazards:

- Hydrocarbons (in reservoir);
- Hydrocarbons in surface installations (natural gas, condensate);
- Environmental / Ambient hazards (conditions at sea);

- Dynamic situation (air transport);
- Dynamic situation at sea;
- Differences in height (objects at height, lifting and hoisting);
- Enclosed spaces.

A second check on major hazards for N05-A are hazards that fall in certain categories of the Risk Assessment Matrix (RAM):
- The hazards with accompanying risks in category 'High' in the RAM (red category);
- The hazards with accompanying risks with a potential consequence ranked as 5.

Risk assessment matrix

Potential consequences					A	B	C	D	E
Harm to People P	Asset Damage A	Environmental Impact E	Reputation Impact R		Never heard of in Industry	Heard of in Industry	Has occurred in NL or UK EP Industry	Happens several times per year in NL or UK Industry	Happens several times per year in own company
No injury or health effect	No damage	No effect	No impact	0	Low	Low	Low	Low	Low
Slight injury not effecting daily life	Slight damage >10.K US $	Slight impact	Slight impact	1	Low	Low	Low	Low	Low
Minor injury or health effect, restriction in work or life for 5 days	Minor damage 10K-100K $	Minor environmental damage, but self-reversible	Minor impact	2	Low	Low	Low	Medium	Medium
Major injury or health effect, lost time or effect for more than 5 days	Moderate damage 100K-1000K $	Limited environmental damage that will persist or needs intervention	Significant regional impact	3	Low	Low	Medium	Medium	High
Permanent total disability or up to 3 fatalities	Major damage 1-10x10.6 $	Severe Environmental damage that will require extensive measures to restore	Major impact on NL reputation	4	Low	Medium	Medium	High	High
More than 3 fatalities	Massive damage over 10x10.6 $	Persistent severe Environmental damage that will lead to loss of use or natural resources over wide area	Major impact on Companywide reputation	5	Medium	Medium	High	High	High
Score P, A, E, R, on Consequences and Likelihood. The highest score is valid for the registration and investigation. Example an incident with a score for either P,A,E,R in E3 makes it a High for Registration and Investigation				An incident can score different on P, A, E, R. An incident can happen with damage several times per year(score E on Asset), but hardly ever with Environmental damage (score B on Environment)					

Figure 8: Risk Assessment Matrix

It is not only the residual risk that needs to be controlled. There are other issues that need to be verified before the final acceptance of the HSE system (and document). ONE-Dyas aspires to improve its acceptance criteria continuously in spite of legally required minimum levels.

6.4.2 Initial Major Accident Hazard identification for N05-A

In order to provide a concise but complete overview of all the hazards and risks related to the offshore operation the HAZOP, HAZID and specific studies are summarized in a list of hazards and risks and in the scenario-based risk identification. The scenario-based risk identification describes, for each hazard, possible accident scenarios that might occur on the platforms. In these descriptions, initial events (causes), consequences and safeguards (risk controls) are given together with references to the studies discussing this scenario. The lists of hazards and risks and the scenario-based risk assessment are given in Appendix 5. and Appendix 7.

Based on the guideline for Major Accident Hazard Identification [Ref. 9], The EU directive 2013/30/EU (see previous section) and on the findings in Appendix 5. & Appendix 7. the following Major Accident Hazards are identified for N05-A [Ref. 15]:

Table 6.3: Major Accident Hazards N05-A

Major Accident Hazard	Comment
Hydrocarbons under pressure	Process release, including gas ingress in Living Quarters, dropped load on hydrocarbon containing equipment.
	Riser and pipeline release.
	Well blowout.
Methanol	-
Shipping traffic	-
Extreme Weather	Of a magnitude that would cause substantial damage and partial collapse of the platform.
Structural Failure	e.g. due to design errors, construction errors, fatigue or marine corrosion.
Helicopter transport	In case of helideck crash or ditch near platform.

6.5 Control of Major Accident Prevention (SECEs)

As part of the implementation of the Offshore Safety Directive a Corporate Major Accident Prevention policy (CMAPP) is in place [Ref. 10]. The CMAPP establishes overall aims for controlling the risk of a major accident and describes the arrangements that have been put into effect to achieve those aims.

Based on the initial identification of Major Accident Hazards (section 6.4.2) initial Safety and Environmental Critical Elements and corresponding controls are defined in this chapter. Controls such as performance standards and independent verification is defined to make sure that the barriers for preventing incidents are in place and working.

6.5.1 Identification of Safety Environmental Critical Elements (SECEs)

The assessment of Major Accident Hazards is executed using so-called bow-tie diagrams, in which the hazards are broken down in terms of threats, top event and consequences and control measures (barriers, lines of defence, layers of protection) are shown.

Control measures taken can be divided into various types.

- Barriers that prevent the release of the hazard (protective measures)
- Barriers that prevent the incident from creating the unwanted effect (mitigating measures)

A barrier may consist of a number of Safety and Environmental Critical Elements (SECEs).

The definition of an SECE is:
“Safety and Environmental Critical Elements mean parts of an installation, including computer programmes, the purpose of which is to prevent or limit the effect of a major accident, or the failure of which could cause or contribute substantially to a major accident.”

Within ONE-Dyas responsible engineers (also known as technical authorities) will be assigned to a specific SECE and its performance standards (this will be done in line with Ref. 13).

Initial identification of barriers and SECEs for N05-A

The hazards identified from the Major Accident Hazard list (see Table 6.3Table 6.3: Major Accident Hazards N05-A) will be assessed in more detail. This assessment is prepared using bow-tie diagrams, in which the hazards are broken down in terms of threats, top event and consequences and control measures (barriers, lines of defence, layers of protection). The bow-tie diagrams will be further reviewed during detailed design.

The following initial Safety and Environmental Critical Elements have been identified. For details reference is made to the procedure of the management of Safety and Environmental Critical Elements [Ref. 11 & 12] and the Major Accident Hazards Identification [Ref. 15].

Table 6.4: Initial Safety and Environmental Critical Elements N05-A

SECE	Description
01-P-HYC-a	Containment of Hydrocarbons facilities
01-P-HYC-b	Containment of Hydrocarbons Wells
02-P-HYC	Pipeline Systems
03-P-STR	Structure
04-P-CPR	Collision Prevention
05-P-LIFT	Lifting and Dropped Objects
06-D-F&G	Fire and Gas Detection
07-P-IGN	Prevention of Ignition
08-C-ESD	ESD & Isolation and Blowdown
09-P-PR	Pressure Relief
10-M-VEN	Ventilation Systems
11-M-FES	Fixed Fire Extinction Systems
12-M-FEP	Fire and Explosion Protection
13-M-POF	Portable Fire Prevention
14-C-EPS	Emergency Power Systems
15-C-COM	Emergency communications
16-E-MUS	Muster Stations
17-E-E&E	Evacuation and Escape
18-E-LIG	Emergency Lighting
19-E- PSE	Personal Survival Equipment
20-E-ESS	Escape By Sea
21-E-R&R	Rescue and Recovery Systems

6.5.2 Defining Performance standard

Major accident prevention assurance (Performance standard)

Each of the identified SECEs is linked to a performance standard which outlines the functionality, reliability, availability and survivability criteria to ensure risks are managed effectively to fulfil its hazard management function.

Performance standards are defined as:

- "Clear and measurable parameters for the performance of (parts of) process installations, equipment and management systems, which contribute directly to the fulfilment of the HSE objectives."

At the moment of writing, the design performance standards for the safety and environmental critical elements are being drafted. The following details will be included:

- Description of goals and boundaries
- Defined scope and functionality of the system
- Specified criteria for each safety critical component with a clearly defined (technical) basis
- Defined measurable / auditable parameters with defined acceptance criteria

6.5.3 Assurance and verification of SECEs

Verification schemes and independent verification

When each SECE and its performance standard is defined, assessment of the SECEs performance will take place. This is controlled via assurance and independent verification.

Typical operational verification activities are:

- Witness SECE Assurance activities, e.g. tests, inspections, musters etc.
- Visually examine condition of SECEs, e.g. piping, vessels, hazardous area equipment etc.
- Audit compliance with SECE Assurance Processes.

Verification will also be carried it out by an Independent Competent Body (ICB). This to make sure that all SECEs have been identified, appropriate standards have been set and met, and that maintenance, inspection and testing arrangements have been carried out satisfactorily.

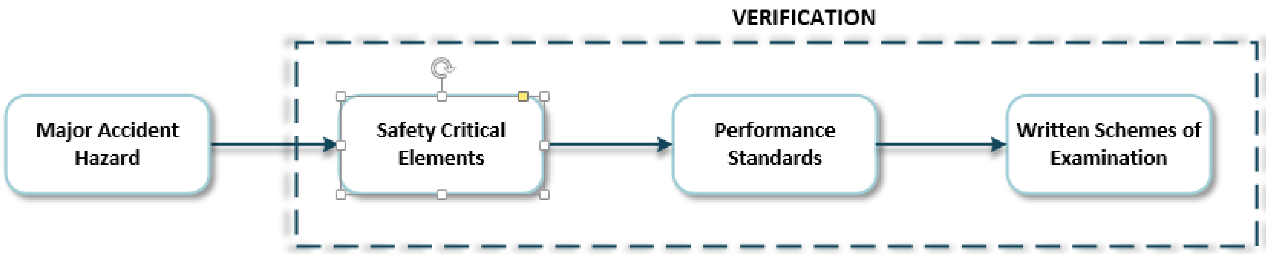

Figure 9: Verification of safety and environmental critical elements

Responsibilities of the Independent Competent Body are:

- Review and comment on the record of SECEs;
- Participate in the development and periodic review of the Verification Scheme;
- Perform Verification activities as defined in the Verification Scheme;
- Report to the Responsible Engineer on the suitability of SECEs, detailing examinations / reviews performed, findings and remedial actions recommended;
- Communicate any reservations on the list of SECEs or the content of the Verification Scheme to the Responsible Engineer.

When the performance standards of each SECEs has been drafted, specific verification schemes of all SECEs will be made accordingly. This will be verified by ONE-Dyas's Responsible Engineers and by an Independent Competent Body.

6.6 Follow up next phase

As part of the HSE Management system the existing and new health and safety hazards are identified and assessed and control measures are evaluated (if existing) and implemented (if new). The risk assessment process describes the above steps and how these steps are executed for all ONE-Dyas installations.

The specific studies are executed in all stages of the life cycle of the facilities:
- During the conceptual design phase the design alternatives are being evaluated with respect to health, safety and environment.
- During the design phase a variety of cause and consequence studies are executed to support the hazard assessment.
- During the operational phase studies are executed to minimize workplace risks and maintain technical integrity. In this phase, verifications and investigations (e.g. RI&I, HSE audits) take place in order to check and improve the quality of control measures.

Table 6.5: follow up next phase

Risk Assessment step	Generic approach	Specific approach
Hazard Identification and Impact Assessment	• Generic Hazard List	• HAZOP/HAZID studies • Consequence analysis (fire, explosion, smoke/gas dispersion, ship impact, noise, dropped objects)
Assessment of Control measures	• Bow-tie diagrams • List of Safety Environmental Critical Elements and Activities • List of performance standards • List of verification schemes	• Bow-tie evaluation • Assessment of suitability of control measures/Comparison against performance standards (safety instrumented systems, emergency systems, escape/evacuation/rescue systems) • Assessment of health risks (RI&E), major hazard risks (fire, explosion, ship impact)
Evaluation of Risks	• Definition of acceptance criteria	• Quantified Risk Assessment • Comparison against acceptance criteria • ALARP Demonstration

During the design phase of the project, a HAZOP and a HAZID studies are executed to identify the potential hazards and the required control measures [Appendix 5. &Appendix 6.]. In the HSE Case – design notification Report these hazards are described and evaluated and the risks are assessed both qualitatively and quantitatively.

Specific studies are identified to be executed during the design phase of the project and to be included in the RoMH / HSE Case. These studies are:
- Quantitative Risk Assessment;
- Fire and Explosion Assessment;
- Rescue and Recovery Study;
- Dropped Objects Risk Assessment;
- Evacuation and Escape Risk Assessment;
- Emergency Survivability Risk Assessment;
- Safety and Environmental Critical Elements & Performance Standards;
- Smoke and Gas Ingress Analysis;
- Health Risk Assessment.

Safety and Environmental Critical Elements, Performance standards and verification schemes will be drafted during detailed design.

For the Installation and drilling operation separate HSE documentation is / will be prepared to assess the hazards and risk to personnel involved in the specific activity. If applicable hazards related to simultaneous operations (SIMOPS) are addressed.

7. Conclusion

ONE-Dyas intends to develop the N05 field. As part of this development a platform with treatment facilities including export pipeline is planned to be installed. This design notification has been prepared for the proposed N05-A platform and export pipeline.

During the concept select phase various options and alternatives have been evaluated. Dedicated studies have been executed to achieve an optimal selection of the design and future operational concept with respect to Health, Safety and Environment.

The final chosen concept for the N05-A development comprises the following key characteristics:

- A production platform with process and treatment on the platform;
- A Normally Not Manned Installation (NNMI) with living quarters to allow for planned overnight stay;
- Helideck and motion compensated gangway facilities for personnel transfer;
- Off-gas compressor to recompress flash gas (instead of continuous venting);
- Pipeline to a hot tap in the NGT;
- Electrical main power delivered from a neighbouring wind park.

During the Select and early Define phases of the N05-A development various Health, Safety and Environmental (HSE) studies have been executed to identify and evaluate major hazards related to the design and operation of the installation. Safety systems and measures have been defined, assessed and included in the preliminary platform and export pipeline design to reduce the risks for personnel, environment and assets.

8. References

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9. Abbreviations

Abbreviation	Definition
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
AtoN	Aids to Navigation
AWG	Ameland WestGat platform
Bevi	Besluit externe veiligheid inrichtingen
CAA	Civil Aviation Authority
CCR	Central Control Room
CCTV	Closed Circuit TeleVision
CEO	Chief Executive Officer
CGR	Condensate to Gas Ratio
CI	Corrosion Inhibitor
CMAPP	Control of major accident prevention policy
CMMS	Computerised Maintenance Management System
COO	Chief Operating Officer
DCS	Distributed Control System
DECT	Digital Enhanced Cordless Telecommunications
DIFFS	Deck Integrated Fire Fighting System
E&I	Electrical & Instrumentation
E&P	Exploration and Production
EBD	Emergency BlowDown
EBN	Energie Beheer Nederland B.V.
EC	Emergency Coordinator
EER	Escape, evacuation and rescue
EERTA	Evacuation, Escape, Rescue and TR Assessment
EIA	Environmental Impact Assessment
ERP	Emergency Response Plan
ERT	Emergency Response Team
ESD	Emergency Shutdown
ESDV	Emergency Shutdown Valve
ESSA	Emergency Systems Survivability Assessment
F&G	Fire & Gas
FAR	Fatal Accident Rate
FEHA	Fire and Explosion Hazard Assessment
FGS	Fire and Gas detection System
FPAL	First Point Assessment
GEMS area	Gateway to the Ems area
HAZID	Hazard Identification study
HAZOP	Hazard of Operability Study
HC	Hydrocarbon
HIPPS	High Integrity Pressure Protection System
HMI	Human-Machine Interface
HP	High Pressure
HPU	Hydraulic Power Unit
HSE	Health, Safety and Environment
HSEQ MS	Health, Safety, Environment and Quality Management System
HVAC	Heating, Ventilation and Air Conditioning

Abbreviation	Definition
ICAO	International Civil Aviation Organization
ICT	Information and Communication Technology
ICB	Independent Competent Body
ICV	Independent Competent Verifier
IP	Internet Protocol
IRPA	Individual Risk Per Annum
IRPD	Individual Risk per Day
KO	Knock-Out
LAT	Lowest Astronomical Tide
LED	Light-emitting diode
LEL	Lower Explosive Limit
LER	Local Equipment Room
LERP	Local Emergency Response Plan
LOC	Loss Of Containment
LOS	Line of Sight
LP	Low Pressure
LQ	Living Quarters
MAC	Manual Alarm Call
MA(H)	Major accident (hazard)
MCC	Motor Control Center
MEDEVAC	Medical Evacuation
MEI	Major Environmental incidents
MEOH	Methanol
MER	Milieu-Effect Rapportage
MJA	MeerjarenAfspraak
MoC	Management of Change
MRT	Management Response Team
NER	Nederlandse Emissie Richtlijnen
NFPA	National Fire Protection Association
NGT	Noordgastransport B.V.
NL	The Netherlands
NNMI	Normally Not Manned Installation
NOGEPA	Netherlands Oil and Gas Exploration and Production Association
NORM	Naturally Occurring Radioactive Materials
NOVEC	Gaseous fire suppression agent
OIM	Offshore Installation Manager
OSD	Offshore Safety Directive
OST	On Site Team
PA	Public Address
PFD	Process Flow Diagram
PCS	Process Control System
PGS	Publicatiereeks Gevaarlijke Stoffen
PLC	Programmable Logic Tool
PLL	Potential Loss of Life
POB	Persons On Board
PPE	Personal Protective Equipment
ppm	Parts per Million
PSI	Process Shut-In
PSV	Pressure Safety Valve

Abbreviation	Definition
PtW	Permit to Work
QRA	Quantitative Risk Assessment
RAM	Risk Assessment Matrix
RCR	Remote Control Room
RI&E	Risico Inventarisatie & Evaluatie
RIGG	Rapport Inzake Grote Gevaren (same as RoMH)
RoMH	Report on Major Hazards
SAR	Search And Rescue
SECE	Safety & Environmental Critical Element
SEMS	Safety & Environmental Management System
SGIA	Smoke and Gas Ingress assessment
SGS	Safeguarding System
SIF	Safety Instrumented Functions
SIL	Safety Integrity Level
SIMOPS	SIMultaneous OPerationS
SodM	Staatstoezicht op de Mijnen
SOLAS	Safety of Life at Sea
SOW	Scope Of Work
TEG	TriEthylene Glycol
TLQ	Temporary Living Quarters
TR	Temporary Refuge
TRIF	TR Impairment Frequency
TSI	Train Shut-In
UK	United Kingdom
UPS	Uninterruptible Power Supply
VES	Verification and Examination Scheme
VOC	Volatile Organic Compound
VOIP	Voice over Internet Protocol
VSD	Variable Speed Drive
W2W	Walk to Work
WHCP	Well Head Control Panel
WOAD	World Offshore Accident Databank
WSI	Well Shut-In

Appendix 1. ONE-Dyas HSE policy

Appendix 2. Preliminary plot plans N05-A

Appendix 3. Preliminary process flow diagram N05-A

Appendix 4. Preliminary safety layouts N05-A

Appendix 5. N05-A HAZID report

Appendix 6. N05-A HAZOP report

Appendix 7. Initial scenario based risk evaluation N05-A

1. Hydrocarbons					
Hazard	Consequences	Initial event	Mitigating measures	Initial risk ranking	Residual risk ranking
hydrocarbons (natural gas and/or condensate) under pressure in the installation.	Jet fire/ pool fire / explosion leading to damage, potentially fatally injured personnel. Potential for hydrocarbons spilled to sea, environmental damage. Exposure to condensate (containing benzene, which is carcinogenic).	Loss of containment. Flange leakage, maintenance activities, leakages due to corrosion or erosion. Sources are: flowlines, piping, pressure vessels and other equipment.	Inspection & preventive maintenance minimizing the risk of corrosion and erosion and flange leakages. Permit to work system is in place. Ignition prevention, electrical equipment classified according to hazardous area classification. Grated floors/bunded areas and drainage systems, minimizing pool formation. F&G detection system initiating ESD & EBD. Blast rated fire wall protecting the TR and the lifeboat to ensure personnel not affected by the incident can evacuate the installation. Competent personnel and work instructions / procedures in place.	C5	B5

1. Hydrocarbons					
Hazard	Consequences	Initial event	Mitigating measures	Initial risk ranking	Residual risk ranking
Hydrocarbons in the reservoir.	Catastrophic consequences due to ignited blow-out, platform may be engulfed. Multiple fatalities, loss of platform. Major environmental damage due to hydrocarbon spillage into sea.	Loss of well control leading to blow-out during well intervention (e.g. wire lining, coiled tubing etc).	Multiple physical barriers present during well intervention (stuffing box) as defined in the well barrier policy. Procedures for well intervention. Permit to work system is in place. Ignition prevention, electrical equipment classified according to hazardous area classification. F&G detection system initiating ESD, alarm and EBD. Procedure for calamity control in case of loss of well control. Work instructions / procedures in place. Competent personnel & platform manned during well services and drilling activities.	C5	B5

1. Hydrocarbons					
Hazard	Consequences	Initial event	Mitigating measures	Initial risk ranking	Residual risk ranking
Hydrocarbons in the export riser.	Possible Catastrophic consequences if ignited, engulfment of platform possible, multiple fatalities, loss of platform. Major environmental damage due to hydrocarbon spillage into sea.	Loss of containment after flange leakage, or ship collision impact.	Riser inside the jacket, minimizing effects of low energy ship collisions. Minimization of flanges. Dispersion due to natural ventilation. Few ignition sources. Preventive maintenance and inspection on flanges. Ignition prevention, electrical equipment classified according to hazardous area classification. F&G detection system initiating ESD, alarm and EBD. AIS.	C5	B4

2. Refined hydrocarbons					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Lube oil in machinery and rotating equipment.	Spill of lube oil, potentially to sea.	Leakage of lube oil in machinery and rotating equipment due to flange leakage or during maintenance activities.	Preventive maintenance and inspection. Drainage system. Drip trays in place for detection and secondary containment of small leakages. Work instructions / procedures in place.	C3	C2

2. Refined hydrocarbons					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Diesel in diesel day tanks generator / tote tank.	Spill of diesel, potentially ignited due to hot generator. Spill of diesel to sea.	Leakage of diesel in the (day tank of the) back-up diesel generator.	Preventive maintenance and inspection. Drainage system. F&G detection system initiating ESD/EBD and alarm. Work instructions / procedures in place. Competent personnel & platform manned during diesel transfer.	C2	C2
Hydraulic oil in wellhead panel.	Spill of hydraulic oil to sea.	Leakage of hydraulic oil.	Drip trays to contain small leakages. Drainage system. Valves fail to the safe (closed) position on loss of hydraulic power.	C2	C2

3. Other flammable material					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Methanol in piping / in tank. CI in piping.	Jet fire / pool fire. Spill of methanol, potentially to sea, consequences limited.	Leakage of methanol or CI due to flange leakage.	Preventive maintenance and inspection. Drainage system. Ignition prevention, electrical equipment classified according to hazardous area classification. F&G detection system initiating ESD / EBD and alarm. Work instructions / procedures in place Competent personnel.	C3	B2

4. Explosives					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Not applicable, no explosives present at N05-A. Explosives are only used during well perforation activities. This is outside the scope of the HSE document.	-	-	-	-	-

5. Pressure hazards					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
High pressure equipment.	Damage/ injury by launched equipment or HP jet.	LOC after build-up of overpressure in high pressure equipment (for example N2 bottles or working with HP tools).	Preventive maintenance and inspection. Certified pressure equipment. PPE. Work instructions / procedures in place. Competent personnel.	B3	B3

6. Hazards associated with differences in height					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Hoisting and lifting.	Potential for damaged equipment when load is dropped or swinging against other equipment. Person hit by load.	Dropped object on the installation or into sea on the export pipeline.	Dropped object protection of hydrocarbon containment on main deck. Hoisting and lifting procedures. Rock dumping / buried pipeline and connection riser. Certified crane & competent and certified personnel. Permit to work system is in place. Work instructions / procedures in place.	D4	C4

6. Hazards associated with differences in height					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Hoisting and lifting.		Crane toppling due to load limit violation, crane failure.	Procedures to prevent load limit violation. Certified crane & competent and certified personnel. Regular inspection of crane.	D4	B4
Over the side activities.	Man overboard.	Person falling into sea.	Adverse weather policy. Permit to work system is in place. PPE including harness with life line. Man watch to sound alarm in case of MOB. Guard vessel present in 500 m zone to assist in rescuing MOB victim if applicable. Work instructions / procedures in place. Competent personnel .	D4	B4

7. Objects under induced stress (spring loaded devices, hydraulic operated equipment)					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Release of mechanical force.	Injuries by launched equipment.	Failure of equipment / wrong handling / faulty equipment.	Preventive maintenance and inspection. PPE. Permit to work system is in place. Work instructions / procedures in place. Competent personnel.	C4	B4

8. Dynamic situation hazard (boat transport, helicopter transport, road transport)					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Boat transport.	Potential for catastrophic consequences, multiple fatalities. Loss of platform.	Ship collision.	AIS (for passing vessels). Guard vessel present when required to warn vessel on collision course (in case of drilling). Procedures for supply vessels entering 500m. Supply vessels approach N05-A on DP. Minimal crew size.	C5	B5

8. Dynamic situation hazard (boat transport, helicopter transport, road transport)					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Helicopter transport.	Potential for multiple fatalities due to helicopter incident.	Helicopter ditch / crash.	Helideck in place protecting platform structure. Adverse weather policy. Competent pilots. Helicopter operator experience. Inspection and maintenance helicopters. Second engine. DIFFS in place to extinguish fires on helideck. PPE (including survival suits) for personnel on board helicopter. Coastguard SAR.	C5	B5

9. Environmental hazards					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Extreme weather conditions.	Potential for damage to structure / equipment due to extreme high waves.	Storm, lightning, extreme wind conditions, high sea state, etc.	Earthing . Adverse weather policy and instructions. Air gap, design against 10.000 wave.	C4	B3

10. Hot surfaces					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Hot well stream / hot exhaust.	Injuries due to hot surfaces.	Skin contact with hot surface	Isolation of equipment with hot surface temperature, Warning signs. PPE.	C3	B3

11. Hot fluids					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Hot regenerated glycol.	Injuries due to contact with hot fluids.	LOC.	Inspection & maintenance. Process safeguarding. PPE.	D4	B3

12. Cold surfaces					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Cold well stream due to JT effect after choke valve.	Injuries due to cold surfaces.	Skin contact with cold surface.	Isolation of equipment with cold surface temperature. Warning signs. PPE.	C3	B3

13. Cold fluids					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Impact on N_2 bottle storage.	Liquid N_2 release, personnel exposed to cold liquid release. Personnel injury.	Failure of equipment / wrong handling / faulty equipment / Impact.	Preventive maintenance and inspection. PPE. Permit to work system is in place. Work instructions / procedures in place. Competent personnel.	C4	B4

14. Open flame					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Hot work, e.g. welding.	Ignition of explosive atmosphere. Personnel exposed to open flame.	Open flame in ATEX environment. Contact with open flame	Hazardous Area Classification Drawing. PPE. Permit to work system is in place. . Work instructions / procedures in place.	C4	B3

15. Electricity					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Electric fire.	Injuries / damage to equipment.	Electric fire after short circuit.	Fire detection system, initiating Isolation of electric equipment. Maintenance and inspection. PPE.	C4	B3

15. Electricity					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Electrocution.	Electrocution.	Contact with electricity during maintenance activities.	Earthing . Isolation of electric equipment. PPE. Maintenance and inspection. Permit to work system is in place.	C4	B4

16. Electromagnetic radiation (welding, flare, microwaves, lasers, etc.)					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Welding.	Personnel exposed to electromagnetic radiation. Personnel injury.	Contact with welding equipment during welding.	Only incidental welding.	D2	C2

17. Ionizing radiation – Open source					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Not applicable.	-	-	-	-	-

18. Ionizing radiation – Closed source					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
NORM in the well stream.	Injuries / Over-exposure to radiation.	Opening hydrocarbon containing equipment.	Procedures for opening hydrocarbon containing equipment. NORM procedure. PPE.	C3	B3

19. Asphyxiates (confined spaces, use of CO2 and N2)					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Asphyxiation.	Injuries / fatalities due to asphyxiation.	Low levels of oxygen in confined spaces.	Confined spaces procedures and instruction. Procedures for opening hydrocarbon containing equipment. PPE.	C4	B4

20. Toxic gas (H2S, benzene, exhaust fumes)					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Exposure to toxic gases.	Exposure personnel to exhaust gases, sickness.	Exhaust gases from back-up diesel generator.	Exhaust gases leaded to safe area without personnel.	C3	C2

20. Toxic gas (H2S, benzene, exhaust fumes)					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Benzene in condensate.	Contact to benzene (part of condensate), toxic & carcinogenic, sickness.	Contact with condensate.	Condensate is contained in a closed system. RI&E. PPE. Competent personnel. Work instructions / procedures in place.	C4	C2

21. Toxic liquid (mercury, chemicals such as methanol, glycol, additives					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Exposure to methanol.	Exposure personnel to methanol, sickness.	Leakage of methanol.	Methanol stored in closed containment. Drainage system.	C3	C2

22. Toxic solids					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Exposure to mercury. Mercury currently not expected.	-	-	-	-	-

23. Corrosive substances					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Corrosion.	Corrosion leading to loss of containment of hydrocarbons (see also hydrocarbons).	Corrosive substances in well stream (for example CO2).	Wall thickness. Inspection and preventive maintenance. CI injection (for corrosion in pipeline).	C5	B4

24. Biological hazards (legionella)					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Legionella.	Legionnaires' disease, leading to injuries / sickness / fatalities.	Contact with water containing legionella bacteria.	Frequent testing / cleaning system. Work instructions / procedures in place.	B4	B2

25. Ergonomic hazards (noise, heat/cold stress, physical activities, etc.)					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Noise.	Exposure to high noise levels, sickness & stress.	Running of rotating equipment, compressors and back-up generator.	PPE. Noise enclosures.	D3	D2

26. Psychological hazards (stress, fatigue, living on platform, etc.)					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Offshore exposure.	Stress, fatigue, sickness.	Presence of personnel on N05-A.	Platform is manned with minimal crew size.	D2	C2

27. Security related hazards (vandalism)					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Not applicable	-	-	-	-	-

28. Use of natural resources					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Not applicable	-	-	-	-	-

29. Medical					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Not applicable	-	-	-	-	-

30. Noise					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
See 25 Ergonomic hazards	-	-	-	-	-

31. Entrapment					
Event scenario	Consequences	Initial event	Safeguards	Initial risk ranking	Residual risk ranking
Blockage of routes to muster location.	Escape routes impaired.	Objects blocking access / escape routes.	Dedicated lay down area. Permit to work system is in place. Work instructions / procedures in place. Competent personnel. Good housekeeping.	C4	B4

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