HFO AND GAS FACILITIES IN CONTOURGLOBAL CAP DES BICHES, SENEGAL

QUANTITATIVE RISK ASSESSMENT (QRA) REPORT- CdB1 & CdB2 Facility

CONTOURGLOBAL CAP DES BICHES SENEGAL

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Applicable contract(s) governing the provision of this Report:

Objective:

The objective of this document is to provide the methodology and results of the Quantitative Risk Assessment (QRA) carried out for HFO and Gas facilities in ContourGlobal Cap Des Biches, Senegal facility scope.

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EXECUTIVE SUMMARY & CONCLUSION

Cap des Biches is an 86 MW thermal generation facility developed and constructed by ContourGlobal in two phases. This combined cycle facility consists of five HFO fired diesel engines equipped with a highly efficient “Flexicycle” system, which uses waste heat to power a steam turbine. This state-of-the-art technology enables Cap des Biches to provide the lowest cost energy in Senegal, and the facility can easily be converted to burn natural gas, providing the Senegalese with valuable fuel flexibility.

The oil and gas industry involves risks associated with process failures and chemical releases contain severe consequences which should be managed quantitatively. The Quantitative Risk Assessment (QRA) is a component of an organization's total Risk management: it is a part of the Companies' Risk Management Program. QRA is used to help evaluate potential Risks when qualitative methods cannot provide adequate understanding of the Risks, and more information is needed for Risk management.

The QRA is a formal and structured quantitative analysis methodology used to help Companies manage Risk and improve safety through identifying the Major Hazards (i.e. identify incident scenarios), evaluating the associated likelihood and consequences to people, and calculating risk levels in a numerical way for comparison with Risk Tolerability Criteria, and defining recommendations for guaranteeing proper risk management is in place. QRA helps to make facilities handling hazardous chemicals safer by supporting Risk Based Decision Making.

This report presents the methodology and findings of the Quantitative Risk Assessment (QRA) conducted for the HFO and Gas facilities in ContourGlobal Cap des Biches facility scope . The main goal of this assessment is to evaluate the potential risks involved in operations and to suggest ways to manage these risks to As Low as Reasonably Practicable (ALARP).

In line with above requirements, ContourGlobal commissioned DNV to conduct risk advisory services.

The QRA methodology and assumptions were discussed and agreed upon prior to executing the study. The following are the key findings of the study.

CONCLUSIONS

Location Specific Individual Risk (LSIR) Results

Location specific individual risk contours were calculated for CdB1 & CdB2 Facility to represent level of risk an individual would experience if present in a particular risk location for 24 hours per day, 365 days per year. LSIR contours are presented in Chapter 14.1 of QRA study report.

- LSIR risk contours of 1E+00, 1E-01, 1E-02 and 1E-03 per year are not observed.
- LSIR risk contours, 1E-04, 1E-05 are localised around the tank area.
- LSIR risk contour of 1E-06 & 1E-07 covers all facility & slightly extends outside of the facility (Mainly towards south and east side of facility)
- All the major contributors to the overall LSIR risk are reported in section 14.5
- None of the Public facilities (residential) are exposed to these LSIR levels.

Individual Risk Per Annum (IRPA) Results

Based on the above LSIR levels estimated in section 14.1, the Individual Risk Per Annum (IRPA) for each worker category is calculated based on presence factor as per the working pattern and location. The detailed IRPA results are mentioned in the Table 14-5 based which following conclusions are drawn:

Process IRPA

- The process IRPA for some of CdB1 facility workers (Operators, Senior Operators, Shift Engineer, Mechanical and Electricians) categories are in ALARP region due to highest number of working hours (12 hours shift).
- The process IRPA for the most of the CdB1 & CdB2 facility workers are in Acceptable region.
- The highest process IRPA of 1.29E-05 per year obtained is for Operators for CdB1 facility due to highest number of working hours (12 hours shift).
- The highest process IRPA of 4.02E-06 per year obtained is for Operators for CdB2 facility due to highest number of working hours (12 hours shift).

Non-process IRPA

- The non-process IRPA (Occupational Risk) for the ContourGlobal worker categories is in lower ALARP region.
- The highest Non-Process IRPA of 5.46E-05 per year obtained is for Operators worker category due to highest number of working hours (12 hours shift).

Total IRPA (Process IRPA+Non-Process IRPA)

- The IRPA for the ContourGlobal CdB1 & CdB2 facility worker categories is in ALARP region.
- The highest total IRPA of 7.15E-05 per year obtained is for Operators worker category.

Potential Loss of Life (PLL) Results

- A total PLL value of 3.01E-03 per year is calculated for ContourGlobal CdB1 & CdB2 facilities, i.e. approximately 1 fatality from a Major Accident Hazard every 332 years.

Major Risk Contribution Results

- It is seen that the Pool fire outcomes (56.37%) dominate the overall risk level. Further it is seen that the rest 43.63% of the risk contribution is from jet fire, flash fire and flash fire with explosion. (Refer section 14.5).

ALARP Demonstration:

Following risk reduction measures were evaluated for normal operations phase as part of ALARP demonstration:

1. Possibility of reducing the potential of flammable effects

As part of the ALARP demonstration, the feasibility of reducing the potential consequences of flammable releases was evaluated. The applicable isolation and detection timings for various leak size were considered for Possibility of reducing the potential of flammable effects. Reducing the potential for flammable outcomes is technically achievable if the inventory within an isolatable section is reduced either by:

- Decreasing detection and isolation times, or
- Increasing the degree of sectionalisation through additional shutdown valves.

Based on the assessment performed in section 15, the current configuration of detection systems, shutdown valves, and sectionalisation is deemed adequate for ALARP demonstration. Additional valves or modifications to isolation timings would not yield a proportionate reduction in individual or societal risk, and therefore no further risk-reduction measures are recommended under this category. The detailed analysis is presented in section 15 of the report.

2. Reducing the presence factor of personnel in Contour Global facility

Based on the current manning pattern, Operations and Maintenance personnel spend approximately 7–8 hours daily within the process areas during normal operations, which is considered reasonable given the facility's scale and activities. A reduction in their field presence could lower the process-related individual risk, though the non-process risk would remain within the ALARP range per UK HSE criteria. Since the overall risk to personnel is already assessed as ALARP, further reduction in exposure time is not warranted. Any adjustments to manning or field presence should be determined by management, consistent with the facility's operational philosophy. he detailed analysis is presented in section 15 of the report.

RECOMMENDATIONS

The recommendations are mentioned below:

- Ensure operator-exposure controls are in place for tank farms and fuel-treatment houses (permit-controlled entry limits, remote start/stop/CCTV, and routine sampling panels/HMIs located outside these footprints) to reduce residence time in the highest area-average LSIR zones and lower the operators' IRPA, which is the highest of all worker groups.
- Ensure muster points and primary pedestrian routes are sited away from the south/east quadrants (where the 1E-06/1E-07 LSIR tails extend slightly beyond the fence) and aligned to the lower-risk quadrants identified by the LSIR mapping.
- Ensure that the Emergency Response Plan (ERP) is updated to account for the Major Accident Hazard (MAH) scenarios associated with the new Fuel Gas Systems at the Contour Global facility.
- Ensure hazardous-area classification and ignition-source control are in place along the PRS and engine-inlet areas (electrical classification, hot-surface guarding, vehicle controls), aligned to the fuel-gas ignition scenario basis used in the QRA.
- Ensure open-path (line-of-sight) and point gas detectors are in place along above-ground Fuel Gas pipeline runs at the PRS, and at each engine-room inlet, and that these detectors are interlocked to ESD closure and segment depressurisation.
- Implement restricted access control in tank farm and bunded areas during operations.
- Develop a Community Emergency Response Interface Plan (CERIP) integrating local fire and medical services.
- It is observed that for the existing buildings and control room are not affected due to flash fire risk (refer Figure 2- 6 of Appendix 7). However, in the event of potential flammable gas dispersion, it has potential to reach the existing buildings and control room. Therefore, ensure that effective gas ingress protection measures are in place, including gas detectors, sensors, and alarm systems. These systems will enable early detection of flammable gases and provide timely warnings to occupants, allowing for immediate and appropriate action.

1 INTRODUCTION

1.1 Background

Cap des Biches is an 86 MW thermal generation facility developed and constructed by ContourGlobal in two phases. This combined cycle facility consists of five HFO fired diesel engines equipped with a highly efficient “Flexicycle” system, which uses waste heat to power a steam turbine. This state-of-the-art technology enables Cap des Biches to provide the lowest cost energy in Senegal, and the facility can easily be converted to burn natural gas, providing the Senegalese with valuable fuel flexibility.

The oil and gas industry involves risks associated with process failures and chemical releases contain severe consequences which should be managed quantitatively. The Quantitative Risk Assessment (QRA) is a component of an organization's total Risk management: it is a part of the Companies' Risk Management Program. QRA is used to help evaluate potential Risks when qualitative methods cannot provide adequate understanding of the Risks, and more information is needed for Risk management.

The QRA is a formal and structured quantitative analysis methodology used to help Companies manage Risk and improve safety through identifying the Major Hazards (i.e. identify incident scenarios), evaluating the associated likelihood and consequences to people, and calculating risk levels in a numerical way for comparison with Risk Tolerability Criteria, and defining recommendations for guaranteeing proper risk management is in place. QRA helps to make facilities handling hazardous chemicals safer by supporting Risk Based Decision Making.

In line with above requirements, ContourGlobal commissioned DNV to conduct risk advisory services. This report presents the methodology and findings of the Quantitative Risk Assessment (QRA) conducted for the HFO and Gas facilities in ContourGlobal Cap Des Biches, Senegal facility scope .

1.2 Facility Description

The plant is in Senegal and was constructed in 2016 in two phases:

Phase 1 (CdB1 plant): 52.9 MW (net) with the COD on May 26th

Phase 2 (CdB2 plant): 33.0 MW (net) with the COD on October 31st

The plant is a heavy fuel oil-fired thermal plant and is built on a brownfield site in Rufisque, Senegal, approximately 23 kilometers east of Dakar. Cap des Biches 1 consists of three Wärtsilä 18V46 17.1-MW diesel engine generators (DGs) exhausting into three heat recovery steam generators and a 3.4-MW net ST.

Cap des Biches 2 consists of two Wärtsilä 18V46 17.1-MW DGs operating in a simple-cycle mode.

Each plant has its own step-up transformer:

- CdB1: JSB transformer 67MVA
- CdB2: Siemen's transformer 45MVA

A short transmission line, approximately 500 meters long, connects the Plant to an existing substation. Plant is operated with HFO low sulphur content:

- HFO is delivered by the refinery SAR through a pipeline.
- With option to be delivered by trucks through fuel storage facilities.
- Site has 17 days storage capacity.

The potential conversion to natural gas fuel operation in 2026 is expected to take place, discussions with the offtaker are ongoing. The conversion project will consist of converting the engines from Wärtsilä 18V46 to Wärtsilä 18V50DF (Dual Fuel),The gas supply will be an LNG solution:

- The phase 1: is a rapid solution which consists to install a floating storage unit (FSU) + a regasification unit at the port of Dakar connected to the Cap des Biches site through 02 pipelines of 10 km (Primary and Back up).
- The plant will supplied through a 380m pipeline connected to a gas pressure regulating station at Cap des Biches

1.3 Purpose Of This Document

The purpose of this document is to highlight the methodology, references to statistical/ generic data utilized, impact criteria and results of the Quantitative Risk Assessment carried out for HFO and Gas facilities in ContourGlobal Cap Des Biches, Senegal facility scope together with recommendations with regards to the risk acceptance criteria and potential risk reduction measures (if any) to reduce the risk levels.

The QRA study is conducted in accordance with methodology and base data recommended by following standards:

- UK HSE Quantitative Risk Assessment (QRA) Guideline.
- UK HSE, reducing risks, protecting people. HSE's decision-making process.
- Effects of Thermal Radiation, Centre for Chemical Process Safety, (CCPS)
- UK HSE, Guidance on ALARP Decisions in COMAH.
- IOGP Reports, International Association of Oil & Gas Producers.
- The QRA adopts UK HSE quantitative risk criteria, which is internationally recognized and consistent with the intent of IFC PS4 and World Bank EHS Guidelines. The approach ensures that risks to workers and nearby communities are maintained within the ALARP region, fulfilling IFC/WB principles of risk avoidance, reduction, and continuous improvement.

Table 1-1: UK HSE Compliance with IFC Guidelines

Requirement	IFC Performance Standard 4 / World Bank EHS Guideline Requirement	How Addressed in Current QRA (Using UK HSE Criteria)
Hazard Identification	Identify and assess potential community health and safety risks arising from project activities.	Comprehensive hazard identification carried out for process and non-process events, consistent with UK HSE and CCPS guidance.
Quantitative Risk Assessment (QRA)	Quantify risks to workers and communities, applying recognized international methodologies.	QRA uses UK HSE risk assessment methodology (Purple Book / R2P2) for individual and societal risk estimation.
Risk Criteria and Acceptability	Apply internationally recognized benchmarks to determine acceptable levels of risk.	Risk criteria adopted from UK HSE (tolerable and ALARP regions) aligned with IFC and WB principle of risk minimization to ALARP.
Mitigation and Control Measures	Implement mitigation measures to reduce risks to acceptable levels.	Engineering and procedural risk reduction measures identified in QRA to ensure risks remain ALARP.
Emergency Preparedness and Response	Develop and maintain plans to respond effectively to incidents affecting the community.	QRA outcomes inform the project's Emergency Response Plan and facility siting, consistent with IFC/WB expectations.
Monitoring and Review	Periodic review of risk and safety performance to ensure continued compliance.	QRA to be updated at detailed design and operation stages; ongoing monitoring aligned with HSE and IFC requirements.

1.4 Objective

The objectives of QRA study are mentioned below:

- Identify hazards in a certain process.
- Assess the significance of each incident in terms of on-site & off-site impact.
- Predict the frequency of occurrence.
- Determine the extent of harmful consequences.
- Identify and provide Risk Reduction Measures to ensure the Risk is "As Low As Reasonably Practicable" (ALARP)
- Demonstrate that the preferred Risk Reduction Measure reduces Risk to ALARP.

1.5 Scope of Work

ContourGlobal own a 86MW plant operated with HFO (Heavy Fuel Oil) in Cap des Biches, SENEGAL. A project has been initiated to convert power plant engines to dual Fuel (HFO and Gas) therefore ContourGlobal wants to perform a QRA.

ContourGlobal commissioned DNV to conduct risk advisory services for the HFO and Gas Facilities in ContourGlobal Cap Des Biches, Senegal. The scope of this QRA is limited to existing storage tank facility, GAS pipeline from Senelec station to site & internal pipeline from delivery point to two engine room.

QRA scope includes the following:

- Identification of all the hazards not limiting to those which could lead to catastrophic ruptures of the pipelines and storage vessels.
- Identification of potential failures or incidents (including frequency)
- Consequences analysis of credible major accident scenarios (fire, explosion, etc) with damage criteria for the study to be based on thermal radiation and overpressure. Consequence modelling is carried out using the latest version of DNV PHAST/SAFETI.
- Undertake consequence assessment for identified credible fire, explosion and flammable release scenarios to determine scale, intensity, duration of those credible scenario and potential for escalation.
- Hazardous outcomes to be covered in the analysis includes, but not limited to, Jet Fire, Pool Fire, Flash Fire, Boiling Liquid Expanding Vapour Explosion (BLEVE), Vapour Cloud Explosion (VCE), toxic release etc.
- Review fire and explosion impact of occupied buildings in terms of their locations, design and fire protection measures considered in buildings.
- All related assumptions/parameters, including but not limited to, isolatable sections with fluid parameters (fluid type, temperature, pressure, inventory etc.), representative hole sizes, wind data, ambient temperature and relative humidity.
- Frequency analysis should include leak frequency estimation by failure rate database, event tree analysis and fault tree analysis as applicable. Part count is performed based on relevant isolatable section identified on P&ID.
- Ignition probabilities are estimated using the method described by the IOGP data book.

- Detection and isolation time, ignition probabilities, leak frequencies, modelling assumptions, vulnerability criteria, potential explosion sites and risk criteria adopted and documented within a QRA Assumption Register submitted for review and approval prior to performing the QRA.
- Assessment of onsite risk from Storage Tanks to personnel inside occupied buildings should be in accordance with API RP 752 / 753.
- Estimation of the risks to individuals, groups of individuals (onsite workers, offsite communities) and onsite occupied buildings (internal and neighboring property) based on the representative hazard zones identified.
- Where appropriate, suggest suitable and sufficient risk reduction measures to mitigate identified hazards and risks which should include design review, site layout optimization, engineering and operational recommendations
- Review adequacy of the risk reduction measures for existing facilities and offer recommendations for upgrades where required.

2 DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

Definition	Description
COMPANY:	ContourGlobal
PROJECT:	HFO and GAS Facilities In ContourGlobal Cap Des Biches, Senegal
VENDOR	Person, firms, partnerships, companies, bodies, entities, or a combination thereof who are providing services.
CONSULTANT	Det Norske Veritas (DNV)
SHALL or MUST:	It is to be understood as a mandatory requirement.
SHOULD:	The specified action is recommended but not mandatory. However, the action party will be responsible for the consequences in the event that he/she elects not to do it.
WILL:	A commitment by the COMPANY or a statement of fact.
MAY:	It is to be understood as giving freedom of choice.

2.2 Abbreviations

Definition	Description
ALARP	As Low as Reasonably Practicable
BLEVE	Boiling Liquid Expanding Vapor Explosions
CMPT	Centre for Marine and Petroleum technology (UK)
EER	Escape, Evacuation and Rescue
ESDV	Emergency Shutdown Valve
H & MB	Heat & Material Balance
H_2S	Hydrogen Sulphide
HAZID	Hazard Identification
HC	Hydrocarbon
HSE	Health Safety Environment
IDLH	Immediately Dangerous to Health and Life
IOGP	International Association of Oil & Gas Producers
IRPA	Individual Risk Per Annum
ISO	International Organization for Standardization
kW/m^2	Kilowatt per Square Meter
LFL	Lower Flammability Limit
LOC	Loss of Containment
LSIR	Location Specific Individual Risk
MAH	Major Accidental Hazard
NFR	Normal Flow Rate
NNF	Normally No Flow
NRV	Non-Return Valve

Definition	Description
P&ID	Process and Instrumentation Diagram
PFD	Process Flow Diagrams
PFP	Passive Fire Protection
PHA	Process Hazard Analysis
PHAST	Process Hazard Analysis Software Tool
PLL	Potential Loss of Life
ppm	Parts Per Million
PRV	Pressure Relief Valve
PSV	Pressure Safety Valve
QRA	Quantitative Risk Assessment
RRM	Risk Reduction Measure
SAFETI	Software for the Assessment of Fire, Explosion and Toxic Impacts
SDV	Shut-down Valve
SOW	Scope of Work
STEL	Short Term Exposure Limit
UKOOA	United Kingdom Offshore Operators Association (UK)
VCE	Vapour Cloud Explosion

3 PROJECT DOCUMENTS & STANDARDS

3.1 International References

Table 3-1: International Standards and References

Sr. No.	Document No.	Document Title	Issue Date
[1].	ISBN 0 7176 2151 0	Reducing risks, protecting people. HSE's decision-making process	Dec-2021
[2].	-	Guidance on ALARP Decisions in COMAH https://www.hse.gov.uk/foi/internalops/hid_circs/permissioning/spc_perm_37/#Tools-for-ALARP	Oct-2021
[3].	Research report 283 UK HSE	Development of an intermediate societal risk methodology	Nov-2022
[4].	IOGP Report no. 434-01	Process Release Frequencies	Sep-2019
[5].	IOGP Report no. 434-04	Riser and Pipeline Leak Frequencies	Sep-2019
[6].	IOGP Report no. 434-06	Ignition Probabilities	Sep-2019
[7].	IOGP Report no. 434-07	Consequence Modelling	Mar-2010
[8].	IOGP Report no. 434-12	Occupational Risk	Mar-2010
[9].	IOGP Report no. 434-14	Vulnerability of Human	Mar-2010
[10].	IOGP Report no. 434-09	Land Transport Accident Statistics	Mar-2010
[11].	IOGP Report no. 434-03	Storage Incident Frequencies	Aug-2022
[12].	CPR 18E	Guidelines for Quantitative Risk Assessment "Purple Book"	2005
[13].	CPR 14E	Guidelines for Methods for Calculation of Physical Effects "Yellow Book"	2005
[14].	CMPT	The Centre for Marine and Petroleum Technology (CMPT), A Guide to Quantitative Risk Assessment for Offshore Installations.	1999
[15].	CCPS	Effects of Thermal Radiation, Centre for Chemical Process Safety, (CCPS)	1994
[16].	Vol 75, Part B	IChemE, Modelling of Thermal Radiation from External Hydrocarbon Pool Fires, Trans IChemE.	May-1997
[17].	UK HSE Contract Research Report No. 96/1996	Development of Pool Fire Thermal Radiation Model	-
[18].	ISO17776	Petroleum and natural gas industries - Offshore production installations - Guidelines on tools and techniques for hazard identification and risk assessment	Dec-2016
[19].	API RP 521 RP	Pressure-Relieving and Depressurizing Systems	Jun-2020
[20].	API RP 2218	Fireproofing Practices in Petroleum and Petrochemical Processing Plants	Jul-2013

3.2 Project Specific References

Table 3-2: Project Specific Documents

Sr. No.	Document No.	Document Title
[21].	2756938	Assumption Register - QRA

Sr. No.	Document No.	Document Title
[22].	-	Facility Process Operation Description (Provided by COMPANY)
[23].	DBAC984595	Plot Plan for Power Plant Site CDB1
[24].	DBAC984596	Plot Plan for Engine Hall Section - CdB1
[25].	DBAD000326	Plot Plan for Fuel Treatment House - CdB1
[26].	DBAD009571	Plot Plan for Steam Turbine Building - CdB1
[27].	DBAD288951	Plot Plan for Existing Unloading Area - CdB1
[28].	DBAD778184	Plot Plan for Engine Hall Section - CdB2
[29].	DBAD778185	Plot Plan for Power Plant Site - CdB2
[30].	DBAD778186	Plot Plan for Engine Hall Plan - CdB2
[31].	-	HFO & LFO Process Flow Diagrams (PFD)
[32].	DBAD094107_Rev D	Process & Instrumentation Diagram (P&ID) For Fuel oil system 1 – CdB1
[33].	DBAD094108_Rev C	Process & Instrumentation Diagram (P&ID) For Fuel oil system 2 – CdB1
[34].	DBAD094123_Rev B	Process & Instrumentation Diagram (P&ID) For Fuel oil system 3 – CdB1
[35].	DBAD780117_Rev A	Process & Instrumentation Diagram (P&ID) For Fuel oil system 1 – CdB2
[36].	DBAD780119_Rev A	Process & Instrumentation Diagram (P&ID) For Fuel oil system 2 – CdB2
[37].	DBAD778185_Rev C	Plot Plan for Power Plant Site Preliminary 23.1.2025 Gas Pipe
[38].	-	Gas Specs and Parameters
[39].	-	HFO & LFO Specs
[40].	-	Storage Tank Datasheets
[41].	-	ESD Description Provided By COMPANY
[42].	-	Manning Details Provided By COMPANY

4 QRA METHODOLOGY

The basis of QRA methodology is to identify incident scenarios and evaluate the Risk by defining the frequency of failure, the probability of various consequences and the potential impact of those consequences. The Risk is defined in QRA as a function of probability or frequency and consequence of a particular accident scenario. The methodology adopted for carrying Quantitative Risk Assessment of project facilities is shown in following flowchart.

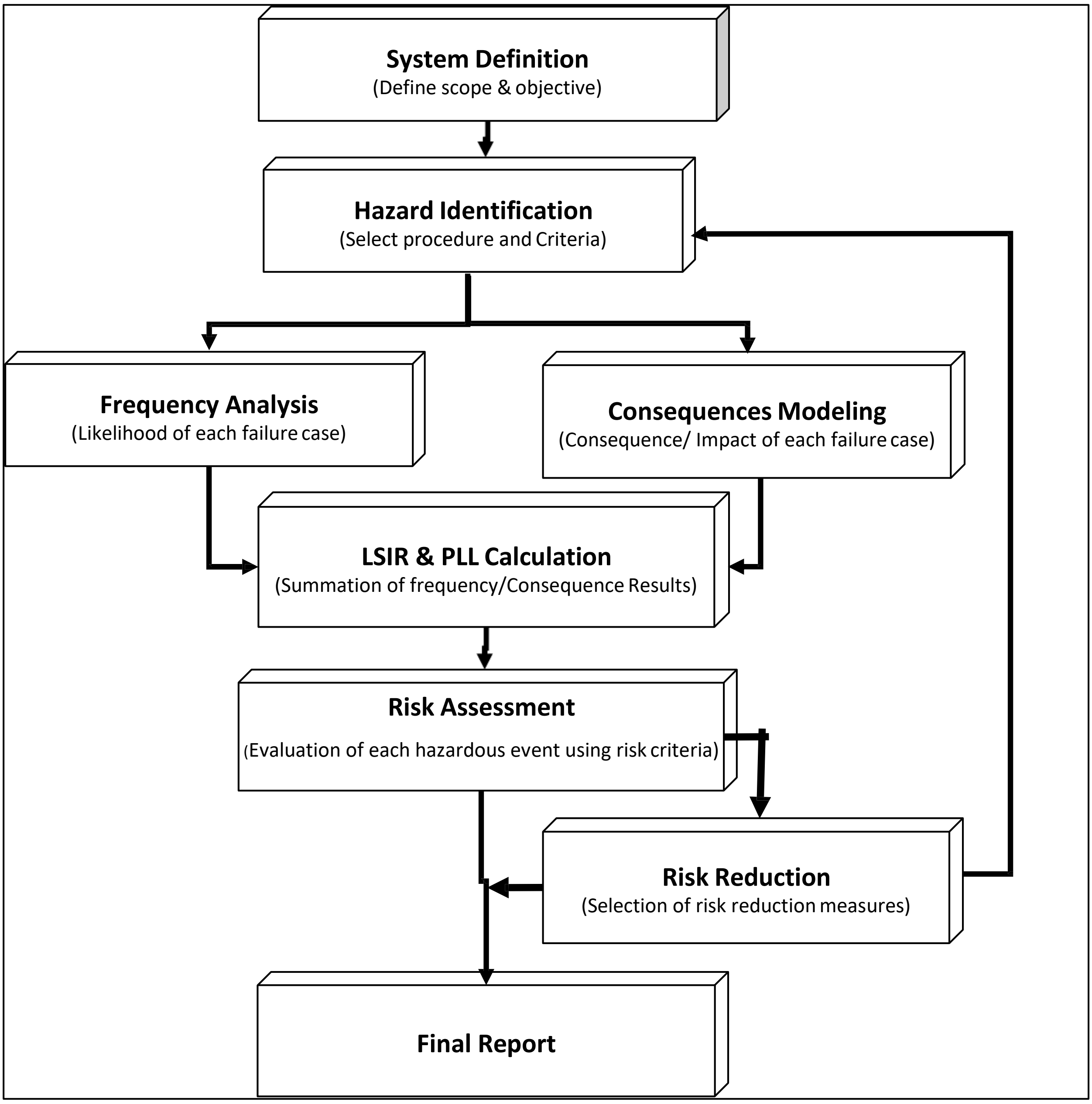

Figure 4-1: QRA Methodology Flowchart

4.1 Hazard Identification

EDD report for ContourGlobal CdB1 & CdB2 facilities is reviewed to identify any potential High, Medium risk which is carried forward to the QRA study. The potential hazardous event is usually called the 'top event' (e.g. hydrocarbons leaks from process equipment, storage facilities or pipelines).

Generally, there are two types of considered hazards, process and non-process:

- Process hazards generally consist of onshore process facilities, storage facilities, piping/pipelines, etc.
- Non-process hazards consist of occupational hazards, transportation risk, escape and evacuation Risk, ship collision, dropped object, etc.

Note: As part of non-process risk assessment, occupational risk assessment is applicable for the personnel working in ContourGlobal facilities.

PFD and P&IDs are used to identify the isolatable sections and various failure cases for all HC containing as well as hazardous inventories. These isolatable sections and failure cases are clearly marked on the P&ID.

Hazard Identification contains the main following steps:

- Review site all materials and identify those that are hazardous.
- Review process, utilities, and storage PFDs to identify areas of concern.
- Identify the isolatable sections: Hazardous events are defined in terms of the isolatable sections and their operating conditions. Isolatable sections are defined and bounded by the location of, Emergency Shut-Down Valves (ESDVs), Locked close manual valves, check valves rated for the maximum pressure, and pumps / compressor that will be tripped upon fire /leak scenario.
- Identify the Hazardous inventories (Inventory Analysis) for each isolatable section.
- Determine the source terms for all accidental events, the source term means the rate at which hazardous material reaches the environment and the conditions of the material (e.g. temperature, pressure & composition).

Once the hazards are identified, the accident scenarios for the QRA are generated:

Figure 4-2:Failure Case Development Meeting

Failure cases are identified for the following categories:

- Pipework, valves, flanges, fittings and associated equipment.
- Pressure vessels/ tanks.
- Atmospheric storage tanks.
- Pipelines.

Methodology for nomenclature of Isolatable section/failure cases is presented in assumption sheet 1.

4.2 Consequence Assessment

A range of consequences are assessed for each release scenario for each identified MAH. The quantity of material available to be released in the event of a leak is specific to each isolatable segment. Key assumptions that apply to the analysis in general are presented below:

a) The inventory associated with each isolatable segment case is defined as the isolatable mass within each segment under normal operating conditions.

b) Total inventory is calculated as a sum of static inventory and dynamic inventory of isolatable segments. Static inventory is based on vessel, piping, and pipeline dimensions. Dynamic inventory is calculated based on the leak rate from specified leak size.

The development of the top event into a serious incident gives estimation for the expected failure cases (accident scenarios), the outcomes depend on the effect of the process parameters, the release hole size, the phases of the hazardous material, the elevation and direction of the release point, the safety systems, the weather conditions, the confinement and congested areas, and presence of ignition sources. QRA studies use Event Trees to model the chronological series of events. Event Tree provides a systematic method to ensure all potential outcomes as a result of a specified top event are identified. Development of credible accident scenarios using Event Trees provides a structure to the conceptual and physical escalation scenario analysis.

Jet fire: A jet fire is a turbulent diffusion flame, resulting from the combustion of a fuel continuously released with significant momentum in a particular direction. Jet fires can occur due to immediate ignition of the released flammable gas or delayed ignition of the HC vapor cloud flashing back leading to a jet fire scenario at the release location. Jet fire can also result from release of two-phase liquid or liquid containing light HC. Upon release, light HC starts flashing immediately forming a flammable mixture. If ignited, this result in a flash fire followed by a jet fire at the source of release.

Flash fire: Flammable gas release or pool vaporization from the two-Phase HC release has the potential to form a flammable vapor cloud. Upon finding a credible ignition source, due to delayed ignition of the flammable gas cloud, a flash fire can occur in an unconfined area. A flash or cloud fire occurs when a cloud of gas burns without generating any significant overpressure. The cloud is typically ignited on its edge, remote from the leak source. The duration of the flash fire is relatively short, but it may stabilize as a continuing jet fire from the leak source. The major hazard to people for those within the burning envelope (including those who might be above on elevated structures). Flame duration and intensity for most flammable clouds are insufficient to cause a significant thermal radiation hazard outside the flame envelope.

Pool fire: A pool fire is a turbulent diffusion flame burning above a horizontal pool of vaporizing flammable liquid, with little or no momentum. The flame can emit fatal levels of radiant heat to the surrounding area. Pool fire events are considered to occur following the ignition of a release (continuous or instantaneous) of hydrocarbon liquids, where a substantial liquid fraction remains following the release. When first ignited, the fire spreads rapidly across the full extent of the hydrocarbon pool and proceeds to consume the liquid at a characteristic burning rate. For a continuous release ignited early, the pool fire grows until equilibrium is reached where burning at the surface just balances the release rate.

For scenarios involving the release of flammable liquids into a bunded area, the size of the resulting pool is assumed to be restricted to the area of the bund. For scenarios, involving the release of liquids into non bunded areas or bund overtop events, either it is assumed that the liquid spreads out to form a circular pool or, where relevant, the pool is constrained by the surrounding topography (e.g., kerbs and gradient).

Vapor cloud explosion (VCE): Upon release in the absence of immediate ignition sources, flammable gas forms a flammable vapor cloud. Upon finding a credible ignition source, delayed ignition of the flammable gas cloud can lead to vapor cloud explosion if the gas is accumulated in a congested area. The degree of explosion will depend upon the congestion and the confined volume. Within the congested area, the flame accelerates to velocities high enough to produce significant levels of overpressure, which could then cause fatalities. VCE events may occur following the delayed ignition of a release (continuous or instantaneous) of flammable vapor or following vaporization of a liquid release. Several features need to be present for a vapor cloud explosion with damaging overpressure to occur: First, the released material must be flammable and at suitable conditions of pressure or temperature. (Such materials include liquefied gases under pressure, ordinary flammable liquids particularly at high temperatures and/or pressures and non-liquefied flammable gases). Second, a cloud of sufficient size must form prior to ignition (dispersion phase).

Fireball:

A fireball is a burning fuel-air cloud, whose energy is emitted primarily in the form of radiant heat. Fireballs were considered to occur following the immediate ignition of large vapor releases. They were also considered possible following the immediate ignition of a large release of liquefied gas.

Toxic Gas: Upon release in the absence of immediate ignition sources, exposure to gas cloud containing H_2S can lead to lethal dose to personnel within the gas cloud. The degree of dose and hence potential fatality depends upon the duration and toxic gas (H_2S) concentration for which personnel are exposed to.

Storage Tanks

- **Full Surface Tank Fire:** For HC/Flammable liquid tanks full surface tank fire scenarios are modelled as pool fire at a height i.e., on the roof of the tank. The degree of the fire depends upon diameter of the tanks, amount of smoke generated and view factor.
- **Bund Fire:** For HC/Flammable liquid tanks where bunds are provided, bund fire scenario is modelled. Based on IOGP database, full bund fire (considering entire bund is filled with HC liquid) is modelled. Where, more than one tank is located inside the bund, full bund fire scenario is modelled considering one tank inventory.

Following failure cases/scenarios are modelled for storage tanks.

- Bund fire.
- Full surface tank fire.
- Catastrophic rupture.

Note: Consequence results for boilover scenarios are added in the QRA report, Appendix 6.

Consequence analysis of these events and its effect on people and other receptors typically consist of three (3) main steps namely source term modelling, physical effect modelling and impact assessment. These steps are described below.

Source Term Modelling: Source term modelling is carried out for each identified scenario to determine the release profile and release parameters for various potential loss of containment scenarios. Following inputs are considered for the source term modelling (as shown in table below):

- Stored inventory (Static and Dynamic)
- Representative material.
- Process parameters (Pressure, Temperature, Flow rate, etc.)
- Release size & direction.

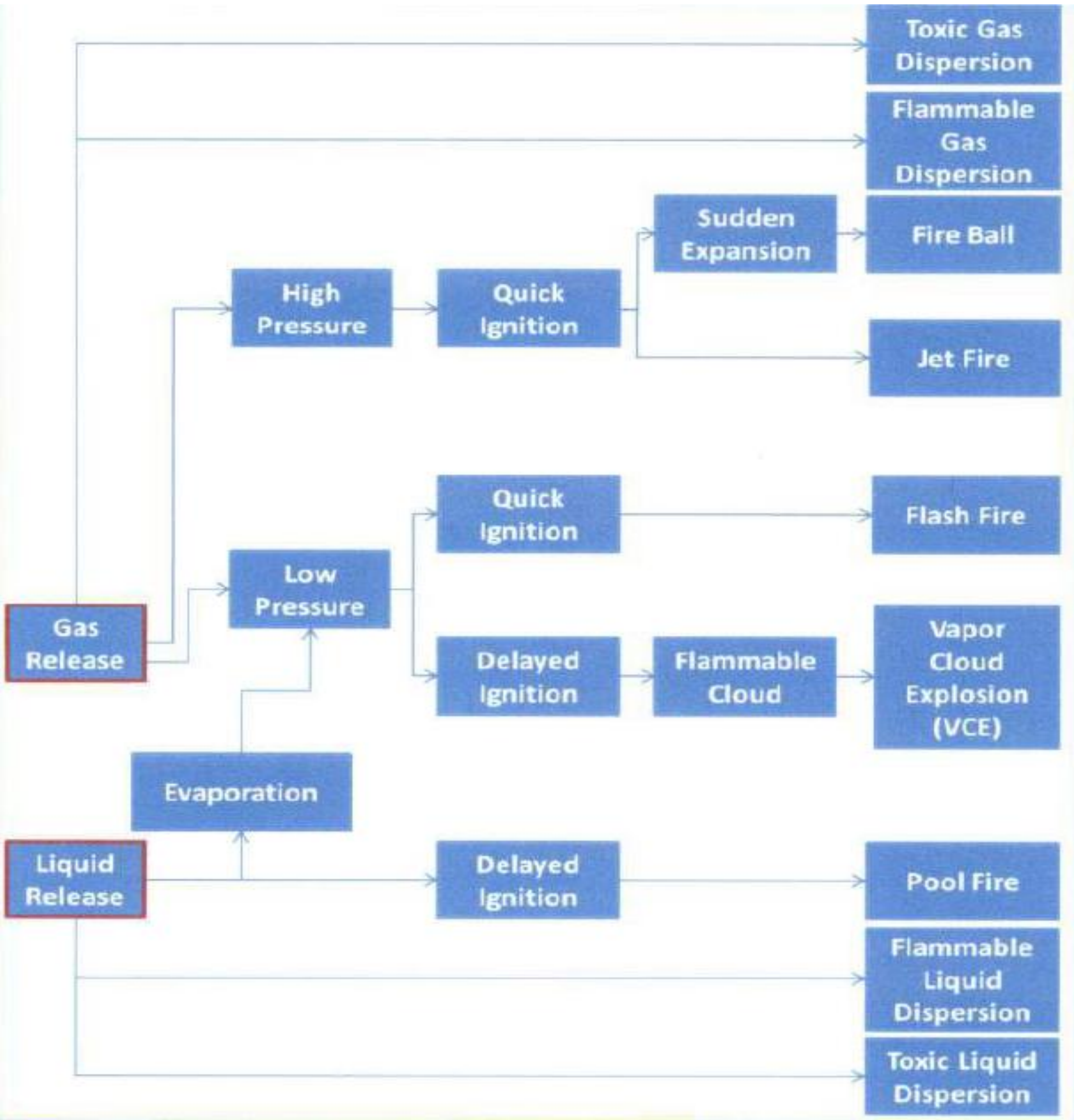

Figure 4-3: Example for Possible Outcomes from Gas and Liquid Release Events

Physical Effect Modelling: Based on the source term modelling results and various potential consequence outcomes based on the event tree approach, physical effect modelling is carried out using DNV SAFETI Software V9.11. The physical effect modelling determines the dispersion profile and extent of various physical effects such as HC dispersion, flash fire envelope, jet fire, pool fire etc.

H&MB available in the operating manuals or latest process information available for each facility is used. Where available, process parameters are selected based on PFDs.

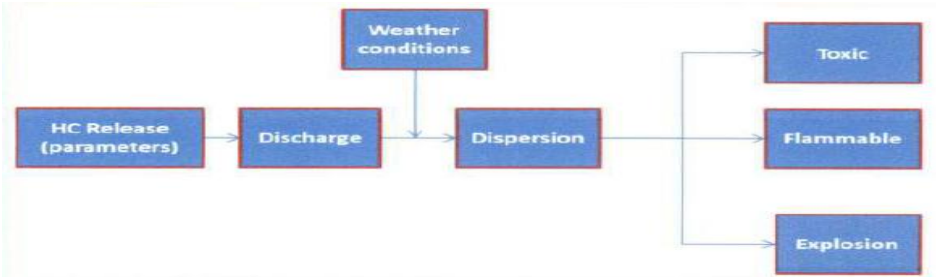

Figure 4-4: The Stages of Developing the HC Releases into the Main Physical Effect

Physical effects is calculated to identify which parts of the facility, community, Company personnel and the public may be exposed for each potential event and the extent of that exposure. This exposure used to estimate the potential for further failure, escalation, impairment, injury, etc. and contribute to decisions on the need to reduce such Risks.

Once the release rate has been estimated the calculation of physical effects depend on many other factors (such as wind profile, obstruction, congestions, ignition sources, exposure duration).

The physical effect modelling determines the dispersion profile and extend of various physical effect such as toxic/ flammable dispersion, flash fire envelope, jet fire, pool fire, explosion effect, smoke dispersion, etc.

The potential outcomes of various 'physical effects' for a given release profile for each scenario under consideration shall be reported in the QRA Report.

Failure case category	possible physical effects					
	Jet fires	Pool fires	Fireballs	BLEVEs	Flash fires	Explosions
1. Pipework, risers, valves, flanges, fittings and associated equipment	Y	Y	N	N	Y	Y
2. Pressure vessels / tanks	Y	Y	Y	Y	Y	Y
3. Atmospheric storage tanks	N	Y	N	N	Y	Y
4. Intermediate bulk containers	N	Y	N	N	N	N
5. Pipelines	Y	Y	N	N	Y	Y
6. Flexible hoses	Y	Y	N	N	Y	Y

Figure 4-5: List of the Possible Physical Effects (Consequences) Apply for Each Failure Case Category

Impact Assessment:

As part of impact assessment, vulnerability of humans to the consequences of major hazard events at onshore, primarily those producing and/or processing hazardous fluids are established. The focus is on Fatality Criteria as QRAs generally address fatality risks. However, injury thresholds can also identified where appropriate.

As part of QRA, impact are assessed on people for quantifying the risk results. Following approach are adopted for the impact assessment to determine the fatality probability.

Thermal Radiation: Fire scenarios such as jet fire, pool fire, and flash fire yield thermal radiation. Thermal dose yielded based on exposure to thermal radiation and the time duration can be lethal.

Explosion Overpressures: Sudden release of high volume of energy from ignition of vapour clouds in congested areas result in explosion overpressure. TNO ME model is used to for modelling explosion overpressures.

Note: Areas in the open air e.g. over open ground or between large structures such as the storage tanks, are not regarded as congested or confined and hence the VCE is not consider for the study.

Toxic: Exposure to toxic gases such as H_2S can lead to fatality. However, fatality probabilities are dependent on concentration to which personnel are exposure to and duration of the event. Hence, probit-based approach is adopted for the risk calculations.

Note: - The maximum H_2S content is around 2 ppm. Therefore, the H_2S release from the vent space do not generate any major toxic consequences and hence it is not assessed and reported in the QRA.

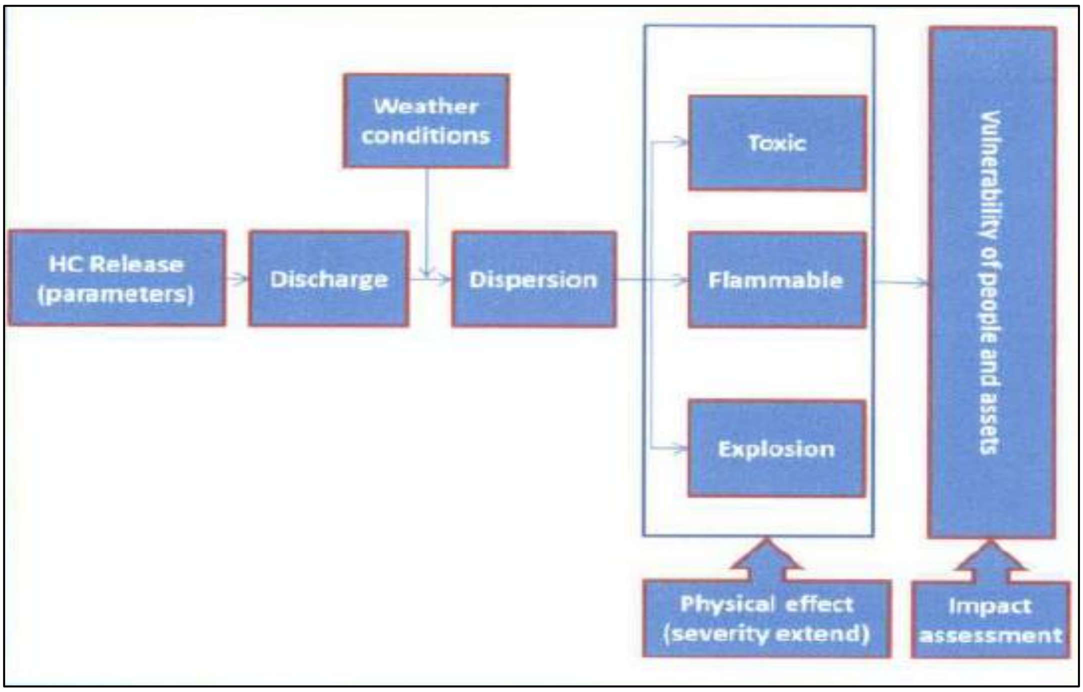

Figure 4-6: The Stages of Developing the HC Releases into the Impact Assessment

4.3 Frequency Assessment

In risk assessment, frequency is estimated based on knowledge and expert judgment, historical experience, and analytical methods. These factors combine to support judgments made by risk assessment teams. Historical experience is expressed in terms of statistical data gathered from existing operations, generally in the form of incidents, base failure rates and failure probabilities.

a) Process equipment leak frequency database: The IOGP Risk assessment data directory is to provide data and information that can be used to improve the quality and consistency of risk assessments with readily available benchmark data. The directory includes references for common incidents analysed in upstream production operations.

b) Parts count: Parts count is undertaken based on P&IDs. The parts count is used as the basis for identifying the release sources corresponding to pinhole, small, medium, large, and full-bore rupture events. Parts count is performed for clearly identified isolatable sections based on the location of ESDVs and thereafter based on failure cases. For each failure case, in each isolatable section, equipment is counted to provide input for estimating leak frequencies. The frequency of each leak scenario and size identified is estimated by combining parts counts for each equipment item with leak frequencies.

c) Leak frequency assessment: The release frequency for each isolatable section is calculated as the sum of the products of the number of components and the generic component failure rate. It is evident from the frequency databases that smaller leaks are more dominant, and larger releases are very rare and therefore it is necessary that various hole size ranges are considered. The output of this is a frequency of potential releases for pinhole, small, medium, large, and catastrophic hole sizes for process equipment releases. The hole size ranges are characterized by a representative hole size within each range. The hole size distribution, representative hole size and associated assumptions are detailed in assumptions register sheet developed for assessment purpose.

d) Ignition probabilities: Ignition characteristics and associated probabilities determine which event tree branch is followed and what will be the potential event for a given release scenario. The ignition probabilities play a major role in determining fire and toxic scenario contribution and therefore selecting the correct ignition probabilities plays an important role in risk calculation. Ignition probabilities provided in IOGP report 434-06 risk assessment data directory is adopted.

Note: Refer APPENDIX 4- PART COUNT AND FAILURE FREQUENCIES for parts count and frequency analysis.

4.4 Event Frequencies

SAFETI software inbuilt event trees are used for calculation of the outcome event frequencies using the user supplied inputs for the ignition probability inputs. Typical event trees are shown in assumption sheet 10 of Assumption register, Ref.[21]

Major risk contributors are presented in the QRA report (refer section 14.5) which confers about the contribution of event outcome frequencies for each area/location.

4.5 Risk Assessment

The calculated process risk is presented & evaluated based on various risk indicators as outlined in table below.

Table 4-1 Typical Risk Presentation

Facility	LSIR	Process IRPA	PLL	FN curve (Public)	FN curve (Workers)
Onshore facilities	LSIR contour for each unit & overall LSIR contour	For each worker group	For each worker group	For nearby public population	For site/accommodations

a) **Location Specific Individual Risk (LSIR):** It is a measure of geographical spread of risk. LSIR is defined as the frequency per year at which an individual, who stays unprotected for 24 hours per day and 365 days per year at a specific location, is expected to sustain fatal harm due to exposure to hazards induced by industrial activity.

This refers to a hypothetical individual who is always present at a particular location. This is useful for showing the spatial distribution of risk.

b) **Occupancy and Manning:** In order to determine the risk to people, the QRA must estimate the number of people exposed and their locations i.e., manning levels and distribution. Individuals shall be assigned to a worker group representative of their work pattern and location.

Each worker group shall be assigned a representative rotation/shift pattern, and the time spent at each area of the facility/plant versus time spent in the control room/offices/accommodation shall also be estimated. These estimates also known as occupancy factor shall be used to calculate the individual risk to each person within each worker group whereas manning is used for calculating PLL.

c) **Individual Risk Per Annum (IRPA):** IRPA is Individual Risk Per Annum of a representative worker of a given worker group considering expected occupancy at all the locations he is expected to be presented within the hazardous location throughout the year. This includes plant, accommodations, recreational activities, etc. The calculation excludes the duration for which personnel is not present at the site due to reasons such as annual leave, personnel is considered not exposed to facility operations or occupational Risk during this duration.

d) **Potential Loss of Life (PLL):** Potential loss of life (PLL) is defined as the sum of overall accident scenarios of the consequences (in terms of fatalities) of accident multiplied by the frequency of occurrence of these accidents over specified period. PLL is expressed as number of fatalities per year or number of fatalities for a specified period such as project lifetime.

e) **Onsite Societal Risk (F-N Curve):** Onsite societal risk represents risks to group workers within the accommodation and indicates potential risk of more than 1 fatality due to facility operation per year. These risks are represented by an F-N Curve plotted on a log-log scale. F-N curves are plots of the cumulative frequency (F) of N or more fatalities per year, against the number of fatalities (N).

f) **Fatal Accidental Rates:** FAR is Fatal Accident Rate defined as the number of fatalities per 10 million hours engaged in that function. IOGP statistics is used in the QRA study.

g) **Non-Process Risk Assessment:** As part of non-process risk assessment, occupational risk is studied for ContourGlobal facilities based on the activities performed by various worker categories.

4.6 Risk Evaluation

Once risks are identified and analysed, risks should be evaluated against set criteria. It must be ensured that all risks are evaluated to meet and comply with UK HSE Quantitative Risk Tolerance criteria as mentioned in approved assumption register, Ref.[21]

4.7 ALARP Demonstration

ALARP process starts by identification of the Major Risk Contributors. These Major Risk Contributors are further broken down to determine the top contributors to risk.

Risk reduction measures are identified against these contributors to reduce the risk, as well as identifying hierarchy of controls for these risk reduction measures.

The objective of ALARP Demonstration:

- Identify and provide risk reduction measures to ensure the risk is "As Low As Reasonably Practicable" (ALARP)
- Demonstrate that the preferred risk reduction measure reduces risk to ALARP by rerun the results after agreeing the suggested reduction measures with the Company (this will help to assure the effectiveness of these measures to reduce Risk to the ALARP)

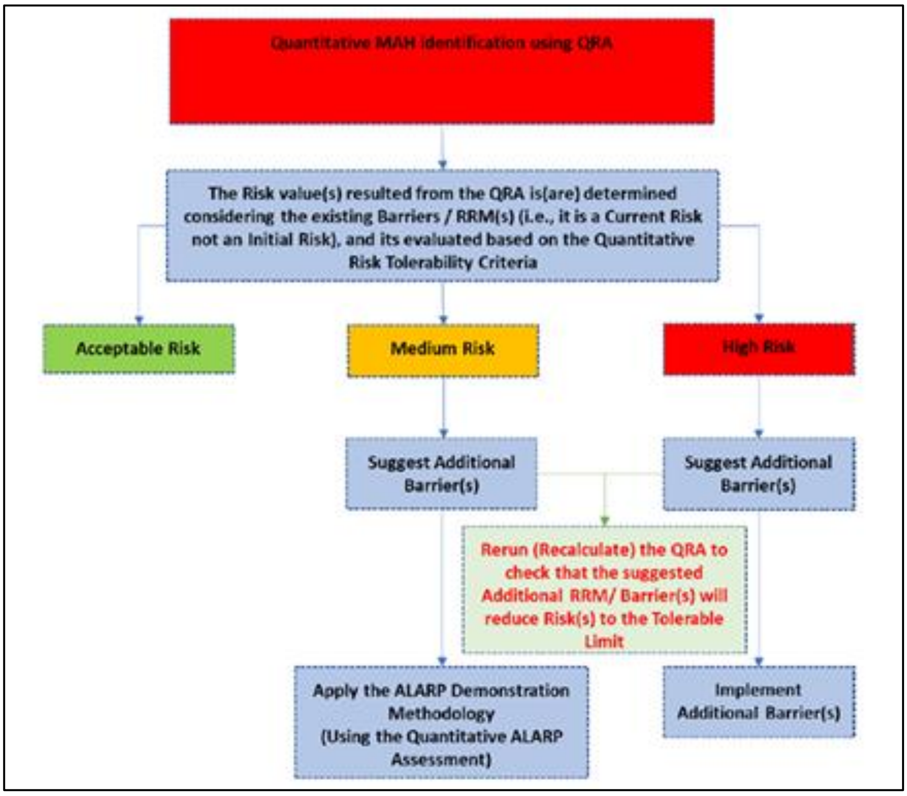

Figure 4-7: The Quantitative MAH Assessment linked to the ALARP Demonstration Methodology

5 FAILURE CASES DESCRIPTION

The failure case selection involves:

a) Identification of isolatable sections containing hazardous material.

b) Development of hazardous scenarios.

PFD and P&IDs are used to identify the isolatable sections and various failure cases for all HC containing as well as hazardous inventories. These isolatable sections and failure cases are clearly marked on the P&ID, refer Appendix 3.

Isolatable sections are marked between two clearly identified isolation valves (ESD) or normally closed blocked valves. The limits of the isolatable sections are defined and bounded by the location between 2 or more of the Emergency Shutdown Valves (SDVs / XVs) or MOV.

Isolatable sections are determined by reviewing process information, such as engineering drawings (P&IDs, PFD and plot plans), process materials and process conditions. Hazardous scenarios (i.e. failure cases) are developed by identifying possible failure modes (represented as releases from selected hole/leak sizes) associated with each isolatable section.

The list of identified isolatable sections with summary of process parameters used for QRA study is presented Appendix 3

The failure cases description for the studied scenarios in the QRA study are mentioned below:

Table 5-1: Failure Case Description for CdB1 Facility

CdB1 Facility				
ISO No.	**Isolatable Section (From)**	**Isolatable Section (To)**	**Failure Case Description (Leak modelled at)**	**Failure Case ID**
ISO1	From battery limit	To PAA900-V-005	LOC at (B/L) PAA900-V-005	**CdB1-ISO1-1**
ISO1	From (B/L) PAA900-V-005	To inlet of PAB902 and PAB901 upto the inlet PAA900-V-007/008	LOC at (B/L) PAA900-V-008	**CdB1-ISO1-2**
ISO2	From HFO unloading tanker manifold (B/L) PAA900-V-017/018/019/020	To inlet of PAB902 and PAB901 upto the inlet NRV PAA900-V-021/022	LOC at PAA901 HFO Unloading Pump Unit	**CdB1-ISO2**
ISO3	From PAA900-V-007 at the inlet of PAB901	At PAB901 HFO storage tank existing (1480m^3) and further upto the inlet of PAC901 HFO transfer pump	At PAB901 HFO storage tank existing (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO3**
ISO4	From PAA900-V-008 at the inlet of PAB902	At PAB902 HFO storage tank existing (1480m^3) further upto the inlet of HFO transfer pump phase 2	At PAB902 HFO storage tank existing (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO4**
ISO5	From PAC901 HFO transfer pump	At PBA902 HFO Pre-storage tank inlet valve PAC900-V024	LOC at PAC901 HFO transfer pump	**CdB1-ISO5**

CdB1 Facility				
ISO No.	**Isolatable Section (From)**	**Isolatable Section (To)**	**Failure Case Description (Leak modelled at)**	**Failure Case ID**
ISO6	From HFO Pre-storage tank inlet valve PAC900-V024	At PBA902 HFO pre-storage tank (3000m^3) further upto the inlet of HFO transfer pump PAC902 pump unit	At PBA902 HFO pre-storage tank (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO6**
ISO7	From HFO transfer pump PAC902 pump	To HFO buffer tank inlet valve PAC900-V007	LOC at HFO transfer pump PAC902 pump	**CdB1-ISO7**
ISO8	PBA901 HFO buffer tank (50m3)	At PBA901 HFO buffer tank (50m^3) further upto the inlet of HFO separator unit PBB901 transfer pump	At PBA901 HFO buffer tank (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO8**
ISO9	From HFO separator unit PBB901 transfer pump outlet	To inlet line of PBC901 HFO day Tank	HFO separator unit PBB901 transfer pump	**CdB1-ISO9**
ISO10	PBC901 HFO day tank (100m3)	PBC901 HFO day tank (100m3) further upto the inlet of HFO feeder unit PCA901 & PCA902 inlet SDVs	At PBC901 HFO day tank (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO10**
ISO11	From inlet SDV of HFO feeder pump unit PCA901	To HFO feeder pump unit PCA901	SDV of HFO feeder pump unit PCA901	**CdB1-ISO11-1**
ISO11	From inlet SDV of HFO feeder pump unit PCA902	To HFO feeder pump unit PCA902	SDV of HFO feeder pump unit PCA902	**CdB1-ISO11-2**
ISO12	HFO feeder pump unit PCA901/902 pump outlet	HFO to engine fuel booster inlet valve	HFO feeder pump unit PCA901/902 pump outlet	**CdB1-ISO12**
ISO13	From LFO unloading valve PAD901 Unloading Pump Unit	To inlet line of PAE901 LFO Storage Tank	LFO unloading PAD901 Unloading Pump	**CdB1-ISO13**
ISO14	From PAE901 LFO storage tank(120m3)	PAE901 LFO storage tank further upto the inlet of LFO transfer unit PAF901 pump	At PAE901 LFO storage tank (120m3) (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO14**
ISO15	From LFO transfer unit PAF901 pump outlet	To inlet line of PBF901 LFO day tank	LFO transfer unit PAF901 pump	**CdB1-ISO15**
ISO16	PBF901 LFO day tank (100m3)	PBF901 LFO day tank (100m3) further upto the inlet SDV of LFO feeder unit PCA903 pump	PBF901 LFO day tank (100m3) (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO16**

CdB1 Facility				
ISO No.	**Isolatable Section (From)**	**Isolatable Section (To)**	**Failure Case Description (Leak modelled at)**	**Failure Case ID**
ISO17	From inlet SDVs of PCA903	To PCA903 LFO feeder unit pump 1	SDVs of PCA903	**CdB1-ISO17-1**
ISO17	From inlet SDVs of PCA903	To PCA903 LFO feeder unit pump 2	SDVs of PCA903	**CdB1-ISO17-2**
ISO18	From PCA903 LFO feeder unit pump outlet	To LFO engine fuel booster inlet valve	PCA903 LFO feeder unit pumps	**CdB1-ISO18**
ISO19	From tie in ESD valve	To engine inlet	Engine inlet SDV	**CdB1-ISO19**
IS020	From engine inlet SDV	To engine hall	Engine Hall Downstream SDV	**CdB1-ISO20**

Table 5-2:Failure Case Description for CdB2 Facility

CdB2 Facility				
ISO No.	**Isolatable Section (From)**	**Isolatable Section (To)**	**Failure Case Description (Leak modelled at)**	**Failure Case ID**
ISO1	From PAC921 HFO transfer pump outlet	To inlet valve PAC900-V201 of PBA921 HFO Storage Tank	LOC at PAC921 HFO transfer pump	**CdB2-ISO1**
ISO2	From PAC900-V201 of PBA921 HFO Storage Tank	At PBA921 HFO storage tank (2000 m^3) and further upto the inlet of PAC922 HFO transfer pump	At PBA921 HFO storage tank (2000 m^3) (Full surface, bund fire, and catastrophic rupture)	**CdB2-ISO2**
ISO3	From PAC922 HFO transfer pump outlet	To PBA921 HFO buffer tank inlet line	At PAC922 HFO transfer pumps	**CdB2-ISO3**
ISO4	PBA921 HFO buffer tank (35 m^3)	At PBA921 HFO buffer tank (35 m^3) and further upto the inlet of HFO transfer separator unit PBB921 pump inlet	At PBA921 HFO buffer tank (35 m^3) (Full surface, bund fire, and catastrophic rupture)	**CdB2-ISO4**
ISO5	From HFO transfer separator unit PBB921 pump outlets	To PBC921 HFO day tank inlet line	LOC at HFO transfer separator unit PBB921 pump	**CdB2-ISO5**
ISO6	From PBC921 HFO day tank (80 m^3)	At PBC921 HFO day tank (80 m^3) and further upto the inlet SDV of HFO feeder module PAC921 pump	At PBC921 HFO day tank (80 m^3) (Full surface, bund fire, and catastrophic rupture)	**CdB2-ISO6**
ISO7	From SDV of HFO feeder module PAC921 pump	To HFO feeder module PAC921 pump	At SDV of HFO feeder module PAC921 pump	**CdB2-ISO7**
ISO8	From HFO feeder module PAC921 pump	To HFO fuel booster inlet valve	At HFO feeder module PAC921 pump	**CdB2-ISO8**

CdB2 Facility				
ISO No.	**Isolatable Section (From)**	**Isolatable Section (To)**	**Failure Case Description (Leak modelled at)**	**Failure Case ID**
ISO9	From PAD921 LFO Unloading unit valves	To inlet line of PAE901 LFO storage tank	PAD921 LFO Unloading unit pumps	**CdB2-ISO9**
ISO10	From PAE901 LFO storage tank	At PAE901 LFO storage tank and further upto the inlet of LFO transfer pump PAF921 pump	At PAE901 LFO storage tank (120 m^3) (Full surface, bund fire, and catastrophic rupture)	**CdB2-ISO10**
ISO11	From LFO transfer pump PAF921 pump outlet	To inlet line of PBF921 LFO day tank	LOC at LFO transfer pump PAF921 pump outlet	**CdB2-ISO11**
ISO12	From PBF921 LFO day tank (80m^3)	At PBF921 LFO day tank (80 m^3) and further upto the inlet SDV of LFO feeder module PAC921 pump	At PBF921 LFO day tank (80m^3) (Full surface, bund fire, and catastrophic rupture)	**CdB2-ISO12**
ISO13	From the inlet SDV of LFO feeder module PAC921 pump	To LFO feeder module PAC921 pump	SDV of LFO feeder module PAC921 pump	**CdB2-ISO13**
ISO14	From LFO feeder module PAC921 pump	To LFO fuel booster inlet valve	At LFO feeder module PAC921 pump	**CdB2-ISO14**
ISO15	From tie in ESD	To the inlet of engine room	At inlet ESD of engine room	**CdB2-ISO15**
ISO16	From engine inlet SDV	To engine hall	Engine Hall Downstream SDV	**CdB2-ISO16**

6 CONSEQUENCE ANALYSIS

Consequence modelling evaluates the effects of potential accidents and assesses their impacts. The estimation of consequences for each possible event is performed using PHAST, a module within DNV's SAFETI risk modelling software.

A range of consequences are assessed for each release scenario for each identified MAH. The quantity of material available to be released in the event of a leak is specific to each isolatable segment. The basis of consequence modelling is highlighted in the assumption register, Ref.[21]

1. **Storage Tanks**

- **Full Surface Tank Fire:** For HC liquid tanks full surface tank fire scenarios are modelled as pool fire at a height i.e., on the roof of the tank. The degree of the fire depends upon diameter of the tanks, amount of smoke generated and view factor.
- **Bund Fire:** For HC liquid tanks where bunds are provided, bund fire scenario are modelled. Based on IOGP database, full bund fire (considering entire bund is filled with HC liquid) is modelled.

Following failure cases/scenarios are modelled for atmospheric storage tanks:

- Bund fire
- Full surface tank fire
- Catastrophic rupture

Boilover scenario: Consequence results for boilover scenarios are added in the QRA report.

2. **GAS (Fuel Gas):** Following outcome events are anticipated upon release of GAS (Fuel Gas)

- Jet Fire
- Flash Fire
- Explosion scenarios (Engine room).

The detailed explosion assessment is appended in Appendix 7.

7 FREQUENCY ASSESSMENT

The release frequencies are estimated based on knowledge and expert judgment, historical experience, and analytical methods which is captured in IOGP report 434-1, Ref.[4]. These include all generic causes leading to loss of containment.

7.1 Parts Count and Failure Frequencies

Equipment part count is undertaken based on facility P&IDs. The parts count is used as the basis for identifying the release sources corresponding to small, medium, large, and full-bore rupture events. Parts counts are performed for individual isolatable section /subsection to derive leak frequency of respective failure case/section or subsection. The detailed part count and failure frequencies are appended in the Appendix 4.

GAS Release:

The latest version of the HCRD & IOGP report 434-1 dataset is contained within the LEAK software, which has been used to apply the data to the parts count in this study. The HCRD data (and hence LEAK) can be used to derive frequencies for a wide range of hole sizes and equipment types (i.e. parts). DNV proprietary software LEAK V3.3 is used for the leak frequency calculation of process equipment and process piping. The leak frequencies for the main process equipment items are based on IOGP report 434-1, Ref.[4]

The failure frequency modification factor is utilized to consider the frequency of loading and unloading operation. Based on the inputs provided by the COMPANY, the time modification factor is calculated for the study and the detailed approach for calculation is mentioned in the approved assumption register, refer Appendix 1.

The time modification factors calculated for the CdB1 and CdB2 facilities are utilized for frequency calculation. Ref.[21]

Storage Tank Fires

Summary of LASTFIRE Data (An analysis of incidents between 1984 and 2011) for Ignited Releases demonstrated in IOGP 434-4 is summarized in the following table:

Table 7-1:Hydrocarbon Storage Tank Fire Scenario Frequencies

Type of Fire	Fire Frequency (per tank year)
Full surface fire	2.10E-05
Liquid spill outside the tank shell (Bund fire)	1.13E-05
Catastrophic Rupture - Instantaneous or very rapid release of the contents	5.00E-06

The frequency of boilover events was not calculated. It is assumed that all full surface fires lead to boilover, for susceptible liquids within the tank.

8 IGNITION PROBABILITY

Ignition probability input has potential to decide the nature of consequence and has impact on risk results and conclusion that can be drawn from the assessment.

IOGP data base (Report No. 431-6.1, March 2010, Ignition Probabilities) estimates the ignition probabilities based on 28 mathematical functions drawn from the UKOOA look-up correlation (Energy Institute, IP Research Report) which relates ignition probabilities in air to release rate for typical scenarios both onshore and offshore.

The values presented in IOGP relate to “total” ignition probability, which can be considered as the sum of the probability of immediate ignition and delayed ignition.

The ignition probability look-up correlation used in this study is based on the following scenario.

Table 8-1: Ignition Probability Curve

Sr. No	Scenario Number	Applicable Location	Look-up Release Type	Application
1	Scenario No. 07	HFO/LFO Storage Tanks	Small Plant Liquid Bund Rural (Liquid release from small onshore plant where the spill is bunded)	Releases of flammable liquids that do not have any significant flash fraction (10% or less) if released from small onshore plants (plant area up to 1200 m^2, site area up to 35,000 m^2) and where the liquid releases from the plant area are suitably bunded or otherwise contained.
2	Scenario No. 05	Fuel Gas	Small Plant Gas LPG (Gas or LPG release from small onshore plant)	Releases of flammable gases, vapour or liquids significantly above their normal (NAP) boiling point from small onshore plants (plant area up to 1200 m2, site area up to 35,000 m^2).

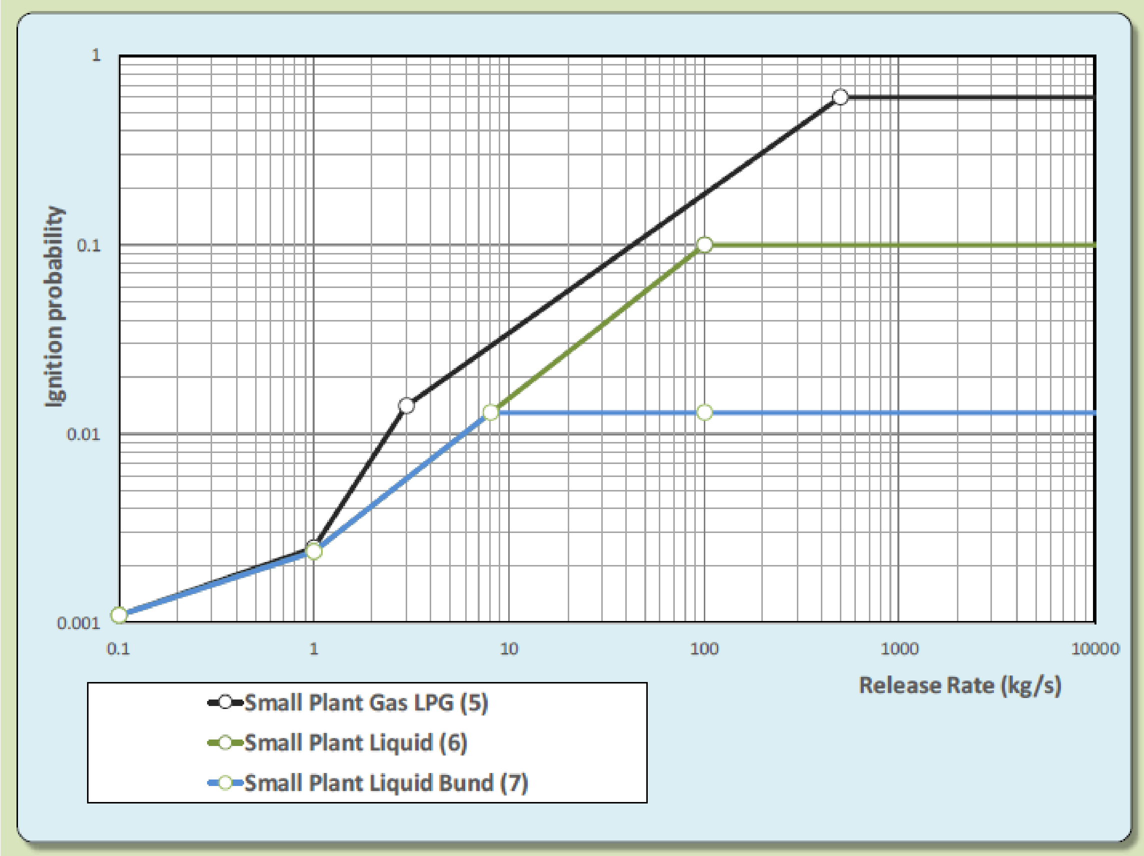

Figure 8-1:UKOOA Look-Up Correlation

Total Ignition Probability = Immediate Ignition Probability + Delayed Ignition Probability

The immediate ignition probability associated with each flammable failure case is a risk analyst programmed value, based on historical ignition data, which varies with leak size and release phase (the larger the leak vapour flow rate, the higher the total ignition probability).

The IP review of ignition and explosion probabilities concludes that; there are too little data to draw any firm conclusions but that "risk assessment approaches based on 30:70 to 50:50 split delayed ignition or jet / pool fire: flash fire / explosion is reasonable". Furthermore, it also identifies that, on average, approximately 20% of ignited gas releases result in explosions.

For this study, the split between immediate and delayed ignition was considered to be 30:70, in line with the IP review of ignition and explosion probabilities. The immediate ignition probability was calculated using the formula:

$$P_{immediate} = P_{total} \times 0.30,$$

where P_{total} was obtained from the IOGP/UKOOA look-up table for the respective plant area.

9 WEATHER CONDITIONS

Environmental Conditions for GlobalContour Facilities, Senegal:

The following meteorological parameters are used as input for consequence modelling & risk calculation:

Table 9-1: Meteorological Data

Parameter	Value	Unit	Notes/Justification
Ambient air temperature	25.35	^0C	It has relatively minor influence on the dispersion characteristics (although there will be buoyancy of gas clouds)
Relative humidity	75.52	%	This has influence on the dispersion of dense gas clouds
Surface parameter	0.03	m	Open flat terrain, grass, few isolated objects
Solar radiation	0.24	kW/m^2	Peak solar radiation. Negligible influence on dispersion/consequence.
Atmospheric pressure	1.0	bar	Negligible influence on dispersion/consequence.

Weather Conditions:

Two (2) representative weather conditions are applied to model the dispersion of each release scenario:

5D – Neutral stability and 5 m/s wind speed. This is typical of moderately turbulent conditions, representative of typical dispersion conditions during daytime conditions.

2F – Stable conditions and 2 m/s wind speed. This is typical of conditions where there is limited turbulence and, hence, limited dilution of dispersing clouds. This tends to be the worst-case conditions for dense gas dispersion during nighttime conditions.

The details of wind data is given below.

Wind Rose and Wind Directional Probabilities (%) For GlobalContour Facilities

The nearest weather station identified is Dakar. The windrose and wind directional probability for the same is given below.

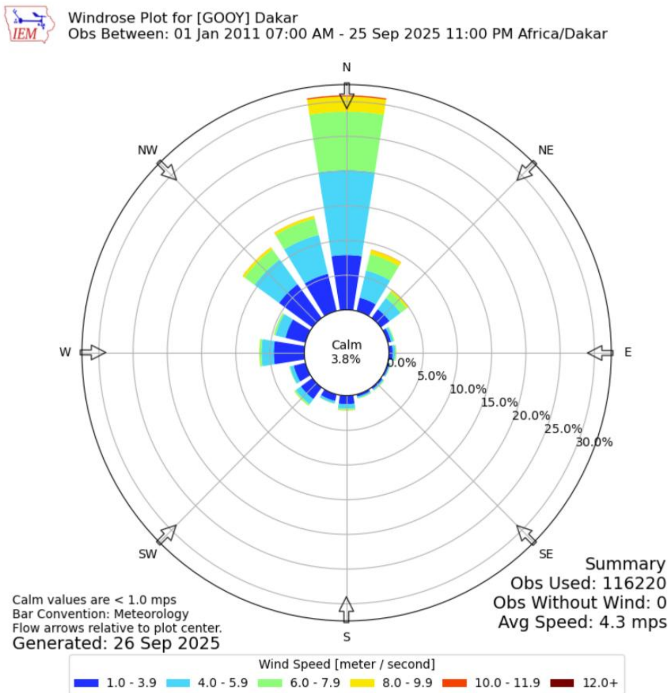

Figure 9-1: Windrose for Rufisque, Senegal

The wind directional probability is for Rufisque, Senegal.

Table 9-2: Wind Directional Probability for Rufisque, Senegal

Direction	Wind Speed % Distribution in 16 Critical Direction	
	2F	5D
349-010	11.681	23.025
011-033	1.976	7.123
034-055	1.56	3.481
056-078	0.496	0.518
079-100	0.546	0.546
101-123	0.237	0.22
124-145	0.284	0.327
146-168	0.337	0.323
169-190	1.231	0.924
191-213	0.977	0.407
214-235	2.079	1.211
236-258	1.763	0.657
259-280	4.459	2.137
281-303	3.002	1.765
304-325	6.009	6.615
326-348	5.512	8.576
Total	**42.14**	**57.85**

10 MANNING LEVELS

The onsite and offsite manning details are mentioned in the assumption register, refer Appendix 1. The manning data is mentioned in Table 10-1. The presence factor is calculated based on onsite manning details as mentioned in the assumption register, refer Appendix 1.

Table 10-1: Manning/Population Data For CdB1 & CdB2 Both

Sr. No	Worker Group	No. of Personnel in Worker Category	Presence Time in the Facility	Average Hours Spent in the Facility						
				Engines Hall	Steam Turbine Hall	Fuel Treatment House	Tanks Area	Heat Recovery Area	Outdoor Installations/ Workshop	Control Room/ Offices/Laboratory/ Warehouse
1	Plant Manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	0.5	0.5	0.5	0.5	0.5	0.5	5
2	Shift engineer	5	12 working hours per shift, 4days 4 days OFF & 24 days annual leave 0% outdoor, 100% indoor	2	1	1	1	1	2	4
3	Senior Operators	5	12 working hours per shift, 4days 4 days OFF & 24 days annual leave 0% outdoor, 100% indoor	2	1	1	1	2	2	3
4	Operators	10	12 working hours per shift, 4days 4 days OFF & 24 days annual leave 0% outdoor, 100% indoor	2	1	1	2	2	2	2
5	Chemist	1	8 working hours per day, 5days 2 days OFF & 24 days annual leave _0% outdoor, 100% indoor	0.5	0.5	0.5	0.5	1	1	4
6	Operation Manager	1	8 working hours per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	0.5	0.5	0.5	0.5	0.5	0.5	5
7	O&M Coordinator	1	8 working hours per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	0.5	0.5	0.5	0.5	0.5	0.5	5
8	Mechanicals	5	8 working hours per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	1	1	1	1	1	2	1
9	Electricians	4	8 hours working per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	1	1	1	1	1	2	1
10	Store keepers	2	8 hours working per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	0.5	0.5	0.5	0.5	0.5	0.5	5
11	Maintenance Manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	0.5	0.5	0.5	0.5	0.5	0.5	5

Sr. No	Worker Group	No. of Personnel in Worker Category	Presence Time in the Facility	Average Hours Spent in the Facility						
				Engines Hall	Steam Turbine Hall	Fuel Treatment House	Tanks Area	Heat Recovery Area	Outdoor Installations/ Workshop	Control Room/ Offices/Laboratory/ Warehouse
12	Finance Team	5	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	0	0	0	0	0	0	8
13	HR team	2	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	0	0	0	0	0	0	8
14	Procurement	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	0	0	0	0	0	0	8
15	HSE team	2	8 working hours per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	1	0.5	1	0.5	1	1	3
16	Admin manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	0	0	0	0	0	0	8
17	Drivers	5	4 hours working per day, 2days 2 days OFF & 24 days annual leave 50% outdoor, 50% indoor	0	0	0	0	0	0	4
18	IT manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	0	0	0	0	0	0	8
19	Tax manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	0	0	0	0	0	0	8

Table 10-2:Manning/Population Data Distribution and Presence Factor

Sr. No	Worker Group	No. of Personnel in Worker Category	Presence Time in the Facility	Avg. No of Days worked at ContourGlobal Facility in a Year	Fraction of days worked at Contour Global Facility	Fraction of hours spent by all worker categories in a single active day							Average Hours Spent in the Facility							Total Hours	Average Hours Spent in the Facility (PER YEAR)							Total Hours	Presence Factor (Year)						
						Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse	Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse		Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse		Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse
1	Plant Manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	244	0.67	0.06	0.06	0.06	0.06	0.06	0.06	0.63	0.50	0.50	0.50	0.50	0.50	0.50	5.00	8.00	121.79	121.79	121.79	121.79	121.79	121.79	1217.86	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.07
2	Shift engineer	5	12 working hours per shift, 4days 4 days OFF & 24 days annual leave 0% outdoor, 100% indoor	171	0.47	0.83	0.42	0.42	0.42	0.42	0.83	1.67	2.00	1.00	1.00	1.00	1.00	2.00	4.00	12.00	341.00	243.57	243.57	243.57	170.50	341.00	682.00	2265.21	0.02	0.03	0.01	0.01	0.01	0.02	0.04
3	Senior Operators	5	12 working hours per shift, 4days 4 days OFF & 24 days annual leave 0% outdoor, 100% indoor	171	0.47	0.83	0.42	0.42	0.42	0.83	0.83	1.25	2.00	1.00	1.00	1.00	2.00	2.00	3.00	12.00	341.00	243.57	243.57	243.57	341.00	341.00	511.50	2265.21	0.02	0.03	0.01	0.01	0.02	0.02	0.03
4	Operators	10	12 working hours per shift, 4days 4 days OFF & 24 days annual leave 0% outdoor, 100% indoor	171	0.47	1.67	0.83	0.83	1.67	1.67	1.67	1.67	2.00	1.00	1.00	2.00	2.00	2.00	2.00	12.00	341.00	243.57	243.57	487.14	341.00	341.00	341.00	2338.29	0.02	0.03	0.01	0.03	0.02	0.02	0.02
5	Chemist	1	8 working hours per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	244	0.67	0.06	0.06	0.06	0.06	0.13	0.13	0.50	0.50	0.50	0.50	0.50	1.00	1.00	4.00	8.00	121.79	121.79	121.79	121.79	243.57	243.57	974.29	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.06
6	Operation Manager	1	8 working hours per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	244	0.67	0.06	0.06	0.06	0.06	0.06	0.06	0.63	0.50	0.50	0.50	0.50	0.50	0.50	5.00	8.00	121.79	121.79	121.79	121.79	121.79	121.79	1217.86	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.07
7	O&M Coordinator	1	8 working hours per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	244	0.67	0.06	0.06	0.06	0.06	0.06	0.06	0.63	0.50	0.50	0.50	0.50	0.50	0.50	5.00	8.00	121.79	121.79	121.79	121.79	121.79	121.79	1217.86	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.07
8	Mechanicals	5	8 working hours per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	244	0.67	0.63	0.63	0.63	0.63	0.63	1.25	0.63	1.00	1.00	1.00	1.00	1.00	2.00	1.00	8.00	243.57	243.57	243.57	243.57	243.57	487.14	243.57	1948.57	0.01	0.03	0.01	0.01	0.01	0.03	0.01

Sr. No	Worker Group	No. of Personnel in Worker Category	Presence Time in the Facility	Avg. No of Days worked at ContourGlobal Facility in a Year	Fraction of days worked at Contour Global Facility	Fraction of hours spent by all worker categories in a single active day							Average Hours Spent in the Facility							Total Hours	Average Hours Spent in the Facility (PER YEAR)							Total Hours	Presence Factor (Year)						
						Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse	Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse		Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse		Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse
9	Electricians	4	8 hours working per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	244	0.67	0.50	0.50	0.50	0.50	0.50	1.00	0.50	1.00	1.00	1.00	1.00	1.00	2.00	1.00	8.00	243.57	243.57	243.57	243.57	243.57	487.14	243.57	1948.57	0.01	0.03	0.01	0.01	0.01	0.03	0.01
10	Store keepers	2	8 hours working per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	244	0.67	0.13	0.13	0.13	0.13	0.13	0.13	1.25	0.50	0.50	0.50	0.50	0.50	0.50	5.00	8.00	121.79	121.79	121.79	121.79	121.79	121.79	1217.86	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.07
11	Maintenance Manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	244	0.67	0.06	0.06	0.06	0.06	0.06	0.06	0.63	0.50	0.50	0.50	0.50	0.50	0.50	5.00	8.00	121.79	121.79	121.79	121.79	121.79	121.79	1217.86	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.07
12	Finance Team	5	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	244	0.67	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	1948.57	1948.57	0.00	0.00	0.00	0.00	0.00	0.00	0.11
13	HR team	2	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	244	0.67	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	1948.57	1948.57	0.00	0.00	0.00	0.00	0.00	0.00	0.11
14	Procurement	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	244	0.67	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	1948.57	1948.57	0.00	0.00	0.00	0.00	0.00	0.00	0.11
15	HSE team	2	8 working hours per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	244	0.67	0.25	0.13	0.25	0.13	0.25	0.25	0.75	1.00	0.50	1.00	0.50	1.00	1.00	3.00	8.00	243.57	121.79	243.57	121.79	243.57	243.57	730.71	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.04
16	Admin manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	244	0.67	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	1948.57	1948.57	0.00	0.00	0.00	0.00	0.00	0.00	0.11

Sr. No	Worker Group	No. of Personnel in Worker Category	Presence Time in the Facility	Avg. No of Days worked at ContourGlobal Facility in a Year	Fraction of days worked at Contour Global Facility	Fraction of hours spent by all worker categories in a single active day							Average Hours Spent in the Facility							Total Hours	Average Hours Spent in the Facility (PER YEAR)							Total Hours	Presence Factor (Year)						
						Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse	Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse		Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse		Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse
17	drivers	5	4 hours working per day, 2days 2 days OFF & 24 days annual leave 50% outdoor, 50% indoor	159	0.43	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	634.00	634.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
18	IT manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	244	0.67	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	1948.57	1948.57	0.00	0.00	0.00	0.00	0.00	0.00	0.11
19	Tax manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	244	0.67	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	1948.57	1948.57	0.00	0.00	0.00	0.00	0.00	0.00	0.11

Note: The presence factor is calculated based on a total of 8,760 hours in a year, presence time in facility and accounting for leave.

11 PROCESS RISK ASSESSMENT

The process risk assessment is conducted for the HFO and Gas facilities in ContourGlobal Cap Des Biches, Senegal facility. The consequence and risk assessment results are mentioned in the section 14.

a) **Location Specific Individual Risk (LSIR):** It is a measure of geographical spread of risk. LSIR is defined as the frequency per year at which an individual, who stays unprotected for 24 hours per day and 365 days per year at a specific location, is expected to sustain fatal harm due to exposure to hazards induced by industrial activity.

   This refers to a hypothetical individual who is always present at a particular location. This is useful for showing the spatial distribution of risk.

b) **Individual Risk Per Annum (IRPA):** IRPA is Individual Risk Per Annum of a representative worker of a given worker group considering expected occupancy at all the locations he is expected to be presented within the hazardous location throughout the year. This includes plant, accommodations, recreational activities, etc. The calculation excludes the duration for which personnel is not present at the site due to reasons such as annual leave, personnel is considered not exposed to facility operations or occupational Risk during this duration.

c) **Potential Loss of Life (PLL):** Potential loss of life (PLL) is defined as the sum of overall accident scenarios of the consequences (in terms of fatalities) of accident multiplied by the frequency of occurrence of these accidents over specified period. PLL is expressed as number of fatalities per year or number of fatalities for a specified period such as project lifetime.

d) **Onsite Societal Risk (F-N Curve):** Onsite societal risk represents risks to group workers within the accommodation and indicates potential risk of more than 1 fatality due to facility operation per year. These risks are represented by an F-N Curve plotted on a log-log scale. F-N curves are plots of the cumulative frequency (F) of N or more fatalities per year, against the number of fatalities (N).

12 NON-PROCESS RISK ASSESSMENT

As part of non-process risk assessment, occupational risk assessment is studied for storage tank facilities.

Occupational Risk covers risks associated with non-installation specific manual activities of a typical worker at ContourGlobal facilities. This includes slips / falls, mechanical impacts, electrocution and is generally limited to a single fatality. The occupational risks include transport risks, which are often analysed separately in QRAs.

Occupational risk is expressed in the form of Fatal Accident Rate (FAR), which is defined as the number of fatalities per 10^8 exposed man hours. The analysis is based on the work activities carried out by the various worker groups and the extent of their working hours with reference to the occupational Fatal Accident Rates (FAR) rates.

The FAR values used for this study shall be based on the overall worldwide COMPANY employees with modification factors for the type of activity and location of the facility installation.

The occupational IRPA of a given worker group shall be determined from the modified FAR for that worker group multiplied by the number of exposed hours in a given year.

The IRPA is calculated from using work pattern data using the following equation:

$$IRPA = FAR \times \frac{Exposed\ Hours\ per\ Year}{10^8}$$

Occupational risk is added in the individual risk (IR) calculation. The generic occupational risk available in the IOGP data "Occupational Risk" is used to calculate occupational IRPA based on number of hours spent by each worker group in ContourGlobal Cap Des Biches, Senegal facility.

IOGP has reported a fatal accidental rate of 2.24 per 10^8 hours of exposure for onshore operations worldwide. This FAR includes land and air transportation which are normally analysed separately by the operations and not included in the process IRPA.

Also, a modification factor is applied to the FAR based on specific functions (area of operation). As per IOGP, Ref.[8] a modification factor of 0.7 and multiplication factor of 1.49 for Africa region is applied to the considered FAR.

Onshore Operations:

- Overall Onshore Personnel FAR per 10^8 hours of exposure = 2.24
- Modification factor for "Production facility" = 0.7
- Multiplication factor for "Africa Region" = 1.49
- Calculated onshore personnel FAR per 10^8 hours of exposure of HFO and Gas facilities in ContourGlobal Cap Des Biches, Senegal facility : 2.24*0.7*1.49 = 2.34

The detail IRPA results are mentioned in the section 14.2

13 RISK ACCEPTANCE CRITERIA

The risk acceptance criteria are the yardsticks to indicate whether the risks are acceptable, or to make some other judgement about their significance. In order to determine acceptability, the risk results are assessed against UK HSE acceptance criteria, Ref.[21]

The risk is presented for:

- Location Specific Individual Risk (LSIR)
- Individual Risk Per Annum (IRPA)
- FN-Curve.
- Potential Loss of Life (PLL)
- Risk ranking points.
- Major risk contributors.

The level of risk calculated for employees and the general public is studied in two principal areas. Individual Risk, which is the level of risk of fatality for specific people, usually defined as individuals within specific groups. The groups are defined by their activities in or around the facilities. The second area is risk to society, which is a measure of the risk of fatality within the general public.

The process for calculating the levels of risk associated with the facility is:

- Calculate the Location Specific Individual Risk (LSIR) from Major Accident Hazard events using the QRA model.
- Define the worker groups and groups of the general public by their location and movements within the effects zone of the facility.
- Calculate Individual Risk (IR) figures for each group using the LSIR data.
- Use the QRA model to calculate societal risk.

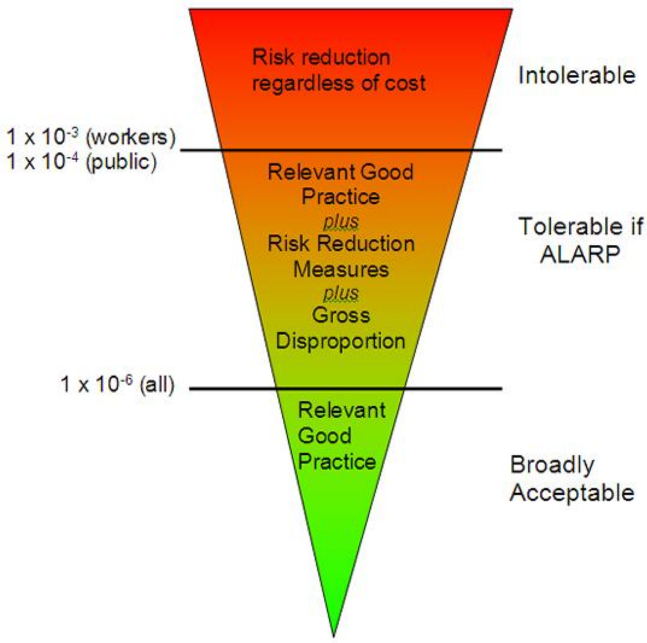

Figure 13-1: Risk Acceptance Criteria

	Workers	Member of public
Maximum tolerable criterion	10^{-3} per year	10^{-4} per year
Broadly acceptable criterion	10^{-6} per year	

Figure 13-2: Risk Tolerability Criteria

Onsite Societal Risk Criteria (FN Curve): Societal Risk (SR) is calculated in order to establish the global view of risk from the facility, in terms of the likelihood of single or multiple fatalities. FN Curve criteria is presented in the FN curve in the following figure, as per agreed assumption register, Ref.[21]

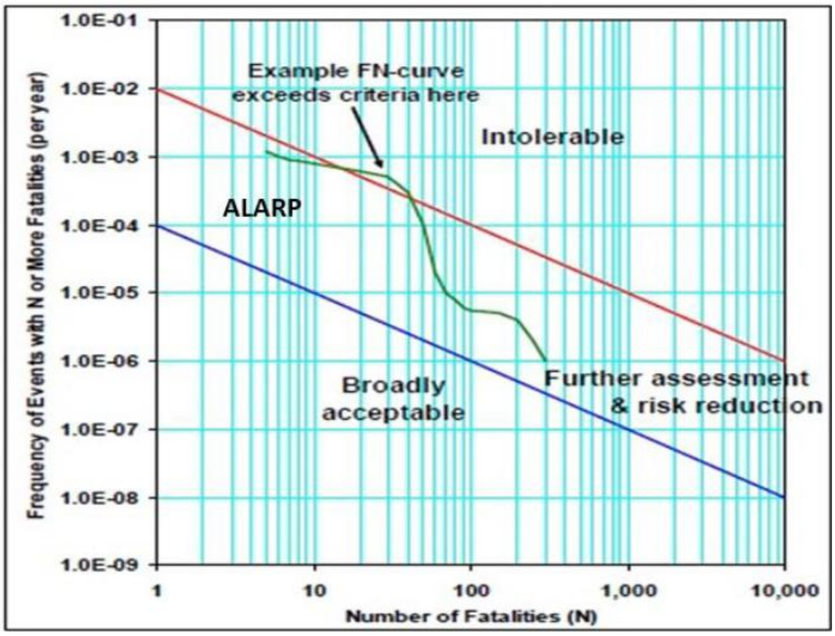

Figure 13-3: FN Curve Onsite Societal Risk Tolerability

14 RISK RESULTS AND ASSESSMENT

The purpose of risk assessment is to develop mitigation measures for unacceptable generators of risk, as well as to reduce the overall level of risk to ALARP. Following subsections describe the risk results from HFO and Gas facilities in ContourGlobal Cap Des Biches, Senegal facility.

14.1 Location Specific Individual Risk (LSIR)

It is a measure of geographical spread of risk. LSIR is defined as the frequency per year at which an individual, who stays unprotected for 24 hours per day and 365 days per year at a specific location, is expected to sustain fatal harm due to exposure to hazards induced by industrial activity.

The Location Specific Individual Risk (LSIR) contours for personnel outdoor for the overall HFO and Gas facilities in ContourGlobal Cap Des Biches, Senegal facility is presented in the Figure 14-1 below.

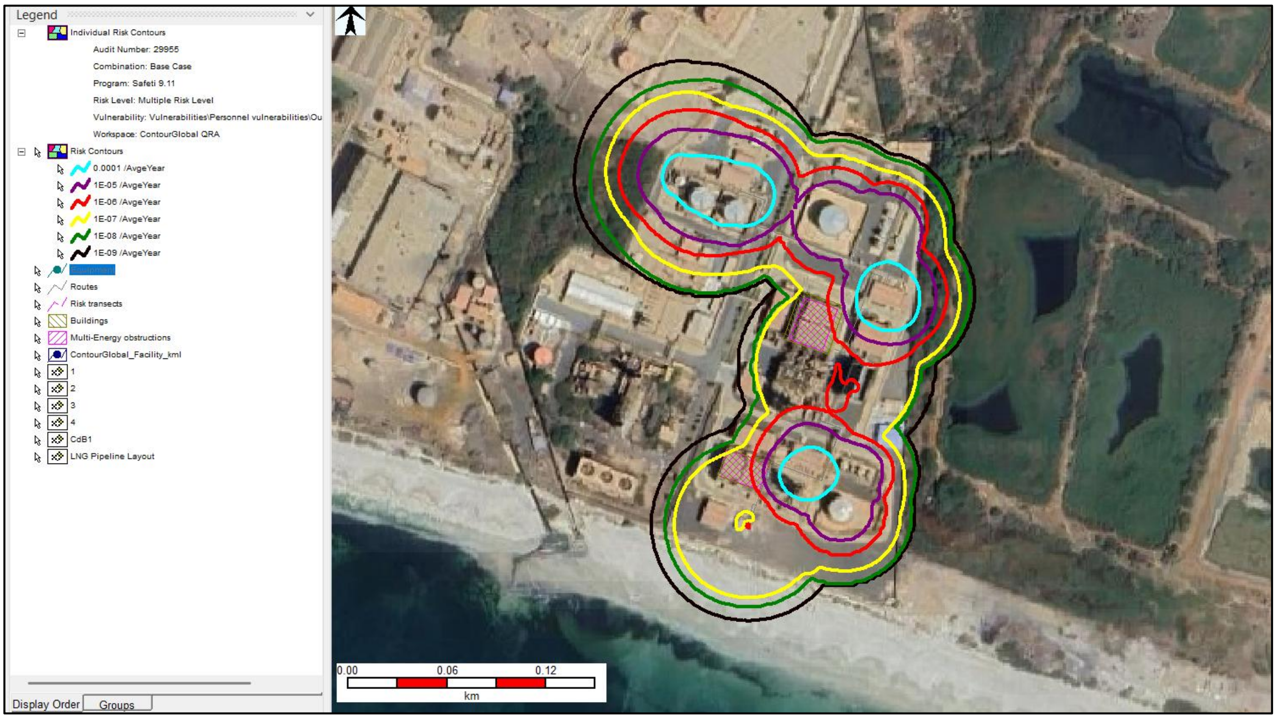

Figure 14-1: LSIR Contour for Overall ContourGlobal CdB1 & CdB2 Facility

Based on the above LSIR results provided for ContourGlobal Cap Des Biches, Senegal facility, following observations are made:

- LSIR risk contours of 1E+00, 1E-01, 1E-02 and 1E-03 per year are not observed.
- LSIR risk contours, 1E-04, 1E-05 are localised around the tank area.
- LSIR risk contour of 1E-06 & 1E-07 covers all facility & slightly extends outside of the facility (Mainly towards south and east side of facility)
- All the major contributors to the overall LSIR risk are reported in section 14.5
- None of the Public facilities (residential) are exposed to these LSIR levels.

An average LSIR is calculated using SAFETI for all potential occupied areas. A summary of the area wise average LSIR summary is provided in the below table along with contribution to the occupied areas from HFO and Gas facilities in ContourGlobal Cap Des Biches, Senegal facility.

Table 14-1: Area Wise Average LSIR Summary For CdB1

Sr. No	Areas	Average LSIR (per year)
1	Engine Hall	7.77E-07
2	Steam turbine Hall	4.50E-05
3	Fuel treatment house	6.42E-04
4	Tank area Note 1	9.49E-05
5	Heat recovery area	9.47E-07
6	Outdoor installations/ Workshop	4.56E-08
7	Control room/ Offices/Laboratory/Warehouse	5.43E-08

Table 14-2:Area Wise Average LSIR Summary For CdB2

Sr. No	Areas	Average LSIR (per year)
1	Engine Hall	2.19E-07
2	Fuel treatment house	2.27E-04
3	Tank area Note 2	2.65E-05
4	Heat recovery area	5.15E-06
5	Outdoor installations/ Workshop	2.40E-07
6	Control room/ Offices/Laboratory/Warehouse	6.85E-07

Based on the above table, the average LSIR for the CdB1 facility is higher for Fuel treatment house 6.42E-04 per year followed by tank area 9.49E-05 per year. The average LSIR for the CdB2 facility is higher for Fuel treatment house 2.27E-04 per year followed by Tank area 2.65E-05 per year. The average LSIR reported to Control room/ Offices/Laboratory/Warehouse for CdB1 & CdB2 is 5.43E-08 per year and 6.85E-07 respectively.

Note 1: For CdB1, the tank area consist of PAB902 HFO Storage Tank, PAB901 HFO Storage Tank (1480 m^3), PBA902 HFO Pre-Storage Tank (3000 m^3), PAE901 LFO Storage Tank (120m^3), PBF901 LFO Day Tank (100m^3), PBA901 HFO Buffer Tank (50 m^3), PBC901 HFO Day Tank (100 m^3).

Note 2: For CdB1, the tank area consist of PAB921 HFO Storage Tank (2000 m^3), PAE901 LFO Storage Tank (120m^3), PBF921 LFO Day Tank (80m^3), PBA921 HFO Buffer Tank (35m^3), PBC921 HFO Day Tank (80 m^3).

14.2 Individual Risk Per Annum (IRPA)

IRPA is Individual Risk Per Annum of a representative worker of a given worker group considering expected occupancy at all the locations he is expected to be presented within the hazardous location throughout the year. This includes plant, accommodations, recreational activities, etc. The calculation excludes the duration for which personnel is not present at the site due to reasons such as annual leave, personnel is considered not exposed to facility operations or occupational Risk during this duration.

Based on the above LSIR levels estimated in section 14.1, the Individual Risk Per Annum (IRPA) for each worker category is calculated based on presence factor as per the working pattern and location. The detailed IRPA results are mentioned in the Table 14-3.

Table 14-3: Summary of Process IRPA For CdB1 Facility

Worker Groups	IRPA Per Shift for Worker Category for CdB1								Risk Assessment for Different Worker Category
	Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory /Warehouse	Total	
Plant Manager	5.40E-09	6.25E-07	4.46E-06	6.60E-07	6.59E-09	3.17E-10	3.77E-09	5.77E-06	Acceptable
Shift engineer	1.51E-08	1.25E-06	8.93E-06	1.32E-06	9.22E-09	8.87E-10	2.11E-09	1.15E-05	ALARP
Senior Operators	1.51E-08	1.25E-06	8.93E-06	1.32E-06	1.84E-08	8.87E-10	1.58E-09	1.15E-05	ALARP
Operators	1.51E-08	1.25E-06	8.93E-06	2.64E-06	1.84E-08	8.87E-10	1.06E-09	1.29E-05	ALARP
Chemist	5.40E-09	6.25E-07	4.46E-06	6.60E-07	1.32E-08	6.34E-10	3.02E-09	5.77E-06	Acceptable
Operation Manager	5.40E-09	6.25E-07	4.46E-06	6.60E-07	6.59E-09	3.17E-10	3.77E-09	5.77E-06	Acceptable
O&M Coordinator	5.40E-09	6.25E-07	4.46E-06	6.60E-07	6.59E-09	3.17E-10	3.77E-09	5.77E-06	Acceptable
Mechanicals	1.08E-08	1.25E-06	8.93E-06	1.32E-06	1.32E-08	1.27E-09	7.54E-10	1.15E-05	ALARP
Electricians	1.08E-08	1.25E-06	8.93E-06	1.32E-06	1.32E-08	1.27E-09	7.54E-10	1.15E-05	ALARP
Store keepers	5.40E-09	6.25E-07	4.46E-06	6.60E-07	6.59E-09	3.17E-10	3.77E-09	5.77E-06	Acceptable
Maintenance Manager	5.40E-09	6.25E-07	4.46E-06	6.60E-07	6.59E-09	3.17E-10	3.77E-09	5.77E-06	Acceptable
Finance Team	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.03E-09	6.03E-09	Acceptable
HR team	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.03E-09	6.03E-09	Acceptable
Procurement	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.03E-09	6.03E-09	Acceptable

Worker Groups	IRPA Per Shift for Worker Category for CdB1								Risk Assessment for Different Worker Category
	Engines hall	Steam turbine Hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory /Warehouse	Total	
HSE team	1.08E-08	6.25E-07	8.93E-06	6.60E-07	1.32E-08	6.34E-10	2.26E-09	1.02E-05	Acceptable
Admin manager	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.03E-09	6.03E-09	Acceptable
drivers	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.96E-09	1.96E-09	Acceptable
IT manager	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.03E-09	6.03E-09	Acceptable
Tax manager	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.03E-09	6.03E-09	Acceptable

Table 14-4: Summary of Process IRPA For CdB2 Facility

Worker Groups	IRPA Per Shift for Worker Category for CdB2							Risk Assessment for Different Worker Category
	Engines hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse	Total	
Plant Manager	1.52E-09	1.58E-06	1.84E-07	3.58E-08	1.67E-09	4.76E-08	1.85E-06	Acceptable
Shift engineer	4.26E-09	3.16E-06	3.68E-07	5.01E-08	4.67E-09	2.67E-08	3.61E-06	Acceptable
Senior Operators	4.26E-09	3.16E-06	3.68E-07	1.00E-07	4.67E-09	2.00E-08	3.65E-06	Acceptable
Operators	4.26E-09	3.16E-06	7.37E-07	1.00E-07	4.67E-09	1.33E-08	4.02E-06	Acceptable
Chemist	1.52E-09	1.58E-06	1.84E-07	7.15E-08	3.34E-09	3.81E-08	1.88E-06	Acceptable
Operation Manager	1.52E-09	1.58E-06	1.84E-07	3.58E-08	1.67E-09	4.76E-08	1.85E-06	Acceptable

Worker Groups	IRPA Per Shift for Worker Category for CdB2							Risk Assessment for Different Worker Category
	Engines hall	Fuel treatment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse	Total	
O&M Coordinator	1.52E-09	1.58E-06	1.84E-07	3.58E-08	1.67E-09	4.76E-08	1.85E-06	Acceptable
Mechanicals	3.05E-09	3.16E-06	3.68E-07	7.15E-08	6.67E-09	9.53E-09	3.62E-06	Acceptable
Electricians	3.05E-09	3.16E-06	3.68E-07	7.15E-08	6.67E-09	9.53E-09	3.62E-06	Acceptable
Store keepers	1.52E-09	1.58E-06	1.84E-07	3.58E-08	1.67E-09	4.76E-08	1.85E-06	Acceptable
Maintenance Manager	1.52E-09	1.58E-06	1.84E-07	3.58E-08	1.67E-09	4.76E-08	1.85E-06	Acceptable
Finance Team	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.62E-08	7.62E-08	Acceptable
HR team	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.62E-08	7.62E-08	Acceptable
Procurement	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.62E-08	7.62E-08	Acceptable
HSE team	3.05E-09	3.16E-06	1.84E-07	7.15E-08	3.34E-09	2.86E-08	3.45E-06	Acceptable
Admin manager	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.62E-08	7.62E-08	Acceptable
drivers	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.48E-08	2.48E-08	Acceptable
IT manager	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.62E-08	7.62E-08	Acceptable
Tax manager	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.62E-08	7.62E-08	Acceptable

Table 14-5:Overall Summary of Process & Non-Process IRPA For ContourGlobal Facility

Sr. No	Worker Group	Non-Process	Process IRPA		Total Integrated IRPA	Risk Assessment for Different Worker Category
		Occupational IRPA	IRPA (based on occupancy factors) for CdB1	IRPA (based on occupancy factors) For CdB2		
1	Plant Manager	4.55E-05	5.77E-06	1.85E-06	5.31E-05	ALARP
2	Shift engineer	5.29E-05	1.15E-05	3.61E-06	6.81E-05	ALARP
3	Senior Operators	5.29E-05	1.15E-05	3.65E-06	6.81E-05	ALARP
4	Operators	5.46E-05	1.29E-05	4.02E-06	7.15E-05	ALARP
5	Chemist	4.55E-05	5.77E-06	1.88E-06	5.32E-05	ALARP
6	Operation Manager	4.55E-05	5.77E-06	1.85E-06	5.31E-05	ALARP
7	O&M Coordinator	4.55E-05	5.77E-06	1.85E-06	5.31E-05	ALARP
8	Mechanicals	4.55E-05	1.15E-05	3.62E-06	6.07E-05	ALARP
9	Electricians	4.55E-05	1.15E-05	3.62E-06	6.07E-05	ALARP
10	Store keepers	4.55E-05	5.77E-06	1.85E-06	5.31E-05	ALARP
11	Maintenance Manager	4.55E-05	5.77E-06	1.85E-06	5.31E-05	ALARP
12	Finance Team	4.55E-05	6.03E-09	7.62E-08	4.56E-05	ALARP
13	HR team	4.55E-05	6.03E-09	7.62E-08	4.56E-05	ALARP
14	Procurement	4.55E-05	6.03E-09	7.62E-08	4.56E-05	ALARP
15	HSE team	4.55E-05	1.02E-05	3.45E-06	5.92E-05	ALARP
16	Admin manager	4.55E-05	6.03E-09	7.62E-08	4.56E-05	ALARP
17	drivers	1.48E-05	1.96E-09	2.48E-08	1.48E-05	ALARP
18	IT manager	4.55E-05	6.03E-09	7.62E-08	4.56E-05	ALARP
19	Tax manager	4.55E-05	6.03E-09	7.62E-08	4.56E-05	ALARP

Based on the above Table 14-3, Table 14-4 & Table 14-5, the following conclusions are drawn:

Process IRPA

- The process IRPA for some of CdB1 facility workers (Operators, Senior Operators, Shift Engineer, Mechanical and Electricians) categories are in ALARP region due to highest number of working hours (12 hours shift).
- The process IRPA for the most of the CdB1 & CdB2 facility workers are in Acceptable region.
- The highest process IRPA of 1.29E-05 per year obtained is for Operators for CdB1 facility due to highest number of working hours (12 hours shift).
- The highest process IRPA of 4.02E-06 per year obtained is for Operators for CdB2 facility due to highest number of working hours (12 hours shift).

Non-process IRPA

- The non-process IRPA (Occupational Risk) for the ContourGlobal worker categories is in lower ALARP region.
- The highest Non-Process IRPA of 5.46E-05 per year obtained is for Operators worker category due to highest number of working hours (12 hours shift).

Total IRPA (Process IRPA+Non-Process IRPA)

- The IRPA for the ContourGlobal CdB1 & CdB2 facility worker categories is in ALARP region.
- The highest total IRPA of 7.15E-05 per year obtained is for Operators worker category.

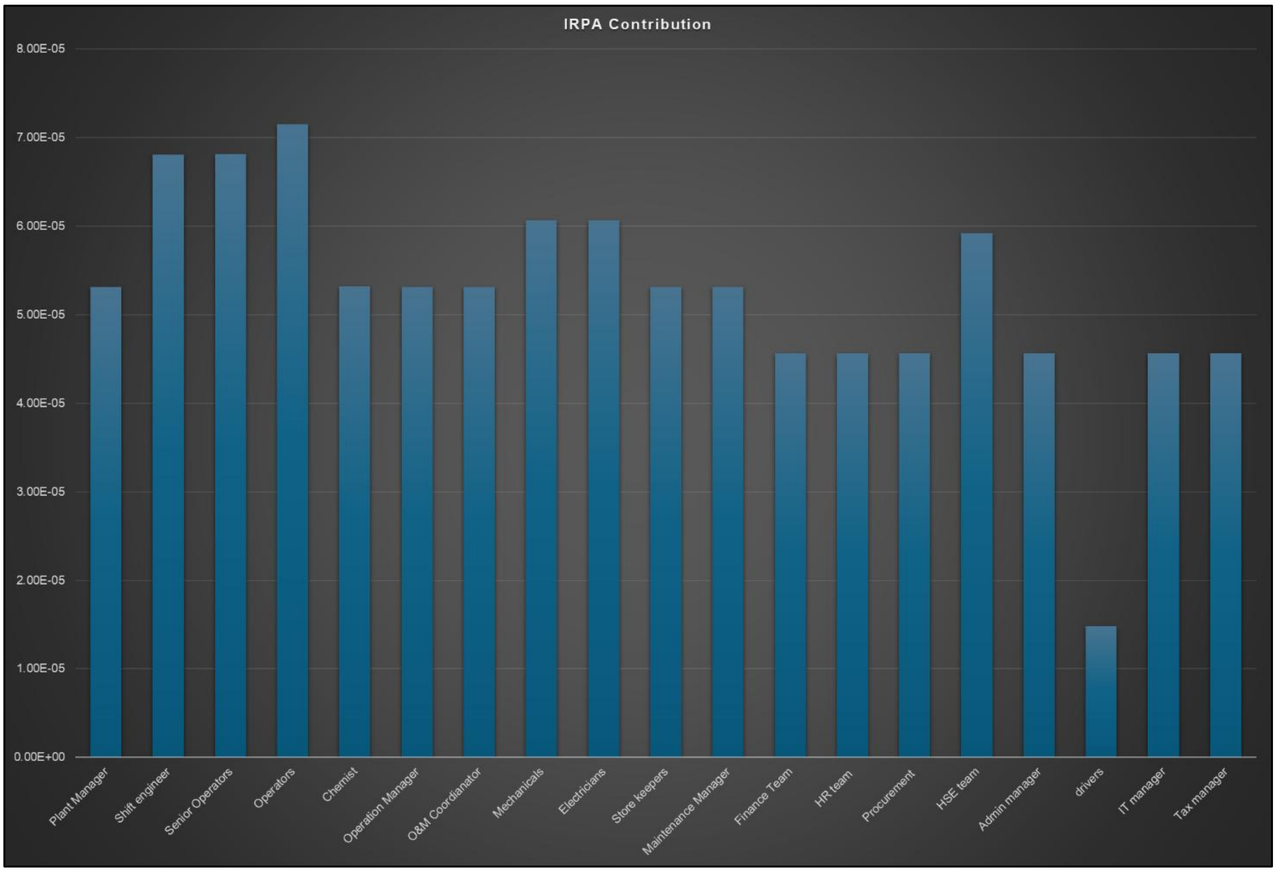

Figure 14-2: IRPA Contribution Amongst Worker Group

Based on IRPA results summarized in the above table and figure, individual risk to ContourGlobal personnels are found to be in the ALARP region of risk acceptance criteria.

14.3 Potential Loss of Life (PLL)

Potential loss of life (PLL) is defined as the sum of overall accident scenarios of the consequences (in terms of fatalities) of accident multiplied by the frequency of occurrence of these accidents over specified period. PLL is expressed as number of fatalities per year or number of fatalities for a specified period such as project lifetime.

A total PLL value of 3.01E-03 per year is calculated for ContourGlobal CdB1 & CdB2 facilities, i.e. approximately 1 fatality from a Major Accident Hazard every 332 years.

The table below summarises potential loss of life (PLL) results for overall ContourGlobal CdB1 & CdB2 facilities.

Table 14-6: PLL Results for Worker Group

Sr. No	Worker Group	No. of Personnel in Worker Category	PLL	Contribution
1	Plant Manager	1	5.31E-05	1.77%

Sr. No	Worker Group	No. of Personnel in Worker Category	PLL	Contribution
2	Shift engineer	5	3.40E-04	11.31%
3	Senior Operators	5	3.41E-04	11.32%
4	Operators	10	7.15E-04	23.77%
5	Chemist	1	5.32E-05	1.77%
6	Operation Manager	1	5.31E-05	1.77%
7	O&M Co-Ordinator	1	5.31E-05	1.77%
8	Mechanicals	5	3.03E-04	10.08%
9	Electricians	4	2.43E-04	8.07%
10	Store keepers	2	1.06E-04	3.53%
11	Maintenance Manager	1	5.31E-05	1.77%
12	Finance Team	5	2.28E-04	7.58%
13	HR team	2	9.12E-05	3.03%
14	Procurement	1	4.56E-05	1.52%
15	HSE team	2	1.18E-04	3.94%
16	Admin manager	1	4.56E-05	1.52%
17	drivers	5	7.42E-05	2.47%
18	IT manager	1	4.56E-05	1.52%
19	Tax manager	1	4.56E-05	1.52%
Total			**3.01E-03**	**100%**

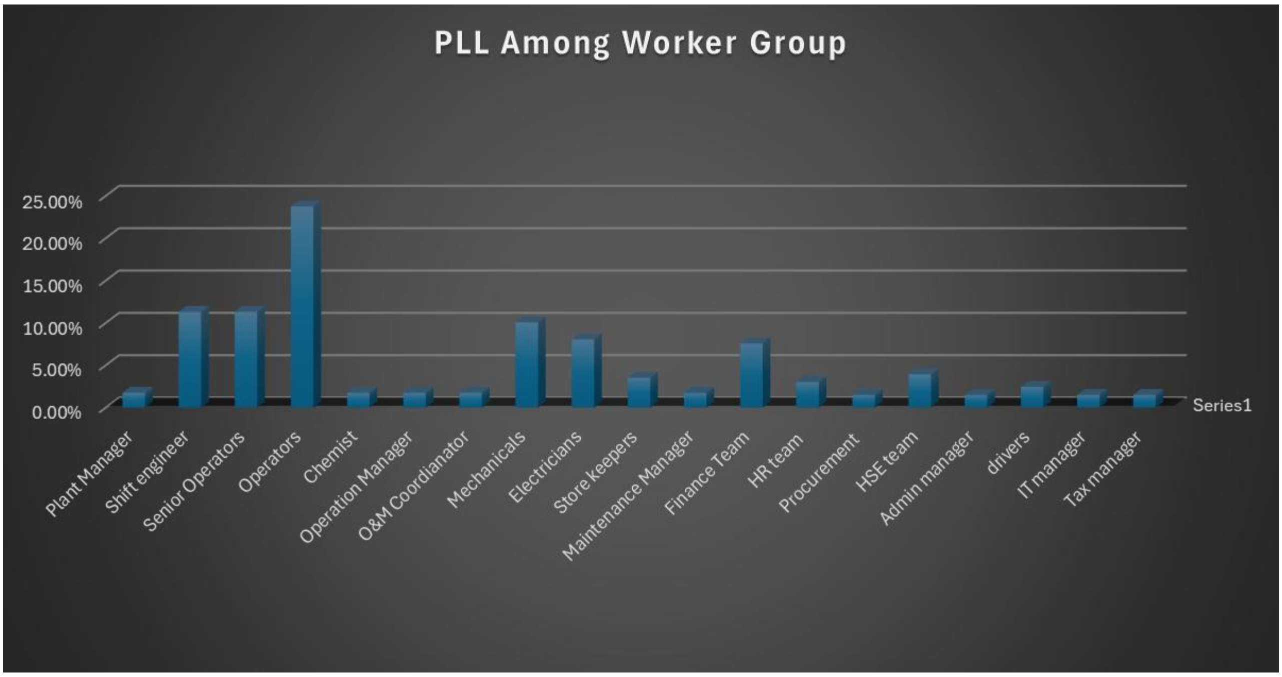

Figure 14-3: PLL Contribution Amongst Worker Group

14.4 Societal Risk (F-N Curve)

The population distribution is often defined as population density. Sources of population data for an area are census reports, detailed maps, aerial photographs, and site inspections by the analyst. Special attention must be made to the various types of population (i.e., residential or industrial), the indoor and outdoor percentage, and the day/night variations and concentrations of people such as hospitals, mosques/churches, or schools. The following assumptions are considered for the offsite population:

1. General public population is considered. Industrial processing facilities (other oil and gas facilities) population is not accounted for societal risk calculation.
2. Population in 500 meters from the plant boundary have been considered for the societal risk calculation.
3. For residential buildings/villa, average of 4 people per villa has been considered.
4. For warehouse, average of 4 people per warehouse has been considered.

Onsite societal risk represents risks to group workers within the buildings and indicates potential risk of more than 1 fatality due to facility operation per year. These risks are represented by an F-N Curve plotted on a log-log scale. F-N curves are plots of the cumulative frequency (F) of N or more fatalities per year, against the number of fatalities (N).

Figure 14-4: ContourGlobal Facility Populated Areas 1&2

Figure 14-5:ContourGlobal Facility Populated Areas 3&4

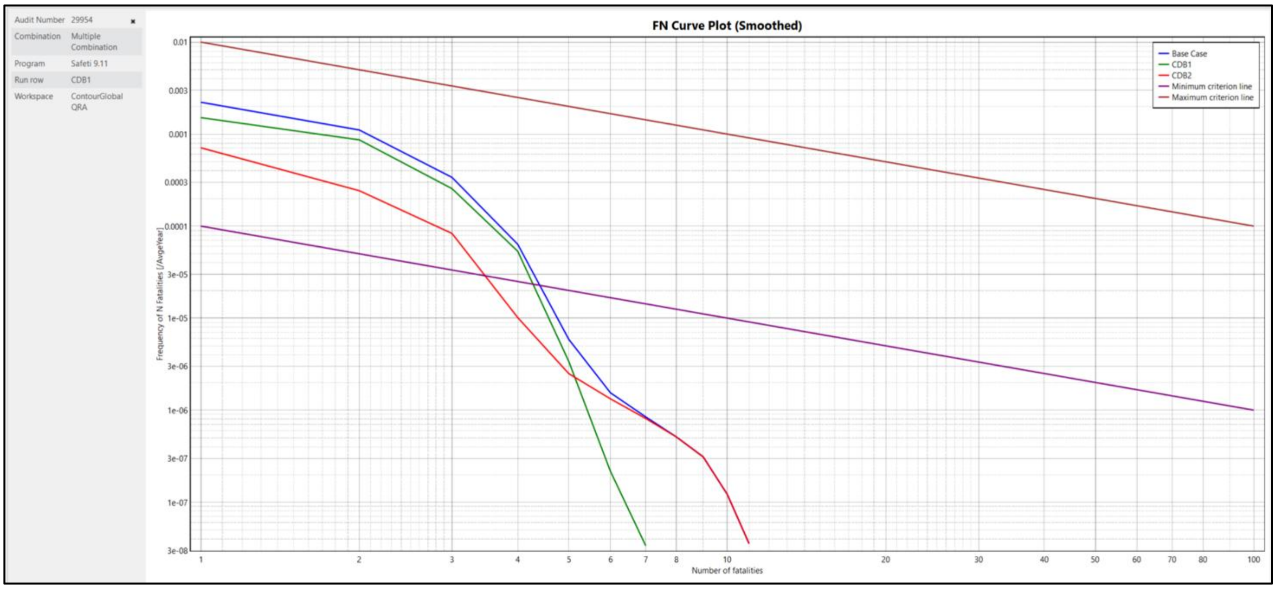

Figure 14-6: FN Curve

Based on the FN curve, it is observed that the societal risk for the CdB1 & CdB2 facilities is significantly less than defined upper limit criteria and falling in the ALARP region.

Note: The offsite F-N curve is not generated as the offsite population is not impacted by the higher LSIR levels.

14.5 Major Risk Contributor

Breakdown of effect wise (Pool Fire, Jet Fire & Flash Fire) contribution considering all failure cases/contributors in Average LSIR of the ContourGlobal CdB1 & CdB2 facilities is presented below:

Table 14-7: Hazardous Event Outcome Risk Contribution

Sr. No	Hazardous Event Outcome	Percentage Risk Contribution
1	Pool Fire	56.37%
2	Jet Fire	38.14%
3	Flash Fire	3.29%
4	Flash fire with explosion	2.19%

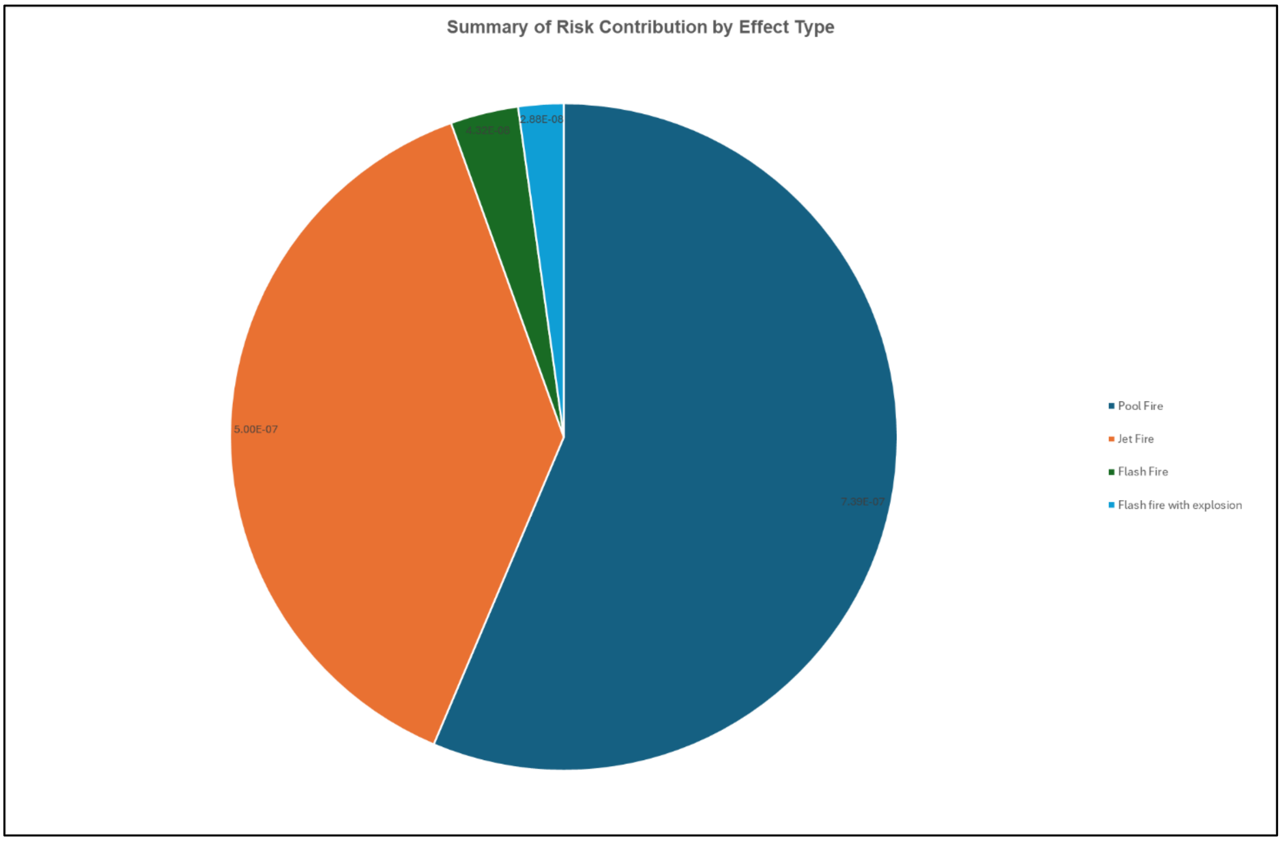

Figure 14-7:Hazardous Event Outcome Risk Contribution

14.5.1 Top 10 Risk Contributor

Following table presents top 10 major risk contributors to the average LSIR (presented in section 14.1) calculated for the ContourGlobal CdB1 & CdB2 facility.

Table 14-8: Top 10 Major Risk Contributors

Sr. No	Failure Case Definition	Failure Case Description	Average LSIR (per year)	% Contribution in Total Risk
1	Study\CdB2\CdB2-ISO2 PBA921 HFO storage tank\Bund Fire\CdB2-ISO2\Pool fire	LOC from PBA921 HFO storage tank\Bund Fire.	8.67E-06	34.46%
2	Study\CdB2\CdB2-ISO12 PBF921 LFO day tank\Bund Fire\CdB2-ISO12\Pool fire	LOC from PBF921 LFO day tank\Bund Fire	4.41E-06	17.56%
3	Study\CdB2\CdB2-ISO4 PBA921 HFO buffer tank\Bund Fire\CdB2-ISO4\Pool fire	LOC from PBA921 HFO buffer tank\Bund Fire	3.95E-06	15.71%
4	Study\CdB2\CdB2-ISO6 PBC921 HFO day tank\Bund Fire\CdB2-ISO6\Pool fire	LOC from PBC921 HFO day tank\Bund Fire	3.09E-06	12.29%
5	Study\CdB2\CdB2-ISO7\CdB2-ISO7/M\CdB2-ISO7/M	LOC from HFO feeder module PAC921 pump	1.05E-06	4.18%
6	Study\CdB2\CdB2-ISO3\CdB2-ISO3/M\CdB2-ISO3/M	LOC from PAC922 HFO transfer pumps	9.44E-07	3.75%
7	Study\CdB2\CdB2-ISO3\CdB2-ISO3/FBR\CdB2-ISO3/FBR	LOC from PAC922 HFO transfer pumps	8.77E-07	3.49%
8	Study\CdB2\CdB2-ISO8\CdB2-ISO8/M\CdB2-ISO8/M	LOC from HFO feeder module PAC921 pump	8.29E-07	3.30%
9	Study\CdB2\CdB2-ISO8\CdB2-ISO8/S\CdB2-ISO8/S	LOC from HFO feeder module PAC921 pump	7.69E-07	3.06%
10	Study\CdB2\CdB2-ISO8\CdB2-ISO8/FBR\CdB2-ISO8/FBR	LOC from HFO feeder module PAC921 pump	5.53E-07	2.20%
Total			**2.51E-05**	5.24E-07

14.5.2 Comparison of GAS (Fuel Gas) Vs HFO/LFO

The following table presents the risk contribution from GAS (Fuel Gas) and HFO/LFO facilities on the CdB1 & CdB2 facilities.

Table 14-9: Risk Contribution for GAS Vs HFO/LFO

Sr.No	Avg.LSIR/year for GAS facilities	Avg.LSIR/year	% Contribution
1	Avg.LSIR/year for GAS facilities	7.20E-05	58%
2	Avg.LSIR/year for HFO/LFO facilities	5.25E-05	42%
Total		1.25E-04	100%

Based on the above table it is observed that the GAS facilities contributes 58% to the overall risk whereas the HFO/LFO facilities contributes about 42% to the overall risk.

15 ALARP DEMONSTRATION

ALARP demonstration is required when the calculated Individual Risk Per Annum for various group lies within ALARP region as per UK HSE risk matrix or the impairment frequencies for various receptors against flammable gas, toxic gas and fire hazards lie between 1.00E-03 to 1.00E-05 per year.

Based on the analysis, it was observed that IRPA risk obtained for the CdB1 & CdB2 facilities is in the ALARP region. The Risk Reduction measures were discussed to present the risk assessment study results and discuss the Risk Reduction Recommendations. All major Hazard scenarios are discussed and options for potential risk reduction measures are identified. This is usually done based on the identification of Major Risk Contributors.

- Risk reduction results are presented to evaluate the effect of the potential risk reduction measures.
- Applicable safety studies will then be updated to incorporate all agreed risk reduction measures.

The principle of ALARP (As Low As Reasonably Practicable) is to demonstrate that the risk levels are in the tolerable region and that the practicality of incorporating any additional risk reduction measures or potential design changes is disproportionate to the benefit obtained. ALARP allows a proportional level of effort to be put into risk reduction once the initial level of risk has been assessed for an operation or process.

Typically, following hierarchy of control is adopted for risk reduction to ALARP level:

a) Elimination of hazard
b) Isolation
c) Engineering
d) Administrative controls
e) Use of personal protective equipment

It is seen that the current risk level for HFO and Gas facilities in ContourGlobal Cap Des Biches, Senegal facility personnel during operations phase lies in the ALARP region of the risk acceptance criteria.

Different best practice design barriers (preventive and /mitigation) against possible hazards considered by the ContourGlobal Cap Des Biches, Senegal facility is presented below:

Table 15-1: Preventive and Mitigative Barriers

Hazard Type	Best Practice Design Barriers	
	Preventive Barriers	Mitigation Barriers
• Pool Fire • Jet Fire • Flash Fire with explosion • Flash Fire	a. Standard process design measures, factor of safety considered in design, structural load, design for seismic zone. b. Process instrumentation/ BPCS with alarm and trips for process deviations. c. Corrosion management, erosion con-trol, external paint. d. PTW system, sampling procedures. e. Operational and control procedures. f. Inspection and preventive mainte-nance system.	a. F&G Detection in process areas. b. Smoke detection in substation and control room. c. Fire manual alarm call points in Tank Farm, Pump Stations/ Valve Manifold area, Utility area, fire water pump house, substation and control room) Emergency Shutdown & Isolation system. d. Ignition controls (HAC) e. Active and passive fire protection. f. Escape routes, primary and secondary with emergency lighting and muster areas. g. PPE Emergency response planning, firefighting team.

Following risk reduction measures are evaluated for normal operations phase as part of ALARP demonstration:

1. Possibility of reducing the potential of flammable effects

As part of the ALARP demonstration, the feasibility of reducing the potential consequences of flammable releases was evaluated. The applicable isolation and detection timings for various leak sizes—used in the Contour Global facility QRA—are summarised in the following table.

Table 15-2: Total Isolation Time Applicable for Project Facility

Plant Area	Isolation Time (min)			
	Small	Medium	Large	Full Bore
Gas pipelines— from the delivery point to the two engine rooms.	10	5	2	2
PAB901/ PAB902 HFO Pre-storage Tanks	20	10	5	5
PAE901 LFO pre-storage Tanks (m^3)	20	10	5	5
PBA901 HFO Storage Tanks (3000m^3)	15	10	5	5
PAB921 HFO Storage Tanks (2000m^3)	15	10	5	5
PBC901/PBC921 HFO Storage Tanks (100m^3/80m^3)	10	7	5	5
PBA901/PBA921 HFO Buffer Tanks (50m^3/35m^3)	10	7	5	5
PBF901/PBF921 LFO Storage Tanks (100m^3/80m^3)	10	7	5	5

Reducing the potential for flammable outcomes is technically achievable if the inventory within an isolatable section is reduced either by:

- Decreasing detection and isolation times, or
- Increasing the degree of sectionalisation through additional shutdown valves.

Both measures reduce the mass available for release before isolation occurs, thereby lowering the hazard footprint (jet fire length, dispersion distance, and overpressure effects).

Assessment of Current Measures:

The assumptions used for leak detection and isolation timings in this QRA are considered realistic and not overly conservative. Review of the existing isolatable sections indicates:

- The number and placement of shutdown valves (e.g. are consistent with industry practice and project design standards.
- Inventory volumes associated with each section are reasonable, and the maximum dispersion distances are already limited by prompt isolation from the start of release.
- Further significant reductions in detection or isolation time would require additional engineered systems whose benefit (in terms of risk reduction) is marginal relative to the increase in complexity and cost.

Based on the above evaluation, the current configuration of detection systems, shutdown valves, and sectionalisation is deemed adequate for ALARP demonstration. Additional valves or modifications to isolation timings would not yield a proportionate reduction in individual or societal risk, and therefore no further risk-reduction measures are recommended under this category.

2. Reducing the presence factor of personnel in Contour Global facility

As per the current manning pattern considered in the study, Operations personnel (Shift Engineer, Operator, Senior Operators) and Maintenance personnel (Mechanical and Electrical staff) spend a significant portion of their working hours in the field/process areas during normal operations (Reference: Study Basis, Assumption No. 14). It has been observed that these personnel spend approximately 7–8 hours per day within the process area of the Contour Global facility.

Given the size and operational characteristics of the facility, the time spent in the process area by Operations and Maintenance personnel is considered reasonable. It is acknowledged, however, that any reduction in their presence factor would proportionally decrease the process-related risk, potentially bringing it into the Acceptable region of the risk criteria. This is because the total individual risk is composed of both process and non-process risks. Although process risk can be reduced by limiting exposure, the non-process risk will remain within the ALARP region.

Since the non-process risk to Operations and Maintenance personnel during normal operations is already within the ALARP range of the UK HSE risk acceptance criteria, further reduction of the presence factor is not recommended at this stage. Any decision to modify or further minimize the time spent by personnel in the process areas should be made by management in alignment with the facility’s operational philosophy.

Conclusion:
A range of potential risk-reduction measures (as described above) were evaluated as part of the QRA study. The current total risk level to Contour Global facility Operations and Maintenance personnel is assessed to be as low as reasonably practicable (ALARP). Therefore, no additional risk-reduction measures are recommended as part of this study.

16 CONCLUSIONS AND RECOMMENDATIONS

The conclusion and recommendations obtained from the study are mentioned below:

16.1 CONCLUSIONS

Location Specific Individual Risk (LSIR) Results

Location specific individual risk contours were calculated for CdB1 & CdB2 Facility to represent level of risk an individual would experience if present in a particular risk location for 24 hours per day, 365 days per year. LSIR contours are presented in Chapter 14.1 of QRA study report.

- LSIR risk contours of 1E+00, 1E-01, 1E-02 and 1E-03 per year are not observed.
- LSIR risk contours, 1E-04, 1E-05 are localised around the tank area.
- LSIR risk contour of 1E-06 & 1E-07 covers all facility & slightly extends outside of the facility in all directions.
- All the major contributors to the overall LSIR risk are reported in section 14.5
- None of the Public facilities (residential) are exposed to these LSIR levels.

Individual Risk Per Annum (IRPA) Results

Based on the above LSIR levels estimated in section 14.1, the Individual Risk Per Annum (IRPA) for each worker category is calculated based on presence factor as per the working pattern and location. The detailed IRPA results are mentioned in the Table 14-5 based which following conclusions are drawn:

Process IRPA

- The process IRPA for some of CdB1 facility workers (Operators, Senior Operators, Shift Engineer, Mechanical and Electricians) categories are in ALARP region due to highest number of working hours (12 hours shift).
- The process IRPA for the most of the CdB1 & CdB2 facility workers are in Acceptable region.
- The highest process IRPA of 1.29E-05 per year obtained is for Operators for CdB1 facility due to highest number of working hours (12 hours shift).
- The highest process IRPA of 4.02E-06 per year obtained is for Operators for CdB2 facility due to highest number of working hours (12 hours shift).

Non-process IRPA

- The non-process IRPA (Occupational Risk) for the ContourGlobal worker categories is in lower ALARP region.
- The highest Non-Process IRPA of 5.46E-05 per year obtained is for Operators worker category due to highest number of working hours (12 hours shift).

Total IRPA (Process IRPA+Non-Process IRPA)

- The IRPA for the ContourGlobal CdB1 & CdB2 facility worker categories is in ALARP region.
- The highest total IRPA of 7.15E-05 per year obtained is for Operators worker category.

Potential Loss of Life (PLL) Results

- A total PLL value of 3.01E-03 per year is calculated for ContourGlobal CdB1 & CdB2 facilities, i.e. approximately 1 fatality from a Major Accident Hazard every 332 years.

Major Risk Contribution Results

- It is seen that the Pool fire outcomes (56.37%) dominate the overall risk level. Further it is seen that the rest 43.63% of the risk contribution is from jet fire, flash fire and flash fire with explosion. (Refer section 14.5).

ALARP Demonstration:

Following risk reduction measures were evaluated for normal operations phase as part of ALARP demonstration:

1. Possibility of reducing the potential of flammable effects

As part of the ALARP demonstration, the feasibility of reducing the potential consequences of flammable releases was evaluated. The applicable isolation and detection timings for various leak size were considered for Possibility of reducing the potential of flammable effects. Reducing the potential for flammable outcomes is technically achievable if the inventory within an isolatable section is reduced either by:

- Decreasing detection and isolation times, or
- Increasing the degree of sectionalisation through additional shutdown valves.

Based on the assessment performed in section 15, the current configuration of detection systems, shutdown valves, and sectionalisation is deemed adequate for ALARP demonstration. Additional valves or modifications to isolation timings would not yield a proportionate reduction in individual or societal risk, and therefore no further risk-reduction measures are recommended under this category. The detailed analysis is presented in section 15 of the report.

2. Reducing the presence factor of personnel in Contour Global facility

Based on the current manning pattern, Operations and Maintenance personnel spend approximately 7–8 hours daily within the process areas during normal operations, which is considered reasonable given the facility's scale and activities. A reduction in their field presence could lower the process-related individual risk, though the non-process risk would remain within the ALARP range per UK HSE criteria. Since the overall risk to personnel is already assessed as ALARP, further reduction in exposure time is not warranted. Any adjustments to manning or field presence should be determined by management, consistent with the facility's operational philosophy. he detailed analysis is presented in section 15 of the report.

16.2 RECOMMENDATIONS

The recommendations are mentioned below:

- Ensure operator-exposure controls are in place for tank farms and fuel-treatment houses (permit-controlled entry limits, remote start/stop/CCTV, and routine sampling panels/HMIs located outside these footprints) to reduce residence time in the highest area-average LSIR zones and lower the operators' IRPA, which is the highest of all worker groups.
- Ensure muster points and primary pedestrian routes are sited away from the south/east quadrants (where the 1E-06/1E-07 LSIR tails extend slightly beyond the fence) and aligned to the lower-risk quadrants identified by the LSIR mapping.
- Ensure that the Emergency Response Plan (ERP) is updated to account for the Major Accident Hazard (MAH) scenarios associated with the new Fuel Gas Systems at the Contour Global facility.
- Ensure hazardous-area classification and ignition-source control are in place along the PRS and engine-inlet areas (electrical classification, hot-surface guarding, vehicle controls), aligned to the fuel-gas ignition scenario basis used in the QRA.
- Ensure open-path (line-of-sight) and point gas detectors are in place along above-ground Fuel Gas pipeline runs at the PRS, and at each engine-room inlet, and that these detectors are interlocked to ESD closure and segment depressurisation.

- Implement restricted access control in tank farm and bunded areas during operations.
- Develop a Community Emergency Response Interface Plan (CERIP) integrating local fire and medical services.
- It is observed that for the existing buildings and control room are not affected due to flash fire risk (refer Figure 2- 6 of Appendix 7). However, in the event of potential flammable gas dispersion, it has potential to reach the existing buildings and control room. Therefore, ensure that effective gas ingress protection measures are in place, including gas detectors, sensors, and alarm systems. These systems will enable early detection of flammable gases and provide timely warnings to occupants, allowing for immediate and appropriate action.

APPENDIX 1- ASSUMPTION REGISTER

HFO AND GAS FACILITIES IN CONTOURGLOBAL CAP DES BICHES, SENEGAL

ASSUMPTION REGISTER - QRA

CONTOURGLOBAL CAP DES BICHES SENEGAL

Report No.: 10585701-01, Rev. 03
Document No.: 2756938
Date: 2025-10-17

Project name:	HFO and gAS Facilities in ContourGlobal Cap des Biches, Senegal	DNV AS - Abu Dhabi Energy Systems Risk - Abu Dhabi - 3630
Report title:	ASSUMPTION REGISTER - QRA	21st Floor, Sky Tower Al Reem Island
Customer:	CONTOURGLOBAL CAP DES BICHES SENEGAL	Abu Dhabi PO Box 3149
Customer contact:	Mr. Papa Mamadou Diack, Plant Manager	United Arab Emirates 100301819700003
Date of issue:	2025-10-17	
Project No.:	10585701-01	
Organisation unit:	Safety Risk Management	
Report No.:	10585701-01, Rev. 03	
Document No.:	2756938	

Applicable contract(s) governing the provision of this Report:

Objective:

The objective of this document is to provide the basis, and assumptions considered to carry out the QRA for HFO and Gas facilities in Contour Global Cap Des Biches, Senegal facility scope.

Prepared by:	Verified by:	Approved by:
Aditya Gohad HSE Consultant	Vikas Naik Senior Consultant	Jeril Philip Head of Section-Risk Management Advisory

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Keywords:

Safety Studies, Assumptions

Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
01	2025-10-06	Draft Assumption Register	Aditya Gohad	Vikas Naik	Jeril Philip
02	2025-10-14	Final Assumption Register	Aditya Gohad	Vikas Naik	Jeril Philip
03	2025-17-10	Final Assumption Register (Change in Ignition probability curve for gas scenario)	Aditya Gohad	Vikas Naik	Jeril Philip

Table of contents

1 INTRODUCTION

Cap des Biches is an 86 MW thermal generation facility developed and constructed by ContourGlobal in two phases. This combined cycle facility consists of five HFO fired diesel engines equipped with a highly efficient “Flexicycle” system, which uses waste heat to power a steam turbine. This state-of-the-art technology enables Cap des Biches to provide the lowest cost energy in Senegal, and the facility can easily be converted to burn natural gas, providing the Senegalese with valuable fuel flexibility.

The Oil and Gas industry' Risks accompanied with process failures and chemical releases contain severe consequences which should be managed quantitatively. The Quantitative Risk Assessment (QRA) is a component of an organization's total Risk management: it is a part of the Companies' Risk Management Program. QRA is used to help evaluate potential Risks when qualitative methods cannot provide adequate understanding of the Risks, and more information is needed for Risk management.

The QRA is a formal and structured quantitative analysis methodology used to help Companies manage Risk and improve safety through identifying the Major Hazards (i.e. identify incident scenarios), evaluating the associated likelihood and consequences to people, and calculating risk levels in a numerical way for comparison with Risk Tolerability Criteria, and defining recommendations for guaranteeing proper risk management is in place. QRA helps to make facilities handling hazardous chemicals safer by supporting Risk Based Decision Making.

In line with above requirements, ContourGlobal commissioned DNV to conduct risk advisory services. This document describes the basis and assumptions for the QRA study.

Following facilities will be studied as part of scope.

1.1 Facility Description

The plant is in Senegal and was constructed in 2016 in two phases:

Phase 1 (CdB1 plant): 52.9 MW (net) with the COD on May 26th

Phase 2 (CdB2 plant): 33.0 MW (net) with the COD on October 31st

The plant is a heavy fuel oil-fired thermal plant and is built on a brownfield site in Rufisque, Senegal, approximately 23 kilometers east of Dakar. Cap des Biches 1 consists of three Wärtsilä 18V46 17.1-MW diesel engine generators (DGs) exhausting into three heat recovery steam generators and a 3.4-MW net ST.

Cap des Biches 2 consists of two Wärtsilä 18V46 17.1-MW DGs operating in a simple-cycle mode.

Each plant has its own step-up transformer:

- CdB 1: JSB transformer 67MVA
- CdB 2: Siemen's transformer 45MVA

A short transmission line, approximately 500 meters long, connects the Plant to an existing substation. Plant is operated with HFO low sulphur content:

- HFO is delivered by the refinery SAR through a pipeline.
- With option to be delivered by trucks through fuel storage facilities.
- Site has 17 days storage capacity.

The potential conversion to natural gas fuel operation in 2026 is expected to take place, discussions with the offtaker are ongoing. The conversion project will consist of converting the engines from Wärtsilä 18V46 to Wärtsilä 18V50DF (Dual Fuel),The gas supply will be an LNG solution:

- The phase 1: is a rapid solution which consists to install a floating storage unit (FSU) + a regasification unit at the port of Dakar connected to the Cap des Biches site through 02 pipelines of 10 km (Primary and Back up).
- The plant will supplied through a 380m pipeline connected to a gas pressure regulating station at Cap des Biches

2 PURPOSE OF THIS DOCUMENT

The purpose of the assumption register is to highlight the key rule sets that will be applied, references to statistical/ generic data utilized, impact criteria and other relevant assumptions that will be followed for the QRA. This document will be updated during the course of study as and when more mature information is made available prior to commencement of the study.

3 SCOPE OF WORK

ContourGlobal own a 86MW plant operated with HFO (Heavy Fuel Oil) in Cap des Biches, SENEGAL. A project has been initiated to convert power plant engines to dual Fuel (HFO and Gas) therefore ContourGlobal want to perform a QRA.

ContourGlobal commissioned DNV to conduct risk advisory services for the HFO and Gas facilities in ContourGlobal Cap Des Biches, Senegal. The scope of this QRA is limited to existing storage tank facility, GAS pipeline from Senelec station to site & internal pipeline from delivery point to two engine room.

QRA scope includes the following:

- Identification of all the hazards not limiting to those which could lead to catastrophic ruptures of the pipelines and storage vessels.
- Identification of potential failures or incidents (including frequency)
- Consequences analysis of credible major accident scenarios (fire, explosion, etc) with damage criteria for the study to be based on thermal radiation and overpressure. Consequence modelling will be carried out using the latest version of DNV PHAST/SAFETI.
- Undertake consequence assessment for identified credible fire, explosion and flammable release scenarios to determine scale, intensity, duration of those credible scenario and potential for escalation.
- Hazardous outcomes to be covered in the analysis will include, but not limited to, Jet Fire, Pool Fire, Flash Fire, Boiling Liquid Expanding Vapour Explosion (BLEVE), Vapour Cloud Explosion (VCE), toxic release etc.
- Review fire and explosion impact of occupied buildings in terms of their locations, design and fire protection measures considered in buildings.
- All related assumptions/parameters, including but not limited to, isolatable sections with fluid parameters (fluid type, temperature, pressure, inventory etc.), representative hole sizes, wind data, ambient temperature and relative humidity.
- Frequency analysis should include leak frequency estimation by failure rate database, event tree analysis and fault tree analysis as applicable. Part count will be performed based on relevant isolatable section identified on P&ID.
- Ignition probabilities will be estimated using the method described by the IOGP data book.
- Detection and isolation time, ignition probabilities, leak frequencies, modelling assumptions, vulnerability criteria, potential explosion sites and risk criteria adopted will be documented within a QRA Assumption Register submitted for review and approval prior to performing the QRA.
- Assessment of onsite risk from Storage Tanks to personnel inside occupied buildings should be in accordance with API RP 752 / 753.
- Estimation of the risks to individuals, groups of individuals (onsite workers, offsite communities) and onsite occupied buildings (internal and neighboring property) based on the representative hazard zones identified.

- Where appropriate, suggest suitable and sufficient risk reduction measures to mitigate identified hazards and risks which should include design review, site layout optimization, engineering and operational recommendations
- Review adequacy of the risk reduction measures for existing facilities and offer recommendations for upgrades where required.

4 DEFINITION AND ABBREVIATIONS

4.1 Definitions

Definition	Description
COMPANY	ContourGlobal
PROJECT	HFO and GAS Facilities In ContourGlobal Cap Des Biches, Senegal
VENDOR	Person, firms, partnerships, companies, bodies, entities, or a combination thereof who are providing services.
CONSULTANT	Det Norske Veritas (DNV)
SHALL or MUST	It is to be understood as a mandatory requirement.
SHOULD	The specified action is recommended but not mandatory. However, the action party will be responsible for the consequences in the event that he/she elects not to do it.
WILL	A commitment by the COMPANY or a statement of fact.
MAY	It is to be understood as giving freedom of choice.

4.2 Abbreviations

Definition	Description
ALARP	As Low as Reasonably Practicable
BLEVE	Boiling Liquid Expanding Vapor Explosions
CMPT	Centre for Marine and Petroleum technology (UK)
EER	Escape, Evacuation and Rescue
ESDV	Emergency Shutdown Valve
H & MB	Heat & Material Balance
H_2S	Hydrogen Sulphide
HAZID	Hazard Identification
HC	Hydrocarbon
HSE	Health Safety Environment
IDLH	Immediately Dangerous to Health and Life
IOGP	International Association of Oil & Gas Producers
IRPA	Individual Risk Per Annum
ISO	International Organization for Standardization
kW/m^2	Kilowatt per Square Meter
LFL	Lower Flammability Limit
LOC	Loss of Containment
LSIR	Location Specific Individual Risk
MAH	Major Accidental Hazard
NFR	Normal Flow Rate
NNF	Normally No Flow
NRV	Non-Return Valve

Definition	Description
P&ID	Process and Instrumentation Diagram
PFD	Process Flow Diagrams
PFP	Passive Fire Protection
PHA	Process Hazard Analysis
PHAST	Process Hazard Analysis Software Tool
PLL	Potential Loss of Life
ppm	Parts Per Million
PRV	Pressure Relief Valve
PSV	Pressure Safety Valve
QRA	Quantitative Risk Assessment
RRM	Risk Reduction Measure
SAFETI	Software for the Assessment of Fire, Explosion and Toxic Impacts
SDV	Shut-down Valve
SOW	Scope of Work
STEL	Short Term Exposure Limit
UKOOA	United Kingdom Offshore Operators Association (UK)
VCE	Vapour Cloud Explosion

5 PROJECT DOCUMENTS & STANDARDS

5.1 International References

Table 5-1: International Standards and References

Sr. No.	Document No.	Document Title	Issue Date
[1].	ISBN 0 7176 2151 0	Reducing risks, protecting people. HSE's decision-making process	Dec-2021
[2].	-	Guidance on ALARP Decisions in COMAH https://www.hse.gov.uk/foi/internalops/hid_circs/permissioning/spc_perm_37/#Tools-for-ALARP	Oct-2021
[3].	Research report 283 UK HSE	Development of an intermediate societal risk methodology	Nov-2022
[4].	IOGP Report no. 434-01	Process Release Frequencies	Sep-2019
[5].	IOGP Report no. 434-04	Riser and Pipeline Leak Frequencies	Sep-2019
[6].	IOGP Report no. 434-06	Ignition Probabilities	Sep-2019
[7].	IOGP Report no. 434-07	Consequence Modelling	Mar-2010
[8].	IOGP Report no. 434-12	Occupational Risk	Mar-2010
[9].	IOGP Report no. 434-14	Vulnerability of Human	Mar-2010
[10].	IOGP Report no. 434-09	Land Transport Accident Statistics	Mar-2010
[11].	IOGP Report no. 434-03	Storage Incident Frequencies	Aug-2022
[12].	CPR 18E	Guidelines for Quantitative Risk Assessment "Purple Book"	2005
[13].	CPR 14E	Guidelines for Methods for Calculation of Physical Effects "Yellow Book"	2005
[14].	CMPT	The Centre for Marine and Petroleum Technology (CMPT), A Guide to Quantitative Risk Assessment for Offshore Installations.	1999
[15].	CCPS	Effects of Thermal Radiation, Centre for Chemical Process Safety, (CCPS)	1994
[16].	Vol 75, Part B	IChemE, Modelling of Thermal Radiation from External Hydrocarbon Pool Fires, Trans IChemE.	May-1997
[17].	UK HSE Contract Research Report No. 96/1996	Development of Pool Fire Thermal Radiation Model	-
[18].	ISO17776	Petroleum and natural gas industries - Offshore production installations - Guidelines on tools and techniques for hazard identification and risk assessment	Dec-2016
[19].	API RP 521 RP	Pressure-Relieving and Depressurizing Systems	Jun-2020
[20].	API RP 2218	Fireproofing Practices in Petroleum and Petrochemical Processing Plants	Jul-2013

5.2 Project Specific References

Table 5-2: Project Specific Documents

Sr. No.	Document No.	Document Title
[21].	-	Facility Process Operation Description (Provided by COMPANY)

Sr. No.	Document No.	Document Title
[22].	DBAC984595	Plot Plan for Power Plant Site CDB1
[23].	DBAC984596	Plot Plan for Engine Hall Section - CdB1
[24].	DBAD000326	Plot Plan for Fuel Treatment House - CdB1
[25].	DBAD009571	Plot Plan for Steam Turbine Building - CdB1
[26].	DBAD288951	Plot Plan for Existing Unloading Area - CdB1
[27].	DBAD778184	Plot Plan for Engine Hall Section - CdB2
[28].	DBAD778185	Plot Plan for Power Plant Site - CdB2
[29].	DBAD778186	Plot Plan for Engine Hall Plan - CdB2
[30].	-	HFO & LFO Process Flow Diagrams (PFD)
[31].	DBAD094107_Rev D	Process & Instrumentation Diagram (P&ID) For Fuel oil system 1 – CdB1
[32].	DBAD094108_Rev C	Process & Instrumentation Diagram (P&ID) For Fuel oil system 2 – CdB1
[33].	DBAD094123_Rev B	Process & Instrumentation Diagram (P&ID) For Fuel oil system 3 – CdB1
[34].	DBAD780117_Rev A	Process & Instrumentation Diagram (P&ID) For Fuel oil system 1 – CdB2
[35].	DBAD780119_Rev A	Process & Instrumentation Diagram (P&ID) For Fuel oil system 2 – CdB2
[36].	DBAD778185_Rev C	Plot Plan for Power Plant Site Preliminary 23.1.2025 Gas Pipe
[37].	-	Gas Specs and Parameters
[38].	-	HFO & LFO Specs
[39].	-	Storage Tank Datasheets
[40].	-	ESD Description Provided By COMPANY
[41].	-	Manning Details Provided By COMPANY

6 QUANTITATIVE RISK ASSESSMENT (QRA)

The basis of QRA methodology is to identify incident scenarios and evaluate the Risk by defining the frequency of failure, the probability of various consequences and the potential impact of those consequences. The Risk is defined in QRA as a function of probability or frequency and consequence of a particular accident scenario. The methodology adopted for carrying Quantitative Risk Assessment of project facilities is shown in following flowchart.

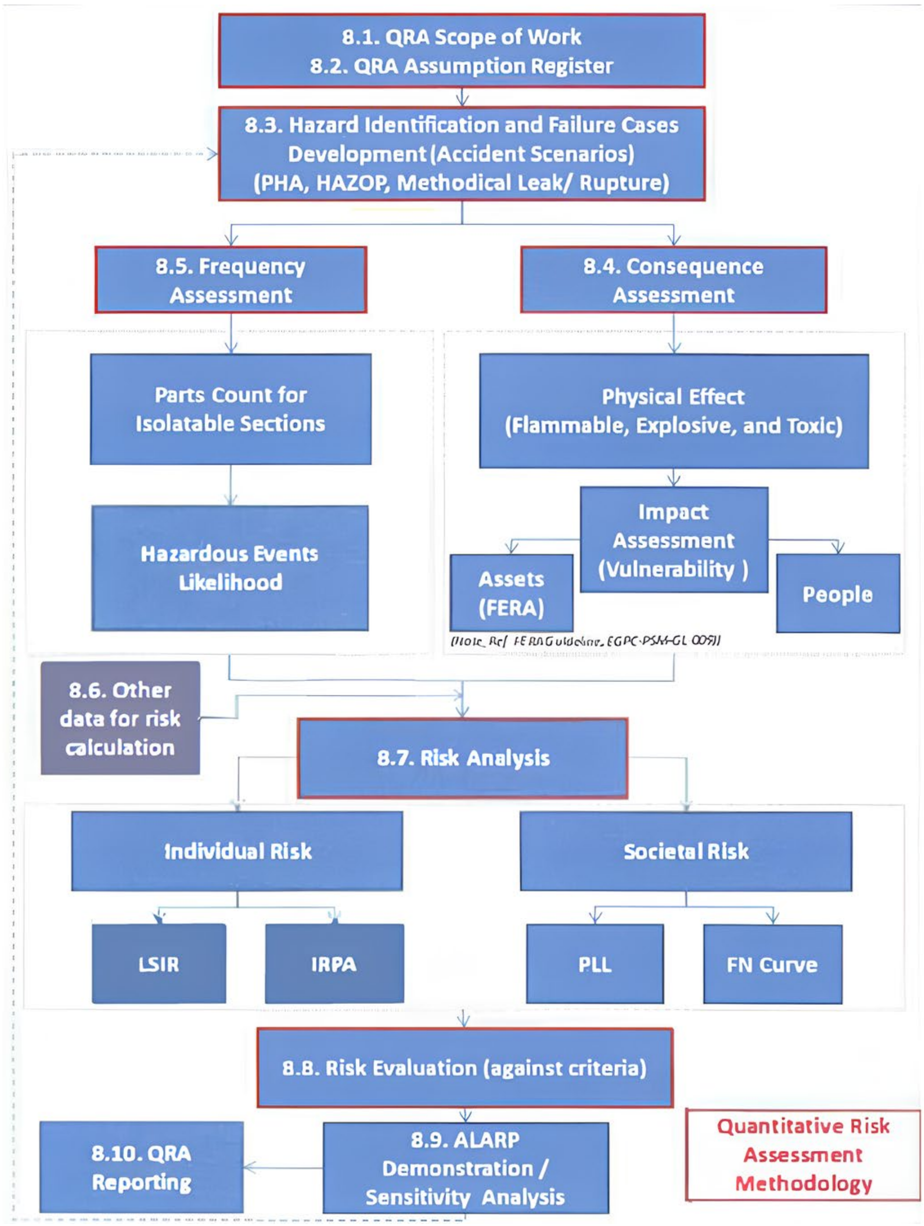


Figure 6-1: QRA Methodology Flowchart

6.1 Hazard Identification

Hazard identification workshop (HAZID) report for the individual facility will be reviewed to identify Major Accident Hazards associated with facilities. In addition, HAZOP report for these facilities will be reviewed to identify any potential High, Medium risk which needs to be carried forward to the QRA study. The potential hazardous event is usually called the 'top event' (e.g. hydrocarbons leaks from process equipment, storage facilities or pipelines).

Generally, there are two types of considered hazards, process and non-process:

- Process hazards generally consist of onshore process facilities, storage facilities, piping/pipelines, etc.
- Non-process hazards consist of occupational hazards, transportation risk, escape and evacuation Risk, ship collision, dropped object, etc.

Note: As part of non-process risk assessment, occupational risk assessment is applicable for the personnel working in ContourGlobal facilities.

PFD and P&IDs will be used to identify the isolatable sections and various failure cases for all HC containing as well as hazardous inventories. These isolatable sections and failure cases will be clearly marked on the P&ID.

Hazard Identification contains the main following steps:

- Review site all materials and identify those that are hazardous.
- Review process, utilities, and storage PFDs to identify areas of concern.
- Identify the isolatable sections: Hazardous events are defined in terms of the isolatable sections and their operating conditions. Isolatable sections are defined and bounded by the location of, Emergency Shut-Down Valves (ESDVs), Locked close manual valves, check valves rated for the maximum pressure, and pumps / compressor that will be tripped upon fire /leak scenario.
- Identify the Hazardous inventories (Inventory Analysis) for each isolatable section.
- Determine the source terms for all accidental events, the source term means the rate at which hazardous material reaches the environment and the conditions of the material (e.g. temperature, pressure & composition).

Once the hazards are identified, the accident scenarios for the QRA can be generated:

Figure 6-2:Failure Case Development Meeting

Failure cases are identified for the following categories:

- Pipework, valves, flanges, fittings and associated equipment.
- Pressure vessels/ tanks.
- Atmospheric storage tanks.
- Pipelines.

Methodology for nomenclature of Isolatable section/failure cases is presented in assumption sheet 1.

6.2 Consequence Assessment

A range of consequences will be assessed for each release scenario for each identified MAH. The quantity of material available to be released in the event of a leak is specific to each isolatable segment. Key assumptions that apply to the analysis in general are presented below:

a) The inventory associated with each isolatable segment case is defined as the isolatable mass within each segment under normal operating conditions.

b) Total inventory is calculated as a sum of static inventory and dynamic inventory of isolatable segments. Static inventory is based on vessel, piping, and pipeline dimensions. Dynamic inventory will be calculated based on the leak rate from specified leak size.

The development of the top event into a serious incident gives estimation for the expected failure cases (accident scenarios), the outcomes depend on the effect of the process parameters, the release hole size, the phases of the hazardous material, the elevation and direction of the release point, the safety systems, the weather conditions, the confinement and congested areas, and presence of ignition sources. QRA studies use Event Trees to model the chronological series of events. Event Tree provides a systematic method to ensure all potential outcomes as a result of a specified top event are identified. Development of credible accident scenarios using Event Trees provides a structure to the conceptual and physical escalation scenario analysis.

Jet fire: A jet fire is a turbulent diffusion flame, resulting from the combustion of a fuel continuously released with significant momentum in a particular direction. Jet fires can occur due to immediate ignition of the released flammable gas or delayed ignition of the HC vapor cloud flashing back leading to a jet fire scenario at the release location. Jet fire can also result from release of two-phase liquid or liquid containing light HC. Upon release, light HC starts flashing immediately forming a flammable mixture. If ignited, this will result in a flash fire followed by a jet fire at the source of release.

Flash fire: Flammable gas release or pool vaporization from the two-Phase HC release has the potential to form a flammable vapor cloud. Upon finding a credible ignition source, due to delayed ignition of the flammable gas cloud, a flash fire can occur in an unconfined area. A flash or cloud fire occurs when a cloud of gas burns without generating any significant overpressure. The cloud is typically ignited on its edge, remote from the leak source. The duration of the flash fire is relatively short, but it may stabilize as a continuing jet fire from the leak source. The major hazard to people for those within the burning envelope (including those who might be above on elevated structures). Flame duration and intensity for most flammable clouds are insufficient to cause a significant thermal radiation hazard outside the flame envelope.

Pool fire: A pool fire is a turbulent diffusion flame burning above a horizontal pool of vaporizing flammable liquid, with little or no momentum. The flame can emit fatal levels of radiant heat to the surrounding area. Pool fire events are considered to occur following the ignition of a release (continuous or instantaneous) of hydrocarbon liquids, where a substantial liquid fraction remains following the release. When first ignited, the fire spreads rapidly across the full extent of the hydrocarbon pool and proceeds to consume the liquid at a characteristic burning rate. For a continuous release ignited early, the pool fire grows until equilibrium is reached where burning at the surface just balances the release rate.

For scenarios involving the release of flammable liquids into a bunded area, the size of the resulting pool is assumed to be restricted to the area of the bund. For scenarios, involving the release of liquids into non bunded areas or bund overtop events, either it is assumed that the liquid spreads out to form a circular pool or, where relevant, the pool is constrained by the surrounding topography (e.g., kerbs and gradient).

Vapor cloud explosion (VCE): Upon release in the absence of immediate ignition sources, flammable gas forms a flammable vapor cloud. Upon finding a credible ignition source, delayed ignition of the flammable gas cloud can lead to vapor cloud explosion if the gas is accumulated in a congested area. The degree of explosion will depend upon the congestion and the confined volume. Within the congested area, the flame accelerates to velocities high enough to produce significant levels of overpressure, which could then cause fatalities. VCE events may occur following the delayed ignition of a release (continuous or instantaneous) of flammable vapor or following vaporization of a liquid release. Several features need to be present for a vapor cloud explosion with damaging overpressure to occur: First, the released material must be flammable and at suitable conditions of pressure or temperature. (Such materials include liquefied gases under pressure, ordinary flammable liquids particularly at high temperatures and/or pressures and non-liquefied flammable gases). Second, a cloud of sufficient size must form prior to ignition (dispersion phase).

Fireball/ BLEVE (Boiling Liquid Expanding Vapor Explosion):

A fireball is a burning fuel-air cloud, whose energy is emitted primarily in the form of radiant heat. Fireballs were considered to occur following the immediate ignition of large vapor releases. They were also considered possible following the immediate ignition of a large release of liquefied gas.

Normally, a fireball refers to combustion of a gaseous undiluted flammable cloud (i.e. pure hydrocarbon) and a BLEVE (Boiling Liquid Expanding Vapor Explosion) to the same event for liquids (also undiluted hydrocarbon). These both result in rapid combustion from the edge inwards as air progresses into the hydrocarbon. A BLEVE has an associated overpressure due to the rapid expansion of the flashing liquid, whereas a fireball may have no associated overpressure. In general terms, transient thermal radiation from a BLEVE is more significant to people than the overpressure, but a small number of large fragments can be thrown large distances, beyond the thermal and overpressure hazard zones, and are also a small Risk. Fireball or BLEVE's effects will be determined by the condition of the line or vessel's contents and of its walls at the moment of failure. These conditions also relate to the cause of container failure, which may be external fire, mechanical impact, corrosion, overpressure, metallurgical failure.

Toxic Gas: Upon release in the absence of immediate ignition sources, exposure to gas cloud containing H_2S can lead to lethal dose to personnel within the gas cloud. The degree of dose and hence potential fatality depends upon the duration and toxic gas (H_2S) concentration for which personnel are exposed to.

Storage Tanks

- **Full Surface Tank Fire:** For HC/Flammable liquid tanks full surface tank fire scenarios are modelled as pool fire at a height i.e., on the roof of the tank. The degree of the fire depends upon diameter of the tanks, amount of smoke generated and view factor.
- **Bund Fire:** For HC/Flammable liquid tanks where bunds are provided, bund fire scenario will be modelled. Based on IOGP database, full bund fire (considering entire bund is filled with HC liquid) is modelled. Where, more than one tank is located inside the bund, full bund fire scenario is modelled considering one tank inventory.

Following failure cases/scenarios will be modelled for storage tanks.

- Bund fire.
- Full surface tank fire.
- Catastrophic rupture.

Note: Consequence results for boilover scenarios will be added in the QRA report.

Consequence analysis of these events and its effect on people and other receptors typically consist of three (3) main steps namely source term modelling, physical effect modelling and impact assessment. These steps are described below.

Source Term Modelling: Source term modelling will be carried out for each identified scenario to determine the release profile and release parameters for various potential loss of containment scenarios. Following inputs will be considered for the source term modelling (as shown in table below):

- Stored inventory (Static and Dynamic)
- Representative material.
- Process parameters (Pressure, Temperature, Flow rate, etc.)
- Release size & direction.

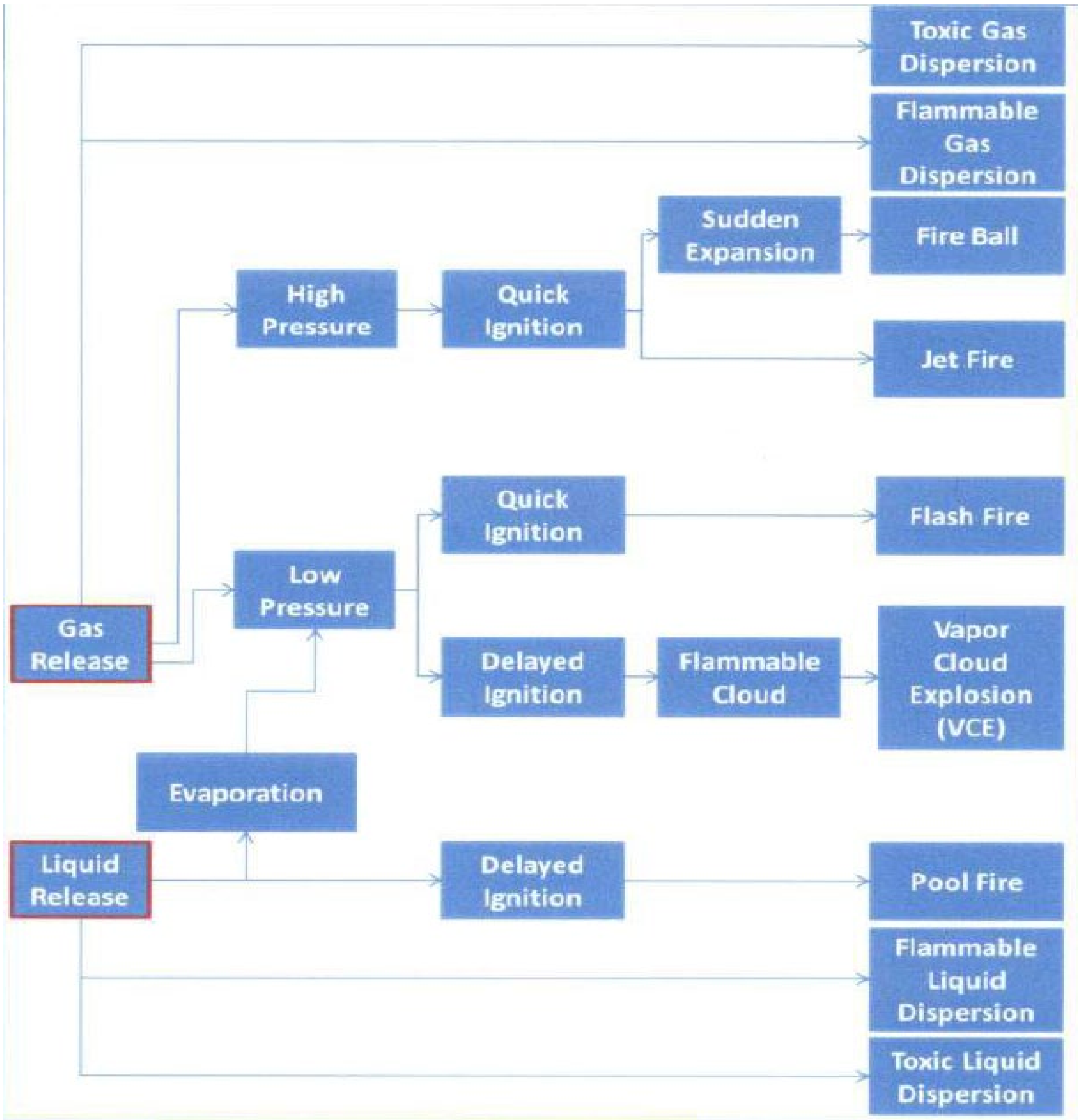


Figure 6-3: Example for Possible Outcomes from Gas and Liquid Release Events

Physical Effect Modelling: Based on the source term modelling results and various potential consequence outcomes based on the event tree approach, physical effect modelling will be carried out using DNV PHAST Software V9.0. The physical effect modelling determines the dispersion profile and extent of various physical effects such as HC dispersion, flash fire envelope, jet fire, pool fire etc.

H&MB available in the operating manuals or latest process information available for each facility will be used. Where available, process parameters will be selected based on PFD's.

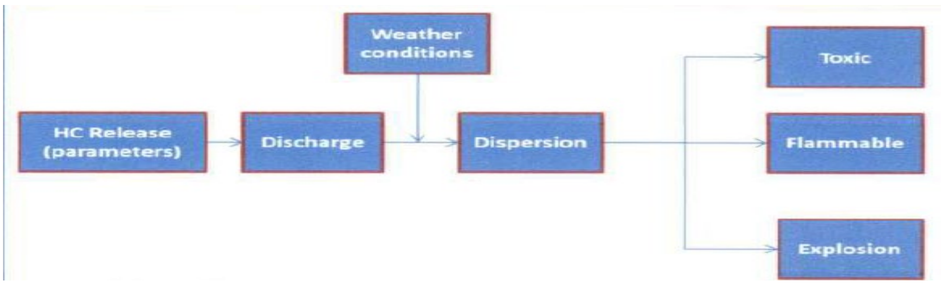


Figure 6-4: The Stages of Developing the HC Releases into the Main Physical Effect

Physical effects is calculated to identify which parts of the facility, community, Company personnel and the public may be exposed for each potential event and the extent of that exposure. This exposure used to estimate the potential for further failure, escalation, impairment, injury, etc. and contribute to decisions on the need to reduce such Risks.

Once the release rate has been estimated the calculation of physical effects will depend on many other factors (such as: wind profile, obstruction, congestions, ignition sources, exposure duration).

The physical effect modelling determines the dispersion profile and extend of various physical effect such as toxic/ flammable dispersion, flash fire envelope, jet fire, pool fire, explosion effect, smoke dispersion, etc.

The potential outcomes of various 'physical effects' for a given release profile for each scenario under consideration shall be reported in the QRA Report.

Failure case category	possible physical effects					
	Jet fires	Pool fires	Fireballs	BLEVEs	Flash fires	Explosions
1. Pipework, risers, valves, flanges, fittings and associated equipment	Y	Y	N	N	Y	Y
2. Pressure vessels / tanks	Y	Y	Y	Y	Y	Y
3. Atmospheric storage tanks	N	Y	N	N	Y	Y
4. Intermediate bulk containers	N	Y	N	N	N	N
5. Pipelines	Y	Y	N	N	Y	Y
6. Flexible hoses	Y	Y	N	N	Y	Y

Figure 6-5: List of the Possible Physical Effects (Consequences) Apply for Each Failure Case Category

Impact Assessment:

As part of impact assessment, vulnerability of humans to the consequences of major hazard events at onshore, primarily those producing and/or processing hazardous fluids are established. The focus is on Fatality Criteria as QRAs generally address fatality risks. However, injury thresholds can also identified where appropriate.

As part of QRA, impact will be assessed on people for quantifying the risk results. Following approach will be adopted for the impact assessment to determine the fatality probability.

Thermal Radiation: Fire scenarios such as jet fire, pool fire, and flash fire will yield thermal radiation. Thermal dose yielded based on exposure to thermal radiation and the time duration can be lethal.

Explosion Overpressures: Sudden release of high volume of energy from ignition of vapour clouds in congested areas will result in explosion overpressure. TNO ME model will be used to for modelling explosion overpressures.

Toxic: Exposure to toxic gases such as H_2S can lead to fatality. However, fatality probabilities are dependent on concentration to which personnel are exposure to and duration of the event. Hence, probit-based approach will be adopted for the risk calculations.

Note: - The maximum H_2S content is around 2 ppm. Therefore, the H_2S release from the vent space do not generate any major toxic consequences and hence will not be assessed and reported in the QRA.

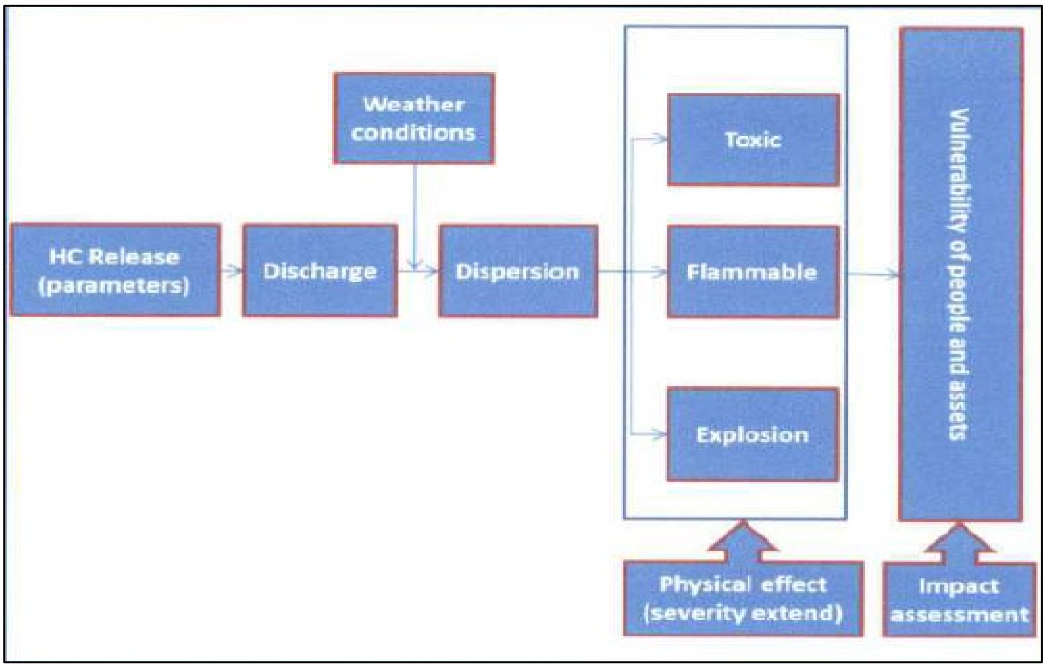


Figure 6-6: The Stages of Developing the HC Releases into the Impact Assessment

6.3 Frequency Assessment

In risk assessment, frequency is estimated based on knowledge and expert judgment, historical experience, and analytical methods. These factors combine to support judgments made by risk assessment teams. Historical experience is expressed in terms of statistical data gathered from existing operations, generally in the form of incidents, base failure rates and failure probabilities.

a) Process equipment leak frequency database: The IOGP Risk assessment data directory is to provide data and information that can be used to improve the quality and consistency of risk assessments with readily available benchmark data. The directory includes references for common incidents analysed in upstream production operations.

b) Parts count: Parts count will be undertaken based on P&IDs. The parts count will be used as the basis for identifying the release sources corresponding to pinhole, small, medium, large, and full-bore rupture events. Parts count will be performed for clearly identified isolatable sections based on the location of ESDVs and thereafter based on failure cases. For each failure case, in each isolatable section, equipment is counted to provide input for estimating leak frequencies. The frequency of each leak scenario and size identified is estimated by combining parts counts for each equipment item with leak frequencies.

c) Leak frequency assessment: The release frequency for each isolatable section is calculated as the sum of the products of the number of components and the generic component failure rate. It is evident from the frequency databases that smaller leaks are more dominant and larger releases are very rare and therefore it is necessary that various hole size ranges are considered. The output of this is a frequency of potential releases for pinhole, small, medium, large, and catastrophic hole sizes for process equipment releases. The hole size ranges are characterized by a representative hole size within each range. The hole size distribution, representative hole size and associated assumptions are detailed in assumptions register sheet developed for assessment purpose.

d) Ignition probabilities: Ignition characteristics and associated probabilities determine which event tree branch will be followed and what will be the potential event for a given release scenario. The ignition probabilities play a major role in determining fire and toxic scenario contribution and therefore selecting the correct ignition probabilities plays an important role in risk calculation. Ignition probabilities provided in IOGP report 434-06 risk assessment data directory will be adopted.

6.4 Event Frequencies

The event frequency of each incident scenario i.e. consequence is derived by multiplying the failure frequency by the probabilities along the event tree branches that lead to that scenario. Note that the failure frequencies are expressed as a frequency (e.g. number of occurrences per year).

SAFETI software inbuilt event trees will be used for calculation of the outcome event frequencies using the user supplied inputs for the ignition probability inputs. Typical event trees are shown in assumption sheet 10.

Event frequencies summary for various areas will be presented in the QRA report.

6.5 Risk Assessment

The calculated process risk will be presented & evaluated based on various risk indicators as outlined in table below.

Table 6-1 Typical Risk Presentation

Facility	LSIR	Process IRPA	PLL	FN curve (Public)	FN curve (Workers)
Onshore facilities	LSIR contour for each unit & overall LSIR contour	For each worker group	For each worker group	For nearby public population	For site/accommodations

a) **Location Specific Individual Risk (LSIR):** It is a measure of geographical spread of risk. LSIR is defined as the frequency per year at which an individual, who stays unprotected for 24 hours per day and 365 days per year at a specific location, is expected to sustain fatal harm due to exposure to hazards induced by industrial activity.

This refers to a hypothetical individual who is always present at a particular location. This is useful for showing the spatial distribution of risk.

b) **Occupancy and Manning:** In order to determine the risk to people, the QRA must estimate the number of people exposed and their locations i.e., manning levels and distribution. Individuals shall be assigned to a worker group representative of their work pattern and location.

Each worker group shall be assigned a representative rotation/shift pattern, and the time spent at each area of the facility/plant versus time spent in the control room/offices/accommodation shall also be estimated. These estimates also known as occupancy factor shall be used to calculate the individual risk to each person within each worker group whereas manning is used for calculating PLL.

c) **Individual Risk Per Annum (IRPA):** IRPA is Individual Risk Per Annum of a representative worker of a given worker group considering expected occupancy at all the locations he is expected to be presented within the hazardous location throughout the year. This includes plant, accommodations, recreational activities, etc. The calculation excludes the duration for which personnel is not present at the site due to reasons such as annual leave, personnel is considered not exposed to facility operations or occupational Risk during this duration.

d) **Potential Loss of Life (PLL):** Potential loss of life (PLL) is defined as the sum of overall accident scenarios of the consequences (in terms of fatalities) of accident multiplied by the frequency of occurrence of these accidents over specified period. PLL is expressed as number of fatalities per year or number of fatalities for a specified period such as project lifetime.

e) **Onsite Societal Risk (F-N Curve):** Onsite societal risk represents risks to group workers within the accommodation and indicates potential risk of more than 1 fatality due to facility operation per year. These risks are represented by an F-N Curve plotted on a log-log scale. F-N curves are plots of the cumulative frequency (F) of N or more fatalities per year, against the number of fatalities (N).

f) **Fatal Accidental Rates:** FAR is Fatal Accident Rate defined as the number of fatalities per 10 million hours engaged in that function. IOGP statistics will be used in the QRA study.

g) **Non-Process Risk Assessment:** As part of non-process risk assessment, occupational risk assessment will be studied for ContourGlobal facilities.

6.6 Risk Evaluation

Once risks are identified and analysed, risks should be evaluated against set criteria as mentioned in assumption sheet 17.

6.7 ALARP Demonstration

The QRA shall provide a clear demonstration that the risk is (or will) be reduced to ALARP. ALARP process starts by identification of the Major Risk Contributors. These Major Risk Contributors are further broken down to determine the top contributors to risk.

Risk reduction measures will be identified against these contributors to reduce the risk, as well as identifying hierarchy of controls for these risk reduction measures.

The objective of ALARP Demonstration:

- Identify and provide risk reduction measures to ensure the risk is "As Low As Reasonably Practicable" (ALARP)
- Demonstrate that the preferred risk reduction measure reduces risk to ALARP by rerun the results after agreeing the suggested reduction measures with the Company (this will help to assure the effectiveness of these measures to reduce Risk to the ALARP)

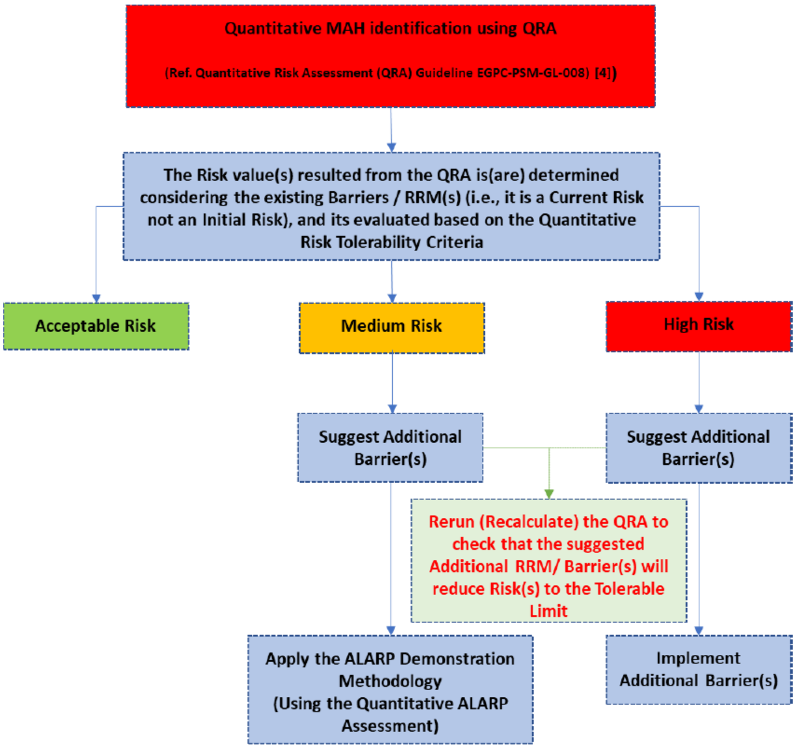


Figure 6-7:The Quantitative MAH Assessment linked to the ALARP Demonstration Methodology

7 APPENDIX A: GLOBAL ASSUMPTION SHEETS

Assumption Sheet 1: Failure Case Definition

ASSUMPTION SHEET		
Assumption No.: 1	**Revision: 03**	**Date: 17-10-2025**
Subject: Failure Case Definition		
Assumption: The failure case definition is mentioned as below:		

Nomenclature	Nomenclature ID	Description
Isolatable Section ID	ISO1	Isolatable Section 1
	ISO2	Isolatable Section 2
Isolatable section may be subdivided based on location of major equipment, change in process conditions to represent best possible failure case scenario.		
Failure Case ID	Area Code/Isolatable Section/ Equipment ID/Piping/Phase	-
Area Code	CdB1	Cap des Biches 1
	CdB2	Cap des Biches 2
Failure Cases/Subsection	ISO1/ISO1	Failure Case/Isolatable Section 1
	ISO1/ISO1-1	Failure Case/Subsection 1 of Isolatable Section 1
	ISO1/ISO1-2	Failure Case/Subsection 2 of Isolatable Section 1
	ISO2/ISO2-1	Failure Case/Subsection 1 of Isolatable Section 2
	ISO2/ISO2-2	Failure Case/Subsection 2 of Isolatable Section 2
Equipment ID	PAB902-T	Equipment Identification Number (e.g. Tank) where PAB902 is Tank ID and "T" is used for Tank nomenclature.
	PAC901	HFO Transfer Pump Unit 3.0
	PP	Process Piping
Phase of Released Fluid	G	Gas Release
	L	Liquid Release
	2PH	2 Phase Release
Example 1	CdB1/ISO1/ISO1-1/ PAB902-T /L	Loss of containment, Tank fire case
Example 2	CdB2/ISO2/ISO2-2/PP-1/L	Loss of containment from piping manifold
While modelling in PHAST/SAFETI, failure case ID will be suffixed with representative leak size (refer sheet 9)		
Failure Case ID	CdB2/ISO2/ISO2-2/PP-1/L	-
Leak Scenario	CdB2/ISO2/ISO2-2/PP-1/L /S	Small Leak (5mm)
	CdB2/ISO2/ISO2-2/PP-1/L /M	Medium Leak (25mm)
	CdB2/ISO2/ISO2-2/PP-1/L /L	Large Leak(50mm)
	CdB2/ISO2/ISO2-2/PP-1/L /R	Full Bore Rupture(150mm)

ASSUMPTION SHEET		
Assumption No.: 1	**Revision: 03**	**Date: 17-10-2025**
Subject: Failure Case Definition		
Justification: The failure case definition shows the location, phase, and size of releases.		
References:		
1. Standard Quantitative Safety Studies Approach 2. P&ID's & PFD's		

Assumption Sheet 2: Failure Case Identification / Isolatable Sections

ASSUMPTION SHEET		
Assumption No.: 2	**Revision: 03**	**Date: 17-10-2025**

Subject: Failure Case Identification / Isolatable Sections

Assumption:

PFD and P&IDs will be used to identify the isolatable sections and various failure cases for all HC containing as well as hazardous inventories. These isolatable sections and failure cases will be clearly marked on the P&ID.

- Isolatable section will be marked between two clearly identified isolation valves (ESD) or normally closed blocked valves. The limits of the isolatable sections will be defined and bounded by the location between 2 or more of the Emergency Shutdown Valves (SDVs / XVs) or MOV, Normally Closed valve with positive isolation or Pressure Safety Valve/ Process Relief Valve (PSVs/ PRVs).
- NRV, level control valves, process valves and process control valves will not be considered for determining the isolation valves.
- Isolatable section will be divided into various failure cases based on the locations, process parameters, operating modes, etc.
- Normally No Flow (NNF) lines are not considered for inventory analysis.

The definition of the isolatable section's boundaries will be based on study of the PFDs and P&IDs. The limits of the isolatable sections will be defined and bounded by the location between 2 or more of the following:

- Emergency Shutdown Valves (SDVs / XVs).
- Normally Closed valve with positive isolation.
- Remote operated valves where it functions as ESDV.

Some considerations about the selection of the selected isolatable sections will be as follows:

- Sections containing non-flammable materials leading to non-major accident hazards (e.g., utilities such as water, steam, compressed air, chemical injection, corrosion inhibitor) will not be considered in the study.

It should be noted that there could be more than one failure case within one isolatable section, dependent on the following justifications:

- Location of different equipment.
- Fluid phase (e.g., Two-phase mixture, gas, liquid).
- Operating conditions such as pressure (i.e., pump suction and pump discharge).

Justification: The assumption has influence on the failure frequency estimation, inventory calculations.

References:

1. Standard Quantitative Safety Studies Approach
2. P&ID's, PFD's, H&MB

Assumption Sheet 3: Meteorological Data

ASSUMPTION SHEET		
Assumption No.: 3	**Revision: 03**	**Date: 17-10-2025**
Subject: Meteorological Data		

Assumption:

<u>Environmental Conditions for GlobalContour Facilities, Senegal:</u>

The following meteorological parameters will be taken as input for consequence modelling & risk calculation:

Table 7-1: Meteorological Data

Parameter	Value	Unit	Notes/Justification
Ambient air temperature	25.35	^{0}C	It has relatively minor influence on the dispersion characteristics (although there will be buoyancy of gas clouds)
Relative humidity	75.52	%	This has influence on the dispersion of dense gas clouds
Surface parameter	0.03	m	Open flat terrain, grass, few isolated objects
Solar radiation	0.24	kW/m^2	Peak solar radiation. Negligible influence on dispersion/consequence.
Atmospheric pressure	1.0	bar	Negligible influence on dispersion/consequence.

<u>Weather Conditions:</u>

Two (2) representative weather conditions will be applied to model the dispersion of each release scenario:

5D – Neutral stability and 5 m/s wind speed. This is typical of moderately turbulent conditions, representative of typical dispersion conditions during daytime conditions.

2F – Stable conditions and 2 m/s wind speed. This is typical of conditions where there is limited turbulence and, hence, limited dilution of dispersing clouds. This will tend to be the worst-case conditions for dense gas dispersion during nighttime conditions.

The details of wind data is given below.

<u>Wind Rose and Wind Directional Probabilities (%) For GlobalContour Facilities</u>

The nearest weather station identified is Dakar. The windrose and wind directional probability for the same is given below.

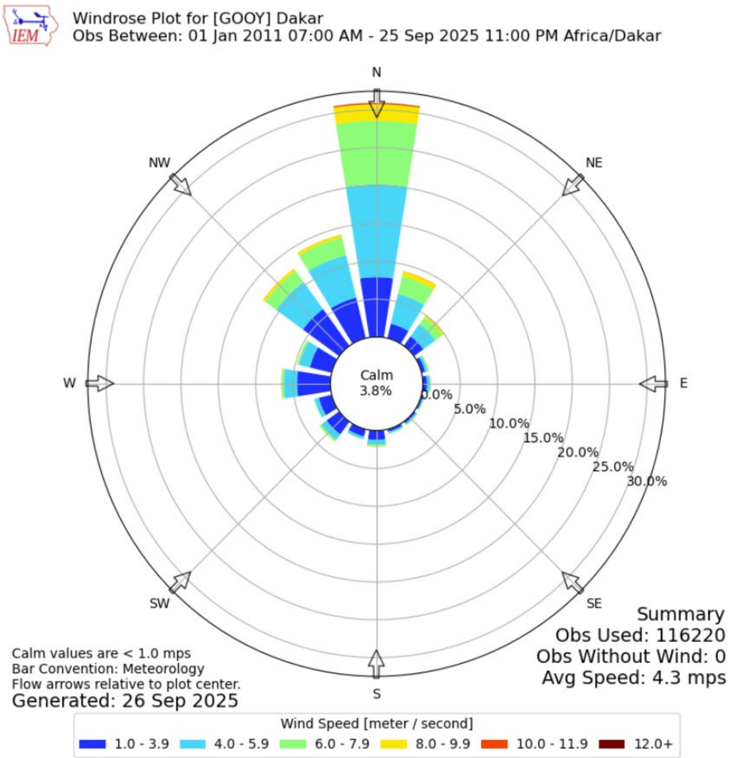


Figure 7-1: Windrose for Rufisque, Senegal

The wind directional probability is for Rufisque, Senegal.

Table 7-2:Wind Directional Probability for Rufisque, Senegal

Direction	Wind Speed % Distribution in 16 Critical Direction	
	2F	5D
349-010	11.681	23.025
011-033	1.976	7.123
034-055	1.56	3.481
056-078	0.496	0.518
079-100	0.546	0.546
101-123	0.237	0.22
124-145	0.284	0.327
146-168	0.337	0.323
169-190	1.231	0.924
191-213	0.977	0.407
214-235	2.079	1.211
236-258	1.763	0.657
259-280	4.459	2.137
281-303	3.002	1.765
304-325	6.009	6.615
326-348	5.512	8.576
Total	**42.14**	**57.85**

Justification: This assumption has influence on the consequence analysis and risk contour.

ASSUMPTION SHEET		
Assumption No.: 3	**Revision: 03**	**Date: 17-10-2025**
Subject: Meteorological Data		
References:		
1. https://mesonet.agron.iastate.edu/sites/windrose.phtml?station=HETR&network=EG__ASOS		

Assumption Sheet 4: Process Parameters

ASSUMPTION SHEET		
Assumption No.: 4	**Revision: 03**	**Date: 17-10-2025**
Subject: Process Parameters (Process Fluid Characterization)		

Assumption:

The operating conditions, fluid stream composition, H&MB etc. will be collected as part of data collection and will be agreed with COMPANY prior to the modelling.

Material: The releases will be represented as a mixture composition, based on the various hydrocarbons in the stream and input to the PHAST discharge modelling.

Process Conditions: Temperature and pressure shall be taken from the PFDs/P&IDs (worst case). If H&MB associated with the HFO/LFO storage tank facilities are not provided.

Flow Rate: Stream flow rates will be taken from the PFDs (worst case). If H&MB associated with the HFO/LFO storage tank facilities are not provided.

Volume / Inventory: The section volume will be derived from the vessel volumes, together with estimates of line lengths associated with each section and the estimated fill fraction of each vessel.

Mixture Composition: The design properties derived for the HFO & LFO in the study will be taken from provided HFO/LFO spec. The Heavy Fuel Oil will be modelled as DNV SAFETI in built HFO/LFO component with physical and chemical properties similar as described in provided HFO/LFO spec.

The GAS composition will be taken from Gas specs and parameters mention in Figure 7-2 , provided by COMPANY.

ANNEX Y1
Technical Specifications for Gas

Composition type		mol %
Methane	CH4	95
Ethane	C2H6	2
Propane	C3H8	3
i-Butane	i-C4H10	0,001
n-Butane	n-C4H10	0
i-Pentane	i-C5H12	0
n-Pentane	n-C5H12	0
Hexane	n-C6H14	0
Heptane	n-C7H16	0
Octane	n-C8H18	0
neo-Pentane	neo-C5H12	0
Ethylene	C2H4	0
Propylene	C3H6	0
Water	H2O	0
Carbon monoxide	CO	0
Carbon dioxide	CO2	0
Hydrogen sulfide	H2S	0
Hydrogen	H2	0
Nitrogen	N2	0
Oxygen	O2	0
Argon	Ar	0
Helium	He	0
Gas feed pressure, abs.	kPa	700
Lower Heating Value (LHV)	kJ/kg	49 660
Lower Heating Value (LHV)	kJ/m^3	38 149

Figure 7-2:GAS Composition

ASSUMPTION SHEET
Note: • Chemical injection, chemical dosing, and corrosion inhibitor will not be included in the modelling. • Only hazardous inventories (i.e., Flammable and/or toxic) will be modelled.
Justification: The assumption has influence on the release rate calculation and consequence analysis.
References:
1. P&ID's, PFD's, H&MB. 2. HFO & LFO Specs, provided by COMPANY as part of required data. 3. Gas specs and parameters, provided by COMPANY as part of required data.

Assumption Sheet 5: Inventory Calculation

ASSUMPTION SHEET		
Assumption No.: 5	**Revision: 03**	**Date: 17-10-2025**
Subject: Inventory Calculation		

Assumption:

Process P&IDs / PFDs will be divided into a number of isolatable sections. Based on the isolatable sections developed, inventory assessment will be carried out for the given isolatable section by adding the following.

- Inventory is identified considering static inventory available in the isolatable section and dynamic inventory identified considering release rate from identified hole size with ESD action assuming to activate within the time mentioned in assumption sheet 6.
- The length of pipe work will be estimated from the plot plan / 3D model, considering horizontal and vertical piping separation. An additional 10% length of the piping will be considered to account for the elevation changes, pipe routing accordingly inventory will be calculated.

The following assumptions will be made:

- In the event of F&G activation, the time to detect and time taken by SDV to completely close are assumed to be as per the time mentioned in assumption sheet 6.
- Normal operating level will be considered based on the review of project document, where this information is not available, the following will be assumed:
    - Vertical Separator Columns – 30% of the vessel height.
    - Columns – 30% of the vessel height.
    - Tanks – 85% of the vessel height (working liquid level)
- The exceptions of the above will be vessels that are intended for vapor only (e.g., compressor suction drum) or liquid only service, in which case 0 or 100% fill is used.
- For pumps and compressors - the volume will be assumed to be that of the piping since they do not hold significant inventory.

Justification: This assumption has influence on the consequence and risk analysis.

References:

1. Standard Quantitative Safety Studies Approach
2. P&ID's, PFD's, H&MB

Assumption Sheet 6: Detection & Isolation Time

ASSUMPTION SHEET		
Assumption No.: 6	**Revision: 03**	**Date: 17-10-2025**
Subject: Detection and Isolation Time		

Assumption:

- Detection time is the time required by the leak detection system to detect a leak.
- Response time is the time taken by the operator to validate the leak and respond.
- Shutdown time is the time for the SDV/ESDVs to close down.

The total isolation time will be (detection time+ response time+ SDV/ESDV shutdown time)

Following approach will be used for isolation activity:

Based on availability of F&G detection system in the process area total time required for initiating the isolation/shutdown will be assumed as follows.

- For automatic blocking system, where the detection of the leakage and closure of the blocking valves is fully automatic, and there is no action of an operator required - The closing time of the blocking valves is two minutes (applicable for onshore facilities)
- For a remote-controlled blocking system where the detection of the leakage is fully automatic and gives a signal in the control room, the operator is then required to validate the signal and close the blocking valves using a switch in the control room - The closing time of the blocking valves is ten minutes (applicable for manoeuvring facilities).

Following table summarizes the total isolation time (detection time+ response time+ SDV/ESDV shutdown time) proposed for various leak size for the Project facilities.

Table 7-3: Total Isolation Time Applicable for Project Facility

Plant Area	Isolation Time (min)			
	Small	Medium	Large	Full Bore
Gas pipelines— from the delivery point to the two engine rooms.	10	5	2	2
PAB901/ PAB902 HFO Prestorage Tanks	20	10	5	5
PAE901 LFO prestorage Tanks (m^3)	20	10	5	5
PBA901 HFO Storage Tanks ($3000m^3$)	15	10	5	5
PAB921 HFO Storage Tanks ($2000m^3$)	15	10	5	5
PBC901/PBC921 HFO Storage Tanks ($100m^3/80m^3$)	10	7	5	5
PBA901/PBA921 HFO Buffer Tanks ($50m^3/35m^3$)	10	7	5	5
PBF901/PBF921 LFO Storage Tanks ($100m^3/80m^3$)	10	7	5	5

ASSUMPTION SHEET		
Assumption No.: 6	**Revision: 03**	**Date: 17-10-2025**
Subject: Detection and Isolation Time		
Justification: The assumption has influence on the inventory analysis**.**		
References:		
1. ESD Description provided by COMPANY 2. RIVM Manual Bevi Risk Assessments version 3.2, dated on 01.07.09API RP 521 RP. 3. Fixed flammable gas detector systems on offshore installations: Optimization and assessment of effectiveness.		

Assumption Sheet 7: Equipment Parts Count

ASSUMPTION SHEET		
Assumption No.: 7	**Revision: 03**	**Date: 17-10-2025**
Subject: Equipment Parts Count		

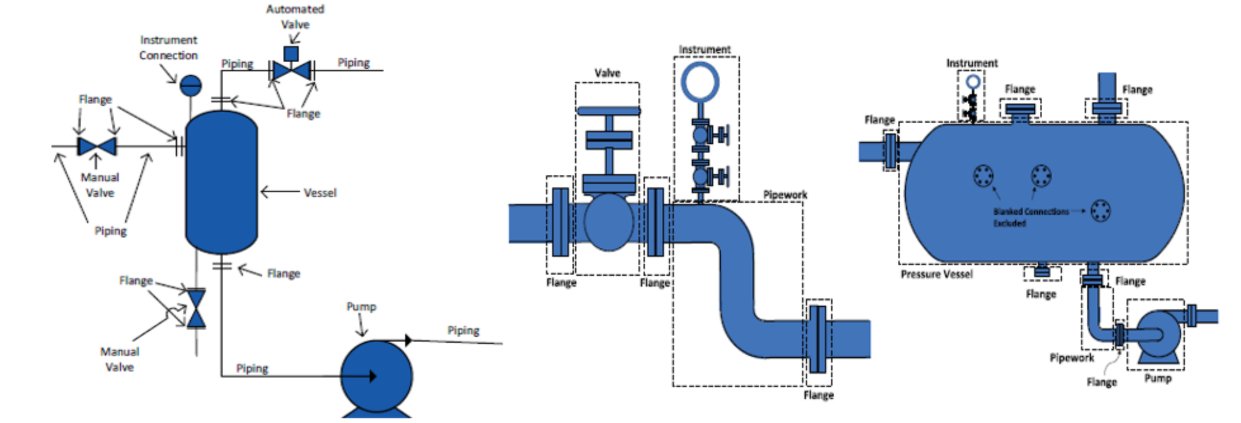
Assumption:

For each of the process failure cases identified, a parts count of the number of components (i.e., potential leak sources, such as valves, flanges, fittings) is conducted using the piping and instrumentation diagrams (P&IDs). Using generic failure frequencies for each component, the total leak frequency for each failure case is then obtained by summing up the frequencies of the individual components. The following rules will be applied in the parts count:

- A flanged joint comprises of two flange faces, a gasket (where fitted) and two welds on the pipe. Each valve counted has two flange faces, unless it is welded in place. Spectacle blinds and orifice plates count as 2 flanges as per P&IDs. Blinds on bleed valves are counted as 1 flange.
- Starting isolation valve and ending isolation valve for each section will be counted 1 flange and 0.5 valve each.
- Small valves (1" and under) will be assumed to be welded or screw type unless otherwise indicated on the P&ID.
- Check valves, Choke Valves, NRV, PSV, Block and bleed will be taken as manual valves.
- ESDVs, EDPVs, MOV, and Control Valves will be counted as actuated valves.
- For normally closed valves, only the 'live' flange will be counted (ignore the valve and anything on the 'dead' side of the valve) i.e., do not include items that do not normally see process fluids, e.g., a blank flange after an isolation valve or a dry thermocouple well.
- Instruments connected to piping includes small-bore connections used for flow, pressure, and temperature sensing. The scope includes the instrument itself plus up to 2 instrument valves, 4 flanges, 1 fitting and associated small bore piping, usually 50mm diameter or less. Equipment connected to vessels (valves, flanges, instruments) for which no dimensions are indicated on P&ID's are counted with dimension 0.5
- Count up to relief valve, and to normally shut isolation valve on spare.
- Where dual or triple pumps are installed in parallel, if normally isolated, then the standby pump(s) and equipment between the isolations will be excluded.
- Process piping length: Main process piping directly associated with vessels, pumps etc., a nominal length of process piping will be estimated using 2D plot plan.

Typical example of part count measurement is shown in figure below:

ASSUMPTION SHEET		
Assumption No.: 7	**Revision: 03**	**Date: 17-10-2025**
Subject: Equipment Parts Count		



The process equipment parts counting will be as per the definition of each equipment part as provided in the release frequency datasheet of each "equipment type" Ref.[1].

Justification: The assumption has influence on the event frequency estimation

References:

1. IOGP Report no. 434-01, September 2019, Process release frequencies.
2. P&ID's & PFD's.

Assumption Sheet 8: Failure/ Release Frequencies

ASSUMPTION SHEET		
Assumption No.: 8	**Revision: 03**	**Date: 17-10-2025**
Subject: Failure/ Release Frequencies		

Assumption:

Equipment failure frequency will be based on IOGP of release frequencies for the different parts count (Process equipment release frequencies, and pipeline release frequencies).

The release/failure frequency datasheet of each "process equipment type" for range of hole sizes can be referred from IOGP report no. 434-01, September 2019, Process release frequencies (based on 1992 to 2015),Ref.[4].

- Steel Process Pipes:

Tabulation

HOLE DIA RANGE (mm)	2" DIA (50 mm)	6" DIA (150 mm)	12" DIA (300 mm)	18" DIA (450 mm)	24" DIA (600 mm)	36" DIA (900 mm)
1 to 3	3.6E-05	1.6E-05	1.1E-05	7.8E-06	6.9E-06	6.9E-06
3 to 10	1.5E-05	6.7E-06	5.1E-06	4.6E-06	4.4E-06	4.4E-06
10 to 50	6.6E-06	2.7E-06	2.5E-06	2.9E-06	3.0E-06	3.0E-06
50 to 150	2.4E-06	5.6E-07	6.4E-07	9.4E-07	1.0E-06	1.0E-06
>150	---	3.5E-07	5.6E-07	1.2E-06	1.6E-06	1.6E-06
TOTAL	6.0E-05	2.7E-05	1.9E-05	1.7E-05	1.7E-05	1.7E-05

- Flanged Joints:

Tabulation

HOLE DIA RANGE (mm)	2" DIA (50 mm)	6" DIA (150 mm)	12" DIA (300 mm)	18" DIA (450 mm)	24" DIA (600 mm)	36" DIA (900 mm)
1 to 3	1.3E-05	2.2E-05	3.9E-05	5.9E-05	6.6E-05	6.6E-05
3 to 10	6.0E-06	9.6E-06	1.5E-05	2.0E-05	2.1E-05	2.1E-05
10 to 50	2.8E-06	4.3E-06	5.9E-06	6.6E-06	6.6E-06	6.6E-06
50 to 150	1.2E-06	9.9E-07	1.1E-06	1.0E-06	9.9E-07	9.9E-07
>150	---	1.7E-06	3.9E-06	6.0E-06	6.7E-06	6.7E-06
TOTAL	2.3E-05	3.8E-05	6.5E-05	9.2E-05	1.0E-04	1.0E-04

- Manual Valves:

Tabulation

HOLE DIA RANGE (mm)	2" DIA (50 mm)	6" DIA (150 mm)	12" DIA (300 mm)	18" DIA (450 mm)	24" DIA (600 mm)	36" DIA (900 mm)
1 to 3	2.4E-05	2.8E-05	4.8E-05	6.3E-05	6.7E-05	6.7E-05
3 to 10	1.3E-05	1.3E-05	2.4E-05	3.6E-05	4.0E-05	4.0E-05
10 to 50	7.4E-06	6.2E-06	1.3E-05	2.3E-05	2.6E-05	2.6E-05
50 to 150	4.3E-06	1.5E-06	3.5E-06	7.1E-06	8.6E-06	8.6E-06
>150	---	1.2E-06	3.5E-06	9.0E-06	1.2E-05	1.2E-05
TOTAL	4.9E-05	5.0E-05	9.2E-05	1.4E-04	1.5E-04	1.5E-04

ASSUMPTION SHEET		
Assumption No.: 8	**Revision: 03**	**Date: 17-10-2025**
Subject: Failure/ Release Frequencies		

- Actuated Valves:

Tabulation

HOLE DIA RANGE (mm)	2" DIA (50 mm)	6" DIA (150 mm)	12" DIA (300 mm)	18" DIA (450 mm)	24" DIA (600 mm)	36" DIA (900 mm)
1 to 3	2.4E-04	1.3E-04	1.3E-04	1.4E-04	1.5E-04	1.5E-04
3 to 10	9.7E-05	6.2E-05	5.5E-05	5.6E-05	5.6E-05	5.6E-05
10 to 50	3.9E-05	3.0E-05	2.5E-05	2.2E-05	2.2E-05	2.2E-05
50 to 150	1.2E-05	7.2E-06	5.6E-06	4.4E-06	4.1E-06	4.1E-06
>150	---	6.1E-06	4.3E-06	2.8E-06	2.4E-06	2.4E-06
TOTAL	3.9E-04	2.4E-04	2.2E-04	2.3E-04	2.3E-04	2.3E-04

- Instrument Connections:

Tabulation

HOLE DIA RANGE (mm)	1" DIA (25 mm)	2" DIA (50 mm)
1 to 3	2.1E-04	2.1E-04
3 to 10	8.5E-05	8.5E-05
10 to 50	4.6E-05	3.5E-05
50 to 150	---	1.1E-05
>150	---	---
TOTAL	3.4E-04	3.4E-04

- Process Vessels:

Tabulation

HOLE DIA RANGE (mm)	Inlets 50 to 150 mm diameter	Inlets >150 mm diameter
1 to 3	5.0E-04	5.0E-04
3 to 10	2.6E-04	2.6E-04
10 to 50	1.4E-04	1.4E-04
50 to 150	7.4E-05	3.8E-05
>150	---	3.6E-05
TOTAL	9.8E-04	9.8E-04

- Centrifugal Pumps:

Tabulation

HOLE DIA RANGE (mm)	Inlets 50 to 150 mm diameter	Inlets >150 mm diameter
1 to 3	5.9E-03	5.9E-03
3 to 10	1.4E-03	1.4E-03
10 to 50	3.0E-04	3.0E-04
50 to 150	3.9E-05	3.0E-05
>150	---	8.9E-06
TOTAL	7.7E-03	7.7E-03

ASSUMPTION SHEET		
Assumption No.: 8	**Revision: 03**	**Date: 17-10-2025**
Subject: Failure/ Release Frequencies		

<u>Storage Tank Fires</u>

Summary of LASTFIRE Data (An analysis of incidents between 1984 and 2011) for Ignited Releases are demonstrated in IOGP 434-4 is summarized in the following table:

Table 7-4:Hydrocarbon Storage Tank Fire Scenario Frequencies

Type of Fire	Fire Frequency (per tank year)
Full surface fire	2.10E-05
Liquid spill outside the tank shell (Bund fire)	1.13E-05
Catastrophic Rupture - Instantaneous or very rapid release of the contents	5.00E-06

The frequency of boilover events was not calculated. It is assumed that all full surface fires lead to boilover, for susceptible liquids within the tank.

ContourGlobal to confirm the type of Tank mentioned in the table below:

Table 7-5: Tank Type & Bund Details

Sr.No	Tank Tag	Tank Type	Tank Bund
CdB1 Facility			
1	PAB902 HFO Storage Tank (1480 m^3)	Fixed Roof	Yes
2	PAB901 HFO Storage Tank (1480 m^3)	Fixed Roof	Yes
3	PBA902 HFO Pre-Storage Tank (3000 m^3)	Fixed Roof	Yes
4	PAE901 LFO Storage Tank (120m^3)	Fixed Roof	Yes
5	PBF901 LFO Day Tank (100m^3)	Fixed Roof	Yes
6	PBA901 HFO Buffer Tank (50 m^3)	Fixed Roof	Yes
7	PBC901 HFO Day Tank (100 m^3)	Fixed Roof	Yes
CdB2 Facility			
8	PAB921 HFO Storage Tank (2000 m^3)	Fixed Roof	Yes
9	PAE901 LFO Storage Tank (120m^3)	Fixed Roof	Yes
10	PBF921 LFO Day Tank (80m^3)	Fixed Roof	Yes
11	PBA921 HFO Buffer Tank (35m^3)	Fixed Roof	Yes
12	PBC921 HFO Day Tank (80 m^3)	Fixed Roof	Yes

Note: The pump type is considered as screw pump.

ASSUMPTION SHEET		
Assumption No.: 8	**Revision: 03**	**Date: 17-10-2025**

Subject: Failure/ Release Frequencies

Failure Frequency Estimation for Unloading Operations:

Tank unloading operation takes place at dedicated site. Therefore, in order to estimate failure frequencies of the usage storage tank facility during unloading operation, the following duration will be considered:

Table 7-6: Unloading Details

Sr. No	Location	Unloading of Fuel Trucks	Average Time Required for Complete Unloading of Each Fuel Truck (hrs)	Number of Unloading Operation Performed in a year	Total Number of Hours for Fuel Truck Unloading Operations in a year	Number of Hours in a year	Time Modification Factor
1	CdB1 (HFO)	To tank PAB902, PAB901, PBA902 via unloading pumps	1.5	48	71	8760	0.008
2	CdB1 (LFO)	To tank PAE901 via unloading pumps	1	6	6	8760	0.001
3	CdB2 (LFO)	To tank PAE901 via unloading pumps	1	11	11	8760	0.001

Note: The number of unloading operations conducted annually, and the average time required to complete the unloading of each truck tank (in hours) are assumed and provided in the tables above. These values will be used to estimate the time modification factor for unloading operations, which helps determine the failure frequencies for these operations.

Justification: The assumption has influence on the event frequency estimation.

References:

1. IOGP Report no. 434-01, September 2019, Process release frequencies
2. IOGP 434-3 Storage Incident Frequencies 2022

Assumption Sheet 9: Leak Sizes & Hole Sizes Distribution

ASSUMPTION SHEET		
Assumption No.: 9	**Revision: 03**	**Date: 17-10-2025**
Subject: Leak Sizes & Hole Sizes Distribution		

Assumption:

Process Equipment & Piping:

The following representative hole sizes will be considered for process equipment leaks for QRA study as per standard.

Table 7-7: Leak & Hole Size Distribution

Hole Size	Hole Size Range (mm)	Representative Hole Size (mm)
Small	1-10	5
Medium	10-50	25
Large	50-150	50
Full Bore Rupture	>150	150 (limit to 150mm for pipe/equipment size above 150mm)

This hole size basis is used to derive release rates for each release.

Justification: The assumption has influence on the end event frequency estimation and release rate calculation

References:

1. IOGP Report no. 434-01, September 2019, Process release frequencies.

Assumption Sheet 10: Event Tree

ASSUMPTION SHEET		
Assumption No.: 10	**Revision: 03**	**Date: 17-10-2025**
Subject: Event Tree		

SAFETI inbuilt event trees for leak scenarios from the process piping/valves and flanges will be used for risk calculations. The event tree structures for continuous and instantaneous releases (with and without rainout) are presented below. For tanks, outcome scenarios will be modelled based on IOGP 434-3 data.

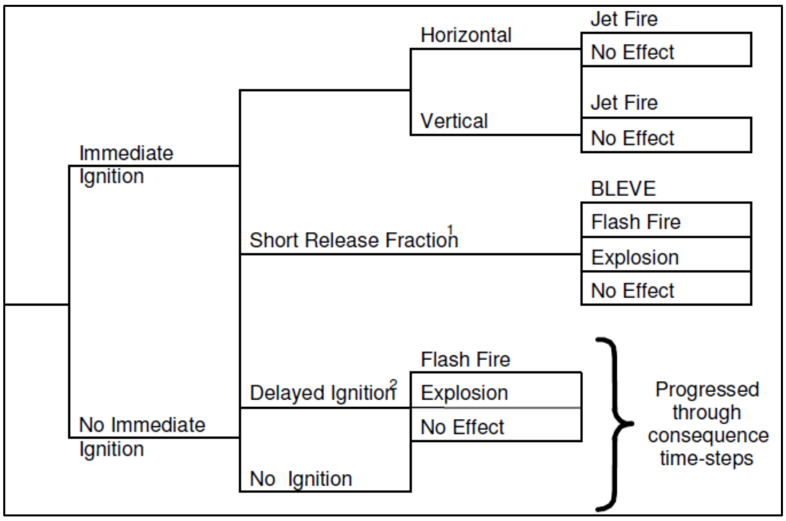


Figure 7-3:Continuous Release without Rainout

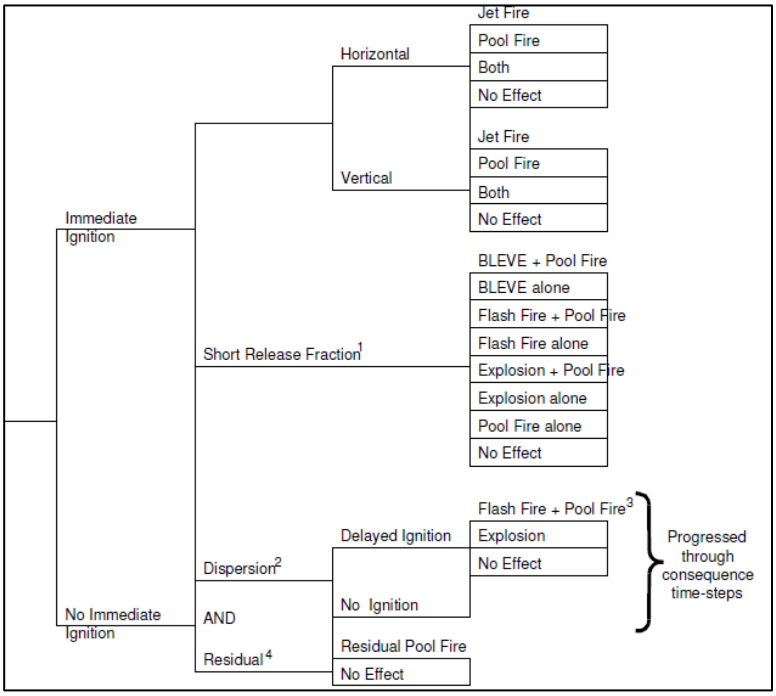


Figure 7-4:Continuous Release with Rainout

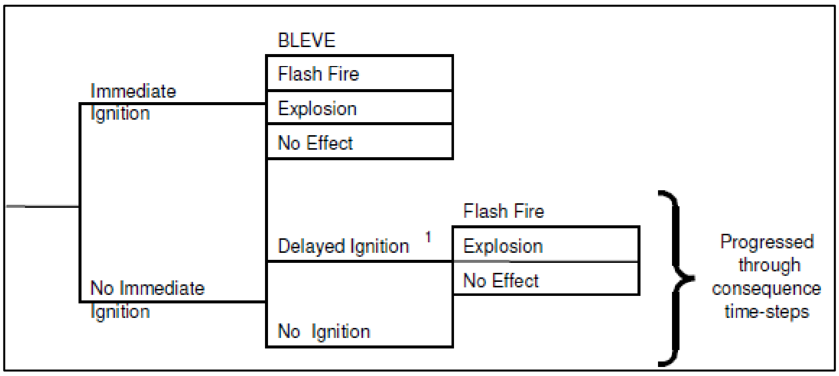


Figure 7-5:Instantaneous Release without Rainout

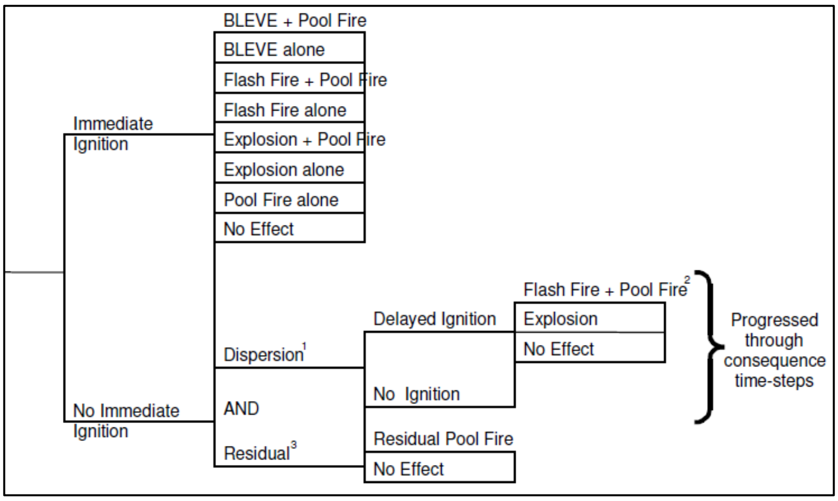


Figure 7-6:Instantaneous Release with Rainout

Justification: The assumption has influence on the end event frequency estimation.

References:

1. IOGP 434-3 Storage Incident Frequencies 2022

Assumption Sheet 11: Modelling Process Parameters-Source Term Modelling

ASSUMPTION SHEET		
Assumption No.: 11	**Revision: 03**	**Date: 17-10-2025**
Subject: Modelling Process Parameters-Source Term Modelling		

Assumption:

Release Location and Height:

Release coordinates for each failure case will be determined as the center of the associated equipment. For process releases, consequence effects will be calculated at 1m elevation from the ground or respective unit elevation. Elevated equipment (i.e., equipment on elevated location) will be modelled at the actual height elevation from given from the respective unit elevation.

Storage Tanks:

- Storage tank having scenario of full surface fire will be modelled with respect to tank height.
- Quadrant bund and full bund fires will be modelled and assessed to present the thermal radiation effect downwind from the bund edge.

Release Orientation:

The orientation of the release is an important factor as it defines the orientation of jet/pool fires and their impact. For process facilities, releases will be modelled as horizontal non-impacted.

Consequence and Risk Effect:

The effect of consequence results will be reported at 1m above the ground or respective unit elevation. Risk calculation will be based on 1m above the ground or respective unit elevation.

Release Rate:

The representative release rate, Q (kg/s), selected in each case is generally taken as the initial maximum release rate, Qo (kg/s), which is calculated within the Phast discharge model. However, certain key scenarios are considered where the representative release rate is adjusted from the initial maximum Qo:

For liquid release, if the initial maximum release rate, Qo, is very large (greater than NFR-normal flow rate) the initial peak release rate will be of very short duration and the representative release rate (to be considered in Phast) will be restricted to the normal flow rate.

If $Qo_{\text{(calculated by Phast)}} < Q_{\text{process}}$ flow rate, then $Qo_{\text{(calculated by Phast)}}$ will be used.

If $Qo_{\text{(calculated by Phast)}} > Q_{\text{process}}$ flow rate, then Q_{process} flow rate= 1.5xQo will be used.

Note: For liquid releases, where releases occur downstream of a pump, then the release rate will typically driven by the normal flow rate of the section in forward flow. Therefore, associated maximum release rate is capped at a maximum of 150% of the inflow rate (i.e. Q_{Process}=1.5xQ*o*).

✓For gas release, the release rate Qo (calculated by PHAST) will be used for each selected hole size.

✓For 2phase release, depending on the gas fraction (will be determined from flash calculation), the release rate will be decided:

➢If Gas fraction is greater than 80%, Qo (calculated by PHAST) will be used for each selected hole size.

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Subject: Modelling Process Parameters-Source Term Modelling		

➢If Gas fraction is less than equal to 80%, Qo (calculated by PHAST) > Q (NFR), then Qo (NFR) as the limiting flowrate will be used for each selected hole size.

Discharge Coefficient (C_d value): SAFETI default discharge coefficient for gas and liquid will be used.

Averaging time: Averaging time of 18.75 sec will be used for flammable dispersion.

Atmospheric Storage Tank Failure Cases:

- Bund fire.
- Full surface tank fire.
- Catastrophic rupture.

Note: Consequence results for boilover scenarios will be added in the QRA report.

Leak/releases from tank inlet and outlet piping within the dike area will be covered under process equipment/piping as described above.

Note: - Approach for modelling boilover scenario-storage tank fires such as full surface fire can last long hours even days if left to burn. During this time, heat from surface of the fire is transferred gradually to bottom of the tank. Layer of water is generally formed at the bottom of the tank due to settling down over a period of time during operation period. If this water layer is not drained, in the event of full surface bund fire, due to continuous heat transfer, the water below crude oil starts boiling and leading to boilover scenario.

Boilover scenario is typically modelled using fireball scenarios. However, likelihood of boilover depends on many factors such as amount of heat transfer, amount of water presence, duration of fire etc. Therefore, prior to modelling boilover, propensity calculations will be carried out (defined as follows) to confirm the surety of boilover.

$$PBO = \left[\left(1 - \frac{393}{TBUL}\right) \left(\frac{\Delta T_{\acute{e}bul}}{60}\right)^2 \left(\frac{\nu_{HC}}{0{,}73}\right) \right]^{\frac{1}{3}}$$

with:

PBO: Propensity to boilover

T_{BUL}: Boiling temperature of the hydrocarbon (K)

Te_{BUL}: Its boiling range in excess of 393 K

HC: Hydrocarbon of the kinematic viscosity at 120 °C / 393 K [m²/s]

The choice to consider a boilover scenario will be based on the following criteria:

- PBO ≥ 0.6 consider a boilover.
- PBO <<< 0.6 do not consider a boilover.
- PBO < or close to 0.6 prudently consider a boilover (e.g. limiting case of some kerosene).

The time before boilover initiation is calculated using boilover equations presented below:

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$$t_{BO} = \frac{\rho \times C_p \times H_{liq} \times (T_{wav} - T_{ser})}{\phi}$$

Where,

t_{BO} – Boilover time – secs.

C_p – specific heat capacity – (2222)J/kg K.

H_{Liq} – Height of liquid level in tank at time of boilover – m.

TWAV – Heat wave temperature K (511K)

T_{SER} – Storage temperature K (313)

Ø- thermal flow entering the fuel from its surface W/m2 (60000)

Note: No instances of boilover were recorded in the current incident survey as per LASTFIRE database, and therefore a generic incident frequency could not be determined. Therefore, it is not included in the risk assessment. However, consequence results for boilover scenario will be provided with QRA report.

Failure case modelling in PHAST:

- Various leak sizes will be modelled as vessel source model / User-defined source.
- Thermal radiation levels generated from Full Surface fire and Bund fire will be obscured by the smoke particles. DNV Phast two-zone fire model will be used for modelling the Full Surface fire and Bund for which considers pool fire for smoky material and is modelled with a luminous zone at the base of the flame and a smoky zone above, with the relative emissive power and relative height of the two zones depending on the size of the pool fire and on the value set for the Carbon hydrogen ratio in the Materials data.

Following notes will be considered:

Note 1: Storage tanks are provided with bund. This provision will be considered while modelling QRA.

Justification: This assumption has impact on the consequence analysis.

References:

1. Best industry practices for QRA study
2. SAFETI.
3. IChemE, Modelling of Thermal Radiation from External Hydrocarbon Pool Fires, Trans IChemE, Vol 75, Part B, May 1997, Ref. [16]
4. UK HSE Contract Research Report No. 96/1996, Development of Pool Fire Thermal Radiation Model

Assumption Sheet 12: Consequence Modelling & Software Tools

ASSUMPTION SHEET		
Assumption No.:12	**Revision: 03**	**Date: 17-10-2025**
Subject: Consequence Modelling & Software Tools		

Assumption:

The consequence modelling will be carried out for all MAE such as fire, explosion and toxic, etc.:

- Immediate Ignition - Determination of jet fire.
- Delayed Ignition - Flammable vapor cloud dispersion, explosions, pool fire and toxic gas dispersion.
- Unignited – Flammable gas and toxic gas dispersion.

The following software used in modelling:

a) DNV SAFETI V9.0 Software

DNV risk modelling software, SAFETI Version 9.0 will be used for QRA study. The SAFETI software is used throughout DNV, as well as by a number of government agencies around the world as well as by major international chemical and petrochemical companies.

One of the programs within the SAFETI risk modelling software is PHAST, DNV's proprietary consequence modelling software package. The SAFETI/ PHAST software package has been in existence since the 1970s and has been under continual development and improvement ever since, which is managed by DNV software development division.

An electronic database of approximately 1400 materials is available to the PHAST/SAFETI software, with the material properties regularly reviewed and if required re-adjusted, based on the latest available data. The PHAST consequence modelling results (for each material) are regularly reviewed and where required re-calibrated, based on the latest available accident and test data.

b) Leak V3.3 Software

The basis of the process and pipe work frequency analysis is the latest interpretation of the (HCRD) Hydrocarbon Release Database:

a) Following the Piper Alpha accident, UK North Sea operators were required to record data on incidents involving the release of hydrocarbons on offshore installations for submission to the UK Health and Safety Executive (HSE). These submissions are compiled and published each year, resulting in the Hydrocarbon Release Database

b) This is considered to be the most comprehensive available failure data for process equipment and pipe work and is widely adopted for both onshore and offshore risk studies.

c) Note that the justification for using offshore data for onshore facilities is: Firstly, no public domain dataset for onshore facilities is available that is comparable to HCRD, considering both the equipment population and completeness of recording releases. Also, although offshore facilities operate in a more challenging (e.g. more corrosive) environment, this is compensated for in the design, inspection and maintenance. Hence there is no apparent reason why onshore and offshore release frequencies should differ significantly.

The latest version of the HCRD dataset is contained within the LEAK software, which has been used to apply the data to the parts count in this study. The HCRD data (and hence LEAK) can be used to derive frequencies for a wide range of hole sizes and equipment types (i.e. parts). DNV proprietary software LEAK V3.3 will be used for the leak frequency calculation of process equipment and process piping. The leak frequencies for the main process equipment items are based on an analysis of the HSE hydrocarbon release database (HCRD) for the period of 1992-2010.

ASSUMPTION SHEET		
Assumption No.:12	**Revision: 03**	**Date: 17-10-2025**
Subject: Consequence Modelling & Software Tools		
Justification: For consequence and risk assessment.		
References:		
1. Standard Quantitative Safety Studies Approach		

Assumption Sheet 13: Potential Outcome and Impact Criteria

ASSUMPTION SHEET		
Assumption No.: 13	**Revision: 03**	**Date: 17-10-2025**
Subject: Potential Outcome and Impact criteria for Physical Effects Modelling		

Assumption:

The results for jet fire, pool fire, flammable gas dispersion / flash fire, toxic gas dispersion and Vapor Cloud Explosion (using SAFETI) will be reported.

- Heat radiation for jet fire will be reported for the following levels:
  - ✓ Jet flame length
  - ✓ 1.6 kW/m^2 (Minimum to cause pain after 1 minute)
  - ✓ 4.7 kW/m^2 (Sufficient to cause pain to personnel if unable to reach cover within 30 seconds)
  - ✓ 6.3 kW/m^2 (Pain within approximately 10 seconds; rapid escape only is possible)
  - ✓ 12.5 kW/m^2 (Significant chance of fatality for medium duration exposure)
  - ✓ 37.5 kW/m^2 (Significant chance of fatality for people exposed instantaneously, sufficient to cause damage to process equipment)
- Heat radiation for pool fire will be reported for the following levels:
  - ✓ Pool diameter
  - ✓ 1.6 kW/m^2 (Minimum to cause pain after 1 minute)
  - ✓ 4.7 kW/m^2 (Sufficient to cause pain to personnel if unable to reach cover within 30 seconds).
  - ✓ 6.3 kW/m^2 (Pain within approximately 10 seconds; rapid escape only is possible).
  - ✓ 12.5 kW/m^2 (Significant chance of fatality for medium duration exposure)
  - ✓ 37.5 kW/m^2 (Significant chance of fatality for people exposed instantaneously, sufficient to cause damage to process equipment)
- Flammable gas dispersion will be reported for the following concentrations:
  - ✓ 0.5 LFL
  - ✓ UFL
- Fireball / BLEVE:
  - ✓ Fireball radius
  - ✓ BLEVE radius
  - ✓ 1.6 kW/m^2
  - ✓ 4.7 kW/m^2 (Sufficient to cause pain to personnel if unable to reach cover within 30 seconds)
  - ✓ 6.3 kW/m^2 (Pain within approximately 10 seconds; rapid escape only is possible)
  - ✓ 12.5 kW/m^2 (Significant chance of fatality for medium duration exposure)
  - ✓ 37.5 kW/m^2 (Significant chance of fatality for people exposed instantaneously, sufficient to cause damage to process equipment).

For calculation of fatality due to flammable gas, thermal radiation and explosion, the following criteria will be applied in QRA study:

ASSUMPTION SHEET		
Assumption No.: 13	**Revision: 03**	**Date: 17-10-2025**

Subject: Potential Outcome and Impact criteria for Physical Effects Modelling

Table 7-8: Fatality Criteria

Type of Hazard	Criteria
Flammable Gas dispersion	Probability of fatality of 1 within lower flammable limit (LFL)
Thermal radiation	✓ ≥37.5kW/m^2 - Probability of Fatality = 1 ✓ ≥12.5kW/m^2 - Probability of Fatality = 0.7 (outdoor) and 0.3 (Indoors) ✓ ≥4.7kW/m^2 - Probability of Fatality = 0.01
Toxic Dispersion	✓ based on Probit, $Pr = a + b * \ln(C^n * t)$, where Pr = probit, C = concentration (in ppm), t = exposure duration to concentration C (in minutes), n = toxic index ✓ For QRA H_2S, UK HSE probit shall be utilized, where A = -30.08, B = 1.16, N = 4.

Surface Emissive Power:

SAFETI pool fire model contains a built-in correlation which calculates the emissive power of the flame as a function of the diameter of the pool and the material properties. The calculation method for surface emissive power is set to calculate SEP, the program will use the correlation to obtain the emissivity. Two-zone pool fire model option will be selected in the pool fire parameters, for the calculation of SEP which considers two layers i.e. base layer and upper layer. The base layer is assumed to emit thermal radiation at the maximum level for the fuel at the pool diameter whereas the upper layer is assumed to be obscuring flame by smoke generated due to combustion process.

Justification: The assumption has influence on determining the consequence impact and risk impact.

References:

1. Effects of Thermal Radiation, Centre for Chemical Process Safety, (CCPS) 1994
2. IOGP, "Vulnerability of Humans," Risk Assessment Data Directory, International Association of Oil & Gas Producers, Report 434-14, March 2010
3. Table B.1, POOLFIRE6 input data, UK HSE Research Report No. 96/1996, Development of Pool Fire Thermal Radiation Model

Assumption Sheet 14: Occupancy and Population Data

ASSUMPTION SHEET		
Assumption No.: 14	**Revision: 03**	**Date: 17-10-2025**
Subject: Occupancy and Manning/ Population Data		

Assumption:

As part of the data collection activities, the occupancy data will be collected from COMPANY and the same will be used in the safety studies.

a. Onsite Manning:

The manning level will be identified for each worker group. It should be assigned a rotation/shift pattern, and the time spent at each area of the facility/plant versus time spent in the control room/offices/accommodation will be considered. These estimates will be used to calculate the Individual Risk in form of IRPA to each person within each worker group.

The manning details mentioned in the Table 7-9 and the details of presence factor is mentioned in the Appendix B.

Table 7-9: Manning/Population Data For CdB1 & CdB2 Both

Sr. No	Worker Group	No. of Personnel in Worker Category	Presence Time in the Facility	Average Hours Spent in the Facility						
				Engines Hall	Steam Turbine Hall	Fuel Treatment House	Tanks Area	Heat Recovery Area	Outdoor Installations/ Workshop	Control Room/ Offices/Laboratory/ Warehouse
1	Plant Manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	0.5	0.5	0.5	0.5	0.5	0.5	5
2	Shift engineer	5	12 working hours per shift, 4days 4 days OFF & 24 days annual leave 0% outdoor, 100% indoor	2	1	1	1	1	2	4
3	Senior Operators	5	12 working hours per shift, 4days 4 days OFF & 24 days annual leave 0% outdoor, 100% indoor	2	1	1	1	2	2	3
4	Operators	10	12 working hours per shift, 4days 4 days OFF & 24 days annual leave 0% outdoor, 100% indoor	2	1	1	2	2	2	2
5	Chemist	1	8 working hours per day, 5days 2 days OFF & 24 days annual leave _0% outdoor, 100% indoor	0.5	0.5	0.5	0.5	1	1	4
6	Operation Manager	1	8 working hours per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	0.5	0.5	0.5	0.5	0.5	0.5	5
7	O&M Coordinator	1	8 working hours per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	0.5	0.5	0.5	0.5	0.5	0.5	5
8	Mechanicals	5	8 working hours per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	1	1	1	1	1	2	1

Sr. No	Worker Group	No. of Personnel in Worker Category	Presence Time in the Facility	Average Hours Spent in the Facility						
				Engines Hall	Steam Turbine Hall	Fuel Treatment House	Tanks Area	Heat Recovery Area	Outdoor Installations/ Workshop	Control Room/ Offices/Laboratory/Warehouse
9	Electricians	4	8 hours working per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	1	1	1	1	1	2	1
10	Store keepers	2	8 hours working per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	0.5	0.5	0.5	0.5	0.5	0.5	5
11	Maintenance Manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	0.5	0.5	0.5	0.5	0.5	0.5	5
12	Finance Team	5	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	0	0	0	0	0	0	8
13	HR team	2	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	0	0	0	0	0	0	8
14	Procurement	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	0	0	0	0	0	0	8
15	HSE team	2	8 working hours per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	1	0.5	1	0.5	1	1	3
16	Admin manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	0	0	0	0	0	0	8
17	Drivers	5	4 hours working per day, 2days 2 days OFF & 24 days annual leave 50% outdoor, 50% indoor	0	0	0	0	0	0	4
18	IT manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	0	0	0	0	0	0	8
19	Tax manager	1	8 hours working per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	0	0	0	0	0	0	8

b. Offsite Population:

The population distribution is often defined as population density. Sources of population data for an area are census reports, detailed maps, aerial photographs, and site inspections by the analyst. Special attention must be made to the various types of population (i.e., residential or industrial), the indoor and outdoor percentage, and the day/night variations and concentrations of people such as hospitals, mosques/churches, or schools. The following assumptions are considered for the offsite population:

1. General public population is considered. Industrial processing facilities (other oil and gas facilities) population is not accounted for societal risk calculation.
2. Population in 500 meters from the plant boundary have been considered for the societal risk calculation.
3. For residential buildings/villa, average of 4 people per villa has been considered.
4. For warehouse, average of 4 people per warehouse has been considered.

Figure 7-7:ContourGlobal Facility Populated Areas 1&2

Figure 7-8:ContourGlobal Facility Populated Areas 3&4

Table 7-10: ContourGlobal Facility Populated Areas

Facility	Population Area Number	Approx. Population Day
ContourGlobal Facility (CdB1 & CdB2)	Populated Area-1	13000
	Populated Area-2	
	Populated Area-3 (Central Electric Cap des Biches-School Charlemange)	140
	Populated Area-4 (Cap des formation et de Perfectionnement)	220

Justification: The assumption has influence on calculations required for determining IRPA.

References:

1. Standard Quantitative Risk Assessment (QRA) Guideline

Assumption Sheet 15: Ignition Probabilities

ASSUMPTION SHEET		
Assumption No.: 15	**Revision: 03**	**Date: 17-10-2025**
Subject: Ignition Probabilities		

Assumption:

Ignition probability input has potential to decide the nature of consequence and has impact on risk results and conclusion that can be drawn from the assessment.

IOGP data base (Report No. 431-6.1, Sep 2019, Ignition Probabilities) estimates the ignition probabilities based on 28 mathematical functions drawn from the UKOOA look-up correlation (Energy Institute, IP Research Report) which relates ignition probabilities in air to release rate for typical scenarios both onshore and offshore.

The values presented in IOGP relate to "total" ignition probability, which can be considered as the sum of the probability of immediate ignition and delayed ignition.

Following Ignition probability lookup correlation will be used based on the scenario.

Table 7-11: Ignition Probability Curve

Sr. No	Scenario Number	Applicable Location	Look-up Release Type	Application
1	Scenario No. 07	HFO/LFO Storage Tanks	Small Plant Liquid Bund Rural (Liquid release from small onshore plant where the spill is bunded)	Releases of flammable liquids that do not have any significant flash fraction (10% or less) if released from small onshore plants (plant area up to 1200 m^2, site area up to 35,000 m^2) and where the liquid releases from the plant area are suitably bunded or otherwise contained.
2	Scenario No. 05	Fuel Gas	Small Plant Gas LPG (Gas or LPG release from small onshore plant)	Releases of flammable gases, vapour or liquids significantly above their normal (NAP) boiling point from small onshore plants (plant area up to 1200 m2, site area up to 35,000 m^2).

ASSUMPTION SHEET		
Assumption No.: 15	**Revision: 03**	**Date: 17-10-2025**
Subject: Ignition Probabilities		

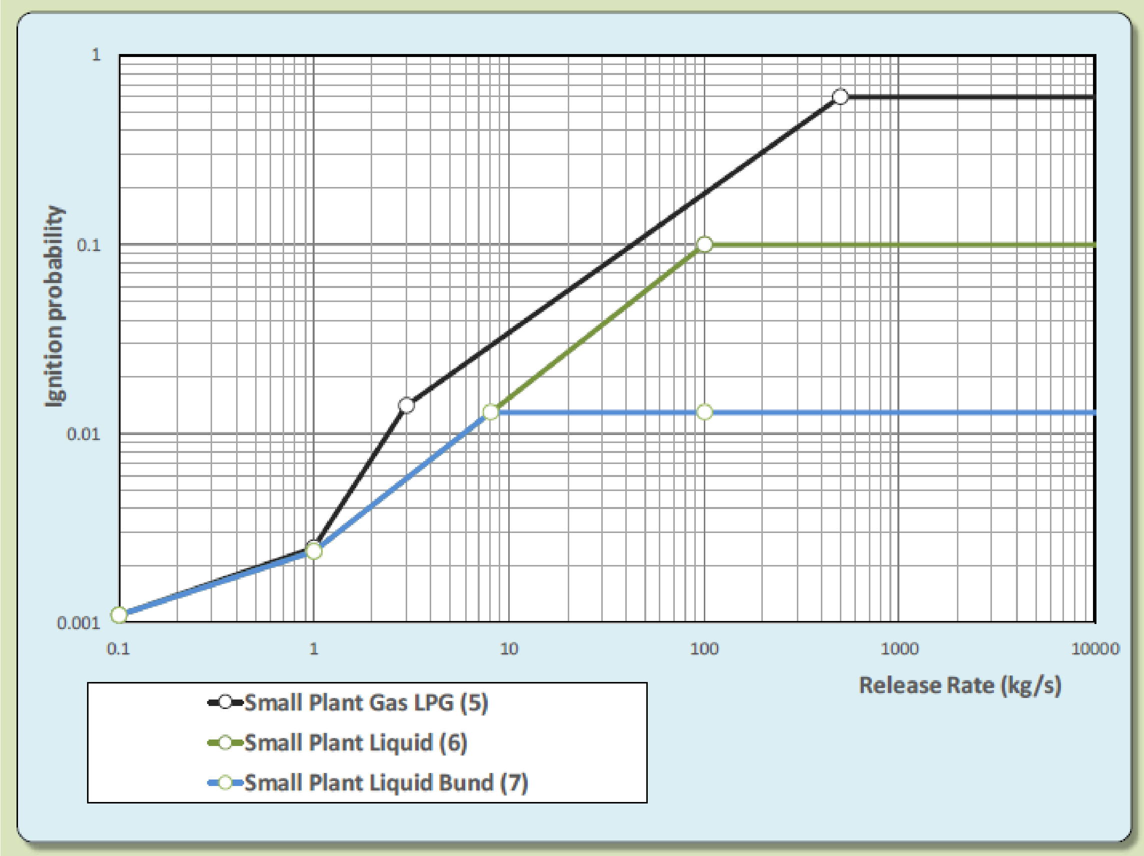


Figure 7-9:UKOOA Look-Up Correlation, Scenario 07

Total Ignition Probability = Immediate Ignition Probability + Delayed Ignition Probability

The immediate ignition probability associated with each flammable failure case is a risk analyst programmed value, based on historical ignition data, which varies with leak size and release phase (the larger the leak vapour flow rate, the higher the total ignition probability).

The IP review of ignition and explosion probabilities concludes that, there are too little data to draw any firm conclusions but that “risk assessment approaches based on 30:70 to 50:50 split delayed ignition or jet / pool fire: flash fire / explosion is reasonable”. Furthermore, it also identifies that, on average, approximately 20% of ignited gas releases result in explosions.

Therefore, for this study, the split immediate: delayed ignition used will be 30:70, in line with IP review will be used as ignition and explosion probabilities.

The immediate ignition probability can be calculated as,

$P_{immediate}$ = P_{total} x 0.30, for plant areas where P_{total} is calculated from IOGP/UKOOA look-up table.

Justification: The assumption has influence on the event outcome frequency estimation

References:

ASSUMPTION SHEET		
Assumption No.: 15	**Revision: 03**	**Date: 17-10-2025**
Subject: Ignition Probabilities		
1. IOGP report no. 434-6, September 2019, Ignition Probabilities		

Assumption Sheet 16: Non-Process Risk Assessment

ASSUMPTION SHEET		
Assumption No.: 16	**Revision: 03**	**Date: 17-10-2025**
Subject: Non-Process Risk Assessment		

Assumption:

Occupational Risk Assessment

Occupational Risk covers risks associated with non-installation specific manual activities of a typical worker at ContourGlobal facilities. This includes slips / falls, mechanical impacts, electrocution and is generally limited to a single fatality. The occupational risks include transport risks, which are often analysed separately in QRAs.

Occupational risk is expressed in the form of Fatal Accident Rate (FAR), which is defined as the number of fatalities per 10^8 exposed man hours. The analysis is based on the work activities carried out by the various worker groups and the extent of their working hours with reference to the occupational Fatal Accident Rates (FAR) rates.

The FAR values used for this study shall be based on the overall worldwide COMPANY employees with modification factors for the type of activity and location of the facility installation.

The occupational IRPA of a given worker group shall be determined from the modified FAR for that worker group multiplied by the number of exposed hours in a given year.

The IRPA is calculated from using work pattern data using the following equation:

$$IRPA = FAR \times \frac{Exposed\ Hours\ per\ Year}{10^8}$$

Justification: The assumption has influence on risk assessment.

References:

1. IOGP report no. 434-12, March 2010, Occupational Risk.

Assumption Sheet 17: Risk Assessment UK HSE Risk Acceptance Criteria

ASSUMPTION SHEET		
Assumption No.: 17	**Revision: 03**	**Date: 17-10-2025**
Subject: Risk Assessment and UK HSE Risk Acceptance Criteria		

Assumption:

The risk will be presented for:

- Location Specific Individual Risk (LSIR)
- Individual Risk Per Annum (IRPA)
- FN-Curve.
- Potential Loss of Life (PLL)
- Risk ranking points.
- Major risk contributors.

When undertaking a QRA the output from the study has to be assessed for acceptability against certain criteria. In this instance the acceptability of risk has to be referenced to the UK HSE acceptance criteria, refer Figure 7-10 . The level of risk calculated for employees and the general public is studied in two principal areas. Individual Risk, which is the level of risk of fatality for specific people, usually defined as individuals within specific groups. The groups are defined by their activities in or around the facilities. The second area is risk to society, which is a measure of the risk of fatality within the general public.

The process for calculating the levels of risk associated with the facility is:

- Calculate the Location Specific Individual Risk (LSIR) from Major Accident Hazard events using the QRA model.
- Define the worker groups and groups of the general public by their location and movements within the effects zone of the facility.
- Calculate Individual Risk (IR) figures for each group using the LSIR data.
- Use the QRA model to calculate societal risk.

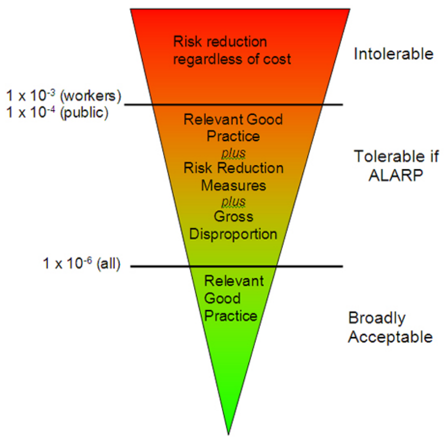


Figure 7-10: Risk Acceptance Criteria, UK HSE

ASSUMPTION SHEET		
Assumption No.: 17	**Revision: 03**	**Date: 17-10-2025**

Subject: Risk Assessment and UK HSE Risk Acceptance Criteria

	Workers	Member of public
Maximum tolerable criterion	10^{-3} per year	10^{-4} per year
Broadly acceptable criterion	10^{-6} per year	

Figure 7-11: Risk Tolerability Criteria

Onsite Societal Risk Criteria (FN Curve): Societal Risk (SR) is calculated in order to establish the global view of risk from the facility, in terms of the likelihood of single or multiple fatalities. FN Curve criteria is presented in the FN curve in the following figure.

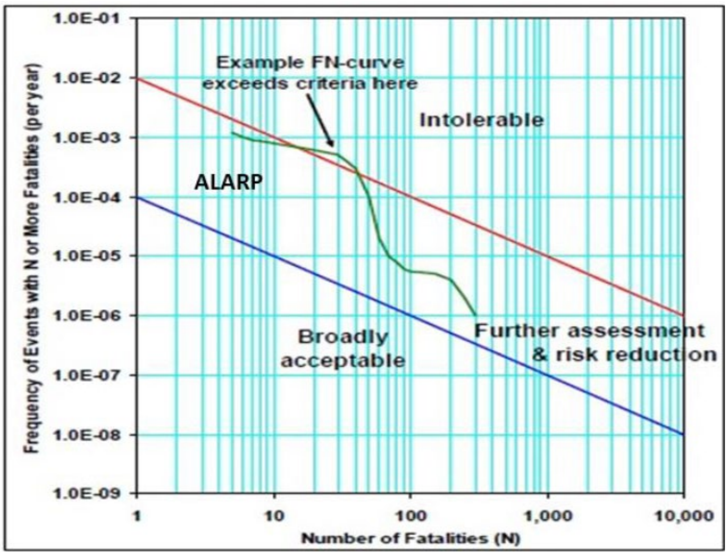


Figure 7-12: FN Curve Onsite Societal Risk Tolerability

Justification: The assumption has influence on risk assessment.

References:

1. https://www.hse.gov.uk/foi/internalops/hid_circs/permissioning/spc_perm_37/

Assumption Sheet 18: ALARP Demonstration and Workshop

ASSUMPTION SHEET		
Assumption No.: 18	**Revision: 03**	**Date: 17-10-2025**
Subject: ALARP Demonstration and Workshop		

Assumption:

ALARP demonstration is required when the calculated Individual Risk Per Annum for various group lies within ALARP region as per UK HSE risk matrix lie between 1.00E-03 to 1.00E-05 per year.

Risk Reduction/ ALARP Workshop

Risk Reduction Measures (RRM) will be identified as part of various quantified risk assessment studies in order to reduce the risks to ALARP. A Risk Reduction Workshop will be conducted to present the risk assessment study results and discuss the Risk Reduction Recommendations. All major Hazard scenarios will be discussed and options for potential risk reduction measures will be identified. This is usually done based on the identification of Major Risk Contributors.

- Risk reduction results will be presented to evaluate the effect of the potential risk reduction measures.
- The QRA study will then be updated to incorporate all agreed risk reduction measures.

The output from the Risk Reduction Workshop will be documented in the ALARP demonstration report.

Justification: The assumption has influence on risk assessment.

References:

1. Guidance on ALARP Decisions in COMAH,R2P2, UK HSE

Assumption Sheet19: Study Deliverable and Report Structure

ASSUMPTION SHEET		
Assumption No.: 19	**Revision: 03**	**Date: 17-10-2025**
Subject: QRA Report Structure		

Assumption:

QRA

The QRA report structure is given below:

- Executive summary & conclusion
- Section 1- Introduction/ Objective/Scope
- Section 2 - Facility Overview
- Section 3 - QRA Methodology
- Section 4 - Hazard Identification
- Section 5 - Failure Cases
- Section 6 - Consequence Assessment
- Section 7 - Frequency Assessment
- Section 8 - Ignition Probabilities
- Section 9 - Explosion Probabilities
- Section 10 - Weather Conditions
- Section 11- Manning Levels
- Section 12- Process Risk Assessment
- Section 13 - Non-Process Risk Assessment
- Section 14 - Risk Results and Assessment (Indoor and outdoor Risk results, LSIR, IRPA & PLL)
- Section 15 - Major Risk Contributor Analysis & Risk Reduction Measures
- Section 16 - ALARP Demonstration
- Section 17 - Conclusion & Recommendations
- Section 18 - References
- Appendix:
    - Appendix 1 - Assumption Register
    - Appendix 2 - Failure Case Definition Table
    - Appendix 3 - Isolatable Section & Failure Case Marking
    - Appendix 4 - Part Count and Failure Frequencies
    - Appendix 5 - Consequence Results (Flammable gas, fire and explosions) & Contours

Justification: This section highlight the report structure

References:

1. Standard Engineering Practices

8 APPENDIX B: MANNING DISTRIBUTION AND PRESENCE FACTOR

Sr. No	Worker Group	No. of Personnel in Worker Category	Presence Time in the Facility			Fraction of hours spent by all worker categories in a single active day							Average Hours Spent in the Facility							Total Hours	Average Hours Spent in the Facility (PER YEAR)							Total Hours	Presence Factor (Year) for CdB1 & CdB2 Area						
				Avg. No of Days worked at ContourGlobal Facility in a Year	Fraction of days worked at ContourGlobal Facility	Engines hall	Steam turbine Hall	Fuel traitment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse	Engines hall	Steam turbine Hall	Fuel traitment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/Warehouse		Engines hall	Steam turbine Hall	Fuel traitment house	Tanks area	Heat recovery area	Outdoor installations/ Workshop	Control room/ Offices/Laboratory/ Warehouse		Engines hall	Steam turbine Hall	Fuel traitment house	Tanks area	Heat recovery area	Outdoor installations / Workshop	Control room/ Offices/Laboratory/Warehouse
1	Plant Manager	1	8 hours workng per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	244	0.67	0.06	0.06	0.06	0.06	0.06	0.06	0.63	0.50	0.50	0.50	0.50	0.50	0.50	5.00	8.00	121.79	121.79	121.79	121.79	121.79	121.79	1217.86	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.07
2	Shift engineer	5	12 working hours per shift, 4days 4 days OFF & 24 days annual leave 0% outdoor, 100% indoor	171	0.47	0.83	0.42	0.42	0.42	0.42	0.83	1.67	2.00	1.00	1.00	1.00	1.00	2.00	4.00	12.00	341.00	243.57	243.57	243.57	170.50	341.00	682.00	2265.21	0.02	0.03	0.01	0.01	0.01	0.02	0.04
3	Senior Operators	5	12 working hours per shift, 4days 4 days OFF & 24 days annual leave 0% outdoor, 100% indoor	171	0.47	0.83	0.42	0.42	0.42	0.83	0.83	1.25	2.00	1.00	1.00	1.00	2.00	2.00	3.00	12.00	341.00	243.57	243.57	243.57	341.00	341.00	511.50	2265.21	0.02	0.03	0.01	0.01	0.02	0.02	0.03
4	Operators	10	12 working hours per shift, 4days 4 days OFF & 24 days annual leave 0% outdoor, 100% indoor	171	0.47	1.67	0.83	0.83	1.67	1.67	1.67	1.67	2.00	1.00	1.00	2.00	2.00	2.00	2.00	12.00	341.00	243.57	243.57	487.14	341.00	341.00	341.00	2338.29	0.02	0.03	0.01	0.03	0.02	0.02	0.02
5	Chemist	1	8 working hours per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	244	0.67	0.06	0.06	0.06	0.06	0.13	0.13	0.50	0.50	0.50	0.50	0.50	1.00	1.00	4.00	8.00	121.79	121.79	121.79	121.79	243.57	243.57	974.29	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.06
6	Operation Manager	1	8 working hours per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	244	0.67	0.06	0.06	0.06	0.06	0.06	0.06	0.63	0.50	0.50	0.50	0.50	0.50	0.50	5.00	8.00	121.79	121.79	121.79	121.79	121.79	121.79	1217.86	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.07
7	O&M Coordianator	1	8 working hours per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	244	0.67	0.06	0.06	0.06	0.06	0.06	0.06	0.63	0.50	0.50	0.50	0.50	0.50	0.50	5.00	8.00	121.79	121.79	121.79	121.79	121.79	121.79	1217.86	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.07
8	Mechanicals	5	8 working hours per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	244	0.67	0.63	0.63	0.63	0.63	0.63	1.25	0.63	1.00	1.00	1.00	1.00	1.00	2.00	1.00	8.00	243.57	243.57	243.57	243.57	243.57	487.14	243.57	1948.57	0.01	0.03	0.01	0.01	0.01	0.03	0.01
9	Electricians	4	8 hours workng per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	244	0.67	0.50	0.50	0.50	0.50	0.50	1.00	0.50	1.00	1.00	1.00	1.00	1.00	2.00	1.00	8.00	243.57	243.57	243.57	243.57	243.57	487.14	243.57	1948.57	0.01	0.03	0.01	0.01	0.01	0.03	0.01
10	Store keepers	2	8 hours workng per day, 5days 2 days OFF & 24 days annual leave 0% outdoor, 100% indoor	244	0.67	0.13	0.13	0.13	0.13	0.13	0.13	1.25	0.50	0.50	0.50	0.50	0.50	0.50	5.00	8.00	121.79	121.79	121.79	121.79	121.79	121.79	1217.86	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.07
11	Maintenance Manager	1	8 hours workng per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	244	0.67	0.06	0.06	0.06	0.06	0.06	0.06	0.63	0.50	0.50	0.50	0.50	0.50	0.50	5.00	8.00	121.79	121.79	121.79	121.79	121.79	121.79	1217.86	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.07
12	Finance Team	5	8 hours workng per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	244	0.67	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	1948.57	1948.57	0.00	0.00	0.00	0.00	0.00	0.00	0.11
13	HR team	2	8 hours workng per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	244	0.67	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	1948.57	1948.57	0.00	0.00	0.00	0.00	0.00	0.00	0.11
14	Procurement	1	8 hours workng per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	244	0.67	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	1948.57	1948.57	0.00	0.00	0.00	0.00	0.00	0.00	0.11
15	HSE team	2	8 working hours per day, 5days 2 days OFF & 24 days annual leave 20% outdoor, 80% indoor	244	0.67	0.25	0.13	0.25	0.13	0.25	0.25	0.75	1.00	0.50	1.00	0.50	1.00	1.00	3.00	8.00	243.57	121.79	243.57	121.79	243.57	243.57	730.71	1948.57	0.01	0.01	0.01	0.01	0.01	0.01	0.04
16	Admin manager	1	8 hours workng per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	244	0.67	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	1948.57	1948.57	0.00	0.00	0.00	0.00	0.00	0.00	0.11
17	drivers	5	4 hours workng per day, 2days 2 days OFF & 24 days annual leave 50% outdoor, 50% indoor	159	0.43	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	634.00	634.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
18	IT manager	1	8 hours workng per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	244	0.67	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	1948.57	1948.57	0.00	0.00	0.00	0.00	0.00	0.00	0.11
19	Tax manager	1	8 hours workng per day, 5days 2 days OFF & 24 days annual leave 40% outdoor, 60% indoor	244	0.67	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	1948.57	1948.57	0.00	0.00	0.00	0.00	0.00	0.00	0.11

Note: The presence factor is calculated based on a total of 8,760 hours in a year, presence time in facility and accounting for leave.

9 APPENDIX C: FAILURE CASE DEFINITION TABLE & FAILURE CASE MARKUP FOR CdB1

Failure Case List for CdB1

ISO No.	Isolatable Section (From)	Isolatable Section (To)	Failure Case Description (Leak modelled at)	Failure Case ID	Pipe Size (inch)	PFD Stream no.	Pressure (barg)	Temp. (DegC)	Phase	Stream flow rate (m3/hr)	Density (kg/m3)	Stream flow rate (kg/s)	Release Height (m)
ISO1	From battery limit	To PAA900-V-005	LOC at (B/L) PAA900-V-005	**CdB1-ISO1-1**	**6**	3	1.2	25.35	Liquid	75	1010	21.04	1
ISO1	From (B/L) PAA900-V-005	To inlet of PAB902 and PAB901 upto the inlet PAA900-V-007/008	LOC at (B/L) PAA900-V-008	**CdB1-ISO1-2**	**6**	3	1.2	25.35	Liquid	75	1010	21.04	1
ISO2	From HFO unloading tanker manifold (B/L) PAA900-V-017/018/019/020	To inlet of PAB902 and PAB901 upto the inlet NRV PAA900-V-021/022	LOC at PAA901 HFO Unloading Pump Unit	**CdB1-ISO2**	**4**	1	4	50	Liquid	40	1010	11.22	1
ISO3	From PAA900-V-007 at the inlet of PAB901	At PAB901 HFO storage tank existing (1480m^3) and further upto the inlet of PAC901 HFO transfer pump	At PAB901 HFO storage tank existing (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO3**	**6**	-	ATM	25.35	Liquid	-	1010	-	11.33
ISO4	From PAA900-V-008 at the inlet of PAB902	At PAB902 HFO storage tank existing (1480m^3) further upto the inlet of HFO transfer pump phase 2	At PAB902 HFO storage tank existing (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO4**	**6**	-	ATM	25.35	Liquid	-	1010	-	11.33
ISO5	From PAC901 HFO transfer pump	At PBA902 HFO Pre-storage tank inlet valve PAC900-V024	LOC at PAC901 HFO transfer pump	**CdB1-ISO5**	**4**	2	4	60	Liquid	15	1010	4.21	1
ISO6	From HFO Pre-storage tank inlet valve PAC900-V024	At PBA902 HFO pre-storage tank (3000m^3) further upto the inlet of HFO transfer pump PAC902 pump unit	At PBA902 HFO pre-storage tank (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO6**	**4**	-	ATM	25.35	Liquid	-	1010	-	12.6
ISO7	From HFO transfer pump PAC902 pump	To HFO buffer tank inlet valve PAC900-V007	LOC at HFO transfer pump PAC902 pump	**CdB1-ISO7**	**4**	9	4	60	Liquid	15	1010	4.21	1
ISO8	PBA901 HFO buffer tank (50m3)	At PBA901 HFO buffer tank (50m^3) further upto the inlet of HFO separator unit PBB901 transfer pump	At PBA901 HFO buffer tank (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO8**	**6**	-	ATM	25.35	Liquid	-	1010	-	3.6
ISO9	From HFO separator unit PBB901 transfer pump outlet	To inlet line of PBC901 HFO day Tank	HFO separator unit PBB901 transfer pump	**CdB1-ISO9**	**5**	5	4	98	liquid	13.3	1010	3.73	1
ISO10	PBC901 HFO day tank (100m3)	PBC901 HFO day tank (100m3) further upto the inlet of HFO feeder unit PCA901 & PCA902 inlet SDVs	At PBC901 HFO day tank (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO10**	**4**	-	ATM	25.35	Liquid	-	1010	-	7.2
ISO11	From inlet SDV of HFO feeder pump unit PCA901	To HFO feeder pump unit PCA901	SDV of HFO feeder pump unit PCA901	**CdB1-ISO11-1**	**4**	-	Tank Head(0.71)	90	Liquid	13.3	1010	3.73	1
ISO11	From inlet SDV of HFO feeder pump unit PCA902	To HFO feeder pump unit PCA902	SDV of HFO feeder pump unit PCA902	**CdB1-ISO11-2**	**4**	-	Tank Head(0.71)	90	Liquid	13.3	1010	3.73	1
ISO12	HFO feeder pump unit PCA901/902 pump outlet	HFO to engine fuel booster inlet valve	HFO feeder pump unit PCA901/902 pump outlet	**CdB1-ISO12**	**3**	6	5	90	Liquid	11	1010	3.09	1
ISO13	From LFO unloading valve PAD901 Unloading Pump Unit	To inlet line of PAE901 LFO Storage Tank	LFO unloading PAD901 Unloading Pump	**CdB1-ISO13**	4	4	4	25.35	Liquid	12.8	900	3.2	1
ISO14	From PAE901 LFO storage tank(120m3)	PAE901 LFO storage tank further upto the inlet of LFO transfer unit PAF901 pump	At PAE901 LFO storage tank (120m3) (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO14**	**3**	-	ATM	25.35	Liquid	-	900	-	6
ISO15	From LFO transfer unit PAF901 pump outlet	To inlet line of PBF901 LFO day tank	LFO transfer unit PAF901 pump	**CdB1-ISO15**	**2**	4	4	25.35	Liquid	12.8	900	3.20	1
ISO16	PBF901 LFO day tank (100m2)	PBF901 LFO day tank (100m3) further upto the inlet SDV of LFO feeder unit PCA903 pump	PBF901 LFO day tank (100m3) (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO16**	**3**	-	ATM	25.35	Liquid	-	900	-	7.2
ISO17	From inlet SDVs of PCA903	To PCA903 LFO feeder unit pump 1	SDVs of PCA903	**CdB1-ISO17-1**	**3**	-	Tank Head(0.63)	25.35	Liquid	12.8	900	3.20	1
ISO17	From inlet SDVs of PCA903	To PCA903 LFO feeder unit pump 2	SDVs of PCA903	**CdB1-ISO17-2**	**3**	-	Tank Head(0.63)	25.35	Liquid	12.8	900	3.20	1
ISO18	From PCA903 LFO feeder unit pump outlet	To LFO engine fuel booster inlet valve	PCA903 LFO feeder unit pumps	**CdB1-ISO18**	**2.5**	7	5	25.35	Liquid	11	900	2.75	1
ISO19	From tie in ESD valve	To engine inlet boundary	Engine inlet SDV	**CdB1-ISO19**	**5**	-	6	25.35	Gas	-	0.71	-	1
ISO20	From engine inlet SDV	To engine hall	Engine Hall Downstream SDV	**CdB1-ISO20**	**5**	-	6	25.35	Gas	-	0.71	-	1

Failure Case ID	Phast Calculated Leak rate (kg/sec)				Considered discharge rate (kg/sec)				Isolation time in sec.			
	S	M	L	FBR	S1	M1	L1	FBR1	S2	M2	L2	FBR2
CdB1-ISO1-1	0.2102	5.255	21.02	195.282	0.2102	5.255	21.02	31.5625	1200	600	300	300
CdB1-ISO1-2	0.2102	5.255	21.02	195.282	0.2102	5.255	21.02	31.5625	1200	600	300	300
CdB1-ISO2	0.377826	9.44565	37.7826	156.005	0.377826	9.44565	11.22	16.8333333	1200	600	300	300
CdB1-ISO3	-	-	-	-	0	0	0	0	1200	600	300	300
CdB1-ISO4	-	-	-	-	0	0	0	0	1200	600	300	300
CdB1-ISO5	0.37541	9.38525	37.541	155.008	0.37541	4.21	4.21	6.3125	1200	600	300	300
CdB1-ISO6	-	-	-	-	0	0	0	0	900	600	300	300
CdB1-ISO7	0.37541	9.38525	37.541	155.008	0.37541	4.21	4.21	6.3125	600	420	300	300
CdB1-ISO8	-	-	-	-	0	0	0	0	600	420	300	300
CdB1-ISO9	0.366201	9.15504	36.6201	236.259	0.366201	3.73	3.73	5.59708333	600	420	300	300
CdB1-ISO10	-	-	-	-	0	0	0	0	600	420	300	300
CdB1-ISO11-1	0.1551	3.87	15.51	64.05	0.1551	3.73	3.73	5.59708333	600	420	300	300
CdB1-ISO11-2	0.1551	3.87	15.51	64.05	0.1551	3.73	3.73	5.59708333	600	420	300	300
CdB1-ISO12	0.411594	10.2898	41.1594	95.5958	0.411594	3.09	3.09	4.62916667	600	420	300	300
CdB1-ISO13	0.350312	8.7578	35.0312	144.645	0.350312	3.2	3.2	4.8	600	420	300	300
CdB1-ISO14	-	-	-	-	0	0	0	0	1200	600	300	300
CdB1-ISO15	0.350312	8.7578	36.1611	36.1611	0.350312	3.20	3.2	4.8	600	420	300	300
CdB1-ISO16	-	-	-	-	0	0	0	0	600	420	300	300
CdB1-ISO17-1	0.139	3.47	13.9	32.29	0.139	3.20	3.20	4.8	600	420	300	300
CdB1-ISO17-2	0.139	3.47	13.9	32.29	0.139	3.20	3.20	4.8	600	420	300	300
CdB1-ISO18	0.391653	9.79132	39.1653	63.1697	0.391653	2.75	2.75	4.125	600	420	300	300
CdB1-ISO19	0.0207972	0.51993	2.07972	13.4175	0.0207972	0.51993	2.07972	13.4175	600	300	120	120
CdB1-ISO20	0.0207972	0.51993	2.07972	13.4175	0.0207972	0.51993	2.07972	13.4175	120	120	120	120

Failure Case ID	Dynamic Inventory					Available inventory for release (kg)			
	S3	M3	L3	FBR3	Static Inventory (Kg)	S4	M4	L4	FBR4
CdB1-ISO1-1	252.24	3153	6306	9468.75	411.97	664.2082804	3564.96828	6717.96828	9880.71828
CdB1-ISO1-2	252.24	3153	6306	9468.75	981.54	1233.780605	4134.540605	7287.540605	10450.29061
CdB1-ISO2	453.3912	5667.39	3366.66667	5050	507.78	961.1739124	6175.172712	3874.449379	5557.782712
CdB1-ISO3	0	0	0	0	1270771.97	1270771.967	1270771.967	1270771.967	1270771.967
CdB1-ISO4	0	0	0	0	1270736.93	1270736.929	1270736.929	1270736.929	1270736.929
CdB1-ISO5	450.492	2525	1262.5	1893.75	954.20	1404.695656	3479.203656	2216.703656	2847.953656
CdB1-ISO6	0	0	0	0	2576022.98	2576022.982	2576022.982	2576022.982	2576022.982
CdB1-ISO7	225.246	1767.5	1262.5	1893.75	228.00	453.2415638	1995.495564	1490.495564	2121.745564
CdB1-ISO8	0	0	0	0	43837.55	43837.54521	43837.55	43837.55	43837.54521
CdB1-ISO9	219.7206	1567.18333	1119.41667	1679.125	15655.43	15875.14595	17222.61	16774.84	17334.55035
CdB1-ISO10	0	0	0	0	86210.29	86210.28929	86210.28929	86210.28929	86210.28929
CdB1-ISO11-1	93.06	1567.18333	1119.41667	1679.125	90.07	183.1323215	1657.255655	1209.488988	1769.197321
CdB1-ISO11-2	93.06	1567.18333	1119.41667	1679.125	90.07	183.1323215	1657.255655	1209.488988	1769.197321
CdB1-ISO12	246.9564	1296.16667	925.833333	1388.75	386.33	633.2822164	1682.492483	1312.15915	1775.075816
CdB1-ISO13	210.1872	1344	960	1440	240.7873941	450.9745941	1584.787394	1200.787394	1680.787394
CdB1-ISO14	0	0	0	0	91944.97	91944.97408	91944.97408	91944.97408	91944.97408
CdB1-ISO15	210.1872	1344	960	1440	272.89	483.0795799	1616.89238	1232.89238	1712.89238
CdB1-ISO16	0	0	0	0	76635.94	76635.94455	76635.94455	76635.94455	76635.94455
CdB1-ISO17-1	83.4	1344	960	1440	22.57	105.9738182	1366.573818	982.5738182	1462.573818
CdB1-ISO17-2	83.4	1344	960	1440	22.57	105.9738182	1366.573818	982.5738182	1462.573818
CdB1-ISO18	234.9918	1155	825	1237.5	243.30	478.2873961	1398.295596	1068.295596	1480.795596
CdB1-ISO19	12.47832	155.979	249.5664	1610.1	1.63	14.10832	157.609	251.1964	1611.73
CdB1-ISO20	2.495664	62.3916	249.5664	1610.1	0.3	2.495664	62.3916	249.5664	1610.1

Failure Case ID	Total Ignition Probability				Immediate Ignition Probability (30%)			
	S6	M6	L6	FBR6	S7	M7	L7	FBR7
CdB1-ISO1-1	0.001390786	0.00883847	0.013	0.013	0.00041724	0.00265154	0.0039	0.0039
CdB1-ISO1-2	0.001390786	0.00883847	0.013	0.013	0.00041724	0.00265154	0.0039	0.0039
CdB1-ISO2	0.00168132	0.013	0.013	0.013	0.0005044	0.0039	0.0039	0.0039
CdB1-ISO3	-	-	-	-	-	-	-	-
CdB1-ISO4	-	-	-	-	-	-	-	-
CdB1-ISO5	0.00168132	0.007377	0.007377	0.010245	0.0005044	0.0022131	0.0022131	0.00307351
CdB1-ISO6	-	-	-	-	-	-	-	-
CdB1-ISO7	0.00168132	0.007377	0.007377	0.010245	0.0005044	0.0022131	0.0022131	0.00307351
CdB1-ISO8	-	-	-	-	-	-	-	-
CdB1-ISO9	0.00168132	0.00662074	0.00662074	0.0095478	0.0005044	0.00198622	0.00198622	0.00286435
CdB1-ISO10	-	-	-	-	-	-	-	-
CdB1-ISO11-1	0.001261555	0.00662074	0.00662074	0.0095478	0.00037847	0.00198622	0.00198622	0.00286435
CdB1-ISO11-2	0.001261555	0.00662074	0.00662074	0.0095478	0.00037847	0.00198622	0.00198622	0.00286435
CdB1-ISO12	0.001759177	0.00584359	0.00584359	0.0081155	0.00052775	0.00175308	0.00175308	0.00243464
CdB1-ISO13	0.00168132	0.00584359	0.00584359	0.0081155	0.0005044	0.00175308	0.00175308	0.00243464
CdB1-ISO14	-	-	-	-	-	-	-	-
CdB1-ISO15	0.00168132	0.00584359	0.00584359	0.0081155	0.0005044	0.00175308	0.00175308	0.00243464
CdB1-ISO16	-	-	-	-	-	-	-	-
CdB1-ISO17-1	0.001099541	0.00584359	0.00584359	0.0081155	0.00032986	0.00175308	0.00175308	0.00243464
CdB1-ISO17-2	0.001099541	0.00584359	0.00584359	0.0081155	0.00032986	0.00175308	0.00175308	0.00243464
CdB1-ISO18	0.00168132	0.0050413	0.0050413	0.007377	0.0005044	0.00151239	0.00151239	0.0022131
CdB1-ISO19	0	0.00195197	0.00741234	0.0411086	0	0.00058559	0.0022237	0.01233259
CdB1-ISO20	0	0.00195197	0.00741234	0.0411086	0	0.00058559	0.0022237	0.01233259

Failure Case ID	Delayed Ignition Probability (70%)				Non Ignition Probability			
	S8	M8	L8	FBR8	S92	M93	L94	FBR95
CdB1-ISO1-1	0.00097355	0.00618693	0.0091	0.0091	0.99860921	0.99116153	0.987	0.987
CdB1-ISO1-2	0.00097355	0.00618693	0.0091	0.0091	0.99860921	0.99116153	0.987	0.987
CdB1-ISO2	0.00117692	0.0091	0.0091	0.0091	0.99831868	0.987	0.987	0.987
CdB1-ISO3	-	-	-	-	-	-	-	-
CdB1-ISO4	-	-	-	-	-	-	-	-
CdB1-ISO5	0.00117692	0.0051639	0.0051639	0.0071715	0.99831868	0.992623	0.992623	0.98975496
CdB1-ISO6	-	-	-	-	-	-	-	-
CdB1-ISO7	0.00117692	0.0051639	0.0051639	0.0071715	0.99831868	0.992623	0.992623	0.98975496
CdB1-ISO8	-	-	-	-	-	-	-	-
CdB1-ISO9	0.00117692	0.00463452	0.00463452	0.0066835	0.99831868	0.99337926	0.99337926	0.99045216
CdB1-ISO10	-	-	-	-	-	-	-	-
CdB1-ISO11-1	0.00088309	0.00463452	0.00463452	0.0066835	0.99873845	0.99337926	0.99337926	0.99045216
CdB1-ISO11-2	0.00088309	0.00463452	0.00463452	0.0066835	0.99873845	0.99337926	0.99337926	0.99045216
CdB1-ISO12	0.00123142	0.00409051	0.00409051	0.0056808	0.99824082	0.99415641	0.99415641	0.99188454
CdB1-ISO13	0.00117692	0.00409051	0.00409051	0.0056808	0.99831868	0.99415641	0.99415641	0.99188454
CdB1-ISO14	-	-	-	-	-	-	-	-
CdB1-ISO15	0.00117692	0.00409051	0.00409051	0.0056808	0.99831868	0.99415641	0.99415641	0.99188454
CdB1-ISO16	-	-	-	-	-	-	-	-
CdB1-ISO17-1	0.00076968	0.00409051	0.00409051	0.0056808	0.99890046	0.99415641	0.99415641	0.99188454
CdB1-ISO17-2	0.00076968	0.00409051	0.00409051	0.0056808	0.99890046	0.99415641	0.99415641	0.99188454
CdB1-ISO18	0.00117692	0.00352891	0.00352891	0.0051639	0.99831868	0.9949587	0.9949587	0.992623
CdB1-ISO19	0	0.00136638	0.00518863	0.028776	1	0.99804803	0.99258766	0.95889137
CdB1-ISO20	0	0.00136638	0.00518863	0.028776	1	0.99804803	0.99258766	0.95889137

THE CODES IN THE DIAGRAM ARE DESCRIBED IN DEVICE LIST No: DBAD094109
LE DÉTAIL DES CODIFICATIONS DE CE PLAN EST DONNÉ DANS LA NOMENCLATURE No: DBAD094109

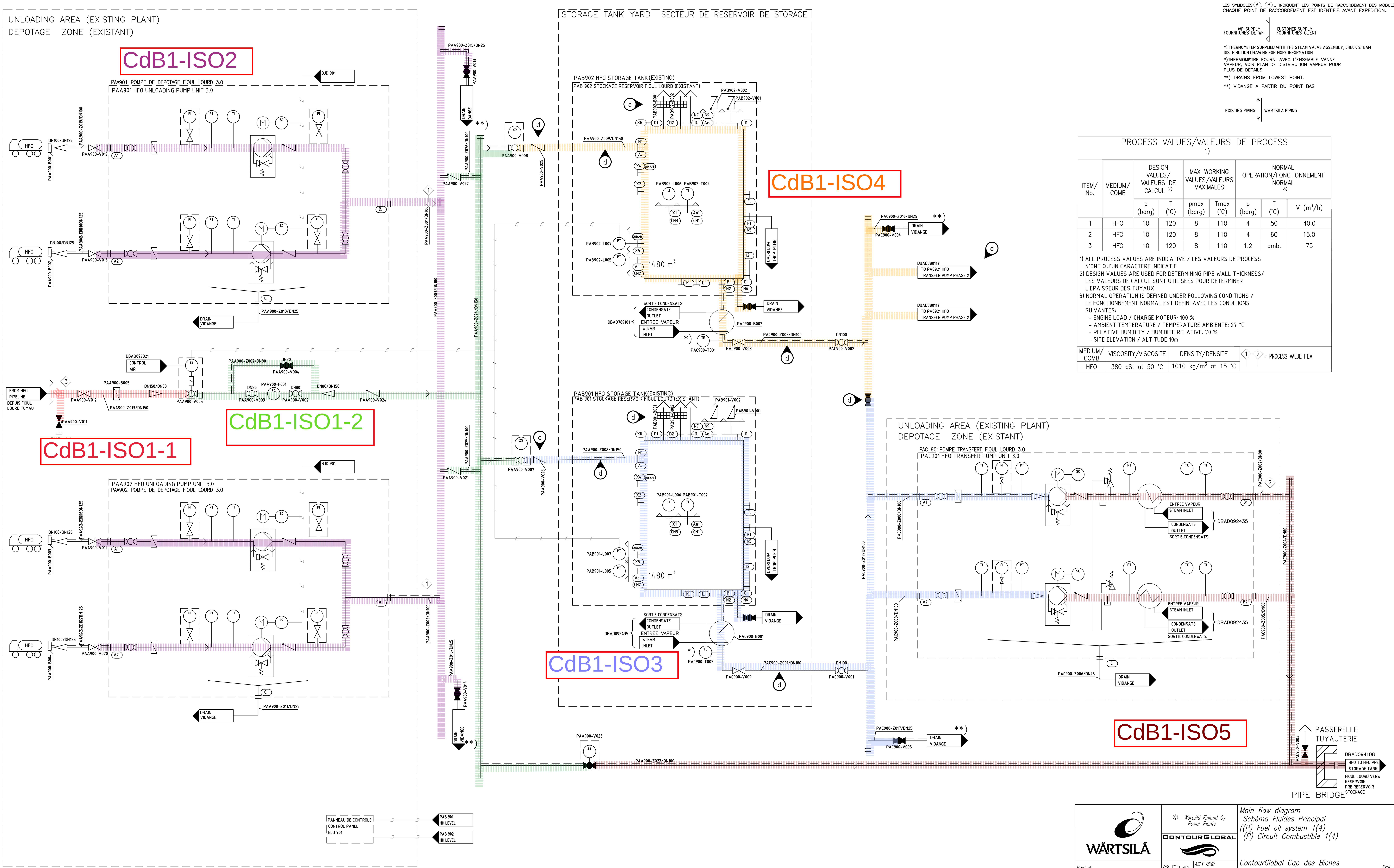
THE SYMBOLS USED IN DIAGRAM ARE DESCRIBED IN DOCUMENT No: DBAB669467
LES SYMBOLES UTILISES DANS LE SCHEMA SONT DECRITS DANS LE DOCUMENT N° :DBAB669467

USE OF (A), (B)... INDICATE CODING OF TERMINATION POINTS ON UNITS.
EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.
LES SYMBOLES (A), (B)... INDIQUENT LES POINTS DE RACCORDEMENT DES MODULES. CHAQUE POINT DE RACCORDEMENT EST IDENTIFIE AVANT EXPEDITION.

WFI SUPPLY / FOURNITURES DE WFI | CUSTOMER SUPPLY / FOURNITURES CLIENT

*) THERMOMETER SUPPLIED WITH THE STEAM VALVE ASSEMBLY, CHECK STEAM DISTRIBUTION DRAWING FOR MORE INFORMATION
*) THERMOMÈTRE FOURNI AVEC L'ENSEMBLE VANNE VAPEUR, VOIR PLAN DE DISTRIBUTION VAPEUR POUR PLUS DE DÉTAILS
**) DRAINS FROM LOWEST POINT.
**) VIDANGE A PARTIR DU POINT BAS

EXISTING PIPING | WARTSILA PIPING



PROCESS VALUES/VALEURS DE PROCESS 1)

ITEM/ No.	MEDIUM/ COMB	DESIGN VALUES/ VALEURS DE CALCUL 2)		MAX WORKING VALUES/VALEURS MAXIMALES		NORMAL OPERATION/FONCTIONNEMENT NORMAL 3)		
		p (barg)	T (°C)	pmax (barg)	Tmax (°C)	p (barg)	T (°C)	V (m^3/h)
1	HFO	10	120	8	110	4	50	40.0
2	HFO	10	120	8	110	4	60	15.0
3	HFO	10	120	8	110	1.2	amb.	75

1) ALL PROCESS VALUES ARE INDICATIVE / LES VALEURS DE PROCESS N'ONT QU'UN CARACTERE INDICATIF
2) DESIGN VALUES ARE USED FOR DETERMINING PIPE WALL THICKNESS/ LES VALEURS DE CALCUL SONT UTILISEES POUR DETERMINER L'EPAISSEUR DES TUYAUX
3) NORMAL OPERATION IS DEFINED UNDER FOLLOWING CONDITIONS / LE FONCTIONNEMENT NORMAL EST DEFINI AVEC LES CONDITIONS SUIVANTES:
- ENGINE LOAD / CHARGE MOTEUR: 100 %
- AMBIENT TEMPERATURE / TEMPERATURE AMBIENTE: 27 °C
- RELATIVE HUMIDITY / HUMIDITE RELATIVE: 70 %
- SITE ELEVATION / ALTITUDE 10m

MEDIUM/ COMB	VISCOSITY/VISCOSITE	DENSITY/DENSITE
HFO	380 cSt at 50 °C	1010 kg/m^3 at 15 °C

(1) (2) = PROCESS VALUE ITEM

REV.	DATE	MADE	APPVD.	MEMO NO.	EXPLANATION
d	10-Feb-2016	kyax01	fmi001		Revised as marked
c	22-Jun-2015	kyax01	fmi001		Revised as marked
b	11-Mar-2015	sgux14	fmi001		Revised as marked

WÄRTSILÄ

CONTOURGLOBAL

Main flow diagram
Schéma Fluides Principal
((P) Fuel oil system 1(4)
(P) Circuit Combustible 1(4)

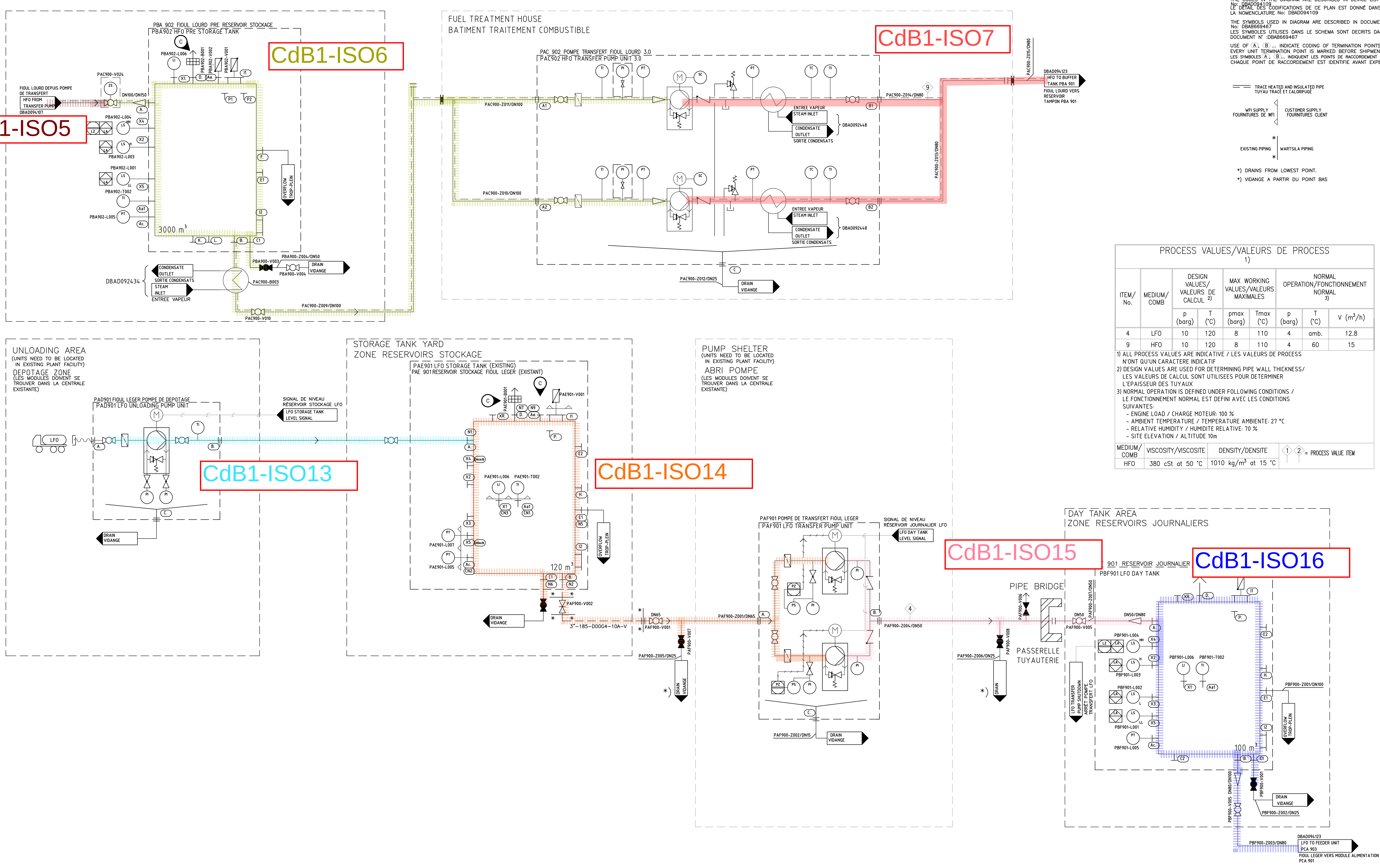
ContourGlobal Cap des Biches
3 x W18V46
Proj. no. P/14027

Product:
ACA
ASLY DRG:

MADE	23-Jun-2014	Poonam Sukhadev
CHKD	26-Sep-2014	aolx01
APPD	03-Oct-2014	Frédéric Michel

Units:
Page No. 1
Based on Document:
Customer Document:
Scale: 1:1
Size: A1
Doc. ID: DBAD094107 d Rev.

Confidential



THE CODES IN THE DIAGRAM ARE DESCRIBED IN DEVICE LIST No: DBAD094109
LE DÉTAIL DES CODIFICATIONS DE CE PLAN EST DONNÉ DANS LA NOMENCLATURE No: DBAD094109

THE SYMBOLS USED IN DIAGRAM ARE DESCRIBED IN DOCUMENT No: DBAB669467
LES SYMBOLES UTILISES DANS LE SCHEMA SONT DECRITS DANS LE DOCUMENT N° :DBAB669467

USE OF (A), (B) ... INDICATE CODING OF TERMINATION POINTS ON UNITS. EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.
LES SYMBOLES (A), (B)... INDIQUENT LES POINTS DE RACCORDEMENT DES MODULES. CHAQUE POINT DE RACCORDEMENT EST IDENTIFIE AVANT EXPEDITION.

TRACE HEATED AND INSULATED PIPE
TUYAU TRACÉ ET CALORIFUGÉ

WFI SUPPLY
FOURNITURES DE WFI
CUSTOMER SUPPLY
FOURNITURES CLIENT

EXISTING PIPING
WARTSILA PIPING

*) DRAINS FROM LOWEST POINT.
*) VIDANGE A PARTIR DU POINT BAS

PROCESS VALUES/VALEURS DE PROCESS 1)

ITEM/ No.	MEDIUM/ COMB	DESIGN VALUES/ VALEURS DE CALCUL 2)		MAX WORKING VALUES/VALEURS MAXIMALES		NORMAL OPERATION/FONCTIONNEMENT NORMAL 3)		
		p (barg)	T (°C)	pmax (barg)	Tmax (°C)	p (barg)	T (°C)	V (m^3/h)
4	LFO	10	120	8	110	4	amb.	12.8
9	HFO	10	120	8	110	4	60	15

1) ALL PROCESS VALUES ARE INDICATIVE / LES VALEURS DE PROCESS N'ONT QU'UN CARACTERE INDICATIF
2) DESIGN VALUES ARE USED FOR DETERMINING PIPE WALL THICKNESS/ LES VALEURS DE CALCUL SONT UTILISEES POUR DETERMINER L'EPAISSEUR DES TUYAUX
3) NORMAL OPERATION IS DEFINED UNDER FOLLOWING CONDITIONS / LE FONCTIONNEMENT NORMAL EST DEFINI AVEC LES CONDITIONS SUIVANTES:
- ENGINE LOAD / CHARGE MOTEUR: 100 %
- AMBIENT TEMPERATURE / TEMPERATURE AMBIENTE: 27 °C
- RELATIVE HUMIDITY / HUMIDITE RELATIVE: 70 %
- SITE ELEVATION / ALTITUDE 10m

MEDIUM/ COMB	VISCOSITY/VISCOSITE	DENSITY/DENSITE
HFO	380 cSt at 50 °C	1010 kg/m^3 at 15 °C

(1) (2) = PROCESS VALUE ITEM

REV.	DATE	MADE	APPVD.	MEMO NO.	EXPLANATION
c	10–Feb–2016	kyax01	fmi001		As marked.
b	11–Mar–2015	sgux14	fmi001		As marked.
a	05–Feb–2015	sgux14	fmi001		As marked.

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CONTOURGLOBAL

Main flow diagram
Schéma Fluides Principal
(P) Fuel oil system 2(4)
(P) Circuit Combustible 2(4)

ContourGlobal Cap des Biches
3 x W18V46

Proj. no. P/14027

Product: ACA ASLY DRG:

MADE	23–Jun–2014	Poonam Sukhadev	Units:
CHKD	25–Sep–2014	aolx01	Page No. 1
APPD	03–Oct–2014	Frédéric Michel	

Based on Document: Customer Document:
Scale: 1:1 Size: A1 Doc. ID: DBAD094108 Rev. C

THE CODES IN THE DIAGRAM ARE DESCRIBED IN DEVICE LIST No: DBAD094109
LE DÉTAIL DES CODIFICATIONS DE CE PLAN EST DONNÉ DANS LA NOMENCLATURE No: DBAD094109

THE SYMBOLS USED IN DIAGRAM ARE DESCRIBED IN DOCUMENT No: DBAB669467
LES SYMBOLES UTILISES DANS LE SCHEMA SONT DECRITS DANS LE DOCUMENT N° :DBAB669467

USE OF (A), (B) ... INDICATE CODING OF TERMINATION POINTS ON UNITS. EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.
LES SYMBOLES (A), (B)... INDIQUENT LES POINTS DE RACCORDEMENT DES MODULES. CHAQUE POINT DE RACCORDEMENT EST IDENTIFIE AVANT EXPEDITION.

TRACE HEATED AND INSULATED PIPE
TUYAU TRACÉ ET CALORIFUGÉ

PROCESS VALUES/VALEURS DE PROCESS 1)

ITEM/ No.	MEDIUM/ COMB	DESIGN VALUES/ VALEURS DE CALCUL 2)		MAX WORKING VALUES/VALEURS MAXIMALES		NORMAL OPERATION/FONCTIONNEMENT NORMAL 3)		
		p (barg)	T (°C)	pmax (barg)	Tmax (°C)	p (barg)	T (°C)	V (m^3/h)
5	HFO	10	120	8	110	4	~98	13.3
6	HFO	10	120	8	110	5	~90	11
7	LFO	10	120	8	110	5	amb.	11

1) ALL PROCESS VALUES ARE INDICATIVE / LES VALEURS DE PROCESS N'ONT QU'UN CARACTERE INDICATIF
2) DESIGN VALUES ARE USED FOR DETERMINING PIPE WALL THICKNESS/ LES VALEURS DE CALCUL SONT UTILISEES POUR DETERMINER L'EPAISSEUR DES TUYAUX
3) NORMAL OPERATION IS DEFINED UNDER FOLLOWING CONDITIONS / LE FONCTIONNEMENT NORMAL EST DEFINI AVEC LES CONDITIONS SUIVANTES:
   - ENGINE LOAD / CHARGE MOTEUR: 100 %
   - AMBIENT TEMPERATURE / TEMPERATURE AMBIENTE: 27 °C
   - RELATIVE HUMIDITY / HUMIDITE RELATIVE: 70 %
   - SITE ELEVATION / ALTITUDE 10m

MEDIUM/ COMB	VISCOSITY/VISCOSITE	DENSITY/DENSITE
HFO	380 cSt at 50 °C	1010 kg/m^3 at 15 °C

◇1 ◇2 = PROCESS VALUE ITEM

REV.	DATE	MADE	APPVD.	MEMO NO.	EXPLANATION
b	11-Mar-2015	sgux14	fmi001		As marked.
a	05-Feb-2015	sgux14	fmi001		As marked.

WÄRTSILÄ

CONTOURGLOBAL

Main flow diagram
Schéma Fluides Principal
(P) Fuel oil system 3(4)
(P) Circuit Combustible 3(4)

ContourGlobal Cap des Biches
3 x W18V46

Product: | ACA | ASLY DRG:

Proj. no. P/14027

			Units:
MADE	23-Jun-2014	Poonam Sukhadev	
CHKD	26-Sep-2014	aolx01	Page No. 1
APPD	03-Oct-2014	Frédéric Michel	

Based on Document: | Customer Document:

Scale: 1:1 | Size: A1 | Doc. ID: DBAD094123 Rev. b

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THE CODES IN THE DIAGRAM ARE DESCRIBED IN DEVICE LIST No:-
LOCAL DEVICE OR GAUGE
LOCAL PANEL
CONTROL BOARD
USE OF (A), (B) ... INDICATE CODING OF TERMINATION POINTS ON UNITS. EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.
PRELIMINARY Drawing
Rev. -
DATE: 25-11-2024
MADE: SGU005
PIPE PENETRATING OUTER WALL
FC = FAIL CLOSE
FO = FAIL OPEN
OPTION B
2 X Manual shutoff
2 X ESD shut-off
2 x ESD venting
FUEL GAS INLET
Considered as Tie-in points
CONTROL PANEL CFA901
CONTROL AIR
ENGINE HALL
ZEB010-Z003/DN80
NHA011 EXHAUST GAS MODULE
ZEB010-B004
ZEB010-B005
SZA011 ENGINE
PRESSURE SET POINT
CHARGE AIR PRESSURE FROM PT601
ZAC010-B001
CONNECTION TO 051 ENGINE
ZAA900-Z001/DN200
ZEB010-Z001/DN25
ZEB010-Z002/015
ZAC011 COMPACT GAS RAMP(CGR)
FOR FLUSHING OF GAS SYSTEM (INERT GAS)
ZAA010-Z004/DN25
ZAA010-Z002/DN100
ZAA010-V001
ZAA010-Z003/DN100
ZAC010-Z001/DN100
CY901
JUNCTION BOX BLR 011
CdB1-ISO20
The engine hall isolation markup is common for both facilities
CONNECTIONS TO 011-031 ENGINES
CdB1-ISO19
© Wärtsilä Finland Oy Power Plants
WÄRTSILÄ
CONTOURGLOBAL
Main flow diagram
(Z) Fuel gas system
ContourGlobal Cap des Biches
5 x W18V50DF
Proj. no. S/22061
MADE 25-Nov-2024 Stefan Guldbrand
Scale: 1:1
Size: A1
DSCAxxxx
XX
Confidential
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10 APPENDIX D: FAILURE CASE DEFINITION TABLE & FAILURE CASE MARKUP FOR CdB2

Failure Case List for CdB2

ISO No.	Isolatable Section (From)	Isolatable Section (To)	Failure Case Description (Leak modelled at)	Failure Case ID	Pipe Size (inch)	PFD Stream no.	Pressure (barg)	Temp. (DegC)	Phase	Stream flow rate (m3/hr)	Density (kg/m3)	Stream flow rate (kg/s)	Release Height (m)
ISO1	From PAC921 HFO transfer pump outlet	To inlet valve PAC900-V201 of PBA921 HFO Storage Tank	**LOC at PAC921 HFO transfer pump**	**CdB2-ISO1**	3	1	4	60	Liquid	15	1010	4.21	1
ISO2	From PAC900-V201 of PBA921 HFO Storage Tank	At PBA921 HFO storage tank (2000 m^3) and further upto the inlet of PAC922 HFO transfer pump	**At PBA921 HFO storage tank (2000 m^3) (Full surface, bund fire, and catastrophic rupture)**	**CdB2-ISO2**	4	-	ATM	25.35	Liquid	-	1010	-	12.6
ISO3	From PAC922 HFO transfer pump outlet	To PBA921 HFO buffer tank inlet line	**At PAC922 HFO transfer pumps**	**CdB2-ISO3**	3	4	4	60	Liquid	15	1010	4.21	1
ISO4	PBA921 HFO buffer tank (35 m^3)	At PBA921 HFO buffer tank (35 m^3) and further upto the inlet of HFO transfer separator unit PBB921 pump inlet	**At PBA921 HFO buffer tank (35 m^3) (Full surface, bund fire, and catastrophic rupture)**	**CdB2-ISO4**	5	-	ATM	25.35	Liquid	-	1010	-	5.4
ISO5	From HFO transfer separator unit PBB921 pump outlets	To PBC921 HFO day tank inlet line	**LOC at HFO transfer separator unit PBB921 pump**	**CdB2-ISO5**	2.5	1	4	98	Liquid	9	1010	2.53	1
ISO6	From PBC921 HFO day tank (80 m^3)	At PBC921 HFO day tank (80 m^3) and further upto the inlet SDV of HFO feeder module PAC921 pump	**At PBC921 HFO day tank (80 m^3) (Full surface, bund fire, and catastrophic rupture)**	**CdB2-ISO6**	3	-	ATM	25.35	Liquid	-	1010	-	5.4
ISO7	From SDV of HFO feeder module PAC921 pump	To HFO feeder module PAC921 pump	**At SDV of HFO feeder module PAC921 pump**	**CdB2-ISO7**	3	-	Tank head (0.53)	90	Liquid	9	1010	2.53	1
ISO8	From HFO feeder module PAC921 pump	To HFO fuel booster inlet valve	**At HFO feeder module PAC921 pump**	**CdB2-ISO8**	3	2	4	90	Liquid	8.5	1010	2.38	1
ISO9	From PAD921 LFO Unloading unit valves	To inlet line of PAE901 LFO storage tank	**PAD921 LFO Unloading unit pumps**	**CdB2-ISO9**	4	2	4	25.35	liquid	24	900	6	1
ISO10	From PAE901 LFO storage tank	At PAE901 LFO storage tank and further upto the inlet of LFO transfer pump PAF921 pump	**At PAE901 LFO storage tank (120 m^3) (Full surface, bund fire, and catastrophic rupture)**	**CdB2-ISO10**	2.5	-	ATM	25.35	Liquid	-	900	-	6
ISO11	From LFO transfer pump PAF921 pump outlet	To inlet line of PBF921 LFO day tank	**LOC at LFO transfer pump PAF921 pump outlet**	**CdB2-ISO11**	2.5	3	4	25.35	Liquid	12.8	900	3.2	1
ISO12	From PBF921 LFO day tank (80m^3)	At PBF921 LFO day tank (80 m^3) and further upto the inlet SDV of LFO feeder module PAC921 pump	**At PBF921 LFO day tank (80m^3) (Full surface, bund fire, and catastrophic rupture)**	**CdB2-ISO12**	2.5	-	ATM	25.35	Liquid	-	900	-	5.4
ISO13	From the inlet SDV of LFO feeder module PAC921 pump	To LFO feeder module PAC921 pump	**SDV of LFO feeder module PAC921 pump**	**CdB2-ISO13**	2.5	-	Tank Head (0.47)	25.35	Liquid	12.8	900	3.2	1
ISO14	From LFO feeder module PAC921 pump	To LFO fuel booster inlet valve	**At LFO feeder module PAC921 pump**	**CdB2-ISO14**	1.5	3	4	25.35	Liquid	8.5	900	2.125	1
ISO15	From tie in ESD	To the inlet of engine room	**At inlet ESD of engine room**	**CdB2-ISO15**	5	-	6	25.35	Gas	-	0.71	-	1
ISO16	From engine inlet SDV	To engine hall	**Engine Hall Downstream SDV**	**CdB2-ISO16**	5	-	6	25.35	Gas	-	0.71	-	1

ISO No.	Phast Calculated Leak rate (kg/sec)				Considered discharge rate (kg/sec)				Isolation time in sec.				Dynamic Inventory				
	S	M	L	FBR	S1	M1	L1	FBR1	S2	M2	L2	FBR2	S3	M3	L3	FBR3	Static Inventory (Kg)
ISO1	0.37541	9.38525	37.541	87.1918	0.37541	4.21	4.21	6.31	900.00	600.00	300.00	300.00	337.869	2525	1262.5	1893.75	1324.06
ISO2	-	-	-	-	-	-	-	-	900.00	600.00	300.00	300.00	0	0	0	0	1717305.12
ISO3	0.37541	9.38525	37.541	87.1918	0.37541	4.21	4.21	6.31	600.00	420.00	300.00	300.00	225.246	1767.5	1262.5	1893.75	202.66
ISO4	-	-	-	-	-	-	-	-	600.00	420.00	300.00	300.00	0	0	0	0	30321.16
ISO5	0.366201	9.15504	36.6201	59.0646	0.366201	2.53	2.53	3.79	600.00	420.00	300.00	300.00	219.7206	1060.5	757.5	1136.25	132.29
ISO6	-	-	-	-	-	-	-	-	600.00	420.00	300.00	300.00	0	0	0	0	68857.89
ISO7	0.134	3.35	13.4	31.13	0.134	2.53	2.53	3.79	600.00	420.00	300.00	300.00	80.4	1060.5	757.5	1136.25	50.67
ISO8	0.368154	9.20384	36.8154	85.5065	0.368154	2.38	2.38	3.58	600.00	420.00	300.00	300.00	220.8924	1001.583333	715.4166667	1073.125	450.73
ISO9	0.350312	8.7578	35.0312	144.645	0.350312	6.00	6.00	9.00	1200.00	600.00	300.00	300.00	420.3744	3600	1800	2700	270.2169645
ISO10	-	-	-	-	-	-	-	-	600.00	420.00	300.00	300.00	0	0	0	0	105394.56
ISO11	0.350312	8.7578	35.0312	56.5018	0.350312	3.20	3.20	4.80	600.00	420.00	300.00	300.00	210.1872	1344	960	1440	848.65
ISO12	-	-	-	-	-	-	-	-	600.00	420.00	300.00	300.00	0	0	0	0	61346.29
ISO13	0.12	3	12	19.36	0.12	3.00	3.20	4.80	600.00	420.00	300.00	300.00	72	1260	960	1440	15.68
ISO14	0.350312	8.7578	0	20.3406	0.350312	2.13	0.00	3.19	600.00	420.00	300.00	300.00	210.1872	892.5	0	956.25	281.80
ISO15	0.0207972	0.51993	2.07972	13.4175	0.0207972	0.52	2.08	13.42	600.00	300.00	120.00	120.00	12.47832	155.979	249.5664	1610.1	0.40
ISO16	0.0207972	0.51993	2.07972	13.4175	0.0207972	0.52	2.08	13.42	120.00	120.00	120.00	120.00	2.495664	62.3916	249.5664	1610.1	0.25

ISO No.	Available inventory for release (kg)				Total Ignition Probability				Immediate Ignition Probability (30%)				Delayed Ignition Probability (70%)				Non Ignition Probability			
	S4	M4	L4	FBR4	S6	M6	L6	FBR6	S7	M7	L7	FBR7	S8	M8	L8	FBR8	S92	M93	L94	FBR95
ISO1	1661.932126	3849.063126	2586.563126	3217.813126	0.00168132	0.007377001	0.007377001	0.01024504	0.000504396	0.0022131	0.0022131	0.003073513	0.001176924	0.005163901	0.005163901	0.00717153	0.99831868	0.992622999	0.992622999	0.989754958
ISO2	1717305.12	1717305.12	1717305.12	1717305.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ISO3	427.9087233	1970.162723	1465.162723	2096.412723	0.00168132	0.007377001	0.007377001	0.01024504	0.000504396	0.0022131	0.0022131	0.003073513	0.001176924	0.005163901	0.005163901	0.00717153	0.99831868	0.992622999	0.992622999	0.989754958
ISO4	30321.16435	30321.16435	30321.16435	30321.16435	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ISO5	352.0143222	1192.793722	889.7937222	1268.543722	0.00168132	0.005041301	0.005041301	0.00662074	0.000504396	0.00151239	0.00151239	0.001986221	0.001176924	0.003528911	0.003528911	0.00463452	0.99831868	0.994958699	0.994958699	0.993379263
ISO6	68857.89339	68857.89339	68857.89339	68857.89339	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ISO7	131.0656808	1111.165681	808.1656808	1186.915681	0.001099541	0.005041301	0.005041301	0.00662074	0.000329862	0.00151239	0.00151239	0.001986221	0.000769678	0.003528911	0.003528911	0.00463452	0.998900459	0.994958699	0.994958699	0.993379263
ISO8	671.6199262	1452.31	1166.14	1523.852526	0.00168132	0.004207707	0.004207707	0.00662074	0.000504396	0.001262312	0.001262312	0.001986221	0.001176924	0.002945395	0.002945395	0.00463452	0.99831868	0.995792293	0.995792293	0.993379263
ISO9	690.5913645	3870.216964	2070.216964	2970.216964	0.00168132	0.010245042	0.010245042	0.013	0.000504396	0.003073513	0.003073513	0.0039	0.001176924	0.00717153	0.00717153	0.0091	0.99831868	0.989754958	0.989754958	0.987
ISO10	105394.5592	105394.5592	105394.5592	105394.5592	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ISO11	1058.837354	2192.650154	1808.650154	2288.650154	0.00168132	0.005843586	0.005843586	0.00811546	0.000504396	0.001753076	0.001753076	0.002434639	0.001176924	0.00409051	0.00409051	0.00568083	0.99831868	0.994156414	0.994156414	0.991884536
ISO12	61346.29088	61346.29088	61346.29088	61346.29088	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ISO13	87.67626263	1275.676263	975.6762626	1455.676263	0.001099541	0.005843586	0.005843586	0.00811546	0.000329862	0.001753076	0.001753076	0.002434639	0.000769678	0.00409051	0.00409051	0.00568083	0.998900459	0.994156414	0.994156414	0.991884536
ISO14	491.9836971	1174.296497	281.7964971	1238.046497	0.00168132	0.004207707	0	0.00584359	0.000504396	0.001262312	0	0.001753076	0.001176924	0.002945395	0	0.00409051	0.99831868	0.995792293	1	0.994156414
ISO15	12.87832	156.379	249.9664	1610.5	0.00000	0.001951966	0.007412335	0.04110863	0	0.00058559	0.002223701	0.012332588	0	0.001366376	0.005188635	0.02877604	1	0.998048034	0.992587665	0.958891375
ISO16	2.745664	62.6416	249.8164	1610.35	0.00000	0.001951966	0.007412335	0.04110863	0	0.00058559	0.002223701	0.012332588	0	0.001366376	0.005188635	0.02877604	1	0.998048034	0.992587665	0.958891375

a) Réservoirs HFO à équiper de deux vannes d'urgence si le volume > 500m3
b) Fourni avec ensemble vanne vapeur
c) Les connexions au réservoir de stockage LFO existant doivent être réévaluées pendant la phase de conception

a) HFO tanks to be equipped with two emergency valves if volume > 500m3
b) Supplied with steam valve assembly
c) Connections to existing LFO storage tank should be re-evaluated during operative design phase

THE CODES IN THE DIAGRAM ARE DESCRIBED IN DEVICE LIST No:DBAD780118
LE DÉTAIL DES CODIFICATIONS DE CE PLAN EST DONNÉ DANS LA NOMENCLATURE No:DBAD780118
THE SYMBOLS USED IN DIAGRAM ARE DESCRIBED IN DOCUMENT No: DBAB669467
LES SYMBOLES UTILISES DANS LE SCHEMA SONT DECRITS DANS LE DOCUMENT N° :
USE OF A, B ... INDICATE CODING OF TERMINATION POINTS ON UNITS.
LES SYMBOLES A, B ... INDIQUENT LES POINTS DE RACCORDEMENT DES MODULES.
EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.
CHAQUE POINT DE RACCORDEMENT EST IDENTIFIE AVANT EXPEDITION.

PROCESS VALUES/VALEURS DE PROCESS 1)

ITEM/ No.	MEDIUM/ COMB	DESIGN VALUES/ VALEURS DE CALCUL 2) p (barg)	DESIGN VALUES/ VALEURS DE CALCUL 2) T (°C)	NORMAL OPERATION/FONCTIONNEMENT NORMAL 3) p (barg)	T (°C)	V (m³/h)
1	HFO	14	135	4	60	15
2	LFO	14	110	4	amb.	24
3	LFO	14	110	4	amb.	12.8
4	HFO	14	135	4	60	15

1) ALL PROCESS VALUES ARE INDICATIVE / LES VALEURS DE PROCESS N'ONT QU'UN CARACTERE INDICATIF
2) DESIGN VALUES ARE USED FOR DETERMINING PIPE WALL THICKNESS/ LES VALEURS DE CALCUL SONT UTILISEES POUR DETERMINER L'EPAISSEUR DES TUYAUX
3) NORMAL OPERATION IS DEFINED UNDER FOLLOWING CONDITIONS / LE FONCTIONNEMENT NORMAL EST DEFINI AVEC LES CONDITIONS SUIVANTES:
- ENGINE LOAD / CHARGE MOTEUR: 100 %
- AMBIENT TEMPERATURE / TEMPERATURE AMBIENTE: 27 °C
- RELATIVE HUMIDITY / HUMIDITE RELATIVE: 70 %
- SITE ELEVATION / ALTITUDE 10m

MEDIUM/ COMB	VISCOSITY/VISCOSITE	DENSITY/DENSITE	1 2 = PROCESS VALUE ITEM
HFO	380 cSt at 50 °C	1010 kg/m³ at 15 °C	

REV.	DATE	MADE	APPVD.	MEMO NO.	EXPLANATION
a	23-Feb-2016	kfax01	fmi001		Revised as marked.translation added.

WÄRTSILÄ

CONTOURGLOBAL

Main flow diagram
Schéma Fluides Principal
(P) Fuel oil system 1(3)
(P) Circuit Combustible 1(3)

ContourGlobal Cap des Biches Extension
2 x W18V46

Proj. no. P/15034

Product: W18V46

MADE 17-Dec-2015 Ghanshyam Patil
CHKD 08-Jan-2016 Kim Fagerudd
APPD 23-Jan-2016 Frédéric Michel

Scale: 1:1 Size: A1 Doc. ID: DBAD780117 Rev. a

Confidential

b) Supplied with steam valve assembly
Fourni avec ensemble vanne vapeur

THE CODES IN THE DIAGRAM ARE DESCRIBED IN DEVICE LIST No:DBAD780118
LE DÉTAIL DES CODIFICATIONS DE CE PLAN EST DONNÉ DANS LA NOMENCLATURE No:DBAD780118

THE SYMBOLS USED IN DIAGRAM ARE DESCRIBED IN DOCUMENT No: DBAB669467
LES SYMBOLES UTILISES DANS LE SCHEMA SONT DECRITS DANS LE DOCUMENT N° :–
USE OF (A), (B) ... INDICATE CODING OF TERMINATION POINTS ON UNITS.
LES SYMBOLES (A), (B) ... INDIQUENT LES POINTS DE RACCORDEMENT DES MODULES.
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(a) PROCESS VALUES/VALEURS DE PROCESS 1)

ITEM/ No.	MEDIUM/ COMB	DESIGN VALUES/ VALEURS DE CALCUL 2)		NORMAL OPERATION/FONCTIONNEMENT NORMAL 3)		
		p (barg)	T (°C)	p (barg)	T (°C)	V (m^3/h)
1	HFO	14	135	4	~98	9
2	HFO	14	135	4	90	8.5
3	LFO	14	110	4	amb.	8.5

1) ALL PROCESS VALUES ARE INDICATIVE / LES VALEURS DE PROCESS N'ONT QU'UN CARACTERE INDICATIF
2) DESIGN VALUES ARE USED FOR DETERMINING PIPE WALL THICKNESS/ LES VALEURS DE CALCUL SONT UTILISEES POUR DETERMINER L'EPAISSEUR DES TUYAUX
3) NORMAL OPERATION IS DEFINED UNDER FOLLOWING CONDITIONS / LE FONCTIONNEMENT NORMAL EST DEFINI AVEC LES CONDITIONS SUIVANTES:
   - ENGINE LOAD / CHARGE MOTEUR: 100 %
   - AMBIENT TEMPERATURE / TEMPERATURE AMBIENTE: 27 °C
   - RELATIVE HUMIDITY / HUMIDITE RELATIVE: 70 %
   - SITE ELEVATION / ALTITUDE 10m

MEDIUM/ COMB	VISCOSITY/VISCOSITE	DENSITY/DENSITE
HFO	380 cSt at 50 °C	1010 kg/m^3 at 15 °C

(1) (2) = PROCESS VALUE ITEM

REV.	DATE	MADE	APPVD.	MEMO NO.	EXPLANATION
a	23–Feb–2016	ndex07	fmi001		Revised as marked,translation added.

WÄRTSILÄ

CONTOURGLOBAL

Main flow diagram
Schéma Fluides Principal
(P) Fuel oil system 2(3)
(P) Circuit Combustible 2(3)

ContourGlobal Cap des Biches Extension
2 x W18V46
Proj. no. P/15034

Product: W18V46
ACA
ASLY DRG:

MADE	17–Dec–2015	Ghanshyam Patil
CHKD	07–Jan–2016	Kim Fagerudd
APPD	23–Jan–2016	Frédéric Michel

Units:
Page No.
Based on Document:
Customer Document:
Scale: 1:1
Size: A1
Doc. ID: DBAD780119 a Rev.

Confidential

THE CODES IN THE DIAGRAM ARE DESCRIBED IN DEVICE LIST No:–

LOCAL DEVICE OR GAUGE — LOCAL PANEL — CONTROL BOARD

USE OF (A), (B) ... INDICATE CODING OF TERMINATION POINTS ON UNITS. EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.

PIPE PENETRATING OUTER WALL

FC = FAIL CLOSE

FO = FAIL OPEN

WÄRTSILÄ

© Wärtsilä Finland Oy Power Plants

CONTOURGLOBAL

Main flow diagram

(Z) Fuel gas system

ContourGlobal Cap des Biches

5 x W18V50DF

Proj. no. S/22061

MADE	25–Nov–2024	Stefan Guldbrand	Based on Document: / Customer Document:
CHKD			Scale: 1:1 / Size: A1 / Doc. ID: DSCAxxxx / Rev. XX
APPD			

Confidential

About DNV

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Whether assessing a new ship design, optimizing the performance of a wind farm, analyzing sensor data from a gas pipeline or certifying a food company's supply chain, DNV enables its customers and their stakeholders to make critical decisions with confidence.

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APPENDIX 2 - FAILURE CASE DEFINITION TABLE

Failure Case List for CdB1

ISO No.	Isolatable Section (From)	Isolatable Section (To)	Failure Case Description (Leak modelled at)	Failure Case ID	Pipe Size (inch)	PFD Stream no.	Pressure (barg)	Temp. (DegC)	Phase	Stream flow rate (m3/hr)	Density (kg/m3)	Stream flow rate (kg/s)	Release Height (m)
ISO1	From battery limit	To PAA900-V-005	LOC at (B/L) PAA900-V-005	**CdB1-ISO1-1**	**6**	3	1.2	25.35	Liquid	75	1010	21.04	1
ISO1	From (B/L) PAA900-V-005	To inlet of PAB902 and PAB901 upto the inlet PAA900-V-007/008	LOC at (B/L) PAA900-V-008	**CdB1-ISO1-2**	**6**	3	1.2	25.35	Liquid	75	1010	21.04	1
ISO2	From HFO unloading tanker manifold (B/L) PAA900-V-017/018/019/020	To inlet of PAB902 and PAB901 upto the inlet NRV PAA900-V-021/022	LOC at PAA901 HFO Unloading Pump Unit	**CdB1-ISO2**	**4**	1	4	50	Liquid	40	1010	11.22	1
ISO3	From PAA900-V-007 at the inlet of PAB901	At PAB901 HFO storage tank existing (1480m³) and further upto the inlet of PAC901 HFO transfer pump	At PAB901 HFO storage tank existing (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO3**	**6**	-	ATM	25.35	Liquid	-	1010	-	11.33
ISO4	From PAA900-V-008 at the inlet of PAB902	At PAB902 HFO storage tank existing (1480m³) further upto the inlet of HFO transfer pump phase 2	At PAB902 HFO storage tank existing (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO4**	**6**	-	ATM	25.35	Liquid	-	1010	-	11.33
ISO5	From PAC901 HFO transfer pump	At PBA902 HFO Pre-storage tank inlet valve PAC900-V024	LOC at PAC901 HFO transfer pump	**CdB1-ISO5**	**4**	2	4	60	Liquid	15	1010	4.21	1
ISO6	From HFO Pre-storage tank inlet valve PAC900-V024	At PBA902 HFO pre-storage tank (3000m³) further upto the inlet of HFO transfer pump PAC902 pump unit	At PBA902 HFO pre-storage tank (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO6**	**4**	-	ATM	25.35	Liquid	-	1010	-	12.6
ISO7	From HFO transfer pump PAC902 pump	To HFO buffer tank inlet valve PAC900-V007	LOC at HFO transfer pump PAC902 pump	**CdB1-ISO7**	**4**	9	4	60	Liquid	15	1010	4.21	1
ISO8	PBA901 HFO buffer tank (50m3)	At PBA901 HFO buffer tank (50m³) further upto the inlet of HFO separator unit PBB901 transfer pump	At PBA901 HFO buffer tank (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO8**	**6**	-	ATM	25.35	Liquid	-	1010	-	3.6
ISO9	From HFO separator unit PBB901 transfer pump outlet	To inlet line of PBC901 HFO day Tank	HFO separator unit PBB901 transfer pump	**CdB1-ISO9**	**5**	5	4	98	liquid	13.3	1010	3.73	1
ISO10	PBC901 HFO day tank (100m3)	PBC901 HFO day tank (100m3) further upto the inlet of HFO feeder unit PCA901 & PCA902 inlet SDVs	At PBC901 HFO day tank (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO10**	**4**	-	ATM	25.35	Liquid	-	1010	-	7.2
ISO11	From inlet SDV of HFO feeder pump unit PCA901	To HFO feeder pump unit PCA901	SDV of HFO feeder pump unit PCA901	**CdB1-ISO11-1**	**4**	-	Tank Head(0.71)	90	Liquid	13.3	1010	3.73	1
ISO11	From inlet SDV of HFO feeder pump unit PCA902	To HFO feeder pump unit PCA902	SDV of HFO feeder pump unit PCA902	**CdB1-ISO11-2**	**4**	-	Tank Head(0.71)	90	Liquid	13.3	1010	3.73	1
ISO12	HFO feeder pump unit PCA901/902 pump outlet	HFO to engine fuel booster inlet valve	HFO feeder pump unit PCA901/902 pump outlet	**CdB1-ISO12**	**3**	6	5	90	Liquid	11	1010	3.09	1
ISO13	From LFO unloading valve PAD901 Unloading Pump Unit	To inlet line of PAE901 LFO Storage Tank	LFO unloading PAD901 Unloading Pump	**CdB1-ISO13**	4	4	4	25.35	Liquid	12.8	900	3.2	1
ISO14	From PAE901 LFO storage tank(120m3)	PAE901 LFO storage tank further upto the inlet of LFO transfer unit PAF901 pump	At PAE901 LFO storage tank (120m3) (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO14**	**3**	-	ATM	25.35	Liquid	-	900	-	6
ISO15	From LFO transfer unit PAF901 pump outlet	To inlet line of PBF901 LFO day tank	LFO transfer unit PAF901 pump	**CdB1-ISO15**	**2**	4	4	25.35	Liquid	12.8	900	3.20	1
ISO16	PBF901 LFO day tank (100m3)	PBF901 LFO day tank (100m3) further upto the inlet SDV of LFO feeder unit PCA903 pump	PBF901 LFO day tank (100m3) (Full surface, bund fire, and catastrophic rupture)	**CdB1-ISO16**	**3**	-	ATM	25.35	Liquid	-	900	-	7.2
ISO17	From inlet SDVs of PCA903	To PCA903 LFO feeder unit pump 1	SDVs of PCA903	**CdB1-ISO17-1**	**3**	-	Tank Head(0.63)	25.35	Liquid	12.8	900	3.20	1
ISO17	From inlet SDVs of PCA903	To PCA903 LFO feeder unit pump 2	SDVs of PCA903	**CdB1-ISO17-2**	**3**	-	Tank Head(0.63)	25.35	Liquid	12.8	900	3.20	1
ISO18	From PCA903 LFO feeder unit pump outlet	To LFO engine fuel booster inlet valve	PCA903 LFO feeder unit pumps	**CdB1-ISO18**	**2.5**	7	5	25.35	Liquid	11	900	2.75	1
ISO19	From tie in ESD valve	To engine inlet boundary	Engine inlet SDV	**CdB1-ISO19**	**5**	-	6	25.35	Gas	-	0.71	-	1
ISO20	From engine inlet SDV	To engine hall	Engine Hall Downstream SDV	**CdB1-ISO20**	**5**	-	6	25.35	Gas	-	0.71	-	1

Failure Case ID	Phast Calculated Leak rate (kg/sec)				Considered discharge rate (kg/sec)				Isolation time in sec.				Dynamic Inventory				
	S	M	L	FBR	S1	M1	L1	FBR1	S2	M2	L2	FBR2	S3	M3	L3	FBR3	Static Inventory (Kg)
CdB1-ISO1-1	0.2102	5.255	21.02	195.282	0.2102	5.255	21.02	31.5625	1200	600	300	300	252.24	3153	6306	9468.75	411.97
CdB1-ISO1-2	0.2102	5.255	21.02	195.282	0.2102	5.255	21.02	31.5625	1200	600	300	300	252.24	3153	6306	9468.75	981.54
CdB1-ISO2	0.377826	9.44565	37.7826	156.005	0.377826	9.44565	11.22	16.8333333	1200	600	300	300	453.3912	5667.39	3366.66667	5050	507.78
CdB1-ISO3	-	-	-	-	0	0	0	0	1200	600	300	300	0	0	0	0	1270771.97
CdB1-ISO4	-	-	-	-	0	0	0	0	1200	600	300	300	0	0	0	0	1270736.93
CdB1-ISO5	0.37541	9.38525	37.541	155.008	0.37541	4.21	4.21	6.3125	1200	600	300	300	450.492	2525	1262.5	1893.75	954.20
CdB1-ISO6	-	-	-	-	0	0	0	0	900	600	300	300	0	0	0	0	2576022.98
CdB1-ISO7	0.37541	9.38525	37.541	155.008	0.37541	4.21	4.21	6.3125	600	420	300	300	225.246	1767.5	1262.5	1893.75	228.00
CdB1-ISO8	-	-	-	-	0	0	0	0	600	420	300	300	0	0	0	0	43837.55
CdB1-ISO9	0.366201	9.15504	36.6201	236.259	0.366201	3.73	3.73	5.59708333	600	420	300	300	219.7206	1567.18333	1119.41667	1679.125	15655.43
CdB1-ISO10	-	-	-	-	0	0	0	0	600	420	300	300	0	0	0	0	86210.29
CdB1-ISO11-1	0.1551	3.87	15.51	64.05	0.1551	3.73	3.73	5.59708333	600	420	300	300	93.06	1567.18333	1119.41667	1679.125	90.07
CdB1-ISO11-2	0.1551	3.87	15.51	64.05	0.1551	3.73	3.73	5.59708333	600	420	300	300	93.06	1567.18333	1119.41667	1679.125	90.07
CdB1-ISO12	0.411594	10.2898	41.1594	95.5958	0.411594	3.09	3.09	4.62916667	600	420	300	300	246.9564	1296.16667	925.833333	1388.75	386.33
CdB1-ISO13	0.350312	8.7578	35.0312	144.645	0.350312	3.2	3.2	4.8	600	420	300	300	210.1872	1344	960	1440	240.7873941
CdB1-ISO14	-	-	-	-	0	0	0	0	1200	600	300	300	0	0	0	0	91944.97
CdB1-ISO15	0.350312	8.7578	36.1611	36.1611	0.350312	3.20	3.2	4.8	600	420	300	300	210.1872	1344	960	1440	272.89
CdB1-ISO16	-	-	-	-	0	0	0	0	600	420	300	300	0	0	0	0	76635.94
CdB1-ISO17-1	0.139	3.47	13.9	32.29	0.139	3.20	3.20	4.8	600	420	300	300	83.4	1344	960	1440	22.57
CdB1-ISO17-2	0.139	3.47	13.9	32.29	0.139	3.20	3.20	4.8	600	420	300	300	83.4	1344	960	1440	22.57
CdB1-ISO18	0.391653	9.79132	39.1653	63.1697	0.391653	2.75	2.75	4.125	600	420	300	300	234.9918	1155	825	1237.5	243.30
CdB1-ISO19	0.0207972	0.51993	2.07972	13.4175	0.0207972	0.51993	2.07972	13.4175	600	300	120	120	12.47832	155.979	249.5664	1610.1	1.63
CdB1-ISO20	0.0207972	0.51993	2.07972	13.4175	0.0207972	0.51993	2.07972	13.4175	120	120	120	120	2.495664	62.3916	249.5664	1610.1	0.3

Failure Case ID	Available inventory for release (kg)				Total Ignition Probability				Immediate Ignition Probability (30%)				Delayed Ignition Probability (70%)				Non Ignition Probability			
	S4	M4	L4	FBR4	S6	M6	L6	FBR6	S7	M7	L7	FBR7	S8	M8	L8	FBR8	S92	M93	L94	FBR95
CdB1-ISO1-1	664.2082804	3564.96828	6717.96828	9880.71828	0.001390786	0.00883847	0.013	0.013	0.00041724	0.00265154	0.0039	0.0039	0.00097355	0.00618693	0.0091	0.0091	0.99860921	0.99116153	0.987	0.987
CdB1-ISO1-2	1233.780605	4134.540605	7287.540605	10450.29061	0.001390786	0.00883847	0.013	0.013	0.00041724	0.00265154	0.0039	0.0039	0.00097355	0.00618693	0.0091	0.0091	0.99860921	0.99116153	0.987	0.987
CdB1-ISO2	961.1739124	6175.172712	3874.449379	5557.782712	0.00168132	0.013	0.013	0.013	0.0005044	0.0039	0.0039	0.0039	0.00117692	0.0091	0.0091	0.0091	0.99831868	0.987	0.987	0.987
CdB1-ISO3	1270771.967	1270771.967	1270771.967	1270771.967	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CdB1-ISO4	1270736.929	1270736.929	1270736.929	1270736.929	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CdB1-ISO5	1404.695656	3479.203656	2216.703656	2847.953656	0.00168132	0.007377	0.007377	0.010245	0.0005044	0.0022131	0.0022131	0.00307351	0.00117692	0.0051639	0.0051639	0.0071715	0.99831868	0.992623	0.992623	0.98975496
CdB1-ISO6	2576022.982	2576022.982	2576022.982	2576022.982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CdB1-ISO7	453.2415638	1995.495564	1490.495564	2121.745564	0.00168132	0.007377	0.007377	0.010245	0.0005044	0.0022131	0.0022131	0.00307351	0.00117692	0.0051639	0.0051639	0.0071715	0.99831868	0.992623	0.992623	0.98975496
CdB1-ISO8	43837.54521	43837.55	43837.55	43837.54521	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CdB1-ISO9	15875.14595	17222.61	16774.84	17334.55035	0.00168132	0.00662074	0.00662074	0.0095478	0.0005044	0.00198622	0.00198622	0.00286435	0.00117692	0.00463452	0.00463452	0.0066835	0.99831868	0.99337926	0.99337926	0.99045216
CdB1-ISO10	86210.28929	86210.28929	86210.28929	86210.28929	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CdB1-ISO11-1	183.1323215	1657.255655	1209.488988	1769.197321	0.001261555	0.00662074	0.00662074	0.0095478	0.00037847	0.00198622	0.00198622	0.00286435	0.00088309	0.00463452	0.00463452	0.0066835	0.99873845	0.99337926	0.99337926	0.99045216
CdB1-ISO11-2	183.1323215	1657.255655	1209.488988	1769.197321	0.001261555	0.00662074	0.00662074	0.0095478	0.00037847	0.00198622	0.00198622	0.00286435	0.00088309	0.00463452	0.00463452	0.0066835	0.99873845	0.99337926	0.99337926	0.99045216
CdB1-ISO12	633.2822164	1682.492483	1312.15915	1775.075816	0.001759177	0.00584359	0.00584359	0.0081155	0.00052775	0.00175308	0.00175308	0.00243464	0.00123142	0.00409051	0.00409051	0.0056808	0.99824082	0.99415641	0.99415641	0.99188454
CdB1-ISO13	450.9745941	1584.787394	1200.787394	1680.787394	0.00168132	0.00584359	0.00584359	0.0081155	0.0005044	0.00175308	0.00175308	0.00243464	0.00117692	0.00409051	0.00409051	0.0056808	0.99831868	0.99415641	0.99415641	0.99188454
CdB1-ISO14	91944.97408	91944.97408	91944.97408	91944.97408	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CdB1-ISO15	483.0795799	1616.89238	1232.89238	1712.89238	0.00168132	0.00584359	0.00584359	0.0081155	0.0005044	0.00175308	0.00175308	0.00243464	0.00117692	0.00409051	0.00409051	0.0056808	0.99831868	0.99415641	0.99415641	0.99188454
CdB1-ISO16	76635.94455	76635.94455	76635.94455	76635.94455	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CdB1-ISO17-1	105.9738182	1366.573818	982.5738182	1462.573818	0.001099541	0.00584359	0.00584359	0.0081155	0.00032986	0.00175308	0.00175308	0.00243464	0.00076968	0.00409051	0.00409051	0.0056808	0.99890046	0.99415641	0.99415641	0.99188454
CdB1-ISO17-2	105.9738182	1366.573818	982.5738182	1462.573818	0.001099541	0.00584359	0.00584359	0.0081155	0.00032986	0.00175308	0.00175308	0.00243464	0.00076968	0.00409051	0.00409051	0.0056808	0.99890046	0.99415641	0.99415641	0.99188454
CdB1-ISO18	478.2873961	1398.295596	1068.295596	1480.795596	0.00168132	0.0050413	0.0050413	0.007377	0.0005044	0.00151239	0.00151239	0.0022131	0.00117692	0.00352891	0.00352891	0.0051639	0.99831868	0.9949587	0.9949587	0.992623
CdB1-ISO19	14.10832	157.609	251.1964	1611.73	0	0.00195197	0.00741234	0.0411086	0	0.00058559	0.0022237	0.01233259	0	0.00136638	0.00518863	0.028776	1	0.99804803	0.99258766	0.95889137
CdB1-ISO20	2.495664	62.3916	249.5664	1610.1	0	0.00195197	0.00741234	0.0411086	0	0.00058559	0.0022237	0.01233259	0	0.00136638	0.00518863	0.028776	1	0.99804803	0.99258766	0.95889137

Failure Case List for CdB2

ISO No.	Isolatable Section (From)	Isolatable Section (To)	Failure Case Description (Leak modelled at)	Failure Case ID	Pipe Size (inch)	PFD Stream no.	Pressure (barg)	Temp. (DegC)	Phase	Stream flow rate (m3/hr)	Density (kg/m3)	Stream flow rate (kg/s)	Release Height (m)
ISO1	From PAC921 HFO transfer pump outlet	To inlet valve PAC900-V201 of PBA921 HFO Storage Tank	**LOC at PAC921 HFO transfer pump**	**CdB2-ISO1**	**3**	1	4	60	Liquid	15	1010	4.21	1
ISO2	From PAC900-V201 of PBA921 HFO Storage Tank	At PBA921 HFO storage tank (2000 m^3) and further upto the inlet of PAC922 HFO transfer pump	**At PBA921 HFO storage tank (2000 m^3) (Full surface, bund fire, and catastrophic rupture)**	**CdB2-ISO2**	**4**	-	ATM	25.35	Liquid	-	1010	-	12.6
ISO3	From PAC922 HFO transfer pump outlet	To PBA921 HFO buffer tank inlet line	**At PAC922 HFO transfer pumps**	**CdB2-ISO3**	**3**	4	4	60	Liquid	15	1010	4.21	1
ISO4	PBA921 HFO buffer tank (35 m^3)	At PBA921 HFO buffer tank (35 m^3) and further upto the inlet of HFO transfer separator unit PBB921 pump inlet	**At PBA921 HFO buffer tank (35 m^3) (Full surface, bund fire, and catastrophic rupture)**	**CdB2-ISO4**	**5**	-	ATM	25.35	Liquid	-	1010	-	5.4
ISO5	From HFO transfer separator unit PBB921 pump outlets	To PBC921 HFO day tank inlet line	**LOC at HFO transfer separator unit PBB921 pump**	**CdB2-ISO5**	**2.5**	1	4	98	Liquid	9	1010	2.53	1
ISO6	From PBC921 HFO day tank (80 m^3)	At PBC921 HFO day tank (80 m^3) and further upto the inlet SDV of HFO feeder module PAC921 pump	**At PBC921 HFO day tank (80 m^3) (Full surface, bund fire, and catastrophic rupture)**	**CdB2-ISO6**	**3**	-	ATM	25.35	Liquid	-	1010	-	5.4
ISO7	From SDV of HFO feeder module PAC921 pump	To HFO feeder module PAC921 pump	**At SDV of HFO feeder module PAC921 pump**	**CdB2-ISO7**	**3**	-	Tank head (0.53)	90	Liquid	9	1010	2.53	1
ISO8	From HFO feeder module PAC921 pump	To HFO fuel booster inlet valve	**At HFO feeder module PAC921 pump**	**CdB2-ISO8**	**3**	2	4	90	Liquid	8.5	1010	2.38	1
ISO9	From PAD921 LFO Unloading unit valves	To inlet line of PAE901 LFO storage tank	**PAD921 LFO Unloading unit pumps**	**CdB2-ISO9**	4	2	4	25.35	liquid	24	900	6	1
ISO10	From PAE901 LFO storage tank	At PAE901 LFO storage tank and further upto the inlet of LFO transfer pump PAF921 pump	**At PAE901 LFO storage tank (120 m^3) (Full surface, bund fire, and catastrophic rupture)**	**CdB2-ISO10**	**2.5**	-	ATM	25.35	Liquid	-	900	-	6
ISO11	From LFO transfer pump PAF921 pump outlet	To inlet line of PBF921 LFO day tank	**LOC at LFO transfer pump PAF921 pump outlet**	**CdB2-ISO11**	**2.5**	3	4	25.35	Liquid	12.8	900	3.2	1
ISO12	From PBF921 LFO day tank (80m^3)	At PBF921 LFO day tank (80 m^3) and further upto the inlet SDV of LFO feeder module PAC921 pump	**At PBF921 LFO day tank (80m^3) (Full surface, bund fire, and catastrophic rupture)**	**CdB2-ISO12**	**2.5**	-	ATM	25.35	Liquid	-	900	-	5.4
ISO13	From the inlet SDV of LFO feeder module PAC921 pump	To LFO feeder module PAC921 pump	**SDV of LFO feeder module PAC921 pump**	**CdB2-ISO13**	**2.5**	-	Tank Head (0.47)	25.35	Liquid	12.8	900	3.2	1
ISO14	From LFO feeder module PAC921 pump	To LFO fuel booster inlet valve	**At LFO feeder module PAC921 pump**	**CdB2-ISO14**	**1.5**	3	4	25.35	Liquid	8.5	900	2.125	1
ISO15	From tie in ESD	To the inlet of engine room	**At inlet ESD of engine room**	**CdB2-ISO15**	**5**	-	6	25.35	Gas	-	0.71	-	1
ISO16	From engine inlet SDV	To engine hall	**Engine Hall Downstream SDV**	**CdB2-ISO16**	**5**	-	6	25.35	Gas	-	0.71	-	1

ISO No.	Phast Calculated Leak rate (kg/sec) S	M	L	FBR	Considered discharge rate (kg/sec) S1	M1	L1	FBR1	Isolation time in sec. S2	M2	L2	FBR2	Dynamic Inventory S3	M3	L3	FBR3	Static Inventory (Kg)
ISO1	0.37541	9.38525	37.541	87.1918	0.37541	4.21	4.21	6.31	900.00	600.00	300.00	300.00	337.869	2525	1262.5	1893.75	1324.06
ISO2	-	-	-	-	-	-	-	-	900.00	600.00	300.00	300.00	0	0	0	0	1717305.12
ISO3	0.37541	9.38525	37.541	87.1918	0.37541	4.21	4.21	6.31	600.00	420.00	300.00	300.00	225.246	1767.5	1262.5	1893.75	202.66
ISO4	-	-	-	-	-	-	-	-	600.00	420.00	300.00	300.00	0	0	0	0	30321.16
ISO5	0.366201	9.15504	36.6201	59.0646	0.366201	2.53	2.53	3.79	600.00	420.00	300.00	300.00	219.7206	1060.5	757.5	1136.25	132.29
ISO6	-	-	-	-	-	-	-	-	600.00	420.00	300.00	300.00	0	0	0	0	68857.89
ISO7	0.134	3.35	13.4	31.13	0.134	2.53	2.53	3.79	600.00	420.00	300.00	300.00	80.4	1060.5	757.5	1136.25	50.67
ISO8	0.368154	9.20384	36.8154	85.5065	0.368154	2.38	2.38	3.58	600.00	420.00	300.00	300.00	220.8924	1001.583333	715.4166667	1073.125	450.73
ISO9	0.350312	8.7578	35.0312	144.645	0.350312	6.00	6.00	9.00	1200.00	600.00	300.00	300.00	420.3744	3600	1800	2700	270.2169645
ISO10	-	-	-	-	-	-	-	-	600.00	420.00	300.00	300.00	0	0	0	0	105394.56
ISO11	0.350312	8.7578	35.0312	56.5018	0.350312	3.20	3.20	4.80	600.00	420.00	300.00	300.00	210.1872	1344	960	1440	848.65
ISO12	-	-	-	-	-	-	-	-	600.00	420.00	300.00	300.00	0	0	0	0	61346.29
ISO13	0.12	3	12	19.36	0.12	3.00	3.20	4.80	600.00	420.00	300.00	300.00	72	1260	960	1440	15.68
ISO14	0.350312	8.7578	0	20.3406	0.350312	2.13	0.00	3.19	600.00	420.00	300.00	300.00	210.1872	892.5	0	956.25	281.80
ISO15	0.0207972	0.51993	2.07972	13.4175	0.0207972	0.52	2.08	13.42	600.00	300.00	120.00	120.00	12.47832	155.979	249.5664	1610.1	0.40
ISO16	0.0207972	0.51993	2.07972	13.4175	0.0207972	0.52	2.08	13.42	120.00	120.00	120.00	120.00	2.495664	62.3916	249.5664	1610.1	0.25

ISO No.	Available inventory for release (kg) S4	M4	L4	FBR4	Total Ignition Probability S6	M6	L6	FBR6	Immediate Ignition Probability (30%) S7	M7	L7	FBR7	Delayed Ignition Probability (70%) S8
ISO1	1661.932126	3849.063126	2586.563126	3217.813126	0.00168132	0.007377001	0.007377001	0.01024504	0.000504396	0.0022131	0.0022131	0.003073513	0.001176924
ISO2	1717305.12	1717305.12	1717305.12	1717305.12	-	-	-	-	-	-	-	-	-
ISO3	427.9087233	1970.162723	1465.162723	2096.412723	0.00168132	0.007377001	0.007377001	0.01024504	0.000504396	0.0022131	0.0022131	0.003073513	0.001176924
ISO4	30321.16435	30321.16435	30321.16435	30321.16435	-	-	-	-	-	-	-	-	-
ISO5	352.0143222	1192.793722	889.7937222	1268.543722	0.00168132	0.005041301	0.005041301	0.00662074	0.000504396	0.00151239	0.00151239	0.001986221	0.001176924
ISO6	68857.89339	68857.89339	68857.89339	68857.89339	-	-	-	-	-	-	-	-	-
ISO7	131.0656808	1111.165681	808.1656808	1186.915681	0.001099541	0.005041301	0.005041301	0.00662074	0.000329862	0.00151239	0.00151239	0.001986221	0.000769678
ISO8	671.6199262	1452.31	1166.14	1523.852526	0.00168132	0.004207707	0.004207707	0.00662074	0.000504396	0.001262312	0.001262312	0.001986221	0.001176924
ISO9	690.5913645	3870.216964	2070.216964	2970.216964	0.00168132	0.010245042	0.010245042	0.013	0.000504396	0.003073513	0.003073513	0.0039	0.001176924
ISO10	105394.5592	105394.5592	105394.5592	105394.5592	-	-	-	-	-	-	-	-	-
ISO11	1058.837354	2192.650154	1808.650154	2288.650154	0.00168132	0.005843586	0.005843586	0.00811546	0.000504396	0.001753076	0.001753076	0.002434639	0.001176924
ISO12	61346.29088	61346.29088	61346.29088	61346.29088	-	-	-	-	-	-	-	-	-
ISO13	87.67626263	1275.676263	975.6762626	1455.676263	0.001099541	0.005843586	0.005843586	0.00811546	0.000329862	0.001753076	0.001753076	0.002434639	0.000769678
ISO14	491.9836971	1174.296497	281.7964971	1238.046497	0.00168132	0.004207707	0	0.00584359	0.000504396	0.001262312	0	0.001753076	0.001176924
ISO15	12.87832	156.379	249.9664	1610.5	0.00000	0.001951966	0.007412335	0.04110863	0	0.00058559	0.002223701	0.012332588	0
ISO16	2.745664	62.6416	249.8164	1610.35	0.00000	0.001951966	0.007412335	0.04110863	0	0.00058559	0.002223701	0.012332588	0

ISO No.	Delayed Ignition Probability (70%) M8	L8	FBR8	Non Ignition Probability S9	M9	L9	FBR9
ISO1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ISO2	-	-	-	-	-	-	-
ISO3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ISO4	-	-	-	-	-	-	-
ISO5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ISO6	-	-	-	-	-	-	-
ISO7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ISO8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ISO9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ISO10	-	-	-	-	-	-	-
ISO11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ISO12	-	-	-	-	-	-	-
ISO13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ISO14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ISO15	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
ISO16	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]

APPENDIX 3- ISOLATABLE SECTION & FAILURE CASE MARKING

THE CODES IN THE DIAGRAM ARE DESCRIBED IN DEVICE LIST No: DBAD094109
LE DÉTAIL DES CODIFICATIONS DE CE PLAN EST DONNÉ DANS LA NOMENCLATURE No: DBAD094109

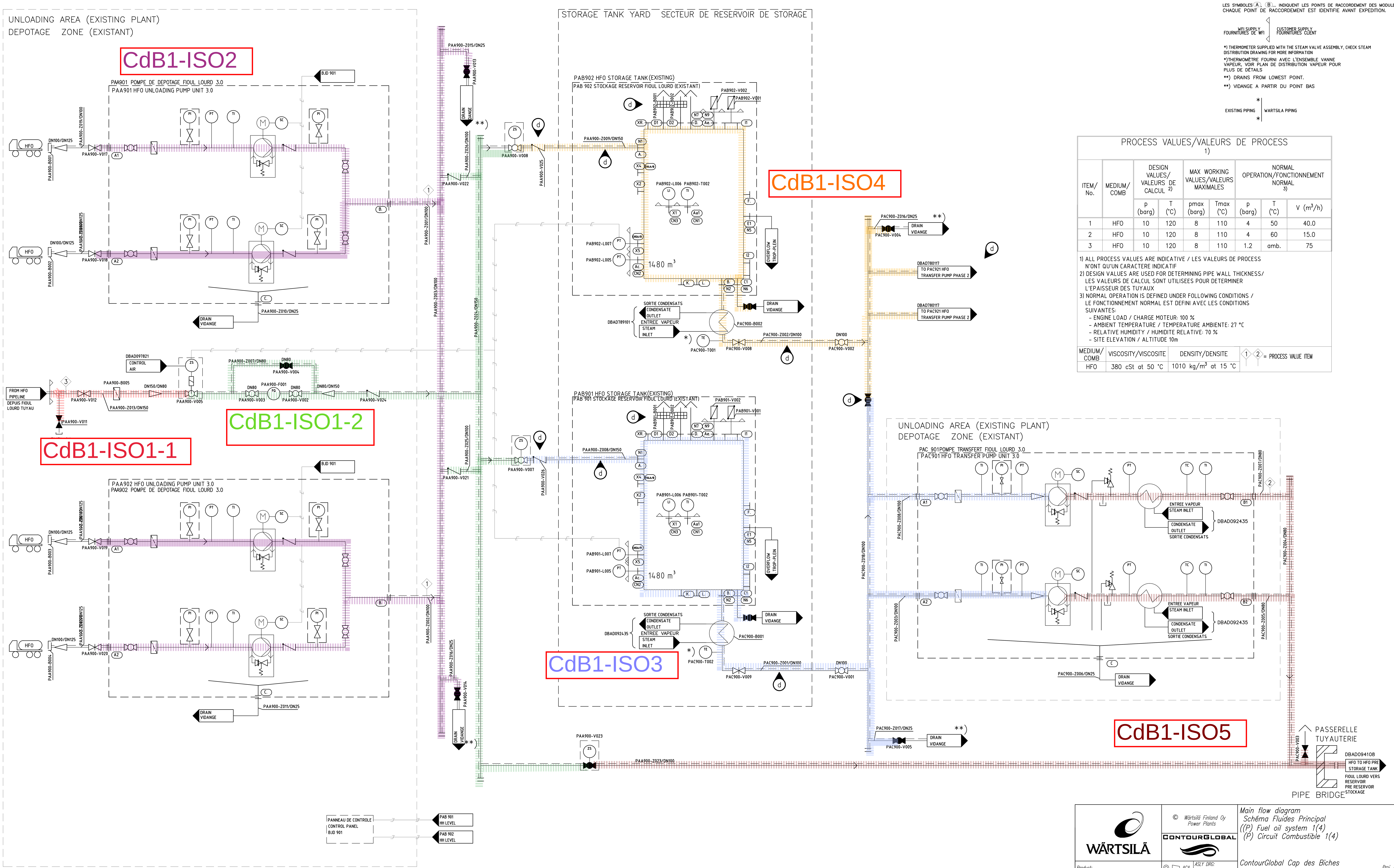
THE SYMBOLS USED IN DIAGRAM ARE DESCRIBED IN DOCUMENT No: DBAB669467
LES SYMBOLES UTILISES DANS LE SCHEMA SONT DECRITS DANS LE DOCUMENT N° :DBAB669467

USE OF (A), (B)... INDICATE CODING OF TERMINATION POINTS ON UNITS.
EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.
LES SYMBOLES (A), (B)... INDIQUENT LES POINTS DE RACCORDEMENT DES MODULES. CHAQUE POINT DE RACCORDEMENT EST IDENTIFIE AVANT EXPEDITION.

WFI SUPPLY / FOURNITURES DE WFI | CUSTOMER SUPPLY / FOURNITURES CLIENT

*) THERMOMETER SUPPLIED WITH THE STEAM VALVE ASSEMBLY, CHECK STEAM DISTRIBUTION DRAWING FOR MORE INFORMATION
*) THERMOMÈTRE FOURNI AVEC L'ENSEMBLE VANNE VAPEUR, VOIR PLAN DE DISTRIBUTION VAPEUR POUR PLUS DE DÉTAILS
**) DRAINS FROM LOWEST POINT.
**) VIDANGE A PARTIR DU POINT BAS

EXISTING PIPING | WARTSILA PIPING



PROCESS VALUES/VALEURS DE PROCESS 1)

ITEM/ No.	MEDIUM/ COMB	DESIGN VALUES/ VALEURS DE CALCUL 2)		MAX WORKING VALUES/VALEURS MAXIMALES		NORMAL OPERATION/FONCTIONNEMENT NORMAL 3)		
		p (barg)	T (°C)	pmax (barg)	Tmax (°C)	p (barg)	T (°C)	V (m^3/h)
1	HFO	10	120	8	110	4	50	40.0
2	HFO	10	120	8	110	4	60	15.0
3	HFO	10	120	8	110	1.2	amb.	75

1) ALL PROCESS VALUES ARE INDICATIVE / LES VALEURS DE PROCESS N'ONT QU'UN CARACTERE INDICATIF
2) DESIGN VALUES ARE USED FOR DETERMINING PIPE WALL THICKNESS/ LES VALEURS DE CALCUL SONT UTILISEES POUR DETERMINER L'EPAISSEUR DES TUYAUX
3) NORMAL OPERATION IS DEFINED UNDER FOLLOWING CONDITIONS / LE FONCTIONNEMENT NORMAL EST DEFINI AVEC LES CONDITIONS SUIVANTES:
- ENGINE LOAD / CHARGE MOTEUR: 100 %
- AMBIENT TEMPERATURE / TEMPERATURE AMBIENTE: 27 °C
- RELATIVE HUMIDITY / HUMIDITE RELATIVE: 70 %
- SITE ELEVATION / ALTITUDE 10m

MEDIUM/ COMB	VISCOSITY/VISCOSITE	DENSITY/DENSITE
HFO	380 cSt at 50 °C	1010 kg/m^3 at 15 °C

(1) (2) = PROCESS VALUE ITEM

REV.	DATE	MADE	APPVD.	MEMO NO.	EXPLANATION
d	10–Feb–2016	kyax01	fmi001		Revised as marked
c	22–Jun–2015	kyax01	fmi001		Revised as marked
b	11–Mar–2015	sgux14	fmi001		Revised as marked

WÄRTSILÄ

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CONTOURGLOBAL

Main flow diagram
Schéma Fluides Principal
((P) Fuel oil system 1(4)
(P) Circuit Combustible 1(4)

ContourGlobal Cap des Biches
3 x W18V46
Proj. no. P/14027

Product: | ACA | ASLY DRG:

MADE 23–Jun–2014 Poonam Sukhadev
CHKD 26–Sep–2014 aolx01
APPD 03–Oct–2014 Frédéric Michel

Units: | Page No. 1 | Based on Document: | Customer Document:
Scale: 1:1 | Size: A1 | Doc. ID: DBAD094107 | Rev. d

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LE DÉTAIL DES CODIFICATIONS DE CE PLAN EST DONNÉ DANS LA NOMENCLATURE No: DBAD094109

THE SYMBOLS USED IN DIAGRAM ARE DESCRIBED IN DOCUMENT No: DBAB669467
LES SYMBOLES UTILISES DANS LE SCHEMA SONT DECRITS DANS LE DOCUMENT N° :DBAB669467

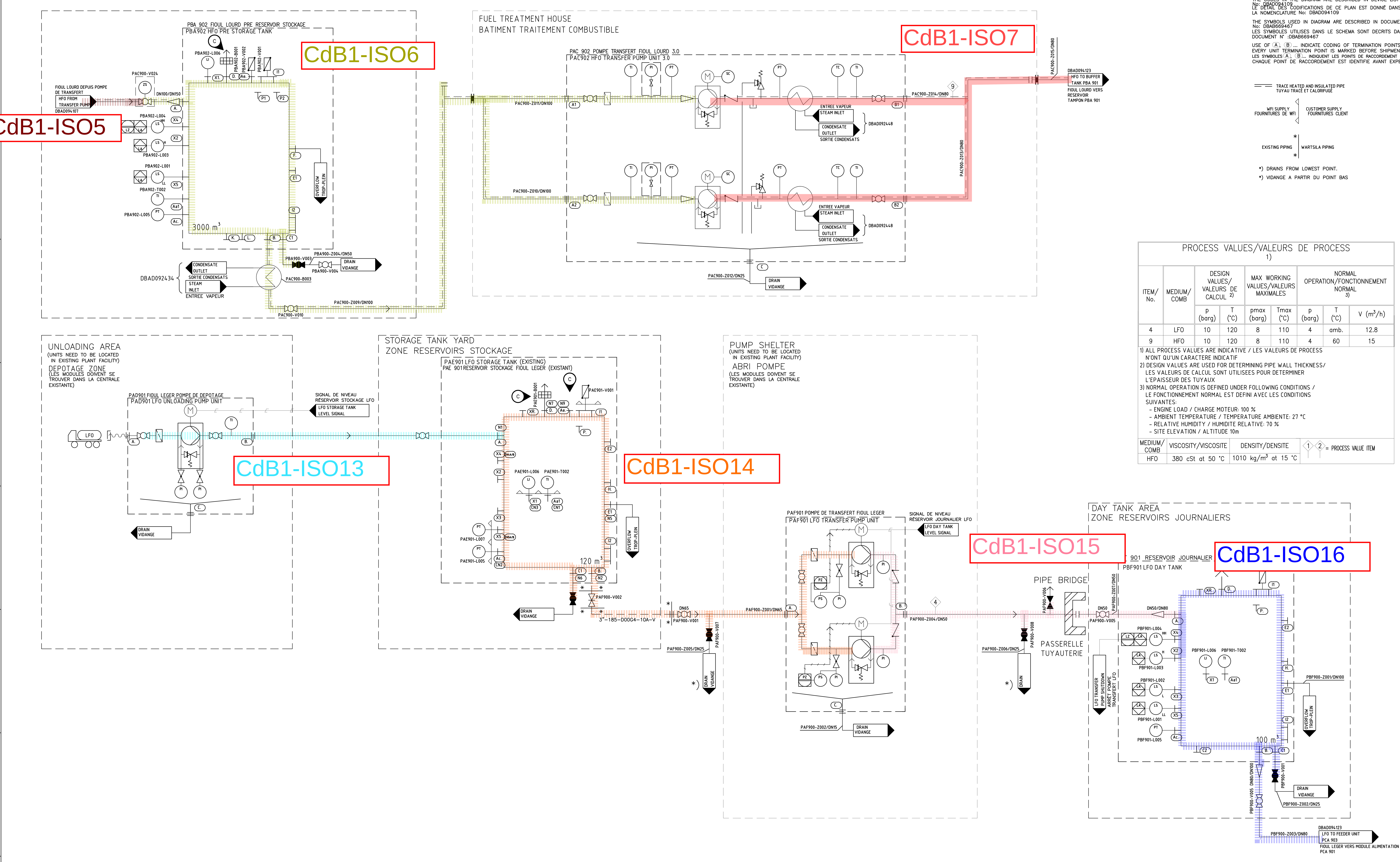
USE OF (A), (B) ... INDICATE CODING OF TERMINATION POINTS ON UNITS. EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.
LES SYMBOLES (A), (B)... INDIQUENT LES POINTS DE RACCORDEMENT DES MODULES. CHAQUE POINT DE RACCORDEMENT EST IDENTIFIE AVANT EXPEDITION.

TRACE HEATED AND INSULATED PIPE / TUYAU TRACÉ ET CALORIFUGÉ

WFI SUPPLY / FOURNITURES DE WFI — CUSTOMER SUPPLY / FOURNITURES CLIENT

EXISTING PIPING — WARTSILA PIPING

*) DRAINS FROM LOWEST POINT.
*) VIDANGE A PARTIR DU POINT BAS



ITEM/ No.	MEDIUM/ COMB	DESIGN VALUES/ VALEURS DE CALCUL 2)		MAX WORKING VALUES/VALEURS MAXIMALES		NORMAL OPERATION/FONCTIONNEMENT NORMAL 3)		
		p (barg)	T (°C)	pmax (barg)	Tmax (°C)	p (barg)	T (°C)	V (m^3/h)
4	LFO	10	120	8	110	4	amb.	12.8
9	HFO	10	120	8	110	4	60	15

PROCESS VALUES/VALEURS DE PROCESS 1)

1) ALL PROCESS VALUES ARE INDICATIVE / LES VALEURS DE PROCESS N'ONT QU'UN CARACTERE INDICATIF
2) DESIGN VALUES ARE USED FOR DETERMINING PIPE WALL THICKNESS/ LES VALEURS DE CALCUL SONT UTILISEES POUR DETERMINER L'EPAISSEUR DES TUYAUX
3) NORMAL OPERATION IS DEFINED UNDER FOLLOWING CONDITIONS / LE FONCTIONNEMENT NORMAL EST DEFINI AVEC LES CONDITIONS SUIVANTES:
- ENGINE LOAD / CHARGE MOTEUR: 100 %
- AMBIENT TEMPERATURE / TEMPERATURE AMBIENTE: 27 °C
- RELATIVE HUMIDITY / HUMIDITE RELATIVE: 70 %
- SITE ELEVATION / ALTITUDE 10m

MEDIUM/ COMB	VISCOSITY/VISCOSITE	DENSITY/DENSITE
HFO	380 cSt at 50 °C	1010 kg/m^3 at 15 °C

(1) (2) = PROCESS VALUE ITEM

REV.	DATE	MADE	APPVD.	MEMO NO.	EXPLANATION
c	10-Feb-2016	kyax01	fmi001		As marked.
b	11-Mar-2015	sgux14	fmi001		As marked.
a	05-Feb-2015	sgux14	fmi001		As marked.

WÄRTSILÄ — CONTOURGLOBAL

Main flow diagram
Schéma Fluides Principal
(P) Fuel oil system 2(4)
(P) Circuit Combustible 2(4)

ContourGlobal Cap des Biches
3 x W18V46
Proj. no. P/14027

Product: — ACA — ASLY DRG:

MADE	23-Jun-2014	Poonam Sukhadev
CHKD	25-Sep-2014	aolx01
APPD	03-Oct-2014	Frédéric Michel

Units: — Page No. 1 — Scale: 1:1 — Size: A1 — Doc. ID: DBAD094108 Rev. C

Based on Document: — Customer Document:

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LE DÉTAIL DES CODIFICATIONS DE CE PLAN EST DONNÉ DANS LA NOMENCLATURE No: DBAD094109

THE SYMBOLS USED IN DIAGRAM ARE DESCRIBED IN DOCUMENT No: DBAB669467
LES SYMBOLES UTILISES DANS LE SCHEMA SONT DECRITS DANS LE DOCUMENT N° :DBAB669467

USE OF (A), (B) ... INDICATE CODING OF TERMINATION POINTS ON UNITS. EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.
LES SYMBOLES (A), (B)... INDIQUENT LES POINTS DE RACCORDEMENT DES MODULES. CHAQUE POINT DE RACCORDEMENT EST IDENTIFIE AVANT EXPEDITION.

TRACE HEATED AND INSULATED PIPE
TUYAU TRACÉ ET CALORIFUGÉ

PROCESS VALUES/VALEURS DE PROCESS 1)								
ITEM/ No.	MEDIUM/ COMB	DESIGN VALUES/ VALEURS DE CALCUL 2)		MAX WORKING VALUES/VALEURS MAXIMALES		NORMAL OPERATION/FONCTIONNEMENT NORMAL 3)		
		p (barg)	T (°C)	pmax (barg)	Tmax (°C)	p (barg)	T (°C)	V (m^3/h)
5	HFO	10	120	8	110	4	~98	13.3
6	HFO	10	120	8	110	5	~90	11
7	LFO	10	120	8	110	5	amb.	11

1) ALL PROCESS VALUES ARE INDICATIVE / LES VALEURS DE PROCESS N'ONT QU'UN CARACTERE INDICATIF
2) DESIGN VALUES ARE USED FOR DETERMINING PIPE WALL THICKNESS/ LES VALEURS DE CALCUL SONT UTILISEES POUR DETERMINER L'EPAISSEUR DES TUYAUX
3) NORMAL OPERATION IS DEFINED UNDER FOLLOWING CONDITIONS / LE FONCTIONNEMENT NORMAL EST DEFINI AVEC LES CONDITIONS SUIVANTES:
   - ENGINE LOAD / CHARGE MOTEUR: 100 %
   - AMBIENT TEMPERATURE / TEMPERATURE AMBIENTE: 27 °C
   - RELATIVE HUMIDITY / HUMIDITE RELATIVE: 70 %
   - SITE ELEVATION / ALTITUDE 10m

MEDIUM/ COMB	VISCOSITY/VISCOSITE	DENSITY/DENSITE
HFO	380 cSt at 50 °C	1010 kg/m^3 at 15 °C

◇1 ◇2 = PROCESS VALUE ITEM

REV.	DATE	MADE	APPVD.	MEMO NO.	EXPLANATION
b	11–Mar–2015	sgux14	fmi001		As marked.
a	05–Feb–2015	sgux14	fmi001		As marked.

CONTOURGLOBAL

Main flow diagram
Schéma Fluides Principal
(P) Fuel oil system 3(4)
(P) Circuit Combustible 3(4)

ContourGlobal Cap des Biches
3 x W18V46
Proj. no. P/14027

Product:
ACA
ASLY DRG:
Based on Document:
Customer Document:

MADE	23–Jun–2014	Poonam Sukhadev
CHKD	26–Sep–2014	aolx01
APPD	03–Oct–2014	Frédéric Michel

Units:
Page No. 1
Scale: 1:1
Size: A1
Doc. ID: DBAD094123 b Rev.

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THE CODES IN THE DIAGRAM ARE DESCRIBED IN DEVICE LIST No:–

LOCAL DEVICE OR GAUGE · LOCAL PANEL · CONTROL BOARD

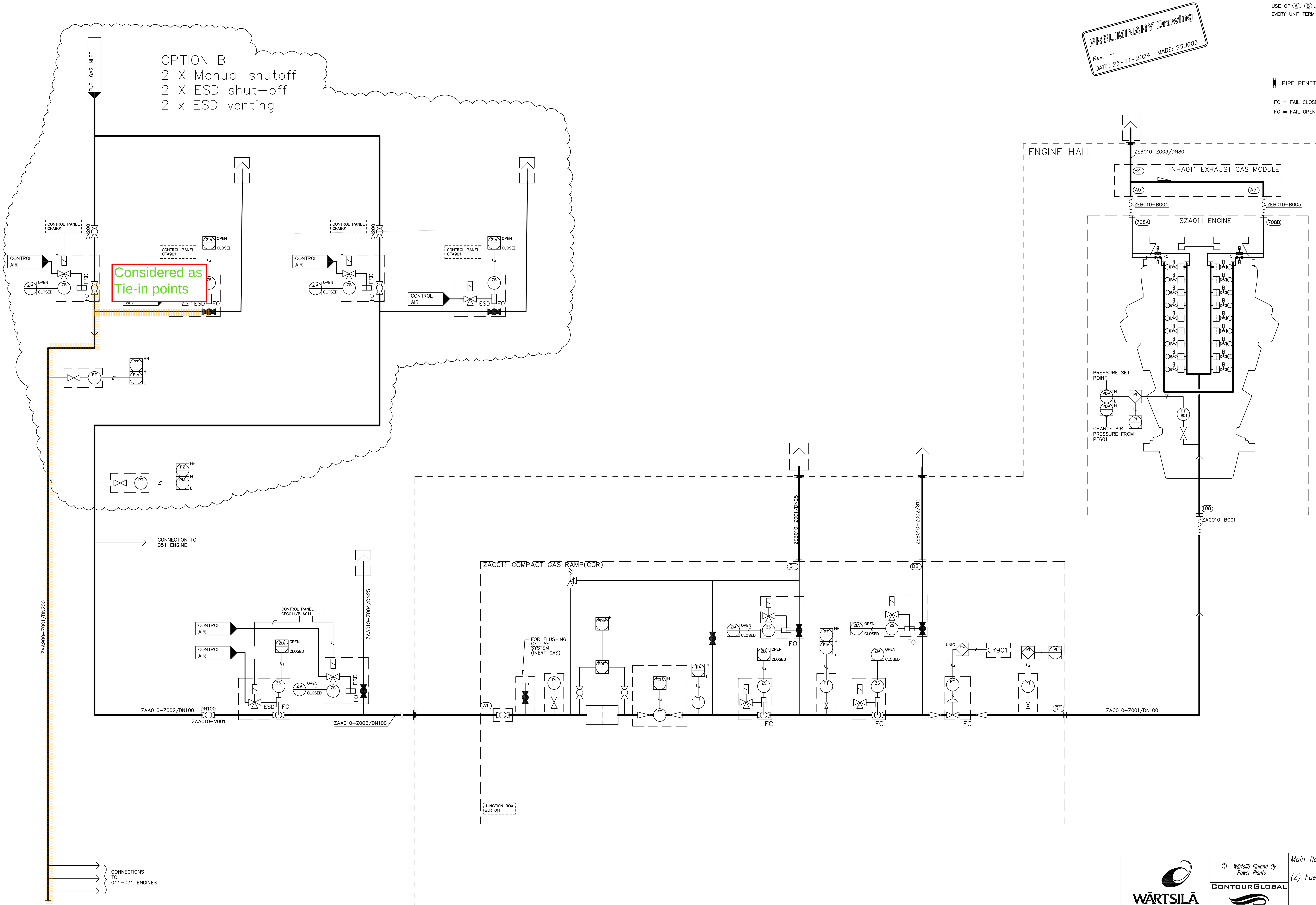
USE OF (A), (B) ... INDICATE CODING OF TERMINATION POINTS ON UNITS. EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.

PRELIMINARY Drawing
Rev. –
DATE: 25–11–2024 MADE: SGU005

PIPE PENETRATING OUTER WALL

FC = FAIL CLOSE

FO = FAIL OPEN



CdB1-ISO19

WÄRTSILÄ

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CONTOURGLOBAL

Main flow diagram

(Z) Fuel gas system

ContourGlobal Cap des Biches

5 x W18V50DF

Proj. no. S/22061

Product: | ACA | ASLY DRG:

MADE 25–Nov–2024 Stefan Guldbrand

CHKD

APPD

Units: | Based on Document: | Customer Document:

Page No. | Scale: 1:1 | Size: A1 | Doc. ID: DSCAxxxx | Rev. XX

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a) Réservoirs HFO à équiper de deux vannes d'urgence si le volume > 500m3
b) Fourni avec ensemble vanne vapeur
c) Les connexions au réservoir de stockage LFO existant doivent être réévaluées pendant la phase de conception

a) HFO tanks to be equipped with two emergency valves if volume > 500m3
b) Supplied with steam valve assembly
c) Connections to existing LFO storage tank should be re-evaluated during operative design phase

THE CODES IN THE DIAGRAM ARE DESCRIBED IN DEVICE LIST No:DBAD780118
LE DÉTAIL DES CODIFICATIONS DE CE PLAN EST DONNÉ DANS LA NOMENCLATURE No:DBAD780118

THE SYMBOLS USED IN DIAGRAM ARE DESCRIBED IN DOCUMENT No: DBAB669467
LES SYMBOLES UTILISES DANS LE SCHEMA SONT DECRITS DANS LE DOCUMENT N° :–
USE OF (A), (B) ... INDICATE CODING OF TERMINATION POINTS ON UNITS.
LES SYMBOLES (A), (B) ... INDIQUENT LES POINTS DE RACCORDEMENT DES MODULES.
EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.
CHAQUE POINT DE RACCORDEMENT EST IDENTIFIE AVANT EXPEDITION.

PROCESS VALUES/VALEURS DE PROCESS 1)

ITEM/ No.	MEDIUM/ COMB	DESIGN VALUES/ VALEURS DE CALCUL 2)		NORMAL OPERATION/FONCTIONNEMENT NORMAL 3)		
		p (barg)	T (°C)	p (barg)	T (°C)	V (m^3/h)
1	HFO	14	135	4	60	15
2	LFO	14	110	4	amb.	24
3	LFO	14	110	4	amb.	12.8
4	HFO	14	135	4	60	15

1) ALL PROCESS VALUES ARE INDICATIVE / LES VALEURS DE PROCESS N'ONT QU'UN CARACTERE INDICATIF
2) DESIGN VALUES ARE USED FOR DETERMINING PIPE WALL THICKNESS/ LES VALEURS DE CALCUL SONT UTILISEES POUR DETERMINER L'EPAISSEUR DES TUYAUX
3) NORMAL OPERATION IS DEFINED UNDER FOLLOWING CONDITIONS / LE FONCTIONNEMENT NORMAL EST DEFINI AVEC LES CONDITIONS SUIVANTES:
   - ENGINE LOAD / CHARGE MOTEUR: 100 %
   - AMBIENT TEMPERATURE / TEMPERATURE AMBIENTE: 27 °C
   - RELATIVE HUMIDITY / HUMIDITE RELATIVE: 70 %
   - SITE ELEVATION / ALTITUDE 10m

MEDIUM/ COMB	VISCOSITY/VISCOSITE	DENSITY/DENSITE
HFO	380 cSt at 50 °C	1010 kg/m^3 at 15 °C

(1) (2) = PROCESS VALUE ITEM

REV.	DATE	MADE	APPVD.	MEMO NO.	EXPLANATION
a	23-Feb-2016	kfax01	fmi001		Revised as marked.translation added.

WÄRTSILÄ
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CONTOURGLOBAL

Main flow diagram
Schéma Fluides Principal
(P) Fuel oil system 1(3)
(P) Circuit Combustible 1(3)

ContourGlobal Cap des Biches Extension
2 x W18V46
Proj. no. P/15034

Product: W18V46 | ACA | ASLY DRG:

MADE	17-Dec-2015	Ghanshyam Patil
CHKD	08-Jan-2016	Kim Fagerudd
APPD	23-Jan-2016	Frédéric Michel

Units: | Page No. | Based on Document: | Customer Document:
Scale: 1:1 | Size: A1 | Doc. ID: DBAD780117 | Rev. a

Confidential

THE CODES IN THE DIAGRAM ARE DESCRIBED IN DEVICE LIST No:DBAD780118
LE DÉTAIL DES CODIFICATIONS DE CE PLAN EST DONNÉ DANS LA NOMENCLATURE No:DBAD780118

THE SYMBOLS USED IN DIAGRAM ARE DESCRIBED IN DOCUMENT No: DBAB669467
LES SYMBOLES UTILISES DANS LE SCHEMA SONT DECRITS DANS LE DOCUMENT N° :
USE OF (A), (B)... INDICATE CODING OF TERMINATION POINTS ON UNITS.
LES SYMBOLES (A), (B)... INDIQUENT LES POINTS DE RACCORDEMENT DES MODULES.
EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.
CHAQUE POINT DE RACCORDEMENT EST IDENTIFIE AVANT EXPEDITION.

b) Supplied with steam valve assembly
Fourni avec ensemble vanne vapeur

(a) PROCESS VALUES/VALEURS DE PROCESS 1)

ITEM/ No.	MEDIUM/ COMB	DESIGN VALUES/ VALEURS DE CALCUL 2)		NORMAL OPERATION/FONCTIONNEMENT NORMAL 3)		
		p (barg)	T (°C)	p (barg)	T (°C)	V (m^3/h)
1	HFO	14	135	4	~98	9
2	HFO	14	135	4	90	8.5
3	LFO	14	110	4	amb.	8.5

1) ALL PROCESS VALUES ARE INDICATIVE / LES VALEURS DE PROCESS N'ONT QU'UN CARACTERE INDICATIF
2) DESIGN VALUES ARE USED FOR DETERMINING PIPE WALL THICKNESS/ LES VALEURS DE CALCUL SONT UTILISEES POUR DETERMINER L'EPAISSEUR DES TUYAUX
3) NORMAL OPERATION IS DEFINED UNDER FOLLOWING CONDITIONS / LE FONCTIONNEMENT NORMAL EST DEFINI AVEC LES CONDITIONS SUIVANTES:
   - ENGINE LOAD / CHARGE MOTEUR: 100 %
   - AMBIENT TEMPERATURE / TEMPERATURE AMBIENTE: 27 °C
   - RELATIVE HUMIDITY / HUMIDITE RELATIVE: 70 %
   - SITE ELEVATION / ALTITUDE 10m

MEDIUM/ COMB	VISCOSITY/VISCOSITE	DENSITY/DENSITE
HFO	380 cSt at 50 °C	1010 kg/m^3 at 15 °C

(1) (2) = PROCESS VALUE ITEM

Main flow diagram
Schéma Fluides Principal
(P) Fuel oil system 2(3)
(P) Circuit Combustible 2(3)

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ContourGlobal Cap des Biches Extension
2 x W18V46
Proj. no. P/15034

Product:	W18V46	
MADE	17-Dec-2015	Ghanshyam Patil
CHKD	07-Jan-2016	Kim Fagerudd
APPD	23-Jan-2016	Frédéric Michel

Based on Document: | Customer Document:
Scale: 1:1 | Size: A1 | Doc. ID: DBAD780119 Rev. a

REV.	DATE	MADE	APPVD.	MEMO NO.	EXPLANATION
a	23-Feb-2016	ndex07	fmi001		Revised as marked,translation added.

THE CODES IN THE DIAGRAM ARE DESCRIBED IN DEVICE LIST No:-
LOCAL DEVICE OR GAUGE
LOCAL PANEL
CONTROL BOARD
USE OF (A), (B) ... INDICATE CODING OF TERMINATION POINTS ON UNITS. EVERY UNIT TERMINATION POINT IS MARKED BEFORE SHIPMENT.
PRELIMINARY Drawing
Rev. -
DATE: 25-11-2024
MADE: SGU005
PIPE PENETRATING OUTER WALL
FC = FAIL CLOSE
FO = FAIL OPEN
OPTION B
2 X Manual shutoff
2 X ESD shut-off
2 x ESD venting
FUEL GAS INLET
Considered as Tie-in points
Considered as Tie-in points
CONTROL PANEL CFA901
CONTROL AIR
ENGINE HALL
ZEB010-Z003/DN80
NHA011 EXHAUST GAS MODULE
ZEB010-B004
ZEB010-B005
SZA011 ENGINE
PRESSURE SET POINT
CHARGE AIR PRESSURE FROM PT601
ZAC010-B001
CdB2-ISO16
CdB2-ISO15
CONNECTION TO 051 ENGINE
ZEB010-Z001/DN25
ZEB010-Z002/Ø15
ZAC011 COMPACT GAS RAMP(CGR)
FOR FLUSHING OF GAS SYSTEM (INERT GAS)
CONTROL PANEL CFC011/ZHA011
ZAA010-Z004/DN25
ZAA010-Z002/DN100
DN100
ZAA010-V001
ZAA010-Z003/DN100
ZAC010-Z001/DN100
CY901
ZAA900-Z001/DN200
CdB1-ISO20
The engine hall isolation markup is common for both facilities
JUNCTION BOX BLR 011
CONNECTIONS TO 011-031 ENGINES
CdB1-ISO19
© Wärtsilä Finland Oy Power Plants
CONTOURGLOBAL
WÄRTSILÄ
Main flow diagram
(Z) Fuel gas system
ContourGlobal Cap des Biches
5 x W18V50DF
Proj. no. S/22061
MADE 25-Nov-2024 Stefan Guldbrand
Scale: 1:1
Size: A1
DSCAxxxx
Confidential

APPENDIX 4- PART COUNT AND FAILURE FREQUENCIES

Parts Count CdB1

Installation	Area	Segment	Equipment			Base Element						
Name	Name	Name	Name	Systems MF	Time MF	Type	Library	Number	Size (mm)	Pressure (bar)	Gas (Vol) (%)	Liquid (Vol) (%)
CdB1 Facility	CdB1 Rev-01	CdB1/ISO	CdB1-ISO1-1	1	1	VALVE_MAN-01in	Standard	0.5	25.4	1.2	0	100
						VALVE_MAN-06in	Standard	1	152.4	1.2	0	100
						VALVE ACT NON P/L-03	Standard	0.5	76.2	1.2	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.2	0	100
						PIPE_PROC-03in	Standard	5	76.2	1.2	0	100
						PIPE_PROC-06in	Standard	19.8	152.4	1.2	0	100
			CdB1-ISO1-2	1	1	VALVE_MAN-03in	Standard	3	76.2	1.2	0	100
						VALVE_MAN-04in	Standard	2	101.6	1.2	0	100
						VALVE_MAN-06in	Standard	1	152.4	1.2	0	100
						VALVE ACT NON P/L-03	Standard	0.5	76.2	1.2	0	100
						VALVE ACT NON P/L-04	Standard	0.5	101.6	1.2	0	100
						VALVE ACT NON P/L-06	Standard	1	152.4	1.2	0	100
						PIPE_PROC-03in	Standard	5	76.2	1.2	0	100
						PIPE_PROC-04in	Standard	7.16	101.6	1.2	0	100
						PIPE_PROC-06in	Standard	44	152.4	1.2	0	100
						FLANGE-06in	Standard	4	152.4	1.2	0	100
			CdB1-ISO2	0.05	0.008	VALVE_MAN-01in	Standard	1	25.4	4	0	100
						VALVE_MAN-04in	Standard	14	101.6	4	0	100
						FLANGE-04in	Standard	8	101.6	4	0	100
						SMALL_BORE_FIT	Standard	16	101.6	4	0	100
						PUMP_RECIPR	Standard	4	101.6	4	0	100
						PIPE_PROC-01in	Standard	6	152.4	4	0	100
						PIPE_PROC-04in	Standard	56	101.6	4	0	100
			CdB1-ISO3	1	1	VALVE_MAN-01in	Standard	1	25.4	1.01	0	100
						VALVE_MAN-04in	Standard	4.5	101.6	1.01	0	100
						VALVE_MAN-06in	Standard	1	152.4	1.01	0	100
						VALVE ACT NON P/L-06	Standard	0.5	152.4	1.01	0	100
						FLANGE-04in	Standard	6	101.6	1.01	0	100
						SMALL_BORE_FIT	Standard	4	50.8	1.01	0	100
						SMALL_BORE_FIT	Standard	7	101.6	1.01	0	100
						HEATEX SH&T HCintube	Standard	1	101.6	1.01	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.01	0	100
						PIPE_PROC-04in	Standard	10	101.6	1.01	0	100
						PIPE_PROC-06in	Standard	5	152.4	1.01	0	100
			CdB1-ISO4	1	1	VALVE_MAN-01in	Standard	0.5	25.4	1.01	0	100
						VALVE_MAN-04in	Standard	4.5	101.6	1.01	0	100
						VALVE_MAN-06in	Standard	1	152.4	1.01	0	100
						VALVE ACT NON P/L-06	Standard	0.5	152.4	1.01	0	100
						FLANGE-04in	Standard	6	101.6	1.01	0	100
						SMALL_BORE_FIT	Standard	4	50.8	1.01	0	100
						SMALL_BORE_FIT	Standard	7	101.6	1.01	0	100
						HEATEX SH&T HCintube	Standard	1	101.6	1.01	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.01	0	100
						PIPE_PROC-04in	Standard	6.11	101.6	1.01	0	100
						PIPE_PROC-06in	Standard	5	152.4	1.01	0	100
			CdB1-ISO5	0.05	1	VALVE_MAN-03in	Standard	5	76.2	4	0	100
						VALVE_MAN-04in	Standard	0.5	101.6	4	0	100
						VALVE ACT NON P/L-04	Standard	1	101.6	4	0	100
						FLANGE-03in	Standard	6	76.2	4	0	100
						FLANGE-04in	Standard	2	101.6	4	0	100
						SMALL_BORE_FIT	Standard	6	76.2	4	0	100
						HEATEX SH&T HCintube	Standard	2	76.2	4	0	100
						PUMP_RECIPR	Standard	2	101.6	4	0	100
						PIPE_PROC-03in	Standard	23	76.2	4	0	100
						PIPE_PROC-04in	Standard	93	101.6	4	0	100
			CdB1-ISO6	1	1	VALVE_MAN-01in	Standard	0.5	25.4	1.01	0	100
						VALVE_MAN-04in	Standard	3	101.6	1.01	0	100
						VALVE ACT NON P/L-04	Standard	0.5	101.6	1.01	0	100
						FLANGE-04in	Standard	6	152.4	1.01	0	100
						SMALL_BORE_FIT	Standard	6	50.8	1.01	0	100
						SMALL_BORE_FIT	Standard	6	101.6	1.01	0	100
						HEATEX SH&T HCintube	Standard	1	101.6	1.01	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.01	0	100
						PIPE_PROC-04in	Standard	58	101.6	1.01	0	100
			CdB1-ISO7	0.05	1	VALVE_MAN-03in	Standard	5	76.2	4	0	100
						FLANGE-03in	Standard	6	76.2	4	0	100
						SMALL_BORE_FIT	Standard	6	76.2	4	0	100
						HEATEX SH&T HCintube	Standard	2	76.2	4	0	100
						PUMP_RECIPR	Standard	2	101.6	4	0	100
						PIPE_PROC-03in	Standard	45	76.2	4	0	100
			CdB1-ISO8	1	1	VALVE_MAN-01in	Standard	0.5	25.4	1.013	0	100
						VALVE_MAN-06in	Standard	1	152.4	1.013	0	100
						FLANGE-06in	Standard	2	152.4	1.013	0	100
						SMALL_BORE_FIT	Standard	6	50.8	1.013	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.013	0	100
						PIPE_PROC-06in	Standard	45	152.4	1.013	0	100
			CdB1-ISO9	0.05	1	VALVE_MAN-0.75in	Standard	4	19.05	4	0	100
						VALVE_MAN-03in	Standard	4	76.2	4	0	100
						VALVE_MAN-05in	Standard	2	127	4	0	100
						HEATEX SH&T HCintube	Standard	2	127	4	0	100
						PUMP_RECIPR	Standard	2	152.4	4	0	100
						PIPE_PROC-0.75in	Standard	5	19.05	4	0	100
						PIPE_PROC-01in	Standard	5	25.4	4	0	100
						PIPE_PROC-03in	Standard	85	76.2	4	0	100
						PIPE_PROC-05in	Standard	5	127	4	0	100
			CdB1-ISO10	1	1	VALVE_MAN-01in	Standard	0.5	25.4	1.01	0	100
						VALVE_MAN-04in	Standard	3	101.6	1.01	0	100
						VALVE ACT NON P/L-04	Standard	1	101.6	1.01	0	100
						FLANGE-04in	Standard	2	101.6	1.01	0	100
						SMALL_BORE_FIT	Standard	5	50.8	1.01	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.01	0	100
						PIPE_PROC-04in	Standard	40	101.6	1.01	0	100
			CdB1-ISO11-1	1	1	VALVE_MAN-04in	Standard	1	101.6	1.01	0	100
						VALVE ACT NON P/L-04	Standard	1	101.6	1.01	0	100
						SMALL_BORE_FIT	Standard	4	101.6	1.01	0	100
						PIPE_PROC-04in	Standard	10	101.6	1.01	0	100
			CdB1-ISO11-2	1	1	VALVE_MAN-04in	Standard	1	101.6	1.01	0	100
						VALVE ACT NON P/L-04	Standard	1	101.6	1.01	0	100
						SMALL_BORE_FIT	Standard	4	101.6	1.01	0	100
						PIPE_PROC-04in	Standard	10	101.6	1.01	0	100
			CdB1-ISO12	0.05	1	VALVE_MAN-01.5in	Standard	7	38.1	5	0	100
						VALVE_MAN-03in	Standard	8	76.2	5	0	100
						SMALL_BORE_FIT	Standard	14	76.2	5	0	100
						PUMP_RECIPR	Standard	2	101.6	5	0	100
						PIPE_PROC-01.5in	Standard	5	38.1	5	0	100
						PIPE_PROC-03in	Standard	75	76.2	5	0	100
			CdB1-ISO13	1	0.001	VALVE_MAN-04in	Standard	2.5	101.6	4	0	100
						SMALL_BORE_FIT	Standard	1	101.6	4	0	100
						PUMP_RECIPR	Standard	1	101.6	4	0	100
						PIPE_PROC-04in	Standard	30	101.6	4	0	100
			CdB1-ISO14	1	1	VALVE_MAN-01in	Standard	1	25.4	1.01	0	100
						VALVE_MAN-03in	Standard	4	76.2	1.01	0	100
						FLANGE-03in	Standard	4	76.2	1.01	0	100
						SMALL_BORE_FIT	Standard	4	50.8	1.01	0	100
						SMALL_BORE_FIT	Standard	2	76.2	1.01	0	100
						PIPE_PROC-03in	Standard	32	76.2	1.01	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.01	0	100
			CdB1-ISO15	0.05	1	VALVE_MAN-01in	Standard	1	25.4	4	0	100
						VALVE_MAN-02in	Standard	3	50.8	4	0	100
						FLANGE-02in	Standard	4	50.8	4	0	100
						SMALL_BORE_FIT	Standard	2	50.8	4	0	100
						PUMP_RECIPR	Standard	2	63.5	4	0	100
						PIPE_PROC-02in	Standard	136	50.8	4	0	100
			CdB1-ISO16	1	1	VALVE_MAN-01in	Standard	0.5	25.4	1.01	0	100
						VALVE_MAN-03in	Standard	3	76.2	1.01	0	100
						FLANGE-03in	Standard	4	76.2	1.01	0	100
						VALVE ACT NON P/L-03	Standard	1	76.2	1.01	0	100
						SMALL_BORE_FIT	Standard	7	50.8	1.01	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.01	0	100
						PIPE_PROC-03in	Standard	30	76.2	1.01	0	100
			CdB1-ISO17-1	1	1	VALVE_MAN-03in	Standard	0.5	76.2	1.01	0	100
						VALVE ACT NON P/L-03	Standard	0.5	76.2	1.01	0	100
						SMALL_BORE_FIT	Standard	1	76.2	1.01	0	100
						PIPE_PROC-03in	Standard	5	76.2	1.01	0	100
			CdB1-ISO17-2	1	1	VALVE_MAN-03in	Standard	0.5	76.2	1.01	0	100
						VALVE ACT NON P/L-03	Standard	0.5	76.2	1.01	0	100
						SMALL_BORE_FIT	Standard	1	76.2	1.01	0	100
						PIPE_PROC-03in	Standard	5	76.2	1.01	0	100
			CdB1-ISO18	0.05	1	VALVE_MAN-01in	Standard	1	25.4	5	0	100
						VALVE_MAN-01.5in	Standard	3	38.1	5	0	100
						VALVE_MAN-03in	Standard	5	63.5	5	0	100
						FLANGE-03in	Standard	4	63.5	5	0	100
						PUMP_RECIPR	Standard	2	76.2	5	0	100
						PIPE_PROC-01in	Standard	5	25.4	5	0	100
						PIPE_PROC-01.5in	Standard	5	38.1	5	0	100
						PIPE_PROC-03in	Standard	75	63.5	5	0	100
			CdB1-ISO19	1	1	VALVE ACT NON P/L-05	Standard	1	127	6	100	0
						SMALL_BORE_FIT	Standard	1	127	6	100	0
						FLANGE-05in	Standard	2	127	6	100	0
						PIPE_PROC-05in	Standard	165	127	6	100	0
			CdB1-ISO20	1	1	VALVE_MAN-05in	Standard	1.5	127	6	100	0
						VALVE ACT NON P/L-01	Standard	2	127	6	100	0
						VALVE ACT NON P/L-05	Standard	3.5	127	6	100	0
						FLANGE-05in	Standard	6	127	6	100	0
						SMALL_BORE_FIT	Standard	6	50.8	6	100	0
						PIPE_PROC-05in	Standard	33	127	6	100	0

Frequencies CdB1

Project

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ContourGlobal CdB1	Category	Total Leaks Gas (/AvgeYear)	Liquid (/AvgeYear)	Total (/AvgeYear)
	Small	1.008E-02	4.203E-02	5.211E-02
	Medium	1.235E-03	5.720E-03	6.955E-03
	Large	4.315E-04	2.270E-03	2.701E-03
	FBR	0.000E+00	1.049E-04	1.049E-04
	Total	1.175E-02	5.012E-02	6.187E-02

Installations

\ContourGlobal CdB1

CdB1 Facility	Category	Total Leaks Gas (/AvgeYear)	Liquid (/AvgeYear)	Total (/AvgeYear)
	Small	1.008E-02	4.203E-02	5.211E-02
	Medium	1.235E-03	5.720E-03	6.955E-03
	Large	4.315E-04	2.270E-03	2.701E-03
	FBR	0.000E+00	1.049E-04	1.049E-04
	Total	1.175E-02	5.012E-02	6.187E-02

Areas

\ContourGlobal CdB1\CdB1 Facility

CdB1 Rev-01	Category	Total Leaks Gas (/AvgeYear)	Liquid (/AvgeYear)	Total (/AvgeYear)
	Small	1.008E-02	4.203E-02	5.211E-02
	Medium	1.235E-03	5.720E-03	6.955E-03
	Large	4.315E-04	2.270E-03	2.701E-03
	FBR	0.000E+00	1.049E-04	1.049E-04
	Total	1.175E-02	5.012E-02	6.187E-02

Segments

\ContourGlobal CdB1\CdB1 Facility\CdB1 Rev-01

CdB1/ISO	Category	Total Leaks Gas (/AvgeYear)	Liquid (/AvgeYear)	Total (/AvgeYear)
	Small	1.008E-02	4.203E-02	5.211E-02
	Medium	1.235E-03	5.720E-03	6.955E-03
	Large	4.315E-04	2.270E-03	2.701E-03
	FBR	0.000E+00	1.049E-04	1.049E-04
	Total	1.175E-02	5.012E-02	6.187E-02

Equipment

\ContourGlobal CdB1\CdB1 Facility\CdB1 Rev-01\CdB1/ISO

		Total Leaks		
	Category	Gas (/AvgeYear)	Liquid (/AvgeYear)	Total (/AvgeYear)
CdB1-ISO1-1	Small	0.000E+00	9.432E-04	9.432E-04
	Medium	0.000E+00	1.238E-04	1.238E-04
	Large	0.000E+00	2.883E-05	2.883E-05
	FBR	0.000E+00	8.110E-06	8.110E-06
	Total	0.000E+00	1.104E-03	1.104E-03
CdB1-ISO1-2	Small	0.000E+00	2.333E-03	2.333E-03
	Medium	0.000E+00	3.057E-04	3.057E-04
	Large	0.000E+00	8.966E-05	8.966E-05
	FBR	0.000E+00	2.955E-05	2.955E-05
	Total	0.000E+00	2.758E-03	2.758E-03
CdB1-ISO2	Small	0.000E+00	5.347E-06	5.347E-06
	Medium	0.000E+00	1.066E-06	1.066E-06
	Large	0.000E+00	8.468E-07	8.468E-07
	FBR	0.000E+00	2.839E-09	2.839E-09
	Total	0.000E+00	7.262E-06	7.262E-06
CdB1-ISO3	Small	0.000E+00	5.057E-03	5.057E-03
	Medium	0.000E+00	7.227E-04	7.227E-04
	Large	0.000E+00	3.131E-04	3.131E-04
	FBR	0.000E+00	5.936E-06	5.936E-06
	Total	0.000E+00	6.099E-03	6.099E-03
CdB1-ISO4	Small	0.000E+00	4.895E-03	4.895E-03
	Medium	0.000E+00	6.984E-04	6.984E-04
	Large	0.000E+00	3.069E-04	3.069E-04
	FBR	0.000E+00	5.936E-06	5.936E-06
	Total	0.000E+00	5.906E-03	5.906E-03
CdB1-ISO5	Small	0.000E+00	5.572E-04	5.572E-04
	Medium	0.000E+00	1.035E-04	1.035E-04
	Large	0.000E+00	7.353E-05	7.353E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	7.342E-04	7.342E-04
CdB1-ISO6	Small	0.000E+00	6.933E-03	6.933E-03
	Medium	0.000E+00	9.453E-04	9.453E-04
	Large	0.000E+00	3.883E-04	3.883E-04
	FBR	0.000E+00	6.774E-06	6.774E-06
	Total	0.000E+00	8.273E-03	8.273E-03
CdB1-ISO7	Small	0.000E+00	4.165E-04	4.165E-04
	Medium	0.000E+00	8.591E-05	8.591E-05
	Large	0.000E+00	6.734E-05	6.734E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	5.698E-04	5.698E-04
CdB1-ISO8	Small	0.000E+00	2.984E-03	2.984E-03
	Medium	0.000E+00	3.633E-04	3.633E-04
	Large	0.000E+00	9.678E-05	9.678E-05
	FBR	0.000E+00	2.041E-05	2.041E-05
	Total	0.000E+00	3.464E-03	3.464E-03
CdB1-ISO9	Small	0.000E+00	4.554E-04	4.554E-04
	Medium	0.000E+00	9.494E-05	9.494E-05
	Large	0.000E+00	3.970E-05	3.970E-05
	FBR	0.000E+00	2.817E-05	2.817E-05
	Total	0.000E+00	6.182E-04	6.182E-04
CdB1-ISO10	Small	0.000E+00	3.465E-03	3.465E-03
	Medium	0.000E+00	4.378E-04	4.378E-04
	Large	0.000E+00	1.482E-04	1.482E-04
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	4.051E-03	4.051E-03

CdB1-ISO11-1	Small	0.000E+00	1.854E-03	1.854E-03
	Medium	0.000E+00	2.268E-04	2.268E-04
	Large	0.000E+00	7.805E-05	7.805E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	2.159E-03	2.159E-03
CdB1-ISO11-2	Small	0.000E+00	1.854E-03	1.854E-03
	Medium	0.000E+00	2.268E-04	2.268E-04
	Large	0.000E+00	7.805E-05	7.805E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	2.159E-03	2.159E-03
CdB1-ISO12	Small	0.000E+00	5.492E-04	5.492E-04
	Medium	0.000E+00	9.660E-05	9.660E-05
	Large	0.000E+00	6.129E-05	6.129E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	7.071E-04	7.071E-04
CdB1-ISO13	Small	0.000E+00	2.865E-06	2.865E-06
	Medium	0.000E+00	6.071E-07	6.071E-07
	Large	0.000E+00	5.110E-07	5.110E-07
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	3.983E-06	3.983E-06
CdB1-ISO14	Small	0.000E+00	3.513E-03	3.513E-03
	Medium	0.000E+00	4.523E-04	4.523E-04
	Large	0.000E+00	1.537E-04	1.537E-04
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	4.119E-03	4.119E-03
CdB1-ISO15	Small	0.000E+00	5.224E-04	5.224E-04
	Medium	0.000E+00	9.260E-05	9.260E-05
	Large	0.000E+00	6.277E-05	6.277E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	6.778E-04	6.778E-04
CdB1-ISO16	Small	0.000E+00	3.965E-03	3.965E-03
	Medium	0.000E+00	4.993E-04	4.993E-04
	Large	0.000E+00	1.700E-04	1.700E-04
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	4.635E-03	4.635E-03
CdB1-ISO17-1	Small	0.000E+00	6.848E-04	6.848E-04
	Medium	0.000E+00	8.480E-05	8.480E-05
	Large	0.000E+00	2.964E-05	2.964E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	7.993E-04	7.993E-04
CdB1-ISO17-2	Small	0.000E+00	6.848E-04	6.848E-04
	Medium	0.000E+00	8.480E-05	8.480E-05
	Large	0.000E+00	2.964E-05	2.964E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	7.993E-04	7.993E-04
CdB1-ISO18	Small	0.000E+00	3.503E-04	3.503E-04
	Medium	0.000E+00	7.270E-05	7.270E-05
	Large	0.000E+00	5.305E-05	5.305E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	4.760E-04	4.760E-04
CdB1-ISO19	Small	5.540E-03	0.000E+00	5.540E-03
	Medium	6.790E-04	0.000E+00	6.790E-04
	Large	2.341E-04	0.000E+00	2.341E-04
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	6.453E-03	0.000E+00	6.453E-03
CdB1-ISO20	Small	4.545E-03	0.000E+00	4.545E-03
	Medium	5.557E-04	0.000E+00	5.557E-04
	Large	1.974E-04	0.000E+00	1.974E-04
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	5.298E-03	0.000E+00	5.298E-03

Parts Count CdB2

Installation	Area	Segment	Equipment			Base Element						
Name	Name	Name	Name	Systems MF	Time MF	Type	Library	Number	Size (mm)	Pressure (bar)	Gas (Vol) (%)	Liquid (Vol) (%)
CdB2 Facility	CdB2 Rev-01	CdB2/ISO	CdB2-ISO1	0.05	1	VALVE_MAN-01in	Standard	1.5	25.4	4	0	100
						VALVE_MAN-03in	Standard	5	76.2	4	0	100
						VALVE_ACT_NON_P/L-03	Standard	0.5	76.2	4	0	100
						FLANGE-03in	Standard	6	76.2	4	0	100
						SMALL_BORE_FIT	Standard	6	76.2	4	0	100
						HEATEX_SH&T_HCintub	Standard	2	76.2	4	0	100
						PUMP_RECIPR	Standard	2	101.6	4	0	100
						PIPE_PROC-01in	Standard	3	25.4	4	0	100
						PIPE_PROC-03in	Standard	261	76.2	4	0	100
			CdB2-ISO2	1	1	VALVE_MAN-01in	Standard	0.5	25.4	1.01	0	100
						VALVE_MAN-04in	Standard	3	101.6	1.01	0	100
						VALVE_ACT_NON_P/L-03	Standard	0.5	76.2	1.01	0	100
						FLANGE-04in	Standard	2	101.6	1.01	0	100
						SMALL_BORE_FIT	Standard	6	50.8	1.01	0	100
						SMALL_BORE_FIT	Standard	7	101.6	1.01	0	100
						HEATEX_SH&T_HCintub	Standard	1	76.2	1.01	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.01	0	100
						PIPE_PROC-03in	Standard	5	76.2	1.01	0	100
						PIPE_PROC-04in	Standard	31	101.6	1.01	0	100
			CdB2-ISO3	0.05	1	VALVE_MAN-03in	Standard	6	76.2	4	0	100
						FLANGE-03in	Standard	6	76.2	4	0	100
						SMALL_BORE_FIT	Standard	6	76.2	4	0	100
						HEATEX_SH&T_HCintub	Standard	2	76.2	4	0	100
						PUMP_RECIPR	Standard	2	101.6	4	0	100
						PIPE_PROC-03in	Standard	40	76.2	4	0	100
			CdB2-ISO4	1	1	VALVE_MAN-01in	Standard	0.5	25.4	1.01	0	100
						VALVE_MAN-03in	Standard	1	76.2	1.01	0	100
						VALVE_MAN-05in	Standard	2	127	1.01	0	100
						SMALL_BORE_FIT	Standard	9	50.8	1.01	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.01	0	100
						PIPE_PROC-03in	Standard	40	76.2	1.01	0	100
						PIPE_PROC-05in	Standard	5	127	1.01	0	100
			CdB2-ISO5	0.05	1	VALVE_MAN-01in	Standard	2	25.4	4	0	100
						VALVE_MAN-01.5in	Standard	1.5	38.1	4	0	100
						VALVE_MAN-03in	Standard	12	63.5	4	0	100
						PUMP_RECIPR	Standard	2	127	4	0	100
						PIPE_PROC-01in	Standard	5	25.4	4	0	100
						PIPE_PROC-03in	Standard	35	63.5	4	0	100
						PIPE_PROC-01.5in	Standard	5	38.1	4	0	100
			CdB2-ISO6	1	1	VALVE_MAN-01in	Standard	0.5	25.4	1.01	0	100
						VALVE_MAN-03in	Standard	2	76.2	1.01	0	100
						VALVE_ACT_NON_P/L-03	Standard	0.5	76.2	1.01	0	100
						SMALL_BORE_FIT	Standard	7	50.8	1.01	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.01	0	100
						PIPE_PROC-03in	Standard	35	76.2	1.01	0	100
			CdB2-ISO7	1	1	VALVE_MAN-03in	Standard	2.5	76.2	1.01	0	100
						VALVE_ACT_NON_P/L-03	Standard	0.5	76.2	1.01	0	100
						SMALL_BORE_FIT	Standard	4	76.2	1.01	0	100
						PIPE_PROC-03in	Standard	10	76.2	1.01	0	100
			CdB2-ISO8	0.05	1	VALVE_MAN-01in	Standard	0.5	25.4	4	0	100
						VALVE_MAN-01.5in	Standard	11.5	38.1	4	0	100
						SMALL_BORE_FIT	Standard	6	38.1	4	0	100
						PUMP_RECIPR	Standard	2	76.2	4	0	100
						PIPE_PROC-01in	Standard	1	25.4	4	0	100
						PIPE_PROC-01.5in	Standard	5	38.1	4	0	100
						PIPE_PROC-03in	Standard	87.6	76.2	4	0	100
			CdB2-ISO9	1	0.001	VALVE_MAN-04in	Standard	6	101.6	4	0	100
						FLANGE-04in	Standard	2	101.6	4	0	100
						SMALL_BORE_FIT	Standard	6	101.6	4	0	100
						PUMP_RECIPR	Standard	2	101.6	4	0	100
						PIPE_PROC-04in	Standard	30	101.6	4	0	100
			CdB2-ISO10	1	1	VALVE_MAN-01in	Standard	0.5	25.4	1.01	0	100
						VALVE_MAN-03in	Standard	3.5	63.5	1.01	0	100
						SMALL_BORE_FIT	Standard	4	50.8	1.01	0	100
						SMALL_BORE_FIT	Standard	2	63.5	1.01	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.01	0	100
						PIPE_PROC-03in	Standard	30	63.5	1.01	0	100
			CdB2-ISO11	0.05	1	VALVE_MAN-01in	Standard	1.5	25.4	4	0	100
						VALVE_MAN-03in	Standard	1	63.5	4	0	100
						FLANGE-02in	Standard	2	50.8	4	0	100
						SMALL_BORE_FIT	Standard	2	50.8	4	0	100
						VALVE_MAN-02in	Standard	2	50.8	4	0	100
						PUMP_RECIPR	Standard	2	63.5	4	0	100
						PIPE_PROC-01in	Standard	3	25.4	4	0	100
						PIPE_PROC-02in	Standard	5	50.8	4	0	100
						PIPE_PROC-03in	Standard	267	63.5	4	0	100
			CdB2-ISO12	1	1	VALVE_MAN-01in	Standard	0.5	25.4	1.01	0	100
						VALVE_MAN-03in	Standard	2	63.5	1.01	0	100
						VALVE_ACT_NON_P/L-03	Standard	0.5	63.5	1.01	0	100
						FLANGE-03in	Standard	2	63.5	1.01	0	100
						SMALL_BORE_FIT	Standard	7	50.8	1.01	0	100
						PIPE_PROC-03in	Standard	46.5	63.5	1.01	0	100
						PIPE_PROC-01in	Standard	1	25.4	1.01	0	100
			CdB2-ISO13	1	1	VALVE_MAN-03in	Standard	0.5	63.5	1.01	0	100
						VALVE_ACT_NON_P/L-03	Standard	0.5	63.5	1.01	0	100
						SMALL_BORE_FIT	Standard	1	63.5	1.01	0	100
						PIPE_PROC-03in	Standard	5	63.5	1.01	0	100
			CdB2-ISO14	0.05	1	VALVE_MAN-01in	Standard	1.5	25.4	4	0	100
						VALVE_MAN-01.5in	Standard	5.5	38.1	4	0	100
						SMALL_BORE_FIT	Standard	3	38.1	4	0	100
						PUMP_RECIPR	Standard	1	63.5	4	0	100
						PIPE_PROC-01in	Standard	3	25.4	4	0	100
						PIPE_PROC-01.5in	Standard	5	38.1	4	0	100
						PIPE_PROC-03in	Standard	87.6	63.5	4	0	100
			CdB2-ISO15	1	1	VALVE_MAN-05in	Standard	1	127	6	100	0
						VALVE_ACT_NON_P/L-05	Standard	1.5	127	6	100	0
						SMALL_BORE_FIT	Standard	1	127	6	100	0
						PIPE_PROC-05in	Standard	40	127	6	100	0
			CdB2-ISO16	1	1	VALVE_MAN-05in	Standard	1.5	127	6	100	0
						VALVE_ACT_NON_P/L-01	Standard	2	127	6	100	0
						VALVE_ACT_NON_P/L-05	Standard	3.5	127	6	100	0
						SMALL_BORE_FIT	Standard	6	50.8	6	100	0
						FLANGE-05in	Standard	6	127	6	100	0
						PIPE_PROC-05in	Standard	27.5	127	6	100	0

Frequencies CdB2

Project

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ContourGlobal CdB2	Category	Total Leaks Gas (/AvgeYear)	Total Leaks Liquid (/AvgeYear)	Total Leaks Total (/AvgeYear)
	Small	6.261E-03	2.851E-02	3.477E-02
	Medium	7.720E-04	3.822E-03	4.594E-03
	Large	2.745E-04	1.534E-03	1.809E-03
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	7.307E-03	3.387E-02	4.117E-02

Installations

\ContourGlobal CdB2

CdB2 Facility	Category	Total Leaks Gas (/AvgeYear)	Total Leaks Liquid (/AvgeYear)	Total Leaks Total (/AvgeYear)
	Small	6.261E-03	2.851E-02	3.477E-02
	Medium	7.720E-04	3.822E-03	4.594E-03
	Large	2.745E-04	1.534E-03	1.809E-03
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	7.307E-03	3.387E-02	4.117E-02

Areas

\ContourGlobal CdB2\CdB2 Facility

CdB2 Rev-01	Category	Total Leaks Gas (/AvgeYear)	Total Leaks Liquid (/AvgeYear)	Total Leaks Total (/AvgeYear)
	Small	6.261E-03	2.851E-02	3.477E-02
	Medium	7.720E-04	3.822E-03	4.594E-03
	Large	2.745E-04	1.534E-03	1.809E-03
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	7.307E-03	3.387E-02	4.117E-02

Segments

\ContourGlobal CdB2\CdB2 Facility\CdB2 Rev-01

CdB2/ISO	Category	Total Leaks Gas (/AvgeYear)	Total Leaks Liquid (/AvgeYear)	Total Leaks Total (/AvgeYear)
	Small	6.261E-03	2.851E-02	3.477E-02
	Medium	7.720E-04	3.822E-03	4.594E-03
	Large	2.745E-04	1.534E-03	1.809E-03
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	7.307E-03	3.387E-02	4.117E-02

Equipment

\ContourGlobal CdB2\CdB2 Facility\CdB2 Rev-01\CdB2/ISO

	Category	Total Leaks		
		Gas (/AvgeYear)	Liquid (/AvgeYear)	Total (/AvgeYear)
CdB2-ISO1	Small	0.000E+00	9.103E-04	9.103E-04
	Medium	0.000E+00	1.500E-04	1.500E-04
	Large	0.000E+00	8.921E-05	8.921E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	1.149E-03	1.149E-03
CdB2-ISO2	Small	0.000E+00	6.365E-03	6.365E-03
	Medium	0.000E+00	8.702E-04	8.702E-04
	Large	0.000E+00	3.652E-04	3.652E-04
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	7.600E-03	7.600E-03
CdB2-ISO3	Small	0.000E+00	4.075E-04	4.075E-04
	Medium	0.000E+00	8.486E-05	8.486E-05
	Large	0.000E+00	6.703E-05	6.703E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	5.594E-04	5.594E-04
CdB2-ISO4	Small	0.000E+00	4.757E-03	4.757E-03
	Medium	0.000E+00	5.923E-04	5.923E-04
	Large	0.000E+00	1.984E-04	1.984E-04
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	5.548E-03	5.548E-03
CdB2-ISO5	Small	0.000E+00	2.704E-04	2.704E-04
	Medium	0.000E+00	6.306E-05	6.306E-05
	Large	0.000E+00	5.009E-05	5.009E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	3.836E-04	3.836E-04
CdB2-ISO6	Small	0.000E+00	3.907E-03	3.907E-03
	Medium	0.000E+00	4.891E-04	4.891E-04
	Large	0.000E+00	1.636E-04	1.636E-04
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	4.559E-03	4.559E-03
CdB2-ISO7	Small	0.000E+00	1.866E-03	1.866E-03
	Medium	0.000E+00	2.313E-04	2.313E-04
	Large	0.000E+00	8.145E-05	8.145E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	2.179E-03	2.179E-03

CdB2-ISO8	Small	0.000E+00	4.557E-04	4.557E-04
	Medium	0.000E+00	9.040E-05	9.040E-05
	Large	0.000E+00	5.304E-05	5.304E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	5.991E-04	5.991E-04
CdB2-ISO9	Small	0.000E+00	5.887E-06	5.887E-06
	Medium	0.000E+00	1.228E-06	1.228E-06
	Large	0.000E+00	1.027E-06	1.027E-06
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	8.142E-06	8.142E-06
CdB2-ISO10	Small	0.000E+00	3.299E-03	3.299E-03
	Medium	0.000E+00	4.186E-04	4.186E-04
	Large	0.000E+00	1.416E-04	1.416E-04
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	3.859E-03	3.859E-03
CdB2-ISO11	Small	0.000E+00	7.842E-04	7.842E-04
	Medium	0.000E+00	1.256E-04	1.256E-04
	Large	0.000E+00	7.343E-05	7.343E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	9.832E-04	9.832E-04
CdB2-ISO12	Small	0.000E+00	4.457E-03	4.457E-03
	Medium	0.000E+00	5.599E-04	5.599E-04
	Large	0.000E+00	1.897E-04	1.897E-04
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	5.206E-03	5.206E-03
CdB2-ISO13	Small	0.000E+00	6.848E-04	6.848E-04
	Medium	0.000E+00	8.480E-05	8.480E-05
	Large	0.000E+00	2.964E-05	2.964E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	7.993E-04	7.993E-04
CdB2-ISO14	Small	0.000E+00	3.399E-04	3.399E-04
	Medium	0.000E+00	6.068E-05	6.068E-05
	Large	0.000E+00	3.089E-05	3.089E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	0.000E+00	4.315E-04	4.315E-04
CdB2-ISO15	Small	1.881E-03	0.000E+00	1.881E-03
	Medium	2.364E-04	0.000E+00	2.364E-04
	Large	8.391E-05	0.000E+00	8.391E-05
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	2.201E-03	0.000E+00	2.201E-03
CdB2-ISO16	Small	4.380E-03	0.000E+00	4.380E-03
	Medium	5.356E-04	0.000E+00	5.356E-04
	Large	1.906E-04	0.000E+00	1.906E-04
	FBR	0.000E+00	0.000E+00	0.000E+00
	Total	5.106E-03	0.000E+00	5.106E-03

APPENDIX 5- CONSEQUENCE RESULTS (FLAMMABLE GAS, FIRE AND EXPLOSIONS)

Pool Fire CdB1

Path	Scenario	Weather	Distance downwind to intensity level 1 (1.6 kW/m2) (m)	Distance downwind to intensity level 2 (4.7 kW/m2) (m)	Distance downwind to intensity level 3 (6.3 kW/m2) (m)	Distance downwind to intensity level 4 (12.5 kW/m2) (m)	Distance downwind to intensity level 5 (37.5 kW/m2) (m)
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/S	CdB1-ISO1-1/S	Category 2F	19.8023	14.1887	13.058	10.9087	8.0442
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/S	CdB1-ISO1-1/S	Category 5D	19.4541	14.5552	13.611	11.8146	9.64593
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/M	CdB1-ISO1-1/M	Category 2F	48.8352	33.7212	30.5861	23.654	14.9564
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/M	CdB1-ISO1-1/M	Category 5D	49.0435	34.9718	32.0386	26.3715	14.8931
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/L	CdB1-ISO1-1/L	Category 2F	64.9467	43.9117	39.1194	29.5443	22.7403
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/L	CdB1-ISO1-1/L	Category 5D	65.4067	45.8453	41.2887	29.2497	22.7642
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/FBR	CdB1-ISO1-1/FBR	Category 2F	72.1268	48.3209	42.9782	32.9572	26.0316
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/FBR	CdB1-ISO1-1/FBR	Category 5D	72.1483	50.2867	44.6278	32.3457	26.1089
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/S	CdB1-ISO1-2/S	Category 2F	19.8023	14.1887	13.058	10.9087	8.0442
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/S	CdB1-ISO1-2/S	Category 5D	19.4541	14.5552	13.611	11.8146	9.64593
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/M	CdB1-ISO1-2/M	Category 2F	48.8352	33.7212	30.5861	23.654	14.9564
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/M	CdB1-ISO1-2/M	Category 5D	49.0435	34.9718	32.0386	26.3715	14.8931
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/L	CdB1-ISO1-2/L	Category 2F	64.9467	43.9117	39.1194	29.5443	22.7403
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/L	CdB1-ISO1-2/L	Category 5D	65.4067	45.8453	41.2887	29.2497	22.7642
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/FBR	CdB1-ISO1-2/FBR	Category 2F	72.1268	48.3209	42.9782	32.9572	26.0316
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/FBR	CdB1-ISO1-2/FBR	Category 5D	72.1483	50.2867	44.6278	32.3457	26.1089
Study\CdB1\CdB1-ISO2\CdB1-ISO2/S	CdB1-ISO2/S	Category 2F	26.158	19.1851	17.758	15.1358	11.2241
Study\CdB1\CdB1-ISO2\CdB1-ISO2/S	CdB1-ISO2/S	Category 5D	26.3531	20.2543	19.0629	16.7357	13.4002
Study\CdB1\CdB1-ISO2\CdB1-ISO2/M	CdB1-ISO2/M	Category 2F	59.2296	42.1601	38.3746	29.9439	22.1493
Study\CdB1\CdB1-ISO2\CdB1-ISO2/M	CdB1-ISO2/M	Category 5D	60.35	43.9774	40.927	31.6386	22.5267
Study\CdB1\CdB1-ISO2\CdB1-ISO2/L	CdB1-ISO2/L	Category 2F	61.2561	43.5863	39.5943	30.783	23.3288
Study\CdB1\CdB1-ISO2\CdB1-ISO2/L	CdB1-ISO2/L	Category 5D	62.5017	45.557	42.2556	31.937	23.7004
Study\CdB1\CdB1-ISO2\CdB1-ISO2/FBR	CdB1-ISO2/FBR	Category 2F	66.978	47.2559	42.7488	33.3685	26.4591
Study\CdB1\CdB1-ISO2\CdB1-ISO2/FBR	CdB1-ISO2/FBR	Category 5D	68.0503	49.5267	45.4822	33.7298	26.8656
Study\CdB1\CdB1-ISO5\CdB1-ISO5/S	CdB1-ISO5/S	Category 2F	26.1991	19.2402	17.8215	15.2057	11.3077
Study\CdB1\CdB1-ISO5\CdB1-ISO5/S	CdB1-ISO5/S	Category 5D	26.4642	20.382	19.194	16.8744	13.5593
Study\CdB1\CdB1-ISO5\CdB1-ISO5/M	CdB1-ISO5/M	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB1\CdB1-ISO5\CdB1-ISO5/M	CdB1-ISO5/M	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB1\CdB1-ISO5\CdB1-ISO5/L	CdB1-ISO5/L	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB1\CdB1-ISO5\CdB1-ISO5/L	CdB1-ISO5/L	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB1\CdB1-ISO5\CdB1-ISO5/FBR	CdB1-ISO5/FBR	Category 2F	54.8112	39.0998	35.7779	28.3709	19.8648
Study\CdB1\CdB1-ISO5\CdB1-ISO5/FBR	CdB1-ISO5/FBR	Category 5D	55.6771	40.8041	37.9694	31.5662	20.3201
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/S	Category 2F	26.1991	19.2402	17.8215	15.2057	11.3077
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/S	Category 5D	26.4642	20.382	19.194	16.8744	13.5593
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/M	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/M	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/L	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/L	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/FBR	Category 2F	54.8112	39.0998	35.7779	28.3709	19.8648
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/FBR	Category 5D	55.6771	40.8041	37.9694	31.5662	20.3201
Study\CdB1\CdB1-ISO7\CdB1-ISO7/S	CdB1-ISO7/S	Category 2F	26.1991	19.2402	17.8215	15.2057	11.3077
Study\CdB1\CdB1-ISO7\CdB1-ISO7/S	CdB1-ISO7/S	Category 5D	26.4642	20.382	19.194	16.8744	13.5593
Study\CdB1\CdB1-ISO7\CdB1-ISO7/M	CdB1-ISO7/M	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB1\CdB1-ISO7\CdB1-ISO7/M	CdB1-ISO7/M	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB1\CdB1-ISO7\CdB1-ISO7/L	CdB1-ISO7/L	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB1\CdB1-ISO7\CdB1-ISO7/L	CdB1-ISO7/L	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB1\CdB1-ISO7\CdB1-ISO7/FBR	CdB1-ISO7/FBR	Category 2F	54.8112	39.0998	35.7779	28.3709	19.8648
Study\CdB1\CdB1-ISO7\CdB1-ISO7/FBR	CdB1-ISO7/FBR	Category 5D	55.6771	40.8041	37.9694	31.5662	20.3201
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/S	Category 2F	26.1991	19.2402	17.8215	15.2057	11.3077
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/S	Category 5D	26.4642	20.382	19.194	16.8744	13.5593
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/M	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/M	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/L	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/L	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/FBR	Category 2F	54.8112	39.0998	35.7779	28.3709	19.8648
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/FBR	Category 5D	55.6771	40.8041	37.9694	31.5662	20.3201
Study\CdB1\CdB1-ISO9\CdB1-ISO9/S	CdB1-ISO9/S	Category 2F	26.4524	19.5742	18.17	15.5812	11.7396
Study\CdB1\CdB1-ISO9\CdB1-ISO9/S	CdB1-ISO9/S	Category 5D	27.1231	21.1127	19.9398	17.6529	14.4298
Study\CdB1\CdB1-ISO9\CdB1-ISO9/M	CdB1-ISO9/M	Category 2F	49.7376	35.7481	32.958	26.8934	18.1272
Study\CdB1\CdB1-ISO9\CdB1-ISO9/M	CdB1-ISO9/M	Category 5D	50.5692	37.8657	35.0956	30.1755	19.0422
Study\CdB1\CdB1-ISO9\CdB1-ISO9/L	CdB1-ISO9/L	Category 2F	49.7376	35.7481	32.958	26.8934	18.1272

Path	Scenario	Weather	Distance downwind to intensity level 1 (1.6 kW/m2) (m)	Distance downwind to intensity level 2 (4.7 kW/m2) (m)	Distance downwind to intensity level 3 (6.3 kW/m2) (m)	Distance downwind to intensity level 4 (12.5 kW/m2) (m)	Distance downwind to intensity level 5 (37.5 kW/m2) (m)
Study\CdB1\CdB1-ISO9\CdB1-ISO9/L	CdB1-ISO9/L	Category 5D	50.5692	37.8657	35.0956	30.1755	19.0422
Study\CdB1\CdB1-ISO9\CdB1-ISO9/FBR	CdB1-ISO9/FBR	Category 2F	54.351	39.0507	35.8591	28.7785	20.1324
Study\CdB1\CdB1-ISO9\CdB1-ISO9/FBR	CdB1-ISO9/FBR	Category 5D	55.4179	41.1014	38.1948	32.3229	20.8719
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/S	CdB1-ISO11-1/S	Category 2F	17.499	12.518	11.5236	9.59599	7.20057
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/S	CdB1-ISO11-1/S	Category 5D	17.152	12.809	11.9802	10.4216	8.61121
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/M	CdB1-ISO11-1/M	Category 2F	44.4423	30.4445	27.652	21.5813	12.8145
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/M	CdB1-ISO11-1/M	Category 5D	44.4083	31.6967	28.9239	24.0013	12.8675
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/L	CdB1-ISO11-1/L	Category 2F	44.4423	30.4445	27.652	21.5813	12.8145
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/L	CdB1-ISO11-1/L	Category 5D	44.4083	31.6967	28.9239	24.0013	12.8675
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/FBR	CdB1-ISO11-1/FBR	Category 2F	48.427	33.1169	29.9222	22.8339	14.1907
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/FBR	CdB1-ISO11-1/FBR	Category 5D	48.6592	34.3323	31.427	25.5463	14.0978
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/S	CdB1-ISO11-2/S	Category 2F	17.499	12.518	11.5236	9.59599	7.20057
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/S	CdB1-ISO11-2/S	Category 5D	17.152	12.809	11.9802	10.4216	8.61121
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/M	CdB1-ISO11-2/M	Category 2F	44.4423	30.4445	27.652	21.5813	12.8145
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/M	CdB1-ISO11-2/M	Category 5D	44.4083	31.6967	28.9239	24.0013	12.8675
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/L	CdB1-ISO11-2/L	Category 2F	44.4423	30.4445	27.652	21.5813	12.8145
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/L	CdB1-ISO11-2/L	Category 5D	44.4083	31.6967	28.9239	24.0013	12.8675
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/FBR	CdB1-ISO11-2/FBR	Category 2F	48.427	33.1169	29.9222	22.8339	14.1907
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/FBR	CdB1-ISO11-2/FBR	Category 5D	48.6592	34.3323	31.427	25.5463	14.0978
Study\CdB1\CdB1-ISO12\CdB1-ISO12/S	CdB1-ISO12/S	Category 2F	28.189	21.0067	19.5367	16.8429	12.7694
Study\CdB1\CdB1-ISO12\CdB1-ISO12/S	CdB1-ISO12/S	Category 5D	29.3455	23.0673	21.8332	19.4282	15.8908
Study\CdB1\CdB1-ISO12\CdB1-ISO12/M	CdB1-ISO12/M	Category 2F	49.0355	35.6402	33.0192	27.375	18.7525
Study\CdB1\CdB1-ISO12\CdB1-ISO12/M	CdB1-ISO12/M	Category 5D	50.1484	38.1109	35.5389	30.8246	20.1854
Study\CdB1\CdB1-ISO12\CdB1-ISO12/L	CdB1-ISO12/L	Category 2F	49.0355	35.6402	33.0192	27.375	18.7525
Study\CdB1\CdB1-ISO12\CdB1-ISO12/L	CdB1-ISO12/L	Category 5D	50.1484	38.1109	35.5389	30.8246	20.1854
Study\CdB1\CdB1-ISO12\CdB1-ISO12/FBR	CdB1-ISO12/FBR	Category 2F	53.7964	39.1083	36.1087	29.5091	20.7378
Study\CdB1\CdB1-ISO12\CdB1-ISO12/FBR	CdB1-ISO12/FBR	Category 5D	55.0725	41.5378	38.5628	33.3092	21.8503
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/S	Category 2F	28.189	21.0067	19.5367	16.8429	12.7694
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/S	Category 5D	29.3455	23.0673	21.8332	19.4282	15.8908
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/M	Category 2F	49.0355	35.6402	33.0192	27.375	18.7525
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/M	Category 5D	50.1484	38.1109	35.5389	30.8246	20.1854
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/L	Category 2F	49.0355	35.6402	33.0192	27.375	18.7525
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/L	Category 5D	50.1484	38.1109	35.5389	30.8246	20.1854
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/FBR	Category 2F	53.7964	39.1083	36.1087	29.5091	20.7378
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/FBR	Category 5D	55.0725	41.5378	38.5628	33.3092	21.8503
Study\CdB1\CdB1-ISO13\CdB1-ISO13/S	CdB1-ISO13/S	Category 2F	25.534	18.8184	17.4358	14.9153	10.9737
Study\CdB1\CdB1-ISO13\CdB1-ISO13/S	CdB1-ISO13/S	Category 5D	25.9091	20.0754	18.9314	16.6813	13.2325
Study\CdB1\CdB1-ISO13\CdB1-ISO13/M	CdB1-ISO13/M	Category 2F	47.7665	34.0899	31.3806	25.505	16.6908
Study\CdB1\CdB1-ISO13\CdB1-ISO13/M	CdB1-ISO13/M	Category 5D	48.3708	36.077	33.4265	28.5831	17.6927
Study\CdB1\CdB1-ISO13\CdB1-ISO13/L	CdB1-ISO13/L	Category 2F	47.7665	34.0899	31.3806	25.505	16.6908
Study\CdB1\CdB1-ISO13\CdB1-ISO13/L	CdB1-ISO13/L	Category 5D	48.3708	36.077	33.4265	28.5831	17.6927
Study\CdB1\CdB1-ISO13\CdB1-ISO13/FBR	CdB1-ISO13/FBR	Category 2F	52.401	37.3338	34.227	27.3565	18.4229
Study\CdB1\CdB1-ISO13\CdB1-ISO13/FBR	CdB1-ISO13/FBR	Category 5D	53.2266	39.3349	36.3105	30.822	19.1637
Study\CdB1\CdB1-ISO15\CdB1-ISO15	CdB1-ISO15	Category 2F	25.534	18.8184	17.4358	14.9153	10.9737
Study\CdB1\CdB1-ISO15\CdB1-ISO15	CdB1-ISO15	Category 5D	25.9091	20.0754	18.9314	16.6813	13.2325
Study\CdB1\CdB1-ISO15\CdB1-ISO15/M	CdB1-ISO15/M	Category 2F	47.7665	34.0899	31.3806	25.505	16.6908
Study\CdB1\CdB1-ISO15\CdB1-ISO15/M	CdB1-ISO15/M	Category 5D	48.3708	36.077	33.4265	28.5831	17.6927
Study\CdB1\CdB1-ISO15\CdB1-ISO15/L	CdB1-ISO15/L	Category 2F	47.7665	34.0899	31.3806	25.505	16.6908
Study\CdB1\CdB1-ISO15\CdB1-ISO15/L	CdB1-ISO15/L	Category 5D	48.3708	36.077	33.4265	28.5831	17.6927
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/S	CdB1-ISO17-1/S	Category 2F	16.7179	12.0002	11.0496	9.23192	6.7817
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/S	CdB1-ISO17-1/S	Category 5D	16.4332	12.3446	11.566	10.0889	8.32074
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/M	CdB1-ISO17-1/M	Category 2F	43.2898	29.5886	26.8727	20.9804	12.1599
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/M	CdB1-ISO17-1/M	Category 5D	43.3068	30.9808	28.321	23.4668	12.5451
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/L	CdB1-ISO17-1/L	Category 2F	43.2898	29.5886	26.8727	20.9804	12.1599
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/L	CdB1-ISO17-1/L	Category 5D	43.3068	30.9808	28.321	23.4668	12.5451
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/FBR	CdB1-ISO17-1/FBR	Category 2F	47.3868	32.297	29.1834	22.2961	13.3652
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/FBR	CdB1-ISO17-1/FBR	Category 5D	47.6507	33.726	30.7046	25.1909	13.5316
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/S	CdB1-ISO17-2/S	Category 2F	16.7179	12.0002	11.0496	9.23192	6.7817
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/S	CdB1-ISO17-2/S	Category 5D	16.4332	12.3446	11.566	10.0889	8.32074
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/M	CdB1-ISO17-2/M	Category 2F	43.2898	29.5886	26.8727	20.9804	12.1599
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/M	CdB1-ISO17-2/M	Category 5D	43.3068	30.9808	28.321	23.4668	12.5451
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/L	CdB1-ISO17-2/L	Category 2F	43.2898	29.5886	26.8727	20.9804	12.1599

Path	Scenario	Weather	Distance downwind to intensity level 1 (1.6 kW/m2) (m)	Distance downwind to intensity level 2 (4.7 kW/m2) (m)	Distance downwind to intensity level 3 (6.3 kW/m2) (m)	Distance downwind to intensity level 4 (12.5 kW/m2) (m)	Distance downwind to intensity level 5 (37.5 kW/m2) (m)
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/L	CdB1-ISO17-2/L	Category 5D	43.3068	30.9808	28.321	23.4668	12.5451
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/FBR	CdB1-ISO17-2/FBR	Category 2F	47.3868	32.297	29.1834	22.2961	13.3652
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/FBR	CdB1-ISO17-2/FBR	Category 5D	47.6507	33.726	30.7046	25.1909	13.5316
Study\CdB1\CdB1-ISO18\CdB1-ISO18/S	CdB1-ISO18/S	Category 2F	27.102	20.1172	18.6772	16.0606	11.9073
Study\CdB1\CdB1-ISO18\CdB1-ISO18/S	CdB1-ISO18/S	Category 5D	27.8853	21.8221	20.6298	18.2729	14.6594
Study\CdB1\CdB1-ISO18\CdB1-ISO18/M	CdB1-ISO18/M	Category 2F	47.2053	34.053	31.4846	25.9566	17.2865
Study\CdB1\CdB1-ISO18\CdB1-ISO18/M	CdB1-ISO18/M	Category 5D	48.0666	36.3443	33.8508	29.1902	18.8287
Study\CdB1\CdB1-ISO18\CdB1-ISO18/L	CdB1-ISO18/FBR	Category 2F	47.2053	34.053	31.4846	25.9566	17.2865
Study\CdB1\CdB1-ISO18\CdB1-ISO18/L	CdB1-ISO18/FBR	Category 5D	48.0666	36.3443	33.8508	29.1902	18.8287
Study\CdB1\CdB1-ISO18\CdB1-ISO18/FBR	CdB1-ISO18/FBR	Category 2F	52.005	37.4687	34.5152	28.0369	19.0766
Study\CdB1\CdB1-ISO18\CdB1-ISO18/FBR	CdB1-ISO18/FBR	Category 5D	53.0437	39.7839	36.8371	31.689	20.2072
Study\CdB1\CdB1-ISO3 PAB901 HFO storage tank existing\Full Surface Fire\CdB1-ISO3	Pool fire	Category 2F	44.5894	19.0289	reached at height of inte	ot reached at height of intere	Not reached at height of interest
Study\CdB1\CdB1-ISO3 PAB901 HFO storage tank existing\Full Surface Fire\CdB1-ISO3	Pool fire	Category 5D	46.4094	25.7258	reached at height of inte	ot reached at height of intere	Not reached at height of interest
Study\CdB1\CdB1-ISO3 PAB901 HFO storage tank existing\Bund Fire\CdB1-ISO3	Pool fire	Category 2F	58.5809	37.0949	32.2105	22.5711	15.8171
Study\CdB1\CdB1-ISO3 PAB901 HFO storage tank existing\Bund Fire\CdB1-ISO3	Pool fire	Category 5D	59.0038	39.0764	34.3393	22.6543	16.2562
Study\CdB1\CdB1-ISO4 PAB902 HFO storage tank existing\Full Surface Fire\CdB1-ISO4	Pool fire	Category 2F	44.5894	19.0289	reached at height of inte	ot reached at height of intere	Not reached at height of interest
Study\CdB1\CdB1-ISO4 PAB902 HFO storage tank existing\Full Surface Fire\CdB1-ISO4	Pool fire	Category 5D	46.4094	25.7258	reached at height of inte	ot reached at height of intere	Not reached at height of interest
Study\CdB1\CdB1-ISO4 PAB902 HFO storage tank existing\Bund Fire\CdB1-ISO4	Pool fire	Category 2F	58.5809	37.0949	32.2105	22.5711	15.8171
Study\CdB1\CdB1-ISO4 PAB902 HFO storage tank existing\Bund Fire\CdB1-ISO4	Pool fire	Category 5D	59.0038	39.0764	34.3393	22.6543	16.2562
Study\CdB1\CdB1-ISO6 PBA902 HFO pre-storage tank\Full Surface Fire\CdB1-ISO6	Pool fire	Category 2F	49.7999	reached at height of inte	reached at height of inte	ot reached at height of intere	Not reached at height of interest
Study\CdB1\CdB1-ISO6 PBA902 HFO pre-storage tank\Full Surface Fire\CdB1-ISO6	Pool fire	Category 5D	51.8632	27.8299	reached at height of inte	ot reached at height of intere	Not reached at height of interest
Study\CdB1\CdB1-ISO6 PBA902 HFO pre-storage tank\Bund Fire\CdB1-ISO6	Pool fire	Category 2F	79.3639	49.9311	43.4893	32.0265	24.232
Study\CdB1\CdB1-ISO6 PBA902 HFO pre-storage tank\Bund Fire\CdB1-ISO6	Pool fire	Category 5D	78.8763	52.1607	44.6476	32.5682	24.8166
Study\CdB1\CdB1-ISO8 PBA901 HFO buffer tank\Full Surface Fire\CdB1-ISO8	Pool fire	Category 2F	25.2404	15.889	13.6789	8.15394	Not reached at height of interest
Study\CdB1\CdB1-ISO8 PBA901 HFO buffer tank\Full Surface Fire\CdB1-ISO8	Pool fire	Category 5D	25.8522	16.6689	14.6593	10.6741	Not reached at height of interest
Study\CdB1\CdB1-ISO8 PBA901 HFO buffer tank\Bund Fire\CdB1-ISO8	Pool fire	Category 2F	61.4773	38.8224	33.7012	23.8831	17.0946
Study\CdB1\CdB1-ISO8 PBA901 HFO buffer tank\Bund Fire\CdB1-ISO8	Pool fire	Category 5D	61.7085	40.8158	35.6108	24.0539	17.5609
Study\CdB1\CdB1-ISO10 PBC901 HFO day tank\Full Surface Fire\CdB1-ISO10	Pool fire	Category 2F	25.0627	12.8409	reached at height of inte	ot reached at height of intere	Not reached at height of interest
Study\CdB1\CdB1-ISO10 PBC901 HFO day tank\Full Surface Fire\CdB1-ISO10	Pool fire	Category 5D	25.4578	14.9763	12.3621	ot reached at height of intere	Not reached at height of interest
Study\CdB1\CdB1-ISO10 PBC901 HFO day tank\Bund Fire\CdB1-ISO10	Pool fire	Category 2F	61.4773	38.8224	33.7012	23.8831	17.0946
Study\CdB1\CdB1-ISO10 PBC901 HFO day tank\Bund Fire\CdB1-ISO10	Pool fire	Category 5D	61.7085	40.8158	35.6108	24.0539	17.5609
Study\CdB1\CdB1-ISO14 PAE901 LFO storage tank\Full Surface Fire\CdB1-ISO14	Pool fire	Category 2F	33.1687	19.0011	15.4479	ot reached at height of intere	Not reached at height of interest
Study\CdB1\CdB1-ISO14 PAE901 LFO storage tank\Full Surface Fire\CdB1-ISO14	Pool fire	Category 5D	33.4956	20.9329	18.2457	ot reached at height of intere	Not reached at height of interest
Study\CdB1\CdB1-ISO14 PAE901 LFO storage tank\Bund Fire\CdB1-ISO14	Pool fire	Category 2F	42.982	27.6166	24.4186	17.3253	8.43933
Study\CdB1\CdB1-ISO14 PAE901 LFO storage tank\Bund Fire\CdB1-ISO14	Pool fire	Category 5D	43.3315	29.0636	26.0649	20.2963	8.67204
Study\CdB1\CdB1-ISO16 PBF901 LFO day tank\Full Surface Fire\CdB1-ISO16	Pool fire	Category 2F	26.7416	13.9777	reached at height of inte	ot reached at height of intere	Not reached at height of interest
Study\CdB1\CdB1-ISO16 PBF901 LFO day tank\Full Surface Fire\CdB1-ISO16	Pool fire	Category 5D	27.2652	16.231	13.5329	ot reached at height of intere	Not reached at height of interest
Study\CdB1\CdB1-ISO16 PBF901 LFO day tank\Bund Fire\CdB1-ISO16	Pool fire	Category 2F	64.79	40.4496	35.077	25.2181	17.9915
Study\CdB1\CdB1-ISO16 PBF901 LFO day tank\Bund Fire\CdB1-ISO16	Pool fire	Category 5D	64.3543	42.1192	35.9513	25.4641	18.5159

Jet Fire CdB1

Path	Scenario	Weather	Flame length (m)	Distance downwind to intensity level 1 (1.6 kW/m2) (m)	Distance downwind to intensity level 2 (4.7 kW/m2) (m)	Distance downwind to intensity level 3 (6.3 kW/m2) (m)	Distance downwind to intensity level 4 (12.5 kW/m2) (m)	Distance downwind to intensity level 5 (37.5 kW/m2) (m)
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/S	CdB1-ISO1-1/S	Category 2F	0.194939	0.375083	0.296036	0.275509	0.242279	Not reached at height of interest
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/S	CdB1-ISO1-1/S	Category 5D	0.154301	0.337771	0.257989	0.241297	0.213723	0.176967
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/M	CdB1-ISO1-1/M	Category 2F	0.64785	1.36582	1.0565	0.993586	0.868007	0.701664
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/M	CdB1-ISO1-1/M	Category 5D	0.524346	1.26774	0.952181	0.892781	0.774864	0.633958
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/L	CdB1-ISO1-1/L	Category 2F	0.993568	2.16244	1.65837	1.56142	1.36811	1.11129
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/L	CdB1-ISO1-1/L	Category 5D	0.823948	2.06718	1.54581	1.44392	1.25052	1.02558
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/FBR	CdB1-ISO1-1/FBR	Category 2F	1.11277	2.44346	1.87157	1.76061	1.54248	1.25598
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/FBR	CdB1-ISO1-1/FBR	Category 5D	0.920711	2.3346	1.74283	1.62397	1.4064	1.15381
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/S	CdB1-ISO1-2/S	Category 2F	0.194939	0.375083	0.296036	0.275509	0.242279	Not reached at height of interest
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/S	CdB1-ISO1-2/S	Category 5D	0.154301	0.337771	0.257989	0.241297	0.213723	0.176967
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/M	CdB1-ISO1-2/M	Category 2F	0.64785	1.36582	1.0565	0.993586	0.868007	0.701664
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/M	CdB1-ISO1-2/M	Category 5D	0.524346	1.26774	0.952181	0.892781	0.774864	0.633958
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/L	CdB1-ISO1-2/L	Category 2F	0.993568	2.16244	1.65837	1.56142	1.36811	1.11129
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/L	CdB1-ISO1-2/L	Category 5D	0.823948	2.06718	1.54581	1.44392	1.25052	1.02558
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/FBR	CdB1-ISO1-2/FBR	Category 2F	1.11277	2.44346	1.87157	1.76061	1.54248	1.25598
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/FBR	CdB1-ISO1-2/FBR	Category 5D	0.920711	2.3346	1.74283	1.62397	1.4064	1.15381
Study\CdB1\CdB1-ISO2\CdB1-ISO2/S	CdB1-ISO2/S	Category 2F	0.837126	1.89419	1.44238	1.35242	1.18526	0.977966
Study\CdB1\CdB1-ISO2\CdB1-ISO2/S	CdB1-ISO2/S	Category 5D	0.695385	1.85625	1.36985	1.27167	1.0944	0.8874
Study\CdB1\CdB1-ISO2\CdB1-ISO2/M	CdB1-ISO2/M	Category 2F	2.57361	6.32941	4.75645	4.44707	3.86013	3.18497
Study\CdB1\CdB1-ISO2\CdB1-ISO2/M	CdB1-ISO2/M	Category 5D	2.08912	6.0969	4.43354	4.1107	3.50243	2.82308
Study\CdB1\CdB1-ISO2\CdB1-ISO2/L	CdB1-ISO2/L	Category 2F	2.72284	6.72645	5.05092	4.72169	4.09639	3.37925
Study\CdB1\CdB1-ISO2\CdB1-ISO2/L	CdB1-ISO2/L	Category 5D	2.20513	6.4662	4.69832	4.35525	3.70443	2.98812
Study\CdB1\CdB1-ISO2\CdB1-ISO2/FBR	CdB1-ISO2/FBR	Category 2F	3.1051	7.75115	5.81038	5.42517	4.70494	3.87439
Study\CdB1\CdB1-ISO2\CdB1-ISO2/FBR	CdB1-ISO2/FBR	Category 5D	2.50765	7.43604	5.39375	4.99739	4.24738	3.41846
Study\CdB1\CdB1-ISO5\CdB1-ISO5/S	CdB1-ISO5/S	Category 2F	0.986052	2.25754	1.71782	1.60897	1.40755	1.163
Study\CdB1\CdB1-ISO5\CdB1-ISO5/S	CdB1-ISO5/S	Category 5D	0.818484	2.21147	1.63049	1.51219	1.29998	1.05418
Study\CdB1\CdB1-ISO5\CdB1-ISO5/M	CdB1-ISO5/M	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB1\CdB1-ISO5\CdB1-ISO5/M	CdB1-ISO5/M	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB1\CdB1-ISO5\CdB1-ISO5/L	CdB1-ISO5/L	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB1\CdB1-ISO5\CdB1-ISO5/L	CdB1-ISO5/L	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB1\CdB1-ISO5\CdB1-ISO5/FBR	CdB1-ISO5/FBR	Category 2F	2.7282	6.74219	5.06239	4.73238	4.10551	3.38186
Study\CdB1\CdB1-ISO5\CdB1-ISO5/FBR	CdB1-ISO5/FBR	Category 5D	2.20085	6.45472	4.6898	4.34734	3.69764	2.98255
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/S	Category 2F	0.986052	2.25754	1.71782	1.60897	1.40755	1.163
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/S	Category 5D	0.818484	2.21147	1.63049	1.51219	1.29998	1.05418
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/M	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/M	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/L	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/L	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/FBR	Category 2F	2.7282	6.74219	5.06239	4.73238	4.10551	3.38186
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/FBR	Category 5D	2.20085	6.45472	4.6898	4.34734	3.69764	2.98255
Study\CdB1\CdB1-ISO7\CdB1-ISO7/S	CdB1-ISO7/S	Category 2F	0.986052	2.25754	1.71782	1.60897	1.40755	1.163
Study\CdB1\CdB1-ISO7\CdB1-ISO7/S	CdB1-ISO7/S	Category 5D	0.818484	2.21147	1.63049	1.51219	1.29998	1.05418
Study\CdB1\CdB1-ISO7\CdB1-ISO7/M	CdB1-ISO7/M	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB1\CdB1-ISO7\CdB1-ISO7/M	CdB1-ISO7/M	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB1\CdB1-ISO7\CdB1-ISO7/L	CdB1-ISO7/L	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB1\CdB1-ISO7\CdB1-ISO7/L	CdB1-ISO7/L	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB1\CdB1-ISO7\CdB1-ISO7/FBR	CdB1-ISO7/FBR	Category 2F	2.7282	6.74219	5.06239	4.73238	4.10551	3.38186
Study\CdB1\CdB1-ISO7\CdB1-ISO7/FBR	CdB1-ISO7/FBR	Category 5D	2.20085	6.45472	4.6898	4.34734	3.69764	2.98255
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/S	Category 2F	0.986052	2.25754	1.71782	1.60897	1.40755	1.163
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/S	Category 5D	0.818484	2.21147	1.63049	1.51219	1.29998	1.05418
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/M	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/M	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/L	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139

Path	Scenario	Weather	Flame length (m)	Distance downwind to intensity level 1 (1.6 kW/m2) (m)	Distance downwind to intensity level 2 (4.7 kW/m2) (m)	Distance downwind to intensity level 3 (6.3 kW/m2) (m)	Distance downwind to intensity level 4 (12.5 kW/m2) (m)	Distance downwind to intensity level 5 (37.5 kW/m2) (m)
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/L	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/FBR	Category 2F	2.7282	6.74219	5.06239	4.73238	4.10551	3.38186
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/FBR	Category 5D	2.20085	6.45472	4.6898	4.34734	3.69764	2.98255
Study\CdB1\CdB1-ISO9\CdB1-ISO9/S	CdB1-ISO9/S	Category 2F	1.6234	3.85739	2.91355	2.72844	2.37698	1.96477
Study\CdB1\CdB1-ISO9\CdB1-ISO9/S	CdB1-ISO9/S	Category 5D	1.36594	3.85411	2.81533	2.61561	2.23452	1.80793
Study\CdB1\CdB1-ISO9\CdB1-ISO9/M	CdB1-ISO9/M	Category 2F	3.9054	9.93846	7.42537	6.92909	5.99745	4.93285
Study\CdB1\CdB1-ISO9\CdB1-ISO9/M	CdB1-ISO9/M	Category 5D	3.06071	9.2505	6.6961	6.19421	5.25616	4.22301
Study\CdB1\CdB1-ISO9\CdB1-ISO9/L	CdB1-ISO9/L	Category 2F	3.9054	9.93846	7.42537	6.92909	5.99745	4.93285
Study\CdB1\CdB1-ISO9\CdB1-ISO9/L	CdB1-ISO9/L	Category 5D	3.06071	9.2505	6.6961	6.19421	5.25616	4.22301
Study\CdB1\CdB1-ISO9\CdB1-ISO9/FBR	CdB1-ISO9/FBR	Category 2F	4.61498	11.9058	8.87418	8.27897	7.1536	5.87746
Study\CdB1\CdB1-ISO9\CdB1-ISO9/FBR	CdB1-ISO9/FBR	Category 5D	3.57428	10.9497	7.9106	7.31418	6.19964	4.96985
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/S	CdB1-ISO11-1/S	Category 2F	1.11676	2.40368	1.85138	1.74087	1.52197	1.23685
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/S	CdB1-ISO11-1/S	Category 5D	0.88917	2.18958	1.64204	1.53535	1.33393	1.09904
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/M	CdB1-ISO11-1/M	Category 2F	3.53824	8.38839	6.34384	5.94019	5.16687	4.24763
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/M	CdB1-ISO11-1/M	Category 5D	2.87238	7.8703	5.79922	5.39419	4.63216	3.78259
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/L	CdB1-ISO11-1/L	Category 2F	3.53824	8.38839	6.34384	5.94019	5.16687	4.24763
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/L	CdB1-ISO11-1/L	Category 5D	2.87238	7.8703	5.79922	5.39419	4.63216	3.78259
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/FBR	CdB1-ISO11-1/FBR	Category 2F	4.01195	9.61514	7.25661	6.7955	5.90741	4.84953
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/FBR	CdB1-ISO11-1/FBR	Category 5D	3.29725	9.15643	6.73073	6.257	5.36553	4.37534
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/S	CdB1-ISO11-2/S	Category 2F	1.11676	2.40368	1.85138	1.74087	1.52197	1.23685
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/S	CdB1-ISO11-2/S	Category 5D	0.88917	2.18958	1.64204	1.53535	1.33393	1.09904
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/M	CdB1-ISO11-2/M	Category 2F	3.53824	8.38839	6.34384	5.94019	5.16687	4.24763
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/M	CdB1-ISO11-2/M	Category 5D	2.87238	7.8703	5.79922	5.39419	4.63216	3.78259
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/L	CdB1-ISO11-2/L	Category 2F	3.53824	8.38839	6.34384	5.94019	5.16687	4.24763
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/L	CdB1-ISO11-2/L	Category 5D	2.87238	7.8703	5.79922	5.39419	4.63216	3.78259
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/FBR	CdB1-ISO11-2/FBR	Category 2F	4.01195	9.61514	7.25661	6.7955	5.90741	4.84953
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/FBR	CdB1-ISO11-2/FBR	Category 5D	3.29725	9.15643	6.73073	6.257	5.36553	4.37534
Study\CdB1\CdB1-ISO12\CdB1-ISO12/S	CdB1-ISO12/S	Category 2F	1.42408	3.38163	2.55322	2.39373	2.08423	1.72696
Study\CdB1\CdB1-ISO12\CdB1-ISO12/S	CdB1-ISO12/S	Category 5D	1.21343	3.43699	2.50769	2.32985	1.98929	1.60852
Study\CdB1\CdB1-ISO12\CdB1-ISO12/M	CdB1-ISO12/M	Category 2F	3.00556	7.54934	5.65155	5.27797	4.57552	3.7725
Study\CdB1\CdB1-ISO12\CdB1-ISO12/M	CdB1-ISO12/M	Category 5D	2.37722	7.11665	5.15745	4.77207	4.05215	3.25834
Study\CdB1\CdB1-ISO12\CdB1-ISO12/L	CdB1-ISO12/L	Category 2F	3.00556	7.54934	5.65155	5.27797	4.57552	3.7725
Study\CdB1\CdB1-ISO12\CdB1-ISO12/L	CdB1-ISO12/L	Category 5D	2.37722	7.11665	5.15745	4.77207	4.05215	3.25834
Study\CdB1\CdB1-ISO12\CdB1-ISO12/FBR	CdB1-ISO12/FBR	Category 2F	3.53247	8.98395	6.71288	6.26905	5.42471	4.46952
Study\CdB1\CdB1-ISO12\CdB1-ISO12/FBR	CdB1-ISO12/FBR	Category 5D	2.75624	8.35613	6.04407	5.59002	4.74146	3.80742
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/S	Category 2F	1.42408	3.38163	2.55322	2.39373	2.08423	1.72696
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/S	Category 5D	1.21343	3.43699	2.50769	2.32985	1.98929	1.60852
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/M	Category 2F	3.00556	7.54934	5.65155	5.27797	4.57552	3.7725
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/M	Category 5D	2.37722	7.11665	5.15745	4.77207	4.05215	3.25834
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/L	Category 2F	3.00556	7.54934	5.65155	5.27797	4.57552	3.7725
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/L	Category 5D	2.37722	7.11665	5.15745	4.77207	4.05215	3.25834
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/FBR	Category 2F	3.53247	8.98395	6.71288	6.26905	5.42471	4.46952
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/FBR	Category 5D	2.75624	8.35613	6.04407	5.59002	4.74146	3.80742
Study\CdB1\CdB1-ISO13\CdB1-ISO13/S	CdB1-ISO13/S	Category 2F	2.0043	4.6598	3.53686	3.31536	2.89488	2.39883
Study\CdB1\CdB1-ISO13\CdB1-ISO13/S	CdB1-ISO13/S	Category 5D	1.69034	4.65476	3.41844	3.17769	2.72298	2.20842
Study\CdB1\CdB1-ISO13\CdB1-ISO13/M	CdB1-ISO13/M	Category 2F	4.21288	10.371	7.79942	7.29322	6.33184	5.223
Study\CdB1\CdB1-ISO13\CdB1-ISO13/M	CdB1-ISO13/M	Category 5D	3.53549	10.3647	7.54072	6.98853	5.95111	4.79796
Study\CdB1\CdB1-ISO13\CdB1-ISO13/L	CdB1-ISO13/L	Category 2F	4.21288	10.371	7.79942	7.29322	6.33184	5.223
Study\CdB1\CdB1-ISO13\CdB1-ISO13/L	CdB1-ISO13/L	Category 5D	3.53549	10.3647	7.54072	6.98853	5.95111	4.79796
Study\CdB1\CdB1-ISO13\CdB1-ISO13/FBR	CdB1-ISO13/FBR	Category 2F	4.78895	11.9109	8.942	8.35431	7.24833	5.97584
Study\CdB1\CdB1-ISO13\CdB1-ISO13/FBR	CdB1-ISO13/FBR	Category 5D	4.00556	11.8708	8.62247	7.9876	6.79122	5.47059
Study\CdB1\CdB1-ISO15\CdB1-ISO15	CdB1-ISO15	Category 2F	2.0043	4.6598	3.53686	3.31536	2.89488	2.39883
Study\CdB1\CdB1-ISO15\CdB1-ISO15	CdB1-ISO15	Category 5D	1.69034	4.65476	3.41844	3.17769	2.72298	2.20842
Study\CdB1\CdB1-ISO15\CdB1-ISO15/M	CdB1-ISO15/M	Category 2F	4.21288	10.371	7.79942	7.29322	6.33184	5.223

Path	Scenario	Weather	Flame length (m)	Distance downwind to intensity level 1 (1.6 kW/m2) (m)	Distance downwind to intensity level 2 (4.7 kW/m2) (m)	Distance downwind to intensity level 3 (6.3 kW/m2) (m)	Distance downwind to intensity level 4 (12.5 kW/m2) (m)	Distance downwind to intensity level 5 (37.5 kW/m2) (m)
Study\CdB1\CdB1-ISO15\CdB1-ISO15/M	CdB1-ISO15/M	Category 5D	3.53549	10.3647	7.54072	6.98853	5.95111	4.79796
Study\CdB1\CdB1-ISO15\CdB1-ISO15/L	CdB1-ISO15/L	Category 2F	4.21288	10.371	7.79942	7.29322	6.33184	5.223
Study\CdB1\CdB1-ISO15\CdB1-ISO15/L	CdB1-ISO15/L	Category 5D	3.53549	10.3647	7.54072	6.98853	5.95111	4.79796
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/S	CdB1-ISO17-1/S	Category 2F	0.438969	0.846691	0.664321	0.626088	0.552057	Not reached at height of interest
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/S	CdB1-ISO17-1/S	Category 5D	0.344266	0.749849	0.574395	0.537981	0.475773	0.391574
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/M	CdB1-ISO17-1/M	Category 2F	1.49914	3.17474	2.45148	2.30506	2.0275	1.6425
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/M	CdB1-ISO17-1/M	Category 5D	1.18932	2.86886	2.16443	2.0243	1.76446	1.45857
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/L	CdB1-ISO17-1/L	Category 2F	1.49914	3.17474	2.45148	2.30506	2.0275	1.6425
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/L	CdB1-ISO17-1/L	Category 5D	1.18932	2.86886	2.16443	2.0243	1.76446	1.45857
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/FBR	CdB1-ISO17-1/FBR	Category 2F	1.71054	3.66113	2.82154	2.65236	2.33086	1.89717
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/FBR	CdB1-ISO17-1/FBR	Category 5D	1.37797	3.37229	2.53448	2.37093	2.05727	1.70458
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/S	CdB1-ISO17-2/S	Category 2F	0.438969	0.846691	0.664321	0.626088	0.552057	Not reached at height of interest
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/S	CdB1-ISO17-2/S	Category 5D	0.344266	0.749849	0.574395	0.537981	0.475773	0.391574
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/M	CdB1-ISO17-2/M	Category 2F	1.49914	3.17474	2.45148	2.30506	2.0275	1.6425
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/M	CdB1-ISO17-2/M	Category 5D	1.18932	2.86886	2.16443	2.0243	1.76446	1.45857
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/L	CdB1-ISO17-2/L	Category 2F	1.49914	3.17474	2.45148	2.30506	2.0275	1.6425
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/L	CdB1-ISO17-2/L	Category 5D	1.18932	2.86886	2.16443	2.0243	1.76446	1.45857
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/FBR	CdB1-ISO17-2/FBR	Category 2F	1.71054	3.66113	2.82154	2.65236	2.33086	1.89717
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/FBR	CdB1-ISO17-2/FBR	Category 5D	1.37797	3.37229	2.53448	2.37093	2.05727	1.70458
Study\CdB1\CdB1-ISO18\CdB1-ISO18/S	CdB1-ISO18/S	Category 2F	2.42557	5.76443	4.36206	4.08542	3.56102	2.94963
Study\CdB1\CdB1-ISO18\CdB1-ISO18/S	CdB1-ISO18/S	Category 5D	2.11064	5.99726	4.381	4.06716	3.4725	2.80796
Study\CdB1\CdB1-ISO18\CdB1-ISO18/M	CdB1-ISO18/M	Category 2F	4.6159	11.5291	8.65016	8.08143	7.01012	5.78532
Study\CdB1\CdB1-ISO18\CdB1-ISO18/M	CdB1-ISO18/M	Category 5D	3.93863	11.7945	8.55073	7.91784	6.72546	5.4096
Study\CdB1\CdB1-ISO18\CdB1-ISO18/L	CdB1-ISO18/FBR	Category 2F	4.6159	11.5291	8.65016	8.08143	7.01012	5.78532
Study\CdB1\CdB1-ISO18\CdB1-ISO18/L	CdB1-ISO18/FBR	Category 5D	3.93863	11.7945	8.55073	7.91784	6.72546	5.4096
Study\CdB1\CdB1-ISO18\CdB1-ISO18/FBR	CdB1-ISO18/FBR	Category 2F	5.24888	13.2381	9.91294	9.26131	8.02302	6.61465
Study\CdB1\CdB1-ISO18\CdB1-ISO18/FBR	CdB1-ISO18/FBR	Category 5D	4.44714	13.4571	9.74144	9.01661	7.65184	6.14792
Study\CdB1\CdB1-ISO19\CdB1-ISO19/S	CdB1-ISO19/S	Category 2F	2.11088	2.32048	2.18372	2.15407	2.10714	Not reached at height of interest
Study\CdB1\CdB1-ISO19\CdB1-ISO19/S	CdB1-ISO19/S	Category 5D	2.11061	2.25276	2.15328	2.12791	2.00742	Not reached at height of interest
Study\CdB1\CdB1-ISO19\CdB1-ISO19/M	CdB1-ISO19/M	Category 2F	8.67253	12.6081	10.7672	10.3914	9.64551	8.60142
Study\CdB1\CdB1-ISO19\CdB1-ISO19/M	CdB1-ISO19/M	Category 5D	8.66203	12.0716	10.4714	10.1472	9.49953	8.57399
Study\CdB1\CdB1-ISO19\CdB1-ISO19/L	CdB1-ISO19/L	Category 2F	16.0529	28.0689	22.5755	21.5053	19.4286	16.4286
Study\CdB1\CdB1-ISO19\CdB1-ISO19/L	CdB1-ISO19/L	Category 5D	16.429	27.339	22.3186	21.3605	19.5056	17.0165
Study\CdB1\CdB1-ISO19\CdB1-ISO19/FBR	CdB1-ISO19/FBR	Category 2F	36.332	78.3171	59.3464	55.66	48.5819	39.573
Study\CdB1\CdB1-ISO19\CdB1-ISO19/FBR	CdB1-ISO19/FBR	Category 5D	38.0399	77.4617	59.3213	55.9707	49.5586	41.8004
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/S	Category 2F	2.11088	2.32048	2.18372	2.15407	2.10714	Not reached at height of interest
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/S	Category 5D	2.11061	2.25276	2.15328	2.12791	2.00742	Not reached at height of interest
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/M	Category 2F	8.67253	12.6081	10.7672	10.3914	9.64551	8.60142
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/M	Category 5D	8.66203	12.0716	10.4714	10.1472	9.49953	8.57399
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/L	Category 2F	16.0529	28.0689	22.5755	21.5053	19.4286	16.4286
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/L	Category 5D	16.429	27.339	22.3186	21.3605	19.5056	17.0165
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/FBR	Category 2F	36.332	78.3171	59.3464	55.66	48.5819	39.573
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/FBR	Category 5D	38.0399	77.4617	59.3213	55.9707	49.5586	41.8004

Flash Fire CdB1

Path	Scenario	Weather	Maximum distance (at height of interest) to LFL fraction (m)	Maximum distance (at height of interest) to UFL (m)
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/S	CdB1-ISO1-1/S	Category 2F	3.54792	1.83788
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/S	CdB1-ISO1-1/S	Category 5D	3.74986	1.77376
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/M	CdB1-ISO1-1/M	Category 2F	6.52225	4.09841
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/M	CdB1-ISO1-1/M	Category 5D	6.69963	4.27488
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/L	CdB1-ISO1-1/L	Category 2F	7.33258	4.95697
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/L	CdB1-ISO1-1/L	Category 5D	7.66522	5.26063
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/FBR	CdB1-ISO1-1/FBR	Category 2F	7.58275	5.19828
Study\CdB1\CdB1-ISO1-1\CdB1-ISO1-1/FBR	CdB1-ISO1-1/FBR	Category 5D	7.91317	5.53728
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/S	CdB1-ISO1-2/S	Category 2F	3.54792	1.83788
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/S	CdB1-ISO1-2/S	Category 5D	3.74986	1.77376
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/M	CdB1-ISO1-2/M	Category 2F	6.52225	4.09841
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/M	CdB1-ISO1-2/M	Category 5D	6.69963	4.27488
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/L	CdB1-ISO1-2/L	Category 2F	7.33258	4.95697
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/L	CdB1-ISO1-2/L	Category 5D	7.66522	5.26063
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/FBR	CdB1-ISO1-2/FBR	Category 2F	7.58275	5.19828
Study\CdB1\CdB1-ISO1-2\CdB1-ISO1-2/FBR	CdB1-ISO1-2/FBR	Category 5D	7.91317	5.53728
Study\CdB1\CdB1-ISO2\CdB1-ISO2/S	CdB1-ISO2/S	Category 2F	5.93627	2.15222
Study\CdB1\CdB1-ISO2\CdB1-ISO2/S	CdB1-ISO2/S	Category 5D	5.98274	2.08713
Study\CdB1\CdB1-ISO2\CdB1-ISO2/M	CdB1-ISO2/M	Category 2F	14.2007	7.786
Study\CdB1\CdB1-ISO2\CdB1-ISO2/M	CdB1-ISO2/M	Category 5D	12.5505	7.70949
Study\CdB1\CdB1-ISO2\CdB1-ISO2/L	CdB1-ISO2/L	Category 2F	14.8388	8.23399
Study\CdB1\CdB1-ISO2\CdB1-ISO2/L	CdB1-ISO2/L	Category 5D	13.0025	8.19496
Study\CdB1\CdB1-ISO2\CdB1-ISO2/FBR	CdB1-ISO2/FBR	Category 2F	16.4225	9.35403
Study\CdB1\CdB1-ISO2\CdB1-ISO2/FBR	CdB1-ISO2/FBR	Category 5D	14.1502	9.49664
Study\CdB1\CdB1-ISO3 PAB901 HFO storage tank existing\Catastrophic Rupture\CdB1-I	Catastrophic rupture	Category 2F	13.3838	13.3826
Study\CdB1\CdB1-ISO3 PAB901 HFO storage tank existing\Catastrophic Rupture\CdB1-I	Catastrophic rupture	Category 5D	15.3137	15.3128
Study\CdB1\CdB1-ISO4 PAB902 HFO storage tank existing\Catastrophic Rupture\CdB1-I	Catastrophic rupture	Category 2F	13.3837	13.3825
Study\CdB1\CdB1-ISO4 PAB902 HFO storage tank existing\Catastrophic Rupture\CdB1-I	Catastrophic rupture	Category 5D	15.3136	15.3127
Study\CdB1\CdB1-ISO5\CdB1-ISO5/S	CdB1-ISO5/S	Category 2F	5.96982	2.13581
Study\CdB1\CdB1-ISO5\CdB1-ISO5/S	CdB1-ISO5/S	Category 5D	6.01649	2.07261
Study\CdB1\CdB1-ISO5\CdB1-ISO5/M	CdB1-ISO5/M	Category 2F	11.7117	5.88007
Study\CdB1\CdB1-ISO5\CdB1-ISO5/M	CdB1-ISO5/M	Category 5D	10.7872	5.69578
Study\CdB1\CdB1-ISO5\CdB1-ISO5/L	CdB1-ISO5/L	Category 2F	11.7116	5.87983
Study\CdB1\CdB1-ISO5\CdB1-ISO5/L	CdB1-ISO5/L	Category 5D	10.7872	5.69578
Study\CdB1\CdB1-ISO5\CdB1-ISO5/FBR	CdB1-ISO5/FBR	Category 2F	12.9983	6.80249
Study\CdB1\CdB1-ISO5\CdB1-ISO5/FBR	CdB1-ISO5/FBR	Category 5D	11.7651	6.64349
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/S	Category 2F	5.96982	2.13581
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/S	Category 5D	6.01649	2.07261
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/M	Category 2F	11.7117	5.88007
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/M	Category 5D	10.7872	5.69578
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/L	Category 2F	11.7116	5.87983
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/L	Category 5D	10.7872	5.69578
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/FBR	Category 2F	12.9983	6.80249
Study\CdB1\CdB1-ISO5\Route\CdB1-ISO5\CdB1-ISO5	CdB1-ISO5/FBR	Category 5D	11.7651	6.64349
Study\CdB1\CdB1-ISO6 PBA902 HFO pre-storage tank\Catastrophic Rupture\CdB1-ISO6	Catastrophic rupture	Category 2F	15.8925	15.8915

Path	Scenario	Weather	Maximum distance (at height of interest) to LFL fraction (m)	Maximum distance (at height of interest) to UFL (m)
Study\CdB1\CdB1-ISO6 PBA902 HFO pre-storage tank\Catastrophic Rupture\CdB1-ISO6	Catastrophic rupture	Category 5D	17.9096	17.9087
Study\CdB1\CdB1-ISO7\CdB1-ISO7/S	CdB1-ISO7/S	Category 2F	5.96995	2.13581
Study\CdB1\CdB1-ISO7\CdB1-ISO7/S	CdB1-ISO7/S	Category 5D	6.0165	2.07261
Study\CdB1\CdB1-ISO7\CdB1-ISO7/M	CdB1-ISO7/M	Category 2F	11.7116	5.88031
Study\CdB1\CdB1-ISO7\CdB1-ISO7/M	CdB1-ISO7/M	Category 5D	10.7872	5.69578
Study\CdB1\CdB1-ISO7\CdB1-ISO7/L	CdB1-ISO7/L	Category 2F	11.7116	5.87983
Study\CdB1\CdB1-ISO7\CdB1-ISO7/L	CdB1-ISO7/L	Category 5D	10.7872	5.69578
Study\CdB1\CdB1-ISO7\CdB1-ISO7/FBR	CdB1-ISO7/FBR	Category 2F	12.9983	6.80249
Study\CdB1\CdB1-ISO7\CdB1-ISO7/FBR	CdB1-ISO7/FBR	Category 5D	11.7651	6.64349
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/S	Category 2F	5.96995	2.13581
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/S	Category 5D	6.0165	2.07261
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/M	Category 2F	11.7116	5.88031
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/M	Category 5D	10.7872	5.69578
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/L	Category 2F	11.7116	5.87983
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/L	Category 5D	10.7872	5.69578
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/FBR	Category 2F	12.9983	6.80249
Study\CdB1\CdB1-ISO7\Route\CdB1-ISO7\CdB1-ISO7	CdB1-ISO7/FBR	Category 5D	11.7651	6.64349
Study\CdB1\CdB1-ISO8 PBA901 HFO buffer tank\Catastrophic Rupture\CdB1-ISO8	Catastrophic rupture	Category 2F	6.92965	6.92435
Study\CdB1\CdB1-ISO8 PBA901 HFO buffer tank\Catastrophic Rupture\CdB1-ISO8	Catastrophic rupture	Category 5D	7.61405	7.61312
Study\CdB1\CdB1-ISO9\CdB1-ISO9/S	CdB1-ISO9/S	Category 2F	6.13349	2.06254
Study\CdB1\CdB1-ISO9\CdB1-ISO9/S	CdB1-ISO9/S	Category 5D	6.10002	1.99209
Study\CdB1\CdB1-ISO9\CdB1-ISO9/M	CdB1-ISO9/M	Category 2F	12.0493	5.58718
Study\CdB1\CdB1-ISO9\CdB1-ISO9/M	CdB1-ISO9/M	Category 5D	11.5626	5.33117
Study\CdB1\CdB1-ISO9\CdB1-ISO9/L	CdB1-ISO9/L	Category 2F	12.0494	5.58718
Study\CdB1\CdB1-ISO9\CdB1-ISO9/L	CdB1-ISO9/L	Category 5D	11.5626	5.33117
Study\CdB1\CdB1-ISO9\CdB1-ISO9/FBR	CdB1-ISO9/FBR	Category 2F	13.5137	6.53975
Study\CdB1\CdB1-ISO9\CdB1-ISO9/FBR	CdB1-ISO9/FBR	Category 5D	12.6616	6.2602
Study\CdB1\CdB1-ISO10 PBC901 HFO day tank\Catastrophic Rupture\CdB1-ISO10	Catastrophic rupture	Category 2F	6.84338	6.83871
Study\CdB1\CdB1-ISO10 PBC901 HFO day tank\Catastrophic Rupture\CdB1-ISO10	Catastrophic rupture	Category 5D	8.1946	8.12689
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/S	CdB1-ISO11-1/S	Category 2F	3.01321	1.59273
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/S	CdB1-ISO11-1/S	Category 5D	3.17762	1.50081
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/M	CdB1-ISO11-1/M	Category 2F	4.64042	3.01818
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/M	CdB1-ISO11-1/M	Category 5D	5.32517	3.18576
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/L	CdB1-ISO11-1/L	Category 2F	4.64044	3.01818
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/L	CdB1-ISO11-1/L	Category 5D	5.32527	3.18576
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/FBR	CdB1-ISO11-1/FBR	Category 2F	4.82095	3.20573
Study\CdB1\CdB1-ISO11-1\CdB1-ISO11-1/FBR	CdB1-ISO11-1/FBR	Category 5D	5.52852	3.39715
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/S	CdB1-ISO11-2/S	Category 2F	3.01321	1.59273
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/S	CdB1-ISO11-2/S	Category 5D	3.17762	1.50081
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/M	CdB1-ISO11-2/M	Category 2F	4.64042	3.01818
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/M	CdB1-ISO11-2/M	Category 5D	5.32517	3.18576
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/L	CdB1-ISO11-2/L	Category 2F	4.64044	3.01818
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/L	CdB1-ISO11-2/L	Category 5D	5.32527	3.18576
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/FBR	CdB1-ISO11-2/FBR	Category 2F	4.82095	3.20573
Study\CdB1\CdB1-ISO11-2\CdB1-ISO11-2/FBR	CdB1-ISO11-2/FBR	Category 5D	5.52852	3.39715
Study\CdB1\CdB1-ISO12\CdB1-ISO12/S	CdB1-ISO12/S	Category 2F	6.60778	2.09873

Path	Scenario	Weather	Maximum distance (at height of interest) to LFL fraction (m)	Maximum distance (at height of interest) to UFL (m)
Study\CdB1\CdB1-ISO12\CdB1-ISO12/S	CdB1-ISO12/S	Category 5D	6.43209	2.0371
Study\CdB1\CdB1-ISO12\CdB1-ISO12/M	CdB1-ISO12/M	Category 2F	12.4227	5.15989
Study\CdB1\CdB1-ISO12\CdB1-ISO12/M	CdB1-ISO12/M	Category 5D	12.5995	4.90396
Study\CdB1\CdB1-ISO12\CdB1-ISO12/L	CdB1-ISO12/L	Category 2F	12.4227	5.15992
Study\CdB1\CdB1-ISO12\CdB1-ISO12/L	CdB1-ISO12/L	Category 5D	12.5995	4.90396
Study\CdB1\CdB1-ISO12\CdB1-ISO12/FBR	CdB1-ISO12/FBR	Category 2F	14.0989	6.11615
Study\CdB1\CdB1-ISO12\CdB1-ISO12/FBR	CdB1-ISO12/FBR	Category 5D	13.8862	5.8001
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/S	Category 2F	6.60778	2.09873
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/S	Category 5D	6.43209	2.0371
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/M	Category 2F	12.4227	5.15989
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/M	Category 5D	12.5995	4.90396
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/L	Category 2F	12.4227	5.15992
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/L	Category 5D	12.5995	4.90396
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/FBR	Category 2F	14.0989	6.11615
Study\CdB1\CdB1-ISO12\Route\CdB1-ISO12\CdB1-ISO12	CdB1-ISO12/FBR	Category 5D	13.8862	5.8001
Study\CdB1\CdB1-ISO13\CdB1-ISO13/S	CdB1-ISO13/S	Category 2F	5.81615	2.32301
Study\CdB1\CdB1-ISO13\CdB1-ISO13/S	CdB1-ISO13/S	Category 5D	5.86284	2.24887
Study\CdB1\CdB1-ISO13\CdB1-ISO13/M	CdB1-ISO13/M	Category 2F	10.8786	5.80391
Study\CdB1\CdB1-ISO13\CdB1-ISO13/M	CdB1-ISO13/M	Category 5D	10.2323	5.66235
Study\CdB1\CdB1-ISO13\CdB1-ISO13/L	CdB1-ISO13/L	Category 2F	10.8787	5.80391
Study\CdB1\CdB1-ISO13\CdB1-ISO13/L	CdB1-ISO13/L	Category 5D	10.2323	5.66235
Study\CdB1\CdB1-ISO13\CdB1-ISO13/FBR	CdB1-ISO13/FBR	Category 2F	12.0798	6.70135
Study\CdB1\CdB1-ISO13\CdB1-ISO13/FBR	CdB1-ISO13/FBR	Category 5D	11.1743	6.59697
Study\CdB1\CdB1-ISO14 PAE901 LFO storage tank\Catastrophic Rupture\CdB1-ISO14	Catastrophic rupture	Category 2F	7.9663	7.91329
Study\CdB1\CdB1-ISO14 PAE901 LFO storage tank\Catastrophic Rupture\CdB1-ISO14	Catastrophic rupture	Category 5D	9.61494	9.6122
Study\CdB1\CdB1-ISO15\CdB1-ISO15	CdB1-ISO15	Category 2F	5.81615	2.32301
Study\CdB1\CdB1-ISO15\CdB1-ISO15	CdB1-ISO15	Category 5D	5.86284	2.24887
Study\CdB1\CdB1-ISO15\CdB1-ISO15/M	CdB1-ISO15/M	Category 2F	10.8786	5.80391
Study\CdB1\CdB1-ISO15\CdB1-ISO15/M	CdB1-ISO15/M	Category 5D	10.2323	5.66235
Study\CdB1\CdB1-ISO15\CdB1-ISO15/L	CdB1-ISO15/L	Category 2F	10.8787	5.80391
Study\CdB1\CdB1-ISO15\CdB1-ISO15/L	CdB1-ISO15/L	Category 5D	10.2323	5.66235
Study\CdB1\CdB1-ISO16 PBF901 LFO day tank\Catastrophic Rupture\CdB1-ISO16	Catastrophic rupture	Category 2F	6.84705	6.8462
Study\CdB1\CdB1-ISO16 PBF901 LFO day tank\Catastrophic Rupture\CdB1-ISO16	Catastrophic rupture	Category 5D	8.22183	8.2204
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/S	CdB1-ISO17-1/S	Category 2F	2.75979	1.59781
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/S	CdB1-ISO17-1/S	Category 5D	3.01144	1.53424
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/M	CdB1-ISO17-1/M	Category 2F	3.83324	2.63249
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/M	CdB1-ISO17-1/M	Category 5D	4.79206	2.83848
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/L	CdB1-ISO17-1/L	Category 2F	3.83324	2.63249
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/L	CdB1-ISO17-1/L	Category 5D	4.79206	2.83848
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/FBR	CdB1-ISO17-1/FBR	Category 2F	3.94663	2.75164
Study\CdB1\CdB1-ISO17-1\CdB1-ISO17-1/FBR	CdB1-ISO17-1/FBR	Category 5D	4.85877	2.97007
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/S	CdB1-ISO17-2/S	Category 2F	2.75979	1.59781
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/S	CdB1-ISO17-2/S	Category 5D	3.01144	1.53424
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/M	CdB1-ISO17-2/M	Category 2F	3.83324	2.63249
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/M	CdB1-ISO17-2/M	Category 5D	4.79206	2.83848
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/L	CdB1-ISO17-2/L	Category 2F	3.83324	2.63249

Path	Scenario	Weather	Maximum distance (at height of interest) to LFL fraction (m)	Maximum distance (at height of interest) to UFL (m)
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/L	CdB1-ISO17-2/L	Category 5D	4.79206	2.83848
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/FBR	CdB1-ISO17-2/FBR	Category 2F	3.94663	2.75164
Study\CdB1\CdB1-ISO17-2\CdB1-ISO17-2/FBR	CdB1-ISO17-2/FBR	Category 5D	4.85877	2.97007
Study\CdB1\CdB1-ISO18\CdB1-ISO18/S	CdB1-ISO18/S	Category 2F	6.30144	2.36736
Study\CdB1\CdB1-ISO18\CdB1-ISO18/S	CdB1-ISO18/S	Category 5D	6.23926	2.2914
Study\CdB1\CdB1-ISO18\CdB1-ISO18/M	CdB1-ISO18/M	Category 2F	11.2961	5.52758
Study\CdB1\CdB1-ISO18\CdB1-ISO18/M	CdB1-ISO18/M	Category 5D	11.1872	5.33458
Study\CdB1\CdB1-ISO18\CdB1-ISO18/L	CdB1-ISO18/FBR	Category 2F	11.2962	5.52758
Study\CdB1\CdB1-ISO18\CdB1-ISO18/L	CdB1-ISO18/FBR	Category 5D	11.1872	5.33458
Study\CdB1\CdB1-ISO18\CdB1-ISO18/FBR	CdB1-ISO18/FBR	Category 2F	12.7051	6.48065
Study\CdB1\CdB1-ISO18\CdB1-ISO18/FBR	CdB1-ISO18/FBR	Category 5D	12.3173	6.28058
Study\CdB1\CdB1-ISO19\CdB1-ISO19/S	CdB1-ISO19/S	Category 2F	1.26966	0.550867
Study\CdB1\CdB1-ISO19\CdB1-ISO19/S	CdB1-ISO19/S	Category 5D	1.01864	0.558521
Study\CdB1\CdB1-ISO19\CdB1-ISO19/M	CdB1-ISO19/M	Category 2F	4.69411	1.66493
Study\CdB1\CdB1-ISO19\CdB1-ISO19/M	CdB1-ISO19/M	Category 5D	4.59737	1.45246
Study\CdB1\CdB1-ISO19\CdB1-ISO19/L	CdB1-ISO19/L	Category 2F	9.50708	2.9037
Study\CdB1\CdB1-ISO19\CdB1-ISO19/L	CdB1-ISO19/L	Category 5D	8.97325	2.85649
Study\CdB1\CdB1-ISO19\CdB1-ISO19/FBR	CdB1-ISO19/FBR	Category 2F	27.7216	7.44565
Study\CdB1\CdB1-ISO19\CdB1-ISO19/FBR	CdB1-ISO19/FBR	Category 5D	28.8627	7.15786
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/S	Category 2F	1.26966	0.550867
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/S	Category 5D	1.01864	0.558521
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/M	Category 2F	4.69411	1.66493
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/M	Category 5D	4.59737	1.45246
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/L	Category 2F	9.50708	2.9037
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/L	Category 5D	8.97325	2.85649
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/FBR	Category 2F	27.7216	7.44565
Study\CdB1\CdB1-ISO19\Route\CdB1-ISO19\CdB1-ISO19	CdB1-ISO19/FBR	Category 5D	28.8627	7.15786

Pool Fire CdB2

Path	Scenario	Weather	Distance downwind to intensity level 1 (1.6 kW/m2) (m)	Distance downwind to intensity level 2 (4.7 kW/m2) (m)	Distance downwind to intensity level 3 (6.3 kW/m2) (m)	Distance downwind to intensity level 4 (12.5 kW/m2) (m)	Distance downwind to intensity level 5 (37.5 kW/m2) (m)
Study\CdB2\CdB2-ISO1\CdB2-ISO1/S	CdB2-ISO1/S	Category 2F	26.1991	19.2402	17.8215	15.2057	11.3077
Study\CdB2\CdB2-ISO1\CdB2-ISO1/S	CdB2-ISO1/S	Category 5D	26.4642	20.382	19.194	16.8744	13.5593
Study\CdB2\CdB2-ISO1\CdB2-ISO1/M	CdB2-ISO1/M	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB2\CdB2-ISO1\CdB2-ISO1/M	CdB2-ISO1/M	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB2\CdB2-ISO1\CdB2-ISO1/L	CdB2-ISO1/L	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB2\CdB2-ISO1\CdB2-ISO1/L	CdB2-ISO1/L	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB2\CdB2-ISO1\CdB2-ISO1/FBR	CdB2-ISO1/FBR	Category 2F	54.8112	39.0998	35.7779	28.3709	19.8648
Study\CdB2\CdB2-ISO1\CdB2-ISO1/FBR	CdB2-ISO1/FBR	Category 5D	55.6771	40.8041	37.9694	31.5662	20.3201
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/S	Category 2F	26.1991	19.2402	17.8215	15.2057	11.3077
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/S	Category 5D	26.4642	20.382	19.194	16.8744	13.5593
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/M	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/M	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/L	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/L	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/FBR	Category 2F	54.8112	39.0998	35.7779	28.3709	19.8648
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/FBR	Category 5D	55.6771	40.8041	37.9694	31.5662	20.3201
Study\CdB2\CdB2-ISO3\CdB2-ISO3/S	CdB2-ISO3/S	Category 2F	26.1991	19.2402	17.8215	15.2057	11.3077
Study\CdB2\CdB2-ISO3\CdB2-ISO3/S	CdB2-ISO3/S	Category 5D	26.4642	20.382	19.194	16.8744	13.5593
Study\CdB2\CdB2-ISO3\CdB2-ISO3/M	CdB2-ISO3/M	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB2\CdB2-ISO3\CdB2-ISO3/M	CdB2-ISO3/M	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB2\CdB2-ISO3\CdB2-ISO3/L	CdB2-ISO3/L	Category 2F	50.3048	35.9124	33.0024	26.6358	17.8403
Study\CdB2\CdB2-ISO3\CdB2-ISO3/L	CdB2-ISO3/L	Category 5D	50.9045	37.7292	34.8002	29.7378	18.4293
Study\CdB2\CdB2-ISO3\CdB2-ISO3/FBR	CdB2-ISO3/FBR	Category 2F	54.8112	39.0998	35.7779	28.3709	19.8648
Study\CdB2\CdB2-ISO3\CdB2-ISO3/FBR	CdB2-ISO3/FBR	Category 5D	55.6771	40.8041	37.9694	31.5662	20.3201
Study\CdB2\CdB2-ISO5\CdB2-ISO5/S	CdB2-ISO5/S	Category 2F	26.4524	19.5742	18.17	15.5812	11.7396
Study\CdB2\CdB2-ISO5\CdB2-ISO5/S	CdB2-ISO5/S	Category 5D	27.1231	21.1127	19.9398	17.6529	14.4298
Study\CdB2\CdB2-ISO5\CdB2-ISO5/M	CdB2-ISO5/M	Category 2F	45.3995	32.6462	30.195	24.9807	16.6361
Study\CdB2\CdB2-ISO5\CdB2-ISO5/M	CdB2-ISO5/M	Category 5D	46.0905	34.7451	32.3626	27.8676	18.1176
Study\CdB2\CdB2-ISO5\CdB2-ISO5/L	CdB2-ISO5/L	Category 2F	45.3995	32.6462	30.195	24.9807	16.6361
Study\CdB2\CdB2-ISO5\CdB2-ISO5/L	CdB2-ISO5/L	Category 5D	46.0905	34.7451	32.3626	27.8676	18.1176
Study\CdB2\CdB2-ISO5\CdB2-ISO5/FBR	CdB2-ISO5/FBR	Category 2F	49.8905	35.8589	33.0565	26.9606	18.1914
Study\CdB2\CdB2-ISO5\CdB2-ISO5/FBR	CdB2-ISO5/FBR	Category 5D	50.7224	37.9704	35.1842	30.2497	19.1019
Study\CdB2\CdB2-ISO7\CdB2-ISO7/S	CdB2-ISO7/S	Category 2F	16.461	11.755	10.816	8.98854	6.80479
Study\CdB2\CdB2-ISO7\CdB2-ISO7/S	CdB2-ISO7/S	Category 5D	16.1077	12.0056	11.2259	9.76859	8.09625
Study\CdB2\CdB2-ISO7\CdB2-ISO7/M	CdB2-ISO7/M	Category 2F	40.2064	27.4418	24.9876	19.766	11.4153
Study\CdB2\CdB2-ISO7\CdB2-ISO7/M	CdB2-ISO7/M	Category 5D	39.9685	28.6113	26.2252	21.727	11.9651
Study\CdB2\CdB2-ISO7\CdB2-ISO7/L	CdB2-ISO7/L	Category 2F	40.2064	27.4418	24.9876	19.766	11.4153
Study\CdB2\CdB2-ISO7\CdB2-ISO7/L	CdB2-ISO7/L	Category 5D	39.9685	28.6113	26.2252	21.727	11.9651
Study\CdB2\CdB2-ISO7\CdB2-ISO7/FBR	CdB2-ISO7/FBR	Category 2F	44.0991	30.0556	27.2497	21.1451	12.3751
Study\CdB2\CdB2-ISO7\CdB2-ISO7/FBR	CdB2-ISO7/FBR	Category 5D	44.061	31.2965	28.5061	23.5678	12.4208
Study\CdB2\CdB2-ISO8\CdB2-ISO8/S	CdB2-ISO8/S	Category 2F	26.3877	19.4919	18.0839	15.489	11.6356
Study\CdB2\CdB2-ISO8\CdB2-ISO8/S	CdB2-ISO8/S	Category 5D	26.9465	20.9196	19.7431	17.4487	14.209
Study\CdB2\CdB2-ISO8\CdB2-ISO8/M	CdB2-ISO8/M	Category 2F	44.5542	31.9863	29.5836	24.49	16.2487
Study\CdB2\CdB2-ISO8\CdB2-ISO8/M	CdB2-ISO8/M	Category 5D	45.1481	33.9972	31.6643	27.2342	17.6505
Study\CdB2\CdB2-ISO8\CdB2-ISO8/L	CdB2-ISO8/L	Category 2F	44.5542	31.9863	29.5836	24.49	16.2487
Study\CdB2\CdB2-ISO8\CdB2-ISO8/L	CdB2-ISO8/L	Category 5D	45.1481	33.9972	31.6643	27.2342	17.6505
Study\CdB2\CdB2-ISO8\CdB2-ISO8/FBR	CdB2-ISO8/FBR	Category 2F	49.0613	35.2028	32.4501	26.4797	17.7305
Study\CdB2\CdB2-ISO8\CdB2-ISO8/FBR	CdB2-ISO8/FBR	Category 5D	49.8024	37.247	34.5203	29.6487	18.6101
Study\CdB2\CdB2-ISO9\CdB2-ISO9/S	CdB2-ISO9/S	Category 2F	25.534	18.8184	17.4358	14.9153	10.9737
Study\CdB2\CdB2-ISO9\CdB2-ISO9/S	CdB2-ISO9/S	Category 5D	25.9091	20.0754	18.9314	16.6813	13.2325
Study\CdB2\CdB2-ISO9\CdB2-ISO9/M	CdB2-ISO9/M	Category 2F	54.9572	39.1158	35.7687	28.3129	19.5469
Study\CdB2\CdB2-ISO9\CdB2-ISO9/M	CdB2-ISO9/M	Category 5D	55.9226	41.0368	38.0982	31.81	20.2458
Study\CdB2\CdB2-ISO9\CdB2-ISO9/L	CdB2-ISO9/L	Category 2F	54.9572	39.1158	35.7687	28.3129	19.5469
Study\CdB2\CdB2-ISO9\CdB2-ISO9/L	CdB2-ISO9/L	Category 5D	55.9226	41.0368	38.0982	31.81	20.2458
Study\CdB2\CdB2-ISO9\CdB2-ISO9/FBR	CdB2-ISO9/FBR	Category 2F	59.6304	42.3694	38.5511	30.072	21.92
Study\CdB2\CdB2-ISO9\CdB2-ISO9/FBR	CdB2-ISO9/FBR	Category 5D	60.9021	44.3604	41.3055	32.2339	22.614
Study\CdB2\CdB2-ISO11\CdB2-ISO11/S	CdB2-ISO11/S	Category 2F	25.534	18.8184	17.4358	14.9153	10.9737
Study\CdB2\CdB2-ISO11\CdB2-ISO11/S	CdB2-ISO11/S	Category 5D	25.9091	20.0754	18.9314	16.6813	13.2325
Study\CdB2\CdB2-ISO11\CdB2-ISO11/M	CdB2-ISO11/M	Category 2F	47.7665	34.0899	31.3806	25.505	16.6908
Study\CdB2\CdB2-ISO11\CdB2-ISO11/M	CdB2-ISO11/M	Category 5D	48.3708	36.077	33.4265	28.5831	17.6927
Study\CdB2\CdB2-ISO11\CdB2-ISO11/L	CdB2-ISO11/L	Category 2F	47.7665	34.0899	31.3806	25.505	16.6908
Study\CdB2\CdB2-ISO11\CdB2-ISO11/L	CdB2-ISO11/L	Category 5D	48.3708	36.077	33.4265	28.5831	17.6927
Study\CdB2\CdB2-ISO11\CdB2-ISO11/FBR	CdB2-ISO11/FBR	Category 2F	52.401	37.3338	34.227	27.3565	18.4229
Study\CdB2\CdB2-ISO11\CdB2-ISO11/FBR	CdB2-ISO11/FBR	Category 5D	53.2266	39.3349	36.3105	30.822	19.1637

Path	Scenario	Weather	Distance downwind to intensity level 1 (1.6 kW/m2) (m)	Distance downwind to intensity level 2 (4.7 kW/m2) (m)	Distance downwind to intensity level 3 (6.3 kW/m2) (m)	Distance downwind to intensity level 4 (12.5 kW/m2) (m)	Distance downwind to intensity level 5 (37.5 kW/m2) (m)
Study\CdB2\CdB2-ISO13\CdB2-ISO13/S	CdB2-ISO13/S	Category 2F	15.7152	11.2669	10.3739	8.65188	6.40029
Study\CdB2\CdB2-ISO13\CdB2-ISO13/S	CdB2-ISO13/S	Category 5D	15.4235	11.5707	10.8394	9.46399	7.84992
Study\CdB2\CdB2-ISO13\CdB2-ISO13/M	CdB2-ISO13/M	Category 2F	42.1969	28.7112	26.0537	20.3084	11.5443
Study\CdB2\CdB2-ISO13\CdB2-ISO13/M	CdB2-ISO13/M	Category 5D	42.1704	30.0776	27.4835	22.7027	11.9906
Study\CdB2\CdB2-ISO13\CdB2-ISO13/L	CdB2-ISO13/L	Category 2F	42.8359	29.1342	26.418	20.5253	11.7047
Study\CdB2\CdB2-ISO13\CdB2-ISO13/L	CdB2-ISO13/L	Category 5D	42.8406	30.5139	27.8539	22.9995	12.0773
Study\CdB2\CdB2-ISO13\CdB2-ISO13/FBR	CdB2-ISO13/FBR	Category 2F	46.8869	31.7966	28.6828	21.7952	12.8644
Study\CdB2\CdB2-ISO13\CdB2-ISO13/FBR	CdB2-ISO13/FBR	Category 5D	47.1406	33.2153	30.1939	24.6797	13.0203
Study\CdB2\CdB2-ISO14\CdB2-ISO14/S	CdB2-ISO14/S	Category 2F	25.534	18.8184	17.4358	14.9153	10.9737
Study\CdB2\CdB2-ISO14\CdB2-ISO14/S	CdB2-ISO14/S	Category 5D	25.9091	20.0754	18.9314	16.6813	13.2325
Study\CdB2\CdB2-ISO14\CdB2-ISO14/M	CdB2-ISO14/M	Category 2F	43.1912	30.8803	28.5286	23.5285	15.284
Study\CdB2\CdB2-ISO14\CdB2-ISO14/M	CdB2-ISO14/M	Category 5D	43.6462	32.7911	30.5234	26.1484	16.8092
Study\CdB2\CdB2-ISO2 PBA921 HFO storage tank\Full Surface Fire\CdB2-ISO2	Pool fire	Category 2F	45.0634	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest
Study\CdB2\CdB2-ISO2 PBA921 HFO storage tank\Full Surface Fire\CdB2-ISO2	Pool fire	Category 5D	47.1428	24.8181	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest
Study\CdB2\CdB2-ISO2 PBA921 HFO storage tank\Bund Fire\CdB2-ISO2	Pool fire	Category 2F	67.4742	42.486	36.9163	26.6506	19.6136
Study\CdB2\CdB2-ISO2 PBA921 HFO storage tank\Bund Fire\CdB2-ISO2	Pool fire	Category 5D	67.3591	44.4924	38.3556	26.9829	20.121
Study\CdB2\CdB2-ISO4 PBA921 HFO buffer tank\Full Surface Fire\CdB2-ISO4	Pool fire	Category 2F	19.4429	10.67	8.15553	Not reached at height of interest	Not reached at height of interest
Study\CdB2\CdB2-ISO4 PBA921 HFO buffer tank\Full Surface Fire\CdB2-ISO4	Pool fire	Category 5D	19.5451	11.7284	10.0071	Not reached at height of interest	Not reached at height of interest
Study\CdB2\CdB2-ISO4 PBA921 HFO buffer tank\Bund Fire\CdB2-ISO4	Pool fire	Category 2F	48.9077	31.476	27.5624	18.8963	11.3461
Study\CdB2\CdB2-ISO4 PBA921 HFO buffer tank\Bund Fire\CdB2-ISO4	Pool fire	Category 5D	49.7061	32.9876	29.7855	19.8333	11.6773
Study\CdB2\CdB2-ISO6 PBC921 HFO day tank\Full Surface Fire\CdB2-ISO6	Pool fire	Category 2F	25.732	14.7659	12.0984	Not reached at height of interest	Not reached at height of interest
Study\CdB2\CdB2-ISO6 PBC921 HFO day tank\Full Surface Fire\CdB2-ISO6	Pool fire	Category 5D	25.7527	16.0298	13.8788	Not reached at height of interest	Not reached at height of interest
Study\CdB2\CdB2-ISO6 PBC921 HFO day tank\Bund Fire\CdB2-ISO6	Pool fire	Category 2F	48.9077	31.476	27.5624	18.8963	11.3461
Study\CdB2\CdB2-ISO6 PBC921 HFO day tank\Bund Fire\CdB2-ISO6	Pool fire	Category 5D	49.7061	32.9876	29.7855	19.8333	11.6773
Study\CdB2\CdB2-ISO10 PAE901 LFO storage tank\Full Surface Fire\CdB2-ISO10	Pool fire	Category 2F	33.1687	19.0011	15.4479	Not reached at height of interest	Not reached at height of interest
Study\CdB2\CdB2-ISO10 PAE901 LFO storage tank\Full Surface Fire\CdB2-ISO10	Pool fire	Category 5D	33.4956	20.9329	18.2457	Not reached at height of interest	Not reached at height of interest
Study\CdB2\CdB2-ISO10 PAE901 LFO storage tank\Bund Fire\CdB2-ISO10	Pool fire	Category 2F	42.982	27.6166	24.4186	17.3253	8.43933
Study\CdB2\CdB2-ISO10 PAE901 LFO storage tank\Bund Fire\CdB2-ISO10	Pool fire	Category 5D	43.3315	29.0636	26.0649	20.2963	8.67204
Study\CdB2\CdB2-ISO12 PBF921 LFO day tank\Full Surface Fire\CdB2-ISO12	Pool fire	Category 2F	27.1074	15.79	12.9836	Not reached at height of interest	Not reached at height of interest
Study\CdB2\CdB2-ISO12 PBF921 LFO day tank\Full Surface Fire\CdB2-ISO12	Pool fire	Category 5D	27.5384	17.1789	14.973	Not reached at height of interest	Not reached at height of interest
Study\CdB2\CdB2-ISO12 PBF921 LFO day tank\Bund Fire\CdB2-ISO12	Pool fire	Category 2F	51.7268	32.994	28.7208	19.5326	12.0398
Study\CdB2\CdB2-ISO12 PBF921 LFO day tank\Bund Fire\CdB2-ISO12	Pool fire	Category 5D	52.6969	34.8602	31.229	20.1531	12.4197

Jet Fire CdB2

Path	Scenario	Weather	Flame length (m)	Distance downwind to intensity level 1 (1.6 kW/m2) (m)	Distance downwind to intensity level 2 (4.7 kW/m2) (m)	Distance downwind to intensity level 3 (6.3 kW/m2) (m)	Distance downwind to intensity level 4 (12.5 kW/m2) (m)	Distance downwind to intensity level 5 (37.5 kW/m2) (m)
Study\CdB2\CdB2-ISO1\CdB2-ISO1/S	CdB2-ISO1/S	Category 2F	0.986052	2.25754	1.71782	1.60897	1.40755	1.163
Study\CdB2\CdB2-ISO1\CdB2-ISO1/S	CdB2-ISO1/S	Category 5D	0.818484	2.21147	1.63049	1.51219	1.29998	1.05418
Study\CdB2\CdB2-ISO1\CdB2-ISO1/M	CdB2-ISO1/M	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB2\CdB2-ISO1\CdB2-ISO1/M	CdB2-ISO1/M	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB2\CdB2-ISO1\CdB2-ISO1/L	CdB2-ISO1/L	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB2\CdB2-ISO1\CdB2-ISO1/L	CdB2-ISO1/L	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB2\CdB2-ISO1\CdB2-ISO1/FBR	CdB2-ISO1/FBR	Category 2F	2.7282	6.74219	5.06239	4.73238	4.10551	3.38186
Study\CdB2\CdB2-ISO1\CdB2-ISO1/FBR	CdB2-ISO1/FBR	Category 5D	2.20085	6.45472	4.6898	4.34734	3.69764	2.98255
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/S	Category 2F	0.986052	2.25754	1.71782	1.60897	1.40755	1.163
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/S	Category 5D	0.818484	2.21147	1.63049	1.51219	1.29998	1.05418
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/M	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/M	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/L	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/L	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/FBR	Category 2F	2.7282	6.74219	5.06239	4.73238	4.10551	3.38186
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/FBR	Category 5D	2.20085	6.45472	4.6898	4.34734	3.69764	2.98255
Study\CdB2\CdB2-ISO3\CdB2-ISO3/S	CdB2-ISO3/S	Category 2F	0.986052	2.25754	1.71782	1.60897	1.40755	1.163
Study\CdB2\CdB2-ISO3\CdB2-ISO3/S	CdB2-ISO3/S	Category 5D	0.818484	2.21147	1.63049	1.51219	1.29998	1.05418
Study\CdB2\CdB2-ISO3\CdB2-ISO3/M	CdB2-ISO3/M	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB2\CdB2-ISO3\CdB2-ISO3/M	CdB2-ISO3/M	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB2\CdB2-ISO3\CdB2-ISO3/L	CdB2-ISO3/L	Category 2F	2.36419	5.77651	4.34603	4.06436	3.53048	2.9139
Study\CdB2\CdB2-ISO3\CdB2-ISO3/L	CdB2-ISO3/L	Category 5D	1.91723	5.55514	4.04445	3.75119	3.19782	2.57989
Study\CdB2\CdB2-ISO3\CdB2-ISO3/FBR	CdB2-ISO3/FBR	Category 2F	2.7282	6.74219	5.06239	4.73238	4.10551	3.38186
Study\CdB2\CdB2-ISO3\CdB2-ISO3/FBR	CdB2-ISO3/FBR	Category 5D	2.20085	6.45472	4.6898	4.34734	3.69764	2.98255
Study\CdB2\CdB2-ISO5\CdB2-ISO5/S	CdB2-ISO5/S	Category 2F	1.6234	3.85739	2.91355	2.72844	2.37698	1.96477
Study\CdB2\CdB2-ISO5\CdB2-ISO5/S	CdB2-ISO5/S	Category 5D	1.36594	3.85411	2.81533	2.61561	2.23452	1.80793
Study\CdB2\CdB2-ISO5\CdB2-ISO5/M	CdB2-ISO5/M	Category 2F	3.34673	8.41381	6.29959	5.88199	5.0959	4.19575
Study\CdB2\CdB2-ISO5\CdB2-ISO5/M	CdB2-ISO5/M	Category 5D	2.6539	7.92212	5.74042	5.31703	4.51664	3.62971
Study\CdB2\CdB2-ISO5\CdB2-ISO5/L	CdB2-ISO5/L	Category 2F	3.34673	8.41381	6.29959	5.88199	5.0959	4.19575
Study\CdB2\CdB2-ISO5\CdB2-ISO5/L	CdB2-ISO5/L	Category 5D	2.6539	7.92212	5.74042	5.31703	4.51664	3.62971
Study\CdB2\CdB2-ISO5\CdB2-ISO5/FBR	CdB2-ISO5/FBR	Category 2F	3.92968	10.0055	7.47466	6.97487	6.03682	4.96501
Study\CdB2\CdB2-ISO5\CdB2-ISO5/FBR	CdB2-ISO5/FBR	Category 5D	3.07658	9.30266	6.7334	6.22861	5.28513	4.2461
Study\CdB2\CdB2-ISO7\CdB2-ISO7/S	CdB2-ISO7/S	Category 2F	0.955745	2.00693	1.55164	1.46265	1.28418	1.03989
Study\CdB2\CdB2-ISO7\CdB2-ISO7/S	CdB2-ISO7/S	Category 5D	0.758447	1.81085	1.36948	1.2776	1.11687	0.922507
Study\CdB2\CdB2-ISO7\CdB2-ISO7/M	CdB2-ISO7/M	Category 2F	2.8025	6.43721	4.89728	4.59302	4.00786	3.29709
Study\CdB2\CdB2-ISO7\CdB2-ISO7/M	CdB2-ISO7/M	Category 5D	2.27955	6.02325	4.4658	4.16256	3.58979	2.94633
Study\CdB2\CdB2-ISO7\CdB2-ISO7/L	CdB2-ISO7/L	Category 2F	2.8025	6.43721	4.89728	4.59302	4.00786	3.29709
Study\CdB2\CdB2-ISO7\CdB2-ISO7/L	CdB2-ISO7/L	Category 5D	2.27955	6.02325	4.4658	4.16256	3.58979	2.94633
Study\CdB2\CdB2-ISO7\CdB2-ISO7/FBR	CdB2-ISO7/FBR	Category 2F	3.18941	7.40879	5.62617	5.27264	4.59627	3.78156
Study\CdB2\CdB2-ISO7\CdB2-ISO7/FBR	CdB2-ISO7/FBR	Category 5D	2.60927	6.98466	5.16705	4.81349	4.14486	3.39799
Study\CdB2\CdB2-ISO8\CdB2-ISO8/S	CdB2-ISO8/S	Category 2F	1.48807	3.5121	2.65626	2.48945	2.16826	1.79194
Study\CdB2\CdB2-ISO8\CdB2-ISO8/S	CdB2-ISO8/S	Category 5D	1.24424	3.48225	2.54684	2.36714	2.02411	1.63888
Study\CdB2\CdB2-ISO8\CdB2-ISO8/M	CdB2-ISO8/M	Category 2F	2.98208	7.42579	5.56932	5.20531	4.51152	3.71596
Study\CdB2\CdB2-ISO8\CdB2-ISO8/M	CdB2-ISO8/M	Category 5D	2.38651	7.0565	5.12035	4.74472	4.03337	3.24913
Study\CdB2\CdB2-ISO8\CdB2-ISO8/L	CdB2-ISO8/L	Category 2F	2.98208	7.42579	5.56932	5.20531	4.51152	3.71596
Study\CdB2\CdB2-ISO8\CdB2-ISO8/L	CdB2-ISO8/L	Category 5D	2.38651	7.0565	5.12035	4.74472	4.03337	3.24913
Study\CdB2\CdB2-ISO8\CdB2-ISO8/FBR	CdB2-ISO8/FBR	Category 2F	3.48855	8.79829	6.58381	6.14658	5.32323	4.38165
Study\CdB2\CdB2-ISO8\CdB2-ISO8/FBR	CdB2-ISO8/FBR	Category 5D	2.76179	8.27017	5.99497	5.5474	4.71114	3.78894
Study\CdB2\CdB2-ISO9\CdB2-ISO9/S	CdB2-ISO9/S	Category 2F	2.0043	4.6598	3.53686	3.31536	2.89488	2.39883
Study\CdB2\CdB2-ISO9\CdB2-ISO9/S	CdB2-ISO9/S	Category 5D	1.69034	4.65476	3.41844	3.17769	2.72298	2.20842
Study\CdB2\CdB2-ISO9\CdB2-ISO9/M	CdB2-ISO9/M	Category 2F	5.1307	12.8284	9.62103	8.98729	7.7915	6.42034
Study\CdB2\CdB2-ISO9\CdB2-ISO9/M	CdB2-ISO9/M	Category 5D	4.28289	12.767	9.26545	8.58125	7.29276	5.87054
Study\CdB2\CdB2-ISO9\CdB2-ISO9/L	CdB2-ISO9/L	Category 2F	5.1307	12.8284	9.62103	8.98729	7.7915	6.42034
Study\CdB2\CdB2-ISO9\CdB2-ISO9/L	CdB2-ISO9/L	Category 5D	4.28289	12.767	9.26545	8.58125	7.29276	5.87054
Study\CdB2\CdB2-ISO9\CdB2-ISO9/FBR	CdB2-ISO9/FBR	Category 2F	5.79776	14.6214	10.9373	10.2149	8.84355	7.27789
Study\CdB2\CdB2-ISO9\CdB2-ISO9/FBR	CdB2-ISO9/FBR	Category 5D	4.81844	14.5091	10.5133	9.7327	8.26372	6.64335

Path	Scenario	Weather	Flame length (m)	Distance downwind to intensity level 1 (1.6 kW/m2) (m)	Distance downwind to intensity level 2 (4.7 kW/m2) (m)	Distance downwind to intensity level 3 (6.3 kW/m2) (m)	Distance downwind to intensity level 4 (12.5 kW/m2) (m)	Distance downwind to intensity level 5 (37.5 kW/m2) (m)
Study\CdB2\CdB2-ISO11\CdB2-ISO11/S	CdB2-ISO11/S	Category 2F	2.0043	4.6598	3.53686	3.31536	2.89488	2.39883
Study\CdB2\CdB2-ISO11\CdB2-ISO11/S	CdB2-ISO11/S	Category 5D	1.69034	4.65476	3.41844	3.17769	2.72298	2.20842
Study\CdB2\CdB2-ISO11\CdB2-ISO11/M	CdB2-ISO11/M	Category 2F	4.21288	10.371	7.79942	7.29322	6.33184	5.223
Study\CdB2\CdB2-ISO11\CdB2-ISO11/M	CdB2-ISO11/M	Category 5D	3.53549	10.3647	7.54072	6.98853	5.95111	4.79796
Study\CdB2\CdB2-ISO11\CdB2-ISO11/L	CdB2-ISO11/L	Category 2F	4.21288	10.371	7.79942	7.29322	6.33184	5.223
Study\CdB2\CdB2-ISO11\CdB2-ISO11/L	CdB2-ISO11/L	Category 5D	3.53549	10.3647	7.54072	6.98853	5.95111	4.79796
Study\CdB2\CdB2-ISO11\CdB2-ISO11/FBR	CdB2-ISO11/FBR	Category 2F	4.78895	11.9109	8.942	8.35431	7.24833	5.97584
Study\CdB2\CdB2-ISO11\CdB2-ISO11/FBR	CdB2-ISO11/FBR	Category 5D	4.00556	11.8708	8.62247	7.9876	6.79122	5.47059
Study\CdB2\CdB2-ISO13\CdB2-ISO13/S	CdB2-ISO13/S	Category 2F	0.355613	0.664211	0.525543	0.498222	0.437503	Not reached at height of interest
Study\CdB2\CdB2-ISO13\CdB2-ISO13/S	CdB2-ISO13/S	Category 5D	0.277737	0.585127	0.451862	0.422312	0.374863	0.307979
Study\CdB2\CdB2-ISO13\CdB2-ISO13/M	CdB2-ISO13/M	Category 2F	1.25411	2.58285	2.00886	1.89029	1.66657	1.36764
Study\CdB2\CdB2-ISO13\CdB2-ISO13/M	CdB2-ISO13/M	Category 5D	1.0012	2.3428	1.77566	1.66688	1.45764	1.20717
Study\CdB2\CdB2-ISO13\CdB2-ISO13/L	CdB2-ISO13/L	Category 2F	1.27719	2.63431	2.04824	1.92734	1.69901	1.39299
Study\CdB2\CdB2-ISO13\CdB2-ISO13/L	CdB2-ISO13/L	Category 5D	1.01815	2.38619	1.80783	1.69719	1.48379	1.2293
Study\CdB2\CdB2-ISO13\CdB2-ISO13/FBR	CdB2-ISO13/FBR	Category 2F	1.48779	3.10752	2.40985	2.26735	1.99662	1.62434
Study\CdB2\CdB2-ISO13\CdB2-ISO13/FBR	CdB2-ISO13/FBR	Category 5D	1.19068	2.83104	2.14237	2.0038	1.75139	1.45205
Study\CdB2\CdB2-ISO14\CdB2-ISO14/S	CdB2-ISO14/S	Category 2F	2.0043	4.6598	3.53686	3.31536	2.89488	2.39883
Study\CdB2\CdB2-ISO14\CdB2-ISO14/S	CdB2-ISO14/S	Category 5D	1.69034	4.65476	3.41844	3.17769	2.72298	2.20842
Study\CdB2\CdB2-ISO14\CdB2-ISO14/M	CdB2-ISO14/M	Category 2F	3.69652	9.00533	6.78467	6.34678	5.5165	4.55681
Study\CdB2\CdB2-ISO14\CdB2-ISO14/M	CdB2-ISO14/M	Category 5D	3.10915	9.0139	6.5692	6.09092	5.19162	4.19133
Study\CdB2\CdB2-ISO15\CdB2-ISO15/S	CdB2-ISO15/S	Category 2F	2.11088	2.32048	2.18372	2.15407	2.10714	Not reached at height of interest
Study\CdB2\CdB2-ISO15\CdB2-ISO15/S	CdB2-ISO15/S	Category 5D	2.11061	2.25276	2.15328	2.12791	2.00742	Not reached at height of interest
Study\CdB2\CdB2-ISO15\CdB2-ISO15/M	CdB2-ISO15/M	Category 2F	8.67253	12.6081	10.7672	10.3914	9.64551	8.60142
Study\CdB2\CdB2-ISO15\CdB2-ISO15/M	CdB2-ISO15/M	Category 5D	8.66203	12.0716	10.4714	10.1472	9.49953	8.57399
Study\CdB2\CdB2-ISO15\CdB2-ISO15/L	CdB2-ISO15/L	Category 2F	16.0529	28.0689	22.5755	21.5053	19.4286	16.4286
Study\CdB2\CdB2-ISO15\CdB2-ISO15/L	CdB2-ISO15/L	Category 5D	16.429	27.339	22.3186	21.3605	19.5056	17.0165
Study\CdB2\CdB2-ISO15\CdB2-ISO15/FBR	CdB2-ISO15/FBR	Category 2F	36.332	78.3171	59.3464	55.66	48.5819	39.573
Study\CdB2\CdB2-ISO15\CdB2-ISO15/FBR	CdB2-ISO15/FBR	Category 5D	38.0399	77.4617	59.3213	55.9707	49.5586	41.8004
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/S	Category 2F	2.11088	2.32048	2.18372	2.15407	2.10714	Not reached at height of interest
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/S	Category 5D	2.11061	2.25276	2.15328	2.12791	2.00742	Not reached at height of interest
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/M	Category 2F	8.67253	12.6081	10.7672	10.3914	9.64551	8.60142
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/M	Category 5D	8.66203	12.0716	10.4714	10.1472	9.49953	8.57399
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/L	Category 2F	16.0529	28.0689	22.5755	21.5053	19.4286	16.4286
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/L	Category 5D	16.429	27.339	22.3186	21.3605	19.5056	17.0165
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/FBR	Category 2F	36.332	78.3171	59.3464	55.66	48.5819	39.573
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/FBR	Category 5D	38.0399	77.4617	59.3213	55.9707	49.5586	41.8004

Flash Fire CdB2

Path	Scenario	Weather	Maximum distance (at height of interest) to LFL fraction (m)	Maximum distance (at height of interest) to UFL (m)
Study\CdB2\CdB2-ISO1\CdB2-ISO1/S	CdB2-ISO1/S	Category 2F	5.96991	2.13581
Study\CdB2\CdB2-ISO1\CdB2-ISO1/S	CdB2-ISO1/S	Category 5D	6.0165	2.07261
Study\CdB2\CdB2-ISO1\CdB2-ISO1/M	CdB2-ISO1/M	Category 2F	11.7117	5.88007
Study\CdB2\CdB2-ISO1\CdB2-ISO1/M	CdB2-ISO1/M	Category 5D	10.7872	5.69578
Study\CdB2\CdB2-ISO1\CdB2-ISO1/L	CdB2-ISO1/L	Category 2F	11.7116	5.87983
Study\CdB2\CdB2-ISO1\CdB2-ISO1/L	CdB2-ISO1/L	Category 5D	10.7872	5.69578
Study\CdB2\CdB2-ISO1\CdB2-ISO1/FBR	CdB2-ISO1/FBR	Category 2F	12.9983	6.80249
Study\CdB2\CdB2-ISO1\CdB2-ISO1/FBR	CdB2-ISO1/FBR	Category 5D	11.7651	6.64349
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/S	Category 2F	5.96991	2.13581
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/S	Category 5D	6.0165	2.07261
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/M	Category 2F	11.7117	5.88007
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/M	Category 5D	10.7872	5.69578
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/L	Category 2F	11.7116	5.87983
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/L	Category 5D	10.7872	5.69578
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/FBR	Category 2F	12.9983	6.80249
Study\CdB2\CdB2-ISO1\Route\CdB2-ISO1\CdB2-ISO1	CdB2-ISO1/FBR	Category 5D	11.7651	6.64349
Study\CdB2\CdB2-ISO2 PBA921 HFO storage tank\Catastrophic Rupture\CdB2-ISO2	Catastrophic rupture	Category 2F	14.3145	14.3133
Study\CdB2\CdB2-ISO2 PBA921 HFO storage tank\Catastrophic Rupture\CdB2-ISO2	Catastrophic rupture	Category 5D	16.2999	16.299
Study\CdB2\CdB2-ISO3\CdB2-ISO3/S	CdB2-ISO3/S	Category 2F	5.96995	2.13581
Study\CdB2\CdB2-ISO3\CdB2-ISO3/S	CdB2-ISO3/S	Category 5D	6.0165	2.07261
Study\CdB2\CdB2-ISO3\CdB2-ISO3/M	CdB2-ISO3/M	Category 2F	11.7116	5.88031
Study\CdB2\CdB2-ISO3\CdB2-ISO3/M	CdB2-ISO3/M	Category 5D	10.7872	5.69578
Study\CdB2\CdB2-ISO3\CdB2-ISO3/L	CdB2-ISO3/L	Category 2F	11.7116	5.87983
Study\CdB2\CdB2-ISO3\CdB2-ISO3/L	CdB2-ISO3/L	Category 5D	10.7872	5.69578
Study\CdB2\CdB2-ISO3\CdB2-ISO3/FBR	CdB2-ISO3/FBR	Category 2F	12.9983	6.80249
Study\CdB2\CdB2-ISO3\CdB2-ISO3/FBR	CdB2-ISO3/FBR	Category 5D	11.7651	6.64349
Study\CdB2\CdB2-ISO4 PBA921 HFO buffer tank\Catastrophic Rupture\CdB2-ISO4	Catastrophic rupture	Category 2F	5.09422	5.09364
Study\CdB2\CdB2-ISO4 PBA921 HFO buffer tank\Catastrophic Rupture\CdB2-ISO4	Catastrophic rupture	Category 5D	7.20562	7.2033
Study\CdB2\CdB2-ISO5\CdB2-ISO5/S	CdB2-ISO5/S	Category 2F	6.13349	2.06254
Study\CdB2\CdB2-ISO5\CdB2-ISO5/S	CdB2-ISO5/S	Category 5D	6.10002	1.99209
Study\CdB2\CdB2-ISO5\CdB2-ISO5/M	CdB2-ISO5/M	Category 2F	10.7999	4.77907
Study\CdB2\CdB2-ISO5\CdB2-ISO5/M	CdB2-ISO5/M	Category 5D	10.6016	4.56329
Study\CdB2\CdB2-ISO5\CdB2-ISO5/L	CdB2-ISO5/L	Category 2F	10.8	4.77916
Study\CdB2\CdB2-ISO5\CdB2-ISO5/L	CdB2-ISO5/L	Category 5D	10.6016	4.56329
Study\CdB2\CdB2-ISO5\CdB2-ISO5/FBR	CdB2-ISO5/FBR	Category 2F	12.1013	5.62208
Study\CdB2\CdB2-ISO5\CdB2-ISO5/FBR	CdB2-ISO5/FBR	Category 5D	11.5943	5.35948
Study\CdB2\CdB2-ISO6 PBC921 HFO day tank\Catastrophic Rupture\CdB2-ISO6	Catastrophic rupture	Category 2F	6.69441	6.69373
Study\CdB2\CdB2-ISO6 PBC921 HFO day tank\Catastrophic Rupture\CdB2-ISO6	Catastrophic rupture	Category 5D	8.17691	8.17613
Study\CdB2\CdB2-ISO7\CdB2-ISO7/S	CdB2-ISO7/S	Category 2F	2.55925	1.46149
Study\CdB2\CdB2-ISO7\CdB2-ISO7/S	CdB2-ISO7/S	Category 5D	2.87056	1.34537
Study\CdB2\CdB2-ISO7\CdB2-ISO7/M	CdB2-ISO7/M	Category 2F	3.51785	2.34534
Study\CdB2\CdB2-ISO7\CdB2-ISO7/M	CdB2-ISO7/M	Category 5D	4.42013	2.48916
Study\CdB2\CdB2-ISO7\CdB2-ISO7/L	CdB2-ISO7/L	Category 2F	3.51785	2.34533
Study\CdB2\CdB2-ISO7\CdB2-ISO7/L	CdB2-ISO7/L	Category 5D	4.42013	2.48916
Study\CdB2\CdB2-ISO7\CdB2-ISO7/FBR	CdB2-ISO7/FBR	Category 2F	3.65865	2.48189

Path	Scenario	Weather	Maximum distance (at height of interest) to LFL fraction (m)	Maximum distance (at height of interest) to UFL (m)
Study\CdB2\CdB2-ISO7\CdB2-ISO7/FBR	CdB2-ISO7/FBR	Category 5D	4.5413	2.64031
Study\CdB2\CdB2-ISO8\CdB2-ISO8/S	CdB2-ISO8/S	Category 2F	6.09811	2.08132
Study\CdB2\CdB2-ISO8\CdB2-ISO8/S	CdB2-ISO8/S	Category 5D	6.09589	2.00956
Study\CdB2\CdB2-ISO8\CdB2-ISO8/M	CdB2-ISO8/M	Category 2F	10.476	4.68009
Study\CdB2\CdB2-ISO8\CdB2-ISO8/M	CdB2-ISO8/M	Category 5D	10.2165	4.47466
Study\CdB2\CdB2-ISO8\CdB2-ISO8/L	CdB2-ISO8/L	Category 2F	10.4762	4.68008
Study\CdB2\CdB2-ISO8\CdB2-ISO8/L	CdB2-ISO8/L	Category 5D	10.2165	4.47466
Study\CdB2\CdB2-ISO8\CdB2-ISO8/FBR	CdB2-ISO8/FBR	Category 2F	11.7236	5.50842
Study\CdB2\CdB2-ISO8\CdB2-ISO8/FBR	CdB2-ISO8/FBR	Category 5D	11.1829	5.26823
Study\CdB2\CdB2-ISO9\CdB2-ISO9/S	CdB2-ISO9/S	Category 2F	5.8161	2.32301
Study\CdB2\CdB2-ISO9\CdB2-ISO9/S	CdB2-ISO9/S	Category 5D	5.8617	2.24887
Study\CdB2\CdB2-ISO9\CdB2-ISO9/M	CdB2-ISO9/M	Category 2F	12.7816	7.22332
Study\CdB2\CdB2-ISO9\CdB2-ISO9/M	CdB2-ISO9/M	Category 5D	11.7053	7.1533
Study\CdB2\CdB2-ISO9\CdB2-ISO9/L	CdB2-ISO9/L	Category 2F	12.7816	7.22333
Study\CdB2\CdB2-ISO9\CdB2-ISO9/L	CdB2-ISO9/L	Category 5D	11.7052	7.1533
Study\CdB2\CdB2-ISO9\CdB2-ISO9/FBR	CdB2-ISO9/FBR	Category 2F	14.1754	8.23759
Study\CdB2\CdB2-ISO9\CdB2-ISO9/FBR	CdB2-ISO9/FBR	Category 5D	12.7627	8.27061
Study\CdB2\CdB2-ISO10 PAE901 LFO storage tank\Catastrophic Rupture\CdB2-ISO10	Catastrophic rupture	Category 2F	8.18043	8.17719
Study\CdB2\CdB2-ISO10 PAE901 LFO storage tank\Catastrophic Rupture\CdB2-ISO10	Catastrophic rupture	Category 5D	9.82056	9.81903
Study\CdB2\CdB2-ISO11\CdB2-ISO11/S	CdB2-ISO11/S	Category 2F	5.81615	2.32301
Study\CdB2\CdB2-ISO11\CdB2-ISO11/S	CdB2-ISO11/S	Category 5D	5.86284	2.24887
Study\CdB2\CdB2-ISO11\CdB2-ISO11/M	CdB2-ISO11/M	Category 2F	10.8786	5.80391
Study\CdB2\CdB2-ISO11\CdB2-ISO11/M	CdB2-ISO11/M	Category 5D	10.2323	5.66235
Study\CdB2\CdB2-ISO11\CdB2-ISO11/L	CdB2-ISO11/L	Category 2F	10.8787	5.80391
Study\CdB2\CdB2-ISO11\CdB2-ISO11/L	CdB2-ISO11/L	Category 5D	10.2323	5.66235
Study\CdB2\CdB2-ISO11\CdB2-ISO11/FBR	CdB2-ISO11/FBR	Category 2F	12.0798	6.70135
Study\CdB2\CdB2-ISO11\CdB2-ISO11/FBR	CdB2-ISO11/FBR	Category 5D	11.1743	6.59697
Study\CdB2\CdB2-ISO12 PBF921 LFO day tank\Catastrophic Rupture\CdB2-ISO12	Catastrophic rupture	Category 2F	6.69894	6.69815
Study\CdB2\CdB2-ISO12 PBF921 LFO day tank\Catastrophic Rupture\CdB2-ISO12	Catastrophic rupture	Category 5D	8.13751	8.13666
Study\CdB2\CdB2-ISO13\CdB2-ISO13/S	CdB2-ISO13/S	Category 2F	2.3127	1.44383
Study\CdB2\CdB2-ISO13\CdB2-ISO13/S	CdB2-ISO13/S	Category 5D	2.71267	1.35343
Study\CdB2\CdB2-ISO13\CdB2-ISO13/M	CdB2-ISO13/M	Category 2F	2.99728	2.10984
Study\CdB2\CdB2-ISO13\CdB2-ISO13/M	CdB2-ISO13/M	Category 5D	3.72407	2.28062
Study\CdB2\CdB2-ISO13\CdB2-ISO13/L	CdB2-ISO13/L	Category 2F	3.0094	2.12234
Study\CdB2\CdB2-ISO13\CdB2-ISO13/L	CdB2-ISO13/L	Category 5D	3.71195	2.29492
Study\CdB2\CdB2-ISO13\CdB2-ISO13/FBR	CdB2-ISO13/FBR	Category 2F	3.10207	2.20705
Study\CdB2\CdB2-ISO13\CdB2-ISO13/FBR	CdB2-ISO13/FBR	Category 5D	3.66141	2.38408
Study\CdB2\CdB2-ISO14\CdB2-ISO14/S	CdB2-ISO14/S	Category 2F	5.81615	2.32301
Study\CdB2\CdB2-ISO14\CdB2-ISO14/S	CdB2-ISO14/S	Category 5D	5.86284	2.24887
Study\CdB2\CdB2-ISO14\CdB2-ISO14/M	CdB2-ISO14/M	Category 2F	9.76146	4.97528
Study\CdB2\CdB2-ISO14\CdB2-ISO14/M	CdB2-ISO14/M	Category 5D	9.34929	4.82278
Study\CdB2\CdB2-ISO15\CdB2-ISO15/S	CdB2-ISO15/S	Category 2F	1.26966	0.550867
Study\CdB2\CdB2-ISO15\CdB2-ISO15/S	CdB2-ISO15/S	Category 5D	1.01864	0.558521
Study\CdB2\CdB2-ISO15\CdB2-ISO15/M	CdB2-ISO15/M	Category 2F	4.69411	1.66493
Study\CdB2\CdB2-ISO15\CdB2-ISO15/M	CdB2-ISO15/M	Category 5D	4.59737	1.45246
Study\CdB2\CdB2-ISO15\CdB2-ISO15/L	CdB2-ISO15/L	Category 2F	9.50708	2.9037

Path	Scenario	Weather	Maximum distance (at height of interest) to LFL fraction (m)	Maximum distance (at height of interest) to UFL (m)
Study\CdB2\CdB2-ISO15\CdB2-ISO15/L	CdB2-ISO15/L	Category 5D	8.97325	2.85649
Study\CdB2\CdB2-ISO15\CdB2-ISO15/FBR	CdB2-ISO15/FBR	Category 2F	27.7216	7.44565
Study\CdB2\CdB2-ISO15\CdB2-ISO15/FBR	CdB2-ISO15/FBR	Category 5D	28.8627	7.15786
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/S	Category 2F	1.26966	0.550867
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/S	Category 5D	1.01864	0.558521
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/M	Category 2F	4.69411	1.66493
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/M	Category 5D	4.59737	1.45246
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/L	Category 2F	9.50708	2.9037
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/L	Category 5D	8.97325	2.85649
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/FBR	Category 2F	27.7216	7.44565
Study\CdB2\CdB2-ISO15\Route\CdB2-ISO15\CdB2-ISO15	CdB2-ISO15/FBR	Category 5D	28.8627	7.15786

APPENDIX 6- BOILOVER CALCULATION & CONSEQUENCE DISTANCE

Boilover Scenario:

One of the major escalation risks of a full surface fire is that of a boil over. An uncontrolled full surface fire may result in escalation to cause a boil over. The crude oil upon burning produces deep, rapidly propagating hot zones that result in large volumes of oil being projected out of the burning tank when the hot zone eventually comes in contact with an underlying water layer. The generated superheated steam explosion was estimated to propel burning oil and vapour to a height and downwind distance of ten times the tank diameter. Pictorial representation of the effects of boilover is presented in the figure below and the boilover hot zone formation process and temperature profile prior boilover are presented in Figure 2 and Figure 3.

(a) (b)

Figure 1: During Steady State Burning and b) During the Boilover Occurrence

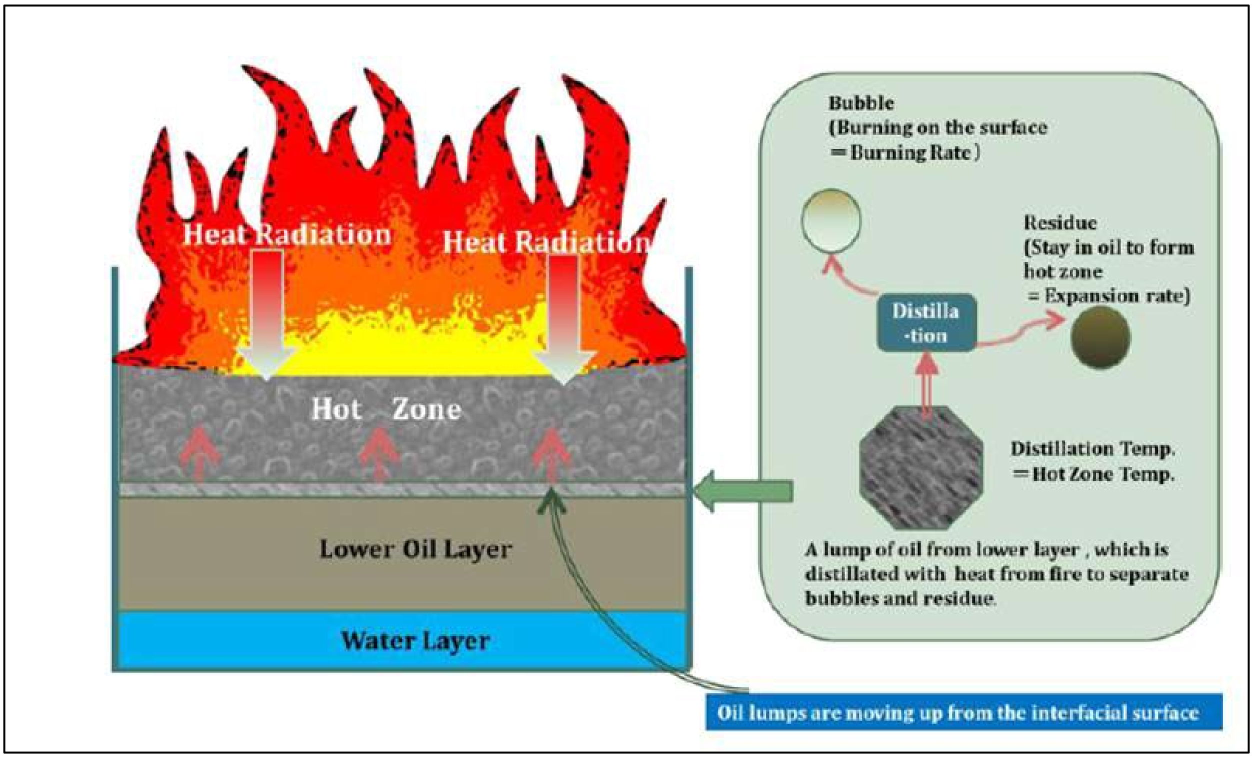

Figure 2: Boilover Hot Zone Formation

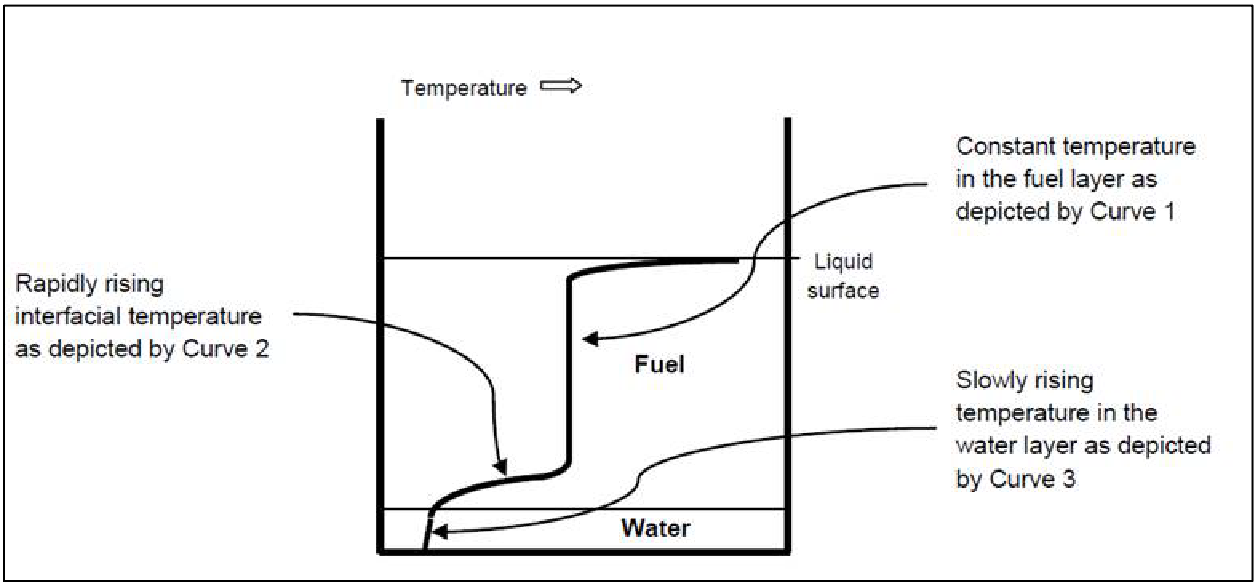

Figure 3: Typical Temperature Profile Within the Fuel-Water Layer Prior To Boilover

Modelling approach and Results of Boilover scenarios

In-line with approved Assumption Register, Boilover scenario is typically modelled using fireball scenarios. However, likelihood of boilover depends on many factors such as amount of heat transfer, amount of water presence, duration of fire etc. Therefore, prior to modelling boilover, propensity calculations will be carried out (defined as follows) to confirm the surety of boilover.

$$PBO = \left[\left(1 - \frac{393}{TBUL}\right)\left(\frac{\Delta T_{ébul}}{60}\right)^2 \left(\frac{\nu_{HC}}{0,73}\right)\right]^{\frac{1}{3}}$$

with:

PBO: Propensity to Boilover

T_{BUL}: Boiling temperature of the hydrocarbon- 526 K

T_{eBUL}: Its boiling range in excess of 393 K -212 K

HC: Hydrocarbon of the kinematic viscosity at 120 °C / 393 K [0.0001 m²/s]

The choice to consider a Boil-Over scenario will be based on the following criteria:

- PBO ≥ 0.6 consider a Boil-Over
- PBO <<< 0.6 do not consider a Boil-Over
- PBO < or close to 0.6 prudently consider a Boil-Over (e.g. limiting case of some kerosene).

The time before boilover initiation is calculated using boilover equations presented below:

$$t_{BO} = \frac{\rho \times C_p \times H_{liq} \times (T_{wav} - T_{ser})}{\phi}$$

Where, t_{BO} – Boilover time – secs

Density of Hydrocarbon (ρ)- 889 Kg/m^3

C_p – specific heat capacity – 2000 J/kg K (From SAFETI calculation)

H_{Liq} – Height of Liquid level in tank at time of boilover

TWAV – Heat Wave temperature K (511K)

T_{SER} – Storage Temperature K (298.5 K)

Ø- thermal flow entering the fuel from its surface W/m^2 (100000)

The PBO value and boilover time calculated and presented in Table 1.

Table -1: Calculated PBO and Boilover Time for CdB1

Tanks	Propensity (PBO)	Boil-over Occurrence (PBO ≥ 0.6, YES OR PBO ≤ 0.6, NO)	Calculated Boilover Time from The Start of Tank Full Surface Fire
PAB901 HFO storage tank	6	Yes	9.64 hours
PAB902 HFO storage tank	6	Yes	9.64 hours
PBA902 HFO pre-storage tank	6	Yes	10.73 hours
PBA901 HFO	6	Yes	3.06 hours

Tanks	Propensity (PBO)	Boil-over Occurrence (PBO ≥ 0.6, YES OR PBO ≤ 0.6, NO)	Calculated Boilover Time from The Start of Tank Full Surface Fire
buffer tank			
PBC901 HFO day tank	6	Yes	6.13 hours
PAE901 LFO storage tank	6	Yes	4.55 hours
PBF901 LFO day tank	6	Yes	5.46 hours

Table-2:Calculated PBO and Boilover Time for CdB2

Tanks	Propensity (PBO)	Boil-over Occurrence (PBO ≥ 0.6, YES OR PBO ≤ 0.6, NO)	Calculated Boilover Time from The Start of Tank Full Surface Fire
PBA921 HFO storage tank	6	Yes	10.73 hours
PBA921 HFO buffer tank	6	Yes	4.59 hours
PBC921 HFO day tank	6	Yes	4.59 hours
PAE901 LFO storage tank	6	Yes	4.55 hours
PBF921 LFO day tank	6	Yes	4.09 hours

Table-3 & Table 4 shows the predicted results on the consequences of the boilover phenomenon for HFO & LFO storage tanks. Based on the fraction of fuel that vaporized prior to the boilover, the mass of liquid fuel remaining in the tank at the moment when the boilover occurred were determined and presented along with fire ball impacts in the following table.

The HFO and LFO is subjected to the necessary conditions for a boilover to occur, and it is observed that the vapor fraction is negligible, being less than 5%. However, in the sensitivity analysis, a vapor fraction of 1% is considered for the boilover scenario.

Table-3 : Calculated Fireball Effects at the Time of Boilover for CdB1 Facility

Tank ID	Fireball Mass (kg)	Fireball Diameter (m)	Fireball Duration (Sec)	Thermal Radiation				
				1.6 kW/m^2	4.7 kW/m^2	6.3 kW/m^2	12.5 kW/m^2	37.5 KW/m2
PAB901 HFO storage tank	1270771.97	97.60	12.57	601.42	361.63	313.25	220.25	111.45
PAB902 HFO storage tank	1270736.93	97.60	12.57	601.41	361.62	313.25	220.24	111.45
PBA902 HFO pre-storage tank	2576022.98	123.5	15	765.18	461.69	400.32	282.18	144.11
PBA901 HFO buffer tank	43837.55	31.77	5.41	187.35	111.12	95.86	66.87	32.24
PBC901 HFO day tank	86210.29	39.80	6.41	237.36	141.11	121.82	85.14	41.41
PAE901 LFO storage tank	91944.97	40.67	6.52	253.37	150.99	130.49	91.25	45.62
PBF901 LFO day tank	76635.94	38.27	6.23	237.76	141.58	122.34	85.69	42.64

Table 4:Calculated Fireball Effects at the Time of Boilover for CdB2 Facility

Tank ID	Fireball Mass (kg)	Fireball Diameter (m)	Fireball Duration (Sec)	Thermal Radiation				
				1.6 kW/m^2	4.7 kW/m^2	6.3 kW/m^2	12.5 kW/m^2	37.5 KW/m2
PBA921 HFO storage tank	1717305.12	107.90	13.55	666.35	401.25	347.72	244.77	124.35
PBA921 HFO buffer tank	30321.16	28	4.94	164.66	97.54	84.11	58.61	28.15
PBC921 HFO day tank	68857.89	36.93	6.06	219.45	130.67	112.51	78.58	38.10
PAE901 LFO storage tank	105394.56	42.56	6.74	265.72	158.42	136.94	95.80	47.97
PBF921 LFO day tank	61346.29	35.53	5.89	220.01	130.91	113.94	79.26	39.29

The thermal radiation obtained from the boilover scenario is mentioned in the above table. However, the likelihood of boilover scenario is rare as it occurs after the full surface fire.

APPENDIX 7- BUILDING RISK ASSESSMENT

Appendix-7: Building Risk Assessment

CONTOURGLOBAL CAP DES BICHES SENEGAL

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1 EXPLOSION OVERPRESSURE ASSESSMENT FOR ENGINE ROOM

A TNO Multi-Energy Method (MEM) assessment has been carried out using the GAMES methodology for the identified Potential Explosion Sites (PES). Engine Room 1 and Engine Room 2 were classified as PES due to the potential for fuel gas loss of containment within these rooms in the CdB1 and CdB2 facilities, respectively.

The GAMES methodology, as indicated in the TNO Report PML 1998 [/12/] was used to calculate the blast curves and subsequently the Building blast overpressures, using as critical inputs

1. The full obstructed region volumes (including voids)

2. A flame length path equal to the radius of the hemisphere.

Less conservative approach was considered. This approach consisted of mainly redefining the obstructed volume inside the Engine Room to exclude the void space below the PES and using the average value of the flame length path (Lp). The blast curves obtained by this methodology were similar to the ones suggested by the DNV paper [13], which provides visual examples (photographs) of blast curves for certain congested areas.

1.1 Introduction

Buildings and structures are subjected to wide range of loading. This includes normal design loading such as dead load, live load, and environmental load (i.e. wind, seismic, etc.). Buildings must be designed to resist combinations of these loads as specified in national or international codes of practice and standards. In addition, a building may also be subjected to blast loading.

For Building structural design the blast overpressure and impulse must be considered. This is defined by peak incident overpressure (P0), positive phase duration (t0) and a load time history (i.e., variation of overpressure with time during the positive phase).

This section reports the blast overpressure arising due to accumulation of flammable cloud inside the Engine Room. There are a number of generally accepted simplified methods for the prediction of blast loads. The TNO GAMES Methodology as given in TNO report PML 1998-C53 is considered to determine the blast strength. Further DNV Phast standalone Multi-Energy Explosion model is used to plot the overpressure results on the layout for the identified blast strength and confined volume from the center of Potential Explosive Site (PES).

1.2 Curve Selection Method using TNO GAMES Approach

The GAMES approach provides a better estimate of Strength curve than an arbitrary number. GAME stands for Guidelines for Application of Multi-Energy method and this was an R&D project funded by the HSE and executed by TNO in the late 1990's. Fitzgerald (2001) notes the GAMES program provided a change in the method in that a peak pressure is calculated from one of two equations, one for 2D and one for 3D flame expansion, and a severity level is solved for corresponding to the calculated pressure. The GAMES program provided guidance on how to choose proper values for the variables in the calculations.

The peak overpressure and corresponding Multi-Energy Curve Strength can be estimated using the GAMES approach. This is only necessary for closer in far-field effects where the TNO curves have not all merged into the single TNT decay curve.

Two correlations were derived in the GAMES project to determine a value for the overpressure in a explosion inside the Engine Room. The overpressure is correlated to a set of parameters characterizing the environment in which the flammable cloud is located. The difference between the two correlations is due to the type of confinement of the flammable cloud.

For low ignition energy and no confinement (open, 3D), the expression is:

$P_0 = 0,84 \ (VBR \times L_p/D)^{2.75} \times S_L{}^{2.7} \times D^{0.7}$ --(1)

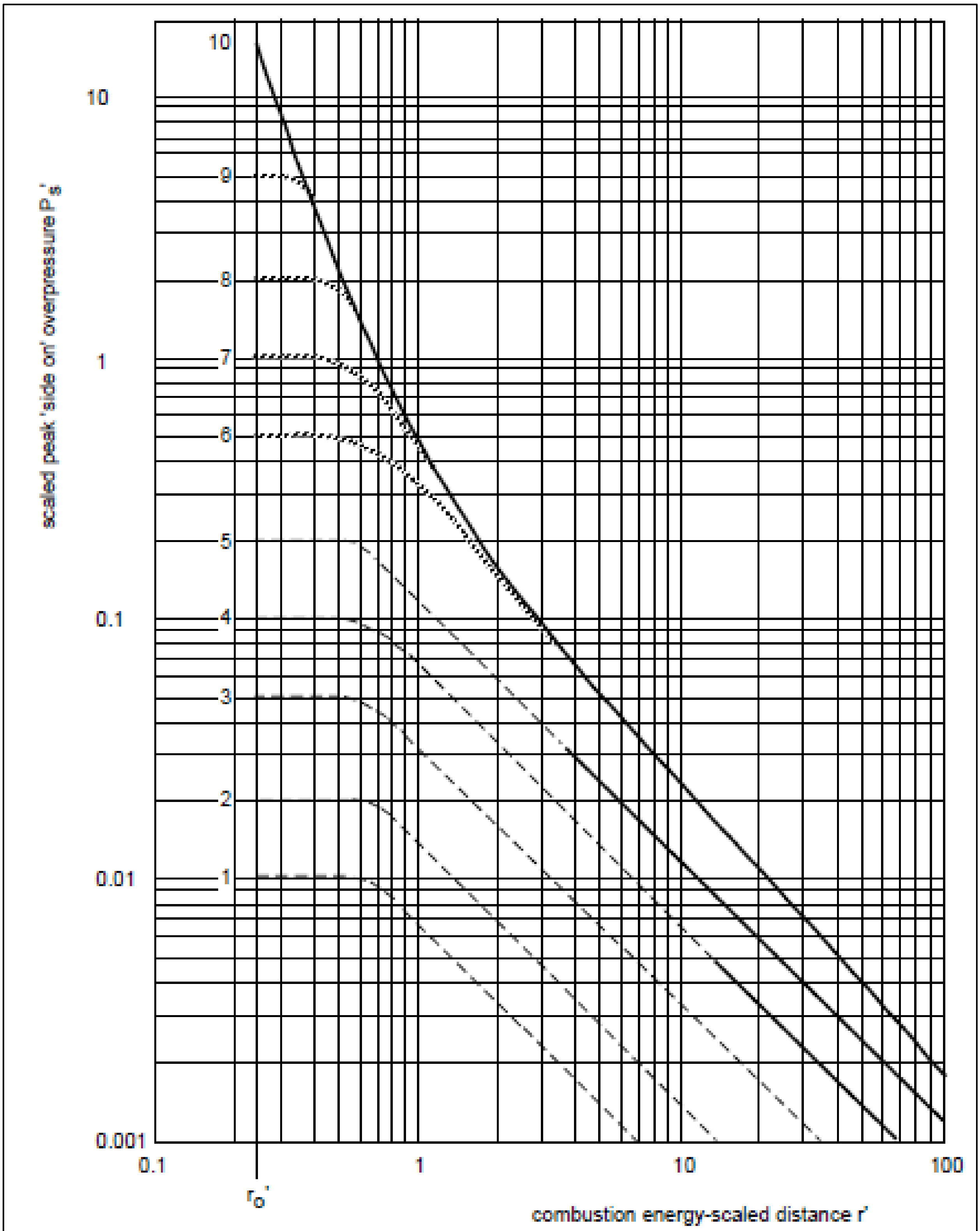

Figure 1-1:TNO MEM blast chart: Peak Side-on Overpressure

For low ignition energy and confinement between parallel plates (2D):

$P_0 = 3.38\ (VBR \times L_p/D)^{2.25} \times S_L^{\ 2.7} \times D^{0.7}$ ---(2)

Where VBR is the volume blockage ratio within the obstructed region, L_p (m) is the flame path length and D (m) is the characteristic diameter of the obstacles. S_L (m/s) is the laminar burning velocity; a material property of the fuel. Once P_0 (bar) is calculated the appropriate curve to choose is selected by comparing this value with the value of overpressure for each multi energy curve at radii less than r'_0.

r'_0 is the radius of a hemi-spherical gas cloud with equal volume as the flammable gas cloud entrained within the pertinent confined space.

1.2.1 Obstruction Region or Potential Explosion Sites (PES)

A volume within a plant with sufficient congestion and/or confinement that a flammable vapor cloud ignited there could likely develop into an explosion. An obstructed region is an area where obstacles are present generating turbulence which will accelerate the flame if a cloud is ignited within this region. The facility plot plans, and 3D maps are reviewed to identify potential congested and confined regions that are termed as “Potential Explosion Sites”.

Criteria considered for the definition of an obstructed region: Procedure suggested in TNO Yellow Book for the determination of the boundaries of the obstructed region is considered in this study. The procedure to build up an obstructed region is based on the effect obstacles have on the generation of turbulence in the expansion flow ahead of the flame. A zone with obstacle-induced turbulence will exist behind an obstacle. The length of this zone is related to a characteristic dimension of the obstacle. However, if the scale of an obstacle becomes larger it is assumed that the length of the influenced zone is bounded by an upper value.

The obstructed region is defined as a box that contains all the obstacles in the obstructed region, including the space between a confining surface and an obstructed region where the distance between that surface and any obstacle in the obstructed region is less than 10 times D1 or 1.5 times D2. Where D1 is the smallest dimension oriented in a plane perpendicular to the flame propagation direction and D2 is obstacle dimension parallel to the flame propagation direction. (D1 and D2 belonging to any obstacle in the obstructed region).

Criteria considered for definition of multiple/single explosion sources: To apply the TNO MEM model, each obstructed region should be treated separately as a confined explosion source if the separation distance is sufficiently large. Otherwise, obstructed regions are combined to form larger confined source. The issue of whether two or more congested spaces combine into a single space is addressed as suggested in GAMES report. Annex D of the GAMES report recommends:

“*The critical separation distance around a potential blast source area is equal to half its linear dimension in each direction. If the distance between potential sources is larger, the sources should be modelled as separate blasts. If not, they should be modelled as one single blast of summed energy content.*”

The background to this recommendation given by TNO is:

“*As the expansion factor for stoichiometric hydrocarbon-air combustion is approximately 8, the bubble of donor combustion products will not expand beyond a distance of half the donor dimension (0.5DD). Therefore, a critical separation distance of 0.5DD seems a safe and conservative limit in the high explosion pressure range. This statement is in accordance with the preliminary guideline drafted during the GAMES-project (Mercx et al., 1998).*”

1.2.2 Obstructed Region Volume (Vor)

The procedure to determine the volume of the obstructed region starts with the definition of a box containing all obstacles in the obstructed region as per criteria defined in section 10.2.3. The volume of that box is the initial volume of the obstructed region. As this box probably contains a lot of free space without obstacles, the volume can be reduced by excluding this free space. For example, space at the bottom of pipe-racks.

1.2.3 Obstacle Volume (Vob)

Obstacle volume (V_{ob}) is sum of volumes of all obstacles in the obstructed region.

1.2.4 Volume Blockage Ratio (VBR)

VBR is defined as the ratio of the total volume of the obstacles inside an obstructed region (V_{ob}) and the volume of that obstructed region (V_{or}).

1.2.5 Typical Diameter (D)

Typical diameter 'D' is the characteristic diameter of the obstacles. It is a measure of turbulence the flame front experience during explosion. The combination of Lp/D in the GAMES correlation is in fact a measure of the number of obstacles the flame passes while it burns through the mixture. The determination of D in a realistic case is not obvious. Various definitions for the average obstacle size are possible. The GAMES approach recommends use of hydraulic diameter, which is defined as 4 times the ratio between the summed volumes and the summed surface areas of an object distribution.

$$D_{hym} = 4\frac{\sum V_i}{\sum A_i}$$

Criteria considered for determination of 'D' for Non-cylindrical obstacles: Non-cylindrical obstacles like boxes, cable trays and plates will be represented by cylinders having a length equal to the largest dimension of the obstacle and a cross-section area equal to the cross-section area of the obstacle.

1.2.6 Flame Path (Lp)

The term Lp is the distance a flame can travel and therefore accelerate within the congested area. In a worst-case, if ignition occurs at a boundary to the congested area, it is the length of the congested area.

The exercises with the cases in GAMES analysis have shown that a wide range of values is possible for the flame path length. For elongated or flat obstructed regions, the distance from the ignition location to the shortest edge (the top included) results in very low overpressures. Using the longest distance to an edge, on the other hand, results in far too high overpressures.

In order to deal with the problem of aspect ratios other than one, a simple model is presented in Annex E of GAMES report. There it is assumed that the pressure will not rise after the flame leaves the obstructed region through the nearest edge if the pressure at that instant is below a certain limit. The underlying physics is that the flame speed acceleration for pressures below that limit is too low to overtake pressure reduction due to venting.

Observed in the exercises conducted in GAMES study is that the final average numerical overpressures are in between the predicted values using the correlation with values for the flame path length according to the distances of the ignition location to the two nearest edges (Chemical Plant subcase of paragraph 5.3) or the second and third nearest edge (Gas Processing case). Furthermore, it is not clear whether there is a single value for the overpressure limit. The exercises still show an increase in overpressure after the start of venting through one of the edges also at a low overpressure level.

The best results are obtained where an average value for Lp is used. The average value is the radius of a hemisphere with a volume equivalent to the volume of the obstructed region (V_{or}) Acceptable results are obtained for aspect ratios smaller than about 5.

Central ignition is implicit when the radius of a hemisphere is adopted for Lp. The numerical results however show lower overpressures, in most cases studied during GAMES, for edge ignition. Applying an average flame path length would cover all ignition locations in most cases.

Criteria considered for determination of 'L_p': Application of above GAMES guidance for Lp = radius of hemisphere of Vor for this project does not results in much confidence, hence a modified approach is considered for determination of Lp in this project. The Lp is determined as an average of two nearest edges, 1/2 of width and 1/2 of height.

L_{pAVG} = Average of (Width, Height, 1/2 of width and 1/2 of height of PES)

Further in order to have confidence on the obtained blast strengths using this modified approach, the resultant blast strength considering L_{pAVG} were compared with DNV approach of using reference photographs of congested volumes for blast strength estimation.

The blast strength level obtained considering L_{pAVG} where consistent with the reference photographs for various blast strength levels.

1.2.7 Laminar Burning Velocity (SL)

A homogeneous stoichiometric flammable cloud of methane is assumed to completely fill the obstructed region for all assessments. The laminar burning velocities of 0.45 (m/s) and the stoichiometric concentration of 9.5% is considered for flammable cloud of methane (ref Table 5.1 TNO Yellow Book)

1.2.8 Interpretation of Overpressure

The empirical models predict the "free field pressure" as the blast wave travels over the ground. The pressure that any object receives is however up to twice as high and is called the reflection pressure. This combines with the pulse duration to give an impulse to the structure. There are established correlations for front face, rear face, and roof overpressures from a passing pressure wave (ASCE, 1997). These corrected values should be used in structural evaluations.

1.3 Identification of Potential Explosion Sites (PES)

Based on review of layout following locations are identified wherein the possibility of sufficient congestion and/or confinement of a flammable vapor cloud are foreseen, which if ignited there could likely develop into an explosion:

Table 1-1: Identified PES for CdB1 & CdB2

Potential Explosive Site	Process Area	Obstructed Region Volume (V_{or})	Obstacle Volume V_{ob}	VBR	Sum of Surface Area	Typical diameter (D_{hym})	Laminar burning velocity of flammable mixtures_ SL (m/s)	L_p	P_0 (Bar)	Selected TNO Curve
Engine Room CdB1	Cap Des Biches 1	7492.61	1208.84	0.18	780.48	6.20	0.46	15.30	0.04	Curve 3
Engine Room CdB2	Cap Des Biches 2	5619.46	902.24	0.18	585.36	6.17	0.46	13.90	0.03	Curve 3

Note: Based on the Explosion risk analysis performed for the Engine Room, it is observed that threshold overpressure levels of 0.35 bar and 0.5 bar are not reached at DAL 1E-04/year considering the forced ventilation max. 27 m^3/s of the Engine Room which will vent out the flammable released material.

2 BUILDING RISK ASSESSEMENT

As part of the Building Risk Assessment, the potential impacts of fire, flammable gas dispersion, and explosion on process buildings — including the control room and steam turbine building — have been evaluated. The fire and explosion load criteria corresponding to a 1E-04 per year exceedance frequency, as outlined in Table 2-1, have been assessed for these buildings. The resulting risk outcomes for fire and explosion loads are presented in the following section.

Explosion Overpressure Exceedance Curves for Process Buildings:

The comprehensive overpressure exceedance curves are presented within this section of the report, providing a detailed analysis of overpressure loads.

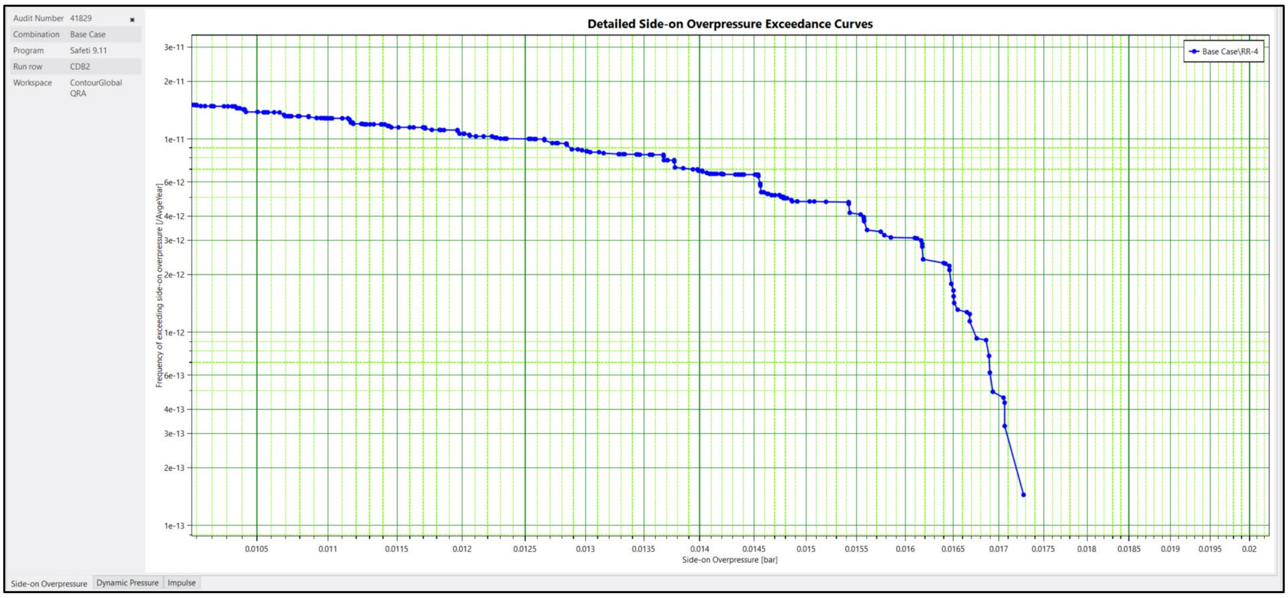

Figure 2-1: Explosion Overpressure Exceedance Curve for Control Room of CdB2

The table below displays the calculated blast overpressure load corresponding to a 1E-04 and 1E-05 per year design accidental load criterion.

Table 2-1: Overpressure (bar) Observed on Process Buildings

Target	Explosion Load (bar) 1E-04/year	Explosion Load (bar) 1E-05/year
Control Room CdB1	Not Reached	Not Reached
Control Room CdB2	Not Reached	Not Reached
Steam Turbine	Not Reached	Not Reached

Summary of explosion overpressure assessment for process buildings at CdB1 & CdB2 Facilities:

The explosion overpressure assessment conducted for the process buildings at CdB1 and CdB2 facilities indicates that the design accidental load (DAL) criteria of 1E-04/year and 1E-05/year were not reached for any of the evaluated targets, including the control rooms and steam turbine enclosure.

This confirms that no significant explosion overpressure impact is expected on the assessed buildings under the defined design accidental load frequencies. Therefore, the existing structural design and layout are considered adequate with respect to explosion resistance for the evaluated scenarios.

Note: The exceedance curve for CdB1 control room and steam turbine building is not obtained as the potential explosion severity and corresponding overpressures fall within a low-risk range way beyond 1E-11/year.

Pool Fire Risk Contour (37.5 kW/m²)

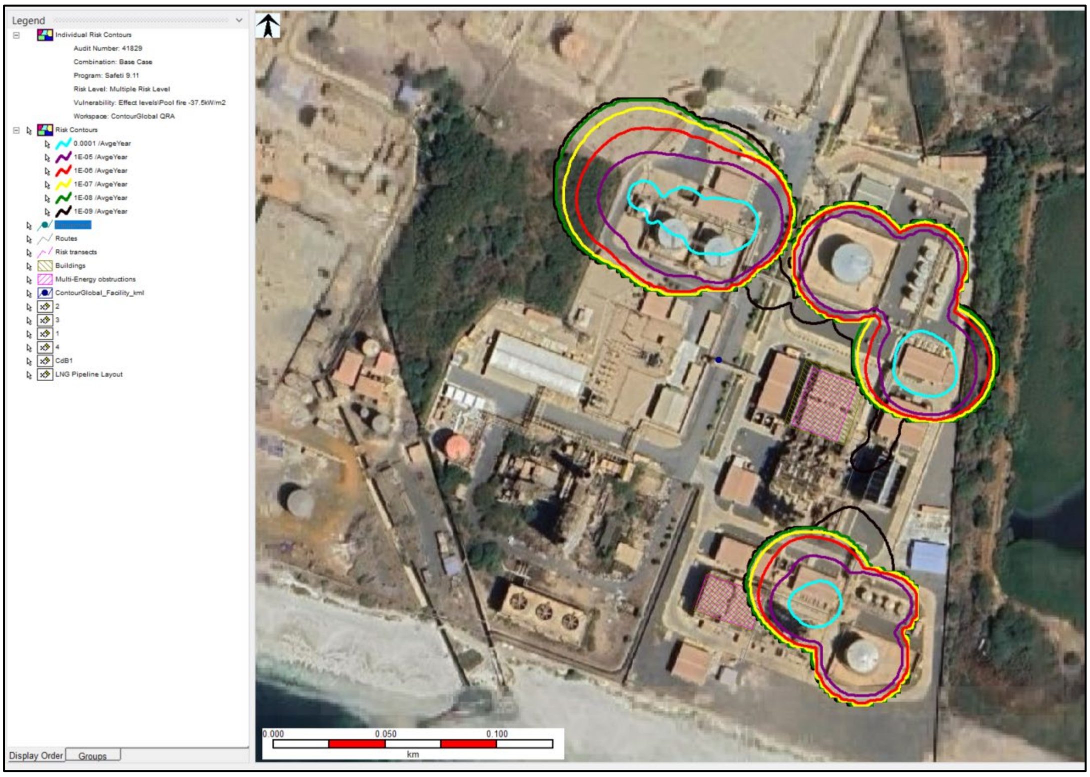

Figure 2-2: Pool Fire Risk Contour for 37.5 kW/m²

Pool Fire Risk Contour (12.5 kW/m²):

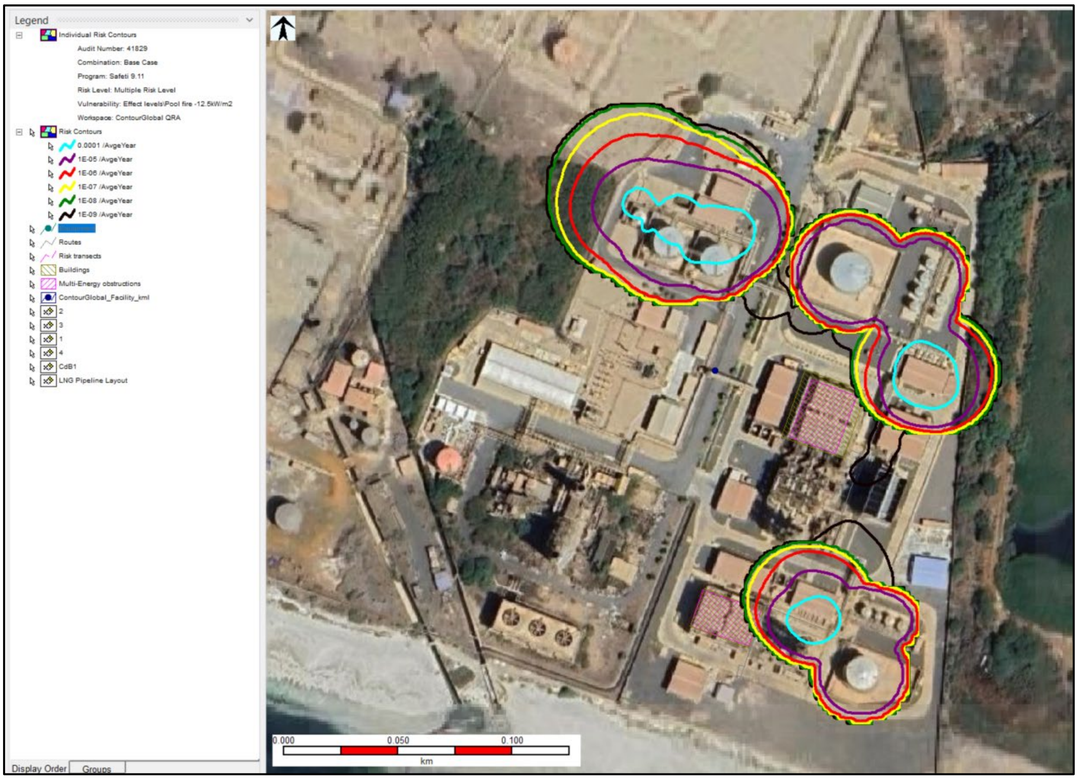

Figure 2-3: Pool Fire Risk Contour for 12.5 kW/m²

Based on the pool fire risk contours, following observations are made:

- The pool fire risk is localized around the tank area.
- No pool fire (37.5 kW/m^2 & 12.5 kW/m^2 (pool flame)) impact at DAL of 1E-04/year was observed on the process buildings inside the CdB1 & CdB2 facility.

<u>Jet Fire Risk Contour (12.5 kW/m^2):</u>

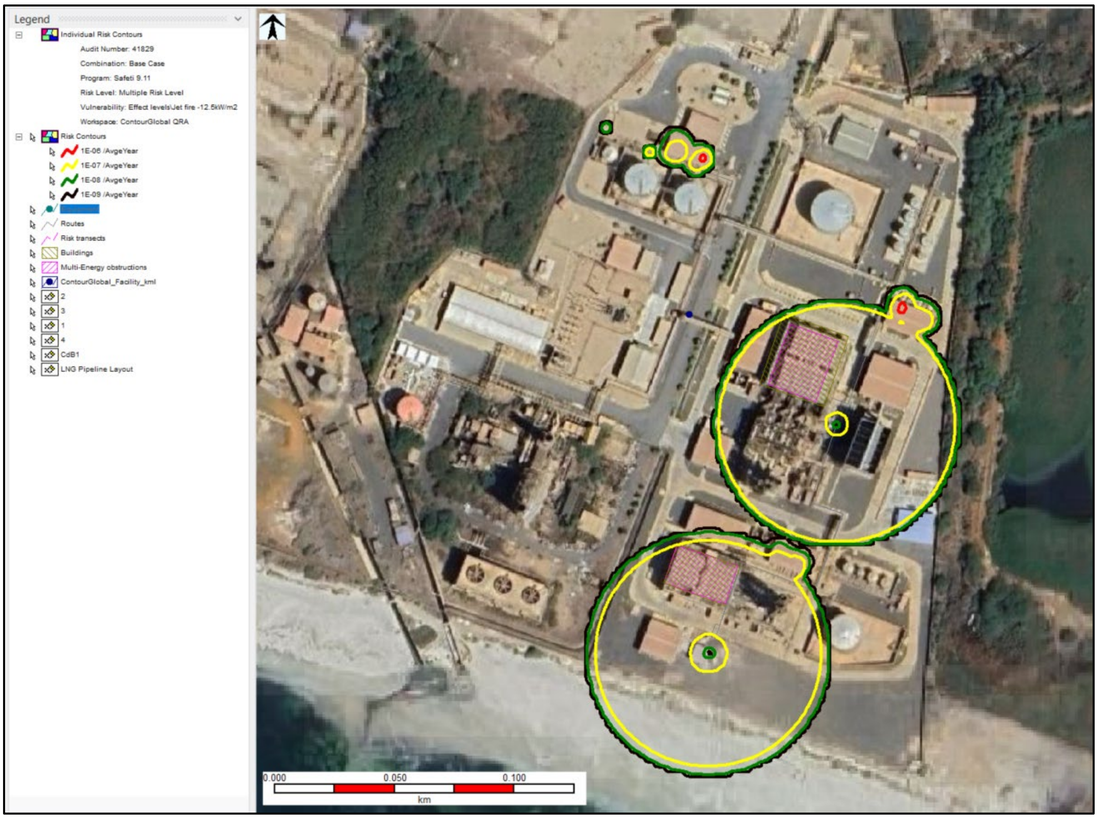

Figure 2-4:Jet Fire Risk Contour for 12.5 kW/m^2

Jet Fire Risk Contour (37.5 kW/m^2):

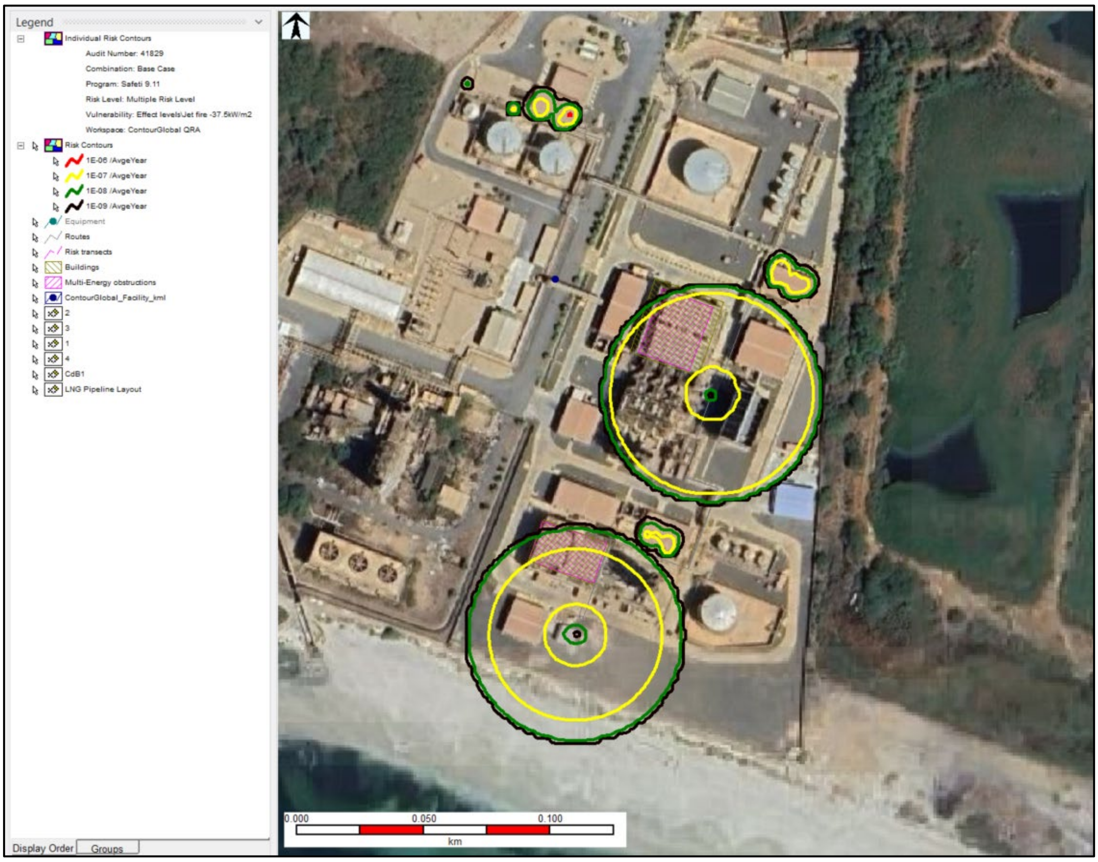

Figure 2-5:Jet Fire Risk Contour for 37.5 kW/m^2

Based on the jet fire risk contours, following observations are made:

- Jet Fire contours from 1E+00 till 1E-06 per year are not observed.
- No jet fire (37.5 kW/m^2 & 12.5 kW/m^2) impact at DAL of 1E-04/year was observed on the process buildings inside the CdB1 & CdB2 facility.

Flash Fire Risk Contour (LFL):

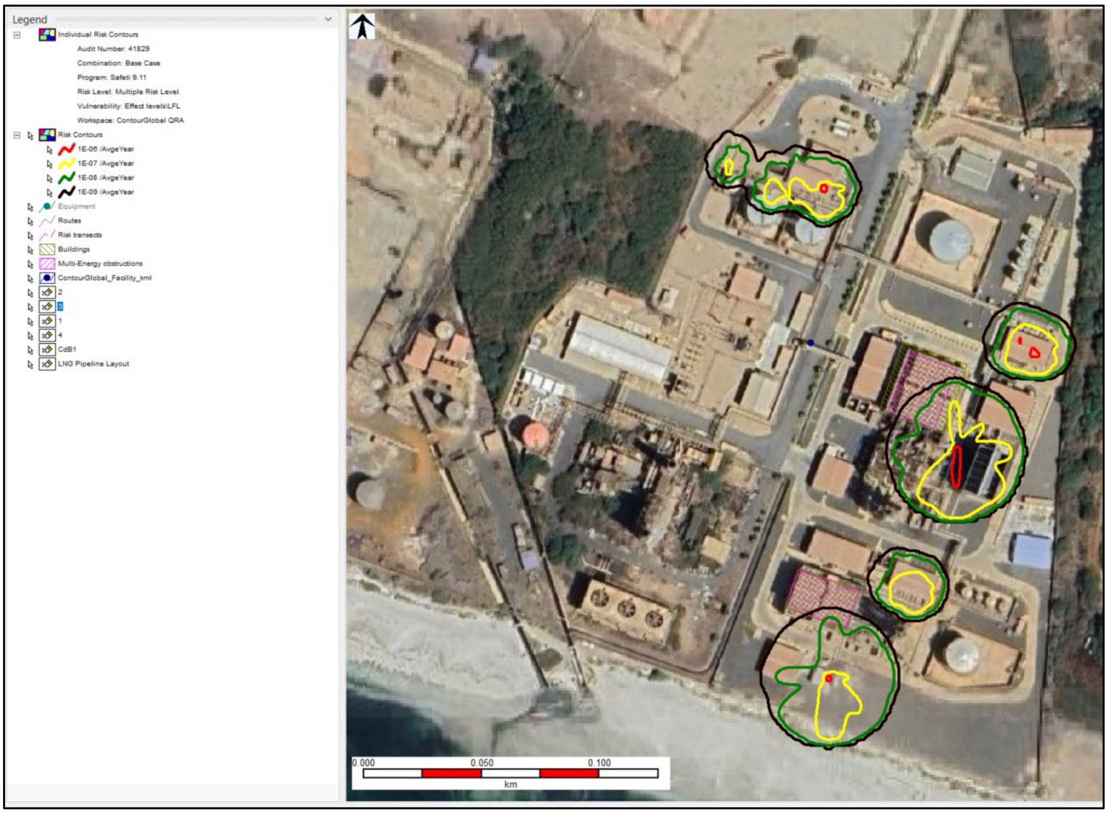

Figure 2-6: Flash Fire Risk Contour

Based on the flash fire risk contours, following observations are made:

- The flash risk is localized around the gas pipeline.
- No flash fire (LFL) impact at DAL of 1E-04/year was observed on the process buildings inside the CdB1 & CdB2 facility.

Explosion Risk Contour (0.5 & 0.35 bar):

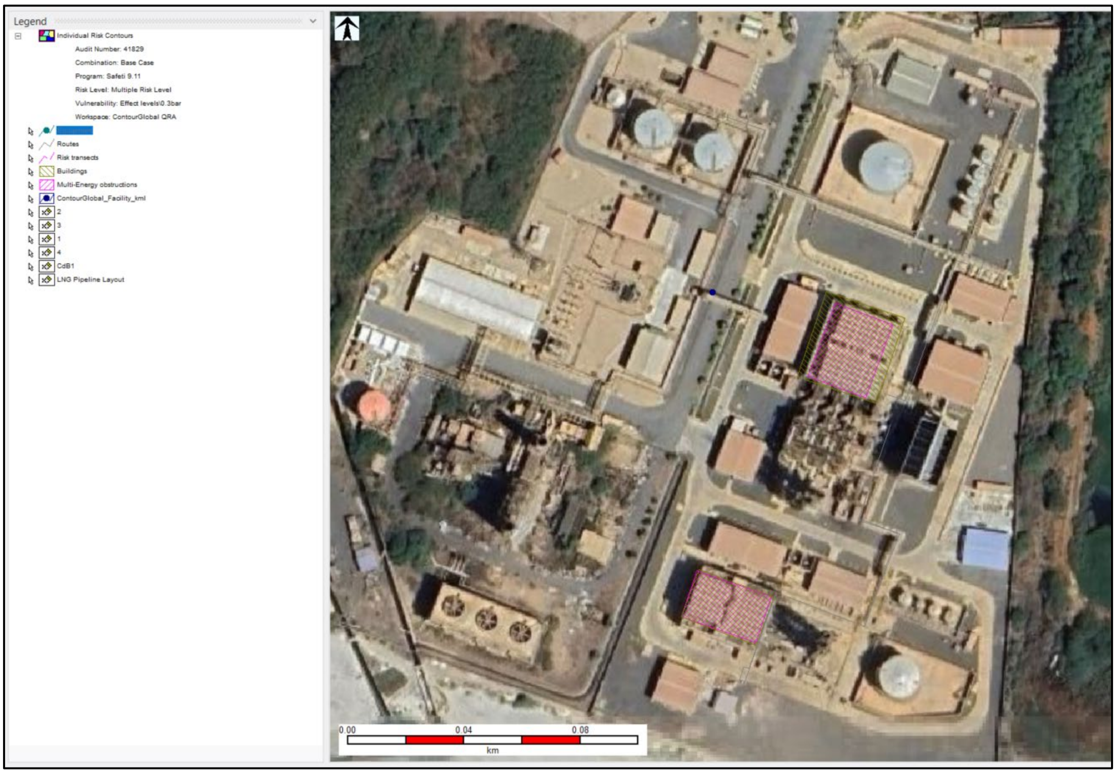

Figure 2-7: Explosion Risk Contour

Based on the explosion risk analysis, following observations are made:

- No explosion risk was identified, and no overpressure impact of 0.35 bar or 0.5 bar at a DAL of 1E-04/year was observed on the process buildings within the CdB1 and CdB2 facilities.

3 CONCLUSION & RECOMMENDATIONS

3.1 Conclusion

Explosion overpressure analysis was performed for the Engine Room areas at CdB1 and CdB2 using the TNO explosion modelling methodology. The assessment outcomes demonstrate that the predicted explosion overpressures and associated severity levels remain within acceptable low-risk thresholds.

As part of the Building Risk Assessment, the potential impacts of fire, flammable gas dispersion, and explosion on process buildings — including the control room and steam turbine building were evaluated. The fire and explosion load criteria corresponding to a 1E-04 per year exceedance frequency were assessed for these buildings. Based on the assessment, the existing process buildings and control room, the fire & explosion risk corresponding to a Dangerous Area Level (DAL) of 1E-04/year was not exceeded, indicating compliance with the established design accidental load criteria.

3.2 Recommendation

Based on the results presented in above sections, the recommendations are:

1. It is observed that for the existing buildings and control room are not affected due to flash fire risk (refer Figure 2-6). However, in the event of potential flammable gas dispersion, it has potential to reach the existing buildings and control room. Therefore, ensure that effective gas ingress protection measures are in place, including gas detectors, sensors, and alarm systems. These systems will enable early detection of flammable gases and provide timely warnings to occupants, allowing for immediate and appropriate action.

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