

A1. Introduction

A HAZID study was undertaken as part of the SafeSBU project to ensure a risk-approach to the identification and assessment of hazards associated with the storage, bunkering and usage of green fuels (specifically methanol and ammonia) in ports and green-fuelled ships within the port area.

A HAZID is a systematic and structured team-based study to identify the hazards and hazardous scenarios associated with a system or process. HAZID studies assess the system or process from a “top-down” perspective using a set of guidewords to prompt the team to identify and assess hazards and identify actions for risk reduction to manage the associated risk.

The HAZID was undertaken in line with the guidance provided in Appendix C of ISO 17776 [A1] on how to carry out HAZID Studies.

A2. Scope and Objectives

The scope of the HAZID study was the identification and qualitative assessment of hazards associated with the storage, bunkering and usage of methanol and ammonia in ports and in methanol/ammonia-fuelled ships within the port area, along with the associated causes and consequences of a loss of control of such hazards, and identification of measures for prevention or mitigation of such a loss of control.

The HAZID focused on the identification of major accident hazards (i.e. those with the potential to result in fires, explosions or releases of hazardous (e.g. flammable or toxic) inventories, leading to possible fatalities or serious (i.e. irreversible) injuries, major environmental impact, major asset damage/long-term shutdown or significant reputational impact).

The objective was to undertake a systematic identification of hazards associated with the scope and identify measures (both technical and operational/procedural) to prevent or mitigate a loss of control of those hazards, with the aim of providing a risk-based approach to the development of guidelines for safe storage, bunkering and usage of green fuels as part of the SafeSBU project, as well as providing an illustration of the hazard identification process to be followed by designers or operators of facilities and operations associated with the scope.

The HAZID, including the risk assessment, was based on a typical port facility and should not be used as a substitute for undertaking a specific HAZID for each port facility or operation.

While non-major accident (occupational) hazards were identified during the HAZID, these were not the focus of the study. Risks not directly associated with the storage, bunkering and usage of green fuels were also not the focus of the study. Furthermore, risks associated with public perception, external stakeholder engagement or project delays and costs were outside the scope of the study.

A3. Definitions

Cause	The means by which control of a hazard may be lost (e.g. mechanical failure, human error) resulting in a hazardous event.
Consequence	The eventual outcome of a hazardous event, e.g. fatalities or environmental damage. A hazardous event may have more than one possible consequence.
Guidewords	A set of words or phrases used as prompts to stimulate discussion within the HAZID and enable the identification of hazards.
Hazard	A potential source (e.g. activity, situation, substance) of harm to persons, the environment, assets or reputation.
Hazardous Event	The initial outcome of a loss of control of a hazard (e.g. loss of containment).

Major Accident	An incident, such as a major spill, fire, or explosion, caused by uncontrolled events during the operation of a facility which poses a serious risk to human health or the environment inside or outside the facility, and which involves one or more hazardous substances.
Residual Risk	The risk associated with a hazard taking into account risk reduction measures.
Risk Reduction Measure	A measure put in place to prevent a hazardous event or mitigate its consequences. These may be technical (equipment), operational (e.g. processes and procedures) or organisational (e.g. competence and training).

A4. Date and Attendees

The study was held at DBI Offices in Hvidovre, Denmark between 10th and 12th March 2026 and involved the following personnel.

- Mohammad Ahli-Gharamaleki - P2X Specialist, DBI
- Rian Holdstock - Project Manager, Force Technology
- Robert McTaggart - HAZID Facilitator / Risk Management Specialist, DBI
- Jonas B K Meyer - Risk Management Specialist, Force Technology
- Lars Nøhr-Nielsen - Project Manager, Force Technology
- Juan Carlos Lopez Santiago - HAZID Scribe, DBI
- Jan Stilling - New Building and Sustainability Manager, MHO-Co
- Jens Thomsen – Specialist, Force Technology
- Leonard Sang Tuei - Project Leader, DBI
- Olga Uribe - Project Manager, Port of Rønne A/S
- Martin Østergaard - Project Manager, Complete Solutions

Each member contributed to the HAZID with knowledge of their own discipline, as well as across disciplines. Contributions were in the form of constructive knowledge sharing regarding hazard identification and assessment, and identification of information regarding prevention and mitigation measures.

A5. Methodology

To provide a systematic process for hazard identification, the scope was divided into the following study areas:

1. Fuel storage and associated systems (e.g. leak prevention and detection, spill containment/drainage, purging/inerting, pressure relief, venting, monitoring), as well as fuel receipt (by road/rail or sea), acceptance, and interfaces with storage systems.
2. Fuel transfer and bunkering (both quayside and onboard ship) and associated systems (e.g. connection/disconnection, SIMOPs, control, monitoring and communication, pressure relief, overfill protection, shutdown).
3. Usage on ships while alongside and manoeuvring within the port area and associated systems (e.g. fire and gas detection, ignition source control, venting/purging).
4. General hazards e.g. security, escape/evacuation and emergency response.

Terms of Reference were issued prior to the study so that team members could familiarise themselves with the scope, objectives and methodology of the study to ensure they were prepared beforehand.

The team-based study followed the steps below:

i. Explanation

The study began with an explanation of the HAZID methodology and the study scope by the HAZID facilitator, to ensure that all participants had a common understanding. Further explanation of each study area was given by a subject matter expert prior to studying the area.

ii. Select Guideword

The facilitator used guidewords to prompt the identification of hazards for each study area. Guidewords were selected from the list presented in Table A1. The guidewords are based on a standard list for studies of this type and are included here for guidance. It was only necessary to discuss and record those which were relevant to the scope of the HAZID.

Table A1 List of HAZID Guidewords

Hazard Category	Guideword	Considerations (examples)
Process Hazards	Release of Flammable / Toxic Inventory	Pressure (high/low) Corrosion / erosion Fatigue Vibration Equipment failure Material specification Design temperature/pressures Containment of leak / spills Other fires and explosions (domino effect)
	Overpressure	Blockage Thermal expansion Pressure relief
	Excess / Zero level	Overfilling of tanks, vessels
	Inspection and maintenance	Insufficient/incorrect
	Start-up / Shutdown	
	Process control and emergency shutdown systems	Failure
System Hazards	Detection Systems (leak detection, F&G detection, CCTV etc.)	Capability and suitability (type of detector) Reliability Response time
	Firefighting Systems	Firefighting medium (water / CO2 etc.) Unavailability of firewater supply
	Ventilation	Failure / loss of supply
	Power	Loss of supply
	Water and other utility liquids	Loss of supply
	Drainage	Segregation of hazardous/non-hazardous drains Spread of flammable material through drains Spill containment Capacity
	Purging / Inert Gas	Loss of supply
	Air	Loss of plant/instrument air

Hazard Category	Guideword	Considerations (examples)
Other Hazards	Stored Combustibles / Flammables	Improper storage Inadequate Ventilation Common / Separate inventory
	Structural Failure	Fatigue Excess weight Exposure to heat radiation (process fire) Material defects
	External Hazards	Extreme weather (e.g. flooding, snow/ice, lightning etc.) Environmental Neighbouring facilities/population
Operations	Process Fuels (methanol/ammonia)	Isolation Status Depressurisation Inerting / purging Venting Wrong composition Wrong operating condition
	Non-process hydrocarbons	Conventional fuels, lubricants etc.
	Other flammable materials	
	Simultaneous Operations	
	Dynamic Situations	Moving equipment Impact / collision Traffic interfaces
	Lifting operations	Damage from dropped / swinging loads Impact resistance
	Ignition sources / hot work	Open flame Spark potential Electrical equipment Hot surfaces Hazardous area classification Ex-rated equipment
	Human Factors (including emergency response)	Training and competence Roles and responsibilities (inc. supervision/leadership) Scheduling and traffic interfaces Quality Control Communication (protocols, language etc.) Shift patterns (fatigue/stress, manning, handover) Tools and equipment Physical capability Goal conflicts and trade-offs Safety critical information Time constraints Equipment interfaces.
	Ergonomic hazards	Chemicals / hazardous materials Noise Heat Cold Vibration Humidity Lighting

Hazard Category	Guideword	Considerations (examples)
	Work location	Access Confined or awkward place
	Organisation and Planning	Roles and responsibilities Contingencies Communication Management of Change Coordination and control Planning and procedures Training and competence
	Emergency response	Alarms and communication Emergency elsewhere Safe suspension of work Egress and muster Escape routes, rescue, and recovery equipment / life-saving equipment / PPE.
	Waste / discharges	Containment Disposal
	Work	Takes too long Change control Human error Delays / time pressures
	Isolation of safety systems	F&G detection Active Fire Protection Emergency Shutdown

To avoid repetition when considering different fuels, the HAZID first considered the hazards , causes, consequences and specific controls associated with both fuels, and then considered specific hazards associated with each respective fuel and its properties.

iii. Scenario Identification

For each potential hazard, the possible scenarios involving a loss of control of the hazard were identified, including the potential high-level causes of a loss of control and the subsequent effects, in terms of potential consequences. The credible worst-case consequences of a loss of control (without taking into account controls and mitigation) were then identified, in terms of safety effects, environmental impact and/or asset damage.

For each scenario identified, the measures in place for preventing a hazardous event or mitigating its consequences were then identified and recorded. Detailed measures for risk reduction were not discussed within the HAZID, but instead the hazards and other issues affecting the requirements for those measures were identified along with actionable recommendations for inclusion in the guidelines.

iv. Risk Ranking

The Risk Assessment Matrix presented in Figure A1 was used to assess the risk associated with the hazards identified and their potential consequences. Each hazard was given a score for both its consequence and frequency which is combined to provide an overall risk ranking. The consequence ranking is based on the credible worst-case outcome of a loss of control of the hazard at the site, without taking into account preventative controls and mitigation. The frequency ranking is based on the frequency of the worst-case consequence, taking into account well-understood and prescribed controls and mitigation (e.g. implementation of codes and standards, ignition source control, etc.). It should be noted that the risk ranking was undertaken at a generic level only to provide an illustration of the HAZID process and a high-level indication of the risks.

v. Reporting

The discussions from the study were recorded in a worksheet in sufficient detail to be understood outside the context of the study.

A list of actions raised during the HAZID is presented in Table A2 below. All actions raised are as examples of areas where more specific preventative controls or mitigation may be required, or where more detailed risk evaluation should be used to define specific requirements for port operations.. The full HAZID worksheet is presented in Table A3.

Table A2 List of HAZID Actions

No.	Action
Storage	
1.	Provide oil company procedures for fuel receipt (Action on Port of Rønne)
2.	Specify requirements for security restrictions for fuel receipt area and ensure receipt is within an ISPS area.
3.	Specify undertaking of consequence modelling of tanker BLEVE.
4.	Provide example drawings of transfer schematics for fuel receipt. (Action on Complete Solutions)
5.	Specify use of risk assessment to identify requirements for additional gas detection/monitoring (general requirement throughout port).
6.	Investigate possible means of suppressing ammonia leakage during transfer from tanker to storage (e.g. water curtains, dry fog).
7.	Specify the need to ensure dispersion modelling is undertaken to identify safe location for venting (general requirement throughout port).
8.	Consideration to be given to possibility of underground storage.
9.	Specify that requirements for gas detection in storage area are to be based on assessment of likely leak sources.
10.	Consider requirements for ESD on gas detection in storage area (how initiated, necessary actions - e.g. stop all activities and ignition sources).
11.	Define requirements for suitable firefighting measures in storage area (e.g. including AR-AFFF and required water capacity).
12.	Investigate possible solutions for ammonia suppression in storage area (e.g. water curtains), including requirements for effluent disposal.
13.	Investigate possible requirements for ammonia shelter in storage area.
14.	Consider requirements for redundancy of ammonia storage cooling system.
15.	Specify undertaking of consequence modelling of storage BLEVE.
16.	Consider requirements for disposal of liquid effluents used for firefighting/toxic release suppression.
Bunkering	
17.	Investigate whether provision of the double wall piping is mandatory for fuel transfer to bunkering stations.
18.	Investigate the instrumentation in the fixed pipeline from the storage to the bunkering station, including pressure relief valves.
19.	Investigate requirements for gas detection in vicinity of transfer pipeline to bunkering station.
20.	Investigate the classification and size of the ATEX classification zone around transfer pipelines.
21.	Consider requirements for flame detection systems in place to detect methanol fires in the event of a leakage from transfer pipelines.
22.	Investigate whether ESD is required to be operated automatically or manually in the event of leak detection during ammonia transfer.

No.	Action
23.	Investigate the minimum requirements and procedures to ensure appropriate mooring.
24.	Investigate the need for tugboats during ship-to-ship bunkering.
25.	Review the requirements of the IGF Code with respect to the bunkering station on the ship.
26.	Investigate the competency requirements for bunkering operations personnel, including certifications.
27.	Investigate the requirements for inerting prior to bunkering.
28.	Consider the use of fixed flame detection in bunkering area (subject to risk assessment)
29.	Specify that requirements for firefighting systems in bunkering area should be based on risk assessment.
30.	Investigate possible means of suppressing ammonia leakage in bunkering area (e.g. water curtains, dry fog).
31.	Investigate requirements for ammonia leak detection during bunkering.
32.	Ensure that there are means to measure the temperature and pressure inside the hose during bunkering.
33.	Investigate possible pressure relief solutions during bunkering of ammonia.
34.	Specify that purging should be appropriate for the fuel being purged.
Usage	
35.	Investigate requirement for switching to a higher extraction air flow in case of gas detection inside the fuel preparation room / TCS.
36.	Investigate whether shutdown of fuel transfer onboard is automatic or done manually by the operator.
37.	Investigate the requirements for the secondary containment in case of ammonia release inside the fuel preparation room / TCS.
38.	Review onboard pressure relief requirements for ammonia.
39.	Investigate the redundancy requirements for onboard cooling system for ammonia.
40.	Investigate secondary containment requirements in case of ammonia release onboard.
41.	Investigate requirements for redundancy of the nitrogen system onboard.
42.	Investigate requirements for ventilation inside the engine room in event of a release of fuel.
43.	Investigate requirements for fixed and portable ammonia release suppression systems onboard.
General	
44.	Specify that emergency equipment, escape routes, emergency access and assembly points should be determined based on risk assessment.
45.	Specify that emergency response procedures and training (including emergency exercises) need to reflect specific responses to hazardous release or fire/explosion involving methanol/ammonia.
46.	While sabotage is not specifically related to the use of green fuels, it should be considered as a potential cause of the hazardous events identified within the HAZID and therefore suitable risk reduction measures should be implemented to reduce its likelihood.
47.	While IT Security is not specifically related to the use of green fuels, it should be considered as a potential cause of many of the hazardous events identified within the HAZID and therefore suitable risk reduction measures should be implemented to reduce its likelihood.

A6. References

- [A1] ISO 17776:2016 Petroleum and natural gas industries — Offshore production installations — Major accident hazard management during the design of new installations

Figure A1 Risk Assessment Matrix used for Project HAZID

		Frequency									
		F1	F2	F3	F4	F5					
Consequences	C5										
	C4										
	C3										
	C2										
	C1										
Guidance for Consequence Scoring						Guidance for Frequency Scoring					
		People	Environment	Asset	Reputation						
C5	Catastrophic	Multiple (>3) fatalities or permanent disabilities	Massive impact	Massive damage or long-term loss of production/shutdown	Massive reputational impact	F5	Very likely	More than once per year at location			
C4	Serious	1 to 3 fatalities or permanent disabilities	Major impact	Major damage or medium-term loss of production/shutdown	Major reputational impact	F4	Likely	Has occurred at location or more than once per year in company			
C3	Significant	Major injury or health effect, >3 days absence	Moderate impact	Moderate damage or operational impact	Moderate reputational impact	F3	Possible	Has occurred in company or more than once per year in industry			
C2	Less significant	First aid injury or minor health effect, <3 days absence	Minor impact	Minor damage or operational impact	Minor reputational impact	F2	Less likely	Has occurred in industry			
C1	Negligible	Minor injury or health effect	Minimal impact	Minimal damage or operational impact	Minimal reputational impact	F1	Unlikely	Not known in industry but credible			
	High	Unacceptable - additional measures must be implemented to reduce the risk.									
	Medium	Tolerable if ALARP - Additional control measures should be considered to reduce the risk to a level which is as low as reasonably practicable.									
	Low	"Broadly acceptable" - Risk is generally considered acceptable provided that all control measures are applied. Additional control measures should still be considered if practicable.									

Table A3 HAZID Worksheets

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Storage				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Prevention	Mitigation				
Fuel receipt at facility									
1	Fuel delivery to port (by ship)	Collision, grounding	Release of flammable or toxic material, possible fire/explosion, exposure to toxic release, pollution to sea	- Pre-notification to port and authorisation - Oil company procedures and restrictions - Port security monitoring - Speed restrictions in port area - Pilot vessel, tugboat - SIMOPs study and risk reduction measures.		C5	F1	Medium	1. Provide oil company procedures for fuel receipt (information only). (Action on Port of Rønne)
2	Fuel delivery to port (by road/rail)	Vehicle collision	Release of flammable or toxic material, possible fire/explosion, exposure to toxic release.	- Pre-notification to fuel company onsite - Driver qualification for driving with hazardous goods (AdR)' - Oil company procedures and restrictions - Port security monitoring - Speed restrictions on site - SIMOPs study and risk reduction measures. - Safety zones and access to authorised personnel only in receipt area.		C5	F1	Medium	2. Specify requirement for security restrictions for fuel receipt area and ensure receipt is within an ISPS area.
3	Fuel delivery to port (by road/rail)	External fire	Possible truck fire/explosion/BLEVE	- Cooling of tank (e.g. using water cannons) in event of fire. - Vapour / BoG management (e.g. closed loop recirculation) - Pressure relief on tankers		C5	F1	Medium	3. Specify undertaking of consequence modelling of tanker BLEVE as a specific case.
4	Fuel delivery to port (general)	Fuel quality out of spec. due to errors during the original production of the fuel.	Contamination of fuel leading to operability problems. - Possible damage to the assets e.g. additional wear/corrosion of storage/piping system. Also see ‘Bunkering’ Item 3 below.	- Sampling done by manufacturer of the fuel according to ISO standard		C3	F2	Medium	

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Storage				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Prevention	Mitigation				
Fuel transfer from tanker to storage (NB transfer from ship to shore is covered under Bunkering)									
5	Release of flammable / toxic inventory	Incorrect connection	Release of flammable or toxic material, possible fire/explosion, exposure to toxic release	- Transfer checklist/procedures- Competency and training of truck driver - Standardised connections - Drip-free connections	- Hazardous area classification and ignition source control - Flow indication on truck - Monitoring of gas in area during transfer - Emergency stop (manual) on gas/leak detection - Suitable fire detection linked to ESD (esp. for methanol) - Suitable PPE (BA, eye wash, shower) - Drip trays for spillage with drainage	C5	F1	Medium	4. Provide example drawings of transfer schematics for fuel receipt (information only). (Action on Complete Solutions) 5. Specify use of risk assessment to identify requirements for additional gas detection/monitoring (general requirement throughout port). 6. Investigate possible means of suppressing ammonia leakage during transfer from tanker to storage (e.g. water curtains, dry fog).
		Incorrect disconnection		- As above - Draining / purging of system prior to disconnection (for ammonia)					
		Vehicle drive away during transfer		- Driver training - Legislation (BEK 1254) states that transfer must be observed from outside - Breakaway valves - shutdown on loss of pressure					
		Vehicular collision		- Site speed restrictions					
		Mechanical failure		- Inspection and maintenance - Material specification according to codes and standards.					

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Storage				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Prevention	Mitigation				
5	Release of flammable / toxic inventory (continued)	Overfilling of storage tank (or incorrect tank filled)	As above	- Level indication/alarms on storage tanks - automatically shuts down delivery - Legislation (BEK 1254) states that transfer must be observed from outside. - Emergency stop in event of overfilling.	As above				
		Overpressure of storage tank during transfer (e.g. due to overfilling, blockage of ventilation)		- Pressure relief valves on tanks					
		Hazardous release from ventilation	Possible release of hazardous material during normal operation	- Ventilation to safe location (ammonia to dedicated enclosed location)		C4	F2	Medium	7. Specify the need to ensure dispersion modelling is undertaken to identify safe location for venting (general requirement throughout port).
6	Environmental release	Spillage of methanol during transfer in excess of oil separator capacity	Release of toxic inventory to water treatment plant resulting in possible operator exposure and significant health effects.		- Gas detection in line to water treatment plant	C3	F1	Low	
Fuel Storage									
7	Release of flammable / toxic inventory	Mechanical failure (corrosion, erosion, vibration, fatigue, cold stress, and other metallurgical/mechanical damage mechanisms etc.)	Leakage or rupture leading to release of flammable or toxic material, possible fire/explosion, exposure to toxic release	- Material specification according to codes and standards.- Inspection (NDT etc.) and maintenance (preventative/corrective) - Double walled tanks and piping (for underground storage according to BEK)	- Hazardous area classification and ignition source control - Tank level monitoring in control room, alarm on low level - Suitable fire detection - Firefighting equipment - Drip trays under tanks for spillage with drainage with level indication - Only suitably qualified personnel permitted to enter storage tank area, subject to PtW - Suitable PPE if working in tank area (inc. BA for ammonia)	C5	F1	Medium	8. Consideration to be given to possibility of underground storage. 9. Specify that requirements for gas detection in storage areas are to be based on assessment of likely leak sources. 10. Consider requirements for ESD on gas detection in storage area (how initiated, necessary actions - e.g. stop all activities and ignition sources). 11. Define requirements for suitable firefighting measures in storage area (e.g. including AR-AFFF and required water capacity). 12. Investigate possible solutions for ammonia suppression in storage area (e.g. water curtains), including requirements for effluent disposal. 13. Investigate possible requirements for ammonia shelter in storage area. 14. Consider requirements for redundancy of ammonia storage cooling system.

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Storage				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Prevention	Mitigation				
7	Release of flammable / toxic inventory (continued)	Overpressure	As above	- Pressure relief valves on tanks	As above				
		Operation conditions outside design specifications		- Operating procedures					
		New product incompatible with existing storage design (retrofit)		- Risk assessment of impact of new fuel on design (part of MoC)					
		Incorrect start-up and shutdown		- Operating procedures					
		Incorrect material selection		- Material specification according to codes and standards.					
		Failure of cooling system (ammonia only)		- Continuous monitoring of cooling system.					
		External collision / accidental drop of loads		- Traffic and safety signs - Traffic rules - Safety distances - Work permits e.g. lifting procedures - Traffic barriers e.g. bollards					
		Weather e.g. floods		- Designed to withstand design flooding conditions.					
		Overpressure of storage tank (e.g. due to blockage)		- Pressure relief valves on tanks					
		External fire	Possible storage tank fire/explosion/BLEVE	- Cooling of tank (e.g. using water cannons) - Vapour / BoG management (e.g. closed loop recirculation) - Pressure relief on storage tanks.		C5	F1	Medium	15. Specify undertaking of consequence modelling of storage BLEVE as a specific case.
8	Inerting/vacuum	Failure of storage tank inerting/vacuum system (pressure leak detection)	Failure to remove air from storage tank, leading to reduced safety margin due to flammable gas mixture.	- Alarm at control room on loss of vacuum - remedial action on loss of vacuum.		C4	F1	Medium	
9	Environmental release	Disposal of e.g. ammonia water curtain or AR-AFFF fire extinguishing medium (general hazard but quantities involved are larger in storage area).	Possible discharge of liquid effluents in excess of permitted limits.			C3	F1	Low	16. Consider requirements for disposal of liquid effluents used for firefighting/toxic release suppression.

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Bunkering				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Prevention	Mitigation				
Transfer from storage to bunkering station (via fixed pipelines)									
1	Release of flammable / toxic inventory (methanol)	Mechanical failure in the transfer pipeline (corrosion, lack of maintenance)	- Release of flammable/toxic material - Possible pool fire or running fire (depending on the landscape) - Possible exposure to toxic release - Possible spray fire / spray release (in the event of overpressure in the transfer pipeline)	- Inspection and maintenance - Design specifications for pipeline according to relevant standards - Flow meters in the pipeline may detect the leakage - Pumping procedure.	ATEX classification	C5	F1	Medium	17. Investigate whether provision of the double wall piping is mandatory for fuel transfer to bunkering stations. 18. Investigate the instrumentation in the fixed pipeline from the storage to the bunkering station, including pressure relief valves. 19. Investigate requirements for gas detection in vicinity of transfer pipeline to bunkering station. 20. Investigate the classification and size of the ATEX classification zone around transfer pipelines. 21. Consider requirements for flame detection systems in place to detect methanol fires in the event of a leakage from transfer pipelines.
		Overpressure in the transfer pipeline							
		Operation conditions outside design specifications due to operator error							
		Incorrect material selection of transfer pipeline							
		External collision / accidental drop of loads							
		Weather e.g. floods		- Traffic and safety signs - Traffic rules - Safety distances - Work permits e.g. lifting procedures - Traffic barriers e.g. bollards					
				- Flood defences					
2	Release of flammable / toxic inventory (ammonia)	As methanol release (Item 1)	- Release of toxic gas material - Frostbite for the personnel in the surroundings - Damage to the surrounding assets due to corrosivity or ice formation - Possible fire or running fire (depending on the landscape) - Possible exposure to toxic release	- As methanol (Item 1)	- Special PPE - ESD of plant. - External emergency responders dispatched to site. Also see Bunkering (Item 5)	C5	F1	Medium	22. Investigate whether ESD is required to be operated automatically or manually in the event of leak detection during ammonia transfer.
		Hydraulic shock		- Design specifications for pipeline according to relevant standards and suitable for the fuel being transported					

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Bunkering				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Prevention	Mitigation				
Preparation and transfer from bunkering station to the ship									
3	Preparation	Checklists not followed or misaligned, e.g. high workload, over familiarity, lack of time to prepare, checklist not appropriate for the corresponding fuel	- Release of flammable/toxic material - Possible pool fire - Possible exposure to toxic release - Possible spray fire / spray release - Possible explosion if the release occurs inside an enclosed area without ventilation - Possible environmental release to sea	- Toolbox talks to review checklist & existing risk assessment. - Checklist signed by both parties for bunkering to occur. - RACE matrix for producing, reviewing & signing the checklists, and to ensure the checklist is suitable for the fuel.	- Portable gas detectors used by people on deck and onshore - CCTV (NB will not detect gas release) - Area surrounding bunkering area is classified as ATEX classified - Suitable firefighting system - ESD system shuts down the bunkering operation by stopping the pump and close isolation valves. - Drip trays - Grounding of the piping system and manifold (reduces likelihood of ignition) - Safety equipment e.g. safety showers and eye wash stations - Only competent personnel permitted in bunkering stations during bunkering operations. Competent personnel must wear appropriate PPE.	C5	F1	Medium	
		Incompatibility of connections (part of checklists)		- Pre-notification of bunkering procedures and requirements from the vessel owner/operator. - Checklist item to ensure compatibility of connections.					

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Bunkering				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Prevention	Mitigation				
3	Preparation (continued)	Volume requested from ship exceeds capacity due to operator error (part of checklist)	- Possible overfilling of the ship storage tank, leading to a major release of flammable/toxic material as above.	- Instrumentation on tank. - Checklist to ensure correct volumes. - Visual measurements & controls on both sides of operations. - Vessel and fuel specific training.	As above				
		Simultaneous operations (SIMOPS) interfere with bunkering operations	- Release of flammable/toxic material - Possible pool fire - Possible exposure to toxic release - Possible spray fire / spray release - Possible explosion if the release occurs inside an enclosed area without ventilation - Possible release to sea	- Port restrictions - Harbour restriction zones - SIMOPS risk assessment of operations in other parts of harbour and ensure suitable limits are in place.					
		Inadequate mooring during ship to ship bunkering due to human error or incorrect information used during mooring calculations	- Vessel movement during bunkering leading to hose rupture - Release of flammable / toxic fuel (most likely on the receiving vessel) - Possible fire / explosion - Environmental release	- Training and competences of the vessels' master (supplying and receiving vessels) - Quality checklists of mooring equipment					
4	Contamination	Fuel quality out of spec due to errors during the original production of the fuel.	- Damage to the assets e.g. Additional wear on the piping system - Contamination of the content of the storage tank	- Collection of samples of the fuel while bunkering by the receiving agent and prior to bunkering by vessel operator/owner. Note - analysis is conducted after bunkering and will only reduce the likelihood of contamination occurring in the future. - Sampling done by fuel manufacturer of the fuel according to ISO standard.		C3	F2	Medium	

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Bunkering				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Prevention	Mitigation				
5	Connection	Assembly error / hose damage / human error		- Pre-start checklist before connection to check seal - Checklist after connection - Double dry connections ensure correct connection between couplings - Hose must be certified and inspected for wear	As Item 3	C5	F1	Medium	25. Review the requirements of the IGF Code with respect to the bunkering station on the ship. 26. Investigate the competency requirements for bunkering operations personnel, including certifications.
6	Purging / inerting	Incorrect inerting due to improper purging prior to bunkering.	To be determined.						27. Investigate the requirements for inerting prior to bunkering.
7	Bunkering	Hose rupture	- Release of flammable / toxic material - Possible environmental release - Possible fire - Possible explosion if it happens in an enclosed area - Possible exposure to toxic release in case of ammonia	- Preventive maintenance - Pre-use inspection - Correct storage of hose according to relevant standards - Operation within design parameters - Hose must be designed and tested according to relevant standards and type approved	As Item 3	C5	F1	Medium	28. Consider the use of fixed flame detection in bunkering area (subject to risk assessment) 29. Specify that requirements for firefighting systems in bunkering area should be based on risk assessment. 30. Investigate possible means of suppressing ammonia leakage in bunkering area (e.g. water curtains, dry fog).
		Blown gasket		- Visual inspection to ensure it is fitted for future use - Design of gasket according to relevant standards					
		Overflow		- Level instrumentation triggers an alarm - Visual level glass indication - Bunkering procedures to reduce fuel velocity					
		Vessel movement (see preparation)		See SIMOPS (Item 3)					
		Weather		- Weather forecast and weather monitoring during bunkering					

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Bunkering				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Prevention	Mitigation				
7	Bunkering (continued)	Loss of communication	As above	- Bunker watch in the manifold communicates with bunker vessel verbally - Bunker barge communicates with bunker vessel - Dedicated channels for communication during bunkering communication	As Item 3				
		Overpressure		- Recirculation valve opens in case of overpressure - Manual ESD system shuts down the bunkering operation in case of overpressure					
		Operator error		- Operating procedures - Training and competent personnel					
		Hydraulic shock		- Monitoring pressure and temperature - Lower flowrate during start of the bunkering operation according to operating procedures					
		Release of methanol vapour at the receiving ship		Inerting of tank					
		Collision		See SIMOPS (Item 3)					
		External fire		- Manual ESD system shuts down the bunkering operation in event of fire elsewhere - Fire alarm in the surroundings and in the bunker vessel.					

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Bunkering				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Prevention	Mitigation				
7	Bunkering (continued)	Dropped loads	As above	- No lifting permitted in the vicinity of the bunker station during bunkering operations - Dropped load protection if required to protect the bunkering station	As Item 3				
		Incorrect cooling of transfer piping (applies to ammonia)	- Overpressure inside the bunker hose, leading to the release of flammable / toxic ammonia - Possible fire - Possible environmental release - Possible toxic effects on personnel - Possible release leads to a two-phase ammonia inside the piping, leading to damage to the assets e.g. cavitation of the pump	- Continuous monitoring of pressure and temperature of coolant and ammonia. - Automatic ESD system shuts down the bunkering operation in event of loss of cooling.		C5	F1	Medium	31. Investigate requirements for ammonia leak detection during bunkering. 32. Ensure that there are means to measure the temperature and pressure inside the hose during bunkering. 33. Investigate possible pressure relief solutions during bunkering of ammonia.
8	Disconnection	Failure to purge (nitrogen)	- Release of flammable / toxic residual fuel when disconnecting - Possible fire - Possible explosion if it happens in an enclosed area - Possible exposure to toxic release in case of ammonia	- Purging is reviewed as part of the preparation checklist - Bunkering procedures - Spill tray on board the ship	As Item 3	C4	F2	Medium	34. Specify that purging should be appropriate for the fuel being purged
		Insufficient purging		- Bunkering procedures - Spill tray on board ship					

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Usage				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark							
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action				
				Prevention	Mitigation								
Fuel Preparation Room / Tank Connection Space													
1	Release of flammable / toxic inventory	Mechanical failure (e.g. corrosion, erosion, vibration, fatigue, cold stress, and other metallurgical/mechanical damage mechanisms etc.)	- Leakage or rupture leading to release of flammable or toxic material - Possible fire/explosion, - Exposure to toxic release in case of ammonia	- Material specification according to codes and standards. - Inspection (NDT etc.) and maintenance (preventative/corrective)	- Hazardous area classification and ignition source control in the fuel preparation room / TCS - Dedicated redundant air extraction systems to remove vapour from spaces. Gas detection in air extraction triggers shutdown of fuel transfer - Smoke, heat & suitable flame detection following best practices and assessment of most likely release sources. Tank level monitoring in control room, alarm on low level - Suitable fire detection - Suitable firefighting equipment including AR-AFFF for methanol and water screens for ammonia - Gas detection in cofferdam (methanol) - Secondary containment in the fuel preparation room in case of methanol - Limited access to enter the fuel preparation room (additional requirements for ammonia). - Suitable PPE worn inside fuel preparation room and TCS.	C5	F1	Medium	35. Investigate requirement for switching to a higher extraction air flow in case of gas detection inside the fuel preparation room / TCS. 36. Investigate whether shutdown of fuel transfer onboard is automatic or done manually by the operator. 37. Investigate the requirements for the secondary containment in case of ammonia release inside the fuel preparation room / TCS.				
		Overpressure e.g. failure of the control system of transfer pump leading to the shutoff pressure. For ammonia: failure of cooling system		- PRVs on tanks - Vented to safe location (methanol) - BoG management - Piping design & material selection according to relevant standards & design conditions					38. Review onboard pressure relief requirements for ammonia.				
		Blockage of PRV (for methanol)		- Maintenance and inspection and functional test of PRVs									
		Operation conditions outside design specifications		- Operating procedures - Piping design & material selection according to relevant standards & design conditions									
		Incorrect material selection		- Material specification according to codes and standards.									
		Failure of cooling system (ammonia only) (Note: separate overpressure for methanol and for ammonia)		- Continuous monitoring of cooling system.					39. Investigate the redundancy requirements for onboard cooling system for ammonia.				
		External collision / Grounding		- Layout / structural requirements for methanol & ammonia fuelled ships according to relevant standards and IMO interim guidelines.					40. Investigate secondary containment requirements in case of ammonia release onboard.				
		Fire in adjacent areas or compartments of the ship											

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Usage				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Prevention	Mitigation				
2	Purging / inerting	Failure of nitrogen generation	- Loss of the ability to refill the buffer tank	- Buffer tank ensures sufficient nitrogen must be always available		C3	F2	Medium	41. Investigate requirements for redundancy of the nitrogen system onboard.
		Leakage of nitrogen supply to the inerting system (methanol)	- Loss of safety margin inside the storage tank	- Pressure transmitter in the buffer tank alarms in case of low pressure		C4	F1	Medium	
		Leakage of nitrogen supply to the system	- Loss of the ability to purge or pressure test the pipeline, leading to the incapacity to re-start the methanol transfer system - Possible release of fuel to surroundings in case of need to break containment	- Suitable PPE to be worn in case of possible release of fuel		C3	F1	Low	
Engine Room									
3	Release of flammable / toxic inventory	Mechanical failure (e.g. corrosion, erosion, vibration, fatigue, cold stress, and other metallurgical/mechanical damage mechanisms etc.)	- Leakage or rupture leading to release of flammable or toxic material - Possible fire/explosion, - Exposure to toxic release in case of ammonia	- Material specification according to codes and standards. - Inspection (NDT etc.) and maintenance (preventative/corrective) -Ventilated double wall in all the pipeline inside the engine room - Leak detection inside the double wall	- Failed ignition in the engine will shut down the transfer of fuel - Bilge well in engine room collect any spillage - High level indication in the bilge well triggers alarm - Suitable PPE, including portable gas detectors - Suitable fire detection systems - Fixed water mist system - Manually initiated fixed firefighting AR-AFFF system and portable AR-AFFF fire extinguishers	C5	F1	Medium	42. Investigate requirements for ventilation inside the engine room in event of a release of fuel. 43. Investigate requirements for fixed and portable ammonia release suppression systems onboard.
		Overpressure e.g. failure of the control system of transfer pump leading to the shutoff pressure. For ammonia: failure of cooling system		- PRVs on tanks - Vented to a safe location (for methanol) - Boil-off gas management - Piping design & material selection according to relevant standards & design conditions					

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: Usage				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Prevention	Mitigation				
3	Release of flammable / toxic inventory (continued)	Operation conditions outside design specifications	As above	- Operating procedures - Piping design & material selection according to relevant standards & design conditions	As above				
		Incorrect material selection		- Material specification according to codes and standards.					
		Fire in adjacent areas or compartments of the ship		- Fire rating (A60) around the engine room, bulkheads and decks.					
		Impact e.g. dropped loads, manual handling, etc. leading to damage in the equipment		- Structural design - Impact protection if required - Manual handling procedures.					

Title: HAZID of Storage, Bunkering and Usage of Green Fuels within Port Area Project: SafeSBU Domain: General Hazards				Date: 10/03/26 to 12/03/26		Location: DBI, Hvidovre, Denmark			
Item No.	Risk	Cause(s)	Consequences	Existing/Planned Safeguards		C	F	Risk (R)	Action
				Preventative	Mitigation				
1	Emergency response	Emergency equipment, escape routes, emergency access and assembly points unavailable following hazardous event.	Increased likelihood of fatalities/injuries following hazardous release or fire/explosion involving methanol/ammonia.			C5	F1	Medium	44. Specify that emergency equipment, escape routes, emergency access and assembly points should be determined based on risk assessment.
		Inadequate emergency response to loss of containment or fire of methanol/ammonia.		Emergency procedures/training.					45. 'Specify that emergency response procedures and training (including emergency exercises) need to reflect specific responses to hazardous release or fire/explosion involving methanol/ammonia.
2	Sabotage	Deliberate action by internal staff, external parties.	As for flammable/toxic releases described elsewhere in HAZID (not ranked).	ISPS Site	As for flammable/toxic releases described elsewhere in HAZID.	Not ranked, depends on specific action and its consequences.			46. While sabotage is not specifically related to the use of green fuels, it should be considered as a potential cause of the hazardous events identified within the HAZID and therefore suitable risk reduction measures should be implemented to reduce its likelihood.
3	IT Security	Deliberate action by internal staff, external parties.	As for flammable/toxic releases described elsewhere in HAZID (not ranked).	Site and company IT procedures and systems	As for flammable/toxic releases described elsewhere in HAZID.	Not ranked, depends on specific action and its consequences.			47. While IT Security is not specifically related to the use of green fuels, it should be considered as a potential cause of many of the hazardous events identified within the HAZID and therefore suitable risk reduction measures should be implemented to reduce its likelihood.