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BUNKERING SHIPS

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RULE NOTE

BUREAU VERITAS

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RULES, RULE NOTES AND GUIDANCE NOTES

NR620 DT R03 February 2024 takes precedence over previous revision.

The PDF electronic version of this document available on the Bureau Veritas Marine & Offshore website https://marine-offshore.bureauveritas.com/ is the official version and shall prevail if there are any inconsistencies between the PDF version and any other available version.

These rules are provided within the scope of the Bureau Veritas Marine & Offshore General Conditions, enclosed at the end of Part A of NR467, Rules for the Classification of Steel Ships. The latest version of these General Conditions is available on the Bureau Veritas Marine & Offshore website.

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NR620

BUNKERING SHIPS

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CHAPTER 1
CLASSIFICATION OF BUNKERING SHIPS

Section 1 Principles of Classification and Definitions

Section 1 Principles of Classification and Definitions

1 General

1.1 Application

1.1.1 The present Rule Note applies to ships carrying liquefied natural gas (LNG) or liquefied ammonia or methanol as cargo and intended to ensure the transfer of such cargoes to ships using these products as fuel.

1.1.2 In accordance with NR467, Pt A, Ch 1, Sec 2, [4.4.5], ships complying with the requirements defined in this Rule Note and with the applicable requirements defined in [1.4] are to be assigned the service notation **liquefied gas carrier** completed with additional service features defined in [1.5].

1.1.3 In accordance with NR467, Pt A, Ch 1, Sec 2, [4.4.4], ships complying with the requirements defined in this Rule Note and with the applicable requirements defined in [1.4] are to be assigned the service notation **chemical tanker** completed with additional service features defined in [1.5].

1.2 Scope

1.2.1 In general, the requirements of this Rule Note apply to bunkering station and transfer systems of the ship.

1.2.2 This Rule Note covers:

- the design and installation of the transfer systems from the bunkering ship to the receiving ship and the vapour transfer system from the receiving ship to the bunkering ship, including hoses, transfer arms and auxiliary equipment supporting the transfer system
- the design and installation of the equipment intended for the boil-off gas management of the bunkering ship
- the design and installation of the piping system of the bunkering ship
- the safety arrangements.

1.3 Exclusion

1.3.1 This Rule Note does not cover the storage tanks, associated piping and process systems which are to comply with the requirements of:

- IGC Code and NR467, Part D, Chapter 9 for ships assigned the service notation **liquefied gas carrier**
- IBC Code and NR467, Part D, Chapter 8 for ships assigned the service notation **chemical tanker**.

1.4 Applicable requirements

1.4.1 Ships covered by this Rule Note are to comply with the requirements of:

- NR467, Part A
- NR216, Rules on Materials and Welding for the Classification of Marine Units
- NR467, Part D, Chapter 9 for ships assigned the service notation **liquefied gas carrier**, except where otherwise specified
- NR467, Part D, Chapter 8 for ships assigned the service notation **chemical tanker**, except where otherwise specified
- applicable requirements defined in Tab 1.

Table 1 : Applicable requirements

Item	Type of ship		
	Liquefied gas carrier (LNG)	Liquefied gas carrier (NH3)	Chemical tanker intended for carriage of methanol
Ship arrangement	NR467, Part B	NR467, Part B	NR467, Part B
Hull	NR467, Part B	NR467, Part B	NR467, Part B
Stability	NR467, Part B	NR467, Part B	NR467, Part B
Machinery and cargo systems	NR467, Part C	NR467, Part C	NR467, Part C
Electrical installations	NR467, Part C	NR467, Part C	NR467, Part C
Automation	NR467, Part C	NR467, Part C	NR467, Part C
Fire protection, detection and extinction	NR467, Part C	NR467, Part C	NR467, Part C
Carriage of product	NR467, Part D, Chapter 9	NR467, Part D, Chapter 9	NR467, Part D, Chapter 8
Bunkering and vapour control systems	Chapter 2	Chapter 3	Chapter 4

1.5 Classification notations

1.5.1 Liquefied gas carriers may be assigned one of the following additional service features:

- **LNG bunkering** when the ship is equipped in order to ensure the transfer of liquefied natural gas to LNG-fuelled ships in accordance with the requirements of this Chapter and of Chapter 2
- **Ammonia bunkering** when the ship is equipped in order to ensure the transfer of liquefied ammonia to ammonia-fuelled ships in accordance with the requirements of this Chapter and of Chapter 3.

1.5.2 Chemical tankers equipped in order to ensure the transfer of methanol to methanol-fuelled ships and complying with the requirements of this Chapter and of Chapter 4 may be assigned the additional service feature **Methanol bunkering**.

1.5.3 The additional service features **LNG bunkering** or **ammonia bunkering** may be completed by the complementary additional service features listed in Tab 2 where the ship is designed for a specific additional functionality and complies with the requirements listed in Tab 2.

Table 2 : Additional service features

Additional service feature	Definition	LNG bunkering	Ammonia bunkering
Initial-CD	where the ship is designed for initial cooling down of the gas-fuelled ship LNG fuel tank	Ch 2, Sec 9	–
RE	where the ship is designed to receive liquefied gas from a gas-fuelled ship for which the gas fuel tanks have to be emptied	Ch 2, Sec 9	Ch 3, Sec 9
IG-Supply	where the ship is designed to supply inert gas and dry air, to ensure LNG or ammonia freeing and aeration, to a gas-fuelled ship	Ch 2, Sec 9	Ch 3, Sec 9
BOG	where the ship is designed to recover and manage the boil-off gas generated during the bunkering operation	Ch 2, Sec 9	Ch 3, Sec 9
Effluent-recovery	where the ship is designed to recover effluents containing dissolved ammonia from an ammonia-fuelled ship	–	Ch 3, Sec 9
VPS	where the ship is designed to manage its ammonia vapour released in normal or failure operation	–	Ch 3, Sec 9

1.6 Certification scheme for materials and equipment

1.6.1 Materials and equipment certification schemes are to comply with the requirements of NR320, Certification Scheme of Materials and Equipment for the Classification of Marine Units.

2 References

2.1 Acronyms

2.1.1 The following acronyms are used:

BAC : Break-Away Coupling

BOG : Boil-Off Gas

DD/CC : Dry Disconnect-connecting Coupling.

ERC : Emergency Release Coupling

ERS : Emergency Release System

ESD : Emergency Shut-Down systems

MAAT : Maximum Allowable Applied Twist

MBR : Minimum Bend Radius

PEL : Permissible Exposure Limit

PERC : Powered Emergency Release Coupling

QCDC : Quick Connect/Disconnect Couplers.

2.2 Definitions

2.2.1 Auxiliary equipment

Auxiliary equipment refers to equipment of systems which are used in the transfer system, including the following equipment:

- hydraulic systems
- power supply
- inert gas systems
- supporting equipment
- water mist

2.2.2 Bunkering station

Bunkering station means the area or space where the connections with the transfer system for the bunkering operations take place and includes the following equipment:

- hoses and piping connections used for liquid and vapour return lines, including the isolating valves and the emergency shut-down valves
- automation and alarms systems
- drip tray with its draining arrangement and other arrangements intended for the ship structure protection
- gas and leak detection systems
- associated fire-fighting installations.

2.2.3 Break-away coupling (BAC)

A break-away coupling is a type of emergency release coupling, located on the transfer system, which is triggered by applying a set “break-away” load to the equipment itself. The “break-away” load is typically a mechanical tension applied at the equipment’s release collar in response to either the receiving ship or the bunkering ship drifting away from one another. When the coupling is released, each separated section seals at both sides instantly by self-closing interlocked isolating valves. The BAC is also commonly known as a passive ERC.

2.2.4 Bunkering emergency shut-down system (ESD)

An ESD is a system that safely and effectively stops the transfer of liquid (and vapour as applicable) between the receiving ship and the bunkering ship in the event of an emergency during the bunkering operation, and puts the system in a safe condition.

Note 1: The bunkering ESD system comes in addition to the ESD required by NR467, Part D, Chapter 9, if a separate transfer system is provided.

2.2.5 Bunkering connections

Bunkering connections correspond to the end of the piping fixed to the bunkering ship (i.e. manifold for a system with flexible hose and before the swivel for a system with transfer arm).

2.2.6 Dry disconnect/connect coupling (DD/CC)

Mechanical device, consisting of two parts, nozzle and a receptacle (each equipped with non-return valves), which enable quick, safe and dry connection and disconnection between the bunkering ship hose bunkering system and the receiving ship’s manifold without employing bolts.

The nozzle is fixed on the hose bunkering system end and the receptacle on the receiving ship’s manifold. These couplings are also known as “Dry-Disconnect Couplings” or “Dry-Break Couplings” and considered as a type of QCDC.

2.2.7 Emergency release coupling (ERC)

An ERC is a coupling, part of the ERS located on the transfer system, which separates at a predetermined section, when required. Each separated section is equipped with interlocked isolating valves, which close before or simultaneously with the separation of the ERC to minimize loss of product when the equipment is activated.

An emergency release coupling can be activated:

- by maximal allowable forces applied to the predetermined section (Break-Away Coupling or BAC, also called passive ERC)
- by manual or automatic powered control, in case of emergency (Powered Emergency Release Coupling or PERC, also called active ERC).

2.2.8 Enclosed space

Enclosed space means any space within which, in the absence of artificial ventilation, the ventilation will be limited and any explosive, or toxic, atmosphere will not be dispersed naturally.

2.2.9 Hazardous area

Hazardous area means an area in which an explosive gas atmosphere is or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of electrical apparatus.

Hazardous areas are divided into Zone 0, 1 and 2 as defined below and:

- Zone 0: Area in which an explosive gas atmosphere is present continuously or is present for long periods
- Zone 1: Area in which an explosive gas atmosphere is likely to occur in normal operation
- Zone 2: Area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it does occur, is likely to do so only infrequently and will exist for a short period only.

2.2.10 Hose assembly

Hose assembly means the hose and its end-fittings. End-fitting means the assembly of connector and mechanical device which forms the transition between the connector and the flexible pipe body whose different pipe layers are terminated in the end fitting in such a way as to transfer the load between the flexible hose assembly and the connector.

2.2.11 Manifold

A manifold is a pipe assembly to which the outboard flanges of the transfer system are connected.

2.2.12 Non-hazardous area

Non-hazardous area means an area in which an explosive gas atmosphere is not expected to be present in quantities such as to require special precautions for the constructions, installation and use of electrical apparatus.

2.2.13 Permissible exposure limit

Permissible exposure limit, for the purpose of this Rule Note, means a concentration of ammonia vapours in the air of 30 ppm, corresponding to the Acute Exposure Guideline Level 1 (AEGL-1) given by US-EPA.

2.2.14 Quick connect disconnect coupler (QCDC)

A QCDC is a manual or hydraulic mechanical device used to connect the transfer system to the receiving ship manifold.

Integrated interlock function ensure that the valves are closed before couplings can be fully disconnected, minimizing liquid release when disconnecting.

2.2.15 Receiving ship

A receiving ship is a ship receiving LNG, ammonia, or methanol, as fuel.

2.2.16 Safety zone

The safety zone is a zone around the bunkering ship's transfer manifold, the receiving ship's bunkering station and the LNG, ammonia or methanol transfer system, as defined by Safety studies addressing the flammability of LNG vapours or the toxicity and flammability of ammonia and methanol vapours, and where only dedicated and essential personnel and activities are allowed during bunkering.

2.2.17 Swivel

A swivel is a swing joint contained in the transfer arm allowing the transfer of liquid between the arm parts. It enables the arm to freely follow the relative motions of the receiving ship and the bunkering ship.

2.2.18 Transfer arm

Transfer arm refers to any system allowing to support hoses or rigid pipes during bunkering operations.

2.2.19 Toxicity area

Toxicity area means an area in which a toxic atmosphere is or may be expected to be present, in quantities such as to require special precautions to avoid health effects on people. In the scope of this Rule Note, toxicity areas are required to be defined for ammonia bunkering ship only.

2.2.20 Transfer system

A transfer system is a system used to connect the bunkering ship and the receiving ship in order to transfer liquid only or both liquid and vapour.

The transfer system includes:

- rigid pipes, hoses, swivels, valves, couplings
- supporting structure
- handling system and its control/monitoring system.
- saddles, fall arrest system, Vessel Separation Detector, vapour return line (if any).

2.2.21 Vapour return lines

A vapour return line is a connection between the bunkering ship and the receiving ship to prevent pressure increase in the receiving tank due to liquid transfer and associated boil-off.

2.3 Referenced documents

2.3.1 NR467

NR467 means Rules for the Classification of Steel Ships.

2.3.2 NR320

NR320 means the latest version of NR320, Certification Scheme of Materials and Equipment for the Classification of Marine Units.

2.3.3 NR216

NR216 means the latest version of NR216, Rules on Materials and Welding for the Classification of Marine Units.

2.3.4 IGC Code

IGC Code means the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, published by the International Maritime Organization.

2.3.5 IBC Code

IGC Code means the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemical in Bulk, published by the International Maritime Organization.

2.3.6 IEC 60092-502:1999

IEC 60092-502:1999 means the International Electrotechnical Commission standard: Electrical installations in ships (Part 502: Tankers - Special features).

2.3.7 EN 1474-2:2020

EN 1474-2:2020 means the European Standard: Installation and equipment for liquefied natural gas - Design and testing of marine transfer systems - Part 2: Design and testing of transfer hoses.

2.3.8 ISO 20519:2022

ISO 20519:2022 means the International Organization for Standardization: Ships and marine technology - Specification for bunkering of liquefied natural gas fuelled vessels.

2.3.9 ISO 21593:2019

ISO 21593:2019 means the International Organization for Standardization: Ships and marine technology - Technical requirements for dry-disconnect/connect couplings for bunkering liquefied natural gas.

CHAPTER 2
LNG BUNKERING SHIPS

Section 1 General

1 Application

1.1

1.1.1 Ships to be assigned the additional service feature **LNG bunkering** are to comply with the requirements of this Chapter.

2 Documention to be submitted

2.1 General

2.1.1 The documents listed in Tab 1 are to be submitted.

2.1.2 The drawings and related information to be submitted are listed in Tab 1 and in Sec 9 for complementary additional service features.

2.1.3 The operating manuals and procedures to be submitted are listed in Tab 2. Operating manuals are to detail, but not be limited to, equipment specifications, equipment service life, instructions for installation, handling, storage, and periodic inspections.

3 Tests and trials

3.1 LNG transfer system trials in working condition

3.1.1 The LNG transfer system, defined in Ch 1, Sec 1, [2.2.20], is to be operated in the presence of a Surveyor during the first bunkering operation.

The survey conducted during the first LNG transfer is to consist of:

a) General visual examination and witness satisfactory operation of the whole fluid transfer system (LNG and vapour return lines) from bunkering ship to the receiving ship including piping, QCDC, ERC, swivel, flanges and flexible hoses.

b) Witness satisfactory operation of the following:

- control and monitoring systems
- connections systems (QCDC).

3.1.2 Maintenance and inspections

The owner is to maintain a record of all maintenance and inspections conducted for the transfer system, as required in NR467, Pt A, Ch 4, Sec 5, [11].

Table 1 : Documentation to be submitted

No	A/I **(1)**	Documents
1	A	General arrangement of the ship showing the location of the bunkering station and bunkering control station
2	I	Risk analysis report for the LNG bunkering transfer system, LNG bunkering station and LNG bunkering operation, in accordance with App 1 and risk analysis follow-up report
3	A	Details of maximum bunkering flow and maximum pressure (see Sec 4)
4	A	Details of LNG transfer components (see Sec 4)
5	A	Details of bunkering system ESD (see Sec 4)
6	I	Safe type certificates for electrical equipment, located in hazardous areas
7	A	Instrumentation list
8	A	Drawing of transfer arm
9	A	Technical specifications of the transfer system
(1) A : To be submitted for approval I : To be submitted for information		

Table 2 : Operating manuals and procedures to be submitted

No	A/I **(1)**	Documents
1	I	Bunkering procedure, including inerting and gas freeing
2	I	BOG management procedure
3	I	Operating envelop of the bunkering ship
4	I	LNG transfer components operating manual (see Sec 4)

(1) A : To be submitted for approval
I : To be submitted for information

Section 2 Ship Arrangement

1 General design requirements

1.1 Risk analysis

1.1.1 LNG transfer system

The design and the arrangement of the LNG transfer system are to be substantiated by a risk analysis to be performed in accordance with App 1.

1.2 Hazardous area classification

1.2.1 General

The hazardous areas are to be in accordance with NR467, Pt D, Ch 9, Sec 10, Tab 1.

1.2.2 Zone 1

In addition to those defined in NR467 Pt D, Ch 9, Sec 10, Tab 1, the following areas or spaces are to be classified as hazardous area zone 1:

- bunkering station
- areas on the open deck within spillage coamings surrounding gas bunkering manifold valves and 3 m beyond these, up to a height of 2,4 m above the deck
- when applicable, transfer arm operating amplitude.

1.2.3 Classification of spaces adjacent to hazardous areas

A space separated by gastight boundaries (with or without opening) from an hazardous area may be classified as zone 0, 1, 2 or considered as non-hazardous, taking into account the sources of release inside that space, the type and arrangements of openings and the conditions of ventilation, as per IEC Publication 60092-502, paragraph 4.1.

A gastight bulkhead penetration device of an approved type is not considered as a source of release.

2 Material requirements

2.1 General

2.1.1 Materials used in LNG transfer systems, piping system for liquefied gas and other systems or components in contact with gas are to be in accordance with NR467, Part D, Chapter 9.

Materials are in general to be in accordance with NR216.

3 Arrangement of bunkering system

3.1 Bunkering station

3.1.1 General

The bunkering station is to be:

- located in an area with sufficient natural ventilation. Closed or semi-enclosed bunkering stations will be subject to special consideration.
- physically separated or structurally shielded from accommodation and control stations.
- designed to have sufficient space to allow safe operation
- designed to have sufficient visibility and communication features to allow safe operation
- designed to have sufficient equipment (winch, bracket, …) to ensure safe operations.

Structural strength calculations and drawings manifolds are to be submitted to the Society.

3.1.2 Hazardous area created during bunkering operations

A particular attention is to be paid to the hazardous areas created during the bunkering operations and to restrict the access in order to avoid the presence of unauthorized persons in the vicinity of these hazardous areas and the possibility to create source of ignition.

3.1.3 Drip trays

Drip trays are to be fitted below the liquid bunkering connections and where leakage may occur which can cause damage to the ship structure.

Thermal sensors are to be positioned in way of bunkering connections in the drip tray.

The drip trays are to be made of stainless steel, and capable of being remotely drained over the ship's side without risk of damage to the ship structure and to the receiving ship.

3.1.4 Water curtains

A water piping system is to be fitted in way of the hull under the bunkering manifold to provide low-pressure water curtain for additional protection of the hull steel and the ship's structure. This system is to be in operation when transfer system is in progress. Other solutions are acceptable with justification.

3.1.5 Bow and stern arrangements

Bunkering station may be accepted at the ship bow and stern provided that the relevant requirements of NR467, Pt D, Ch 9, Sec 3, [1.8], are satisfied.

3.2 Bunkering control station

3.2.1 The bunkering control station is to be considered as a control station with regard to requirements of NR467, Part C and NR467, Part D.

3.2.2 Control of the bunkering operations is to be possible from a safe location with regard to bunkering operations and may be from the cargo control room. At this location, overfilling alarm, automatic and manual shutdown are to be indicated.

4 Ventilation of closed or semi-enclosed bunkering stations

4.1 General

4.1.1 Ventilation of closed or semi-enclosed spaces is to be of the mechanical type and the exhaust is to be led from the lower part of the compartment. Furthermore a gas detection system is to be fitted.

4.1.2 Any duct used for the ventilation of hazardous areas is to be separated from that used for the ventilation of non-hazardous areas. The ventilation is to be capable of functioning at all temperature conditions the ship is designed to operate in. Electric fan motors are not to be located in ventilation ducts for hazardous areas unless the motor is certified for the same area classification and operating conditions as the space served.

4.1.3 The ventilation ducts are to have the same area classification as the ventilated space.

4.1.4 Ventilation capacity is to be in accordance with NR467, Pt D, Ch 9, Sec 12, [1.2.2].

Section 3 Hull and Stability

1 Location of cargo tanks

1.1 General

1.1.1 The location of cargo tanks is to be in accordance with NR467, Part D, Chapter 9.

2 Fatigue assessment

2.1 General

2.1.1 Fatigue assessment is to comply with the requirements of NR467.

In addition, the following provisions are to be applied:

- in case the ship is expected to operate in alternate conditions more than 20% of its design life, additional intermediate load cases will have to be selected for fatigue calculations.
- for ships assigned a navigation notation other than **unrestricted navigation**, the fatigue damage is to be assessed taking into account the loading/unloading cycles and the wave load cycles.

3 Cargo Containment

3.1 Sloshing

3.1.1 The sloshing loads on the cargo containment system and internal components are to be evaluated, as defined in NR467, Part D, Ch 9, Sec 4, [3.4.4], based on the standard filling levels for the navigation condition (full load condition and ballast condition).

In addition, all cargo tanks are to be checked for several relevant partial filling levels. CFD calculations or test campaigns are to be carried out in order to verify the sloshing pressure for the whole range of filling levels between 0 and 100%.

Section 4 Transfer Systems

1 General

1.1 Application

1.1.1 This Section covers the LNG transfer system, LNG vapour return transfer system and their mandatory associated components including:

- hose assemblies
- QCDC
- ERC
- insulating flanges.

This Section also covers the following systems:

- support
- swivels
- auxiliary equipment.

References to the specific requirements for each component of the transfer system are given in Tab 1.

Table 1 : Applicable requirements

	Design requirements		Production requirements	Installation on board
	Requirements for type approval	Type approval testing		
Hoses	[2.1]	[2.2]	[2.3]	[2.4]
QCDC	[3.1]	[3.2]	[3.3]	[3.4]
ERC	[4.1]	[4.2]	[4.3]	[4.4]
Isolation flanges	[5]	-	-	-
Support	[6]	-	-	-
Swivels	[8]	-	-	-
Auxiliary equipment	[9]	-	-	-
Note 1: In the case a component is not listed, additional requirements may be required by the Society on case-by-case basis.				

1.2 Requirements

1.2.1 Transfer systems and their associated systems are to be considered as essential services as defined in NR467, Pt A, Ch 1, Sec 1, [1.2.1].

1.2.2 The transfer system is to be designed to avoid the release of gas or liquid to the atmosphere during bunkering, connecting/disconnecting and emergency release operations.

2 Bunkering hoses

2.1 Design requirements for type approval

2.1.1 General

The requirements of NR467, Part D, Chapter 9, in particular NR467, Pt D, Ch 9, Sec 5, [11.7], are to be fulfilled.

Bunkering hoses are to be in compliance with the requirements stated in EN 1474-2:2020 for the intended application.

The following characteristics are to be defined by the designer and submitted to the Society:

- extreme service temperature
- maximum working load
- maximum design pressure
- minimum bend radius (MBR)
- maximum allowable applied twist (MAAT).

2.1.2 Maximum design pressure

The maximum design pressure is not to be less than 10 bar in accordance with paragraph NR467, Pt D, Ch 9, Sec 5, [11.7.5].

2.1.3 Materials

All materials are to be compatible with each other and with the fluid conveyed (LNG and LNG vapours).

Material requirements specified in EN 1474-2:2020 are to be met.

2.1.4 End connection and coupling

The end fittings are to be made of stainless steel and be in accordance with NR467, Part D, Chapter 9.

2.2 Type approval testing of bunkering hose

2.2.1 General

Bunkering hoses are to be of a type approved by the Society and in compliance with the requirements stated in EN 1474-2:2020 for the intended application.

2.2.2 Inspection of welds (NDT)

Welds of the hose assembly are to be subjected to non destructive testing (NDT).

All butt welds between the hose assembly and connections systems are to be subjected to a 100% radiographic examination.

2.2.3 BV type approval certificate

When the design assessment and testing are successfully completed and the documentation (study and test reports) are examined, a type approval certificate is issued and given a validity period of 5 years.

2.3 Production requirements of bunkering hose

2.3.1 General

Each hose assembly is to be produced in compliance with the approved type and is subject to a survey by the Society. BV product certificate (C) is required.

2.3.2 Workshop testing

Each produced length of cargo hose complete with end-fittings is to be inspected and tested as per EN 1474-2:2020 (hoses used for prototype testing are not to be used on board). Tests are to be witnessed by the Society's surveyor, unless otherwise agreed.

2.3.3 BV product certificate

Upon satisfactory completion of examination and testing, a BV product certificate is issued in addition to the manufacturer's document stating the results of the tests performed and stating compliance with the approved type.

2.4 Installation on board

2.4.1 Documents

A document containing the following information is to be kept on board:

- hose assembly identification number
- type approval certificate
- date of initial entry into service
- initial test and certificates
- records of all transfer operations
- hose assembly maintenance and user guide.

2.4.2 Marking of products

Each bunkering hose is to be permanently marked with at least the following information:

- manufacturer's name or logo
- hose designation and size
- maximum working pressure
- maximum and minimum working temperature
- overall weight of the hose and end fittings assembly
- date of manufacture
- Society's brand as relevant
- date of last inspection and testing.

3 Quick connect disconnect coupler (QCDC)

3.1 Design requirements for type approval

3.1.1 The strength check of the QCDC is to be based on the internal design pressure and the maximum axial and shear forces that are likely to be exerted on the manifold flange during the bunkering operations.

3.1.2 For clamp featured QCDC, the coupler is to remain leak tight when at least one of the connecting clamps fails at the maximum design load plus at least the design pressure.

3.1.3 The hydraulic operated QCDC is to remain properly connected in case of hydraulic pressure loss and a manual release is to be provided.

3.1.4 Disconnection is to be possible under the maximum manifolds loads, including specified ice build up condition.

3.1.5 QCDC is to be provided with a mechanical or hydraulic device to prevent inadvertent release due to human error, pressure or vibration.

3.1.6 For hydraulic operated QCDC, an interlock is to be provided to prevent opening during transfer operations or when it is subjected to pressure.

3.1.7 The dry disconnect-connect coupling (DD/CC) is to be designed and tested as per ISO 21593:2019.

3.2 Type approval testing of QCDC

3.2.1 General

QCDC are to be of a type approved by the Society.

3.2.2 Hydrostatic pressure test

The QCDC is to be subjected to a hydrostatic pressure test at ambient temperature for a minimum duration of 30 minutes, pressurized at least 1,5 times the design pressure with the blanking plate for appropriate pressure rating. Permanent deformation is not be allowed.

3.2.3 Pneumatic pressure test

The QCDC is to be subjected to a pneumatic pressure test for 30 minutes using air and/or N_2 at 0,6 MPa to check equipment leak tightness.

3.2.4 Release performance test

The QCDC is to be subjected to a type test to confirm the release performance under ice built up condition (10 mm for DN 25 to DN 80; 25 mm for DN 100 to bigger diameters). The test is to be performed 3 times and at a temperature below the minimum design temperature under the maximum axial and shear forces that are likely to be exerted on the receiving ship's manifold. Also, the QCDC is not to be pressurized and, when applicable, the hydraulic pressure actuator of the equipment is to be set to the minimum available.

For hydraulic clamp featured QCDC, clamps operation times is to be verified in the range of 10s to 15s and the release from test flange is to be completed without hook up. In addition, it is to be demonstrated that the QCDC does not permit accidental clamps opening.

3.2.5 Emergency leakage test (clamp featured QCDC)

The QCDC is to be subjected to an emergency leakage test at ambient temperature and at a temperature below the minimum design temperature. The test is to be carried out to verify that equipment remains leak tight under the maximum axial and shear forces that are likely to be exerted plus the design pressure when at least one of the clamps fails.

3.2.6 BV type approval certificate

When the design assessment and testing are successfully completed and the documentation (study and test reports) are examined, a type approval certificate is issued and given a validity period of 5 years.

3.3 Production requirements of QCDC

3.3.1 General

Each QCDC is to be produced in compliance with the approved type and is subject to a survey by the Society. BV product certificate (C) is required.

3.3.2 Pressure test

Each QCDC is to be subjected to a hydraulic pressure test, at ambient temperature, to a pressure not less than 1,5 times the design pressure, to demonstrate that the QCDC is capable of withstanding its pressure without leaking. Test is to be carried out for at least 30 minutes.

3.3.3 Release performance test

The hydraulic operated QCDC is to be subjected to a release performance test carried out three times without external loads at ambient temperature to verify the connection and release functions and to confirm operation below minimum available hydraulic pressure. The QCDC is to be tested for the full range of flange sizes specified. When applicable, operating times of the QCDC connecting/disconnecting is to be recorded and certified to be between 10s and 15s.

3.3.4 BV product certificate

Upon satisfactory completion of examination and testing, a BV product certificate is issued in addition to the manufacturer's document stating the results of the tests performed and stating compliance with the approved type.

4 Emergency release coupling (ERC)

4.1 Design requirements for type approval

4.1.1 The ERC is to permit clean and safe separation of the transfer system from the receiving ship's manifold under conditions of maximum flow and ice build-up. The disconnection is not to result in damage to the system's integrity nor product leakage. The design of the ERC is to permit easy reconnection after a release.

4.1.2 Justifications are to be submitted regarding the compatibility with hoses and the maximum axial and shear forces likely to be exerted on the ERC during the bunkering operations.

4.1.3 The powered ERC (PERC) is to be designed for:

- remote and local manual activation
- automatic activation in case the safe working envelope and/or parameters of the transfer system are exceeded beyond a predetermined point.

4.1.4 For powered ERC (PERC) opening time is to be within 2s after activation.

4.1.5 All electrical components of the ERC actuator are to be of a certified safe type for zone 1 hazardous area.

When applicable, the availability of hydraulic power is to be monitored. If the power supply of ERC by the hydraulic source is no longer available, bunkering operation is to be stopped.

4.1.6 The ERC valves are to be made of steel or otherwise demonstrated to be fire resistant in accordance with ISO 10497:2010 or API 6FA (or other standard deemed acceptable by the Society).

4.2 Type approval testing of ERC

4.2.1 General

The ERC is to be of a type approved by the Society.

4.2.2 Release loading values test

The ERC is to be subjected to a type test to confirm the values of axial and shear forces at which it automatically separates. The test is to be carried out at a temperature below the minimum design temperature under ice build up condition (10 mm for DN 25 to DN 80; 25 mm for DN 100 to bigger diameters).

4.2.3 Hydrostatic pressure test

The ERC is to be subjected to a hydrostatic pressure test, at ambient temperature, to a pressure not less than 1,5 times the design pressure, to demonstrate that the equipment is capable of withstanding its pressure without deformation nor leaking. The test is to be carried out for at least 30 minutes.

4.2.4 Pneumatic pressure test

The ERC is to be subjected to a pneumatic pressure test for 30 minutes using air and/or N_2 at 0,6 MPa to check equipment leak tightness.

4.2.5 Strength test

The ERC is to be subjected to a strength type test to confirm that it remains leak tight with no deformations under the design pressure and the maximum axial and shear forces that are likely to be exerted during the bunkering operations. The test is to be carried out at ambient temperature and at a temperature below the minimum design temperature.

4.2.6 Release performance test for powered ERC (PERC)

The PERC is to be subjected to a type test to confirm the release performance under ice build up (10 mm for DN 25 to DN 80; 25 mm for DN 100 to bigger diameters). The test is to be carried out 3 times at a temperature below the minimum design temperature under the maximum axial and shear forces that are likely to be exerted. It is to be confirmed that the PERC will automatically release within 2s in case of activation.

4.2.7 Valve operating test for powered ERC (PERC)

The PERC, when featured with interlocking isolating valves, is to be subjected to a valve operating test at a temperature below the minimum design temperature under the maximum axial and shear forces that are likely to be exerted plus the design pressure. Valves are to be closed and opened 10 times with an opening relief pressure of not more than 0,5 MPa.

The valve operating torques or the actuator hydraulic pressure are to be recorded and it is to be checked that the values are below the minimum available operating torques or hydraulic pressure specified for the actuator.

4.2.8 Cryogenic seat leak test

The ERC valves are to be subjected to a cryogenic seat leak test at a temperature below the minimum design temperature, pressurized to 0,3 MPa, 1 MPa and design pressure, to confirm that leakage rates are within the acceptable limits.

The valve is to be supported in its normal operating attitude and the pressure retaining valve seat is to remain fully immersed in testing medium throughout the test.

Seat and gland seal leakage rates are to be measured and recorded twice for a period of 1 minute each for each pressure level. Allowable leakage rates are:

- Zero (valve stem)
- 1 cm^3/min per mm of nominal diameter ND (valve seat).

4.2.9 Fire test

The ERC valves are to be fire tested in accordance with ISO 10497:2010 - Testing of valves — Fire type-testing requirements (or other standard deemed acceptable by the Society).

4.2.10 BV type approval certificate

When the design assessment and testing are successfully completed and the documentation (study and test reports) are examined, a type approval certificate is issued and given a validity period of 5 years.

4.3 Production requirements of ERC

4.3.1 General

Each ERC is to be produced in compliance with the approved type and is subject to a survey by the Society. BV product certificate (C) is required.

4.3.2 Pressure test

The ERC is to be subjected to a hydraulic pressure test, at ambient temperature, to a pressure not less than 1,5 times the design pressure, to demonstrate that the ERC is capable of withstanding its pressure without leaking. The test is to be carried out for at least 30 minutes.

4.3.3 Release performance

Workshop release performance test is to be carried out three times at ambient temperature to verify the interlock(s) and to demonstrate that the powered ERC (PERC) activation time is within 2s and to confirm operation below minimum available hydraulic pressure. In all tests, the valves are to be closed and then the powered ERC (PERC) is to release within 2s of activation.

4.3.4 BV product certificate

Upon satisfactory completion of examination and testing, a BV product certificate is issued in addition to the manufacturer's document stating the results of the tests performed and stating compliance with the approved type.

5 Electrical isolation flanges

5.1 General

5.1.1 Before installation in the LNG transfer system, each isolation flange is to be subjected to a test of electrical resistance in air and the resistance is to be not less than 10 000Ω.

5.1.2 The resistance of each insulation flange is to be measured after installation in the complete LNG transfer system and the resistance is to be not less than 1000Ω.

6 Supports

6.1 General

6.1.1 Hoses are to be suitably supported in such a way that the allowable bending radius is satisfied. They are not normally to lay directly on the ground. They are to be arranged with enough slack to allow for all possible movements between the receiving ship and the bunkering ship.

6.1.2 Equipment utilised with the transfer system such as hose rests, saddles, coupling guidance systems are to be approved and tested both before and after installation.

6.1.3 Hose or rigid arm rests and saddles shall not put undue stress on the hoses, the rigid arms or on parts of the vessels manifold which are not designed for such loads. Alternatively, the manifold area may be suitably reinforced. Details of the manifold loads should be submitted to the society for information and review.

7 Transfer arm

7.1 Hose handling arm

7.1.1 Where a transfer arm is provided, the maximum allowable operating amplitude for the system is to be defined and the hose handling arm is to be approved by the Society.

7.1.2 Lifting devices

The lifting devices, where fitted, are to be of suitable capacity to handle the LNG transfer hoses and associated equipment.

8 Swivels

8.1 General

8.1.1 Pressure swivels

The pressure parts of a pressure swivel are to be designed and manufactured according to the requirements of NR467, Pt C, Ch 1, Sec 3 or to a recognised pressure vessel code accepted by the Society.

A pressure swivel is to be isolated from the structural loads due to the connection with the receiving ship.

Means are to be provided to collect and safely dispose of liquid leaks.

8.1.2 Static resistance test

Pressure swivels are to be subjected to a pressure resistance static test, according to their design code.

8.1.3 Dynamic test

Rotation and oscillation test including rest periods are to be performed at design pressure with measurement of starting and running moments.

At least two complete rotations, or equivalent, in each direction are to be performed.

9 Auxiliary equipment

9.1 General

9.1.1 The pieces of auxiliary equipment, as defined in Ch 1, Sec 1, [2.2.1] are to be in accordance with NR467.

10 LNG transfer system

10.1 General

10.1.1 Requirements [10.2.1] and [10.2.2] apply to complete LNG transfer systems including additional safety devices such as dry break-away coupling/self-sealing quick release, ERC, swivels, etc. (i.e: all parts which are downstream the bunkering manifold).

10.1.2 The bunkering line is to be designed and arranged to withstand the surge pressure that may result from the activation of the ERC.

10.1.3 In the event of ERC activation, the hoses are to be adequately supported and protected to prevent potential damage, spark or rupture due to mechanical shocks.

10.2 Testing of the complete system

10.2.1 Pressure test

The LNG transfer system is to be subjected to a hydraulic pressure test, at ambient temperature, to a pressure not less than 1,5 times the design pressure, to demonstrate that the hose assembly is capable of withstanding its pressure without leaking.

10.2.2 Inspection of welds

The welds between the LNG transfer system and the connection system are to be subjected to a non-destructive examination (NDE) test and all butt welds between the LNG transfer system and the connection system are to be subjected to a 100% radiographic examination.

11 Bunkering transfer rate

11.1 General

11.1.1 The bunkering transfer rate is to be kept within the capabilities of the receiving ship.

11.1.2 The maximum LNG transfer rate is to be justified, taking into consideration:

- the management of the BOG generated during bunkering operation
- the temperature of the LNG supplied to the ship
- the characteristics of the receiving tank
- the maximum flow permitted by the ERC
- the maximum flow permitted by the hose
- the maximum flow permitted by the QCDC.

11.1.3 The LNG velocity in the piping system is not to exceed 10m/s in order to avoid the generation of static electricity and to limit the heat transfer due to friction inside the pipes.

11.2 Sampling

11.2.1 Connections for taking LNG samples are to be in accordance with NR467, Part D, Chapter 9.

12 Arrangement for draining the LNG transfer lines

12.1 General

12.1.1 In order to prevent cryogenic liquid spills, the design of the transfer system is to be such that the lines can be drained before disconnection and purged after an emergency disconnection.

13 Compatibility between receiving ship and bunkering ship

13.1 General

13.1.1 The bunkering procedure is to specify that the ship working limits of bunkering are to be checked with regard to at least the following aspects:

- draught and freeboard difference between the receiving ship and the bunkering ship
- compatibility of the bunkering arm or hose operating amplitude with the bunkering station location
- pressure and temperature difference between the LNG tanks of receiving ship and bunkering ship
- vapour management
- vapour return line (pressure and temperature)
- delivery flow rate (maximum and minimum)
- type and size of hose connections systems
- compatibility of the ESD link
- mooring arrangement.

Section 5 Inert Gas Systems

1 General

1.1 Application

1.1.1 This Section covers the inert gas system for purging the bunkering lines.

1.2 Requirements

1.2.1 The inert gas system is to be in accordance with the NR467, Pt D, Ch 9, Sec 9, [1.5] and NR467, Pt D, Ch 9, Sec 9, [1.6].

1.2.2 The inerting capacity is to be designed according to the needs of the bunkering operations and it is not to be less than 5 times the volume of the hose and pipes to be purged.

1.2.3 Nitrogen pressure delivered is to be at least equal to nominal pressure in transfer system in order to perform leak test before every transfer.

Section 6 Gas detection

1 General

1.1 Gas detection in enclosed spaces

1.1.1 Permanently installed gas detectors are to be fitted in all hazardous areas including bunkering station, bunkering process room and other enclosed spaces containing gas piping or other equipment without ducting.

1.1.2 The number of detectors in each space is to be considered taking into account the size, layout and ventilation of the space. At least two independent gas detectors are required in each hazardous area.

1.1.3 The detection equipment is to be located where gas may accumulate and in the ventilation outlets. Gas dispersion analysis or a physical smoke test is to be used to find the best arrangement.

1.1.4 An audible and visual alarm is to be activated before the vapour concentration reaches 30% of the lower explosive limit (LEL).

1.1.5 Audible and visual alarms from the gas detection equipment are to be located on the bridge and in the bunkering control room.

1.2 Gas detection in open areas

1.2.1 In open areas, drip trays fitted with thermal detectors or sensors are to be provided where there is a risk of leakage.

Note 1: The numbers and location of thermal detectors in drip trays are to be justified during detail design engineering based on immediate leakage detection.

1.2.2 Thermal detectors are to activate visual and audible alarms and are to be connected to the ESD system for monitoring leakage detection in navigation bridge and bunkering control positions.

1.2.3 CCTV is recommended to observe the bunkering operation from the bridge or operation control room. The CCTV is to provide images of the bunker connection and also if possible the bunker hose such that movement of transfer system during bunkering are visible. Where CCTV is not provided, a permanent watch is to be maintained from a safe location.

1.2.4 Requirements [1.2.1] to [1.2.3] are applicable to the following areas:

- bunkering station
- areas or spaces where bunkering process systems are installed.

Section 7 Automation Systems

1 General

1.1 Application

1.1.1 This Section provides requirements for the automation systems of the LNG transfer system.

1.2 Emergency shut-down systems (ESD)

1.2.1 The design of the ESD systems is to take into account the possible bunkering ship (or receiving ship) excessive motions.

1.2.2 Any activation of the ESD systems is to be implemented simultaneously on both bunkering ship and receiving ship. The timing sequence is to ensure that no pressure build up in the system nor surge phenomenon is created and that the involved pumps and vapour return compressors (if any) stop before the full closure of any manifold valves.

1.2.3 The bunkering line is to be designed and arranged to withstand the surge pressure that may result from the activation of the emergency release coupling and quick closing of ESD valves. If not demonstrated to be required at a higher value due to pressure surge considerations, a default time of 5 seconds from the trigger of the alarm to full closure of the ESD valves is to be adjusted, in accordance with NR529, Gas fuelled ships.

1.2.4 At least one local manual activation position for the ESD system is to be at a safe distance from the manifold and is to have a clear view of the manifold area.

1.2.5 Any pipeline or component containing liquid, which may be isolated due to the ESD activation, is to be provided with a pressure relief valve.

1.2.6 All electrical components of the ESD system are to be of a certified safe type.

1.3 Alarms and safety actions

1.3.1 If the ventilation in a closed or semi-enclosed bunkering station stops during bunkering operations, a visual and audible alarm is to be triggered at bunkering control location and the ESD is to be activated.

1.3.2 The alarms and safety function actions required for the transfer system are given in Tab 1.

1.4 Communication systems

1.4.1 A communication system with back-up is to be provided between the bunkering ship and the receiving ship. This may be achieved by electric, fibre-optic or pneumatic links, or a combination of these systems.

1.4.2 Communications are to be maintained between the bunkering ship and the receiving ship at all times during the bunkering operation. In the event that communications cannot be maintained, bunkering is to be stopped and not resumed until communications are restored.

1.4.3 The components of the communication system located in hazardous areas and safety zone are to be of a certified safe type.

Table 1 : Alarms and safety actions required for the transfer system

Parameters	Alarm	Activation of the ESD systems	Automatic activation of the emergency release coupling
Low pressure in the supply tank	X	X	
Sudden pressure drop at the transfer pump discharge	X	X	
High level in the receiving tank	X	X	
High pressure in the receiving tank	X	X	
LNG leak detection or vapour detection (anywhere)	X	X	
Gas detection around the bunkering lines, as relevant	X	X	
LNG leak detection or vapour detection from the receiving ship bunkering system	X	X	
Manual activation of the emergency release coupling	X	X	
Safe working envelope of the transfer system exceeded	X	X	X
Disconnection of the ERC	X	X	

Section 8 Fire Safety

1 General

1.1 Application

1.1.1 This section provides requirements for the fire safety systems in the safety zone.

2 Fire protection

2.1 Containment of fire

2.1.1 The bunkering station is to be separated by class A-60 insulation towards other spaces, except for spaces such as tanks, voids, auxiliary machinery spaces of no fire risk, sanitary and similar spaces where the insulation standard may be reduced to class A-0.

3 Fire-fighting

3.1 Water spray system

3.1.1 A water spray system complying with the requirements of the NR467, Pt D, Ch 9, Sec 10, [1.3] is to be fitted to protect the bunkering manifold, associated piping installations and the transfer area.

3.1.2 The water spray system is to be fitted to protect the bunkering manifold, associated piping installations and the transfer area.

3.1.3 The system is to be designed to cover all areas as specified in [3.1.2] with an application rate of 10 l/min/m^2 for horizontal projected surfaces and 4 l/min/m^2 for vertical surfaces.

3.1.4 For the purpose of isolating damaged sections, stop valves are to be fitted at least every 40 m or the system may be divided into two or more sections with control valves located in a safe and readily accessible position not likely to be cut-off in case of fire.

3.1.5 The capacity of the water spray pump is to be sufficient to deliver the required amount of water to the hydraulically most demanding area as specified in [3.1.4] in the areas protected.

3.1.6 Remote start of pumps supplying the water spray system and remote operation of any normally closed valve to the system is to be located in a readily accessible position which is not likely to be cut off in case of fire in the areas protected.

3.1.7 The nozzles are to be of an approved full bore type and they are to be arranged to ensure an effective distribution of water throughout the protected area.

3.2 Dry chemical powder fire-extinguishing system

3.2.1 The dry chemical powder fire-extinguishing system is to comply with the requirements of NR467, Pt D, Ch 9, Sec 10, [1.4].

3.2.2 In the bunkering station area a permanently installed dry chemical powder extinguishing system is to cover all possible leak points. The capacity is to be at least 3,5 kg/s for a minimum of 45s discharge. The system is to be arranged for easy manual release from a safe location outside of the protected area.

3.3 Portable fire extinguishers

3.3.1 One portable dry powder fire-extinguisher of at least 5 kg capacity is to be located near the bunkering station.

Section 9 Complementary Additional Service Features

1 Additional service feature RE

1.1 General

1.1.1 Document to be submitted

The following document is to be submitted to the Society for information in addition to the information required in Sec 1, [3.1]:

- bunkering procedure for LNG receiving from a gas-fuelled ship.

1.1.2 Handling system

The BOG handling system of the bunkering ship is to be sized to handle the extra vapours generated during the gas-fuelled ship tank emptying operation taking into account the fact that the level in the receiving cargo tanks is increasing.

2 Additional service feature IG-Supply

2.1 General

2.1.1 Documents to be submitted

The following documents are to be submitted to the Society for review in addition to the information required in Sec 1, [3.1]:

- diagram of the gas freeing system
- procedure for gas freeing.

2.1.2 Piping system

The lines used for the inert gas are to be independent from the liquid and vapour lines used for normal operation.

3 Additional service feature Initial-CD

3.1 General

3.1.1 Documents to be submitted

The following document is to be submitted to the Society for information in addition to the information required in Sec 1, [3.1]:

- procedure for initial cooling down of receiving vessel.

The following document is to be submitted to the Society for review in addition to the information required in Sec 1, [3.1]:

- justification of the capacity of the ship to handle the extra-vapours generated during the initial cooling down of the receiving ship.

3.1.2 The bunkering ship is to be capable of handling all or part of the boil-off gas from the receiving ship, in addition to its own boil-off, generated during the initial cooling down, without release to the atmosphere. The boil-off gas handling capacity of the bunkering ship is to be indicated and justified.

4 Additional service feature BOG

4.1 General

4.1.1 Documents to be submitted

The following document is to be submitted to the Society for information in addition to the information required in Sec 1, [3.1]:

- bunkering procedure for boil-off gas management.

The following document is to be submitted to the Society for review in addition to the information required in Sec 1, [3.1]:

- justification of the capacity of the ship to handle the extra-vapours generated during the LNG transfer from receiving ship, or to receiving ship.

4.1.2 The bunkering ship is to be capable of handling all or part of the boil-off gas from the receiving ship, in addition to its own boil-off, generated during the bunkering operation, without release to the atmosphere. The boil-off gas handling capacity of the bunkering ship is to be indicated and justified.

4.1.3 Different methods to dispose of the BOG may to be considered:

- liquefaction
- cooling
- utilization by the gas consuming equipment of the ship (e.g. gas or dual fuel engines or boilers)
- gas combustion unit.

A combination of these is allowed. Alternatives may be accepted if they are duly justified to the Society.

4.2 Vapour return line

4.2.1 The system is to be operational and capable of accepting the maximum vapour flow rate generated at loading rate defined by the designer. The maximum vapour flow rate is to be indicated and justified to the Society.

Appendix 1 Risk Analysis

1 General

1.1 Purpose of this appendix

1.1.1 The purpose of this Appendix is to define the scope of the risk analysis which is required for the LNG transfer system and the bunkering operation to assess the consequences of:

- a failure affecting the concerned systems
- a LNG leakage
- a tank over-pressurization, etc

1.1.2 A detailed follow-up report of actions and mitigation measures taken in response to risk analysis findings is to be submitted to the Society for information.

1.2 Type of risk analysis

1.2.1 The required analysis can be a HAZOP analysis or another type of analysis providing equivalent information for the LNG transfer system.

1.3 Single failure concept

1.3.1 The required analysis is to be based on the single failure concept, which means that only one failure needs to be considered at a time. Both detectable and non-detectable failures are to be considered. Consequential failures, i.e failures of any component directly caused by a single failure of another component, are also to be considered.

1.4 Scope of the risk analysis

1.4.1 The scope of the risk analysis is to:

- identify all the possible failures in the concerned systems which could lead to a loss of assigned function
- evaluate the consequences
- identify the failure detection method
- identify the corrective measures.

The results of the risk analysis are to be documented.

1.4.2 The means of protection to prevent failures are to be defined.

a) In the system design, such as:
   - redundancies
   - safety devices, monitoring or alarm provisions which permit restricted operation of the system

b) In the system operation, such as:
   - initiation of redundancy
   - activation of an alternative mode operation.

2 Systems to be analysed

2.1 General

2.1.1 The risk analysis is to be performed at least for the systems and functions defined in [2.2] to [3.3].

2.2 LNG transfer system

2.2.1 Function

The function of the LNG transfer system is to connect the bunkering ship to the receiving ship and transfer the LNG.

2.3 Gas detection system

2.3.1 Definition

The gas detection system includes:

- the gas detection sensors
- the centralized monitoring unit and its power supply
- the wiring between the sensors and the centralized monitoring unit.

2.3.2 Function

The function of gas detections system is to detect any gas leakage by measuring gas concentration in air taking into account the actual air parameters at the measuring point (in particular air velocity).

2.4 Control monitoring and safety systems

2.4.1 Definition

Control, monitoring and safety systems include the relevant equipment serving:

- LNG transfer systems
- Gas detection systems.

3 Unexpected events to be analysed

3.1 LNG leakage

3.1.1 The consequences of a LNG leakage are to be analysed. The following sources of leakage are to be considered:

- leakage of hoses
- leakage within the piping enclosure.

3.2 Risks related to the receiving ship

3.2.1 The risks related to the receiving ship are to include, but not limited to:

- unexpected overpressure on the receiving ship
- unexpected venting on the receiving ship
- unexpected movement of the receiving ship.

3.3 Blackout

3.3.1 The risk analysis referred to in [1.1.1] is also to cover the consequences of a blackout during the bunkering operation.

CHAPTER 3
AMMONIA BUNKERING SHIPS

Section 1 General

1 Application

1.1

1.1.1 Ships to be assigned the additional service feature **ammonia bunkering** are to comply with the requirements of this Chapter.

2 Documention to be submitted

2.1 General

2.1.1 The documents listed in Tab 1 are to be submitted.

2.1.2 The drawings and related information to be submitted are listed in Tab 1 and Sec 9 for complementary additional service features.

2.1.3 The operating manuals and procedures to be submitted are listed in Tab 2. Operating manuals are to detail, but not be limited to, equipment specifications, equipment service life, instructions for installation, handling, storage, and periodic inspections.

3 Tests and trials

3.1 Ammonia transfer system trials in working condition

3.1.1 The ammonia transfer system, defined in Ch 1, Sec 1, [2.2.20], is to be operated in the presence of a Surveyor during the first ammonia bunkering operation.

The survey conducted during the first ammonia transfer is to consist of:

a) General visual examination and witness satisfactory operation of the whole fluid transfer system (ammonia and vapour return lines) from the bunkering ship to the receiving ship including piping, QCDC, ERC, swivel, flanges and flexible hoses.

b) Witness satisfactory operation of the following:
- control and monitoring systems
- connection systems (QCDC).

3.1.2 Maintenance and inspections

The owner is to maintain a record of all maintenance and inspections conducted for the transfer system, as required in NR467, Pt A, Ch 4, Sec 5, [11].

Table 1 : Documentation to be submitted

No	A/I **(1)**	Documents
1	A	General arrangement of the ship showing the location of the bunkering station and bunkering control station
2	I	Risk analysis report for the ammonia bunkering transfer system, ammonia bunkering station and ammonia bunkering operation, in accordance with App 1 and risk analysis follow-up report
3	A	Drawing showing: • the hazardous areas and their classification • the toxicity areas
4	A	Details of maximum bunkering flow and maximum pressure (see Sec 4)
5	A	Details of ammonia transfer components (see Sec 4)
6	A	Details of bunkering system ESD (see Sec 4)
7	A	Manifold drawings
8	I	Safe type certificates for electrical equipment, located in hazardous areas
9	A	Instrumentation list
10	A	Drawing of transfer arm
11	A	Technical specifications of the transfer system

(1) A : To be submitted for approval
I : To be submitted for information

Table 2 : Operating manuals and procedures to be submitted

No	A/I **(1)**	
1	I	Bunkering procedure, including inerting and gas freeing
2	I	BOG management procedure
3	I	Operating envelope of the bunkering ship
4	I	Ammonia transfer components operating manual (see Sec 4)

(1) A : To be submitted for approval
I : To be submitted for information

Section 2 Ship and System Design

1 General design requirements

1.1 Limitations of the toxicity consequences during bunkering operation

1.1.1 As a general principle, the release of ammonia is to be limited to the lowest practicable level.

1.1.2 Direct venting of ammonia to the atmosphere during bunkering operation in normal conditions not permitted.

1.1.3 Venting of ammonia for control of the storage tank pressure is not acceptable.

1.1.4 Venting of ammonia to the atmosphere may be permitted in failure conditions provided that it does not result in dangerous ammonia concentrations.

1.1.5 Unless authorized by the Flag Administration and by the State or Port Administration in the jurisdiction of which the ship is intended to operate, effluents containing liquid or dissolved ammonia are not to be discharged overboard.

1.2 Risk analysis

1.2.1 Toxicity areas

Toxicity areas are to be defined in accordance with App 1.

1.2.2 Ammonia transfer system

The design and arrangement of the ammonia transfer system are to be substantiated by a risk analysis to be performed in accordance with App 1.

1.3 Hazardous area classification

1.3.1 General

The hazardous areas are to be in accordance with NR467, Pt D, Ch 9, Sec 10, Tab 1.

1.3.2 Zone 1

In addition to those defined in NR467 Pt D, Ch 9, Sec 10, Tab 1, the following areas or spaces are to be classified as hazardous area zone 1:

- ammonia bunkering station
- when applicable, transfer arm operating amplitude.

1.3.3 Classification of spaces adjacent to hazardous areas

A space separated by gastight boundaries (with or without opening) from an hazardous area may be classified as zone 0, 1, 2 or considered as non-hazardous, taking into account the sources of release inside that space, the type and arrangements of openings and the conditions of ventilation, as per IEC Publication 60092-502, paragraph 4.1.

A gastight bulkhead penetration device of an approved type is not considered as a source of release.

1.4 Drainage arrangements

1.4.1 Drain tanks likely to contain ammonia or dissolved ammonia are to be located in the cargo area, connected to the vent pipe system and with means for ammonia vapour detection.

1.4.2 Drain tanks likely to contain dissolved ammonia are to be surrounded by protective cofferdams.

1.4.3 If the Flag Administration and the State or Port Administration in the jurisdiction of which the ship is intended to operate authorize the discharge of effluents containing dissolved ammonia directly overboard, the underwater discharge outlet is to be located in the vicinity of the turn of the bilge and so arranged as to avoid the re-intake of ammonia/water mixtures by the ship's seawater intakes.

The underwater discharge outlet arrangement is to be such that the ammonia/water mixture discharged into the sea is not to be pass through the ship's boundary layer. To this end, when the discharge is made normal to the ship's shell plating, the minimum diameter of the discharge outlet is governed by the following equation:

$$D = \frac{Q_d}{5 \cdot L_d}$$

where:

d : minimum diameter of the discharge outlet (m)

L_d : distance from the forward perpendicular to the discharge outlet (m)

Q_d : the maximum rate selected at which the ship may discharge a ammonia/water mixture through the outlet (m3/h

When the discharge is directed at an angle to the ship's shell plating, the above relationship shall be modified by substituting for Q_d the component of Q_d which is normal to the ship's shell plating.

1.4.4 The number and diameter of scupper pipes in enclosed or semi-enclosed bunkering stations where a water mist system is required according to [4.1.1] are to be sufficient to avoid any risk of water accumulation.

2 Material requirements

2.1 General

2.1.1 Materials used in ammonia transfer systems, piping system for liquefied gas and other systems or components in contact with ammonia are to be in accordance with NR467, Part D, Chapter 9, Sec 17, [12].

Materials are in general to be in accordance with NR216.

3 Arrangement of ammonia bunkering system

3.1 General

3.1.1 The ammonia bunkering station is to be arranged in order to mitigate the risks associated with ammonia leakage according to the results of a risk analysis performed in accordance with App 1.

3.1.2 The ammonia bunkering station is to be:

- arranged without dead spaces or obstacles that could lead to ammonia vapour accumulation.
- physically separated or structurally shielded from accommodation and control stations.
- designed to have sufficient space to allow safe operation
- designed to have sufficient visibility and communication features to allow safe operation
- designed to have sufficient equipment (winch, bracket, …) to ensure safe operations.

3.1.3 The bunkering station is to be arranged with means to detect and contain an ammonia leakage, in line with the results of the risk analysis as described in App 1.

3.1.4 Hazardous area and toxicity area created during bunkering operations

A particular attention is to be paid to the hazardous areas and toxicity areas created during the bunkering operations. Measures are to be taken to restrict the access in order to :

- avoid the presence of unauthorized persons in the vicinity of these hazardous areas and the possibility to create source of ignition
- avoid the presence of unprotected persons in the vicinity of toxicity areas.

3.1.5 The following equipment is to be available near the bunkering station:

- protective clothing fully resistant to ammonia
- breathing apparatuses with spare charges
- emergency showers and eye rinsing equipment.

3.1.6 Drip trays

Drip trays are to be fitted below the liquid bunkering connections in the bunkering station.

Drip trays are to be fitted with means for detecting a leakage and activating the safety systems.

Drip trays are to be connected to a drain tank complying with [1.4]. The draining pipe is to be fitted with a remotely closable valve.

3.2 Bunkering control station

3.2.1 Control of the bunkering operations is to be possible from a safe location with regard to bunkering operations and may be from the cargo control room. At this location, overfilling alarm, automatic and manual shutdown are to be indicated.

3.2.2 The bunkering control station is to be considered as a control station for the purposes of applying the requirements of NR467, Part C and NR467, Part D.

4 Arrangement of closed or semi-enclosed bunkering stations

4.1 Water mist system

4.1.1 A water mist system intended to absorb ammonia vapours in the bunkering station in case of ammonia release is to cover the ammonia equipment and piping containing possible sources of leakage, as identified in the risk analysis (see App 1).

4.1.2 The water mist system is to be activated manually in case of ammonia detection at 30 ppm concentration in the space. Manual operation is also to be possible locally and from the outside of the space.

4.1.3 An audible and visual alarm is to be activated in case of activation of the water mist.

4.1.4 Audible and visual alarms are to be located on the bridge, on the bunkering station and in the bunkering control room.

4.2 Ventilation

4.2.1 Enclosed or semi-enclosed bunkering stations are to be fitted with a mechanical ventilation system capable of providing at least 30 air changes per hour during bunkering operation.

4.2.2 Ventilation inlets are to be provided both in the lowest and highest parts of the space and suitably protected.

4.2.3 The ventilation system is to be so arranged that, in case of ammonia leakage detection in the space at the PEL concentration:

a) the ventilation fans are automatically stopped and the water mist system activated in accordance with [4.1] or

b) the ventilation outlet is automatically directed to the ammonia vapour processing system, if applicable (see Sec 9, [5]), or

c) the ammonia concentration at the ventilation outlet, after possible dilution with fresh air or increase of the ventilation rate, is such that resulting ammonia concentrations at any location where crew members may be present remain below the PEL in the worst case release scenario. Relevant justifications are to be submitted.

5 Arrangement of open deck bunkering stations

5.1 General

5.1.1 The arrangement of bunkering stations on open deck is to be defined in accordance with the outcomes of the risk assessment defined in App 1.

Section 3 Hull and Stability

1 Location of cargo tanks

1.1 General

1.1.1 The location of cargo tanks is to be in accordance with NR467, Part D, Chapter 9.

2 Fatigue assessment

2.1 General

2.1.1 Fatigue assessment is to comply with the requirements of NR467. In addition, the following provisions are to be applied:

- in case the ship is expected to operate in alternate conditions more than 20% of its design life, additional intermediate load cases will have to be selected for fatigue calculations.
- for ships assigned a navigation notation other than **unrestricted navigation**, the fatigue damage is to be assessed taking into account the loading/unloading cycles and the wave load cycles.

3 Cargo Containment

3.1 Sloshing

3.1.1 The sloshing loads on the cargo containment system and internal components are to be evaluated, as defined in NR467, Part D, Ch 9, Sec 4, [3.4.4], based on the standard filling levels for the navigation condition (full load condition and ballast condition).

In addition, all cargo tanks are to be checked for several relevant partial filling levels. CFD calculation or test campaigns are to be carried out in order to verify the sloshing pressure for the whole range of filling levels between 0 and 100%.

Section 4 Transfer Systems

1 General

1.1 Application

1.1.1 This Section covers the ammonia transfer system, ammonia vapour return transfer system and their mandatory associated components including:

- hose assemblies
- QCDC
- ERC
- isolating flanges.

This Section also covers the following systems:

- support
- swivels
- auxiliary equipment.

1.2 Requirements

1.2.1 Transfer systems and their associated systems are to be considered as essential services as defined in NR467, Pt A, Ch 1, Sec 1, [1.2.1].

1.2.2 The transfer system is to be designed to avoid the release of gas or liquid to the atmosphere during bunkering, connecting/disconnecting and emergency release operations.

2 Bunkering hoses

2.1 General requirements

2.1.1 The requirements of NR467, Part D, Chapter 9, in particular NR467, Pt D, Ch 9, Sec 5, [11.7], are to be fulfilled.

2.1.2 Bunkering hoses are to be of a type approved by the Society.

2.2 Design requirements

2.2.1 General

The following characteristics are to be defined by the designer and submitted to the Society:

- extreme service temperature
- maximum working load
- maximum design pressure
- minimum bend radius (MBR)
- maximum allowable applied twist (MAAT).

The hose limit states, in particular burst pressure and damaging pull, are to be documented and justified by the designer based on testing. Resistance versus dynamic bending / fatigue loads are to be justified with appropriate testing.

2.2.2 Code or standard

Each system is to comply with the following code or standard as appropriate to the nature of the hose:

- Bonded flexible hoses: OCIMF GMPHOM 2009 / API 17K / API 17B
- Unbounded flexible pipes: API 17J / 17B
- Thermoplastic composites hoses: API 15S

Note 1: Alternative hose technology or international code and standards may be accepted by the Society on a case by case basis.

2.2.3 Qualification for ammonia transfer

In the case of a type of hose which is not covered by a recognized code or standard accepted by the Society for ammonia transfer, qualification is to be carried out in accordance with the methodology detailed in NI 525 “Risk Based Qualification of New Technology - Methodological Guidelines”.

The specificities of the ammonia transfer are to be accounted for in the hose qualification considering:

- consequences of a leakage given the toxicity of ammonia
- compatibility with metallic materials (including risk of stress corrosion cracking) and non-metallic materials
- effects of diffusion across the flexible pipe wall
- effects of quick depressurization on the flexible pipe wall integrity
- long term exposure to the service conditions (fluid, pressure and temperature).

2.2.4 Maximum design pressure

The maximum design pressure is not to be less than 10 bar in accordance with paragraph NR467, Pt D, Ch 9, Sec 5, [11.7.5].

2.2.5 Materials

All materials are to be compatible with each other and with the fluid conveyed (ammonia and ammonia vapours). Materials are to be in accordance with NR467, Part D, Chapter 9.

2.2.6 End connection and coupling

The end fittings are to be made of stainless steel and be in accordance with NR467, Part D, Chapter 9.

2.3 Type testing

2.3.1 The type testing is to be carried out as per the applicable codes or standards, and according to the qualification plan as applicable. Type testing is to be witnessed by the Society unless otherwise agreed.

2.4 Type approval certificate

2.4.1 When the design assessment and testing are successfully completed and the documentation (study and test reports) are examined, a type approval certificate is issued and given a validity period of 5 years, unless otherwise specified.

2.5 Production requirements of bunkering hose

2.5.1 General

Each hose assembly is to be produced in compliance with the approved type and is subject to a survey by the Society. BV product certificate (C) is required.

2.5.2 Workshop testing

Each produced length of cargo hose complete with end-fittings is to be inspected and tested as defined in [2.5.3]and [2.5.4] (hoses used for prototype testing are not to be used on board). Tests are to be witnessed by the Society's surveyor, unless otherwise agreed.

2.5.3 Pressure test

The hose assembly is to be subjected to a hydraulic pressure test at ambient temperature, to a pressure not less than 1,5 times the nominal pressure, but not more than two fifths of its bursting pressure, to demonstrate that the hose assembly is capable of withstanding its pressure without leaking.

2.5.4 Non-destructive testing of welds

Welds of the hose assembly are to be subjected to non destructive testing (NDT).

All butt welds between the hose assembly and connections systems are to be subjected to a 100% radiographic examination.

2.5.5 BV product certificate

Upon satisfactory completion of examination and testing, a BV product certificate is issued in addition to the manufacturer's document stating the results of the tests performed and stating compliance with the approved type.

2.6 Installation on board

2.6.1 Documents

A document containing the following information is to be kept on board:

- hose assembly identification number
- type approval certificate
- date of initial entry into service
- initial test and certificates
- records of all transfer operations
- hose assembly maintenance and user guide.

2.6.2 Marking of products

Each bunkering hose is to be permanently marked with at least the following information:

- manufacturer's name or logo
- hose designation and size
- maximum working pressure
- maximum and minimum working temperature
- overall weight of the hose and end fittings assembly
- date of manufacture
- Society's brand as relevant
- date of last inspection and testing.

3 Quick connect disconnect coupler (QCDC) and dry disconnect-connect coupling (DD/CC)

3.1 General requirements

3.1.1 QCDC and DD/CC are to be of a type approved by the Society.

3.1.2 Dry disconnect method by procedural practice in accordance with ISO standard 20519:2022 may be accepted subject to approval by the Administration of the State whose flag the ship is entitled to fly.

3.2 Design requirements

3.2.1 Each type of QCDC, or DD/CC, is to comply with a relevant Code or Standard acceptable to the Society.

3.2.2 In the case of a type of QCDC, or DD/CC, which is not covered by a recognized code or standard accepted by the Society for ammonia transfer, qualification is to be carried out in accordance with the methodology detailed in the NI 525 “Risk Based Qualification of New Technology - Methodological Guidelines”.

3.2.3 The specificities of the ammonia transfer are to be accounted for in the QCDC, or DD/CC, qualification considering:

- possibility of equipment leakage given the toxicity of ammonia
- compatibility with metallic materials (including risk of stress corrosion cracking) and non-metallic materials

3.2.4 All materials are to be compatible with each other and with the fluid conveyed (ammonia and ammonia vapours). Materials are to be in accordance with NR467, Part D, Chapter 9.

3.2.5 Disconnection is to be possible under the maximum manifolds loads, including specified ice build up condition.

3.2.6 The mechanical design of the QCDC (or DD/CC) is to be based on the internal design pressure and the maximum axial and shear forces that are likely to be exerted on the manifold flange during the bunkering operations.

3.2.7 For clamp featured QCDC, the coupler is to remain leak tight when at least one of the connecting clamps fails at the maximum design load plus at least the design pressure.

3.2.8 The hydraulic operated QCDC is to remain properly connected in case of hydraulic pressure loss and a manual release is to be provided.

3.2.9 QCDC is to be provided with a mechanical or hydraulic device to prevent inadvertent release due to human error, pressure or vibration.

3.2.10 For hydraulic operated QCDC, an interlock is to be provided to prevent opening during transfer operations or when it is subjected to pressure.

3.3 Type testing

3.3.1 The type testing is to be carried out as per the applicable codes or standards, and according to the qualification plan as applicable. Type testing is to be witnessed by the Society unless otherwise agreed.

3.4 Type approval certificate

3.4.1 When the design assessment and testing are successfully completed and the documentation (study and test reports) are examined, a type approval certificate is issued and given a validity period of 5 years, unless otherwise specified.

3.5 Production requirements of QCDC and DD/CC

3.5.1 General

Each QCDC, or DD/CC, is to be produced in compliance with the approved type and is subject to a survey by the Society. BV product certificate (C) is required.

3.5.2 Pressure test

Each equipment is to be subjected to a hydraulic pressure test, at ambient temperature, to a pressure not less than 1,5 times the design pressure, to demonstrate that the equipment is capable of withstanding its pressure without leaking. Test is to be carried out for at least 30 minutes.

3.5.3 Release performance test

The hydraulic operated QCDC is to be subjected to a release performance test carried out three times without external loads at ambient temperature to verify the connection and release functions and to confirm operation below minimum available hydraulic pressure. The QCDC is to be tested for the full range of flange sizes specified. When applicable, operating times of the QCDC connecting/disconnecting is to be recorded and certified to be between 10s and 15s.

3.5.4 BV product certificate

Upon satisfactory completion of examination and testing, a BV product certificate is issued in addition to the manufacturer's document stating the results of the tests performed and stating compliance with the approved type.

4 Emergency release coupling (ERC)

4.1 General requirement

4.1.1 ERC are to be of a type approved by the Society.

4.2 Design requirements

4.2.1 Each type of ERC, is to comply with a relevant Code or Standard acceptable to the Society.

4.2.2 In the case of a type of ERC which is not covered by a recognized code or standard accepted by the Society for ammonia transfer, qualification is to be carried out in accordance with the methodology detailed in the NI 525 “Risk Based Qualification of New Technology - Methodological Guidelines”.

4.2.3 The specificities of the ammonia transfer are to be accounted for in the ERC qualification considering:

- consequences of a leakage given the toxicity of ammonia
- compatibility with metallic materials (including risk of stress corrosion cracking) and non-metallic materials

4.2.4 All materials are to be compatible with each other and with the fluid conveyed (ammonia and ammonia vapours). Materials are to be in accordance with NR467, Part D, Chapter 9.

4.2.5 The ERC is to permit clean and safe separation of the transfer system from the receiving ship's manifold under conditions of maximum flow and ice build-up. The disconnection is not to result in damage to the system's integrity nor product leakage. The design of the ERC is to permit easy reconnection after a release.

4.2.6 Justifications are to be submitted regarding the compatibility with hoses and the maximum axial and shear forces likely to be exerted on the ERC during the bunkering operations.

Details of the manifold loads are to be submitted to the society for information.

4.2.7 The powered ERC (PERC) is to be designed for:

- remote and local manual activation
- automatic activation in case the safe working envelope and/or parameters of the transfer system are exceeded beyond a predetermined point.

4.2.8 For powered ERC (PERC) opening time is not to be more than 2s after activation.

4.2.9 All electrical components of the ERC actuator are to be of a certified safe type for zone 1 hazardous area.

When applicable, the availability of hydraulic power is to be monitored. If the power supply of ERC by the hydraulic source is no longer available, bunkering operation is to be stopped.

4.2.10 The ERC valves are to be made of steel or otherwise demonstrated to be fire resistant in accordance with ISO 10497:2010 or API 6FA (or other standard deemed acceptable by the Society).

4.3 Type testing

4.3.1 The type testing is to be carried out as per the applicable codes or standards, and according to the qualification plan as applicable. Type testing is to be witnessed by the Society unless otherwise agreed.

4.4 Type approval certificate

4.4.1 When the design assessment and testing are successfully completed and the documentation (study and test reports) are examined, a type approval certificate is issued and given a validity period of 5 years, unless otherwise specified.

4.5 Production requirements of ERC

4.5.1 General

Each ERC is to be produced in compliance with the approved type and is subject to a survey by the Society. BV product certificate (C) is required.

4.5.2 Pressure test

The ERC is to be subjected to a hydraulic pressure test, at ambient temperature, to a pressure not less than 1,5 times the design pressure, to demonstrate that the ERC is capable of withstanding its pressure without leaking. The test is to be carried out for at least 30 minutes.

4.5.3 Release performance

Workshop release performance test is to be carried out three times at ambient temperature to verify the interlock(s) and to demonstrate that the powered ERC (PERC) activation time is within 2s and to confirm operation below minimum available hydraulic pressure. In all tests, the valves are to be closed and then the powered ERC (PERC) is to release within 2s of activation.

4.5.4 BV product certificate

Upon satisfactory completion of examination and testing, a BV product certificate is issued in addition to the manufacturer's document stating the results of the tests performed and stating compliance with the approved type.

5 Electrical isolation

5.1 General

5.1.1 All piping and equipment of the transfer system are to be electrically bonded.

6 Supports

6.1 General

6.1.1 Hoses are to be suitably supported in such a way that the allowable bending radius is satisfied. They are not normally to lay directly on the ground. They are to be arranged with enough slack to allow for all possible movements between the receiving ship and the bunkering ship.

7 Transfer arm

7.1

7.1.1 Where a transfer arm is provided, the maximum allowable operating amplitude for the system is to be defined and the hose handling arm is to be approved by the Society.

8 Swivels

8.1 General

8.1.1 Pressure swivels

The pressure parts of a pressure swivel are to be designed and manufactured according to the requirements of NR467, Pt C, Ch 1, Sec 3 or to a recognized pressure vessel code accepted by the Society.

A pressure swivel is to be isolated from the structural loads due to the connection with the receiving ship. Means are to be provided to collect and safely dispose of liquid leaks.

BV product certificate (C) is required.

8.1.2 Static resistance test

Pressure swivels are to be subjected to a pressure resistance static test, according to their design code.

8.1.3 Dynamic test

Rotation and oscillation test including rest periods are to be performed at design pressure with measurement of starting and running moments.

At least two complete rotations, or equivalent, in each direction are to be performed.

9 Auxiliary equipment

9.1 General

9.1.1 The pieces of auxiliary equipment, as defined in Ch 1, Sec 1, [2.2.1], are to be in accordance with NR467.

10 Ammonia transfer system

10.1 General

10.1.1 The bunkering line, including transfer system, is to be designed and arranged to withstand the surge pressure that may result from the activation of the ERC.

10.1.2 In the event of ERC activation, the hoses are to be adequately supported and protected to prevent potential damage, spark or rupture due to mechanical shocks.

10.2 Testing of the complete system

10.2.1 Requirements [10.2.2] and [10.2.3] apply to complete ammonia transfer systems including additional safety devices such as dry break-away coupling/self-sealing quick release, ERC, swivels, etc. (i.e. all parts which are downstream the bunkering manifold).

10.2.2 Pressure test

The ammonia transfer system is to be subjected to a hydraulic pressure test, at ambient temperature, to a pressure not less than 1,5 times the design pressure, to demonstrate that the hose assembly is capable of withstanding its pressure without leaking.

10.2.3 Inspection of welds

The welds between the ammonia transfer system and the connection system are to be subjected to a non-destructive examination (NDE) test and all butt welds between the ammonia transfer system and the connection system are to be subjected to a 100% radiographic examination.

11 Bunkering transfer rate

11.1 General

11.1.1 The bunkering transfer rate is to be kept within the capabilities of the receiving ship.

11.1.2 The maximum ammonia transfer rate is to be justified, taking into consideration:

- the management of the BOG generated during bunkering operation
- the temperature of the ammonia supplied to the ship
- the characteristics of the receiving tank
- the maximum flow permitted by the ERC
- the maximum flow permitted by the hose
- the maximum flow permitted by the QCDC.

11.2 Sampling

11.2.1 The ammonia fuel/cargo sampling system is to be of a closed loop design to ensure that liquid ammonia and its vapours are not vented to atmosphere.

12 Arrangement for draining the ammonia transfer lines

12.1 General

12.1.1 The design of the transfer system is to be such that the lines can be drained and purged before disconnection, according to Sec 5.

13 Compatibility between receiving ship and bunkering ship

13.1 General

13.1.1 The bunkering procedure is to specify that the ship working limits of bunkering are to be checked with regard to at least the following aspects:

- draught and freeboard difference between the receiving ship and the ammonia bunkering ship
- compatibility of the bunkering arm or hose operating amplitude with the bunkering station location
- Bunkering manifold layout and compatibility of the bunkering connection type
- pressure and temperature difference between the ammonia tanks of receiving ship and bunkering ship
- vapour management
- vapour return line (pressure and temperature)
- delivery flow rate (maximum and minimum)
- type and size of hose connections systems
- compatibility of the ESD link
- mooring arrangement.

Section 5 Inert Gas System

1 General

1.1 Application

1.1.1 This Section covers the inert gas systems for purging the bunkering lines.

1.2 Requirements

1.2.1 The inert gas systems are to be in accordance with the NR467, Pt D, Ch 9, Sec 9, [1.5] and NR467, Pt D, Ch 9, Sec 9, [1.6].

1.2.2 The inerting capacity is to be designed according to the needs of the bunkering operations and it is not to be less than 5 times the volume of the hose and pipes to be purged.

1.2.3 Inert gas pressure delivered is to be at least equal to nominal pressure in transfer system in order to perform leak test before every transfer.

1.2.4 Inert gas containing carbon dioxide is not permitted due to contamination of ammonia by carbamates formed as a result of a chemical reaction.

Section 6 Gas detection

1 Gas detection

1.1 General

1.1.1 Permanently installed ammonia detectors providing a 30 ppm ammonia concentration alarm are to be fitted in vent pipes from ammonia tanks.

1.1.2 The detection equipment is to be located in the vent mast outlet.

1.1.3 An audible and visual alarm is to be activated before the vapour concentration reaches 30 ppm ammonia concentration.

1.1.4 Audible and visual alarms from the ammonia detection equipment are to be located on the bridge.

1.2 Ammonia vapour detection in enclosed or semi-enclosed bunkering stations

1.2.1 Permanently installed ammonia detectors providing a 30 ppm ammonia concentration alarm are to be fitted in enclosed or semi-enclosed bunkering stations.

1.2.2 The detection equipment is to be located at the top and bottom of the concerned space, where ammonia is likely to accumulate

1.2.3 The number of detectors in each space is to be considered taking into account the size and layout or the space.

1.2.4 Ammonia dispersion analysis or smoke tests are to be carried out to justify the detector arrangement (number and location) in the bunkering station.

1.2.5 An audible and visual alarm is to be activated before the vapour concentration reaches 30 ppm ammonia concentration.

1.2.6 Audible and visual alarms from the ammonia detection equipment are to be located on the bridge, on the bunkering station, in the bunkering control room and in other critical enclosed spaces on the ship where there may be an accumulation of ammonia vapor.

1.3 Regulations for ammonia vapour detection in open deck bunkering station

1.3.1 Open deck bunkering stations are to be provided with means to detect an ammonia leakage. The type of gas detection system is to be defined in accordance with the outcomes of the risk analysis required in App 1 and its effectiveness is to be documented to the satisfaction of the Society.

Section 7 Automation Systems

1 General

1.1 Application

1.1.1 This Section provides requirements for the automation systems of the ammonia transfer system.

1.2 Emergency shut-down systems (ESD)

1.2.1 The design of the ESD systems is to take into account the possible bunkering ship (or receiving ship) excessive motions.

1.2.2 Any activation of the ESD systems is to be implemented simultaneously on both bunkering ship and receiving ship. The timing sequence is to ensure no pressure build up in the system nor surge phenomenon is created and that the involved pumps and vapour return compressors (if any) stop before the full closure of any manifold valves.

1.2.3 The bunkering line is to be designed and arranged to withstand the surge pressure that may result from the activation of the emergency release coupling and quick closing of ESD valves. If not demonstrated to be required at a higher value due to pressure surge considerations, a default time of 5 seconds from the trigger of the alarm to full closure of the ESD valves is to be adjusted, in accordance with NR671, Ammonia fuelled ships.

1.2.4 At least one local manual activation position for the ESD system is to be at a safe distance from the manifold and is to have a clear view of the manifold area.

1.2.5 Any pipeline or component containing liquid, which may be isolated due to the ESD activation, is to be provided with a pressure relief valve.

1.2.6 All electrical components of the ESD system are to be of a certified safe type.

1.3 Alarms and safety actions

1.3.1 If the ventilation in a closed or semi-enclosed bunkering station stops during bunkering operations, a visual and audible alarm is to be triggered at bunkering control location and the ESD is to be activated.

1.3.2 The alarms and safety function actions required for the transfer system are given in Tab 1.

1.4 Communication systems

1.4.1 A communication system with back-up is to be provided between the bunkering ship and the receiving ship. This may be achieved by electric, fibre-optic or pneumatic links, or a combination of these systems.

1.4.2 It is to be possible to maintain communications between the bunkering ship and the receiving ship at all times during the bunkering operation. In the event that communications cannot be maintained, bunkering is to be stopped and not resumed until communications are restored.

1.4.3 The components of the communication system located in hazardous areas and safety zone are to be of a certified safe type.

Table 1 : Alarms and safety actions required for the transfer system

Parameters	Alarm	Activation of the ESD systems	Automatic activation of the ERC
Low pressure in the supply tank	X	X	
Sudden pressure drop at the transfer pump discharge	X	X	
High level in the receiving tank	X	X	
High pressure in the receiving tank	X	X	
Ammonia leak detection or vapour detection (anywhere)	X	X	
Manual activation of the ERC	X	X	
Safe working envelope of the transfer arms system exceeded, or hose if a PERC is used	X	X	X
Disconnection of the ERC	X	X	

Section 8 Fire Safety

1 General

1.1 Application

1.1.1 This section provides requirements for the fire safety systems in the safety zone.

2 Fire-fighting

2.1 General

2.1.1 Provisions are to be taken to avoid using water based firefighting systems on liquid ammonia fire due to instantaneous vaporization of the liquid phase.

2.2 Dry chemical powder fire-extinguishing system

2.2.1 In the bunkering station area a permanently installed dry chemical powder extinguishing system is to cover all possible leak points. The capacity is to be at least 3,5 kg/s for a minimum of 45s discharge. The system is to be arranged for easy manual release from a safe location outside of the protected area.

2.3 Portable fire extinguishers

2.3.1 One portable dry powder fire-extinguisher of at least 5 kg capacity is to be located near the bunkering station.

Section 9 Complementary Additional Service Features

1 Additional service feature RE

1.1 General

1.1.1 Document to be submitted

The following document is to be submitted to the Society for information in addition to the information required in Sec 1, [3.1]:

- bunkering procedure for ammonia receiving from an ammonia-fuelled ship.

1.1.2 Handling system

The BOG handling system of the ammonia bunkering ship is to be sized to handle the extra vapours generated during the ammonia-fuelled ship tank emptying operation taking into account the fact that the level in the receiving cargo tanks is increasing.

2 Additional service feature IG-Supply

2.1 General

2.1.1 Documents to be submitted

The following documents are to be submitted to the Society for review in addition to the information required in Sec 1, [3.1]:

- diagram of the gas freeing system
- procedure for gas freeing.

2.1.2 Piping system

The lines used for the inert gas are to be independent from the liquid and vapour lines used for normal bunkering operation.

3 Additional service feature Effluent-recovery

3.1 General

3.1.1 Documents to be submitted

The following document is to be submitted to the Society for information in addition to the information required in Sec 1, [3.1]:

- procedure for effluents recovery management.

The following document is to be submitted to the Society for review in addition to the information required in Sec 1, [3.1]:

- justification of the capacity of the ship to handle the effluents containing dissolved ammonia from receiving ship.

3.1.2 Piping system

The lines used for effluent recovery are to be independent from the liquid and vapour lines used for normal bunkering operation.

4 Additional service feature BOG

4.1 General

4.1.1 Documents to be submitted

The following document is to be submitted to the Society for information in addition to the information required in Sec 1, [3.1]:

- bunkering procedure for boil-off gas management.

The following document is to be submitted to the Society for review in addition to the information required in Sec 1, [3.1]:

- justification of the capacity of the ship to handle the extra-vapours generated during the ammonia transfer from receiving ship, or to receiving ship.

4.1.2 The bunkering ship is to be capable of handling all or part of the boil-off gas from the receiving ship, in addition to its own boil-off, generated during the ammonia bunkering operation, without release to the atmosphere. The boil-off gas handling capacity of the bunkering ship is to be indicated and justified.

4.1.3 Different methods to dispose of the BOG may to be considered:

- liquefaction
- cooling
- gas combustion unit.

A combination of these is allowed. Alternatives may be accepted if they are duly justified to the Society.

5 Additional service feature VPS

5.1 General

5.1.1 Documents to be submitted

The following document is to be submitted to the Society for information in addition to the information required in Sec 1, [3.1]:

- Specification of the ammonia vapour processing system

The following document is to be submitted to the Society for review in addition to the information required in Sec 1, [3.1]:

- General arrangement drawing of the ship showing the areas and spaces containing the ammonia installations and piping of the ammonia vapour processing systems
- Justification of the ammonia vapour processing system capacity.

5.1.2 An ammonia vapour processing system complying with the provisions of [5.2.4] is to be provided to:

- reduce ammonia concentration in the vapours released from ammonia systems (bunkering, storage, piping and process). The capacity and performance of the ammonia vapour processing system are to be sufficient to ensure that the remaining ammonia concentration does not exceed the permissible exposure limit, for the different expected emission scenarios (see Tab 1).
- Allow mitigating the consequences of an ammonia leakage in a space containing a potential source of ammonia release.

5.1.3 Ammonia vapour processing system is to be defined in accordance with outcomes of the risk assessment defined in App 1.

5.1.4 The thermal oxidation systems and dissolution systems (scrubbers) used as methods for controlling the pressure and temperature in the ammonia storage tank may also be used to reduce the ammonia concentration in ammonia releases.

5.1.5 The ammonia vapour processing systems that may be used are listed in Tab 1 and detailed requirements for the control of ammonia release are given in App 2, Tab 1. Other processing systems will be given special consideration.

Table 1 : Use of ammonia vapour processing systems

Ammonia vapour processing system	Use in normal / failure bunkering conditions
Ammonia diffusion tank, complying with [5.2]	Normal and failure conditions
Scrubbing system, complying with [5.3]	
Thermal oxidation system, complying with [5.4]	
Dilution system, complying with [5.5]	Failure conditions

5.2 Ammonia diffusion tank

5.2.1 An ammonia diffusion tank is to be provided, receiving the discharge from the pressure-relief devices or vent pipes. The discharge pipe is to distribute ammonia in the bottom of the diffusion tank, but no lower than 10 m below the maximum liquid level.

The capacity of the system is to be based on the solubility of ammonia at the concerned temperature. The tank is to contain the volume of water and ammonia without overflowing. The water is to be prevented from freezing.

The volume of water in the tank is to be not lower than 8 liters of water for each kilogram of ammonia to be dissolved.

5.2.2 The tank is to be provided with a vent pipe connected to the vent mast. An ammonia sensor is to be installed on the vent pipe.

5.2.3 The tank is to be provided with a level indicator and low and high level alarms.

5.2.4 The materials of the tank and related piping (diffusion pipe, discharge pipe and vent pipe) are to comply with the provisions of NR467, Part D, Chapter 9 for ammonia equipment.

5.2.5 The tank is to be provided with means of discharge to a land-based reception facility. When permitted, overboard discharge below the waterline is to comply with the provisions of Sec 2, [1.4.3].

5.3 Ammonia scrubbers

5.3.1 The ammonia scrubber may be maintained in permanent operation or ready for starting in case of ammonia release detection.

5.3.2 The ammonia scrubber is to be of the closed-loop type. Where a neutralizing acid is used, the storage tank and piping distribution system are to comply with the relevant provisions of NR467, Pt C, Ch 1, Sec 11.

5.3.3 The materials used for the scrubber components (spray chambers, water jet piping, etc.) are to comply with the provisions of NR467, Part D, Chapter 9 for ammonia equipment.

5.4 Ammonia combustion unit

5.4.1 Unless otherwise stated in this sub-article, the ammonia combustion unit is to comply with the requirements of NR467, Pt C, Ch 1, Sec 3, [7].

5.4.2 The ammonia combustion unit is to be designed to operate in a range from very small flows (vent lines) to very large flows (storage tank safety valves) while limiting the unburnt amount of ammonia.

5.4.3 A pilot flame is to be provided to initiate and sustain the combustion of ammonia.

5.4.4 The ammonia combustion unit is to be capable of immediate operation upon opening of a safety valve or venting valve. A buffer tank is to be provided where necessary for this purpose.

5.4.5 A phase separator (knockout drum) is to be installed to prevent liquid ammonia (droplets) to enter the ammonia combustion unit without being totally evaporated.

5.5 Dilution system

5.5.1 Dilution systems are to be arranged to provide sufficient dilution of the ammonia-containing gaseous effluents by mixing them with fresh air.

5.5.2 The dilution rate is to be sufficient to reduce the ammonia concentration below the permissible limit. Relevant justifications based on the maximum ammonia emission rate are to be submitted for each venting and ventilation scenario.

5.5.3 The risks in connection with the flammability of the ammonia / air mixture are to be evaluated.

Appendix 1 Risk Analysis

1 General

1.1 Purpose

1.1.1 The purpose of this Appendix is to define the scope of the risk analysis which is required for the ammonia transfer system, ammonia bunkering station and bunkering operation to assess the following risks:

- a failure affecting the concerned systems
- an ammonia leakage
- intoxication
- chemical burning
- pollution
- variations of bunkered ammonia fuel characteristics (temperature)
- rollover
- a tank over-pressurization, etc

1.2 Type of risk analysis

1.2.1 An exhaustive risk assessment is to be performed, considering the hazards associated with physical layout, operation, process and maintenance, following any reasonably foreseeable failure. The risk assessment is to include at least an HAZID study and an HAZOP study. Gas dispersion analysis may be further required as a result of the HAZID study, for detailed assessment of leakage scenarios.

1.2.2 The analysis is to ensure that risks are ALARP (As Low As Reasonably Practicable). Risks which cannot be eliminated are to be mitigated as necessary. Details of risks, and the means by which they are mitigated, are to be documented to the satisfaction of the Society.

1.2.3 Standard EN IEC 60079-10-1:2021 may be used for estimating the extent of the area around a source of release where ammonia concentration would exceed the permissible exposure limit, by substituting the lower flammable limit (LFL) with the permissible exposure limit.

1.3 Single failure concept

1.3.1 The required analysis is to be based on the single failure concept, which means that only one failure needs to be considered at a time. Both detectable and non-detectable failures are to be considered. Consequential failures, i.e failures of any component directly caused by a single failure of another component, are also to be considered.

1.4 Scope of the risk analysis

1.4.1

The scope of the risk analysis is to:

- identify all the possible failures in the concerned systems which could lead to a loss of assigned function
- evaluate the consequences
- identify the failure detection method
- identify the corrective measures.

The results of the risk analysis are to be documented.

1.4.2 The risk assessment is to cover the possible liquid and gaseous ammonia fuel leakages and spills and their consequences during the ship bunkering, in particular with respect to:

- the accumulation of ammonia vapours in spaces or areas containing a potential source of ammonia release and their spreading over the ship's spaces through non-gastight openings
- the spreading of ammonia vapours from the vent mast outlet on open decks and their possible recirculation to accommodation through openings and ventilation inlets
- the formation of ammonia vapour cloud in the vicinity of the ship or in remote locations, taking into account the ambient conditions (e.g. humidity)
- the heat release in case of ammonia dissolution in water
- a probable maximum leakage scenario due to technical failures.

1.4.3 The means of protection to prevent failures are to be defined.

a) In the system design, such as:
- redundancies
- safety devices, monitoring or alarm provisions which permit restricted operation of the system

b) In the system operation, such as:
- initiation of redundancy
- activation of an alternative mode operation.

2 Systems to be analysed

2.1 General

2.1.1 The risk analysis is to be performed at least for the systems and functions defined in [2.2] to [3.3].

2.1.2 The arrangement of the bunkering station is to be taken into account, especially with respect to ammonia leakage detection and containment.

2.1.3 If the VPS notation is applied, additional areas where the probability of leakage is high (eg. liquid dome) are to be included in the analysis.

2.2 Ammonia transfer system

2.2.1 Definition

The ammonia transfer system includes:
- rigid pipes, hoses, swivels, valves, couplings
- supporting structure
- handling system and its control/monitoring system.
- saddles, fall arrest system, Vessel Separation Detector, vapor return line (if any).

2.2.2 Function

The function of the ammonia transfer system is to connect the bunkering ship to the receiving ship and transfer ammonia.

2.3 Leakage detection system

2.3.1 Definition

The leakage detection system includes:
- the leakage detection sensors
- the centralized monitoring unit and its power supply
- the wiring between the sensors and the centralized monitoring unit.

2.3.2 Function

The function of gas detections system is to detect any gas leakage by measuring gas concentration in air taking into account the actual air parameters at the measuring point (in particular air velocity).

2.4 Control monitoring and safety systems

2.4.1 Definition

Control, monitoring and safety systems include the relevant equipment serving:
- Ammonia transfer systems
- Leakage detection systems
- Water mist system

3 Unexpected events to be analysed

3.1 Ammonia leakage

3.1.1 The consequences of an ammonia leakage are to be analysed. The following sources of leakage are to be considered:
- leakage of hoses
- leakage within the piping
- leakage at piping connections, including bunkering flange and QCDC.

3.2 Risks related to the receiving ship

3.2.1 The risks related to the receiving ship are to include, but not limited to:

- unexpected overpressure on the receiving ship
- unexpected venting on the receiving ship
- unexpected movement of the receiving ship.

3.3 Blackout

3.3.1 The risk analysis referred to in [1.2.1] is also to cover the consequences of a blackout during the bunkering operation, including boil-off gas management.

Appendix 2 Control of Ammonia Release

1 General

1.1 Purpose

1.1.1 The purpose of this Appendix is to detaile requirements for the control of ammonia release.

Table 1 : Control of ammonia release

Ammonia release		
Source	Method of control without VPS	Method of control with VPS
Discharge from storage tank safety valves	Release to the vent mast	Release to the vent mast **(2)**
Venting from liquid ammonia drain tanks		Transfer to the ammonia vapour processing system
Discharge from pressure relief systems fitted to the tank hold spaces, if relevant		Transfer to the ammonia vapour processing system
Leakage in a bunkering space containing a potential source of ammonia release	• Dissolution by water mist in the space or; • Release to the vent mast through the ventilation system **(1)**	• Transfer of the ammonia vapours to the ammonia vapour processing system through the ventilation system or; • Release to the vent mast through the ventilation system **(1)**
Venting and purging with nitrogen of ammonia vessels and piping	Release to the vent mast	Transfer to the ammonia vapour processing system

(1) Direct discharge to the vent mast is acceptable only when the resulting ammonia concentrations at any location where crew members may be present remain below the PEL in the worst case release scenario. Relevant justifications are to be submitted.

(2) Release to the vent mast is acceptable only in emergency situation

CHAPTER 4
METHANOL BUNKERING SHIPS

Section 1 General

1 Application

1.1

1.1.1 Ships assigned the additional service feature **Methanol bunkering** are to comply with the requirements of this Chapter.

2 Documentation to be submitted

2.1

2.1.1 The documentation listed in Tab 1 is to be submitted.

2.1.2 Operating manuals are to detail, but not be limited to, equipment specifications, equipment service life, instructions for installation, handling, storage, and periodic inspections.

2.1.3 The operating manuals and procedures to be submitted are listed in Tab 2.

3 Tests and trials

3.1 Methanol transfer system trials in working condition

3.1.1 The methanol transfer system, defined in Ch 1, Sec 1, [2.2.20], is to be operated in the presence of a Surveyor during the first methanol bunkering operation.

The survey conducted during the first methanol transfer is to consist of:

a) General visual examination and witness satisfactory operation of the whole fluid transfer system (methanol and vapour return lines) from the bunkering ship to the receiving ship including piping, DD/CC, ERC, swivel, flanges and flexible hoses.

b) Witness satisfactory operation of the following:

- control and monitoring systems
- connection systems (DD/CC).

3.1.2 Maintenance and inspections

The owner is to maintain a record of all maintenance and inspections conducted for the transfer system, as required in NR467, Pt A, Ch 4, Sec 4, [8].

Table 1 : Documentation to be submitted

No.	A / I **(1)**	Documentation
1	A	General arrangement of the ship showing the location of the bunkering station and bunkering control station
2	I	Risk analysis report for the methanol bunkering transfer system, methanol bunkering station and methanol bunkering operation,, in accordance with App 1, and risk analysis follow-up report
3	A	Drawing showing the hazardous areas and their classification
4	A	Details of maximum bunkering flow and maximum pressure (see Sec 4)
5	A	Details of methanol transfer components (see Sec 4)
6	A	Details of bunkering system ESD (see Sec 4)
7	A	Structural strength calculations and drawings of manifolds
8	I	Safe type certificates for electrical equipment located in hazardous areas
9	A	Instrumentation list
10	A	Drawing of transfer arm
11	A	Technical specifications of the transfer system
(1) A : To be submitted for approval I : To be submitted for information		

Table 2 : Operating manuals and procedures to be submitted

No.	A / I **(1)**	Documentation
1	I	Bunkering procedure, including inerting and gas freeing
2	I	Operating envelope of the bunkering ship
3	I	Methanol transfer components operating manual (see Sec 4)

(1) A: To be submitted for approval
I: To be submitted for information

Section 2 Ship and System Design

1 General design requirements

1.1 Risk analysis

1.1.1 Methanol transfer system and bunkering station

The design and arrangement of the methanol transfer system and bunkering station are to be substantiated by a risk analysis to be performed in accordance with App 1.

1.2 Hazardous area classification

1.2.1 General

The hazardous areas are to be in accordance with IBC Code, Ch 10 and NR467, Pt D, Ch 8, Sec 10.

1.2.2 Zone 1

In addition to those defined in IBC Code and NR467, Pt D, Ch 8, Sec 10, the following areas or spaces are to be classified as hazardous area zone 1 in accordance with IEC 60092-502 [4.2.2.7]:

- methanol bunkering station
- when applicable, transfer arm operating amplitude.

Note 1: Such areas are, for example, all areas within 3m of bunkering manifold, or bunkering valve.

1.2.3 Classification of spaces adjacent to hazardous areas

A space separated by gastight boundaries (with or without opening) from an hazardous area may be classified as zone 0, 1, 2 or considered as non-hazardous, taking into account the sources of release inside that space, the type and arrangements of openings and the conditions of ventilation, as per IEC 60092-502, paragraph 4.4.

A gastight bulkhead penetration device of an approved type is not considered as a source of release.

2 Materials requirements

2.1 General

2.1.1 Materials used in methanol transfer systems, piping systems and other systems or components in contact with methanol are to be in accordance with IBC Code and NR467, Part D, Chapter 8.

Materials are in general to be in accordance with NR216.

3 Arrangement of methanol bunkering system

3.1 General

3.1.1 The bunkering station is to be:

- located in an area with sufficient natural ventilation
- physically separated or structurally shielded from accommodation and control stations
- designed to have sufficient space to allow safe operation
- designed to have sufficient visibility and communication features to allow safe operation
- designed to have sufficient equipment (winch, bracket, …) to ensure safe operations.

Structural strength calculations and drawings of manifolds are to be submitted to the Society.

3.1.2 The bunkering station is to be arranged with means to detect and contain a methanol leakage, in line with the results of the risk analysis as described App 1.

3.1.3 Hazardous area created during bunkering operations

A particular attention is to be paid to the hazardous areas created during the bunkering operations. Measures are to be taken to restrict the access in order to avoid the presence of unauthorized persons in the vicinity of these hazardous areas and the possibility to create a source of ignition.

3.2 Bunkering control station

3.2.1 Control of the bunkering operations is to be possible from a safe location with regards to bunkering operations and may be from the cargo control room. At this location, overfilling alarm, automatic and manual shutdown are to be indicated.

3.2.2 The bunkering control station is to be considered as a control station for the purposes of applying the requirements of IBC Code, NR467, Part C and NR467, Part D, Chapter 8.

4 Arrangement of bunkering stations

4.1 General

4.1.1 The arrangement of bunkering stations is to be defined in accordance with the outcomes of the risk assessment defined in App 1.

4.1.2 If foreseen, the arrangement of closed or semi-enclosed bunkering stations is to be specifically considered by the Society.

4.2 Drip trays

4.2.1 Drip trays are to be fitted below the liquid bunkering connections in the bunkering station. Drip trays are to be fitted with means for detecting a leakage and activating the safety systems.

4.2.2 Each tray is to have a sufficient capacity to ensure that the maximum amount of spill according to the risk assessment can be handled.

4.3 Ventilation

4.3.1 In general, bunkering stations are to be provided with sufficient natural ventilation. For closed and semi-enclosed bunkering station, a mechanical ventilation system complying with the requirements of IBC Code, Ch 12 and NR467, Pt D, Ch 8, Sec 12 is to be provided.

Section 3 Transfer Systems

1 General

1.1 Application

1.1.1 This Section covers the methanol transfer system, methanol vapour return transfer system and their mandatory associated components including:

- hose assemblies
- DD/CC
- ERC
- isolating flanges.

This Section also covers the following systems:

- support
- swivels
- auxiliary equipment.

1.2 Requirements

1.2.1 Transfer systems and their associated systems are to be considered as essential services as defined in NR467, Pt A, Ch 1, Sec 1, [1.2.1] and in accordance with the outcomes of the risk assessment defined in App 1.

1.2.2 The transfer system is to be designed to avoid the release of vapours or liquid to the atmosphere during bunkering, connecting/ disconnecting and emergency release operations.

2 Bunkering hoses

2.1 General requirements

2.1.1 The requirements of IBC Code, Ch 5, [5.7] and NR467, Pt D, Ch 8, Sec 5, [5], are to be fulfilled.

2.1.2 Bunkering hoses are to be of a type approved by the Society.

2.2 Design requirements

2.2.1 General

The following characteristics are to be defined by the designer and submitted to the Society:

- extreme service temperature
- maximum working load
- maximum design pressure
- minimum bend radius (MBR)
- maximum allowable applied twist (MAAT).

The hose limit states, in particular burst pressure and damaging pull, are to be documented and justified by the designer based on testing. Resistance versus dynamic bending / fatigue loads are to be justified with appropriate testing.

2.2.2 Code or standard

Each system is to comply with a relevant Code or Standard acceptable to the Society.

2.2.3 Qualification for methanol transfer

In the case of a type of hose which is not covered by a recognized code or standard accepted by the Society for methanol transfer, qualification is to be carried out in accordance with the methodology detailed in NI525 Risk Based Qualification of New Technology - Methodological Guidelines.

The specificities of the methanol transfer are to be accounted for in the hose qualification considering:

- consequences of a leakage
- compatibility with metallic materials and non-metallic materials
- effects of quick depressurization on the flexible pipe wall integrity
- long term exposure to the service conditions (fluid, pressure and temperature).

2.2.4 Maximum design pressure

The maximum design pressure is not to be less than 10 bar in accordance with IBC Code, Ch 5, [5.7.3].

2.2.5 Materials

All materials are to be compatible with each other and with the fluid conveyed (methanol and methanol vapours). Materials are to be in accordance with IBC Code and NR467, Part D, Chapter 8.

2.2.6 End connection and coupling

The end fittings are to be made of stainless steel and be in accordance with IBC Code and NR467, Part D, Chapter 8.

2.3 Type testing

2.3.1 The type testing is to be carried out as per the applicable codes or standards, and according to the qualification plan as applicable. Type testing is to be witnessed by the Society unless otherwise agreed.

2.4 Type approval certificate

2.4.1 When the design assessment and testing are successfully completed and the documentation (study and test reports) are examined, a type approval certificate is issued and given a validity period of 5 years, unless otherwise specified.

2.5 Production requirements of bunkering hose

2.5.1 General

Each hose assembly is to be produced in compliance with the approved type and is subject to a survey by the Society. BV product certificate (C) is required.

2.5.2 Workshop testing

Each produced length of cargo hose complete with end-fittings is to be inspected and tested as defined in [2.5.3] and [2.5.4] (hoses used for prototype testing are to be rendered unserviceable). Tests are to be witnessed by the Society's surveyor, unless an alternative survey scheme (BV Mode I) has been agreed.

2.5.3 Pressure test

The hose assembly is to be subjected to a hydraulic pressure test at ambient temperature, to a pressure not less than 1,5 times the nominal pressure, but not more than two fifths of its bursting pressure, to demonstrate that the hose assembly is capable of withstanding its pressure without leaking.

2.5.4 Non-destructive testing of welds

Welds of the hose assembly are to be subjected to non destructive testing (NDT) in accordance with IBC Code, Ch 5 and NR467, Pt D, Ch 8, Sec 5, [2.3.1].

2.5.5 BV product certificate

Upon satisfactory completion of examination and testing, a BV product certificate is issued in addition to the manufacturer's document stating the results of the tests performed and stating compliance with the approved type.

2.6 Installation on board

2.6.1 Documents

A document containing the following information is to be available on board:

- hose assembly identification number
- type approval certificate
- date of initial entry into service
- initial test and certificates
- records of all transfer operations
- hose assembly maintenance and user guide.

2.6.2 Marking of products

Each bunkering hose is to be permanently marked with at least the following information:

- manufacturer's name or logo
- hose designation and size
- maximum working pressure
- maximum and minimum working temperature
- overall weight of the hose and end fittings assembly
- date of manufacture
- Society's brand as relevant
- date of last inspection and testing.

3 Quick connect disconnect coupler (QCDC) and dry disconnect-connect coupling (DD/CC)

3.1 General requirements

3.1.1 QCDC and DD/CC are to be of a type approved by the Society.

3.1.2 Dry disconnect method by procedural practice in accordance with recognized standard deemed acceptable by the Society may be accepted subject to approval by the Administration of the State whose flag the ship is entitled to fly.

3.2 Design requirements

3.2.1 Each type of QCDC, or DD/CC, is to comply with a relevant Code or Standard acceptable to the Society.

3.2.2 In the case of a type of QCDC, or DD/CC, which is not covered by a recognized code or standard accepted by the Society for methanol transfer, qualification is to be carried out in accordance with the methodology detailed in NI525 Risk Based Qualification of New Technology - Methodological Guidelines.

3.2.3 The specificities of the methanol transfer are to be accounted for in the QCDC, or DD/CC qualification considering:

- possibility of equipment leakage
- compatibility with metallic materials and non-metallic materials.

3.2.4 All materials are to be compatible with each other and with the fluid conveyed (methanol and methanol vapours). Materials are to be in accordance with IBC Code and NR467, Part D, Chapter 8.

3.2.5 Disconnection is to be possible under the maximum manifold loads.

3.2.6 The mechanical design of the QCDC (or DD/CC) is to be based on the internal design pressure and the maximum axial and shear forces that are likely to be exerted on the manifold flange during the bunkering operations.

3.2.7 For clamp featured QCDC, the coupler is to remain leaktight when at least one of the connecting clamps fails at the maximum design load plus at least the design pressure.

3.2.8 The hydraulic operated QCDC is to remain properly connected in case of hydraulic pressure loss and a manual release is to be provided.

3.2.9 QCDC is to be provided with a mechanical or hydraulic device to prevent inadvertent release due to human error, pressure or vibration.

3.2.10 For hydraulic operated QCDC, an interlock is to be provided to prevent opening during transfer operations or when it is subjected to pressure.

3.3 Type testing

3.3.1 The type testing is to be carried out as per the applicable codes or standards, and according to the qualification plan as applicable. Type testing is to be witnessed by the Society unless otherwise agreed.

3.4 Type approval certificate

3.4.1 When the design assessment and testing are successfully completed and the documentation (study and test reports) are examined, a type approval certificate is issued and given a validity period of 5 years.

3.5 Production requirements of QCDC and DD/CC

3.5.1 General

Each QCDC, or DD/CC, is to be produced in compliance with the approved type and is subject to a survey by the Society. BV product certificate (C) is required.

3.5.2 Pressure test

Each equipment is to be subjected to a hydraulic pressure test, at ambient temperature, to a pressure not less than 1,5 times the design pressure, to demonstrate that the equipment is capable of withstanding its pressure without leaking. Test is to be carried out for at least 30 minutes.

3.5.3 Release performance test

The hydraulic operated QCDC is to be subjected to a release performance test carried out three times without external loads at ambient temperature to verify the connection and release functions and to confirm operation below minimum available hydraulic pressure. The QCDC is to be tested for the full range of flange sizes specified. When applicable, operating times of the QCDC connecting/disconnecting is to be recorded and certified to be between 10s and 15s.

3.5.4 BV product certificate

Upon satisfactory completion of examination and testing, a BV product certificate is issued in addition to the manufacturer's document stating the results of the tests performed and stating compliance with the approved type.

4 Emergency release coupling (ERC)

4.1 General requirement

4.1.1 ERC are to be of a type approved by the Society.

4.2 Design requirements

4.2.1 Each type of ERC is to comply with a relevant Code or Standard acceptable to the Society.

4.2.2 In the case of a type of ERC which is not covered by a recognized code or standard accepted by the Society for methanol transfer, qualification is to be carried out in accordance with the methodology detailed in NI525 Risk Based Qualification of New Technology - Methodological Guidelines.

4.2.3 The specificities of the methanol transfer are to be accounted for in the ERC qualification considering:

- consequences of a leakage
- compatibility with metallic materials and non-metallic materials.

4.2.4 All materials are to be compatible with each other and with the fluid conveyed (methanol and methanol vapours). Materials are to be in accordance with IBC Code and NR467, Part D, Chapter 8.

4.2.5 The ERC is to permit clean and safe separation of the transfer system from the receiving ship's manifold under conditions of maximum flow. The disconnection is not to result in damage to the system's integrity nor product leakage. The design of the ERC is to permit easy reconnection after a release.

4.2.6 Justifications are to be submitted regarding the compatibility with hoses and the maximum axial and shear forces likely to be exerted on the ERC during the bunkering operations.

Details of the manifold loads are to be submitted to the Society for information.

4.2.7 The powered ERC (PERC) is to be designed for:

- remote and local manual activation
- automatic activation in case the safe working envelope and/or parameters of the transfer system are exceeded beyond a predetermined point.

4.2.8 For powered ERC (PERC) opening time is not to be more than 2 seconds after activation.

4.2.9 All electrical components of the ERC actuator are to be of a certified safe type for zone 1 hazardous area.

When applicable, the availability of hydraulic power is to be monitored. If the power supply of ERC by the hydraulic source is no longer available, bunkering operation is to be stopped.

4.2.10 The ERC valves are to be made of steel or otherwise demonstrated to be fire resistant in accordance with ISO 10497:2010 or API 6FA or other standard deemed acceptable by the Society.

4.3 Type testing

4.3.1 The type testing is to be carried out as per the applicable codes or standards, and according to the qualification plan as applicable. Type testing is to be witnessed by the Society unless otherwise agreed.

4.4 Type approval certificate

4.4.1 When the design assessment and testing are successfully completed and the documentation (study and test reports) are examined, a type approval certificate is issued and given a validity period of 5 years, unless otherwise specified.

4.5 Production requirements of ERC

4.5.1 General

Each ERC is to be produced in compliance with the approved type and is subject to a survey by the Society. BV product certificate (C) is required.

4.5.2 Pressure test

The ERC is to be subjected to a hydraulic pressure test, at ambient temperature, to a pressure not less than 1,5 times the design pressure, to demonstrate that the ERC is capable of withstanding its pressure without leaking. The test is to be carried out for at least 30 minutes.

4.5.3 Release performance

Workshop release performance test is to be carried out three times at ambient temperature to verify the interlock(s) and to demonstrate that the powered ERC (PERC) activation time is within 2 seconds and to confirm operation below minimum available hydraulic pressure. In all tests, the valves are to be closed and then the powered ERC (PERC) is to release within 2 seconds of activation.

4.5.4 BV product certificate

Upon satisfactory completion of examination and testing, a BV product certificate is issued in addition to the manufacturer's document stating the results of the tests performed and stating compliance with the approved type.

5 Electrical isolation

5.1 General

5.1.1 All piping and equipment of the transfer system are to be electrically bonded according to IEC 60092-502:1999 [5.5].

6 Supports

6.1 General

6.1.1 Hoses are to be suitably supported in such a way that the allowable bending radius is satisfied. They are to be arranged with enough slack to allow for all possible movements between the receiving ship and the bunkering ship.

7 Transfer arm

7.1 Maximum allowable amplitude

7.1.1 Where a transfer arm is provided, the maximum allowable operating amplitude for the system is to be defined and the hose handling arm is to be approved by the Society.

8 Swivels

8.1 General

8.1.1 Pressure swivels

The pressure parts of a pressure swivel are to be designed and manufactured according to the requirements of NR467, Pt C, Ch 1, Sec 3 or to a recognized pressure vessel code accepted by the Society.

A pressure swivel is to be isolated from the structural loads due to the connection with the receiving ship. Means are to be provided to collect and safely dispose of liquid leaks.

BV product certificate (C) is required.

8.1.2 Static resistance test

Pressure swivels are to be subjected to a pressure resistance static test, according to their design code.

8.1.3 Dynamic test

Rotation and oscillation test including rest periods are to be performed at design pressure with measurement of starting and running moments.

At least two complete rotations, or equivalent, in each direction are to be performed.

9 Auxiliary equipment

9.1 General

9.1.1 The pieces of auxiliary equipment, as defined in Ch 1, Sec 1, [2.2.1], are to be in accordance with NR467.

10 Methanol transfer system

10.1 General

10.1.1 The bunkering line, including transfer system, is to be designed and arranged to withstand the surge pressure that may result from the activation of the ERC.

10.1.2 In the event of ERC activation, the hoses are to be adequately supported and protected to prevent potential damage, spark or rupture due to mechanical shocks

10.2 Testing of the complete system

10.2.1 Requirements [10.2.2] and [10.2.3] apply to complete methanol transfer systems including additional safety devices such as dry break-away coupling/self-sealing quick release, ERC, swivels, etc. (i.e. all parts which are downstream the bunkering manifold).

10.2.2 Pressure test

The methanol transfer system is to be subjected to a hydraulic pressure test, at ambient temperature, to a pressure not less than 1,5 times the design pressure, to demonstrate that the hose assembly is capable of withstanding its pressure without leaking.

10.2.3 Inspection of welds

The welds between the methanol transfer system and the connection system are to be subjected to a non-destructive examination (NDE) testing according to IBC Code, Ch 5 and NR467, Pt D, Ch 8, Sec 5, [2.3.1].

11 Bunkering transfer rate

11.1 General

11.1.1 The maximum methanol transfer rate is to be justified, taking into consideration:

- the characteristics of the receiving tank and pressure relief system
- the maximum flow permitted by the ERC
- the maximum flow permitted by the hose
- the maximum flow permitted by the QCDC.

12 Arrangement for draining the methanol transfer lines

12.1 General

12.1.1 The design of the transfer system is to be such that the lines can be drained and purged before disconnection, according to Sec 4, [1.2].

13 Compatibility between receiving ship and bunkering ship

13.1 General

13.1.1 The bunkering procedure is to specify that the ship working limits of bunkering are to be checked with regard to at least the following aspects:

- draught and freeboard difference between the receiving ship and the methanol bunkering ship
- compatibility of the bunkering arm or hose operating amplitude with the bunkering station location
- bunkering manifold layout and compatibility of the bunkering connection type
- delivery flow rate (maximum and minimum)
- type and size of hose connection systems
- compatibility of the ESD link
- mooring arrangement.

Section 4 Control and Safety Systems

1 Environmental control

1.1 Cargo tank inerting

1.1.1 The cargo tanks are to be protected by an inert gas system complying with the requirements of IBC Code, Ch 9 and NR467, Pt C, Ch 4, Sec 15, [13] and of NR467, Pt D, Ch 8, Sec 9, [2].

Alternative solutions to prevent the creation of an explosive atmosphere in the cargo tanks during bunkering operations may be considered on case-by-case basis.

1.2 Bunkering hoses

1.2.1 Means are to be provided to purge bunkering hoses and pipes with inert gas. The inerting capacity is to be designed according to the needs of the bunkering operations and is not to be less than 5 times the volume of the hoses and pipes to be purged.

1.2.2 The pressure of the inert gas delivered is to be at least equal to the nominal pressure in the transfer system in order to perform leak test before every transfer.

2 Electrical installations and instrumentation

2.1 Electrical equipment installed in hazardous areas

2.1.1 Electrical equipment installed in hazardous areas is to be of a certified safe type suitable for use in the concerned methanol hazardous area zones in accordance with IEC 80079-20-1:2017.

3 Methanol transfer system control and monitoring

3.1 Bunkering emergency shut-down systems (ESD)

3.1.1 The design of the ESD systems is to take into account the possible bunkering ship (or receiving ship) excessive motions.

3.1.2 Any activation of the ESD systems is to be implemented simultaneously on both bunkering ship and receiving ship. The timing sequence is to ensure that no pressure build up in the system nor surge phenomenon is created and that the involved pumps stop before the full closure of any manifold valves.

3.1.3 The bunkering line is to be designed and arranged to withstand the surge pressure that may result from the activation of the emergency release coupling and quick closing of ESD valves.

3.1.4 At least one local manual activation position for the ESD system is to be at a safe distance from the manifold and is to have a clear view of the manifold area.

3.1.5 Any pipeline or component containing liquid, which may be isolated due to the ESD activation, is to be provided with a pressure relief valve.

3.1.6 All electrical components of the ESD system are to be of a certified safe type.

3.2 Alarms and safety actions

3.2.1 If the ventilation in a closed or semi-enclosed bunkering station stops during bunkering operations, a visual and audible alarm is to be triggered at bunkering control location and the ESD is to be activated.

3.2.2 The alarms and safety function actions required for the transfer system are given in Tab 1.

3.3 Communication system

3.3.1 A communication system with back-up is to be provided between the bunkering ship and the receiving ship. This may be achieved by electric, fibre-optic or pneumatic links, or a combination of these systems.

3.3.2 It is to be possible to maintain communications between the bunkering ship and the receiving ship at all times during the bunkering operation. In the event that communications cannot be maintained, provisions are to be made to stop bunkering and not resume bunkering until communications are restored.

3.3.3 The components of the communication system located in hazardous areas and safety zone are to be of a certified safe type.

Table 1 : Alarms and safety actions required for the transfer system

Parameters	Alarm	Activation of the ESD systems	Automatic activation of the ERC
Low pressure in the supply tank	X	X	
Sudden pressure drop at the transfer pump discharge	X	X	
High level in the receiving tank	X	X	
High pressure in the receiving tank	X	X	
Methanol leak detection	X	X	
Manual activation of the ERC	X	X	
Safe working envelope of the transfer arms system exceeded, or hose if a PERC is used	X	X	X
Disconnection of the ERC	X	X	

4 Fire safety systems in the safety zone

4.1 Fixed fire-extinguishing system

4.1.1 The fixed deck foam system provided in accordance with IBC Code, Ch 11, [11.3] and NR467, Pt D, Ch 8, Sec 11, [3] is to cover the bunkering manifold, associated piping installations and the transfer area.

4.2 Portable fire extinguishers

4.2.1 One portable dry powder fire-extinguisher of at least 5 kg capacity is to be located near the bunkering station.

Appendix 1 Risk Analysis

1 General

1.1 Purpose

1.1.1 The purpose of this Appendix is to define the scope of the risk analysis which is required for the methanol transfer system, methanol bunkering station and bunkering operation to assess the following risks:

- a failure affecting the concerned systems
- a methanol leakage
- intoxication
- chemical burning
- pollution
- variations of bunkered methanol fuel characteristics (temperature)
- a tank over-pressurization, etc.

1.2 Type of risk analysis

1.2.1 An exhaustive risk assessment is to be performed, considering the hazards associated with physical layout, operation, process and maintenance, following any reasonably foreseeable failure. The risk assessment is to include at least an HAZID study and an HAZOP study. Gas dispersion analysis may be further required as a result of the HAZID study, for detailed assessment of leakage scenarios.

1.2.2 The analysis is to ensure that risks are ALARP (As Low As Reasonably Practicable). Risks which cannot be eliminated are to be mitigated as necessary. Details of risks, and the means by which they are mitigated, are to be documented to the satisfaction of the Society.

1.3 Single failure concept

1.3.1 The required analysis is to be based on the single failure concept, which means that only one failure needs to be considered at a time. Both detectable and non-detectable failures are to be considered. Consequential failures, i.e failures of any component directly caused by a single failure of another component, are also to be considered.

1.4 Scope of the risk analysis

1.4.1 The scope of the risk analysis is to:

- identify all the possible failures in the concerned systems which could lead to a loss of assigned function
- evaluate the consequences
- identify the failure detection method
- identify the corrective measures.

The results of the risk analysis are to be documented.

1.4.2 The risk assessment is to cover the possible liquid and gaseous methanol fuel leakages and spills and their consequences during the ship bunkering, in particular with respect to:

- the accumulation of methanol vapours in spaces or areas containing a potential source of methanol release and their spreading over the ship's spaces through non-gastight openings
- the spreading of methanol vapours from the vent mast outlet on open decks and their possible recirculation to space through openings and ventilation inlets
- a probable maximum leakage scenario due to technical failures.

1.4.3 The means of protection to prevent failures are to be defined.

a) In the system design, such as:
   - redundancies
   - safety devices, monitoring or alarm provisions which permit restricted operation of the system.

b) In the system operation, such as:
   - initiation of redundancy
   - activation of an alternative mode operation.

2 Systems to be analysed

2.1 General

2.1.1 The risk analysis is to be performed at least for the systems and functions defined in [2.2] to [3.3].

2.1.2 The arrangement of the bunkering station is to be taken into account, especially with respect to methanol leakage detection and containment.

2.2 Methanol transfer system

2.2.1 Definition

The methanol transfer system includes:

- rigid pipes, hoses, swivels, valves, couplings
- supporting structure
- handling system and its control/monitoring system
- saddles, fall arrest system, Vessel Separation Detector, vapour return line (if any).

2.2.2 Function

The function of the methanol transfer system is to connect the bunkering ship to the receiving ship and transfer methanol.

2.3 Leakage detection system

2.3.1 Definition

The leakage detection system includes:

- the leakage detection sensors
- the centralized monitoring unit and its power supply
- the wiring between the sensors and the centralized monitoring unit.

2.3.2 Function

The function of the leakage detections system is to detect any methanol leakage by measuring vapour concentration in air taking into account the actual air parameters at the measuring point (in particular air velocity).

2.4 Control monitoring and safety systems

2.4.1 Definition

Control, monitoring and safety systems include the relevant equipment serving:

- methanol transfer systems
- leakage detection systems
- fire-fighting system.

3 Unexpected events to be analysed

3.1 Methanol leakage

3.1.1 The consequences of a methanol leakage are to be analysed. The following sources of leakage are to be considered:

- leakage of hoses
- leakage within the piping
- leakage at piping connections, including bunkering flange and QCDC.

3.2 Risks related to the receiving ship

3.2.1 The risks related to the receiving ship are to include, but not limited be to:

- unexpected overpressure on the receiving ship
- unexpected venting on the receiving ship
- unexpected movement of the receiving ship.

3.3 Blackout

3.3.1 The risk analysis referred to in [1.2.1] is also to cover the consequences of a blackout during the bunkering operation.

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