Ammonia-fuelled Ships – Tentative Rules

July 2021

Rule Note
NR 671 DT R00 E

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BUREAU VERITAS MARINE & OFFSHORE

GENERAL CONDITIONS

1. INDEPENDENCE OF THE SOCIETY AND APPLICABLE TERMS

1.1 The Society shall remain at all times an independent contractor and neither the Society nor any of its officers, employees, servants, agents or subcontractors shall be or act as an employee, servant or agent of any other party hereto in the performance of the Services.

1.2 The operations of the Society in providing its Services are exclusively conducted by way of random inspections and do not, in any circumstances, involve monitoring or exhaustive verification.

1.3 The Society acts as a services provider. This cannot be construed as an obligation bearing on the Society to obtain a result or as a warranty. The Society is not and may not be considered as an underwriter, broker in Unit's sale or chartering, expert in Unit's valuation, consulting engineer, controller, naval architect, designer, manufacturer, shipbuilder, repair or conversion yard, charterer or shipowner; none of the above listed being relieved from any of their expressed or implied obligations as a result of the interventions of the Society.

1.4 Only the Society is qualified to apply and interpret its Rules.

1.5 The Client acknowledges the latest versions of the Conditions and of the applicable Rules applying to the Services' performance.

1.6 Unless an express written agreement is made between the Parties on the applicable Rules, the applicable Rules shall be the Rules applicable at the time of entering into the relevant contract for the performance of the Services.

1.7 The Services' performance is solely based on the Conditions. No other terms shall apply whether express or implied.

2. DEFINITIONS

2.1 **"Certificate(s)"** means classification or statutory certificates, attestations and reports following the Society's intervention.

2.2 **"Certification"** means the activity of certification in application of national and international regulations or standards ("Applicable Referential"), in particular by delegation from different governments that can result in the issuance of a Certificate.

2.3 **"Classification"** means the classification of a Unit that can result or not in the issuance of a classification Certificate with reference to the Rules. Classification (or Certification as defined in clause 2.2) is an appraisement given by the Society to the Client, at a certain date, following surveys by its surveyors on the level of compliance of the Unit to the Society's Rules and/or to Applicable Referential for the Services provided. They cannot be construed as an implied or express warranty of safety, fitness for the purpose, seaworthiness of the Unit or of its value for sale, insurance or chartering.

2.4 **"Client"** means the Party and/or its representative requesting the Services.

2.5 **"Conditions"** means the terms and conditions set out in the present document.

2.6 **"Industry Practice"** means international maritime and/or offshore industry practices.

2.7 **"Intellectual Property"** means all patents, rights to inventions, utility models, copyright and related rights, trade marks, logos, service marks, trade dress, business and domain names, rights in trade dress or get-up, rights in goodwill or to sue for passing off, unfair competition rights, rights in designs, rights in computer software, database rights, topography rights, moral rights, rights in confidential information (including know-how and trade secrets), methods and protocols for Services, and any other intellectual property rights, in each case whether capable of registration, registered or unregistered and including all applications for and renewals, reversions or extensions of such rights, and all similar or equivalent rights or forms of protection in any part of the world.

2.8 **"Parties"** means the Society and Client together.

2.9 **"Party"** means the Society or the Client.

2.10 **"Register"** means the public electronic register of ships updated regularly by the Society.

2.11 **"Rules"** means the Society's classification rules (available online on veristar.com), guidance notes and other documents. The Society's Rules take into account at the date of their preparation the state of currently available and proven technical minimum requirements but are not a standard or a code of construction neither a guide for maintenance, a safety handbook or a guide of professional practices, all of which are assumed to be known in detail and carefully followed at all times by the Client.

2.12 **"Services"** means the services set out in clauses 2.2 and 2.3 but also other services related to Classification and Certification such as, but not limited to: ship and company safety management certification, ship and port security certification, maritime labour certification, training activities, all activities and duties incidental thereto such as documentation on any supporting means, software, instrumentation, measurements, tests and trials on board. The Services are carried out by the Society according to the Rules and/or the Applicable Referential and to the Bureau Veritas' Code of Ethics. The Society shall perform the Services according to the applicable national and international standards and Industry Practice and always on the assumption that the Client is aware of such standards and Industry Practice.

2.13 **"Society"** means the classification society **'Bureau Veritas Marine & Offshore SAS'**, a company organized and existing under the laws of France, registered in Nanterre under number 821 131 844, or any other legal entity of Bureau Veritas Group as may be specified in the relevant contract, and whose main activities are Classification and Certification of ships or offshore units.

2.14 **"Unit"** means any ship or vessel or offshore unit or structure of any type or part of it or system whether linked to shore, river bed or sea bed or not, whether operated or located at sea or in inland waters or partly on land, including submarines, hovercrafts, drilling rigs, offshore installations of any type and of any purpose, their related and ancillary equipment, subsea or not, such as well head and pipelines, mooring legs and mooring points or otherwise as decided by the Society.

3. SCOPE AND PERFORMANCE

3.1 Subject to the Services requested and always by reference to the Rules, and/or to the Applicable Referential, the Society shall:

- review the construction arrangements of the Unit as shown on the documents provided by the Client;
- conduct the Unit surveys at the place of the Unit construction;
- class the Unit and enter the Unit's class in the Society's Register;
- survey the Unit periodically in service to note whether the requirements for the maintenance of class are met.

The Client shall inform the Society without delay of any circumstances which may cause any changes on the conducted surveys or Services.

3.2 The Society will not:

- declare the acceptance or commissioning of a Unit, nor its construction in conformity with its design, such activities remaining under the exclusive responsibility of the Unit's owner or builder;
- engage in any work relating to the design, construction, production or repair checks, neither in the operation of the Unit or the Unit's trade, neither in any advisory services, and cannot be held liable on those accounts.

4. RESERVATION CLAUSE

4.1 The Client shall always: (i) maintain the Unit in good condition after surveys; (ii) present the Unit for surveys; and (iii) inform the Society in due time of any circumstances that may affect the given appraisement of the Unit or cause to modify the scope of the Services.

4.2 Certificates are only valid if issued by the Society.

4.3 The Society has entire control over the Certificates issued and may at any time withdraw a Certificate at its entire discretion including, but not limited to, in the following situations: where the Client fails to comply in due time with instructions of the Society or where the Client fails to pay in accordance with clause 6.2 hereunder.

4.4 The Society may at times and at its sole discretion give an opinion on a design or any technical element that would 'in principle' be acceptable to the Society. This opinion shall not presume on the final issuance of any Certificate nor on its content in the event of the actual issuance of a Certificate. This opinion shall only be an appraisement made by the Society which shall not be held liable for it.

5. ACCESS AND SAFETY

5.1 The Client shall give to the Society all access and information necessary for the efficient performance of the requested Services. The Client shall be the sole responsible for the conditions of presentation of the Unit for tests, trials and surveys and the conditions under which tests and trials are carried out. Any information, drawing, etc. required for the performance of the Services must be made available in due time.

5.2 The Client shall notify the Society of any relevant safety issue and shall take all necessary safety-related measures to ensure a safe work environment for the Society or any of its officers, employees, servants, agents or subcontractors and shall comply with all applicable safety regulations.

6. PAYMENT OF INVOICES

6.1 The provision of the Services by the Society, whether complete or not, involves, for the part carried out, the payment of fees thirty (30) days upon issuance of the invoice.

6.2 Without prejudice to any other rights hereunder, in case of Client's payment default, the Society shall be entitled to charge, in addition to the amount not properly paid, interest equal to twelve (12) months LIBOR plus two (2) per-cent as of due date calculated on the number of days such payment is delinquent. The Society shall also have the right to withhold Certificates and other documents and/or to suspend or revoke the validity of Certificates.

6.3 In case of dispute on the invoice amount, the undisputed portion of the invoice shall be paid and an explanation on the dispute shall accompany payment so that action can be taken to resolve the dispute.

7. LIABILITY

7.1 The Society bears no liability for consequential loss. For the purpose of this clause consequential loss shall include, without limitation:

- Indirect or consequential loss;
- Any loss and/or deferral of production, loss of product, loss of use, loss of bargain, loss of revenue, loss of profit or anticipated profit, loss of business and business interruption, in each case whether direct or indirect.

The Client shall defend, release, save, indemnify, defend and hold harmless the Society from the Client's own consequential loss regardless of cause.

7.2 Except in case of wilful misconduct of the Society, death or bodily injury caused by the Society's negligence and any other liability that could not be, by law, limited, the Society's maximum liability towards the Client is limited to one hundred and fifty per-cent (150%) of the price paid by the Client to the Society for the Services having caused the damage. This limit applies to any liability of whatsoever nature and howsoever arising, including fault by the Society, breach of contract, breach of warranty, tort, strict liability, breach of statute.

7.3 All claims shall be presented to the Society in writing within three (3) months of the completion of Services' performance or (if later) the date when the events which are relied on were first discovered by the Client. Any claim not so presented as defined above shall be deemed waived and absolutely time barred.

8. INDEMNITY CLAUSE

8.1 The Client shall defend, release, save, indemnify and hold harmless the Society from and against any and all claims, demands, lawsuits or actions for damages, including legal fees, for harm or loss to persons and/or property tangible, intangible or otherwise which may be brought against the Society, incidental to, arising out of or in connection with the performance of the Services (including for damages arising out of or in connection with opinions delivered according to clause 4.4 above) except for those claims caused solely and completely by the gross negligence of the Society, its officers, employees, servants, agents or subcontractors.

9. TERMINATION

9.1 The Parties shall have the right to terminate the Services (and the relevant contract) for convenience after giving the other Party thirty (30) days' written notice, and without prejudice to clause 6 above.

9.2 The Services shall be automatically and immediately terminated in the event the Client can no longer establish any form of interest in the Unit (e.g. sale, scrapping).

9.3 The Classification granted to the concerned Unit and the previously issued Certificates shall remain valid until the date of effect of the termination notice issued, or immediately in the event of termination under clause 9.2, subject to compliance with clause 4.1 and 6 above.

9.4 In the event where, in the reasonable opinion of the Society, the Client is in breach, or is suspected to be in breach of clause 16 of the Conditions, the Society shall have the right to terminate the Services (and the relevant contracts associated) with immediate effect.

10. FORCE MAJEURE

10.1 Neither Party shall be responsible or liable for any failure to fulfil any term or provision of the Conditions if and to the extent that fulfilment has been delayed or temporarily prevented by a force majeure occurrence without the fault or negligence of the Party affected and which, by the exercise of reasonable diligence, the said Party is unable to provide against.

10.2 For the purpose of this clause, force majeure shall mean any circumstance not being within a Party's reasonable control including, but not limited to: acts of God, natural disasters, epidemics or pandemics, wars, terrorist attacks, riots, sabotages, impositions of sanctions, embargoes, nuclear, chemical or biological contaminations, laws or action taken by a government or public authority, quotas or prohibition, expropriations, destructions of the worksite, explosions, fires, accidents, any labour or trade disputes, strikes or lockouts.

11. CONFIDENTIALITY

11.1 The documents and data provided to or prepared by the Society in performing the Services, and the information made available to the Society, will be treated as confidential except where the information:

- is properly and lawfully in the possession of the Society;
- is already in possession of the public or has entered the public domain, other than through a breach of this obligation;
- is acquired or received independently from a third party that has the right to disseminate such information;
- is required to be disclosed under applicable law or by a governmental order, decree, regulation or rule or by a stock exchange authority (provided that the receiving Party shall make all reasonable efforts to give prompt written notice to the disclosing Party prior to such disclosure).

11.2 The Parties shall use the confidential information exclusively within the framework of their activity underlying these Conditions.

11.3 Confidential information shall only be provided to third parties with the prior written consent of the other Party. However, such prior consent shall not be required when the Society provides the confidential information to a subsidiary.

11.4 Without prejudice to sub-clause 11.1, the Society shall have the right to disclose the confidential information if required to do so under regulations of the International Association of Classifications Societies (IACS) or any statutory obligations.

12. INTELLECTUAL PROPERTY

12.1 Each Party exclusively owns all rights to its Intellectual Property created before or after the commencement date of the Conditions and whether or not associated with any contract between the Parties.

12.2 The Intellectual Property developed by the Society for the performance of the Services including, but not limited to drawings, calculations, and reports shall remain the exclusive property of the Society.

13. ASSIGNMENT

13.1 The contract resulting from to these Conditions cannot be assigned or transferred by any means by a Party to any third party without the prior written consent of the other Party.

13.2 The Society shall however have the right to assign or transfer by any means the said contract to a subsidiary of the Bureau Veritas Group.

14. SEVERABILITY

14.1 Invalidity of one or more provisions does not affect the remaining provisions.

14.2 Definitions herein take precedence over other definitions which may appear in other documents issued by the Society.

14.3 In case of doubt as to the interpretation of the Conditions, the English text shall prevail.

15. GOVERNING LAW AND DISPUTE RESOLUTION

15.1 These Conditions shall be construed in accordance with and governed by the laws of England and Wales.

15.2 Any dispute shall be finally settled under the Rules of Arbitration of the Maritime Arbitration Chamber of Paris ("CAMP"), which rules are deemed to be incorporated by reference into this clause. The number of arbitrators shall be three (3). The place of arbitration shall be Paris (France). The Parties agree to keep the arbitration proceedings confidential.

15.3 Notwithstanding clause 15.2, disputes relating to the payment of the Society's invoices may be submitted by the Society to the *Tribunal de Commerce de Nanterre*, France, or to any other competent local Court, at the Society's entire discretion.

16. PROFESSIONAL ETHICS

16.1 Each Party shall conduct all activities in compliance with all laws, statutes, rules, economic and trade sanctions (including but not limited to US sanctions and EU sanctions) and regulations applicable to such Party including but not limited to: child labour, forced labour, collective bargaining, discrimination, abuse, working hours and minimum wages, anti-bribery, anti-corruption, copyright and trademark protection, personal data protection (https://personaldataprotection.bureauveritas.com/privacypolicy).

Each of the Parties warrants that neither it, nor its affiliates, has made or will make, with respect to the matters provided for hereunder, any offer, payment, gift or authorization of the payment of any money directly or indirectly, to or for the use or benefit of any official or employee of the government, political party, official, or candidate.

16.2 In addition, the Client shall act consistently with the Bureau Veritas' Code of Ethics and, when applicable, Business Partner Code of Conduct both available at https://group.bureauveritas.com/group/corporate-social-responsibility/operational-excellence.

RULE NOTE NR 671

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Ammonia-fuelled Ships - Tentative Rules

SECTION 1 AMMONIA-FUELLED SHIPS

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1 Application

1.1 Scope

1.1.1 The purpose of this Rule Note is to provide a set of design and installation requirements for the classification of ships using ammonia as a fuel.

1.1.2 This Rule Note covers the arrangement, installation, control and monitoring of machinery, equipment and systems using ammonia to minimize the risk to the ship, crew, passengers and the environment, taking into account the specific properties of ammonia, in particular its toxicity.

1.1.3 This Rule Note covers ammonia-fuelled installations where ammonia is stored in liquid state in:

- type A tanks at (or near) atmospheric pressure and refrigerated to a temperature of –33.3°C (fully refrigerated tank)
- type C tanks under pressure at ambient temperature (fully pressurised tank)
- type C tanks under pressure lower than the vapour pressure at ambient temperature (semi-pressurised tank).

Other storage arrangements may be considered on a case by case basis.

1.1.4 Ammonia may be supplied to fuel consumers in liquid or gaseous state.

1.1.5 As a general principle, except where otherwise stated in the present Rule Note, ammonia-fuelled ships are to comply with the provisions of NR529, Gas-fuelled ships.

1.2 Statutory requirements

1.2.1 According to IGC Code regulation 16.9.2, liquefied gas carriers carrying ammonia are not allowed to use ammonia as fuel due to its toxicity. The Flag Administration of the ship is to be consulted to consider the possibility of using ammonia as fuel and the approval process to be followed.

1.2.2 For ships other than liquefied gas carriers intended to use ammonia as fuel, reference is made to the requirements of IGF Code, Part A, which requires an alternative design approach to be performed. The Flag Administration of the ship is to be consulted to define the approval process and the conditions in which the use of ammonia as fuel may be envisaged. In this respect, the Society considers that a ship design complying with the provisions of the present Rule Note and taking into account the outcome of the HAZID and HAZOP studies (see [2.3]) may be used as a basis for the engineering analysis required by SOLAS II-1 / reg. 55.3. The equivalence of the alternative design is to be demonstrated to and approved by the Flag Administration.

Note 1: When a ship is intended to use ammonia as fuel, the concerned Port Administrations need to be contacted to define the conditions in which the ship may operate in the area under their jurisdiction, in particular when the ship is at berth and during bunkering operations. Specific assessment, including dispersal analysis, may be required in this respect. This assessment is to cover the whole bunkering system, including the bunkering source and is to allow the definition of the dangerous areas around the bunkering connections.

1.3 Classification

1.3.1 Ammonia-fuelled ships that are designed and built in accordance with the present Rule Note may be assigned the additional service feature **ammoniafuel**.

The additional service feature ammoniafuel is completed by:

- the notation **singlefuel** when the engine uses only ammonia as fuel
- the notation **dualfuel** when the engine uses ammonia as fuel and fuel oil.

The additional service feature e.g. **ammonialfuel dualfuel** or **ammoniafuel singlefuel** may be completed by:

- the notation **-prop** when ammonia fuel is only used for propulsion systems
- the notation **-aux** when ammonia fuel is only used for auxiliary systems.

1.4 Documentation to be submitted

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

The list of documents requested is intended as a guidance for the complete set of information to be submitted, rather than an actual list of titles.

The Society reserves the right to request the submission of additional documents if it is deemed necessary for the evaluation of the system, equipment or components.

Table 1 : List of documents to be submitted

No.	Documents to be submitted	I / A **(1)**
1	General arrangement drawing of the ship showing the areas and spaces containing the ammonia installations and piping including: • the ammonia bunkering stations • the ammonia tanks • the ammonia boil-off management systems • the ammonia fuel handling systems • the ammonia valve units • the ammonia vapour processing systems • the vent mast • the inert gas system	A
2	General specification of the ammonia fuel installation including: • type and capacity of the ammonia storage tanks, range of pressure and temperature anticipated under operational conditions • bunkering method (from terminal, bunker ship or barge, truck) • boil-off management principle	I
3	Drawing showing: • the hazardous areas and their classification • the dangerous areas with respect to ammonia toxicity	A
4	Drawing showing the spaces and areas containing a potential source of ammonia release	A
5	Drawing showing the structural fire protection and cofferdams provided in connection with ammonia installations	A
6	Arrangement of accesses to the spaces containing a potential source of ammonia release	A
7	Arrangement of the ventilation systems serving the spaces containing a potential source of ammonia release	A
8	Calculation of the hull temperature in all design conditions (for membrane tanks and type A tanks)	I
9	Distribution of quality and steel grades in relation to the values obtained from the hull temperature calculation (for membrane tanks and type A tanks)	A
10	Report of HAZID and HAZOP analysis	I
11	Ammonia dispersion analysis, where required	A
FOR THE AMMONIA FUEL TANK:		
12	Drawings of the tanks and material specification	A
13	Structural analysis as per IGC Code, Chapter 4	A
14	Sloshing calculation covering the full range of intended filling levels (for membrane tanks and type A tanks)	A
FOR THE AMMONIA FUEL HANDLING SYSTEM:		
15	Specification, drawings, calculations and material characteristics of the pumps, compressors and heat exchangers	I
FOR THE AMMONIA FUEL PIPING SYSTEM:		
16	Schematic diagram and materials of the ammonia (liquid and vapour) piping systems, including venting systems	A
17	Details of the piping protective enclosure	A
18	Arrangement of the venting mast	A
FOR TANKS OTHER THAN FULLY PRESSURIZED TYPE C TANKS:		
19	Specification of the boil-off vapour management system(s)	I
20	Calculations of the boil-off rate of the tank, for the different operating conditions (maximum ambient temperature, filling rates, pressure and temperature in the tank after bunkering)	A
FOR THE AMMONIA VAPOUR PROCESSING SYSTEMS:		
21	Specification of the ammonia vapour processing system	I
22	Justification of the ammonia vapour processing system capacity	A

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

1.5 Definitions

1.5.1 Ammonia

Ammonia means NH3, either in the liquid state or in the gaseous state.

1.5.2 Ammonia fuel system

Ammonia fuel system includes the ammonia bunkering, storage, preparation, supply and consuming systems.

1.5.3 Ammonia preparation room

Ammonia preparation room means any space containing pumps, compressors, heat exchangers and vaporizers for ammonia preparation purposes.

1.5.4 Ammonia vapour processing system

Ammonia vapour processing system means a system that destroys, recovers or disperses ammonia vapour by thermal oxidation, dissolution in water or dilution with air.

1.5.5 Design vapour pressure

Design vapour pressure is the maximum gauge pressure, at the top of the tank, to be used in the design of the tank.

1.5.6 Space containing a potential source of ammonia release

Space containing a potential source of ammonia release in the context of this Rule Note means a space where a single failure in a system or equipment or a consequential failure of it would result in a release of ammonia in the space. Such spaces are to be clearly identified by the risk analysis.

1.5.7 Normal operational condition

Normal operational condition has the same meaning as in SOLAS Convention, regulation II-1 / 3.5. It includes black-out situations.

1.5.8 Failure condition

Failure condition means a condition under which a component in the ammonia fuel system is affected by a failure or a malfunction resulting in an ammonia leakage.

1.5.9 Permissible exposure limit (PEL)

Permissible exposure limit (PEL), 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.

1.5.10 Permissible discharge limit

Permissible discharge limit, for the purpose of this Rule Note, means a concentration of ammonia in liquid effluents not exceeding the applicable international or local limit.

1.5.11 Hazardous area

Hazardous area has the same meaning as in NR529, regulation 2.2.21.

1.5.12 Dangerous area

Dangerous area, for the purpose of this Rule Note, refers to the ammonia toxicity.

2 General design principles

2.1 Limitations of the toxicity consequences for persons on board

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

2.1.2 Direct venting of ammonia to the atmosphere in normal operational condition is not permitted.

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

2.1.4 Venting of ammonia to the atmosphere is permitted in failure conditions provided that it does not result in dangerous ammonia concentrations.

2.2 Limitations of the toxicity consequences for the environment

2.2.1 Except where otherwise stated, effluents containing liquid or dissolved ammonia are not to be discharged overboard.

2.3 Risk assessment

2.3.1 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.

2.3.2 The risks are to be analysed using acceptable and recognized risk analysis techniques, as per IACS Recommendation No.146 "Risk assessment as required by the IGF code". The risks listed in paragraph 3.2 of IACS Rec.146, as deemed relevant to ammonia, are to be considered as well as the following ones:

- loss of function
- component damage
- fire
- explosion
- collision
- grounding
- intoxication
- chemical burning
- pollution
- variations of bunkered ammonia fuel characteristics (temperature)
- rollover.

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.

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

- the accumulation of ammonia vapours in spaces 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
- the draining of the hold space in case of type A tank failure.

2.3.4 The risk analysis is to cover at least the following spaces, zones and systems:

- storage tanks
- tank hold spaces
- tank connection space (TCS)
- fuel preparation rooms
- bunkering stations
- spaces containing liquid or gaseous ammonia piping
- vent mast.

The ammonia spreading scenarios in case of leakage are to be analyzed.

2.3.5 The risks identified by the HAZID study may be mitigated by operational measures when design options have all been shown not to be reasonably practicable.

2.3.6 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 PEL, by substituting the lower flammable limit (LFL) with the PEL.

3 Ship design and arrangements

3.1 Protection of ammonia fuel storage tanks against external damages

3.1.1 Ammonia fuel storage tanks are to be protected against mechanical damage likely to occur during the ship operation.

3.1.2 Ammonia fuel storage tank are to be protected from external damage caused by collision or grounding, in accordance with the requirements for protective location given in NR529, [5.3].

3.2 Location and protection of ammonia fuel piping

3.2.1 Ammonia fuel piping is not to be located less than 800 mm from the ship's side.

3.2.2 All ammonia fuel pipes are to be protected from mechanical damages likely to occur during the ship operation. This applies in particular to the ammonia fuel pipes located on open decks and to those led through ro-ro spaces and special category spaces.

3.2.3 Ammonia piping is not to be led directly through accommodation spaces, service spaces, electrical equipment rooms or control stations.

3.2.4 Any valve necessary for isolating a storage tank or other components of the ammonia fuel system in case of leakage is to be provided with a remote closing device, which is to be accessible from a protected location.

3.3 Leakage containments

3.3.1 Possible ammonia leakages, as identified by the HAZID, are to be contained by a suitable enclosure, wherever practicable.

3.3.2 All ammonia piping is to be enclosed in a protective gastight enclosure complying with [7.2].

3.3.3 The protective enclosures may be omitted:

a) in the following spaces:
   - ammonia tank hold spaces for tanks other than type C tanks
   - tank connection spaces
   - ammonia preparation rooms
   - bunkering stations,

   provided that the provisions of [3.4.2] to [3.4.6] are complied with.

b) on open decks, for lines containing ammonia fuel only for short durations, such as bunkering lines, subject to justifications by risk analysis and dispersion studies.

c) for fully welded fuel gas vent pipes led through mechanically ventilated spaces.

Note 1: Lines between the ammonia storage tanks and the boil-off gas management systems are not considered as vent pipes.

3.4 Arrangement of spaces containing a potential source of ammonia release

3.4.1 Spaces containing a potential source of ammonia release are to comply with requirements [3.4.2] to [3.4.6].

3.4.2 Access

The access to the space should not be necessary in normal operational condition of the ship (except in the case of the bunkering stations, for which access is necessary for connecting and disconnecting the ammonia transfer hoses).

The access to the space is to be provided with locking arrangements which shall be under the control of the responsible ship's officer. A procedure is to be available onboard specifying the conditions to be observed for safe access to the space. A warning notice with safety instructions is to be provided outside the space, adjacent to each access door.

The space is to have a direct access to the open deck. Where this is not practicable, an alternative arrangement with an air lock may also be considered.

Direct access to the space is not permitted from another space. Where such access is necessary for operational reasons, an air lock is to be provided.

Note 1: Where permitted, airlocks are to allow the access of persons wearing breathing apparatus or carrying a stretcher.

3.4.3 Liquid ammonia leakage collection

Liquid leaks are to be collected in drip trays fitted with draining arrangement in accordance with [3.8].

3.4.4 Ammonia vapour detection

Ammonia sensors are to be provided in the space to detect ammonia vapour concentration exceeding 30 ppm, in accordance with [13.2]. In case of ammonia detection, a continuous audible and visual alarm is to be provided and the automatic closing of the master ammonia fuel valve or ammonia tank valve, as appropriate, is to be activated. Remote manual closing of the valve should also be possible from a safe location.

Alarms are to be activated in the following locations:

- in the space
- outside the space, adjacent to each access door and
- in the control station.

3.4.5 Ventilation

The space is to be provided with an independent ventilation system arranged in accordance with the provisions of [11.2]. The maximum pressure build up in the space due to the ammonia evaporation and taking into account the ventilation system is to be assessed.

3.4.6 Bilge systems

The space is to be provided with a bilge system complying with the provisions of [3.7] and segregated from the bilge system serving other spaces.

The bilge lines serving the space are not to be connected to pumps located in other spaces.

3.5 Arrangement of machinery spaces

3.5.1 A single failure within the ammonia fuel system is not to lead to ammonia release into the machinery space.

3.5.2 All fuel piping within machinery space boundaries are to be enclosed in a gastight enclosure.

3.5.3 An ammonia sensor is to be provided in each machinery space giving an alarm before the ammonia concentration reaches 30 ppm and activating the automatic shutdown of the master gas fuel valve serving the space.

3.6 Ammonia fuel preparation equipment

3.6.1 The equipment intended for ammonia fuel preparation is to be located in a dedicate space.

3.6.2 The pumping, vaporisation and heating capacity is to be sufficient to provide the required pressure and temperature of the ammonia supply at the engine inlets in all ammonia conditions in the storage tank, operating conditions of the ammonia consumers, including transient conditions, irrespective of the ambient conditions. Where necessary, a buffer tank is to be provided.

3.7 Regulations for bilge systems and drainage arrangements

3.7.1 Bilge water from spaces containing a potential source of ammonia release is to be retained on board in dedicated holding tanks for subsequent discharge to reception facilities. The oily bilge water holding tank may be used for such purpose if it is complies with the provisions of [3.7.3].

Note 1: Where the effluents in the tank have an ammonia content less than the permissible discharge limit, they can be dealt with as oily water effluents.

3.7.2 In spaces where a water mist system is installed in pursuance of [10.3], the number and diameter of the scupper pipes or bilge suctions are to be sufficient to avoid any risk of water accumulation.

3.7.3 Bilge water holding tanks and drain tanks likely to contain dissolved ammonia are to be located outside the machinery spaces and provided with a vent pipe led to the ammonia vapour processing system or to the vent mast and with means for ammonia vapour detection. They are to be made of a suitable material complying with the provisions of Article [5].

3.7.4 Bilge water holding tanks and drain tanks likely to contain dissolved ammonia are to be surrounded by protective cofferdams, except on those surfaces bound by ammonia preparation room.

3.7.5 Effluents containing dissolved ammonia with a concentration below the permissible discharge limit may be discharged directly overboard below the waterline in accordance with the standards and operational procedure in MARPOL 73/78, Annex II and other applicable regulations.

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 will not 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:

$$D = Q_d / 5 \cdot L_d$$

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 (m^3/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.

3.8 Drip trays

3.8.1 Drip trays are to be fitted in areas where spills may occur, in particular:

- at the bunkering station
- in fuel preparation rooms, in way of possible liquid fuel leakage sources including detachable pipe connections, pumps, valves and heat exchangers.

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

3.8.3 Drip trays are to be connected to a drain tank complying with [3.7.3]. The draining pipe is to be fitted with a remotely closable valve.

3.9 Control of ammonia vapours

3.9.1 Any release of ammonia vapours to the atmosphere, where permitted, is to be made through a vent mast.

3.9.2 The vent mast outlet is to be located:

- at a height not be less than B/3 or 6 m, whichever is the greater, above the weather deck, working areas and walkways
- not less than B or 25 m, whichever is less, from any opening or air intake to any accommodation and service spaces.

3.9.3 The vent mast may be used for other venting purposes provided there is no risk of flow reversal and chemical reaction between ammonia and other products.

3.9.4 Release of ammonia vapours through the vent mast should not result, for any release scenario, in ammonia concentrations exceeding the PEL at any location where passengers or crew members may be present. Dispersion analysis may be required by the Society.

3.9.5 The vent mast is to be designed for:

- the venting of residual vapours after processing
- the venting of ammonia to the atmosphere in failure conditions, where permitted
- the direct discharge to the vent mast of the large amount of vapour from the tank safety valves in case of fire.

3.9.6 Ammonia vapours generated in normal operational condition of the ship may be led:

- to a suitable location within the ammonia fuel system, where feasible or
- to the ammonia vapour processing system referred to in [10.2], otherwise. The residual vapours are to be discharged through the vent mast.

3.9.7 Ammonia vapours generated in failure conditions may be:

- discharged to the vent mast in compliance with [3.9.4] or
- controlled in compliance with the provisions of [3.9.6] or
- absorbed by water spray in accordance with [10.3], when the vapours are released directly into the space.

3.9.8 Detailed requirements for the control of ammonia release are given in Tab 2.

4 Fuel containment system

4.1 General

4.1.1 Ammonia tanks are to be designed in accordance with the relevant provisions of NR529 Chapter 6, except where otherwise specified in the present Article.

4.2 Operating conditions of the storage tank

4.2.1 The operating conditions of the tank are to be detailed:

- expected pressure and temperature range of ammonia in the tank
- operating principle (vapour bleeding and liquid extraction) and relevant control principles.

4.3 Design and arrangement of ammonia tanks

4.3.1 With the exception of fully pressurised type C tanks, tanks' pressure and temperature are to be maintained at all times within their design range by means acceptable to the Society, e.g. by one of the following methods:

a) reliquefaction of vapours

b) thermal oxidation of vapours

c) pressure accumulation

d) liquefied ammonia fuel cooling

e) dissolution of vapours in water.

The method chosen is to be capable of maintaining tank pressure below the set pressure of the tank pressure relief valves for a period of 21 days assuming full tank at normal service pressure and the ship in idle condition, i.e. only power for domestic load is generated.

4.3.2 Except in the case of fully pressurised type C tanks, at least two independent methods, or independent systems if a single method is used, are to be provided, each one capable of maintaining a full boil-off gas management capacity in the situation where one of them becomes inoperative. One of the methods or systems is to be in stand-by mode and designed for immediate operation.

Note 1: Where pressure accumulation is one of the methods used for managing the boil-off gas, the system used as the second method and its supporting auxiliary services are to maintain the fuel tank pressure and temperature in case of a single failure of a mechanical non-static component or a component of the control systems. This is to be demonstrated by a FMEA analysis.

Table 2 : Control of ammonia release

Ammonia release		Comments
Source	Method of control	
Discharge from storage tank safety valves	Release to the vent mast	Only in case of fire See [4.3.3]
Discharge from safety valves in the ammonia fuel system other than the storage tank ones	Transfer to a suitable location within the ammonia fuel system	
	Transfer to the ammonia vapour processing system	See [10.2]
Venting from bilge water holding tanks likely to contain dissolved ammonia	Transfer to the ammonia vapour processing system	See [10.2]
	Release to the vent mast	See **(1)**
Venting from liquid ammonia drain tanks	Transfer to the ammonia vapour processing system	See [10.2]
Discharge from pressure relief systems fitted to the type A tank hold spaces	Transfer to the ammonia vapour processing system	See [4.3.10], item g)
Discharge from pressure relief systems fitted to tank connection spaces	Transfer to the ammonia vapour processing system	See [10.2]
Venting from the diffusion water tank	Release to the vent mast	See [10.2.2]
Ventilation from the ammonia piping enclosure (double wall space)	Transfer to the ammonia vapour processing system	See [7.2.1], item a)] and [10.2]
	Release to the vent mast	See **(1)**
Venting from the ammonia supply system	Transfer to a suitable location within the ammonia fuel system	
	Transfer to the ammonia vapour processing system	See [10.2]
Leakage in a space containing a potential source of ammonia release	Dissolution by water mist in the space	See [11.2.3], item a)
	Transfer of the ammonia vapours to the ammonia vapour processing system through the ventilation system	See [11.2.3], item b)
	Release to the vent mast through the ventilation system **(1)**	See [11.2.3], item b) **(1)**
Venting and purging with nitrogen of ammonia vessels and piping before inspection and maintenance	Transfer to the ammonia vapour processing system	See [14.1.1]

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

4.3.3 Opening of ammonia storage tank relief valves may occur only in case of overpressure resulting from a fire in the vicinity of the tank. The assessment of the ammonia dispersion scenario through the vent mast is to be carried out.

4.3.4 The Maximum Allowable Working Pressure (MAWP) of the ammonia tank is not to exceed 90% of the Maximum Allowable Relief Valve Setting (MARVS).

4.3.5 Loading and filling limits of the tank are to be in accordance with the provisions of NR529, [6.8.1] and [6.8.2].

4.3.6 Particular consideration is to be paid to a possible vacuum in the ammonia tank.

4.3.7 A water spray system is to be installed for cooling the exposed parts of tank(s) located on open deck.

4.3.8 Ammonia tanks, except fully pressurised type C tanks, are to be fitted with a vapor return line. Alternative arrangements allowing pressure management in the tank during bunkering may also be considered.

4.3.9 Additional requirements for fully pressurized type C tanks

The design pressure of fully pressurized type C tanks is not to be less than the vapour pressure of ammonia at the maximum ambient temperature expected in service with a minimum of 45°C. Higher values of ambient temperature may however be required, depending on the area in which the ship is intended to operate.

4.3.10 Additional requirements for type A tanks

Type A tanks are to comply with the following requirements:

a) The secondary barrier of the tank is to be a complete barrier capable of containing any envisaged leakage of ammonia fuel for a period of 15 days.

b) Where the secondary barrier is constituted by the ship's hull, it is to be constructed of suitable steel capable of withstanding a temperature of –33°C.

c) The sloshing loads on the containment system and internal components are to be evaluated for the full range of intended filling levels. CFD calculation or test campaign is to be carried out for verification of sloshing pressure without any limitation on the filling level.

d) Means for safely disposing of leakages from the tank are to be arranged.

e) The tank hold space is to be provided with a drainage system suitable for handling liquid ammonia in the event of tank leakage or rupture.

   Arrangements are to be made for:

   - draining limited amounts of liquid ammonia to a drain tank in case of tank leakage
   - discharging the large amounts of spilled liquid ammonia expected in case of tank rupture to the sea below the waterline. Relevant safety analysis and operating procedures are to be submitted to the Society.

f) The tank hold space is to be capable of being inerted with a suitable dry inert gas and kept inerted with make-up gas provided by a shipboard inert gas generation system, or by shipboard storage, which is to be sufficient for normal consumption for at least 30 days (see NR529, [6.11.1]).

g) Tank hold spaces which may be subject to pressures beyond their design capabilities are to be provided with a suitable pressure relief system having a relieving capacity determined in accordance with NR467, Pt D, Ch 9, Sec 8, [2.1.4].

4.4 Tank pressure relief systems

4.4.1 The tank pressure relief system is to be in compliance with the provisions of NR529, [6.7.2] and [6.7.3].

5 Materials and general pipe design

5.1 General

5.1.1 The provisions of NR529, Chapter 7, for materials and piping systems also apply to ammonia, except where otherwise specified in the present Article.

5.1.2 Arrangements are to be made to deal with possible icing of ammonia piping components due to low temperatures in the ammonia storage tank or vaporization of pressurized ammonia fuel.

5.1.3 Piping systems containing liquid ammonia are to be designed for the vapour pressure of ammonia at the maximum expected temperature, considering a minimum of 45°C. Alternatively, safety valves are to be fitted where necessary to avoid any risk of overpressure in the piping system.

5.2 Materials

5.2.1 Copper, copper-bearing alloys and zinc are not to be used in pipelines, valves, fittings and other items of equipment in contact with ammonia.

5.2.2 Anhydrous ammonia may cause stress corrosion cracking in containment and piping systems made of carbon-manganese steel or nickel steel. To minimize the risk of this occurring, measures detailed in [5.2.3] to [5.2.8] are to be taken, as appropriate.

5.2.3 Where carbon-manganese steel is used, tanks, process pressure vessels and fuel piping are to be made of fine-grained steel with a specified minimum yield strength not exceeding 355 N/mm^2, and with an actual yield strength not exceeding 440 N/mm^2. One of the following constructional or operational measures are also to be taken:

- lower strength material with a specified minimum tensile strength not exceeding 410 N/mm^2 are to be used; or
- fuel tanks, etc., are to be post-weld stress relief heat treated; or
- ammonia temperature is to be maintained, preferably at a temperature close to the product's boiling point of -33°C, but in no case at a temperature above –20°C; or
- the ammonia is to contain not less than 0,1% w/w water. The relevant bunkering procedure is to be documented and made available onboard the ship.

5.2.4 If carbon-manganese steels with higher yield properties are used other than those specified in [5.2.3], the completed fuel tanks, piping, etc., are to be given a post-weld stress relief heat treatment.

5.2.5 The tensile and yield properties of the welding consumables are to exceed those of the tank or piping material by the smallest practical amount.

5.2.6 Nickel steel containing more than 5% nickel and carbon-manganese steel, not complying with the requirements of [5.2.3] and [5.2.4], are particularly susceptible to ammonia stress corrosion cracking and are not to be used in containment and piping systems for ammonia.

5.2.7 Nickel steel containing not more than 5% nickel may be used, provided the temperature complies with the requirements specified in [5.2.3] third item.

5.2.8 To minimize the risk of ammonia stress corrosion cracking, arrangements are to be made to keep the dissolved oxygen content below 2,5 ppm w/w. Where appropriate, the relevant operational procedure is to be established and kept onboard the ship.

5.2.9 Gaskets and sealing are to be made of rubbers and polymers, such as PTFE, that are compatible with ammonia.

5.3 Prevention of phase changes in ammonia supply lines

5.3.1 Where ammonia fuel is intended to be used in the gaseous state at pressures close to the vapor pressure at expected ambient temperature, the fuel is to be sufficiently heated and the fuel lines are to be properly heat traced.

5.3.2 Where ammonia fuel is intended to be used in the liquid state, the pressure in the fuel manifold is to be sufficient to maintain the fuel in the liquid state.

6 Bunkering

6.1 General

6.1.1 The provisions of NR529, Chapter 8, for LNG bunkering also apply to ammonia, except where otherwise specified in the present Article.

6.2 Arrangement of the bunkering station

6.2.1 The bunkering station is to be of the enclosed type. It is to be arranged without dead spaces or obstacles that could lead to ammonia vapour accumulation.

6.2.2 The bunkering station is to be arranged with:

- an ammonia detection system
- a water mist system complying with [10.3] and automatically activated in case of ammonia detection.

7 Fuel supply to consumers

7.1 General

7.1.1 The provisions of NR529, Chapter 9, for LNG fuel supply to consumers also apply to ammonia, except where otherwise specified in the present Article.

7.2 Secondary enclosure for ammonia fuel piping

7.2.1 Where required by [3.3], the secondary enclosure against leakage is to fulfill one of the following conditions:

a) Ventilated arrangement

The enclosure consists of a pipe or duct maintained at a pressure lower than the atmospheric pressure by an extraction ventilation system having a capacity of at least 30 air changes per hour.

An ammonia detector is to be provided at the fan discharge. In case of ammonia detection, the following automatic actions are to be performed:

- the master ammonia fuel valve or ammonia tank valve, as appropriate, is to be closed
- the vapour processing system is to be activated, when it is not in permanent operation
- the discharge of the ventilation system is to be automatically directed to the ammonia vapour processing systems.

b) Inert gas-pressurized arrangement

The enclosure consists of a pipe or duct pressurized with inert gas at a pressure greater than the ammonia fuel pressure.

A pressure monitoring is to be provided for the space between the ammonia fuel pipe and the enclosure. Loss of inert gas pressure between the pipes is to be indicated by suitable alarms and is to activate the automatic closing of the master ammonia fuel valve or ammonia tank valve, as appropriate.

7.3 Master ammonia fuel valve

7.3.1 A master ammonia fuel valve is to be provided in accordance with the provisions of NR529, [9.4.3].

8 Power generation including propulsion and other ammonia consumers

8.1 General

8.1.1 The provisions of NR529, Chapter 10, for LNG consumers also apply to ammonia, except where otherwise specified in the present Article.

8.2 Diesel Engines

8.2.1 Ammonia engines are to be type approved on the basis of the risk assessment (see [8.2.2]) and type testing (see [8.2.3]).

8.2.2 The risk assessment of the engine is to be carried out using an HAZID analysis or other acceptable methods. It should cover in particular the following hazards:

- presence and possible accumulation of gaseous ammonia in the charge air system and in the crankcase (Otto cycle engines)
- condensation of ammonia vapours in the fuel supply system (Otto cycle engines)
- leakage of high pressure liquid ammonia (Diesel cycle engines)
- presence of unburnt ammonia vapours in the exhaust system
- failure of an ammonia admission valve or injection valve
- failure of the ignition system (sparking plug or pilot injection).

Table 3 : Use of ammonia vapour processing systems

Ammonia vapour processing system	Use in normal operational / failure conditions
Ammonia diffusion tank	normal operational and failure conditions
Scrubbing system	
Thermal oxidation system	
Dilution system	failure condition

8.2.3 The engine is to undergo at least the following type tests, in addition to those required in NR467, Pt C, Ch 1, Sec 2, for standard Diesel engines:

- For dual fuel engines, the lowest specified speed is to be verified in diesel mode and ammonia mode.
- For dual-fuel engines, switch over between ammonia and diesel modes are to be tested at different loads.
- The efficiency of the ventilation arrangement of the double walled ammonia piping system is to be verified.
- The capability of engines driving generators to take sudden load and loss of load is to be verified.

Note 1: Where necessary, an exhaust gas treatment system is to be provided in order to comply with the applicable NOx emission limits stated in MARPOL Annex VI.

8.3 Fuel cells

8.3.1 Fuel cell systems using ammonia are to comply with the relevant requirements given in NI 547.

9 Fire safety and explosion prevention

9.1 General

9.1.1 The provisions of NR529, Chapters 11 and 12, also apply to ammonia, except where otherwise specified in the present Article.

9.2 Inerting

9.2.1 An inert gas system complying with the provisions of NR529, [6.3.12], [6.10], [6.13] and [6.14] is to be provided.

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

9.3 Fire extinguishing

9.3.1 Water based firefighting systems are not to be used on liquid ammonia fire due to instantaneous vaporization of the liquid phase.

9.4 Static electricity

9.4.1 All piping and pieces of equipment are to be electrically bonded.

10 Arrangements for mitigating the consequences of ammonia emissions

10.1 General

10.1.1 Where required in [3.9], ammonia concentration in the vapours released from the ammonia fuel system is to be reduced by means of a dedicated ammonia vapour processing system complying with the provisions of [10.2] and having a capacity and performance suitable to ensure that the ammonia concentration at any location where passengers or crew members may be present does not exceed the PEL, for the different expected emission scenarios. The capacity of the system is to be based on the amount of ammonia to be released from the largest relief device or vent pipe during one hour.

10.1.2 The consequences of an ammonia leakage in a space containing a potential source of ammonia release are to be mitigated by means of:

- one of the ammonia vapour processing systems referred to [10.2] or
- a water mist released within the space in accordance with the provisions of [10.3].

10.1.3 The thermal oxidation systems and dissolution systems (scrubbers) used as methods for controlling the pressure and temperature in the ammonia storage tank (see [4.3.1]) may also be used to reduce the ammonia concentration in ammonia releases.

10.2 Ammonia vapour processing systems

10.2.1 The ammonia vapour processing systems that may be used are listed in Tab 3. They may be used in normal operational or failure conditions, as indicated in Tab 3. Other processing systems will be given special consideration.

10.2.2 Ammonia diffusion tank

The ammonia diffusion tank is to be designed to receive 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 not 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.

Note 1: 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.

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.

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

The materials of the tank and related piping (diffusion pipe, discharge pipe and vent pipe) are to comply with the provisions of Article [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 [3.7.5].

10.2.3 Ammonia scrubbers

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

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 10, [18.5.4].

The materials used for the scrubber components (spray chambers, water jet piping, etc.) are to comply with the provisions of Article [5].

10.2.4 Ammonia combustion unit

Unless otherwise stated below, the ammonia combustion unit is to comply with the requirements of NR467, Pt C, Ch 1, Sec 3, [7].

The ammonia combustion unit is to be designed to operate throughout the expected flow range while limiting the unburnt amount of ammonia.

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

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.

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

10.2.5 Dilution system

The dilution system is to be arranged to provide sufficient dilution of the ammonia-containing gaseous effluents by mixing them with fresh air or increasing the ventilation rate.

The dilution rate is to be sufficient to reduce the ammonia concentration in accordance with [10.1.1]. Relevant justifications based on the maximum ammonia emission rate are to be submitted for each venting and ventilation scenario.

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

10.3 Water mist system

10.3.1 The water mist system is intended to absorb ammonia vapours in a space containing a potential source of ammonia release. It should cover the ammonia equipment and piping containing possible sources of leakage, as identified in the risk analysis (see [2.3]).

10.3.2 The water mist system is to be activated automatically 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.

11 Ventilation

11.1 General

11.1.1 The provisions of NR529, Chapter 13, for ventilation also apply to ammonia, except where otherwise specified in the present Article.

11.2 Arrangement of the ventilation systems serving spaces with risk of exposure to ammonia

11.2.1 The ventilation capacity is to be at least 30 air changes per hour.

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

11.2.3 The ventilation system is to be so arranged that, in case of ammonia leakage detection in the space at a 30 ppm concentration:

a) the ventilation fans are automatically stopped and the water mist system is automatically activated in accordance with [10.3.2]

   or

b) the ventilation outlet is automatically directed to the ammonia vapour processing system

   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 passengers or crew members may be present remain below the PEL in the worst case release scenario. Relevant justifications are to be submitted.

12 Electrical installations

12.1 General

12.1.1 The provisions of NR529, Chapter 14, for electrical installations also apply to ammonia, except where otherwise specified in the present Article.

12.2 Electrical equipment for hazardous spaces

12.2.1 Electrical equipment for hazardous areas is to be certified for ammonia in accordance with IEC 60079-20-1.

13 Control, monitoring and safety systems

13.1 General

13.1.1 The provisions of NR529, Chapter 15, for control, monitoring and safety systems also apply to ammonia, except where otherwise specified in the present Article.

13.2 Regulations for ammonia vapour detection

13.2.1 Permanently installed ammonia detectors providing a 30 ppm ammonia concentration alarm are to be fitted:

- In the tank connection spaces
- in all ducts around fuel pipes
- in ammonia fuel preparation rooms
- in other spaces containing a potential source of ammonia release
- in machinery spaces containing ammonia piping, equipment or consumers
- in air locks
- in ammonia heating circuit expansion tanks
- in motor rooms associated with the ammonia systems
- in bunkering stations
- in vent pipes from ammonia drain tanks
- in vent pipes from bilge water holding tanks serving spaces containing a potential source of ammonia release.

13.2.2 The detection equipment is to be located:

- at the top and bottom of the concerned space, where ammonia is likely to accumulate
- in the vent mast outlet.

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

13.2.4 Ammonia dispersion analysis or smoke tests are to be carried out to justify the detector arrangement (number and location) in the following spaces:

- fuel preparation rooms
- tank connection spaces
- bunkering stations.

13.3 Personal protection

13.3.1 The following equipment is to be available on board:

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

14 Inspection and maintenance

14.1 Onboard surveys

14.1.1 Arrangements are to be made for safely draining, venting and purging with nitrogen all ammonia vessels and piping before inspection and maintenance. Sampling points for measuring ammonia concentration are to be provided where necessary. The sampling system is to be of a closed loop designed to ensure that ammonia liquid and vapour are not vented to atmosphere.

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