



Mærsk Mc-Kinney Møller Center  
for Zero Carbon Shipping



# Ammonia Phase 3 Competencies and Training

## Proposed Overall Framework

04 July 2024

# Executive summary

The decarbonisation of global shipping necessitates alternative fuels, with ammonia emerging as a promising contender due to its low GHG emissions. However, ammonia has specific hazards, such as toxicity, fire, and explosion risks, that necessitate specialized crew training and competencies. Current frameworks, such as the IMO IGF Code, provide a foundation but are insufficient for ammonia's unique challenges.

The Ammonia as Fuel – Competencies and Training Project undertaken by Lloyd's Register Maritime Decarbonisation Hub, and the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, and other their partners, addresses these gaps. This work, referred to as the Ammonia Phase 3 Competencies and Training project, set out an initial task to propose overall information for setting minimum standards.

The key objective of this initiative was to create a proposed framework using Section A-V/3 of the STCW Code as the base document as well as other relevant industry publications. Industry and subject matter experts were consulted to review the proposed framework; suggest modifications or new items and identify and validate the necessary requirements for seafarer training and competencies.

The main product of this initial task is the creation of two tables herein called 'the framework'. There is one table for basic training and one for advanced training. The tables themselves are presented in a manner similar to the approach used in the STCW Code Chapter V. Each table provides recommendations for the following:

- Competencies
- Knowledge, understanding and proficiency
- Methods for demonstrating competence
- Criteria for evaluation

A second set of tables was also created to provide readers with explanatory information providing details related to the proposed minimum standards. These tables are entitled "Proposed Framework: Basic (or Advanced) Training Table with Explanatory Notes". The information in these tables would also be used to assist work on future project tasks and / or those outside the project tasked with the future revision of STCW.

Although accommodations will be needed to upskill and retrain seafarers to use ammonia as a marine fuel, the basic competency statements remain the same as those already established in existing STCW instruments. The largest updates will be centred around:

- The knowledge of the characteristics of ammonia such as toxicity, flammability, explosivity, corrosion, material incompatibility
- Understanding of ammonia-specific operational and maintenance regimes
- New skills associated with the introduction of ammonia-related systems, equipment and materials including dual fuel engines and the increased use of automation and digitalisation
- Modification to some operations such as bunkering to accommodate ammonia as a fuel
- Changes to the approach for emergency response such as those related to releases (leaks or spills), fires and explosions

The proposed approach to training is similar to that already in existence.

This report proposes a set of criteria for future training and competencies to facilitate seafarers to be able to work safely, efficiently and in an environmentally responsible manner while using ammonia as a fuel on a ship with dual fuel engines. This work can serve as an input to the development of future STCW training and competency requirements for personnel on ships using ammonia or those using other gas or low flashpoint fuels. It will also be informative to vessel operators, industry associations, non-governmental agencies and marine training institutions.

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# Disclaimer

The findings of this report are built on extensive cross-sector collaboration between organisations in the maritime industry and beyond. The project team consisted of the Lloyd's Register Maritime Decarbonisation Hub, the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, A. P. Moller-Maersk, NYK Line, TotalEnergies, MAN Energy Solutions, BP, Cargill, CF Industries, Stolt Tankers, Anglo-Eastern Ship Management, Hapag-Lloyd, the Ammonia Safety & Training Institute (ASTI), Seaspan and V.Group.

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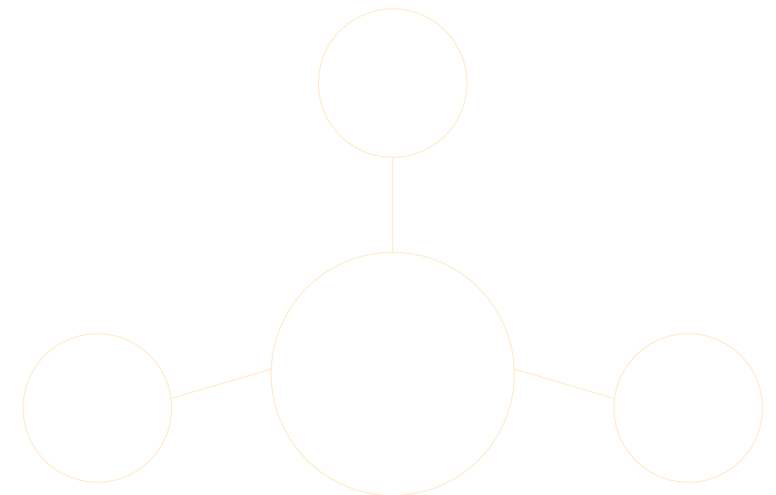
# 1. Background

At the end of 2023, the Ammonia Phase 3 Competencies and Training project was initiated between project partners from the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMCZCS) and the Lloyd's Register Maritime Decarbonisation Hub (The Decarb Hub).

The scope was set to define overall competency and training requirements for the use of ammonia as a marine fuel on tankers, container ships and bulk carriers. To ensure the deliverables reflected industry knowledge and experience, a working group of MMMCZCS project partners was established in conjunction with experts associated with The Decarb Hub.

For the first part of the project, a proposed overall training and competency framework for using ammonia as a fuel, was created. The proposed framework was primarily based on the International Maritime Organization's (IMO) International Convention on Standards of Training, Competency and Watchkeeping for Seafarers Code (STCW) Code relating to the Specifications for minimum standards of competence for training for ships subject to the International Code of Safety for Ships Using Gases or other Low-Flashpoint Fuels (IGF Code).

This report documents a proposed overall competencies and training framework for using ammonia as a fuel. The product itself is provided in the form of two sets of tables.



## 2. Identification of competencies and KUPs

The first task undertaken as part of Phase 3 Ammonia as Fuel – Competencies and Training project was the identification of overall competency information in the context of existing related STCW competency requirements for ships subject to the IGF Code. This section of the STCW code served as a basis since it had been created for liquefied natural gas (LNG) which has some operational and thus competency / training parallels to ammonia as a gas fuel. With that said, the proposed framework did need to take account of the differences in the two fuels such as the toxic nature, the corrosivity and the lesser flammability of ammonia.

The starting point for the identification of competencies was the review of the mandatory STCW specification of minimum standard of competence for basic and advanced training for ships subject to the IGF Code tables as listed below:

- **STCW Table A-V/3-1** – Specification of minimum standard of competence for Basic Training for ships subject to the IGF Code.
- **STCW Table A-V/3-2** – Specification of minimum standard of competence for Advanced Training for ships subject to the IGF Code.

Additionally other mandatory STCW specifications of minimum standards of competence for basic and advanced training for oil tanker cargo operations, chemical tanker cargo operations and liquefied gas tanker cargo operations that have served as inputs have been listed below:

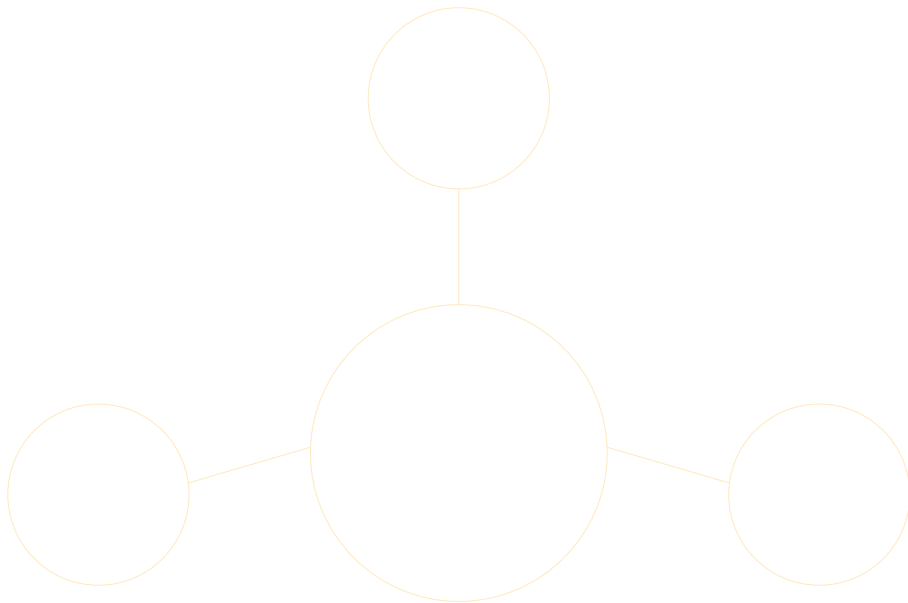
- **STCW Code Table A-V/1-1-1** – Specification of minimum standard of competence in basic training for oil and chemical tanker cargo operations.
- **STCW Code Table A-V/1-1-2** – Specification of minimum standard of competence in advanced training for oil tanker cargo operations.
- **STCW Code Table A-V/1-1-3** – Specification of minimum standard of competence in advanced training for chemical tanker cargo operations.
- **STCW Code Table A-V/1-2-1** – Specification of minimum standard of competence in basic training for liquefied gas tanker cargo operations.
- **STCW Code Table A-V/1-2-2** – Specification of minimum standard of competence in advanced training for liquefied gas tanker cargo operations.

A report by the Global Centre of Maritime Decarbonisation (GCMD) on the Concept Study to Offload Onboard Captured Carbon Dioxide also acted as a source of information. This publication includes operating personnel competency standards for ships with carbon capture and storage capabilities. It provided additional criteria that would be adaptable to personnel on ships operating with ammonia as a fuel.

Concurrently the project partners participated in ammonia fuel workshops that were conducted as part of the Maritime Just Transition Taskforce (MJTTF) project on Training for Decarbonisation. Participation in these series of workshops in many cases validated the proposed competencies and in other cases, provided new ideas for inclusion into the framework. Throughout the project, the MMMCZCS partners volunteered to be a part of a working group to lend their knowledge and expertise to the development of both the framework criteria and to provide a sounding board to the proposed ideas.

The output was a set of proposed competencies and related knowledge, understanding and proficiencies (KUPs) information for overall operations. These were included within the relevant portions of two sets of framework tables. The first set, using a similar format to existing STCW Code tables, addresses Basic Training and Advanced Training. Specifically, both the competencies and the related knowledge, understanding and proficiency (KUPs) criteria were documented. As mentioned above, this has been presented in a similar format to the existing STCW IGF framework but with modifications or additions to account for various aspects related to the use of ammonia as fuel.

The second set of tables is also presented in a format outlining competencies and KUPs for Basic and Advanced training. It provides further details to assist the reader with forming a deeper understanding the proposed criteria by augmenting the competency and KUPs information with explanatory notes.





# 3. Development of training standards

Once the competencies and KUPs were identified, training standards were proposed following the existing STCW framework approach by defining:

- Methods for demonstrating competence.
- Criteria for demonstrating competence.

A similar approach and information sources used for the identification and KUPs was employed for progressing with proposing relevant training requirements into the modified STCW framework tables. The results were documented in the relevant table and thus detailed training information (based on the STCW model) for overall operations was provided.

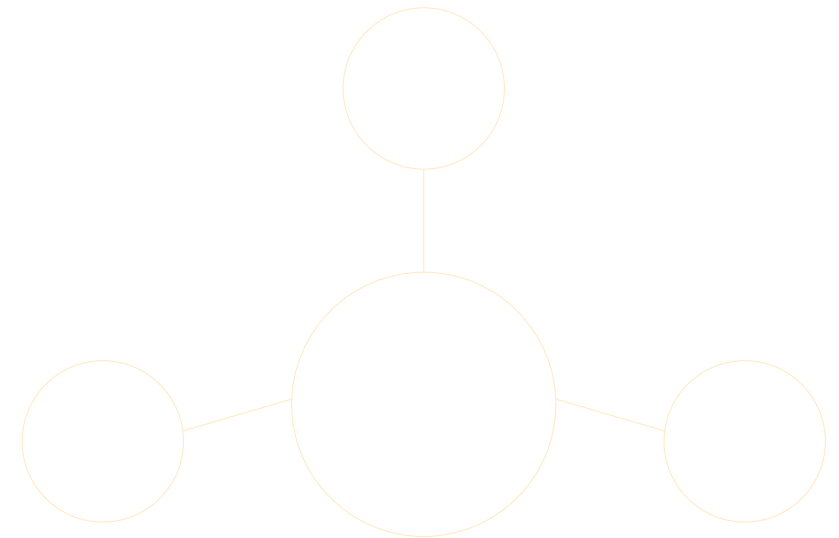
While the proposed framework provides the working group's thoughts with regards to training, some project members wished to highlight that specific training approaches documented in the tables should undergo further scrutiny since this additional consideration may be needed for specific items including but not limited to the following:

- Firefighting would need practical training as well as classroom training and that a simulator would not suffice to develop the required competence
- Leak management including containment actions would need practical training. This could be for response to gas vapours or liquid spills
- Project members felt that relevant personnel would need to participate in training with engine manufacturers to become competent with specific equipment and their operations/maintenance procedures
- The overall training scheme including onboard experience should be similar to that which currently exists for the IGF Code but with modifications as necessary for the unique aspects of the various ammonia fuel forms

# 4. Information about the modified framework tables

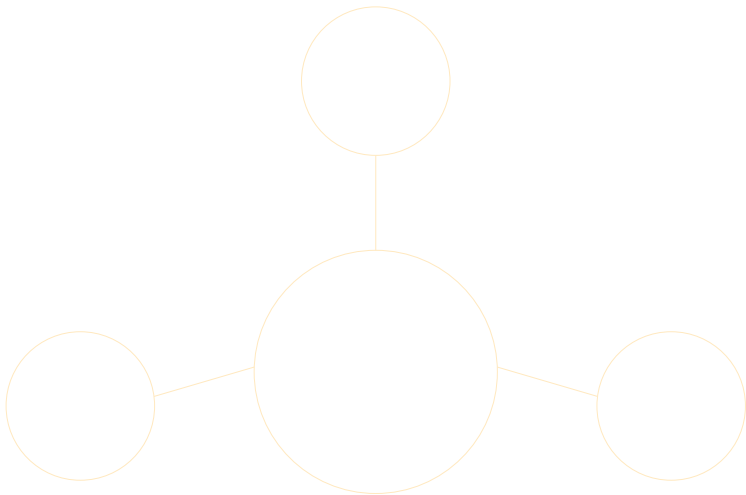
There are structural differences in the format of the first set of tables developed under this project when compared to the STCW standard. Such differences are the inclusion of project numbers for competencies and KUPs and cross-indexing numbers or notations to tie criteria back to the original source of information. The project numbers were provided to allow easy reference to the table's contents. Cross referencing to the information's source provides credibility to the listed items as well as highlighting the proposed amendments. Regardless, the proposed framework outlines particular training and competencies that are expected to aid with further development of detailed training that would support operations specific to the use of ammonia as fuel.

A second set of tables titled "Proposed Framework: Basic (or Advanced) Training Table with Explanatory Notes" is provided to add clarity and detail for the reader with regards to subtleties related to some of the stated criteria and highlights training topics. It also notes where a particular criterion may be relevant to a type / form of ammonia. The intention of providing this additional information was to increase the reader's understanding of potential factors making up the minimum requirements statements. In addition, the documentation of such detailed information would serve as a basis to the future tasks of this project where detailed competencies and training standards will be created for select operational scenarios.



# 5. Proposed Competency and Training Framework for using ammonia as a fuel

One objective of the proposed framework was to maintain the content and structure of the existing STCW IGF structure as much as possible. In addition, it was desirable to record the sources of the information provided in the modified framework tables. The purpose of these objectives was to demonstrate the commonalities and differences that were considered necessary to accommodate the use of ammonia as a fuel. To that point, the following outlines information that will be helpful in understanding what is provided in the proposed framework tables.

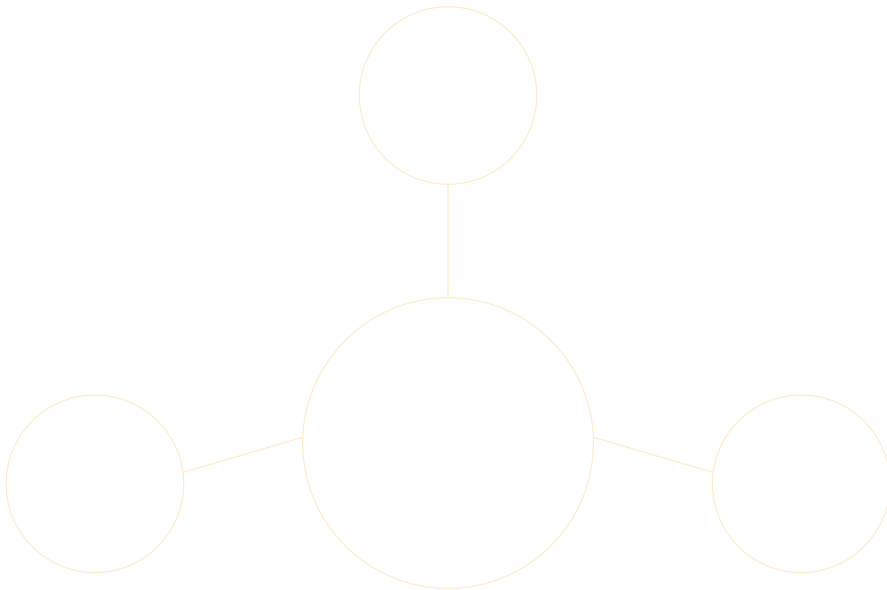


- Two sets of numbers have been provided in the first two columns of the table. The numbers in the first column are those proposed or more accurately, the project reference numbers to assist with the identification of line items to facilitate discussion or written comments. The numbers in the second column provide cross references to track each proposed competency or KUP to its reference source (e.g., Section A-V/3 of the STCW Code)
- **Red text** indicates suggestions for modifying the IGF framework text
- Occasionally there will be suggested text or competencies adopted from the other tables in STCW Chapter V or other industry studies deemed adaptable to ammonia handling and storage on board ships, which are suitably marked in the proposed framework
- There are also suggested items that are **New**. These came from referenced sources or from discussions with an industry working group from MMMCZCS

# 6. Proposed Competency and Training Framework: Basic Training Table

The table below proposes the basic Competency and Training Framework for ammonia and is primarily based on **STCW Table A-V/3-1** relating to specification of minimum standard of competence in basic training for ships subject to the IGF Code. Additionally, other sources have been explored to determine commonalities with ammonia as a fuel on ships as listed below:

- **Table A-V/1-1-1** – Specification of minimum standard of competence in basic training for oil and chemical tanker cargo operations.
- **Table A-V/1-1-3** – Specification of minimum standard of competence in basic training for liquefied gas tanker cargo operations.
- **GCMD** – Concept Study to Offload Onboard Captured Carbon Dioxide (Chapter 8: Operating Personnel Competency Standards).



BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>1</b>	1	<p><b>Competency</b></p> <p>Contribute to the safe operation of a ship (<del>subject to IGF Code</del>) <b>using ammonia as fuel</b></p> <p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme.</li> </ul> <p><b>Criteria for evaluating</b></p> <p>Communications within the area of responsibility are clear and effective.</p> <p>Operations related to ships <del>subject to the IGF Code</del> <b>using ammonia as fuel</b> are carried out in accordance with accepted principles and procedures to ensure safety of operations.</p>
<b>1.1</b>	1.1	<b>Design and operational characteristics of ships</b> <del>subject to the IGF Code</del> <b>using ammonia as fuel</b>
<b>1.2</b>	1.2	Basic knowledge of ships ( <del>subject to the IGF Code</del> ) <b>using ammonia as fuel</b> , their fuel systems and fuel storage systems:
1.2.1	1.2.1	.1 fuels ( <del>addressed by the IGF Code</del> ) <b>for ships using ammonia as fuel</b>
1.2.2	1.2.2	.2 types of fuel systems <del>subject to the IGF Code</del> <b>on ships-using ammonia as fuel</b>
1.2.3	1.2.3	.3 atmospheric, <b>low temperature, pressurised</b> , <del>eryogenic or compressed</del> storage of fuels on board ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del>
1.2.4	1.2.4	.4 general arrangement of fuel storage, <b>handling and transfer</b> systems on board ships <del>subject to the IGF Code</del> <b>using ammonia as fuel</b>
1.2.5	1.2.5	.5 hazard <b>safety, security and marine</b> zones and areas
1.2.6	1.2.6	.6 typical fire safety plan <b>for ships using ammonia as fuel</b>
1.2.7	1.2.7	.7 monitoring, control and safety systems aboard ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del>
<b>1.3</b>	1.3	<b>Basic knowledge of fuels and fuel storage systems' operations</b> <b>related to ammonia fuel type</b> on board ships <del>subject to the IGF Code</del> :
1.3.1	1.3.1	.1 piping systems and valves <b>particular to the fuel service</b>

BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
1.3.2	New	x fuel and fuel residue handling, transfer systems and related equipment
1.3.3	New	x after treatment systems for ammonia fuel
1.3.4	New	x dual fuel engines operations
1.3.5	1.3.2	.2 atmospheric, <del>pressurised, compressed,</del> low temperature or cryogenic storage
1.3.6	New	x fuel tank / storage operations
1.3.7	1.3.3	.3 relief systems and protection screens
1.3.8	New	x pumps and pumping arrangements
1.3.9	New	x ventilation systems related to spaces where fuel vapours could be present
1.3.10	New	x venting and vapour / boil off gas management systems
1.3.11	1.3.4	.4 basic bunkering operations and bunkering systems including hose / vapour line management
1.3.12	1.3.5	.5 protection against low temperature, cryogenic or temperature / pressure accidents
1.3.13	1.3.6	.6 fuel leak monitoring and detection
<b>1.4</b>	1.4	<b>Basic knowledge of the physical properties of fuels on board ships using ammonia as fuel subject to the IGF Code, including:</b>
1.4.1	1.4.1	.1 properties and characteristics
1.4.2	1.4.2	.2 pressure and temperature, including vapour pressure/ temperature relationship
1.4.3	New [LNG C BT 1.2.4]	.3 chemical symbols and markings
<b>1.5</b>	1.5	<b>Knowledge and understanding of safety culture requirements and safety management on board ships subject to the IGF Code using ammonia as fuel.</b>

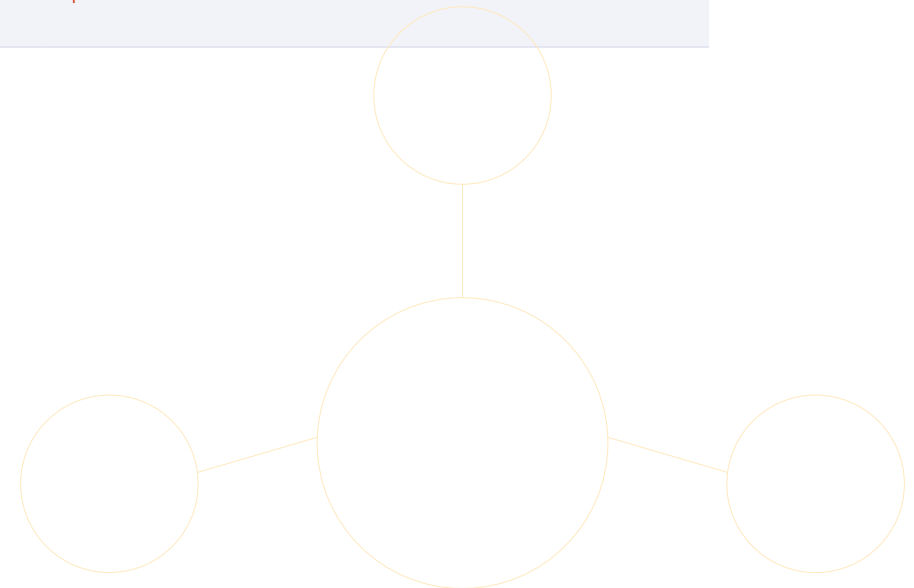
BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>2</b>	2	<p><b>Competency</b></p> <p>Take precautions to prevent hazards on a ship <del>subject to the IGF Code</del> <b>using ammonia as fuel</b></p> <p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme</li> </ul> <p><b>Criteria for evaluating</b></p> <p>Correctly identifies, on a Safety Data Sheet (SDS), relevant hazards to the ship and to personnel, and takes the appropriate actions in accordance with established procedures.</p> <p>Identification and actions on becoming aware of a hazardous situation, conform to established procedures in line with best practice.</p>
<b>2.1</b>	2.1	<b>Basic knowledge of the hazards associated with operations on ships <del>subject to the IGF Code</del> using ammonia as fuel, including</b>
2.1.1	2.1.1	.1 health hazards
2.1.2	2.1.2	.2 environmental hazards
2.1.3	2.1.3	.3 reactivity hazards
2.1.4	2.1.4	.4 corrosion hazards
2.1.5	2.1.5	.5 ignition, explosion ( <b>BLEVE</b> ), <b>implosion</b> and flammability hazards
2.1.6	2.1.6	.6 sources of ignition
2.1.7	2.1.7	.7 electrostatic hazards <b>including static electricity / energy accumulator and generator</b>
2.1.8	2.1.8	.8 toxicity hazards
2.1.9	<b>New [LCO2]</b>	<b>x phase change hazards</b>
2.1.10	2.1.9	.9 vapour leaks and clouds
2.1.11	<b>New [LCO2]</b>	<b>x inert gas hazards</b>

BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
2.1.12	2.1.10	.10 extremely low temperatures
2.1.13	2.1.11	.11 pressure hazards
2.1.14	2.1.12	.12 fuel batch differences
2.1.15	New [LCO2]	x material incompatibilities including fittings
2.1.16	New [LCO2]	x quality / quantity differences including impurities impacts / effect
2.1.17	New	x weather or external environmental conditions including sea states
<b>2.2</b>	2.2	<b>Basic knowledge of hazard controls:</b>
2.2.1	2.2.1	1 emptying, inerting, drying <b>purging, venting and gas freeing</b> monitoring techniques, <b>as appropriate</b>
2.2.2	2.2.2	.2 anti-static measures
2.2.3	2.2.3	.3 ventilation
2.2.4	2.2.4	.4 segregation
2.2.5	2.2.6	.6 measures to prevent ignition, fire, explosion ( <b>BLEVE</b> ) and implosion.
2.2.6	2.2.7	.7 atmospheric control
2.2.7	2.2.8	.8 gas testing, <b>detecting, and sampling</b>
2.2.8	2.2.9	.9 protection against <b>low temperature</b> cryogenic damages
2.2.9	New [LNG C BT 6.3.3]	x prevent ductile or brittle fracture and hazards associated with cold low temperature liquids
<b>2.3</b>	2.3	<b>Understanding of fuel characteristics on ships using ammonia as fuel and related substances subject to the IGF Code as found on a Safety Data Sheet (SDS).</b>



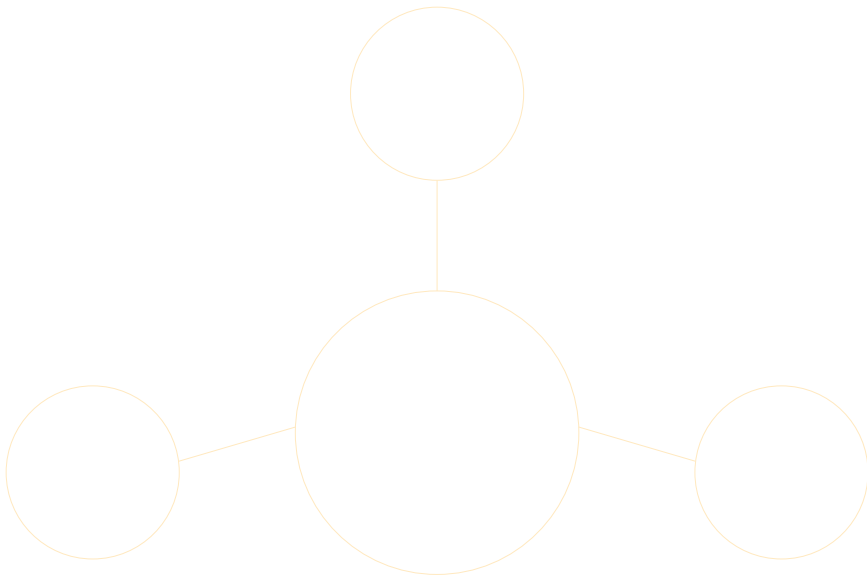
BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>3</b>	3	<p><b>Competency</b></p> <p>Apply occupational health and safety precautions and measures</p> <p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme</li> </ul> <p><b>Criteria for evaluating</b></p> <p>Procedures and safe working practices designed to safeguard personnel and the ship are observed at all times.</p> <p>Appropriate safety and protective equipment is correctly used.</p> <p>First aid dos and don'ts.</p> <p>(Tanker &amp; LNG -C adds – Procedures for entry into enclosed spaces are observed – it was the first item listed under criteria for evaluating)</p>
<b>3.1</b>	3.1	<b>Awareness of function and proper use of gas-measuring instruments and similar equipment:</b>
3.1.1	3.1.1	.1 gas testing
3.1.2	New	x gas sampling related to <del>fuels and</del> atmosphere
3.1.3	New [LCO2]	x gas detection, personal and fixed gas detection, monitoring, and alarm systems
<b>3.2</b>	3.2	<b>Proper use of specialized safety equipment and protective devices, including:</b>
3.2.1	3.2.1	.1 breathing apparatus and aids / devices
3.2.2	3.2.2	.2 protective clothing including PPE, clothing and equipment that is rated for potential low temperatures
3.2.3	3.2.3	.3 resuscitators
3.2.4	3.2.4	.4 rescue and escape equipment including for tanks, enclosed and machinery spaces
3.2.5	New	.5 use and location of mustering points / safe havens

BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>3.3</b>	3.3	Basic knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety relevant to ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del> , including:
3.3.1	3.3.1 [New text-see LNG C 4.1.1 -similar]	.1 precautions to be taken before entering hazardous spaces and zones <b>including enclosed spaces. This would include checks for toxicity, asphyxiation, and flammability.</b>
3.3.2	3.3.2	.2 precautions to be taken before and during repair and maintenance work
3.3.3	3.3.3	.3 safety measures for hot and cold work
3.3.4	New	x precautions against dropped objects
3.3.5	New	x ship / shore safety checklists for port operations
<b>3.4</b>	New	<b>Basic knowledge of measures for decontaminating personal protective equipment, tools, or equipment after exposure to substances</b>
<b>3.5</b>	3.4	Basic knowledge of first aid <b>related to gas or other low flashpoint fuels or related substances</b> with reference to a Safety Data Sheet (SDS).



BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>4</b>	4	<p><b>Competency</b></p> <p>Carry out firefighting operations on a ship <b>using ammonia as fuel</b> <del>subject to the IGF Code</del></p> <p><b>Methods for demonstrating competence</b></p> <p>Practical exercises and instruction conducted under approved and truly realistic training conditions (e.g. Simulated shipboard conditions) and, whenever possible and practicable, in darkness</p> <p><b>Criteria for evaluating</b></p> <p>Initial actions and follow-up actions on becoming aware of an emergency conform with well-established practices and procedures.</p> <p>Action taken on identifying muster signals is appropriate to the indicated emergency and complies with established procedures.</p> <p>Clothing and equipment are appropriate to the indicated emergency and complies with established procedures.</p> <p>The timing and sequence of individual actions are appropriate to the prevailing circumstances and conditions.</p> <p>Extinguishment of the fire is achieved using appropriate procedures, techniques and firefighting agents.</p>
<b>4.1</b>	4.1	Fire organization and action to be taken on ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del>
<b>4.2</b>	4.2	Special hazards associated with fuel systems, <b>storage</b> and fuel handling on ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del>
<b>4.3</b>	4.3	Firefighting agents and methods used to control and extinguish fires in conjunction with the different fuels found on board ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del>
<b>4.4</b>	4.4	Firefighting system operations
<b>4.5</b>	New [From LNG C]	<b>Basic knowledge of spill containment in relation to firefighting operations</b>

BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>5</b>	5	<p><b>Competency</b> Respond to emergencies</p> <p><b>Methods for demonstrating competence</b> Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme</li> </ul> <p><b>Criteria for evaluating</b> The type and impact of the emergency is promptly identified and the response actions conform to the emergency procedures and contingency plans.</p>
<b>5.1</b>	5.1	<b>Basic knowledge of emergency procedures, including emergency shutdown</b>
<b>5.2</b>	New [LCO2]	<b>Basic knowledge of bunkering operations emergency / safety devices such as Emergency Release Systems (ERS), Quick Release Connections (QC DC), Ship-to-Shore Links (SSLs) or Emergency Bunkering Links (EBLs)</b>

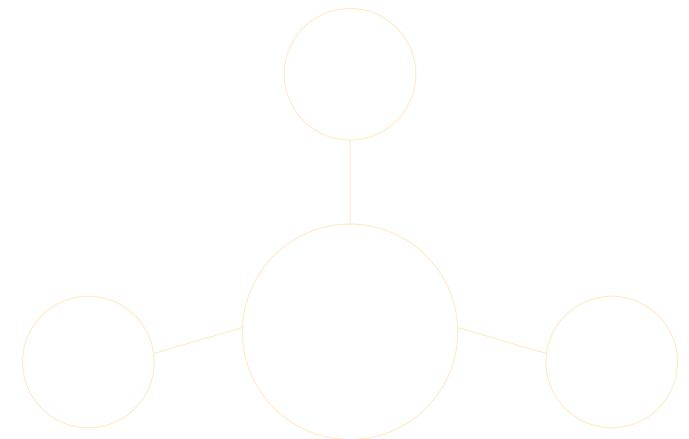


BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>6</b>		<p><b>Competency</b></p> <p>Take precautions to prevent pollution of the environment from the release of the ammonia fuels found on ships subject to the IGF Code</p> <p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme</li> </ul> <p><b>Criteria for evaluating</b></p> <p>Procedures designed to safeguard the environment are observed at all times.</p>
<b>6.1</b>	New [LNG C 6.1]	<b>Basic knowledge of the effects of pollution on human and marine life</b>
<b>6.2</b>	New [LNG C 6.2]	<b>Basic knowledge of shipboard procedures to prevent pollution</b>
<b>6.3</b>	6.1	Basic knowledge of measures to be taken in the event of leakage/spillage/ venting of fuels from ships using ammonia as fuel subject to the IGF Code, including the need to:
6.3.1	6.1.1	.1 report relevant information to the responsible persons
6.3.2	6.1.2	.2 awareness of shipboard spill/leakage/venting response procedures
6.3.3	6.1.3	.3 awareness of appropriate personal protection when responding to a spill/ leakage of ammonia fuels addressed by the IGF Code

# 7. Proposed Competency and Training Framework: Advanced Training Table

The table below proposes the basic training and competency framework for ammonia and is primarily based on **STCW Table A-V/3-2** relating to specification of minimum standard of competence in advanced training for ships subject to the IGF Code. Additionally other sources have been explored to determine commonalities with ammonia as a fuel on ships as listed below:

- **Table A-V/1-1-1** – Specification of minimum standard of competence in basic training for oil and chemical tanker cargo operations.
- **Table A-V/1-1-3** – Specification of minimum standard of competence in basic training for liquefied gas tanker cargo operations.
- **GCMD** – Concept Study to Offload Onboard Captured Carbon Dioxide (Chapter 8: Operating Personnel Competency Standards).

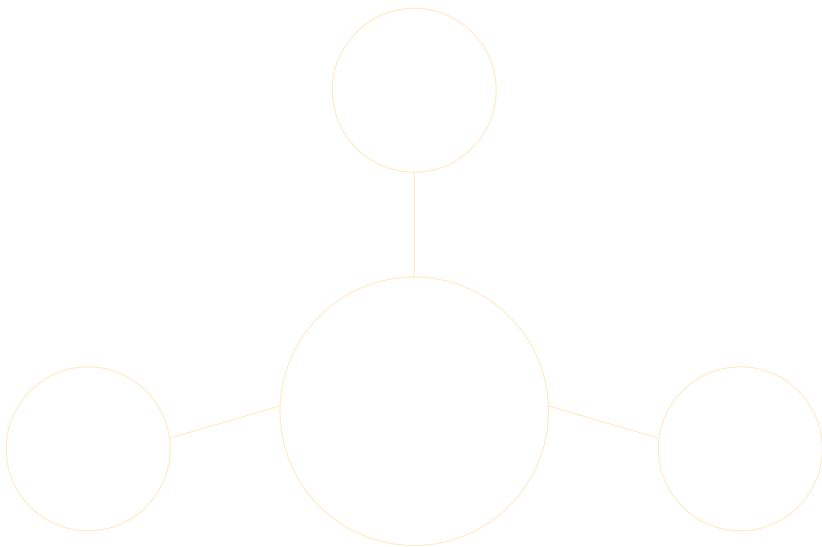


AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>1</b>	1	<p><b>Competency</b></p> <p>Familiarity with physical and chemical properties of fuels aboard ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del></p>
		<p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme</li> </ul>
		<p><b>Criteria for evaluating</b></p> <p>Effective use is made of information resources for identification of properties and characteristics of fuels and their impact on safety, environmental protection and vessel operation.</p>
<b>1.1</b>	1.1 [Also LNG C 2.1]	<b>Basic</b> <b>Advanced</b> knowledge and understanding of simple chemistry and physics and the relevant definitions related to safe bunkering and use of fuels used on board ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del> , including:
1.1.1	1.1.1 [Also LNG C 2.1.1]	.1 the chemical structure of different fuels used on board ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del>
1.1.2	1.1.2 [LNG C 2.1.2]	.2 the properties and characteristics of fuels used on board ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del> , including:
1.1.2.1	1.1.2.1	.2.1 simple physical laws
1.1.2.2	1.1.2.2	.2.2 states of matter <b>including phases</b>
1.1.2.3	1.1.2.3	2.3 liquid and vapour densities
1.1.2.4	New [LNG C AT 2.2.6]	x refrigeration of gases
1.1.2.5	1.1.2.4	2.4 boil-off and weathering of <b>low temperature</b> <del>or cryogenic</del> fuels
1.1.2.6	New [LNG C 2.2.4]	x diffusion and mixing of gases

AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
1.1.2.7	1.1.2.5	.2.5 compression and expansion of gases
1.1.2.8	1.1.2.6	.2.6 critical pressure and temperature of gases
1.1.2.9	1.1.2.7	.2.7 flashpoint, upper and lower flammable limits, auto-ignition temperature
1.1.2.10	New [LNG C 2.1.2.9]	compatibility, reactivity, and positive segregation of gases
1.1.2.11	1.1.2.8	.2.8 saturated vapour pressure/ reference temperature
1.1.2.12	1.1.2.10	.2.10 hydrate formation (TBD if this is credible)
1.1.2.13	1.1.2.11	.2.11 combustion properties: heating values
1.1.2.14	1.1.2.13	.2.13 pollutant characteristics of ammonia fuels addressed by the IGF Code
1.1.4	1.1.4	.4 the nature and properties of solutions
1.1.5	1.1.5	5 thermodynamic units
1.1.6	1.1.6	.6 basic thermodynamic laws and diagrams
1.1.7	1.1.7	.7 properties of materials
1.1.8	1.1.8	.8 effect of low temperature, including ductile or brittle fracture, for liquid low temperature or cryogenic fuels
<b>1.2</b>	1.2 [Also LNG C 2.2]	<b>Understanding the information contained in a Safety Data Sheet (SDS) about ammonia fuels addressed by the IGF Code</b>



AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>2</b>	2	<p><b>Competency</b></p> <p>Operate controls of fuel related to propulsion plant and engineering systems and services and safety devices on ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del></p> <p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme</li> </ul> <p><b>Criteria for evaluating</b></p> <p>Plant, auxiliary machinery and equipment is operated in accordance with technical specifications and within safe operating limits at all times.</p>
<b>2.1</b>	2.1	<b>Operating principles of marine power plants</b>
<b>2.2</b>	2.2	<b>Ships' auxiliary machinery</b>
<b>2.3</b>	2.3	<b>Knowledge of marine engineering terms</b>



AT  
Project  
number

Based on  
STCW IGF # or  
tanker cargo

**Knowledge, understanding and proficiency**

Based on IGF or tanker cargo (oil, chemical, LNG)> also new items

**3**

**Competency**

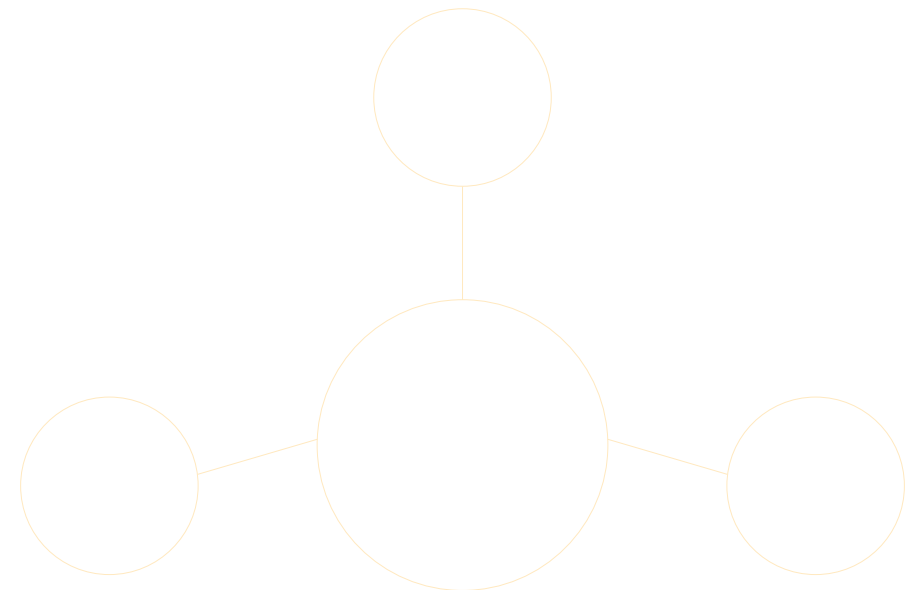
Ability to safely perform and monitor all operations related to the ammonia fuels used on board ships subject to the IGF Code

AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
	<p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme</li> </ul>	<p><b>Criteria for evaluating</b></p> <p>Communications are clear and understood.</p> <p>Successful fuel handling related to ship operations are carried out in a safe manner, taking into account ship designs, systems and equipment.</p> <p>Pumping operations are carried out in accordance with accepted principles and procedures and are relevant to fuels.</p> <p>Operations are planned, risk is managed and carried out in accordance with accepted principles and procedures to ensure safety of operations and to avoid releases of fuels to the environment.</p> <p><del>Cargo operations are carried out in a safe manner, taking into account oil-tanker designs, systems and equipment</del> <b>see handling &amp; pumping above</b></p> <p>Potential non-compliance with (fuel) cargo-operation-related procedures is promptly identified and rectified</p> <p>Proper loading, stowage and unloading of cargoes (fuels) ensures that stability and stress conditions remain within safe limits at all times.</p> <p>Actions taken and procedures followed are correctly applied and the appropriate shipboard cargo-(fuel) related equipment is properly used.</p> <p>Calibration and use of monitoring and gas-detection equipment comply with operational practices and procedures – Occupational Health?</p> <p>Procedures for monitoring and safety systems ensure that all alarms are detected promptly and acted upon in accordance with established emergency procedures.</p> <p>Personnel are allocated duties and informed of procedures and standards of work to be followed, in a manner appropriate to the individuals concerned and in accordance with safe operational practices.</p>
<b>3.1</b>	3.1	Design and characteristics of ships <del>subject to the IGF Code</del> <b>using ammonia as fuel</b>
<b>3.2</b>	3.2	Knowledge of ship design, systems, and equipment found on ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del> , including:

AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
3.2.1	3.2.1	.1 fuel systems for different propulsion engines including dual fuel engines
3.2.2	3.2.2	.2 general arrangement and construction
3.2.3	3.2.3	.3 fuel storage systems on board ships using ammonia as fuel subject to the IGF Code, including materials of construction and insulation
3.2.4	3.2.4	.4 fuel-handling equipment and instrumentations on board ships:
3.2.4.1	3.2.4.1	.4.1 fuel pumps and pumping arrangements
3.2.4.2	3.2.4.2 [LNG C 1.1.4.2] [Also tankers]	.4.2 fuel pipelines and valves
3.2.4.3	3.2.4.3	.4.3 expansion devices
3.2.4.4	3.2.4.4	.4.4 flame screens and arrestors
3.2.4.5	3.2.4.5	.4.5 temperature and pressure monitoring, control and alarm systems including for tanks
3.2.4.6	3.2.4.6	.4.6 fuel tank level-gauging systems
3.2.5	3.2.5	.5 low temperature or cryogenic fuel tanks temperature and pressure maintenance system
3.2.6	3.2.6 [Red text came from LNG C or discussion]	.6 fuel system atmosphere control systems (inert gas, dry air), including for storage, generation and distribution systems
3.2.7	New	x fuel residue drain system
3.2.8	New	x lubricants for engines, compressors, or other equipment
3.2.9	3.2.7	.7 toxic and flammable gas-detecting systems
3.2.10	New	x flame detecting systems
3.2.11	New [LNG C 1.1.10]	x. vapour / boil off management and control systems including liquefaction and reliquefaction

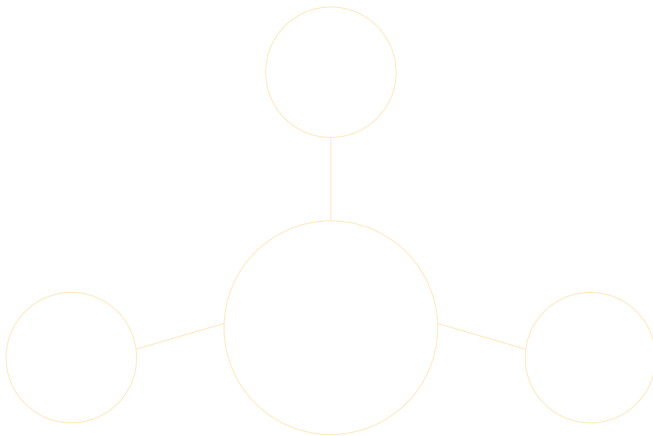
AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
3.2.12	3.2.8	.8 fuel Emergency Shut Down system (ESD)
<b>3.3</b>	3.3	<b>Knowledge of fuel system theory and characteristics, including types of fuel system pumps and their safe operation on board ships <del>subject to the IGF Code</del> using ammonia as fuel</b>
3.3.1	3.3.1	.1 low pressure pumps
3.3.2	3.3.2	.2 high pressure pumps
3.3.3	New	x compressors
3.3.4	3.3.3	.3 vaporizers
3.3.5	3.3.4	.4 heaters
3.3.6	New	x. heat exchangers
3.3.7	New	x filters
3.3.8	New	x ventilation system related to spaces where fuel vapours could be present
3.3.9	New	x venting and vapour / boil off gas management systems
3.3.10	New	x after treatment systems for the ammonia fuel
3.3.11	New [LNG C]	x ballast system, trim and stability operations including damage stability
<b>3.4</b>	3.4	<b>Knowledge of safe procedures and checklists for taking fuel tanks in and out of service, including:</b>
3.4.1	New[similar to LNG C]	x visual checks of tank external / ancillary equipment and components
3.4.2	3.4.1	.1 inerting
3.4.3	New [LNG C]	x gas-up / freeing
3.4.4	3.4.2	.2 warming up / cooling down
3.4.5	New [LCO2]	x tank preparation (conditioning / drying)

AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
3.4.6	3.4.3	.3 initial loading
3.4.7	3.4.4	.4 <b>temperature and</b> pressure control
3.4.8	3.4.5	.5 heating of fuel
3.4.9	New [LCO2]	<b>x vapour management</b>
3.4.10	3.4.6	.6 <b>tank emptying / stripping</b> systems



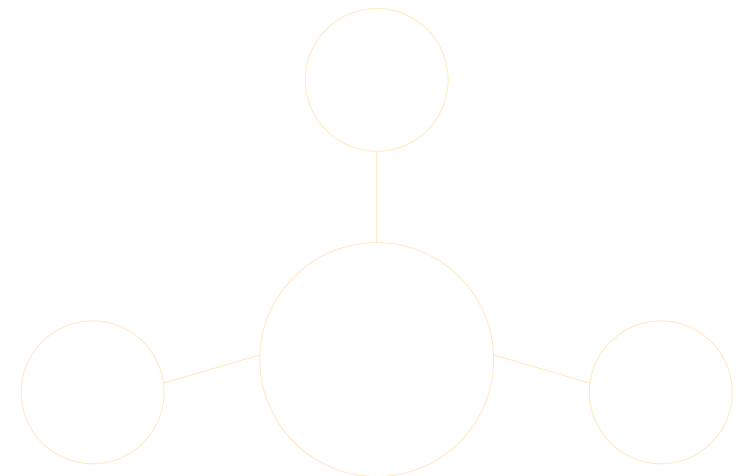
AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>4</b>	4	<p><b>Competency</b></p> <p>Plan and monitor safe bunkering, stowage and securing of the <b>ammonia</b> fuel on board ships <del>subject to the IGF Code</del></p> <p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>4 approved training programme</li> </ul> <p><b>Criteria for evaluating</b></p> <p>Fuel quality and quantity is determined taking into account the current conditions and necessary corrective safe measures are taken.</p> <p>Procedures for monitoring safety systems to ensure that all alarms are detected promptly and acted upon in accordance with established procedures.</p> <p>Operations are planned and carried out in accordance with fuel transfer manuals and procedures to ensure safety of operations and avoid spill damages, <b>releases / leaks</b> and pollution of the environment.</p> <p>Personnel are allocated duties and informed of procedures and standards of work to be followed, in a manner appropriate to the individuals concerned and in accordance with safe working procedures.</p>
<b>4.1</b>	4.1	General knowledge of ships <del>subject to the IGF Code</del> <b>using ammonia as fuel</b>
<b>4.2</b>	4.2	Ability to use all data available on board related to bunkering, storage and securing of <b>ammonia</b> fuels <del>addressed by the IGF Code</del>
<b>4.3</b>	4.3	Ability to establish clear and concise communications and between the ship and the terminal, truck, or the bunker- supply ship.
<b>4.4</b>	4.4	Knowledge of safety and emergency procedures for operation of machinery, fuel- and control systems for ships <del>subject to the IGF Code</del> <b>using ammonia as fuel.</b>
<b>4.5</b>	4.5	Proficiency in the operation of bunkering systems on board ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del> including:
4.5.1	4.5.1	.1 bunkering procedures

AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
4.5.2	4.5.2	.2 emergency procedures
4.5.3	4.5.3	.3 ship-shore/ship-ship interface
4.5.4	4.5.4	.4 prevention of rollover
<b>4.6</b>	4.6	<b>Proficiency to perform fuel-system measurements and calculations, including:</b>
4.6.1	4.6.1	.1 maximum fill quantity
4.6.2	4.6.2	.2 On Board Quantity (OBQ)
4.6.3	4.6.3	.3 Minimum Remain On Board (ROB)
4.6.4	4.6.4	.4 fuel consumption calculations
<b>4.7</b>	4.7	Ability to ensure the safe management of bunkering and other IGF Code fuel related operations concurrent with other onboard operations, both in port and at sea.

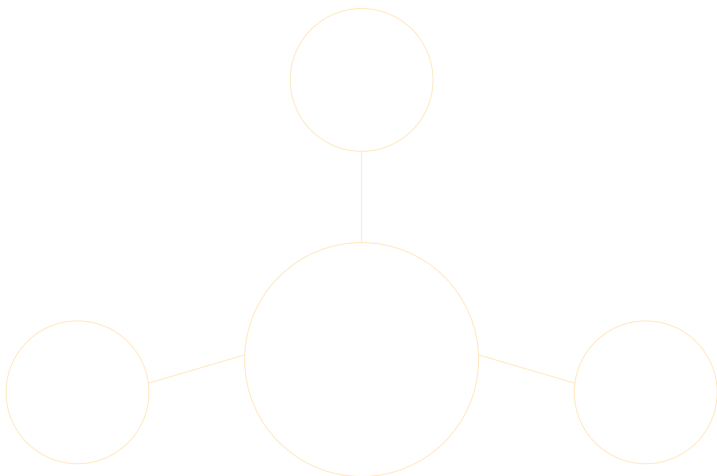




AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>5</b>	5	<p><b>Competency</b></p> <p>Take precautions to prevent pollution of the environment from the release of ammonia fuels from ships <b>subject to the IGF Code (see LNG C 6)</b></p> <p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme</li> </ul> <p><b>Criteria for evaluating</b></p> <p>Procedures designed to safeguard the environment are observed at all times.</p> <p><b>Oil Tankers Table A-V/1-1-2 /6.0 – Operations are conducted in accordance with accepted principles and procedures to prevent pollution.</b></p>
<b>5.1</b>	5.1	<b>Knowledge of the effects of pollution on humans and environment</b>
<b>5.2</b>	New [LNG C 6]	<b>Understanding of procedures to prevent pollution of the environment.</b>
<b>5.3</b>	5.2	<b>Knowledge of measures to be taken in the event of spillage/leakage/ venting</b>



AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>6</b>	6	<p><b>Competency</b></p> <p>Monitor and control compliance with legislative requirements (LNG C 7)</p> <p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme</li> </ul> <p>Note: LNG- C codes leaves out the word “examination” and starts with “Assessment of evidence”.</p> <p><b>Criteria for evaluating</b></p> <p>Operations are planned and performed with approved procedures and legislative requirements.</p>
<b>6.1</b>	6.1 [LNG C 7.1]	Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL), as amended and other relevant IMO instruments, industry guidelines and port regulations as commonly applied
<b>6.2</b>	6.2 (LNG C 7.2)	Proficiency in the use of the applicable regulatory codes-and related documents as appropriate to vessel



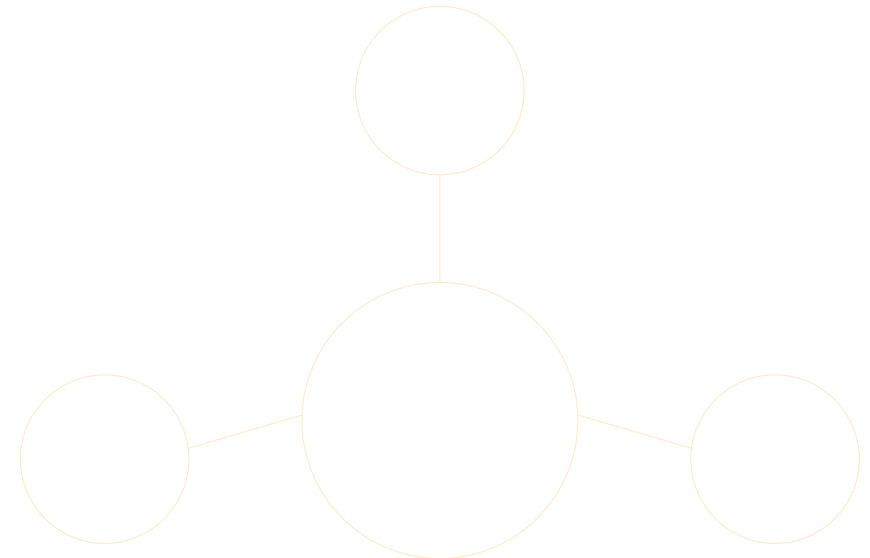
AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>7</b>	7	<p><b>Competency</b></p> <p>Take precautions prevent to hazards</p> <p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme</li> </ul> <p><b>Criteria for evaluating</b></p> <p>Relevant hazards to the ship and to personnel associated with operations on board ships using ammonia as fuel subject to the IGF Codes are correctly identified and proper control measures are taken.</p> <p>Use of flammable and toxic gas-detection devices are in accordance with manuals and good practice.</p>
<b>7.1</b>	7.1 [LNG C 3.1]	<b>Knowledge and understanding of the hazards and control measures associated with fuel system operations on board ships using ammonia as fuel subject to the IGF Code, including:</b>
7.1.1	7.1.1 [LNG C 3.1.1]	.1 flammability
7.1.2	7.1.2 [LNG C 3.1.2]	.2 explosion (BLEVE) and implosion
7.1.3	7.1.3 [LNG C 3.1.3]	3 toxicity
7.1.4	7.1.4 [LNG C 3.1.4]	.4 reactivity
7.1.5	7.1.5 [LNG C 3.1.5]	.5 corrosivity
7.1.6	7.1.6 [LNG C 3.1.6]	.6 health hazards
7.1.7	7.1.7 [LNG C 3.1.7]	.7 inert gas composition

AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
7.1.8	7.1.8 [LNG C 3.1.8]	.8 electrostatic hazards including static electricity / energy accumulator and generator
7.1.9	New [From LCO <sub>2</sub> ]	x phase change hazards
7.1.10	New [2.1.9 BT]	x vapour leaks and clouds
7.1.11	7.1.9	.9 pressurised gases
7.1.12	7.1.10	.10 low temperature
7.1.13	New [From LCO <sub>2</sub> ]	x material incompatibilities including fittings
7.1.14	New [From LCO <sub>2</sub> ]	x quality and quantity differences including impurity impact and effects
<b>7.2</b>	7.2 [LNG C 3.2]	Proficiency to calibrate and use monitoring and fuel / gas detection systems, instruments and equipment on board ships using ammonia as fuel <del>subject to the IGF Code</del>
<b>7.3</b>	7.3 [LNG C 3.3]	Knowledge and understanding of dangers of non-compliance with relevant rules/regulations
<b>7.4</b>	7.4	Knowledge and understanding of risk assessment method analyses on board ships <del>subject to the IGF Code</del> using ammonia as fuel
<b>7.5</b>	7.5	Ability to elaborate and develop risk analyses related to risks on board ships subject to the IGF Code <del>the use of ammonia as fuel</del>
<b>7.6</b>	7.6	Ability to elaborate and develop safety plans and safety instructions for ships subject to the use of ammonia as fuel <del>IGF Code</del>
<b>7.7</b>	7.7	Knowledge of hot and cold work, enclosed spaces and tank entry including permitting procedures
<b>7.8</b>	New	Understanding of how to establish and monitor hazards, safety, security and marine zones / areas and any other monitored locations

AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
<b>8</b>	8	<p><b>Competency</b></p> <p>Apply occupational health and safety precautions and measures on board a ship <b>using ammonia as fuel subject to the IGF Code</b></p> <p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme</li> </ul> <p>Note: LNG- C codes leaves out the word “examination” and starts with “Assessment of evidence”.</p> <p><b>Criteria for evaluating</b></p> <p>Appropriate safety and protective equipment is correctly used.</p> <p>Procedures designed to safeguard personnel and the ship are observed at all times.</p> <p>Working practices are in accordance with legislative requirements, codes of practice, permits to work and environmental concerns.</p> <p>First aid dos and don'ts.</p> <p>Tanker code also has:</p> <ul style="list-style-type: none"> <li>Correct use of breathing apparatus.</li> <li>Procedures for entry into enclosed spaces are observed.</li> </ul>
<b>8.1</b>	8.1	<b>Proper use of safety equipment and protective devices, including:</b>
8.1.1	8.1.1	1 breathing apparatus, aids / devices and evacuating equipment
8.1.2	8.1.2	2 protective clothing and equipment <b>such as that rated for low temperature and personal gas detectors</b>
8.1.3	8.1.3	3 resuscitators
8.1.4	8.1.4	4 rescue and escape equipment <b>including for tanks / enclosed spaces</b>
8.1.5	New	<b>x understanding of use, location of mustering points / safe havens</b>
<b>8.2</b>	8.2 (LNG C 4.1)	<b>Knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety including:</b>

AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
8.2.1	8.2.1 (LNG C 4.1.2)	.1 precautions to be taken before, during and after repair and maintenance work on fuel systems <b>using ammonia as fuel addressed in the IGF Code including</b>
8.2.2	New (see LNG C 4.1.1 -similar)	x precautions to be taken when entering areas with potential high gas (or vapour) concentrations such as hazardous areas, spaces or zones including enclosed spaces
8.2.3	New [LNG C 4.1.3]	x precautions for hot and cold work
8.2.4	New [LNG C 4.1.6]	x precautions for cold burn and frostbite
8.2.5	New [LNG C 4.1.7]	x proper use of personal <del>toxicity</del> and gas monitoring equipment and portable gas meters
8.2.6	New [LNG C 4.1.5]	x use of appropriate Personal Protective Equipment (PPE)
8.2.7	8.2.2 [LNG C 4.1.4]	. 2 <b>precautions for electrical safety (reference to IEC 600079-17)</b>
8.2.8	8.2.3	.3 ship/shore safety checklist
8.2.9	New	x understanding of measures for decontaminating personal protective equipment, tools, or equipment after exposure to substances
<b>8.3</b>	8.3	<b>Basic knowledge of first aid with reference to a Safety Data Sheets (SDS) for ammonia fuels addressed by the IGF Code</b>

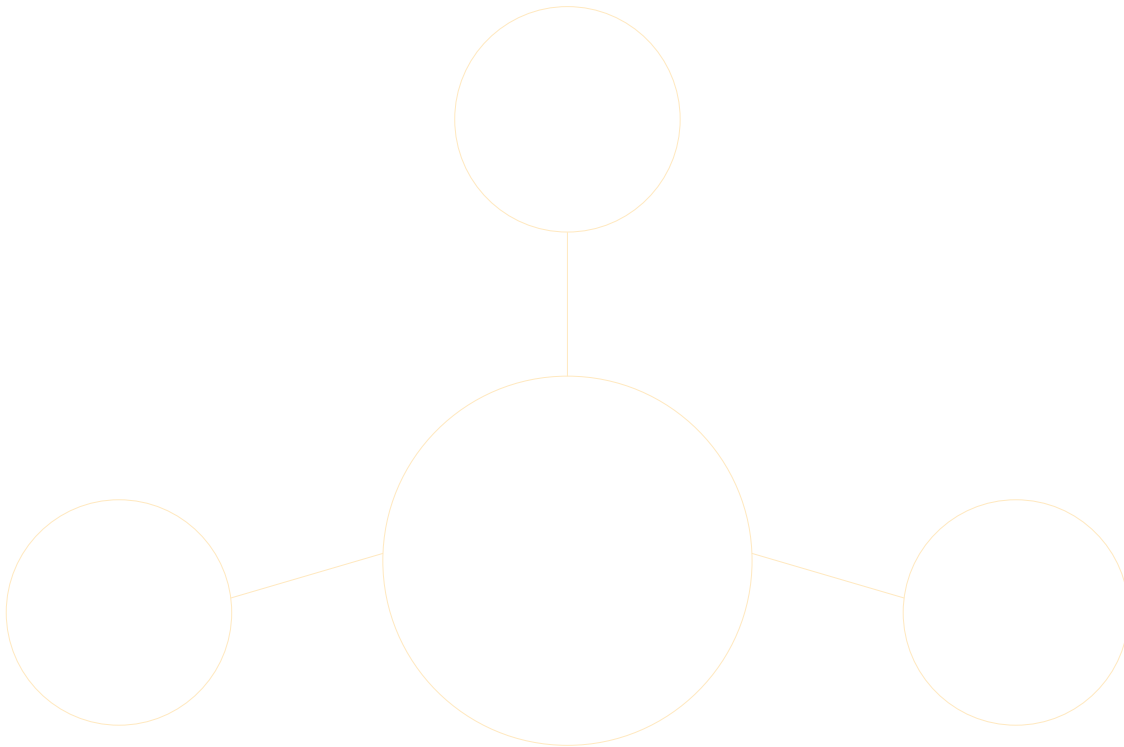
AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
9	9	<p><b>Competency</b></p> <p>Knowledge of the prevention, control and firefighting and extinguishing systems on board ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del></p> <p><b>Methods for demonstrating competence</b></p> <p>Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li>.1 approved in-service experience</li> <li>.2 approved training ship experience</li> <li>.3 approved simulator training</li> <li>.4 approved training programme</li> </ul> <p>Note: LNG- C code leaves out the word “examination” and starts with “Assessment of evidence”.</p> <p><b>Criteria for evaluating</b></p> <p>The type and scale of the problem is promptly identified, and initial actions conform with the emergency procedures for <b>ships using ammonia as fuel</b> <del>addressed by the IGF Code</del>.</p> <p>Evacuation, emergency shutdown and isolation procedures are appropriate <del>to</del> <b>for ships using ammonia</b> <del>the fuels</del>.</p>
9.1	9.1	<p><b>Knowledge of the methods and firefighting appliances to detect, control and extinguish fires of <del>related to ammonia as fuels</del> and their potential interaction with other substances</b> <del>addressed by the IGF Code</del></p>



AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items		
<b>10 New/ Proposed</b>	New	<p data-bbox="667 379 842 400"><b>Competency</b></p> <p data-bbox="667 421 1480 442"><b>Response to emergencies</b> – From LNG Table A-V/1-2-2 (section 5)</p> <p data-bbox="667 472 1962 493">**NOTE: Black text below is the text in LNG C – Red is potential amendments to accommodate ammonia</p> <table border="0" data-bbox="667 523 1962 986"> <tr> <td data-bbox="667 523 1256 783"> <p data-bbox="667 523 1211 544"><b>Methods for demonstrating competence</b></p> <p data-bbox="667 564 1256 617">Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li data-bbox="667 638 1055 659">.1 approved in-service experience</li> <li data-bbox="667 679 1084 700">.2 approved training ship experience</li> <li data-bbox="667 721 1010 742">.3 approved simulator training</li> <li data-bbox="667 762 1039 783">.4 approved training programme</li> </ul> </td> <td data-bbox="1335 523 1962 986"> <p data-bbox="1335 523 1626 544"><b>Criteria for evaluating</b></p> <p data-bbox="1335 564 1962 681">The type and impact of emergency is promptly identified and the response action conform with established emergency procedures and contingency plans.</p> <p data-bbox="1335 702 1962 809">The order of priority and the levels of timescales of making reports and informing personnel on board are relevant to the nature of the emergency and reflect the urgency of the problem.</p> <p data-bbox="1335 829 1962 909">Evacuation, emergency shutdown and isolation are appropriate to the nature of the emergency and implemented properly.</p> <p data-bbox="1335 930 1962 983">The identification of and actions taken in a medical emergency</p> </td> </tr> </table>	<p data-bbox="667 523 1211 544"><b>Methods for demonstrating competence</b></p> <p data-bbox="667 564 1256 617">Examination and assessment of evidence obtained from one or more of the following:</p> <ul style="list-style-type: none"> <li data-bbox="667 638 1055 659">.1 approved in-service experience</li> <li data-bbox="667 679 1084 700">.2 approved training ship experience</li> <li data-bbox="667 721 1010 742">.3 approved simulator training</li> <li data-bbox="667 762 1039 783">.4 approved training programme</li> </ul>	<p data-bbox="1335 523 1626 544"><b>Criteria for evaluating</b></p> <p data-bbox="1335 564 1962 681">The type and impact of emergency is promptly identified and the response action conform with established emergency procedures and contingency plans.</p> <p data-bbox="1335 702 1962 809">The order of priority and the levels of timescales of making reports and informing personnel on board are relevant to the nature of the emergency and reflect the urgency of the problem.</p> <p data-bbox="1335 829 1962 909">Evacuation, emergency shutdown and isolation are appropriate to the nature of the emergency and implemented properly.</p> <p data-bbox="1335 930 1962 983">The identification of and actions taken in a medical emergency</p>
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<b>10.1</b>	New (LNG C 5.1)	<b>Knowledge and understanding of liquefied gas tanker ammonia fuel emergency procedures, including:</b>		
10.1.1	New (LNG C 5.1.1)	.1 ship emergency response plans including emergency shutdown		
10.1.2	New (LCO2)	x bunkering operations emergency / safety devices such as Emergency Release System (ERS), Quick Release Connections (QC DC), Ship-to-Shore Links (SSLs), Bunkering Safety Link (BSLs).		
10.1.3	New (LCO2)	4. automatic, remote, and manual shutdown capabilities for ammonia fuel.		
10.1.4	New (LNG C 5.1.4)	5.actions to be taken in the event of failure of systems or services essential to cargo ammonia fuel operations		



AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items
10.1.5	New (LCO2)	x marine emergency situations related to such aspects as mooring, bunkering, stability, or security
<b>10.2</b>	New [LNG C 5.2]	x actions to be taken following <b>allision</b> , collision, grounding or spillage and envelopment of the ship in toxic or flammable vapour
<b>10.3</b>	New (Discussions)	x actions to be taken, including emergency response, related to port operations including SIMOPS
<b>10.4</b>	New (LCO2)	x actions to be taken during adverse local weather or metocean conditions
<b>10.5</b>	New (LNG C 5.3)	Knowledge of medical first-aid procedures and antidotes on board <del>ships using ammonia as fuel liquefied gas tankers, with reference to the Medical First Aid Guide for Use in Accidents involving Dangerous Goods (MFAG)</del>



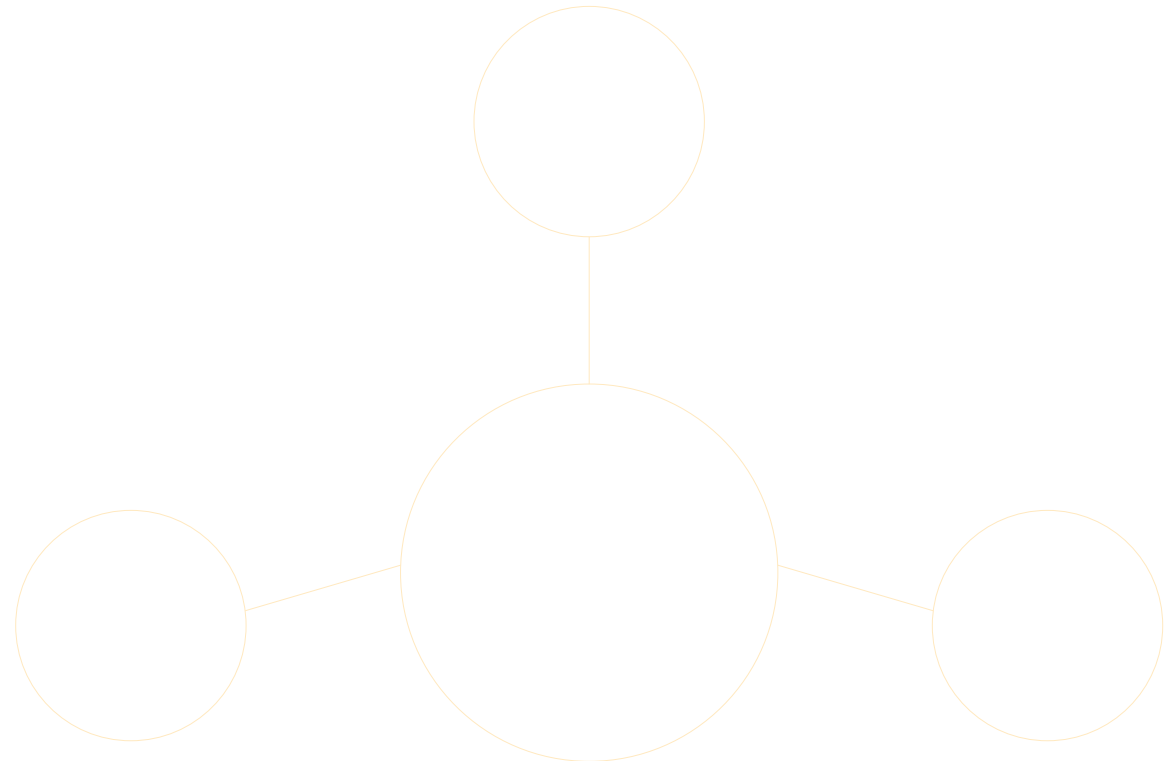
# 8. Proposed Framework: Basic Training Table with Explanatory Notes

BT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>1</b>	1	<b>Contribute to the safe operation of a ship (<del>subject to IGF Code</del>) using ammonia as fuel</b>	
<b>1.1</b>	1.1	Design and operational characteristics of ships <del>subject to the IGF Code</del> using ammonia as fuel	
<b>1.2</b>	1.2	Basic knowledge of ships ( <del>subject to the IGF Code</del> ) using ammonia as fuel, their fuels systems and fuel storage systems:	<p>Assumption: Basic knowledge of ship types using ammonia fuel including general arrangement and construction and that personnel meet STCW requirements for ship type. This would include knowledge of conventional fuel systems.</p> <p>New knowledge would include tank temperature / pressure management and BOG management. For maintenance, tanks must be gas free for various tasks. Tank must be cooled down in preparation for filling / fuelling.</p>
1.2.1	1.2.1	1 fuels ( <del>addressed by the IGF Code</del> ) for ships using ammonia as fuel	Anhydrous ammonia fuel in various forms: refrigerated, semi-refrigerated, pressurised.
1.2.2	1.2.2	.2 types of fuel systems <del>subject to the IGF Code</del> on ships using ammonia as fuel	Systems related to refrigerated, semi-refrigerated or pressurised fuel as appropriate to vessel type.

BT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
1.2.3	1.2.3	.3 atmospheric, <b>low temperature, pressurised, cryogenic or compressed</b> storage of fuels on board ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del>	Ammonia is low temperature (- 33 degrees C). Pressurised also applies.
1.2.4	1.2.4	4 general arrangement of fuel storage, <b>handling and transfer</b> systems on board ships <del>subject to the IGF Code</del> <b>using ammonia as fuel</b>	
1.2.5	1.2.5	.5 hazard, <b>safety, security and marine</b> zones and areas	Zones as defined in SIGTTO or SGMF documents.
1.2.6	1.2.6	.6 typical fire safety plan <b>for ships using ammonia as fuel</b>	
1.2.7	1.2.7	.7 monitoring, control and safety systems aboard ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del>	
<b>1.3</b>	1.3	<b>Basic knowledge of fuels and fuel storage systems' operations related to ammonia fuel type on board ships subject to the IGF Code:</b>	Fuel type for ammonia – refrigerated, semi-refrigerated, pressurised. Also tank structure, type, location. These can change based on ship type.
1.3.1	1.3.1	.1 piping systems and valves <b>particular to the fuel service</b>	Double walled piping. Valve internals may differ for NH <sub>3</sub> service.
1.3.2	New	x fuel and fuel residue <b>handling, transfer systems and related equipment</b>	This could include the fuel system and well as the systems for handling residues. The residues need to be stored and offloaded.
1.3.3	New	x <b>after treatment systems for ammonia fuel</b>	The after-treatment systems are required to treat the emissions with the intention of reducing pollution.
1.3.4	New	x <b>dual fuel engines operations</b>	
1.3.5	1.3.2	.2 atmospheric, <b>pressurised, compressed, low temperature</b> or <b>cryogenic</b> storage	Pressurised, low temperature storage (but not cryogenic).

BT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
1.3.6	New	x fuel tank / storage operations	This Includes emptying, inerting, drying purging, venting, and gas-freeing. Tank cleaning and inspection operations for dry dock including maintenance of submerged pumps. BOG operations for refrigerated NH <sub>3</sub> . There could be lifting ops for ISO tanks or bunkering hoses.
1.3.7	1.3.3	.3 relief systems and protection screens	Relief systems (closed?) A potential for screens on vent masts.
1.3.8	New	x pumps and pumping arrangements	High/ low pressure.
1.3.9	New	x ventilation systems related to spaces where fuel vapours could be present	This would apply to zones, spaces, machinery spaces. It includes piping systems.
1.3.10	New	x venting and vapour / boil off gas management systems	Ammonia Release Mitigation Systems Includes catch systems and knock out drums – similar to LNG Gas combustion unit – Learning about the system should include understanding of what occurs with the residuals and contaminated waste.
1.3.11	1.3.4	.4 basic bunkering operations and bunkering systems including hose / vapour line management	This could include familiarization with lifting operation / system for hose and lines.
1.3.12	1.3.5	.5 protection against low temperature, cryogenic or temperature / pressure accidents	Noting NH <sub>3</sub> is low temperature only.
1.3.13	1.3.6	.6 fuel leak monitoring and detection	Knowledge of vapour dispersion and potential for vapour clouds.
<b>1.4</b>	1.4	<b>Basic knowledge of the physical properties of fuels on board ships using ammonia as fuel subject to the IGF Code, including:</b>	
1.4.1	1.4.1	.1 properties and characteristics	

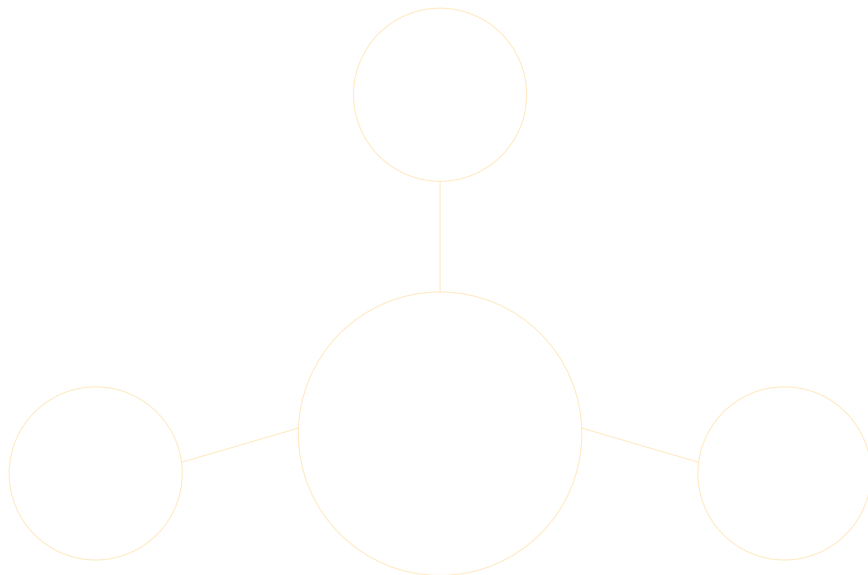
BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
1.4.2	1.4.2	.2 pressure and temperature, including vapour pressure/ temperature relationship	
1.4.3	New [LNG C BT 1.2.4]	x chemical symbols and markings	This may apply to support chemicals like caustic, methanol, glycol as well as ammonia.
<b>1.5</b>	1.5	<b>Knowledge and understanding of safety culture requirements and safety management on board ships subject to the IGF Code using ammonia as fuel.</b>	



BT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>2</b>	2	<b>Take precautions to prevent hazards on a ship <del>subject to the IGF Code</del> using ammonia as fuel</b>	
<b>2.1</b>	2.1	Basic knowledge of the hazards associated with operations on ships <del>subject to the IGF Code</del> using ammonia as fuel, including	
2.1.1	2.1.1	.1 health hazards	This includes new concept of exposure measurement and concentration measures / AEGL.
2.1.2	2.1.2	.2 environmental hazards	This would include the potential for forming nitrous oxide. Impact of ammonia slip. Slips overboard.
2.1.3	2.1.3	.3 reactivity hazards	When water / moisture is present (corrosion) or when water is added to a pool of ammonia – potential implosion or exothermic reaction. Formation of ammonium hydroxide which is corrosive.
2.1.4	2.1.4	.4 corrosion hazards	Moisture or water can create ammonium hydroxide.
2.1.5	2.1.5	.5 ignition, explosion (BLEVE), implosion and flammability hazards	See BT 2.2.6 Low probability events but unique to NH <sub>3</sub> -adding ammonia to water can lead to implosion if this occurs in an enclosed space.
2.1.6	2.1.6	.6 sources of ignition	Removal of these as general good operational practice but nothing unique for ammonia.
2.1.7	2.1.7	.7 electrostatic hazards including static electricity / energy accumulator and generator	Not applicable for ammonia itself but includes static electricity / energy accumulator and generator for other substances.
2.1.8	2.1.8	.8 toxicity hazards	This includes exposure measurement concept of concentration measures / AEGL.
2.1.9	New [LCO2]	x phase change hazards	In particular, the changes from liquid to gas and the circumstances allowing this.

BT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
2.1.9	2.1.9	.9 vapour leaks and clouds	Seafarers to understand dispersion patterns, factors impacting these and needed response.
2.1.11	New [LCO2]	x inert gas hazards	The inert gas could be nitrogen (N <sub>2</sub> ) or dry air.
2.1.12	2.1.10	.10 extremely low temperatures	Low temperature concerns – not extreme.
2.1.13	2.1.11	.11 pressure hazards	
2.1.14	2.1.12	.12 fuel batch differences	This is less likely with ammonia (NH <sub>3</sub> )
2.1.15	New [LCO2]	x material incompatibilities including fittings	Avoidance of incompatible materials / metals such as copper, zinc, nickel and their alloys, and some plastics. For example, for seals, nitrile rubber is usually used instead of conventional rubber because it is decomposed by ammonia.
2.1.16	New [LCO2]	x quality / quantity differences including impurities impacts / effect	This is less likely with ammonia (NH <sub>3</sub> )
2.1.17	New	x weather or external environmental conditions including sea states	Weather will change cooldown rate ahead of bunkering for example. This item is to capture external factors that can affect ops – vapour generation from sloshing / ship motions. Also seafarers need an understanding of the potential impact of weather or atmospheric conditions on dispersion.
<b>2.2</b>	2.2	<b>Basic knowledge of hazard controls:</b>	
2.2.1	2.2.1	1 emptying, inerting, drying purging, venting and gas freeing monitoring techniques, as appropriate	Purging and venting particularly important.
2.2.2	2.2.2	.2 anti-static measures	While not specific to NH <sub>3</sub> would apply overall.
2.2.3	2.2.3	.3 ventilation	
2.2.4	2.2.4	.4 segregation	

BT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
2.2.5	2.2.6	.6 measures to prevent ignition, fire, explosion (BLEVE) and implosion.	Implosion unique to NH <sub>3</sub> – e.g., adding water to a pool. BLEVE could involve a deck / ISO tank.
2.2.6	2.2.7	.7 atmospheric control	For external atmosphere, operations will change – cooldown ahead of bunkering for example
2.2.7	2.2.8	.8 gas testing, detecting and sampling	For atmospheric testing – not fuel
2.2.8	2.2.9	9 protection against low temperature cryogenic damages	Low but not cryogenic – this protection would apply to equipment, materials as well as people.
2.2.9	New [LNG C BT 6.3.3]	x prevent ductile or brittle fracture and hazards associated with cold low temperature liquids	Text is based on LNG C with amendments for ammonia.
<b>2.3</b>	2.3	<b>Understanding of fuel characteristics on ships using ammonia as fuel and related substances subject to the IGF Code as found on a Safety Data Sheet (SDS).</b>	This includes chemicals used to support ammonia operations.

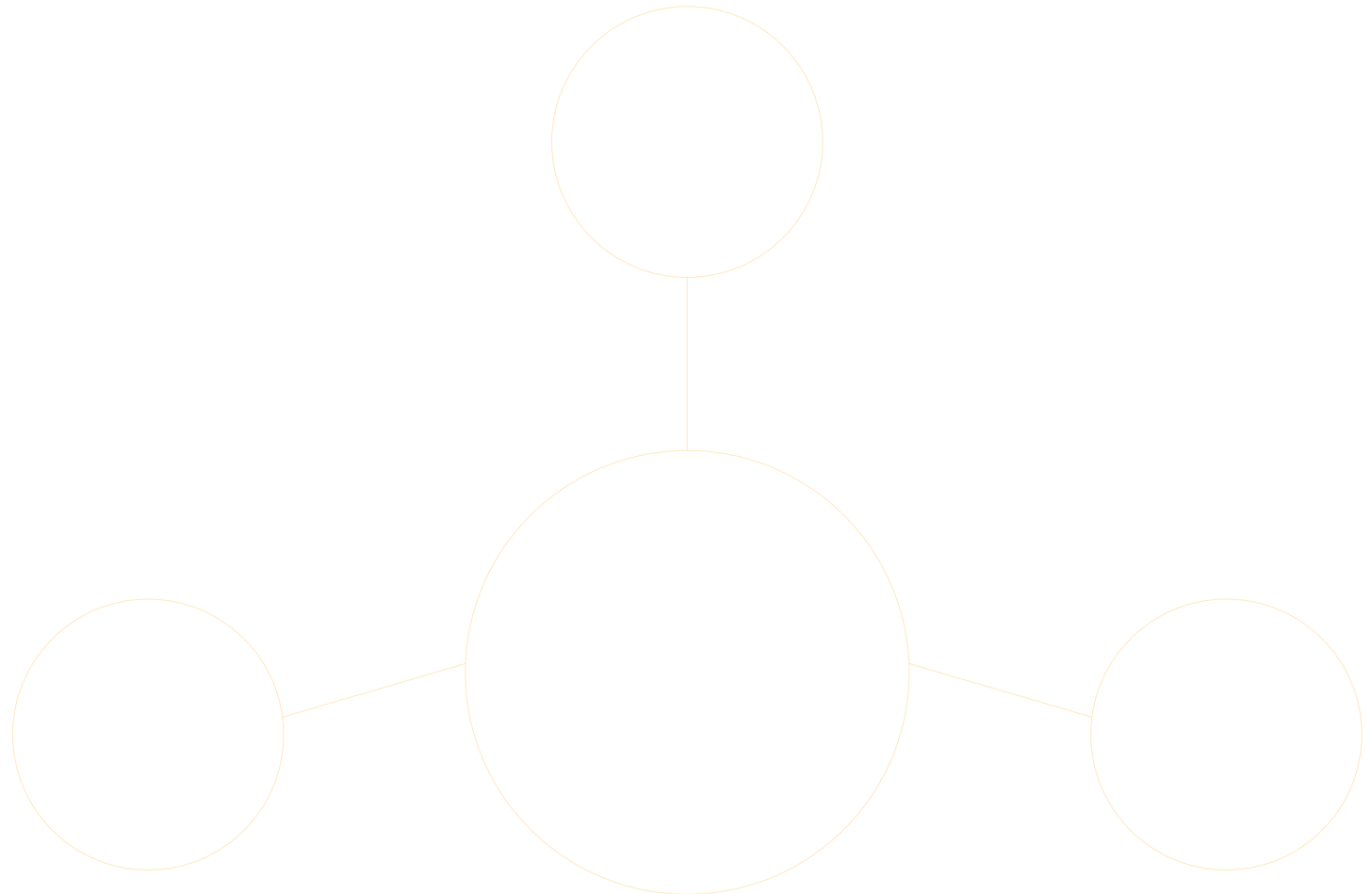




BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>3</b>	3	<b>Apply occupational health and safety precautions and measures</b>	
<b>3.1</b>	3.1	<b>Awareness of function and proper use of gas-measuring instruments and similar equipment:</b>	
3.1.1	3.1.1	.1 gas testing	
3.1.2	New	x gas sampling related to <del>fuels and</del> atmosphere	For atmospheric testing – not fuel – Fuel sampling is not expected to be needed.
3.1.3	New [LCO2]	x gas detection, personal and fixed gas detection, monitoring, and alarm systems	This includes exposure measurement concept of concentration measures / AEGL.
<b>3.2</b>	3.2	<b>Proper use of specialized safety equipment and protective devices, including:</b>	
3.2.1	3.2.1	.1 breathing apparatus and aids / devices	Based on conditions, concentrations, potential for exposure.
3.2.2	3.2.2	.2 protective clothing including PPE, clothing and equipment that is rated for potential low temperatures	Anti-static clothing is not needed for ammonia but could be important to other substances onboard.
3.2.3	3.2.3	.3 resuscitators	
3.2.4	3.2.4	.4 rescue and escape equipment including for tanks, enclosed and machinery spaces	Special equipment may also need to be used in various areas during fire response as well as during operations or maintenance.
3.2.5	New	.5 use and location of mustering points / safe havens	Ammonia industry calls these safe havens

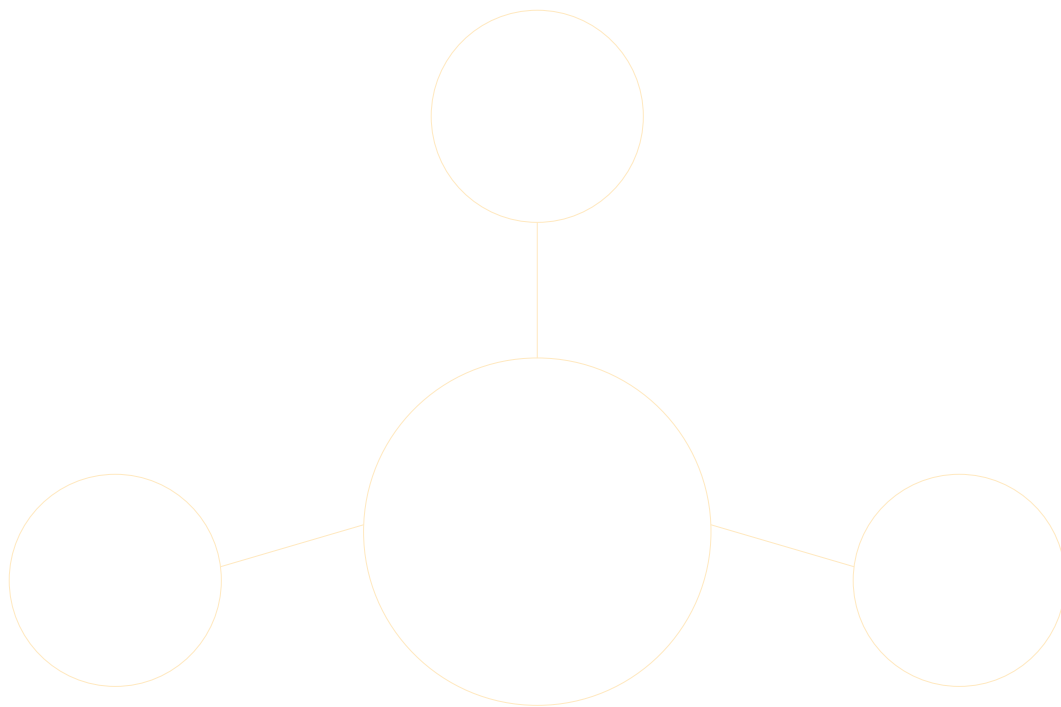
BT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>3.3</b>	3.3	Basic knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety relevant to ships <b>using ammonia as fuel subject to the IGF Code</b> , including:	
3.3.1	3.3.1 [New text- see LNG C 4.1.1 -similar]	.1 precautions to be taken before entering hazardous spaces and zones <b>including enclosed spaces. This would include checks for toxicity, asphyxiation, and flammability.</b>	Precautions for FPRs, TCS, For PCC, container etc , near tanks, compressors, engines rooms , crank case, scavenging manifold while using ammonia. Adequate ventilation requirements and monitoring especially for enclosed spaces.
3.3.2	3.3.2	.2 precautions to be taken before and during repair and maintenance work	Precautions such as special welding skills for ammonia compatible materials. Includes use of risk assessment, job safety analysis and permitting requirements.
3.3.3	3.3.3	.3 safety measures for hot and cold work	This includes use of risk assessment, job safety analysis and permitting.
3.3.4	New	<b>x precautions against dropped objects</b>	This includes lifting operations, crane ops which could result in mechanical damage, insulation damage. See also AT 8.2.3 – under Basic Training seafarers to have awareness of this hazard potential.
3.3.5	New	<b>x ship / shore safety checklists for port operations</b>	This could apply to bunkering, mooring, cargo operations with ammonia onboard.  Maintenance may change including hot work and any special welding requirements. Provisioning; taking on stores / water; or other port operations to be aware of ammonia.
<b>3.4</b>	New	<b>Basic knowledge of measures for decontaminating personal protective equipment, tools, or equipment after exposure to substances</b>	

BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>3.5</b>	3.4	<b>Basic knowledge of first aid related to gas or other low flashpoint fuels or related substances with reference to a Safety Data Sheet (SDS).</b>	Understanding of measure is under AT 8.2.2

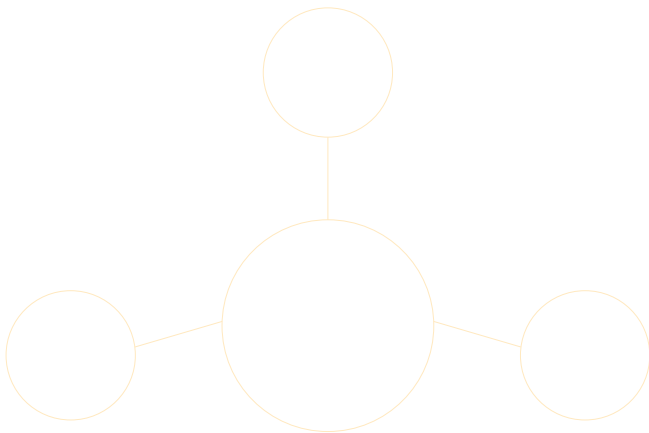


BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>4</b>	4	<b>Carry out firefighting operations on a ship using ammonia as fuel subject to the IGF Code</b>	
<b>4.1</b>	4.1	Fire organization and action to be taken on ships <b>using ammonia as fuel subject to the IGF Code</b>	
<b>4.2</b>	4.2	Special hazards associated with fuel systems, <b>storage</b> and fuel handling on ships <b>using ammonia as fuel subject to the IGF Code</b>	Hazards when adding water to a pool of ammonia. Seafarers should be aware of vapour dispersion characteristics.
<b>4.3</b>	4.3	Firefighting agents and methods used to control and extinguish fires in conjunction with the different fuels found on board ships <b>using ammonia as fuel subject to the IGF Code</b>	Same “methods” in tankerman and LNG -C. Firefighting approach is primarily use of ventilation systems and water. Seafarers will need an understanding of corrosivity and reactivity potential of mixing ammonia with water. (See section AT 10.3 below) There is a special ammonia concern about the hazard of adding water to ammonia and the reaction to pool fires (such as increased vaporization). If methanol is onboard, knowledge of methanol firefighting.
<b>4.4</b>	4.4	Firefighting system operations	Basic knowledge of ammonia flame characteristics. Also familiarity with equipment used and approach.
<b>4.5</b>	New [From LNG C]	<b>Basic knowledge of spill containment in relation to firefighting operations</b>	Understanding corrosivity, potential of mixing ammonia with water – also hazards of putting water onto an ammonia pool. Also applies to methanol if carried on board for treating hydrates.

BT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>5</b>	5	<b>Respond to emergencies</b>	
<b>5.1</b>	5.1	Basic knowledge of emergency procedures, including emergency shutdown	
<b>5.2</b>	New [LCO2]	Basic knowledge of bunkering operations emergency / safety devices such as Emergency Release Systems (ERS), Quick Release Connections (QC DC), Ship-to-Shore Links (SSLs) or Emergency Bunkering Links (EBLs)	NOTE: This applies to all alternative fuels but was missing in STCW previously.



BT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>6</b>	6	<b>Take precautions to prevent pollution of the environment from the release of the ammonia fuels found on ships subject to the IGF Code</b>	
<b>6.1</b>	New [LNG C 6.1]	Basic knowledge of the effects of pollution on human and marine life	See AT 1.2.2.13 below
<b>6.2</b>	New [LNG C 6.2]	Basic knowledge of shipboard procedures to prevent pollution	See AT 1.2.2.13 below.
<b>6.3</b>	6.1	Basic knowledge of measures to be taken in the event of leakage/spillage/ venting of fuels from ships using ammonia as fuel-subject to the IGF Code, including the need to:	For spills, note that adding water to ammonia increases hazard potential. Training to cover vapour dispersion patterns.
6.3.1	6.1.1	.1 report relevant information to the responsible persons	
6.3.2	6.1.2	.2 awareness of shipboard spill/leakage/ venting response procedures	Ensure training includes spill containment measures. This could include use of tarps or covers for vapours.
6.3.3	6.1.3	.3 awareness of appropriate personal protection when responding to a spill/ leakage of ammonia fuels addressed by the IGF Code	May require low temperature rated protective suits as well as other items for ammonia interaction.



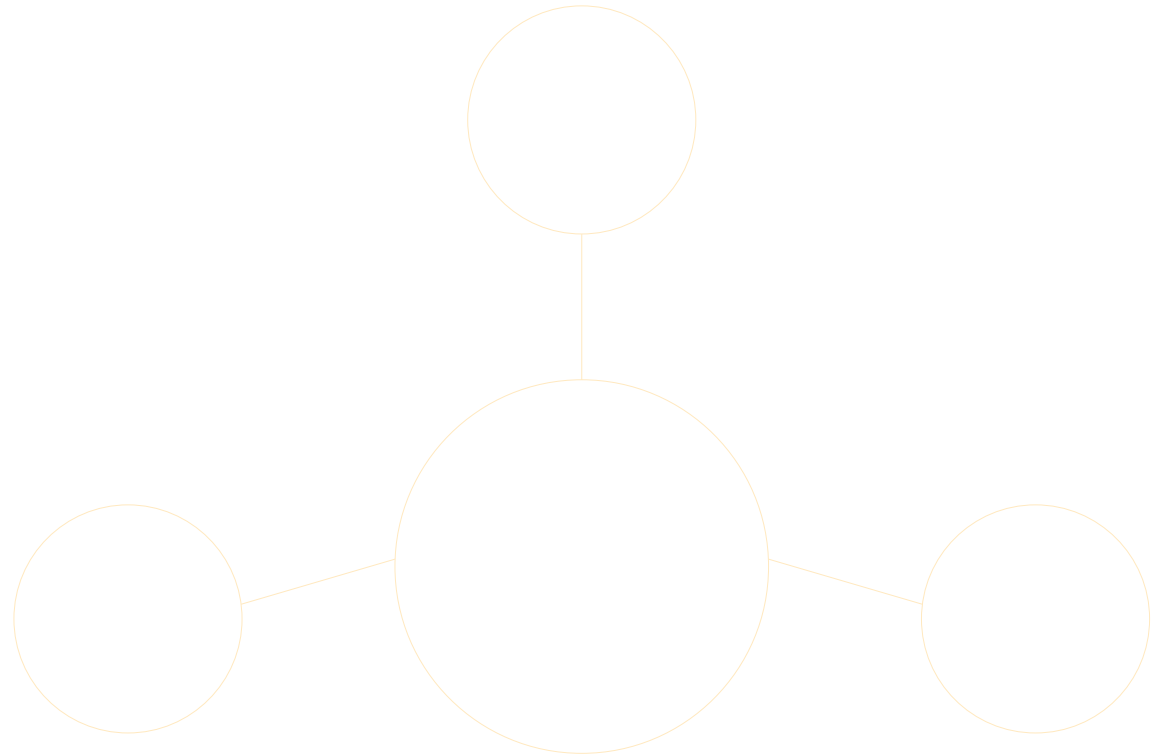
# 9. Proposed Framework: Advanced Training Table with Explanatory Notes

AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>1</b>	1	<b>Familiarity with physical and chemical properties of fuels aboard ships using ammonia as fuel subject to the IGF Code</b>	
<b>1.1</b>	1.1 [Also LNG C 2.1]	Basic <b>Advanced</b> knowledge and understanding of simple chemistry and physics and the relevant definitions related to safe bunkering and use of fuels used on board ships <b>using ammonia as fuel subject to the IGF Code</b> , including:	
1.1.1	1.1.1 [Also LNG C 2.1.1]	.1 the chemical structure of different fuels used on board ships <b>including ammonia fuel subject to the IGF Code</b>	
1.1.2	1.1.2 [LNG C 2.1.2]	.2 the properties and characteristics of fuels used on board ships <b>using ammonia as fuel subject to the IGF Code</b> , including:	
1.1.2.1	1.1.2.1	.2.1 simple physical laws	
1.1.2.2	1.1.2.2	.2.2 states of matter <b>including phases</b>	
1.1.2.3	1.1.2.3	2.3 liquid and vapour densities	

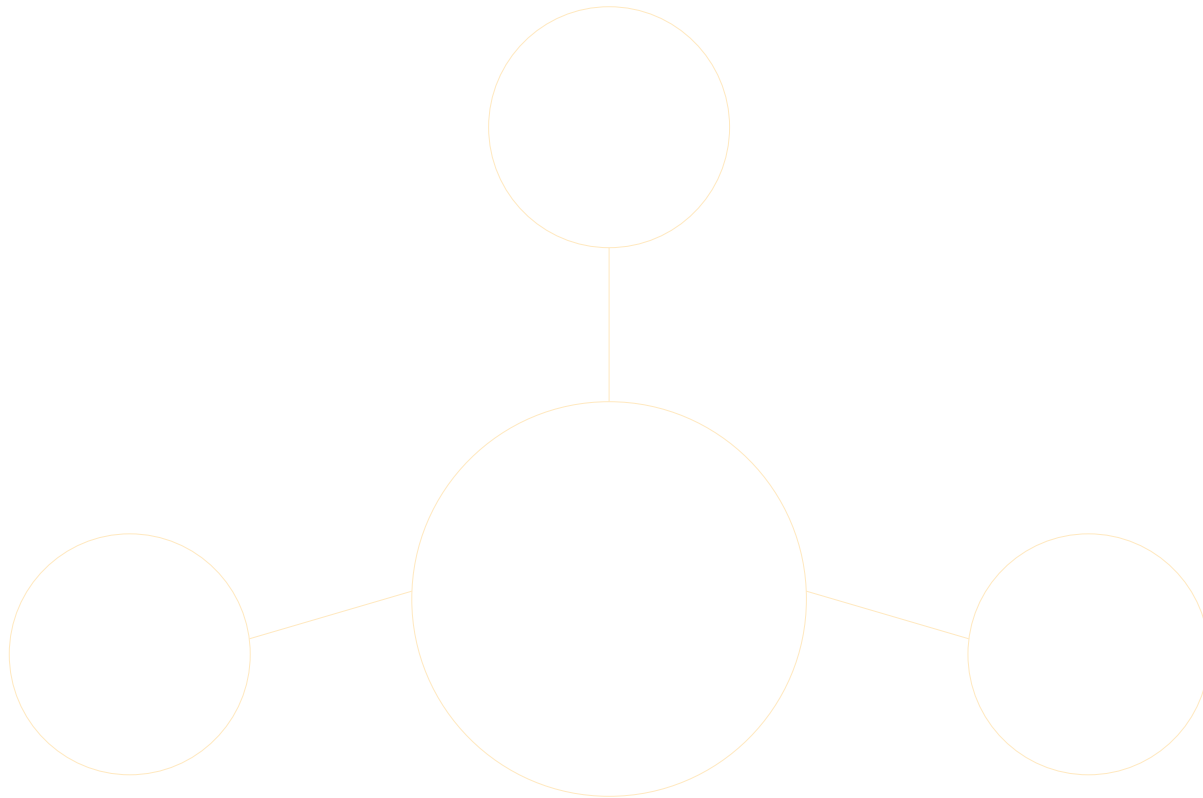
AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
1.1.2.4	New [LNG C AT 2.2.6]	x refrigeration of gases	Text from LNG C 2.2.6 said “reliquefaction and refrigeration of gases”. New text reflects storage type such as refrigerated gas (fully, semi) – liquefaction / reliquefaction.
1.1.2.5	1.1.2.4	2.4 boil-off and weathering of low temperature or cryogenic fuels	Low temperature added for NH <sub>3</sub> . Weathering is not applicable to NH <sub>3</sub> .
1.1.2.6	New [LNG C 2.2.4]	x diffusion and mixing of gases	
1.1.2.7	1.1.2.5	.2.5 compression and expansion of gases	This includes pressurization.
1.1.2.8	1.1.2.6	.2.6 critical pressure and temperature of gases	STCW lists this as a separate line item.
1.1.2.9	1.1.2.7	.2.7 flashpoint, upper and lower flammable limits, auto-ignition temperature	Same as above – STCW language
1.1.2.10	New [LNG C 2.1.2.9]	compatibility, reactivity, and positive segregation of gases	Compatibility and reactivity applies to NH <sub>3</sub> – water. Corrosion, implosion, exothermic reaction.
1.1.2.11	1.1.2.8	.2.8 saturated vapour pressure/ reference temperature	
1.1.2.12	1.1.2.10	.2.10 hydrate formation	This could involve methanol injection for NH <sub>3</sub> .
1.1.2.13	1.1.2.11	.2.11 combustion properties: heating values	Requires pilot fuel for burning in engines.
1.1.2.14	1.1.2.13	.2.13 pollutant characteristics of ammonia fuels addressed by the IGF Code	See BT 6.X above – this could involve a deeper understanding than in basic training. This would include any residues or wastes.
1.1.4	1.1.4	.4 the nature and properties of solutions	This could include the formation of ammonium hydroxide.
1.1.5	1.1.5	.5 thermodynamic units	
1.1.6	1.1.6	.6 basic thermodynamic laws and diagrams	



AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
1.1.7	1.1.7	.7 properties of materials	
1.1.8	1.1.8	.8 effect of low temperature, including ductile or brittle fracture, for liquid low temperature or cryogenic fuels	Ammonia is low temperature not cryogenic.
<b>1.2</b>	1.2 [Also LNG C 2.2]	<b>Understanding the information contained in a Safety Data Sheet (SDS) about ammonia fuels and related substances addressed by the IGF Code</b>	This would include support chemicals for ammonia operations such as caustic, glycol, methanol, etc.



AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>2</b>	2	<b>Operate controls of fuel related to propulsion plant and engineering systems and services and safety devices on ships-using ammonia as fuel subject to the IGF Code</b>	
<b>2.1</b>	2.1	Operating principles of marine power plants	This should include emergency generators if ammonia is used.
<b>2.2</b>	2.2	Ships' auxiliary machinery	Boilers, auxiliary engines may use NH <sub>3</sub> .
<b>2.3</b>	2.3	Knowledge of marine engineering terms	



AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>3</b>	3	<b>Ability to safely perform and monitor all operations related to the ammonia fuels used on board ships subject to the IGF Code</b>	
<b>3.1</b>	3.1	Design and characteristics of ships <del>subject to the IGF Code</del> using ammonia as fuel	
<b>3.2</b>	3.2	Knowledge of ship design, systems, and equipment found on ships using ammonia as fuel <del>subject to the IGF Code</del> , including:	
3.2.1	3.2.1	.1 fuel systems for different propulsion engines including dual fuel engines	For different types of engines / manufacturers, there may be different designs / characteristics.
3.2.2	3.2.2	.2 general arrangement and construction	See BT 1.3.X
3.2.3	3.2.3	.3 fuel storage systems on board ships using ammonia as fuel <del>subject to the IGF Code</del> , including materials of construction and insulation	Tank structures, type, location, coatings. There can be special insulation for ISO tanks.
3.2.4	3.2.4	.4 fuel-handling equipment and instrumentations on board ships:	
3.2.4.1	3.2.4.1	.4.1 fuel pumps and pumping arrangements	
3.2.4.2	3.2.4.2 [LNG C 1.1.4.2] [Also tankers]	.4.2 fuel pipelines and valves	Rigid and flexible; double walled; insulated piping. Valves for ammonia service are different – material differences also.
3.2.4.3	3.2.4.3	.4.3 expansion devices	Note IGF (3.2.4.2) called this out separately though this could be included under piping systems.
3.2.4.4	3.2.4.4	.4.4 flame screens and arrestors	
3.2.4.5	3.2.4.5	.4.5 temperature and pressure monitoring, control and alarm systems including for tanks	
3.2.4.6	3.2.4.6	.4.6 fuel tank level-gauging systems	

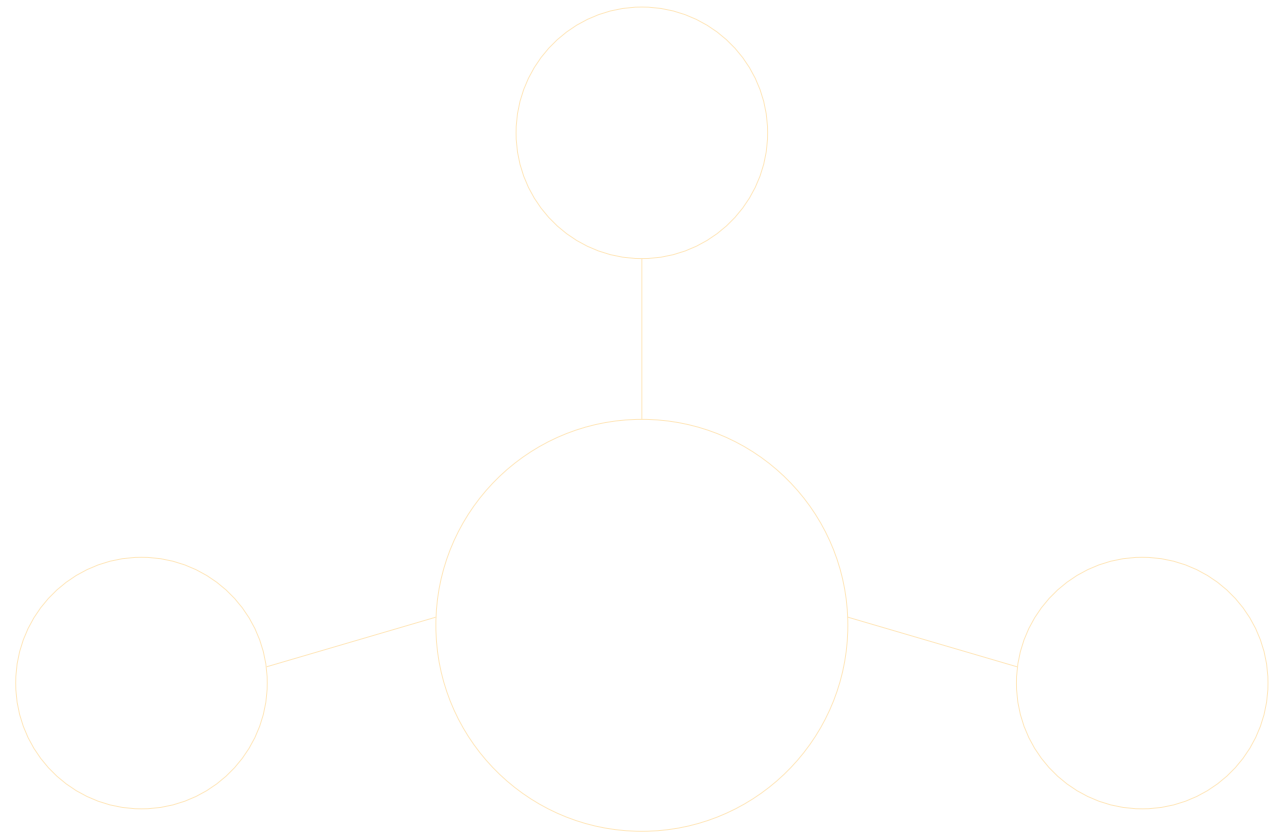
AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
3.2.5	3.2.5	.5 <del>low temperature-cryogenic</del> fuel tanks temperature and pressure maintenance system	Not cryogenic – low temperature
3.2.6	3.2.6 [Red text came from LNG C or discussion]	.6 fuel system atmosphere control systems (inert gas, dry air), including for storage, generation and distribution systems	Nitrogen hazards could be new for some seafarers.
3.2.7	New	x. fuel residue drain system	This includes contaminated fuel waste drain systems including drain tanks, handling and transfer systems.
3.2.8	New	x lubricants for engines, compressors, or other equipment	Dedicated lubricants will be used on engine especially 4-stroke engine for lube oil and related oil drain: There is a potential for ammonia migration into lubricants. In case of fully refrigerated system, the oil used in machinery like compressors will be contaminated with the gas in use hence additional PPE required when conducting work / maintenance.
3.2.9	3.2.7	.7 toxic and flammable gas-detecting systems	
3.2.10	New	x flame detecting systems	
3.2.11	New [LNG C 1.1.10]	x. vapour / boil off management and control systems including liquefaction and reliquefaction	Vapour management for all ship types. For refrigerated ammonia (storage), reliquefaction would be present.
3.2.12	3.2.8	.8 fuel Emergency Shut Down system (ESD)	
<b>3.3</b>	3.3	<b>Knowledge of fuel system theory and characteristics, including types of fuel system pumps and their safe operation on board ships subject to the IGF Code-using ammonia as fuel</b>	Reliquefaction as appropriate to storage methods – refrigerated.
3.3.1	3.3.1	.1 low pressure pumps	
3.3.2	3.3.2	. 2 high pressure pumps	

AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
3.3.3	New	x compressors	Compressors used with reliquefaction and refrigerated ammonia.
3.3.4	3.3.3	.3 vaporizers	
3.3.5	3.3.4	.4 heaters	
3.3.7	New	x heat exchangers	Expected to contain glycol.
3.3.8	New	x filters	Filters may require in service maintenance. It needs to be determined if physical interaction from seafarer is needed or if filters can be backflushed remotely.
3.3.9	New	x ventilation system related to spaces where fuel vapours could be present	There should be consideration for training on ventilation mitigation and the related systems (water labyrinths) to avoid sending NH <sub>3</sub> to atmosphere.
3.3.10	New	x venting and vapour / boil off gas management systems	See entries in Basic training 2.2.3 and 1.3.4. Ammonia Release Mitigation Systems – also vent masts. These systems can include catch systems and knock out drums.
3.3.11	New	x after treatment systems for the ammonia fuel	The after treatment systems are required to treat the emissions to reduce pollution.
3.3.12	New [LNG C]	x ballast system, trim and stability operations including damage stability	Knowledge of tank type / structure / location and potential for sloshing and vapour generation. LR NH <sub>3</sub> Risk study says operations can result in sloshing and formation of gas pockets, vapour generation.

AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>3.4</b>	3.4	Knowledge of safe procedures and checklists for taking fuel tanks in and out of service, including:	
3.4.1	New [similar to LNG C]	x visual checks of tank external / ancillary equipment and components	External inspection by sight (not enclosed space entry). For tanks, this may apply to a deck ISO tank.
3.4.2	3.4.1	.1 inerting	
3.4.3	New [LNG C]	x gas-up / freeing	
3.4.4	3.4.2	.2 warming up / cooling down	
3.4.5	New [LCO2]	x tank preparation (conditioning / drying)	
3.4.6	3.4.3	.3 initial loading	
3.4.7	3.4.4	.4 temperature and pressure control	
3.4.8	3.4.5	.5 heating of fuel	
3.4.9	New [LCO2]	x vapour management	
3.4.10	3.4.6	.6 tank emptying / stripping systems	This could include understanding of the drain systems.

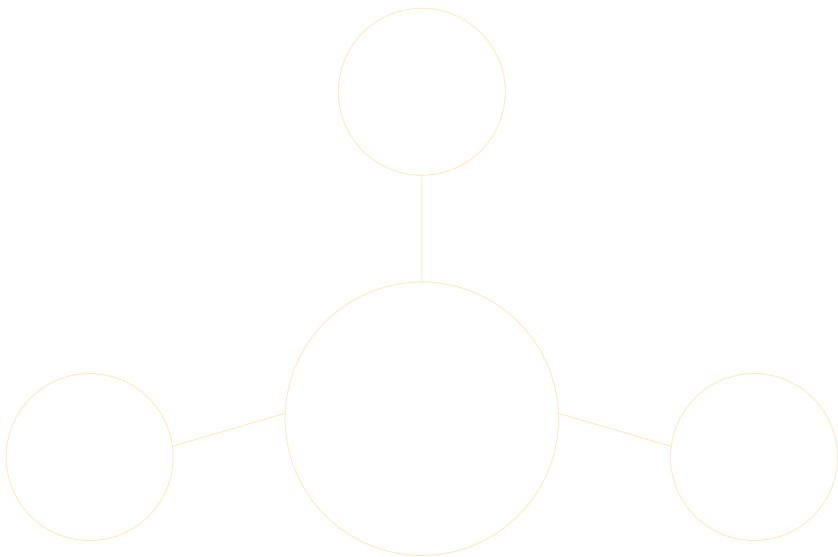
AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>4</b>	4	<b>Plan and monitor safe bunkering, stowage and securing of the ammonia fuel on board ships subject to the IGF Code</b>	
<b>4.1</b>	4.1	General knowledge of ships <del>subject to the IGF Code</del> <b>using ammonia as fuel</b>	
<b>4.2</b>	4.2	Ability to use all data available on board related to bunkering, storage and securing of <b>ammonia</b> fuels <del>addressed by the IGF Code</del>	
<b>4.3</b>	4.3	Ability to establish clear and concise communications and between the ship and the terminal, truck, or the bunker- supply ship	
<b>4.4</b>	4.4	Knowledge of safety and emergency procedures for operation of machinery, fuel, and control systems for ships <del>subject to the IGF Code</del> <b>using ammonia as fuel</b>	
<b>4.5</b>	4.5	Proficiency in the operation of bunkering systems on board ships <b>using ammonia as fuel</b> <del>subject to the IGF Code</del> including:	This would include ship-to-ship (STS) at anchorage. It could also be ship-to-barge, trucks or pipelines.
4.5.1	4.5.1	.1 bunkering procedures	This should include interfaces like hoses and vapour lines.
4.5.2	4.5.2	.2 emergency procedures	See 4.4 above
4.5.3	4.5.3	.3 ship-shore/ship-ship interface	Connections, hose management including vapour lines – see BT 3.3.9
4.5.4	4.5.4	.4 prevention of rollover	Rollover is a chemical phenomenon.
<b>4.6</b>	4.6	Proficiency to perform fuel-system measurements and calculations, including:	
4.6.1	4.6.1	.1 maximum fill quantity	
4.6.2	4.6.2	.2 On Board Quantity (OBQ)	

AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
4.6.3	4.6.3	.3 Minimum Remain On Board (ROB)	This was also in LNG Cargo STCW.
4.6.4	4.6.4	.4 fuel consumption calculations	
<b>4.7</b>	4.7	<b>Ability to ensure the safe management of bunkering and other IGF Code fuel related operations concurrent with other onboard operations, both in port and at sea.</b>	Bunkering practices to be in line with industry and port requirements. Ships to follow terminal operators or ports SIMOPs requirements though these may not be allowed.

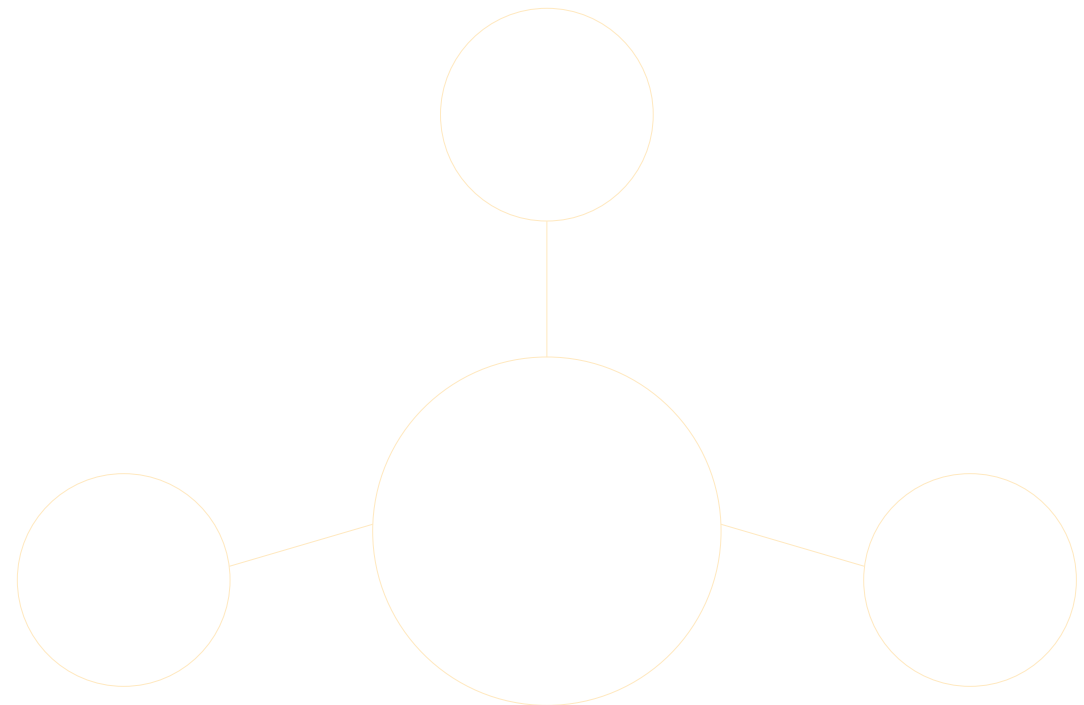




AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>5</b>	5	<b>Take precautions to prevent pollution of the environment from the release of ammonia fuels from ships subject to the IGF Code (see LNG C 6)</b>	
<b>5.1</b>	5.1	Knowledge of the effects of pollution on humans and environment	This could include nitrous oxide, ammonia slip, ammonium hydroxide.
<b>5.2</b>	New [LNG C 6]	<b>Understanding of procedures to prevent pollution of the environment.</b>	Emphasis here on prevention. Could include use of controlled ventilation and use of ammonia release mitigation system as well as spill containment. Consideration to be given to residue and contaminated waste handling and treatment.
<b>5.3</b>	5.2	Knowledge of measures to be taken in the event of spillage/leakage/ venting	Spill containment should be in procedures. NOTE: Precautions of adding water to a pool of ammonia – increases vaporisation and potential for vapour clouds. Could involve use of tarps or covers for leaks. Could involve understanding dispersion of vapour clouds.



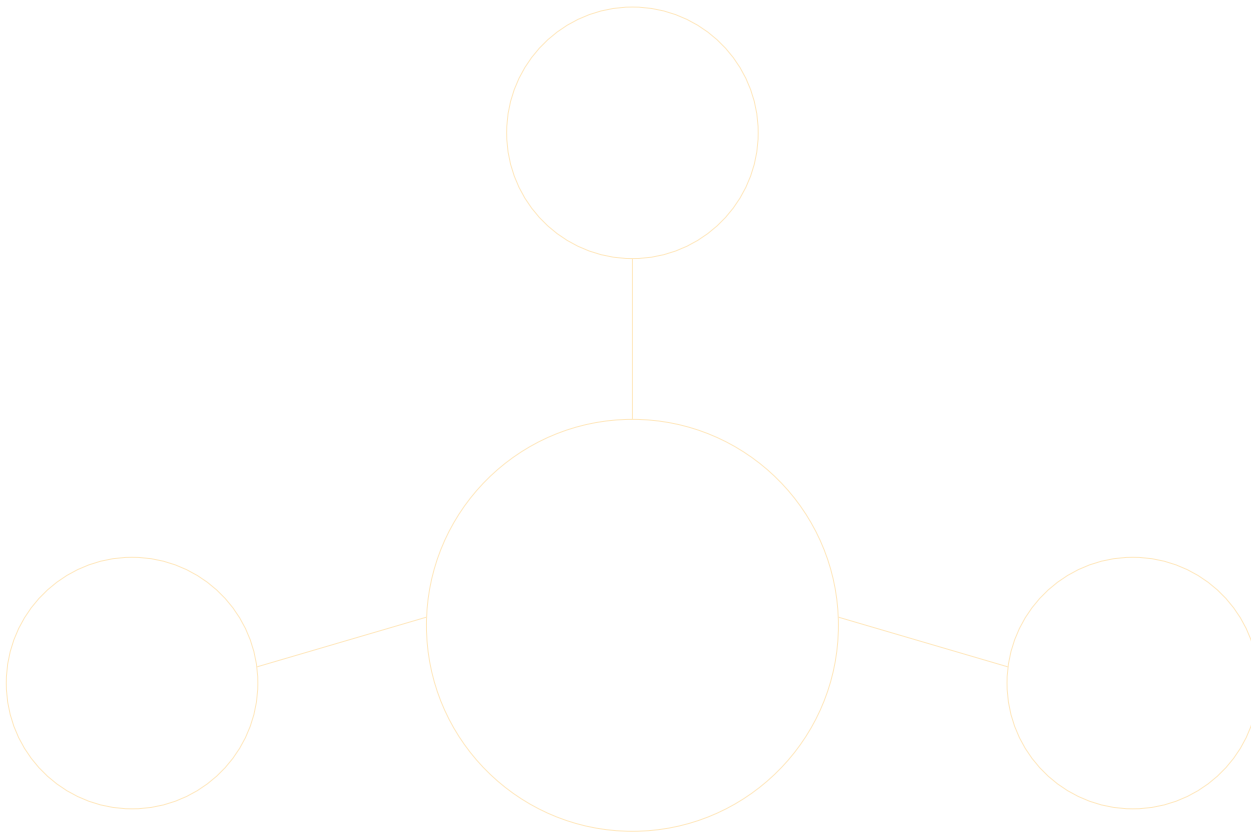
AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>6</b>	6	<b>Monitor and control compliance with legislative requirements (LNG C 7)</b>	
<b>6.1</b>	6.1 [LNG C 7.1]	Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL), as amended and other relevant IMO instruments, industry guidelines and port regulations as commonly applied	
<b>6.2</b>	6.2 (LNG C 7.2)	Proficiency in the use of the <b>applicable regulatory codes</b> and related documents <b>as appropriate to vessel</b>	Regulations such as IGF, IBC, IGC, IMDG codes as appropriate.



AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>7</b>	7	<b>Take precautions prevent to hazards</b>	
<b>7.1</b>	7.1 [LNG C 3.1]	Knowledge and understanding of the hazards and control measures associated with fuel system operations on board ships <b>using ammonia as fuel</b> - <del>subject to the IGF Code</del> , including:	
7.1.1	7.1.1 [LNG C 3.1.1]	.1 flammability	
7.1.2	7.1.2 [LNG C 3.1.2]	.2 explosion (BLEVE) and implosion	Unique to NH <sub>3</sub> -adding ammonia to water in enclosed spaces can lead to implosion. BLEVE could apply to deck / ISO tanks.
7.1.3	7.1.3 [LNG C 3.1.3]	3 toxicity	This includes concept of exposure and concentration measures / AEGL.
7.1.4	7.1.4 [LNG C 3.1.4]	.4 reactivity	With water – especially water added to ammonia. See BT notes above.
7.1.5	7.1.5 [LNG C 3.1.5]	.5 corrosivity	This includes when ammonia is mixed with water or moisture. It should also address the formation of ammonium hydroxide.
7.1.6	7.1.6 [LNG C 3.1.6]	.6 health hazards	This includes concept of exposure and concentration measures / AEGL.
7.1.7	7.1.7 [LNG C 3.1.7]	.7 inert gas composition	Potentially nitrogen. Any precautions with dry air should be provided.
7.1.8	7.1.8 [LNG C 3.1.8]	.8 electrostatic hazards <b>including static electricity / energy accumulator and generator</b>	Concerns include static electricity / energy accumulator and generator. May not be applicable to NH <sub>3</sub> directly but other substances.
7.1.9	New [From LCO <sub>2</sub> ]	x phase change hazards	In particular, the changes from liquid to gas and the circumstances allowing this.

AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
7.1.10	New [2.1.9 BT]	x vapour leaks and clouds	This includes an understanding of dispersion patterns, factors impacting these and needed response.
7.1.11	7.1.9	.9 pressurized gases	
7.1.12	7.1.10	.10 low temperature	
7.1.13	New [From LCO2]	x material incompatibilities including fittings	Avoidance of incompatible materials / metals such as copper, zinc, nickel and their alloys, and some plastics. For example, for seals, nitrile rubber is usually used instead of conventional rubber because it is decomposed by ammonia.
7.1.14	New [From LCO2]	x quality and quantity differences including impurity impact and effects	These concerns are less likely with ammonia (NH <sub>3</sub> ).
<b>7.2</b>	7.2 [LNG C 3.2]	Proficiency to calibrate and use monitoring and fuel / gas detection systems, instruments and equipment on board ships <b>using ammonia as fuel subject to the IGF Code</b>	This item was kept here though it is in Occupational Health. Similar criteria in BT and in AT.
<b>7.3</b>	7.3 [LNG C 3.3]	Knowledge and understanding of dangers of non-compliance with relevant rules/regulations	
<b>7.4</b>	7.4	Knowledge and understanding of risk assessment method analyses on board ships <b>subject to the IGF Code using ammonia as fuel</b>	
<b>7.5</b>	7.5	Ability to elaborate and develop risk analyses related to risks on board ships subject to <del>the IGF Code</del> <b>the use of ammonia as fuel</b>	
<b>7.6</b>	7.6	Ability to elaborate and develop safety plans and safety instructions for ships subject to the <b>use of ammonia as fuel</b> <del>IGF Code</del>	

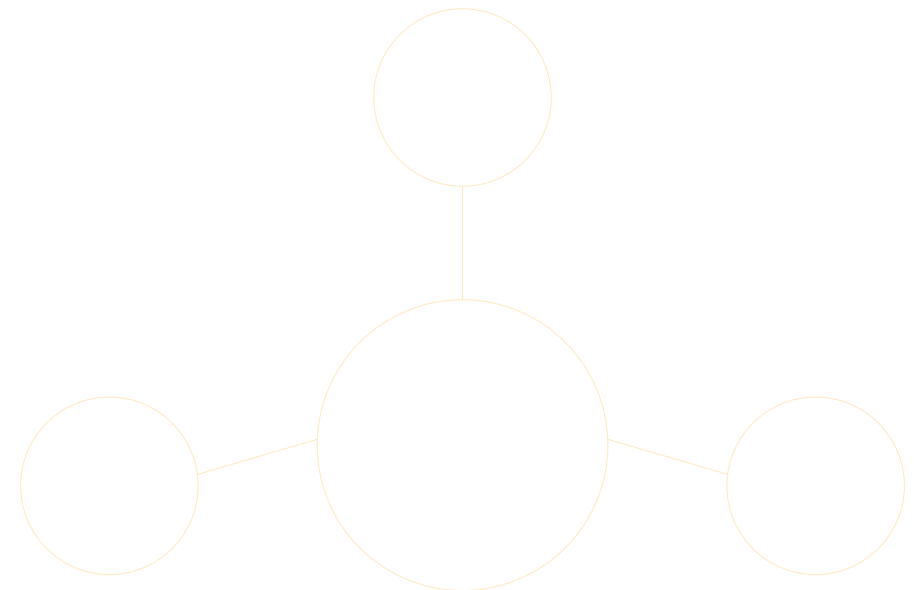
AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
7.7	7.7	Knowledge of hot and cold work, enclosed spaces and tank entry including permitting procedures	
7.8	New	<b>Understanding of how to establish and monitor hazards, safety, security and marine zones / areas and any other monitored locations</b>	There is similar criteria in other locations in this document. The difference here is to establish and monitor not simply be aware. Zones are discussed in SIGTTO and SGMF documents.



AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>8</b>	8	<b>Apply occupational health and safety precautions and measures on board a ship using ammonia as fuel subject to the IGF Code</b>	
<b>8.1</b>	8.1	Proper use of safety equipment and protective devices, including:	
8.1.1	8.1.1	1 breathing apparatus, aids / devices and evacuating equipment	Use depends on the potential conditions, concentrations and time exposures.
8.1.2	8.1.2	2 protective clothing and equipment <b>such as that rated for low temperature and personal gas detectors</b>	Anti-static clothing is not needed for ammonia but could be important for other substances.
8.1.3	8.1.3	3 resuscitators	
8.1.4	8.1.4	4 rescue and escape equipment <b>including for tanks / enclosed spaces</b>	This equipment may also need to be used in various areas during fire response as well as during operations or maintenance activities.
8.1.5	New	<b>x understanding of use, location of mustering points / safe havens</b>	Under BT – awareness of muster points and safe havens. Ammonia industry calls these safe havens. Emergency response must account for anyone using these in an emergency as well as evacuation / rescue from them.
<b>8.2</b>	8.2 <b>(LNG C 4.1)</b>	<b>Knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety including:</b>	
8.2.1	8.2.1 <b>(LNG C 4.1.2)</b>	.1 precautions to be taken before, during and after repair and maintenance work on fuel systems <b>using ammonia as fuel addressed in the IGF Code including</b>	Includes special welding skills for ammonia compatible materials. Includes the use of risk assessment, job safety analysis and permitting.  Also material compatibilities are a concern for work affecting tanks, pumping, piping, electrical and control systems.

AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
8.2.2	New (see LNG C 4.1.1 -similar)	x precautions to be taken when entering areas with potential high gas (or vapour) concentrations such as hazardous areas, spaces or zones including enclosed spaces	This would include in FPRs, TCS. For PCC, containers, etc., near tanks, compressors, engine rooms, crank cases, scavenging manifold while using ammonia. Adequate ventilation requirements and monitoring especially enclosed spaces.  Understanding to include concept of exposure and concentration measures / AEGL.
8.2.3	New [LNG C 4.1.3]	x precautions for hot and cold work	Precautions includes the use of risk assessment, job safety analysis and permitting.
8.2.4	New [LNG C 4.1.6]	x precautions for cold burn and frostbite	Only place cold burn is mentioned in this framework.
8.2.5	New [LNG C 4.1.7]	x proper use of personal toxicity and gas monitoring equipment and portable gas meters	This needs to include concept of toxicity for NH <sub>3</sub> .
8.2.6	New [LNG C 4.1.5]	x use of appropriate Personal Protective Equipment (PPE)	As per written procedures and Company PPE matrix.
8.2.7	8.2.2 [LNG C 4.1.4]	2 precautions for electrical safety (reference to IEC 60079-17)	Nothing extra is needed for ammonia.
8.2.8	8.2.3	.3 ship/shore safety checklist	Industry guidelines for safe working – Potentially for mooring, bunkering, lifting – There is something similar above. – See BT 3.3.X.
8.2.9	New	x understanding of measures for decontaminating personal protective equipment, tools, or equipment after exposure to substances	Basic knowledge of measure is under BT 3.3.  Decontamination regimes will be needed especially bunkering and maintenance tasks.
<b>8.3</b>	8.3	<b>Basic knowledge of first aid with reference to a Safety Data Sheets (SDS) for ammonia fuels addressed by the IGF Code</b>	SDS includes first aid for chemicals used to support ammonia operations as well as ammonia.

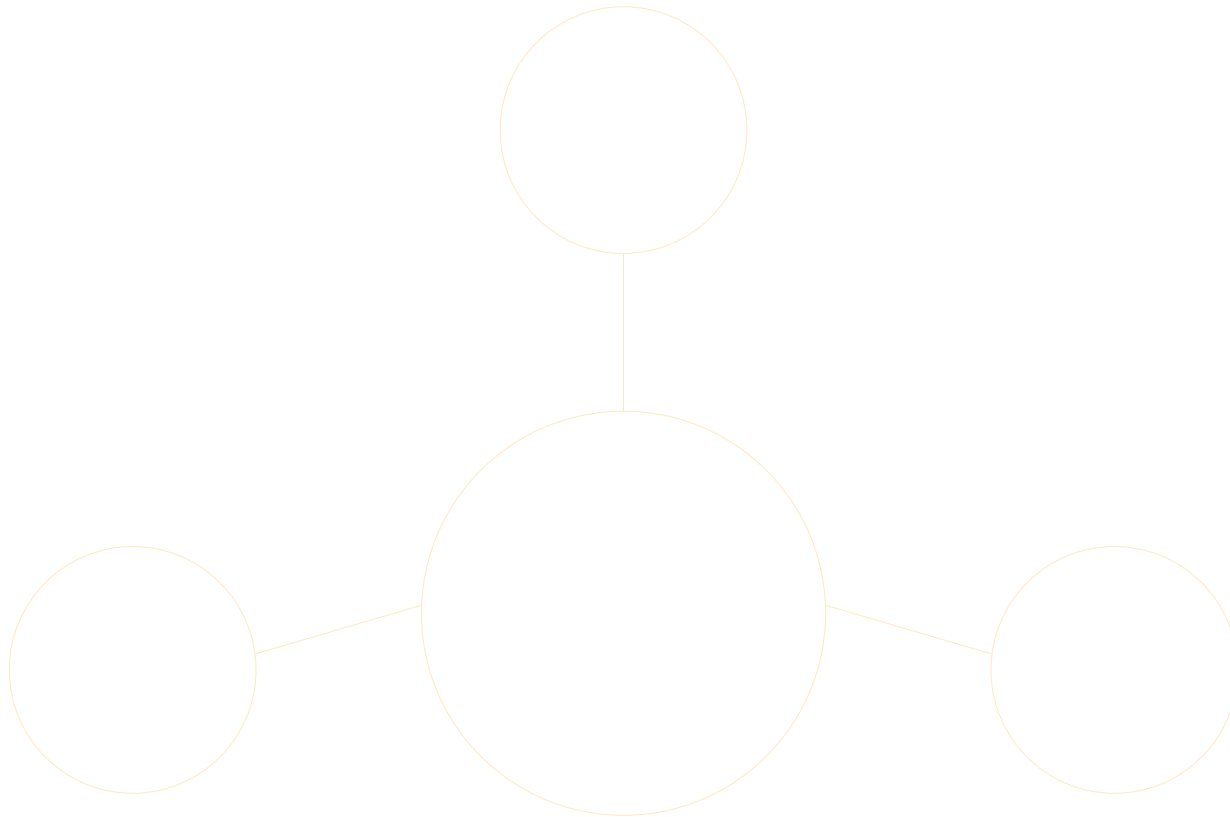
AT Project number	Based on STCW IGF # or tanker cargo	<b>Knowledge, understanding and proficiency</b> Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>9</b>	9	<b>Knowledge of the prevention, control and firefighting and extinguishing systems on board ships using ammonia as fuel subject to the IGF Code</b>	
<b>9.1</b>	9.1	Knowledge of the methods and firefighting appliances to detect, control and extinguish fires <b>of related to ammonia fuels and their potential interactions with other substances addressed by the IGF Code</b>	<p>Same “methods” in tankerman and LNG -C.</p> <p>Firefighting approach is primarily use of ventilation systems and water.</p> <p>Seafarers will need an understanding of corrosivity and reactivity potential of mixing ammonia with water. (See section 10.3 below)</p> <p>There is a special ammonia concern about the hazard of adding water to ammonia and the reaction to pool fires (such as increased vaporization).</p> <p>If methanol is onboard, knowledge of methanol firefighting.</p>





AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
<b>10</b> <b>New / Proposed</b>	5 (LNG C 5)	<b>Response to Emergencies -From LNG Table A-V/1-2-2 (section 5)</b> <b>**NOTE: Black text below is the text in LNG C – Red is potential amendments to accommodate ammonia</b>	
<b>10.1</b>	New (LNG C 5.1)	Knowledge and understanding of <del>liquefied-gas</del> <b>ammonia fuel</b> emergency procedures, including:	
10.1.1	New (LNG C 5.1.1)	x ship emergency response plans <b>including emergency shutdown</b>	
10.1.2	New (LCO2)	x bunkering operations emergency / safety devices such as Emergency Release System (ERS), Quick Release Connections (QC DC), Ship-to-Shore Links (SSLs), Bunkering Safety Link (BSLs).	
10.1.3	New (LCO2)	x automatic, remote, and manual shutdown capabilities for ammonia fuel.	
10.1.4	New (LNG C 5.1.4)	x actions to be taken in the event of failure of systems or services essential to <del>cargo</del> <b>ammonia fuel</b> operations	
10.1.5	New (LCO2)	x marine emergency situations related to such aspects as mooring, bunkering, stability, or security	
<b>10.2</b>	New [LNG C 5.2]	x actions to be taken following <b>allision</b> , collision, grounding or spillage and envelopment of the ship in toxic or flammable vapour	This does not seem to be addressed anywhere else in the IGF framework. This could be addressed in emergency procedures then this would not need a separate line item We may wish to keep it for the future. Language originally created for LNG C 5.2.
<b>10.3</b>	New (Discussions)	x actions to be taken, including emergency response, related to port operations including SIMOPS	

AT Project number	Based on STCW IGF # or tanker cargo	Knowledge, understanding and proficiency Based on IGF or tanker cargo (oil, chemical, LNG)> also new items	Explanatory Notes
10.4	New (LCO2)	x actions to be taken during adverse local weather or metocean conditions	This could include the impact of weather or atmospheric conditions on vapour dispersion.
10.5	New (LNG C 5.3)	Knowledge of medical first-aid procedures and antidotes on board-ships using ammonia as fuel-liquefied gas tankers, with reference to the Medical First Aid Guide for Use in Accidents involving Dangerous Goods (MFAG)	While there in no antidote for ammonia, there are first aid treatments. There are antidotes for methanol – if it would be used on ammonia vessels for treating hydrates. Determine if reference to MFAG should be kept in KUP.



# 10. Conclusions

The existing STCW Code Chapter V Tables A-V/3-1 and A-V/3-2 relating to specification of minimum standards of competence in basic and advanced training for ships subject to the IGF Code stand as an excellent base for developing a framework outlining the minimum standards for competencies and training for ships using ammonia as a fuel, or other gases or low flashpoint fuels.

Several aspects from other existing STCW Code Chapter V related to oil, chemical and liquified gas tanker cargo operations have provided relevant criteria for inclusion in the proposed framework. Additional perceived gaps have been addressed with the incorporation of new competencies and KUPs in the proposed framework.

The proposed framework along with explanatory information is intended to serve as a model for future efforts to be used by the industry to determine the relevant minimum standards that should be considered to define competencies and training for ships using ammonia as fuel, as well as other gases and low flash point fuels.

It is the intent of this report to begin to identify what modified or new minimal standards for competencies and training may be needed to allow seafarers to confidently and safely work onboard vessels using ammonia as a fuel in dual fuel engines. It was recognised that the basic competency statements that exist in STCW instruments would apply, with slight modifications, to ammonia as a fuel. The largest updates will be centred around the following:

- The knowledge of the characteristics of ammonia such as toxicity, flammability, explosivity, corrosion, material incompatibility
- Understanding of ammonia- specific operational and maintenance regimes
- New skills associated with the introduction of new systems, equipment and materials including dual fuel engines and the increased use of automation and digitalisation
- Modification to some operations such as bunkering to accommodate ammonia as a fuel
- Changes to the approach for emergency response such as those related to releases (leaks or spills), fires and explosions

This report also shows that the approach to training will be similar to that which exists today though it was felt by those involved in this project that practical exercises, rather than only classroom or simulator training, will be vital for some high-risk operations such as firefighting.

While this report addresses the human factors considerations related to competencies and training, it should be noted that these topics are just one aspect of human factors that will need to be considered by industry when moving to the use of ammonia as a fuel. Others that deserve thought include:

- The ergonomic design of systems, equipment and interfaces
- Supportive written procedures, processes and practices
- Assessment of workload distribution given additional systems/hardware , interfaces and tasks
- Any new roles and responsibilities for seafarers
- The role of process safety and the management of process hazards in addition to those associated with traditional occupational health and safety
- A formal method for managing change when moving from conventional fuel oil to the addition of ammonia as a second fuel

Many of these factors and their impacts are introduced in the document Human Factors Considerations: Ammonia Fuel End-of-Stage Report published by Lloyd's Register Maritime Decarbonisation Hub (The Decarb Hub) and the Mærsk McKinney Møller Center for Zero Carbon Shipping (MMMCZCS) in 2023.

It should be also noted that this report reflects the state of the planned technology, known fuel characteristics and industry experts' opinions at the time of publication. With advances in ship design, including system and engine technologies, the proposed competencies and the related knowledge, understanding, and proficiencies (KUPs) would need to be re-examined in light of such changes. In addition, the maritime industry and its regulators may form different views on the requirements for staffing ships and the minimum training standards for seafarers than those provided here.

# 11. References

Global Centre for Maritime Decarbonisation (GCMD) – Concept Study to Offload Onboard Captured Carbon Dioxide, Chapter 8, Operating Personnel Competency Standards), March 2024.

STCW Table A-V/3-1 – Specification of minimum standard of competence for basic training for ships subject to the IGF Code.

STCW Table A-V/3-2 – Specification of minimum standard of competence for advanced training for ships subject to the IGF Code.

STCW Code Table A-V/1-1-1 – Specification of minimum standard of competence in basic training for oil and chemical tanker cargo operations.

STCW Code Table A-V/1-1-2 – Specification of minimum standard of competence in advanced training for oil tanker cargo operations.

STCW Code Table A-V/1-1-3 – Specification of minimum standard of competence in advanced training for chemical tanker cargo operations

STCW Code Table A-V/1-2-1 – Specification of minimum standard of competence in basic training for liquefied gas tanker cargo operations

STCW Code Table A-V/1-2-2 – Specification of minimum standard of competence in advanced training for liquefied gas tanker cargo operations.

# Appendix 1: Abbreviations

Abbreviation	Definition
<b>AEGL</b>	Acute Exposure Guideline Level
<b>ARMS</b>	Ammonia Release Mitigation System
<b>AR</b>	Alcohol Resistant
<b>AFFF</b>	Aqueous Film Forming Foam
<b>AT</b>	Advanced Training
<b>BDN</b>	Bunker Delivery Note
<b>BLEVE</b>	Boiling Liquid Expanding Vapour Explosion
<b>BOG</b>	Boil Off Gas
<b>BSL</b>	Bunkering Safety Link
<b>BT</b>	Basic Training
<b>CO2</b>	Carbon Dioxide
<b>EBL</b>	Emergency Bunkering Links
<b>ECR</b>	Engine Control Room
<b>EEBD</b>	Emergency Escape Breathing Devices
<b>ESD</b>	Emergency Shut Down
<b>ERS</b>	Emergency Release System
<b>FPR</b>	Fuel Preparation Room
<b>GCMD</b>	Global Centre for Maritime Decarbonisation
<b>H2</b>	Hydrogen
<b>HVAC</b>	Heating Ventilation and Air Conditioning
<b>IAPH</b>	International Association of Ports and Harbours
<b>IBC</b>	International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk

Abbreviation	Definition
<b>IEC</b>	International Electrotechnical Commission
<b>IGC</b>	International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk
<b>IGF</b>	International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels
<b>IMDG</b>	International Maritime Dangerous Goods Code
<b>IMO</b>	International Maritime Organization
<b>ISO</b>	International Organization for Standardization
<b>KUP</b>	Knowledge, Understanding, and Proficiency
<b>LCO2</b>	Liquid Carbon Dioxide
<b>LEL</b>	Lower Explosive Limit
<b>LFL</b>	Lower Flammability Limit
<b>LNG</b>	Liquified Natural Gas
<b>LNG -C</b>	Liquified Natural Gas Cargo
<b>LPG</b>	Liquefied Petroleum Gas
<b>LR</b>	Lloyd's Register
<b>KUP</b>	Knowledge, Understanding, and Proficiency
<b>MARPOL</b>	International Convention for the Prevention of Pollution from Ships
<b>MeOH</b>	Methanol
<b>MDH</b>	Marine Decarbonisation Hub
<b>MFAG</b>	Medical First Aid Guide for Use in Accidents involving Dangerous Goods
<b>MGO</b>	Marine Gas Oil
<b>MJTTF</b>	Maritime Just Transition Taskforce
<b>MMMCZCS</b>	Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping
<b>n/a</b>	Not Applicable
<b>N2</b>	Nitrogen

Abbreviation	Definition
<b>NH3</b>	Ammonia
<b>O2</b>	Oxygen
<b>OBO</b>	On Board Quantity
<b>PCC</b>	Pure Car Carriers
<b>PPE</b>	Personal Protective Equipment
<b>PPM</b>	Parts Per Million
<b>PPE</b>	Personal Protective Equipment
<b>QC/DC</b>	Quick Connect Disconnect
<b>ROB</b>	Remain On Board
<b>SCR</b>	Selective Catalytic Reduction
<b>SDS</b>	Safety Data Sheet
<b>SGMF</b>	Society for Gas as a Marine Fuel
<b>SIGTTO</b>	Society of International Gas Tanker and Terminal Operators
<b>SIMOPS</b>	Simultaneous Operations
<b>SSLs</b>	Ship-to-Shore Links
<b>SME</b>	Subject Matter Expert
<b>STCW</b>	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
<b>STS</b>	Ship To Ship
<b>TCS</b>	Tank Connection Space
<b>TLV</b>	Threshold Limit Value



# Appendix 2: Acknowledgements

The findings of this report are built on extensive cross-sector collaboration between organisations in the maritime industry and beyond. The project team consisted of the Lloyd’s Register Maritime Decarbonisation Hub, the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, Anglo-Eastern Ship Management, the Ammonia Safety & Training Institute (ASTI), BP, Cargill, CF Industries, Hapag-Lloyd, A. P. Moller-Maersk, Maersk Training, MAN Energy Solutions, NYK Line, Seaspn, Stolt Tankers, TotalEnergies and V.Group.





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