PLATINA3
IWT policy platform
- JOBS & SKILLS -

Report on required competence for operation of vessels with zero or low emission D 3.1

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Author	Boll, Jörn, Maritieme Academie Harlingen j.boll@MaritiemeAcademieHarlingen.nl
Co-author(s)	Pieter Zandhuis, Maritieme Academie Harlingen p.zandhuis@MaritiemeAcademieHarlingen.nl

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Name	Role	Date
Jörn Boll	Task leader	25-07-2022
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Salih Karaarslan	Quality Assurance Manager	16-08-2022
Martin Quispel	Project Coordinator	31-08-2022

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Executive Summary

Right skills for green jobs are certainly the prerequisite to make the transition to a greener economy happen.[1] Today, skills gaps are already recognized as a major bottleneck in a number of sectors,[2] and the inland waterways sector, which relies on a skilled workforce, is no exception.

According to the Communication from the European Commission NAIADES III: Boosting future-proof European inland waterway transport[3] "*The current and future workforce needs to be equipped with the right skills to deal with the green and digital transitions, cyber-security, synchromodality and the automation of vessels and infrastructure. (…) The Commission therefore will also mandate CESNI to prepare standards for skills for alternative fuels operations and for environment-friendly and efficient vessel operation (eco navigation).*"

This energy transition represents a great challenge for the workforce. Inland Waterway Transport (IWT) personnel needs support for a transition to a zero emissions fleet. This transition includes the use of alternative fuels, batteries and electric propulsion systems for which new standards for competence of personnel is needed. In terms of relevant new energy sources and energy carriers, an analysis of pilot projects that have received recommendations from the CCNR or from national bodies (the case of the pusher ELEKTRA operating in Germany) have shown that at least methanol and hydrogen as alternative fuels, batteries and electric propulsion systems should be looked at. So far, the European Standard for Qualifications in Inland Navigation (ES-QIN) does not cover these alternative fuels and technologies. First discussions of the safety risks related to the new sources of energy in CESNI as well as consultation of battery manufacturers and operators of pilot projects have lead to a first set of competences. These competences can be split in a general part, applicable for all alternative fuels, batteries and electric propulsion systems and a more specific part. The work was carried out within the PLATINA3 consortium in cooperation with the permanent working group of CESNI for professional qualifications (CESNI/QP). The latter, assisted by experts from DG MOVE also reflected on the legal framework of introducing such new standards of competence.

In this context, this report aims to identify the competences to deal with alternative fuels, propulsion technology and exhaust gas aftertreatment systems that can be proposed to update ES-QIN and provides an overview of discussion already carried out in CESNI/QP.

[1] International Labor Organization, Skills for Green Jobs: A Global View, 2011, https://www.ilo.org/global/publications/ilo-bookstore/order-online/books/WCMS_159585/lang--en/index.htm

[2] *Ibid*.

[3] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions NAIADES III: Boosting future-proof European inland waterway transport, 24.6.2021, COM(2021) 324 final.

List of tables

List of abbreviations

DMFC	Direct Methanol Fuel Cell
ES-TRIN	European Standard laying down Technical Requirements for Inland Navigation vessels
ES-QIN	European Standard for Qualifications in Inland Navigation
IWT	Inland Waterway Transport
LNG	Liquefied Natural Gas
PEMFC	Proton Exchange Membrane Fuel Cell
RPN	Regulations for Personnel Navigating on the Rhine
SOFC	Solid Oxide Fuel Cell

1. Introduction

The Horizon 2020 PLATINA3 project[4] provides a platform for the implementation of the European Commission's NAIADES III action programme dedicated to inland navigation. The work programme of PLATINA3 has the objective to increase the impact of research and innovation in In IWT and broaden the stakeholder engagement in the sector. Within PLATINA3, policy makers, River Commissions, IWT sector representative organisations, knowledge institutes, education and training institutes, jointly identify means, measures and tools to promote IWT.

PLATINA3 is structured around four fields: market (WP1), fleet (WP2), jobs and skills (WP3) and infrastructure (WP4).

The work package "Jobs and skills" [5] deals with various aspects of this topic, such as

- competence standards related to the use of zero or low emission propulsion systems
- knowledge and skills needed for greener vessel operation in refresher classes
- competence standards related to onboard systems allowing automation of IWT vessels
- use of modern techniques such as simulators, virtual reality (VR) and augmented reality (AR) in training schemes for greener and highly automated vessel operation
- standards for examination of new competences in the EU regulatory
- framework

This report addresses the topic standards for competence for operation of vessels with zero or low emission, which is task 3.1 according to the Grant Agreement, and the Maritieme Academie Harlingen (MAH) leads the execution of this task.

1.1. Presentation Task 3.1

Objective: Identify competences, detailed in knowledge and skills, to deal with alternative fuels, propulsion technology and exhaust gas aftertreatment systems that can be proposed to update European Standard for Qualifications in Inland Navigation (ES-QIN).

Methodology: Based on findings of other projects on zero or low emission propulsion systems (e.g. most promising technologies identified in GRENDEL) and experience gained in drafting competences for lower emission fuels (project LNG Masterplan, CCNR recommendations for first LNG craft including competences and drafting of competence requirements in CESNI), draft content will be proposed feeding in the standards for competence by training institutes. Representatives of employers and trade unions will check the draft with a view to practicability in vessel operation and correct attribution to the management and operational level. River Commission experts will review, contribute with input on infrastructure use and regulatory framework in the respective river basins and provide for feedback from Member State experts.

Activities:

- Creating an overview of knowledge and skills feeding in draft standards for competence for qualified crew
- Reality check from social partners (link and synergy from pilot projects, planned investments)
- Review in the light of feasibility and regulations, e.g. requirements of police regulation at river basin level

[4] PLATINA3, Platform for the implementation of a future inland navigation action programme. See https://platina3.eu/.
[5] PLATINA3 Grant Agreement, p. 3.

1.2. Methodology

According to CESNI's rules of procedure[6] (Art. 6), CESNI shall adopt its work programme on the basis of proposed strategic guidelines prepared by the Secretariat of the CCNR and DG MOVE of the European Commission. These guidelines shall be reexamined after three years.

The work programme of CESNI shall describe the work to be carried out and include general indications of deadlines to be met, the organisation of the activities, and the resources necessary for carrying out the work. It shall specify the priorities and propose any requirements as to research, analysis, preparatory studies or appropriate impact studies.

According to CESNI's rules of procedure (Art. 1), CESNI's mission shall include in particular:

- *"adopting technical standards in various fields, in particular as regards vessels, information technology and crew, to which the respective regulations at the European and international level, including those of the European Union ("the EU") and the CCNR, may refer with a view to their application;*
- *deliberating on the uniform interpretation and application of the said standards, on the method for applying and implementing the corresponding procedures, on procedures for exchanging information, and on the supervisory mechanisms among the Member States;*
- *deliberating on derogations and equivalences of technical requirements for a specific craft;*
- *deliberating on priority topics regarding safety of navigation, protection of the environment, and other areas of inland navigation."*

The CESNI work programme 2022-2024, adopted by CESNI Member States on 28 October 2021[7] provides for a specific task with highest priority (Task with priority "I" which means to be started in the first half of the mandate, task QP-3) to draft "competence standards for new and innovative technologies including the use of relevant alternative fuels, batteries and electric propulsion systems". This task is based on the Strategic Guidelines agreed between Director General Hendrik Hololei of DG MOVE and CCNR in April 2021 that call for joint action in the field. The reasoning for strategic guidelines on jobs and skills (professional qualifications – French acronym QP) indicates that the CCNR Secretariat and DG MOVE continue to strive for

- an open and transparent elaboration of standards for professional qualifications in inland navigation,
- a harmonised implementation of requirements for professional qualifications that ensures level-playing field and maintains the high level of safety of inland navigation,
- an enhanced labour mobility and more quality jobs in inland waterway transport.

The elaboration of standards covers activities where CESNI shall prepare and adopt standards in the field of professional qualifications, actively promoting:

1. the regular revision of ES-QIN to maintain and guarantee the high level of safety in inland navigation and to follow the technical evolution,
2. **the development of competence-based standards for**
    - entrepreneurs, in particular for digitalisation and greening,
    - **working with new and innovative technologies including the use of relevant alternative fuels, batteries and electric propulsion systems,**

[6] https://www.cesni.eu/en/overview-of-documents/rules-of-procedure-and-internal-regulations/
[7] See https://www.cesni.eu/wp-content/uploads/2021/12/CESNI_work_prog_22_24_EN.pdf

- working with increasingly digitalised vessels, included automated vessels,
- eco-navigation,
- modern training tools, including remote learning,

3. the establishment of modern manning requirements,
4. electronic tools for recording and exchanging information on crew.

As presented in the problem analysis for task QP-3[8] work of PLATINA3 is part of this task.

During the CESNI Working Group on professional qualifications, held on 20 May 2021[9], Mr Jörn Boll presented preliminary findings from the task 3.1. Based on findings of other projects and initiatives on zero or low emission propulsion systems and experience gained in drafting competences for lower emission fuels, draft content will be proposed feeding in the standards for competence by training institutes.

Regarding the alternative fuels that are under consideration, or that may play a role in the energy mix of the future, Mr Boll explained that Battery Electric, Fuel Cells and Hydrogen, Ammonia and Methanol as combustion fuel will be considered. E-Fuels (Hydrogen based synthetic Diesel-like fuel) is still in an experimental stage. Experts agreed to strive to go beyond pilot projects currently covered in the permanently updated CCNR overview of pilot projects for zero and low emission fuels[10] (state as displayed in summer 2022), e.g. by including liquid hydrogen as an example of cryogenic gaseous fuel.

The preliminary findings have been presented:

- Electric propulsion in combination with battery packs and/or generators (alternative fuels) is most likely to play a main role in future propulsion systems. Fuel cells also require battery packs as a mean of temporary storage and these systems require profound knowledge to be operated and manipulated safely. Therefore, there is a need for an improved set of skills for the work with High Voltage/High Current systems on board inland vessels.
- There are different bunkering procedures for different fuels, by taking into account the characteristics of the different fuels: liquid at ambient temperatures and pressure (Ammonia/Methanol/E-Fuels), pressurized and Cryogenic (liquid Hydrogen), Standardized bundles of high-pressure storage bottles with a common manifold in a transportable cage (Hydrogen as pressurized gas at ambient temperatures), Charging/exchange of batteries.
- The use of any propulsion system must be safe and manageable for the crew, and new trainings are then needed.

Finally, Mr Boll finished his presentation by stressing the fact that there is still a very dynamic development regarding alternative fuels and concluded to keep the regime open for new developments in the field of fuels, batteries and propulsion systems. Experts thanked Mr. Boll for the efforts to submit a first draft standard that can be introduced when ES-TRIN will provide for the relevant standards for vessel equipment. Experts also welcomed the openness for all existing and upcoming technologies in the PLATINA3 project and underline the necessary link between the work carried out in the different work packages of the project.

On 14 February 2022, during the Temporary Working Group on Quality Management meeting[11], a revised draft competence tables elaborated by Maritieme Academie Harlingen has been presented. They confirm the choice of the most promising technologies which are also tributary to dangers that have to be monitored and note the results of a recent study carried out for the Dutch ministry of Infrastructure by consultants from AVIV from Enschede.

[8] See CESNI document CESNI/QP (21) 87 – Com. Secr.

[9] See Minutes of the online meeting of the Working Group on professional qualifications held on 20 May 2021, CESNI/QP (21)m 47 final

[10] See https://www.ccr-zkr.org/files/documents/reglementRV/rv3nl_rec_122021.pdf

[11] See Minutes of the meeting of the Temporary Working Group on Quality Management held online on 14 February 2022, CESNI/QP/QM (22)m 12 final

After discussion, it has been concluded that it will be key to collect more information from the experts in the field of technologies, manufacturers, classification societies and those who work with pilot projects.

The chair concluded that:

- mitigation measures still need to be more precise e.g. when it comes to the prevention of spreading of thermal runaway on board a vessel,
- there is a tendency not to make the new competence standards mandatory for all boatmasters regardless of the fuel or energy carrier their vessel is using, i.e. to follow the example of the methodology applied by ES-QIN for the LNG expert (i.e. **specific authorisations shall be necessary for all persons sailing a vessel propelled by zero or low emission fuel or energy carrier** that requires specific competences **as a boatmaster and all persons involved in the bunkering operations** of such fuels or energy carriers),
- experts prefer not to integrate the full set of competences needed to sail on vessels using alternative fuels for propulsion into the general standards of competence for boatmasters. If, however, elements of knowledge on locking procedures, signals, emergency situation should be known by all boatmasters, these elements must be known and duly covered by the standards of competence, just as it is the case with LNG or ADN vessels,
- experts show sympathy for an approach like for the competence, examination and assessment of an LNG expert according to ES-QIN. Once there are different experts, their competences could be defined in different competence standards.
- on the manning requirements, the presence of experts on board and when bunkering could be already reflected upon in CESNI/QP/Crew in addition to the current focus on technological progress.

Exchanges with experts on technical requirements for vessels in CESNI revealed that knowledge of “the rules of classification societies” as laid down in the ES-QIN standard for competence for LNG experts should not be applied for zero or low emission fuels or energy carriers as rules of classification societies address naval architects and experts from inspection bodies. They would also cover more than one fuel if they were included as such in the general competence of experts sailing on vessels propelled by zero or low emission fuel. It was concluded that knowledge of “the safety concept from the rules of classification societies” should be used instead. For the specific fuels and energy carriers, the applicable safety concept used in classification society rules used.

It also turned out that the knowledge on storage condition for mediums used in fuel cells has to be as detailed as possible taking into account the storage conditions laid down in upcoming ES-TRIN editions and experience gained from pilot projects.

2. Competence table

Competence-based standards as mentioned in the strategic guidelines for CESNI follow the example of part 1 of the European Standard for Qualifications in inland navigation (ES-QIN). ES-QIN is used as a reference by both Directive (EU) 2017/2397[12] and the new RPN 2022 of CCNR.

According to art. 3(15) of Directive (EU) 2017/2397, competence means "the proven ability to use the knowledge and skills required by the established standards for the proper performance of the tasks necessary for the operation of inland waterway craft".

The competence itself is listed in column 1. Column 2 contains theoretical elements (knowledge) and practical elements (abilities, referred to as skills in the title of column 2). Unlike in maritime transport (STCW-Convention[13]), where knowledge and ability are addressed together, CESNI standards always differentiate between knowledge and skills in competence standards. The advantage of the CESNI system is that the distinction between practical and theoretical elements facilitates the elaboration of CESNI standards for practical examination that provide a detailed list for elements that are subject to practical assessment and listed in part 2 of ES-QIN.

This chapter contains table overviews related to:

1. Competences related to electrical propulsion and auxiliary systems onboard (in general)
2. Competences linked to the use of high-capacity accumulator systems used for propulsion and auxiliary systems on board
3. Competences linked to the use of fuel cell systems on board
4. Competences linked to the use of low flashpoint fuels:
   - Gaseous fuels (cryogenic) – e.g. liquid hydrogen
   - Gaseous fuels (pressurized) – e.g. gaseous hydrogen in bottle racks
   - Liquid fuels – fuels that are liquid at ambient temperatures e.g. methanol
   - Solid fuels – e.g. sodium borohydride
   - Reaction products / depleted energy carrier medium

1. Competences related to electrical propulsion and auxiliary systems onboard (in general)

The expert shall be able to:

COLUMN 1 COMPETENCE	COLUMN 2 KNOWLEDGE AND SKILLS
1. **ensure compliance with relevant legislation, standards and safety and maintenance instructions applicable to craft using high voltage and high current electrical propulsion and auxiliary systems;**	1. Knowledge of regulations relating to craft using electrical propulsion and auxiliary systems such as relevant police regulations and ES-TRIN. 2. Knowledge of safety and maintenance instructions from the manufacturer. 3. Knowledge of safety concepts laid down in classification society rules. 4. Ability to instruct and monitor crew member operations in order to ensure compliance with legislation, standards and instructions

[12] References to CESNI standards have been included in Annex IV of Directive (EU) 2017/2397 by Commission delegated regulation 2022/184 of 22 November 2021, see https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32022R0184

[13] See for a definition *article 1(21) of Directive 2008/106/EC* of the European Parliament and of the Council

	applicable to craft using high voltage and high current electrical propulsion and auxiliary systems on board the craft.
2. obey safety standards when interacting with high voltage and high current electrical propulsion and auxiliary systems;	1. Knowledge of relevant functional, operational and safety requirements for high voltage and high current systems. 2. Knowledge of the basic features and lay out of a high voltage, high current system on board. 3. Knowledge of applicable safety equipment (e.g tools with non-conductive separation) and personal protective equipment (i.e. protective eye - glasses and protective clothing). 4. Knowledge basic electrical theory (including Alternating Current, Direct Current, parallel, series voltage, ampere.). 5. Knowledge of generator, motor and transformer protection (e.g. circuit breakers, thermal relays, sensors). 6. Ability to perform inspection and daily maintenance of the high voltage and high current electrical propulsion and auxiliary system in a safe and efficient manner. 7. Ability to take remedial action necessary during faults in high voltage and high current system.
3. take necessary measures to avoid or mitigate safety hazards linked to high voltage and high current electrical propulsion and auxiliary systems;	1. Knowledge of risk prevention measures when interacting with high voltage and high current electrical propulsion and auxiliary systems. 2. Knowledge of the dangers of an electrical arc (e.g., welding of contacts, molten metal, blinding, plasma and ionized gas burns) 3. Knowledge of safe isolation procedures and operations that can only be carried out by specifically qualified maintenance personnel. 4. Ability to check if components can be touched without risk and to avoid fire risks related to high voltage. 5. Ability to use proper fire extinguishing equipment on burning electrical equipment. 6. Ability to avoid or mitigate measures from an electrical arc.
4. operate craft using high voltage and high current electrical propulsion and auxiliary systems.	1. Knowledge of the key differences between craft operating with conventional diesel powertrains and craft with electric main propulsion. 2. Knowledge of the typical, more direct torque development of electrical motors and ability to handle it effectively. 3. Knowledge of the rate of energy consumption when operating the craft. 4. Ability to detect failure modes based on the available parameters of an electrical propulsion system (e.g., cooling water temperature, winding temperature, Ampere and Voltage levels). 5. Ability to regain steerage way to the craft in case of a failure of the power electronics or failure in the regulation and control of the propulsion installation. 6. Ability to handle the power management between the several power sources and electrical drives during normal and emergency operation (e.g. damage on side of the craft).

2. Competences linked to the use of high-capacity accumulator systems used for propulsion and auxiliary systems on board

2.0 General competences linked to the use of high-capacity accumulator systems used for propulsion and auxiliary systems onboard

The expert shall be able to:

COLUMN 1 COMPETENCE	COLUMN 2 KNOWLEDGE AND SKILLS
1. ensure compliance with relevant legislation, standards as well as safety and maintenance instructions applicable to craft using accumulator electric systems;	1. Knowledge of regulations relating to craft using high-capacity accumulators as energy storage for propulsion and auxiliary systems such as relevant police regulations and ES-TRIN. 2. Knowledge of safety and maintenance instructions. 3. Knowledge of the applicable safety concept used in classification society rules. 4. Ability to instruct and monitor crew members' operations in order to ensure compliance with legislation, standards and instructions applicable to craft using high-capacity accumulator systems.
2. obey safety standards when interacting with accumulators;	1. Knowledge of relevant safety standards, including the use of insulated tools and, dangers of wearing metallic items such as watches and bracelets. 2. Knowledge of applicable safety equipment, procedures (including stock taking of risks and risk-evaluation) and personal protective equipment (e.g. protective eye - glasses and protective clothing). 3. Knowledge of basic accumulator theory (e.g. the effects of uneven charging/discharging of coupled accumulators, frequent used accumulator chemistries.) 4. Knowledge on the prevention of short circuits, too deep discharges, and too high charge currents. 5. Knowledge of risks when interacting with damaged accumulator cells. 6. Knowledge of the environmental conditions for storage and usage of accumulators. 7. Knowledge of the need for battery management systems and the effects of uneven charging/discharging of coupled accumulators. 8. Ability to conduct stock taking of risks and risk-evaluation. 9. Ability to provide first aid in case of contact with uncovered accumulator material such as electrolyte or powder on the skin or in the eyes. 10. Ability to instruct and monitor crew on safety standards when interacting with accumulators.
3. handle fire and explosion hazards.	1. Knowledge of risk avoidance measure of fire when interacting with accumulators including preparation of areas to handle fire and explosion hazards and tools needed to mitigate incidents. 2. Knowledge of failure modes of accumulators (e.g. thermal runaway, over charging, deep discharging, off gassing). 3. Ability to use proper fire extinguishing equipment or trigger the fire extinguishing system on burning accumulators. 4. Ability to prevent spreading of thermal runaway on board. 5. Ability to handle accumulators affected by a thermal runaway and to evacuate it on shore for external connection and additional foam supply in due time.

	6. Ability to take cooling measures in the accumulator room.

2.1 Competences for charging/ exchange procedure (bunkering)

The expert should be able to:

COLUMN 1 COMPETENCE	COLUMN 2 KNOWLEDGE AND SKILLS
1. operate the systems specific to high-capacity accumulator systems to on board systems in a safe way.	1. Knowledge of technical aspects of accumulator charging / exchange systems such as • general configuration and operating manual, • charging system and earthing concept of the installation, • exchange containment system, • safety measures, • electrical wiring and switching system, • battery management system, • redundancy and system protection concept, • ventilation system, • switches and fuses, • control, surveillance and safety systems, alarms and ready-to-use fire protection systems. 2. Ability to verify proper functioning of the components of the charging and exchange systems. 3. Ability to properly respond to alarms and taking necessary actions including registering and notifying the boatmaster. 4. Ability to operate accumulator systems taking into account applicable technical aspects.

2.2 Competences to perform regular checks and maintenance

The expert shall be able to:

COLUMN 1 COMPETENCE	COLUMN 2 KNOWLEDGE AND SKILLS
1. perform and monitor regular checks and maintenance of the accumulator system.	1. Knowledge of procedures for maintenance and monitoring of the high-capacity accumulator system, including those that have to be done by specially trained personnel. 2. Knowledge of possible malfunction and alarms in accordance with manufacturers' instructions. 3. Ability to perform the allowed daily maintenance, weekly maintenance, regular periodic maintenance. 4. Ability to correct malfunctions and to document checks and maintenance work.

3. Competences linked to the use of fuel cell systems on board

3.0 General competences linked to the use of fuel cell systems onboard

The expert shall be able to:

COLUMN 1 COMPETENCE	COLUMN 2 KNOWLEDGE AND SKILLS
1. ensure compliance with relevant legislation, standards and manufacturer's instructions applicable to craft using a fuel cell;	1. Knowledge of regulations and technical requirements related to craft using a fuel cell such as relevant police regulations and relevant regulations on technical requirements. 2. Knowledge of manufacturer's instructions for fuel cell use. 3. Knowledge of the applicable safety concept used in classification society rules on fuel cell use. 4. Ability to instruct and monitor crew members' operations in order to ensure compliance with applicable legislation, standards and instructions, including applicable individual derogations containing additional provisions and precautions to prevent incidents and protect crew, craft and environment.
2. ensure compliance with other relevant health and safety regulations when sailing and moored.	1. Knowledge of relevant health and safety regulations. 2. Ability to instruct and monitor crew members' operations in order to ensure compliance with relevant health and safety regulations.

3.1 Operation of the fuel cell system

The expert shall be able to:

COLUMN 1 COMPETENCE	COLUMN 2 KNOWLEDGE AND SKILLS
1. operate the systems specific to fuel cell systems on-board systems in a safe way.	1. Knowledge of different kinds of fuel cells e.g.) proton exchange membrane fuel cell (PEMFC), solid oxide fuel cell (SOFC), direct methanol fuel cell (DMFC). 2. Knowledge of fuels used in fuel cells, e.g. hydrogen, ammonia, methanol • key properties and characteristics • related hazards • explosive limits, flashpoint • storage conditions for solid or gaseous liquid form according to requirements laid down for storage in ES-TRIN or recommendations concerning the used mediums • by /waste products and carrier mediums. 3. Knowledge of the systems required to operate a fuel cell. 4. Knowledge of the components and functionality of each fuel cell system (e.g. compressor, cell stack, AC-DC converter, reformer, inerting gas system). 5. Ability to deal with hazards related to fuels in fuel cells. 6. Ability to operate specific systems of fuel cells.

3.2 Daily maintenance of the fuel cell system

The expert shall be able to:

COLUMN 1 COMPETENCE	COLUMN 2 KNOWLEDGE AND SKILLS
1. recognise specific points of attention related to the specific characteristics of the fuel cell;	1. Knowledge of definition, composition and quality attributes of the fuel used in the fuel cell, physical properties and characteristics of the product and environmental characteristics. 2. Ability to respect characteristics of fuels used in daily operation. 3. Ability to verify characteristics with design parameters and perform corrections in line with specific storage conditions if needed.
2. recognise risks and manage them.	1. Knowledge of safety plans, hazards and risk, including knowledge of muster list and the related safety tasks, as well as the relevant documents regarding on-board safety in terms of ex-zones and safety instructions. 2. Ability to perform emergency shut down and blow off procedures. 3. Ability to conduct risk management and to assess and control dangerous areas, fire safety and to use personal protective equipment.

4. Competences linked to the use and storage of fuels for own propulsion or vessel operation other than diesel and LNG on board

4.1 Competences linked to the use of cryogenic gaseous fuels

The expert shall be able to:

COLUMN 1 COMPETENCE	COLUMN 2 KNOWLEDGE AND SKILLS
1. ensure compliance with relevant legislation, standards and manufacturer's instructions applicable to craft using propulsion systems using cryogenic gaseous fuels;	1. Knowledge of regulations and standards relating to craft using cryogenic fuels as energy storage for propulsion and auxiliary systems such as relevant police regulations, the relevant regulations on the precautionary measures to be taken according to the ADN for such substances or products. 2. Knowledge of manufacturer's instruction for maintenance and safe operation of such systems. 3. Knowledge of the applicable safety concept used in classification society rules. 4. Ability to instruct and monitor crew member operations in order to ensure compliance with legislation, standards and manufacturer's instructions applicable to craft using cryogenic systems on board the craft and in particular with the bunkering procedure. 5. Ability to perform safe bunkering procedure.

2. obey safety standards when interacting with cryogenic gaseous fuels;	1. Knowledge of relevant functional, operational and safety standards (e.g. thermal protection, avoiding thermal shocks to equipment, functioning of pressure relief valves, boil-off…). 2. Knowledge of the specific properties attached to cryogenic gaseous fuels e.g. temperatures, effect on equipment materials, boil-off effect. 3. Knowledge on the avoidance of explosive atmospheres. 4. Knowledge of the basic features and lay out of the fuel storage systems and the options frequently used on vessels in operation. 5. Knowledge of applicable safety equipment and personal protective equipment (i.e. protective eye – glasses and protective clothing). 6. Knowledge of possible malfunction and alarms and how to react on them, and any other emergency stop options, especially the master gas fuel valve. 7. Ability to conduct daily maintenance and monitoring of the cryogenic system including management of fuel boil-off, knowledge of maintenance and repair work that must be done by specially trained personnel. 8. Ability to perform allowed maintenance tasks, as specified by the manufacturer. 9. Ability to safely remedy or mitigate a spill or leakage, in liquid or gaseous form. 10. Ability to register and notify any (near) incident with the installation operating on board.
3. ensure compliance with other relevant health and safety regulations when sailing and moored;	1. Knowledge of relevant health and safety regulations including relevant local requirements and authorizations in particular in port areas. 2. Ability to instruct and monitor crew members' operations in order to ensure compliance with relevant health and safety regulations, including police regulations.
4. operate the systems specific to cryogenic gaseous fuels on board and connected to on-board systems in a safe way.	1. Knowledge of technical aspects of the cryogenic gaseous fuel system such as • general configuration and operating manual, • bunkering system, • spill control equipment, • containment system, • gas preparation system, • pipe system, • gas supply system, • engine room concept, • ventilation system, • temperature and pressure (how to read a pressure and temperature distribution chart), • valves (in particular, the main gas fuel valve), pressure relief valves, • control, surveillance and safety systems, alarms, gas detection and dry breakaway couplings. 2. Ability to perform and supervise bunkering procedures in order to ensure a safe operation, taking into account the correct use of personal safety equipment and the strict adherence to safety procedures. 3. Ability to fill in mandatory bunkering checklists.

4.2 Competences linked to the use of non-cryogenic gaseous fuels

The expert shall be able to:

COLUMN 1 COMPETENCE	COLUMN 2 KNOWLEDGE AND SKILLS
1. ensure compliance with relevant legislation and standards applicable to craft using propulsion systems using non-cryogenic gaseous fuels;	1. Knowledge of regulations relating to craft using gaseous fuels for propulsion and auxiliary systems such as relevant police regulations, relevant regulations on technical requirements and the precautionary measures to be taken to safely operate equipment described in ES-TRIN. 2. Knowledge of the applicable safety concept used in classification society rules. 3. Ability to instruct and monitor crew members' operations in order to ensure compliance with legislation and standards applicable to craft using gas as a fuel on board the craft and in particular with the bunkering procedure.
2. obey safety standards when interacting with non-cryogenic gaseous fuels;	1. Knowledge of relevant functional, operational and safety standards. 2. Knowledge of the basic features, lay out of the fuel storage systems and measures to ensure gas tightness. 3. Knowledge of ventilation systems. 4. Knowledge of applicable safety equipment and personal protective equipment e.g., protective eye - glasses and protective clothing, gas detector). 5. Knowledge of possible malfunction and alarms and how to react on them, especially the use of master gas fuel valve. 6. Ability to operate ventilation systems. 7. Ability to conduct daily maintenance and monitoring of the system including knowledge of maintenance and repair work that must be done by specially trained personnel. 8. Ability to perform allowed maintenance tasks. 9. Ability to safely remedy or mitigate a spill.
3. ensure compliance with other relevant health and safety regulations when sailing and moored;	1. Knowledge of relevant health and safety regulations including relevant local requirements and authorizations in particular in port areas, complying with the applicable local minimum safety distances. 2. Ability to instruct and monitor crew members' operations in order to ensure compliance with relevant health and safety regulations.
4. operate the systems specific to gaseous fuels on board and connected to on board systems in a safe way.	1. Knowledge of technical aspects of the gaseous fuel system such as • general configuration and operating manual, • bunkering system, • spill control equipment, • containment system, • gas preparation system, • pipe system, • gas supply system, • engine room concept, • ventilation system, • temperature and pressure (how to read a pressure and temperature distribution chart), • valves (in particular, the main gas fuel valve), pressure relief valves, • control, surveillance and safety systems, alarms, gas detection and dry breakaway couplings. 2. Ability to prevent leakage and to understand malfunctions and to instruct and monitor crew members' activities during the general operation of the fuel system, especially during bunkering procedures in order to ensure a safe operation. Taking into account the correct use of personal safety equipment and the strict adherence to safety procedures.

4.3 Competences linked to the use of liquid fuels

The expert shall be able to:

COLUMN 1 COMPETENCE	COLUMN 2 KNOWLEDGE AND SKILLS
1. ensure compliance with relevant legislation and standards applicable to craft using propulsion systems using liquid fuels;	1. Knowledge of regulations relating to craft using liquid fuels, such as methanol, for propulsion and auxiliary systems such as relevant police regulations, the relevant regulations on the precautionary measures to be taken to safely operate technical requirements described in ES-TRIN. 2. Knowledge of the applicable safety concept used in classification society rules. 3. Ability to instruct and monitor crew members' operations in order to ensure compliance with legislation and standards applicable to craft using liquid fuel on board the craft and in particular with the bunkering procedure involving flammable liquids.
2. obey safety standards when interacting with liquid fuels;	1. Knowledge of relevant functional, operational and safety standards. 2. Knowledge of applicable safety equipment and the ability to use it (i.e. protective eye - glasses and protective clothing). 1. Knowledge of possible malfunction and alarms and how to react on them, especially the use of emergency stop e.g. the master fuel valve. 2. Knowledge on the avoidance and remediation of spills when handling liquid fuels. 3. Ability to perform daily control and maintenance on the fuel system. 4. Ability to use the correct bunker connections for various liquids. 5. Ability to deal with spills with a view to possible toxicity of some of the proposed liquid fuels, especially in case of leakage below deck.
3. ensure compliance with other relevant health and safety regulations when sailing and moored;	1. Knowledge of relevant health and safety regulations including relevant local requirements and authorizations in particular in port areas. 2. Ability to prevent leakage. 3. Ability to react on malfunctions and to instruct and monitor crew members' activities during the general operation of the fuel system, especially during bunkering procedures in order to ensure a safe operation, taking into account the correct use of personal safety equipment and the strict adherence to safety procedures, including reporting procedures for (near) incidents, spills and failures during bunkering operations.
4. operate the systems specific to liquid fuels on-board and connected to on board systems in a safe way.	1. Knowledge of technical and operational aspects of the fuel system such as • general configuration and operating manual, • bunkering system, • spill control equipment, • containment system, • gas preparation system, • pipe system, • gas supply system, • engine room concept and fuel cell room for direct methanol fuel cell, • ventilation system, • temperature and pressure (how to read a pressure and temperature distribution chart), • valves (in particular, the main gas fuel valve), pressure relief valves, • control, surveillance and safety systems, alarms, gas detection and dry breakaway couplings. 2. Ability to respect bunkering check list. 3. Ability to prevent leakage and to understand malfunctions and to instruct

	and monitor crew members' activities during the general operation of the fuel system, especially during bunkering procedures in order to ensure a safe operation, taking into account the correct use of personal safety equipment and the strict adherence to safety procedures.

4.4 Reaction product / depleted energy carrier medium

The expert should be able to:

COLUMN 1 COMPETENCE	COLUMN 2 KNOWLEDGE AND SKILLS
1. ensure compliance with relevant legislation and standards applicable to craft using propulsion systems producing reaction products and or depleted energy carrier medium;	1. Knowledge of regulations relating to propulsion and auxiliary systems producing reaction products such as relevant police regulations, the relevant regulations on the precautionary measures to be taken to safely operate technical equipment described in ES-TRIN. 2. Knowledge of the safe disposal/return of reaction products and/or depleted energy carrier medium, such as LOHC. 3. Ability to perform offloading/recycling procedures in compliance with legislation and standards applicable to systems producing reaction products on board the craft and in particular with the offloading/recycling procedure. 4. Ability to monitor crew members' operations in order to ensure compliance with legislation and standards applicable to systems producing reaction products on board the craft and in particular with the offloading/recycling procedure.
2. Obey safety standards when interacting with reaction products of solid or liquid fuels;	1. Knowledge of relevant safety standards including applicable individual derogations containing additional provisions and precaution measures to prevent incidents and protect crew, craft and environment. 2. Ability to use required safety equipment (i.e. protective eye - glasses and protective clothing). 3. Ability to apply relevant safety standards. 4. Knowledge on the avoidance and remediation of spills.
3. ensure compliance with other relevant health and safety regulations when sailing and moored;	1. Knowledge of relevant health and safety regulations including relevant local requirements and authorizations in particular in port areas. 2. Ability to instruct and monitor crew member operations in order to ensure compliance with other relevant health and safety regulations.
4. operate the systems specific to reaction products and or depleted energy carrier mediums and connected to on-board systems in a safe way.	1. Knowledge of technical aspects of the reaction products and or depleted energy carrier medium system such as • general configuration and operating manual, • storage and disposal system, • spill control equipment, • containment system, • pipe/ conveyor system, • engine room concept, • ventilation system. 2. Ability to operate systems producing reaction products taking into account applicable technical aspects.

3. Development of competence tables (main points of discussion in CESNI/QP)

3.1. Need for specific qualification or integration of new competence into existing training schedules

When developing new competences for crew members and personnel involved in the bunkering procedure of craft propelled by Liquefied Natural Gas (LNG), the decision was made, to create a standalone certification trajectory aiming to become an "LNG expert". This is considered an additional qualification that must be obtained on top of an existing professional qualification as a boatmaster or obtained for personnel that is not a boatmaster, but is involved in the bunkering procedures of LNG propelled craft. The example of the LNG expert as first defined in Regulations for Personnel Navigating on the Rhine (RPN) and then specified in Directive (EU) 2017/2397 on professional qualifications in inland navigation could serve as a blueprint for new competences for alternative and zero-emission fuels defined in a **specific qualification** as set out in ES-QIN[14] (option 1).

A second option could be to integrate the specific competence needed for operating and bunkering craft propelled with alternative or zero-emission energies in the **general set of competence of a boatmaster**, as laid down in ES-QIN (option 2). It can be assumed that the use of alternative fuels and electric propulsion and auxiliary systems on board IWT craft will become more widespread in future. Electric propulsion in combination with battery packs and/or generators (running on alternative fuels) are most likely to play a main role in future propulsion systems. It could therefore desirable to include this topic into the existing training and examination trajectories that lead to professional qualifications in IWT instead of creating separate specialist courses for each alternative fuel- and propulsion system.

After discussion with government experts and social partners at the CESNI/QP meetings in October 2021 and February 2022, the draft tables of competence have been drafted according to option 1.

Experts argued that currently only very few pilot projects (e.g. motor vessel MAAS, pushboat ELEKTRA) are in operation and allow the exercise of the new competence related to hydrogen and batteries. Other pilot projects related to methanol have already been approved by technical experts and await delegated act to be published by European Commission. Even though some concrete training schemes and mitigation measures have been agreed by technical experts allowing the pilot operation, several safety measures may still have to be defined in more detail and will need evaluation (as it was done with the LNG craft). The outcome of these procedures could be useful to finalise the draft standards for competence. Experts also find that a modular approach could target specific dangers related to electricity that differ substantially from dangers that are specific to fuels such as methanol.

Experts found that option 1 also should be preferred with a view to addressing persons providing external help on shore for crew members when performing some bunkering/battery replacement activities (e.g. in ports often used for such activities/potential hubs for alternative/zero emission fuels). Such personnel cannot be addressed by an integration of new competence in general nautical skills, as the concerned persons are no crew members. A specific training for shore based or company-related personnel may offer additional perspectives for persons wishing to work in the IWT sector.

In May 2022, during the CESNI/QP meeting in Berlin, experts took note of a report from a DG MOVE expert on the legal framework of new qualifications of specific authorisations under the new legal framework as a preliminary finding with a view to the possibility to establish new specific authorisations for boatmasters sailing craft propelled

[14] https://www.cesni.eu/wp-content/uploads/2020/03/ES-QIN_2019_en.pdf

by alternative/zero emission fuels. According to this information, the imperative of safety and the protection of the environment allows for additional competence requirements not covered by the current legal framework of professional qualifications in inland navigation.

During the same meeting, CESNI/QP experts have also decided that design and dimensions of alternative or zero emission propulsion systems should be addressed in standards of competence for entrepreneurs in inland waterway transport.

3.2. Specific content and elements of the competence tables

1- Basic maintenance and monitoring

In the currently existing training and certification schemes, there is an emphasis on the ability of the crew to perform maintenance and repair work on the (Diesel-) propulsion system. This requires in depth knowledge and understanding of these quite complex mechanical systems. This may not be expected to be done at the same level with most of the upcoming alternative propulsion systems, since they are even more complex. According to the new draft competence tables, daily monitoring and maintenance tasks should certainly remain an integral part of the education and training schemes. At the same time, it should be clear, that more complex maintenance and repairs should be done by certified personnel. For the IWT professional, it is of utmost importance to know, where to find the line between monitoring and daily maintenance and work that has to be done by a certified professional. This line should be reflected in mitigation measures to take and in (practical) examination that could be needed to obtain the qualification of an expert for (one or more) alternative or zero-emission fuels.

2- Understanding electrical and high voltage systems

Since most of the currently developed and/or proposed propulsion systems are using high current/high voltage electricity (fuel cells/ batteries/ alternative fuel powered generators), there is a need for an improved set of competences for the work with high voltage/high current systems on board inland craft. For instance, with a view to firefighting, expert recommend not to use water, but not a burning metals extinguisher, foam or CO2 fire extinguisher.

3- Fire extinguishing of burning LI-ION accumulators

LI-ION accumulators are burning differently than a carbon fuelled fire. Extinguishing is much more challenging and require different firefighting tactics. At this point in time, cooling down the burning accumulator cell with water (or foam) is common practice. When the process of cooling is interrupted too early, the accumulator cell will ignite again when exposed to an atmosphere that facilitates combustion. The cooling process therefore takes a lot of time and must be thoroughly monitored. This is - of course - not ideal in a situation, where the accumulator is installed in a craft's hull since introducing ample amounts of water into the battery storage room may lead to the instability of the craft and will damage adjacent systems which may not be affected by a fire.

4- Hydrogen storage

The existing pilot projects using hydrogen as a fuel for fuel cells share the same method of bunkering and storing the fuel on board of the craft. Standardized bottle-racks containing pressurizes gaseous hydrogen. This is not because this is the most economic and advantageous method to do so, but a currently used option that guarantees safe handling and common availability at this moment. It would be highly desirable to bunker and store liquid hydrogen on board, since the density of liquid hydrogen is much higher. There are currently no certified cryogenic tanks for IWT craft available yet. Experience from the maritime sector shows that the cost of the entire installation might be a considered as quite high and even more problematic than certification. The current derogation scheme in inland navigation would allow to accept non-certified tanks. This is an additional option to be considered by the sector.

5- Repeating training schedule due to continuous development of propulsion systems and energy carriers

There are currently about 28,000 people working in nautical jobs in European IWT which need to be trained and subsequently attend refresher/upskilling courses.

In terms of the development of low/zero emission propulsion and auxiliary systems for inland navigation, new proposals are presented in high frequency. It is therefore not clear, which system will be predominant in the future - if there will be a predominant/standard propulsion system at all. Probably, there will not be a "one size fits all" solution. It is highly likely that we can expect a mixture of systems.[15] It is therefore not possible that a new entrant into the sector can gain all the required knowledge during the initial education/training and certification trajectory at the beginning of the IWT career. The current system related to certificates of qualification for IWT in Europe does not ask for regular mandatory refreshing courses like the code 95 for road transport, for instance. The introduction of such a regime could be desirable[16], since acquiring the necessary competences can't be considered as a one-off course. The development in the field of propulsion (much like in the field of digitalization) is way to dynamic. Craft that have entered the market with sailing patterns optimised for the use of a specific alternative fuel may have to be operated according to different contract and sailing conditions that may require adoption of the concept for optimal energy use. Such concepts are generally known by boatmasters who are able to operate vessels in an economically and ecologically sound way according to ES-QIN 2019 when it comes to conventional diesel propulsion.

It could be of utmost importance that these competences are kept up to date on a regular basis and feed into refresher classes, following the example of the LNG expert[17]. Under the competence-based approach for LNG experts that is applicable since 18 January 2022, an LNG expert has to proof navigation time of 180 days during previous five years or 90 days during the previous year or meet the standards of competence for LNG experts as set out in ES-QIN.

Conclusions

First exchanges at CESNI/QP level, that have also been followed by the chairman of the permanent working group CESNI/PT on technical requirements for inland navigation vessels as well as by the chairman of the group of classification societies, provided first indications for the content of competence tables. These tables still have to be reconsidered by the relevant fora in CESNI and have to be submitted to the Committee, taking into account progress made at the level of ES-TRIN in the dynamic field of new fuels, energy carriers and their storage[18].

As progress of pilot projects that are manifold in terms of used fuels and technology has shown and as shown also in the CCNR study on energy transition in inland navigation, there does not seem to be a "one size fits all" solution for future alternative fuels or energy carriers. This is why further reflections should be given on how these competences fit into the framework of practical and theoretical examination and how and if CESNI Member States wish to impose a framework for certification of competence. These tasks may be addressed in PLATINA3 as far as CESNI work is concerned and could be feeding into a roadmap for the implementation of new competences and requirements for examination.

[15] See e.g. results from study on energy transition in IWT as well the emission roadmap, published on CCNR website https://ccr-zkr.org/12080000-en.html#04

[16] See Deliverable 3.2 of the PLATINA3 project.

[17] Annex I point 4.2 of Directive (EU) 2017/2397 and identical requirement in new RPN

[18] See timeline approved by CESNI - https://www.cesni.eu/wp-content/uploads/2022/04/Timeline-alternative-fuels.png

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Project coordination	Stichting Projecten Binnenvaart
Contact	info@PLATINA3.eu

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