# GUIDELINES

# COMPETENCE REQUIREMENTS FOR THE OPERATION OF CRAFT WITH AN **ELECTRICAL POWER SUPPLY FOR PROPULSION**

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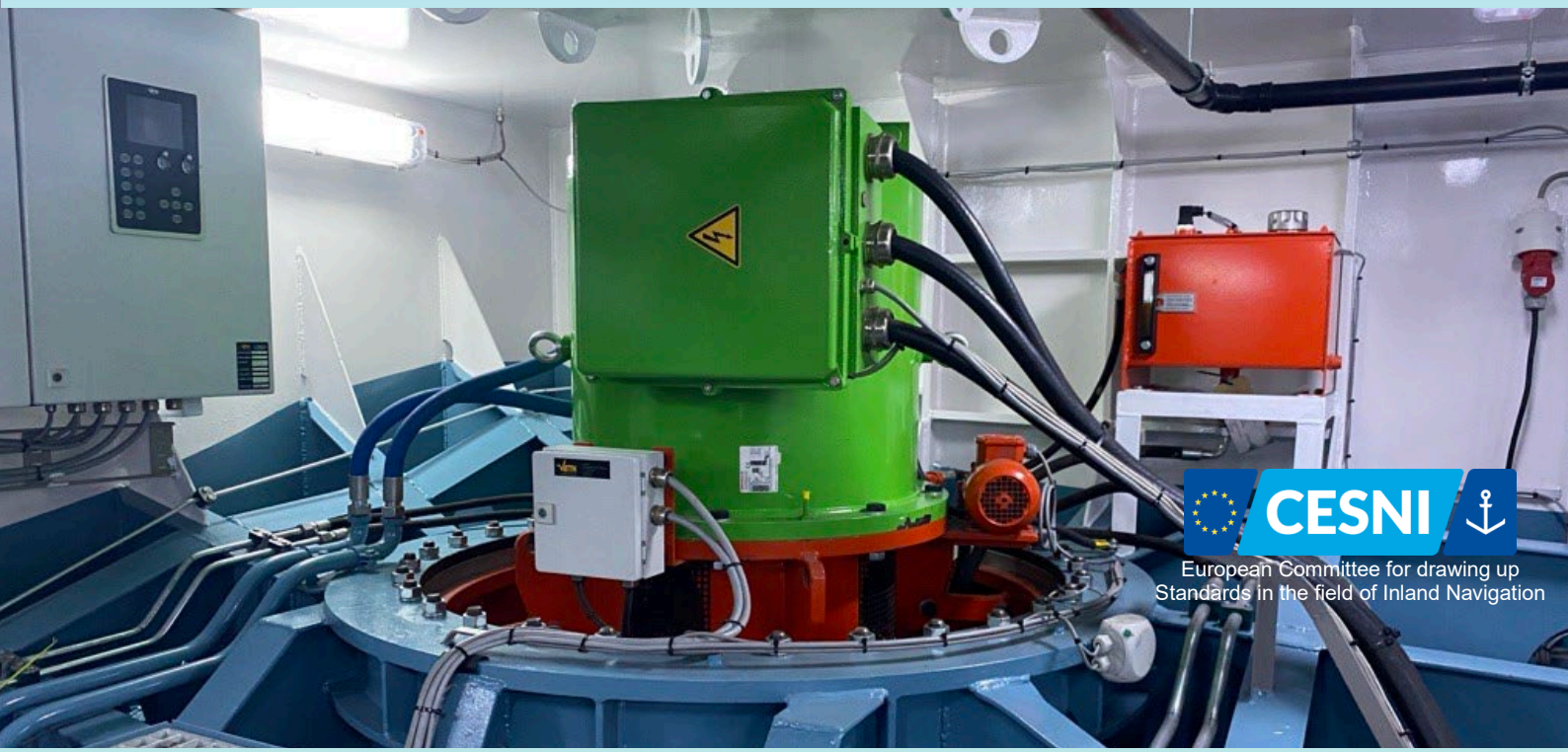

CESNI
European Committee for drawing up Standards in the field of Inland Navigation

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# PART I
# INTRODUCTION

## 1. Objectives and addressees

The CESNI Working group on professional qualifications drew up guidelines for competences for the operation of craft with an electrical power supply for propulsion.
The guidelines provide a list of minimum competence requirements for specialised persons (on board and/or on-shore) who will have to

1) be familiar with the specific risks associated with the new technology they will be handling;
2) familiarise other persons involved (on land or on board), in an instructive function;
3) detect situations likely to result in an accident;
4) detect when an incident has occurred and assess the risks for the vessel and the crew;
5) take immediate protective measures in the event of an incident.

CESNI experts identified the following risks for the operation of craft with an electrical power supply for propulsion:

- **Lithium-ion batteries**: focus is put on craft equipped with lithium-ion batteries for propulsion as risks are linked to lithium-ion batteries; this does not prejudge that other battery technologies may be taken into account;
- **Thermal runaway**: potential fires caused by long chemical reaction can last several hours, if not days; the craft structure may be damaged;
- accumulation of explosive gas in case of fire may lead to **potential explosion**
- **Gas leakage**: in the battery room, gas may be released in case of cell failure. The crew access has to be restricted or the room has to be ventilated;
- **Electrical hazards** may cause injuries to the crew members (electrocution);
- **Incorrect connection** when using interchangeable contactors can be avoided with an automatic connection.

Other elements contributed to the elaboration of the guidelines:

- **Maintenance**: most of the maintenance is regularly carried out by specialised companies/individuals with specific certifications. In case of problems, these companies are called in. Daily maintenance on board which is the responsibility of the crew is limited or not necessary at all.
- **Swappable batteries**: incorrect handling of batteries can lead to damage and make them dangerous, so it is important to follow the instructions provided by the manufacturer.

- **Voltage**: the maximum authorised voltage is currently 690 volts according to ES-TRIN (article 10.06). It is appropriate to limit the scope of application to low voltage (1000 volts), as crew members are in most cases confronted with voltages below 1000v, without prejudice to situations where higher voltages are authorised, such as in the case of exemptions granted by inspection bodies or for recommendation requests.

The guidelines are intended to address first the training institutes and schools that train students in new technologies. They can also address craft owners, who are responsible for ensuring that the crew is trained in new technologies. They can also a useful source of information for insurance companies, which insure the crew against work-related accidents and are therefore likely to set requirements for crew members.

## 2. Definitions

1. "**craft with an electrical power supply for propulsion**": a craft which uses power from (at least one) electrical power source (generators*, batteries, fuel cells).
   **generators may use gas-oil, methanol, hydrogen or any other fuel.*

2. "**craft with batteries***": a craft whose (all or part of)** power supply for propulsion comes from batteries.
   A battery* is a rechargeable ***storage*** device for electrical energy on an electro-chemical basis.
   A battery* can be built-in or swappable.
   ** the term "accumulator" may also be used.*
   *** the use of battery can vary: from assistance to other energy sources (like fuel cell or engine) to full supply for the electric engines used for craft propulsion*

3. "**craft with fuel cells**": a craft whose power supply for propulsion (all or part of it) comes from fuel cells.
   A fuel cell is an energy ***converter*** in which, by oxidation, the chemical energy of the fuel (i.e. methanol or hydrogen) is directly converted to electrical and thermal energy.
   *(A craft with fuel cells is always equipped with batteries.)*

4. "**craft using methanol as fuel**": a craft for which methanol is used by the energy converter (combustion engine or fuel cell).

# PART II
# COMPETENCE TABLES

## 1. Competences for operation of craft with an electrical power supply for propulsion (general)

The specialised person shall be able to:

| COLUMN 1<br>COMPETENCE | COLUMN 2<br>KNOWLEDGE AND SKILLS |
|---|---|
| **1. ensure compliance with relevant legislation, standards and safety and maintenance instructions applicable to craft with an electrical power supply;** | 1. Knowledge of regulations relating to craft with an electrical power supply such as relevant police regulations and ES-TRIN.<br>2. Knowledge of safety and maintenance instructions from the manufacturer.<br>3. Ability to instruct and monitor crew member operations in order to ensure compliance with legislation, standards and instructions applicable to craft with an electrical power supply. |
| **2. ensure compliance with safety standards when operating a craft with an electrical power supply;** | 1. Knowledge of required safety equipment (e.g. tools with non-conductive separation) and personal protective equipment (e.g. eye protection and protective clothing).<br>2. Knowledge of basic electrical theory (including Alternating Current, Direct Current, parallel, series voltage, ampere).<br>3. Knowledge of generator, engine and transformer protection (e.g. circuit breakers, thermal relays, sensors).<br>4. Ability to ensure that all crew members act in a way that safety standards applicable on craft with an electrical power supply are respected. |
| **3. take necessary measures to avoid or mitigate safety hazards linked to the electrical power supply;** | 1. Knowledge of risk prevention measures when operating a craft with an electrical power supply.<br>2. Knowledge of the dangers of an electrical arc (e.g. welding of contacts, molten metal, blinding, plasma and ionised gas burns).<br>3. Knowledge of safe isolation procedures and operations that have to be done by specifically qualified maintenance personnel.<br>4. Ability to use appropriate fire extinguishing equipment on burning electrical equipment.<br>5. Ability to prevent or mitigate the dangers related to an electric arc. |

| COLUMN 1<br>COMPETENCE | COLUMN 2<br>KNOWLEDGE AND SKILLS |
|---|---|
| **4. operate craft with an electrical power supply.** | 1. Knowledge of signs of failure of the electric propulsion and steering system.<br>2. Knowledge of the rate of energy consumption when operating the craft.<br>3. Knowledge of risks related to daily maintenance.<br>4. Ability to detect failure modes based on the available parameters of an electric propulsion system (e.g. cooling water temperature, winding temperature, Ampere and Voltage levels).<br>5. Ability to regain steerageway to the craft in case of a failure of the power electronics or failure in the regulation and control of the propulsion system.<br>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).<br>7. Ability to conduct daily maintenance in a safe way. |

## 2. Competences for operation of craft using batteries for propulsion

### 2.0 General competences

The specialised person shall be able to:

| COLUMN 1<br>COMPETENCE | COLUMN 2<br>KNOWLEDGE AND SKILLS |
|---|---|
| **1. ensure compliance with relevant legislation, standards as well as safety and maintenance instructions applicable to craft with batteries;** | 1. Knowledge of regulations relating to craft with batteries as energy storage for the power supply such as relevant police regulations and ES-TRIN including the conditions to use and storage the batteries.<br>2. Knowledge of safety and maintenance instructions.<br>3. Ability to instruct and monitor crew member operations in order to ensure compliance with legislation, standards and instructions applicable to craft using batteries. |

| COLUMN 1<br>COMPETENCE | COLUMN 2<br>KNOWLEDGE AND SKILLS |
|---|---|
| **2. ensure compliance with safety standards when handling batteries;** | 1. Knowledge of relevant safety standards, including the use of insulated tools, and dangers of wearing metallic items such as watches and bracelets.<br>2. Knowledge of applicable safety equipment and procedures (including risk-inventarisation and risk-evaluation) and personal protective equipment (e.g. eye protection and protective clothing).<br>3. Knowledge of different characteristics of batteries (e.g. the effects of uneven charging/discharging of coupled batteries, chemical components frequently used in batteries).<br>4. Knowledge on the prevention of short circuits, excessive discharges, and too high charging currents.<br>5. Knowledge of risks when handling damaged battery cells.<br>6. Ability to perform first aid in case of contact with uncovered battery material such as electrolyte or powder on the skin or in the eyes.<br>7. Ability to instruct and monitor crew members' operations in order to ensure compliance with safety standards when handling batteries. |
| **3. Handle thermal runaway, fire and explosion hazards.** | 1. Knowledge of fire and explosion risk avoidance measures when handling batteries including preparation of areas to handle fire and explosion hazards and tools needed to mitigate incidents.<br>2. Knowledge of failure modes of batteries (e.g. thermal runaway, over charging, deep discharging, off gassing).<br>3. Ability to activate the fire extinguishing system on thermal runaway and burning batteries.<br>4. Ability to prevent spreading of thermal runaway and batteries fire on board.<br>5. Ability to take all necessary measures in case of burning batteries, including the long-lasting fires (e.g. take cooling and fire-fighting measures in the battery room). |

## 2.1 Competences for charging / swapping procedure

The specialised person shall be able to:

| COLUMN 1<br>COMPETENCE | COLUMN 2<br>KNOWLEDGE AND SKILLS |
|---|---|
| **1. operate the systems specific to batteries on board which are connected to on board systems in a safe way.** | 1. Knowledge of technical aspects of batteries charging / swapping such as<br>• general configuration and operating manual,<br>• charging system and earthing concept of the installation,<br>• swappable batteries,<br>• safety measures,<br>• electrical wiring and switching system,<br>• batteries management system,<br>• redundancy and system protection concept,<br>• ventilation system,<br>• switches and fuses,<br>• control, surveillance and safety systems, alarms and ready-to-use fire-fighting systems.<br>2. Knowledge of the manufacturer's instructions, especially for swappable batteries.<br>3. Ability to verify proper functioning of the components of the charging and swapping.<br>4. Ability to properly respond to alarms and taking necessary actions including registering and notifying the boatmaster.<br>5. Ability to operate batteries systems taking into account relevant technical aspects.<br>6. Ability to apply the manufacturer's instructions, especially for swappable batteries. |

## 2.2 Competences to perform regular checks and maintenance

The specialised person shall be able to:

| COLUMN 1<br>COMPETENCE | COLUMN 2<br>KNOWLEDGE AND SKILLS |
|---|---|
| **1. perform and monitor regular checks and maintenance of the batteries system.** | 1. Knowledge of procedures for maintenance and monitoring of the batteries system, including those that have to be done by specifically qualified maintenance personnel.<br>2. Knowledge of possible malfunction and alarms in accordance with manufacturer's instructions.<br>3. Ability to perform the allowed daily, weekly and regular periodic maintenance.<br>4. Ability to correct malfunctions and to document checks and maintenance work. |

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