

Appendix B

**General Design and Material
Requirements**

**for the
OPV3S Engineering, Design
and Construction**

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1 Document overview

This document describes the general requirements for the third batch of Offshore Patrol Vessels for the Portuguese Navy (OPV3S), focusing, in particular, in the interface requirements for electronic equipment and systems to be incorporated in the vessels, while fulfilling the operational requirements of the OPV platform.

The construction of the OPV is an ongoing program, of which two batches have already been built (four vessels), and a third batch (six vessels) is in process. The third batch will include modification originated from the operation of the two previous batches, as well as the intention to incorporate **SEnsors Weapons And COmmand & Control (SEWACO)** equipment and systems.

This document is organized by the requirements nature, including the following categories:

- Section 2 – Operational Employment;
- Section 3 – Survivability;
- Section 4 – Environmental Conditions;
- Section 5 – Signature;
- Section 6 – Construction;
- Section 7 – Power and Signalling.

2 Operational Employment related requirements

2.1 OPV Dimensional limits

The OPV must comply with the following main dimensions and dimensional limits:

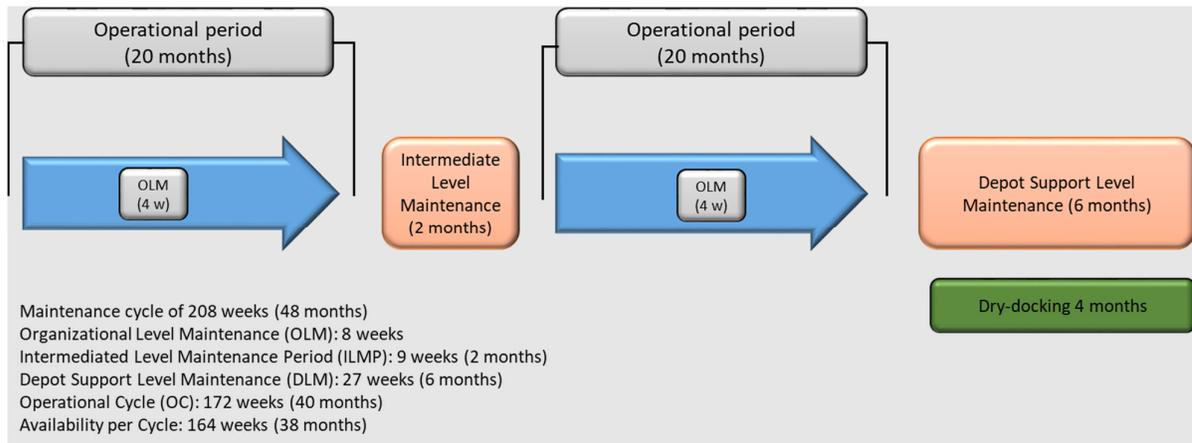
a. Length overall	83.10 m
b. Length on waterline	76.80 m
c. Breadth on waterline	12.26 m
d. Breadth maximum	12.95 m
e. Scantling draught	< 4.5 m
f. Depth (Main deck)	6.90 m
g. Depth (Deck 01)	9.60 m
h. Mast height	TBD
i. Scantling Displacement	TBD

2.2 Availability

The OPV must be designed for an operational life of at least 35 years.

The OPV and its systems must be designed taking into account maintenance cycles of 48 months (as in Figure 1), with an annual availability rate of 220 days and annual navigation time of approximately 2200 hours.

Figure 1 – Maintenance Cycle



2.3 Speed

The OPV must be able to operate in the following speeds:

- a. Maximum speed maintained over 20 knots;
- b. Cruise speed/operation speed between 13 and 15 knots;
- c. Minimum continuous speed below 2 knots.

2.4 Operational Speed Profile

The OPV and its systems must be designed to comply with the following operational speed profile:

- | | |
|--|------------------------|
| a. Speeds smaller than 13 knots | 30% of operation time; |
| b. Speeds between 13 and 15 knots | 50% of operation time; |
| c. Speeds between 15 knots and maximum sustained speed | 10% of operation time; |
| d. Maximum sustained speed | 10% of operation time. |

2.5 Autonomy

The OPV and its systems must be able to remain on mission at sea for periods of up to 30 days (complement of 67) or 20 days (complement of 112), with drinking water production.

The OPV must have a fuel autonomy of up to 14 days traveling at a speed of 15 knots (5000 nautical miles) maintaining a margin of fuel of 20%.

2.6 Manoeuvrability

The OPV must comply with all **IMO MSC 137(76)** - Standards for Ship Manoeuvrability, when navigating in Sea state 2 Douglas scale, wind force 2 Beaufort scale and depths over 110 meters, and the following additional requirements:

- a. The OPV must be able to perform a turning cycle manoeuvre at 20 knots, with a tactical diameter smaller than 5 x length and an advance smaller than 4.5 x length;
- b. The OPV must be able to perform crash stop manoeuvre within 4 x length;
- c. The OPV must be able to turn 360° about a fixed point;

- d. The OPV must be able to move sideways without advance;
- e. The OPV must have manoeuvring capability with speeds lower than 2 knots.

2.7 Environmental Safety

The OPV must comply with **IMO MARPOL Convention**, namely:

- a. Annex I – Regulation for the prevention of pollution by oil;
- b. Annex IV – Prevention of pollution by sewage from ships;
- c. Annex V – Prevention of pollution by garbage from ships;
- d. Annex VI – Prevention of air pollution from Ships (IMO Tier III level for at least one of its propulsion arrangements).

3 Survivability related requirements

3.1 Subdivision

The OPV is to be divided in four main fire zones (divided by A60 passive fire protection – in accordance with **IMO MSC 307(88) FTP Code**) and by ten watertight transverse bulkheads (from the keel up to the main deck). Each main fire zone must have its own segregated individual ventilation and electrical power distribution from their own Load Centers.

The OPV systems must not contradict the platform subdivision and must comply with the following requirements to maximize systems survivability:

- a. System(s) with no redundancy must have all its components concentrated in the same main-fire zone;
- b. Redundant systems should be located in different main fire zone, enabling the partial use of the system when one of the main-fire zones is lost;
- c. Redundant systems that must be located in the same main fire-zone must have electrical power supply from different main fire zones Load Centers.

3.2 Stability

The OPV must comply with **ITDINAV 802(A)** intact and damaged stability criteria for combatant ships (including the intact stability assessment when the ship is subjected to heeling moments produced by winds up to 100 knots), the damage stability assessment taking into consideration the eventual loss of two consecutive watertight compartments, and a future growth margin of 5%.

3.3 Watertightness and Gas tightness

3.3.1 External Watertightness

The OPV, including external systems and equipment, must be watertight up to heeling angles of 60° and all passageways, accesses or penetrations (including cable glands and cables passageways) from the exterior to the interior must be watertight up to a pressure of 70 kPa. There will be no openings in the hull bellow main decks, except for piping (drainage pipes, sea inlet pipes, and sea chests).

3.3.2 Internal Watertightness

There will be no openings in watertight bulkheads bellow main deck and between decks, except for the following watertight openings:

- a. Watertight hatches for normal passageway, cargo and equipment movement, and emergency escape routes;
- b. Watertight doors of the stair trunk;
- c. Two watertight doors to the cargo bay;
- d. Three watertight doors to the podded propulsion rooms;
- e. Watertight Piping and cabling penetrations.

3.3.3 Internal Gastightness

Gastight doors and passages must be used above main deck between main fire zones and in stair trunks, as well as for compartments with CO₂ fire-fighting systems and compartments with high military security requirements.

Bulkheads and decks piping penetrations above main deck, as well as non-watertight, bulkheads cabling penetrations must also be gastight.

3.4 Shock

Electrical and electronic equipment must remain operational and functioning when subjected to a load request equivalent to a "half-sine" type pulse, with 30g of maximum acceleration and 18 ms of duration, taking into account the mounts and/or shock absorbers effect, in accordance with the **IEC 60068-2-27 standard**. Foundations must be designed in accordance, and the equipment manufacturer must indicate the mounts and/or shock absorbers characteristics.

4 Environmental Conditions related requirements

4.1 Sea State operation Limits

The OPV must be able to conduct all missions with no limitations up to Sea state 5 Douglas scale, and to perform Safe and Rescue (SAR) missions up to Sea state 7 Douglas scale.

4.2 Ship motion angles

The OPV and all its systems must be operational without limitations under the following platform conditions, except when specifically approved by the END USER:

- a. Permanent trim angle by the stern of 5°;
- b. Permanent heeling angle of 15° to either side;
- c. Navigate with pitching angles up to 10°;
- d. Navigate with rolling angles up to 40° for both sides.

4.3 Environmental conditions (outside ship)

The OPV and all its systems must be operational without limitations under the following environmental conditions:

- a. Summer time environmental conditions:
 - i. Exterior air temperature 38°C;
 - ii. Exterior relative humidity 70%;
 - iii. Seawater temperature 30°C.
- b. Winter time environmental conditions:
 - i. Exterior air temperature -2°C;
 - ii. Exterior relative humidity 90%
 - iii. Seawater temperature 0°C.
- c. Salinity up to 39 ppmil
- d. Sea State (all equipment and systems) 5 Douglas scale
- e. Sea State (SAR related equipment) 7 Douglas scale

4.4 Open deck installed equipment - wind conditions

All open deck installed equipment must be capable of withstanding forces generated from winds up to 100 knots attached to their foundations, under the performance conditions and levels of degradation set out in the requirements for each individual system/ equipment.

4.5 Open deck installed equipment – green water loads

Open deck installed equipment must be protected from sea effects and must be capable of withstanding at least loads of 36kPa originated from green seas attached to their foundations, under the performance conditions and levels of degradation set out in the requirements for each individual system/ equipment. All shock mounts installed in the open deck must be provided with the relevant cover shield to protect the on-mount equipment against environmental conditions.

4.6 Open deck installed equipment – rain and lighting

All open deck installed equipment performance must comply with DNV operational limits related to rain and lightning.

4.7 Inside installed equipment - heating, ventilation and air condition (HVAC)

OPV equipment and systems installed inside the ship must be able to operate fully under the specified environmental conditions in Table 13 for each compartment ensured by the HVAC system, unless otherwise approved by the END USER:

Table **143** – Compartments environmental requirements

Compartment	Maximum temperature (°C)	Relative Humidity (%)	Minimum temperature (°C)
Habitational	25	35 to 65	20
Sickbay	25	35 to 65	20
Bridge and workspaces	25	35 to 65	20
Operations room, coms room and mast (interior)	25	35 to 65	20
Computer room	25	35 to 65	20
Electronic Equipment rooms	25	35 to 65	20
Machinery rooms	45	-	5
Cargo bay	25	35 to 65	20
Workshops	28	-	15
Storage rooms	32	-	0
Magazines and explosives store	26	< 80	0

If any equipment has specific requirements, such as dedicated fan coils or chilled water refrigeration requirements, these must be stated as soon as possible to be included in the HVAC calculations, and subjected to END USER approval (verify section [6.4.27.4.2](#)). HVAC calculations will be performed according to standards **ISO 7547** and **ISO 8861**.

4.8 Electric and Electronic Index of Protection

OPV equipment and systems installed, unless otherwise approved by the END USER, must have the minimum IP defined in Table 14, by the Classification Society rules, and within the standards **IEC 60529** and **IEC 60034-5**. The table identifies the correspondent IP depending on the type of equipment and its location.

Table 244 – Minimum IP requirements

Compartment	Component	IP
Machinery rooms	Lighting	55
	Transformers	44
	Control Switchboards /Equipment	44
	Communications and alarms systems/ equipment	55
	Junction boxes	67
	Sockets 440V	67
	Sockets 230V/ 115V	56
Open deck (exterior)	Lighting	66/67
	Communications and alarms systems/ equipment	66/67
	Junction boxes	66/67
	Sockets 440V	67
	Sockets 230V/ 115V	56
Bridge; Operations room; Communication room; Mast (interior)	Lighting	22
	Control Switchboards/ Equipment	22
	Communications and alarms systems/ equipment	67
	Junction boxes	67
	Sockets 230V/ 115V	22
Habitational, workspaces and other compartments above the main deck (inclusive)	Lighting	22
	Control Switchboards /Equipment	22/ 44
	Communications and alarms systems/ equipment	67
	Junction boxes	67
	Sockets 440V	67
	Sockets 230V/ 115V	20
Habitational, workspaces, storage compartments and other compartments bellow the main deck	Lighting	55
	Control Switchboards /Equipment	44
	Communications and alarms systems/ equipment	67
	Junction boxes	67
	Sockets 440V	67
	Sockets 230V/ 115V	56
Compartments EX (including magazines and explosives stores)	All components IP 67, in complement to other specific requirements for the compartment	

4.9 Storage – Equipment requirements

The SEWACO equipment must be able to withstand, without harmful consequences, storage in a temperature range of -10°C to 50°C.

4.10 Storage – spare parts requirements

Onboard spare parts of the SEWACO equipment must be able to be stored under the specified environmental conditions in Table 15 of the compartments ensured by the HAVC system, unless approved by the END USER:

Table 345 – Storage compartments environmental requirements

Compartment	Maximum temperature (°C)	Relative Humidity (%)	Minimum temperature (°C)
Storage rooms	32	-	0
Magazines and explosives store	26	< 80	0

5 Signature related requirements

5.1 Radar cross section (RCS)

Radar cross section must be reduced as much as possible by means of changing the geometrical profile of the open-deck equipment, without the use of any Radar Absorbing Material (RAM), taking into account the following guidelines:

- a. Elimination of any unnecessary holes, cavities or portholes;
- b. Elimination of unnecessary small components, including them in the main body of the equipment;
- c. Elimination of unnecessary components on the open deck, locating them in the interior;
- d. Maximize the transverse inclination towards the center line aiming to achieve an inclination of 12.5° with the vertical inwards;
- e. Maximize the longitudinal inclination towards amidships aiming to achieve an inclination of 15° with the vertical inwards.

5.2 Infrared (IR)

The infrared (IR) signature must be reduced as much as possible using standard insulation materials approved by the END USER, and certified according **IMO MSC.307(88)** Fire test Procedure (FTP) code certification.

5.3 Underwater noise

Underwater noise must be reduced as much as possible, and no equipment must be a source to significantly increase the OPV underwater noise, taking into account the following guidelines:

- a. Airborne noise reduction;
- b. Structural vibrations reduction by means of using adequate mounts;
- c. Installation of noise reduction insulation;
- d. Installation of viscoelastic materials to decks and flooring (if required);
- e. Adequate fixation of pipes and cables;
- f. Reduction of fluid velocity within pipes (if required).

5.3.1 Airborne noise

OPV air borne pressure noise in dB(A), measured according to **ISO 2923**, with Beaufort 3 winds at any speed and propulsion arrangement, must not exceed neither the limits stated STANAG 4293, nor the specified limits, in Table 16 for the following compartments:

Table **416** – Compartments airborne noise requirements

Compartment	Maximum sound pressure dB(A)
Sickbay	60
Habitational rooms (Officers and petty officers)	55
Habitational rooms (Ranks and cargo bay)	60
Bridge, Operations room and Communications room	60
Bridge wings	70
Damage Control Stations	65
Offices, Computer room, Electronic Equipment rooms, Main Switchboard forward and aft	65
Electrical and Electronics workshop	65
Ventilation rooms and Mechanical workshop	80
Machinery room Aft (4 generators running)	110
Machinery room Aft (2 generators running)	85
Machinery room Amidships and Forward	85
Podded propulsion rooms	85

Note: the noise level of each room depends on the number of equipment/systems installed inside. As a guideline, the individual noise level for individual components should not exceed more than 7 dB(A) below the noise requirement for the room.

5.3.2 Structural Vibrations

OPV structural vibration in the range from 1 to 80 Hz, measured according to ISO 20283-5, with Beaufort 3 winds at any speed and propulsion arrangement, must not exceed neither the limits stated in IACS Recommendation 132, nor the specified limits, in the Table 17 for the following compartments:

Table 547 – Compartments structural vibrations requirements

Compartment	Maximum vibrations in the 1 to 80 Hz range
Sickbay	3.5 mm/s RMS
Habitational rooms (Officers and petty officers)	4.0 mm/s RMS
Habitational rooms (Ranks and cargo bay)	4.5 mm/s RMS
Bridge, Operations room and Communications room	3.5 mm/s RMS
Bridge wings	5.0 mm/s RMS
Damage Control Stations	5.0 mm/s RMS
Offices, Computer room, Electronic Equipment rooms, Main Switchboard forward and aft	4.5 mm/s RMS
Electrical and Electronics workshop	4.5 mm/s RMS
Ventilation rooms and Mechanical workshop	5.0 mm/s RMS
Machinery room Aft (4 generators running)	6.0 mm/s RMS
Machinery room Aft (2 generators running)	5.0 mm/s RMS
Machinery room Amidships and Forward	5.0 mm/s RMS
Podded propulsion rooms	5.0 mm/s RMS
Any other location	15.0 mm/s RMS

Note: Structural vibrations can be reduced by proper selection of mounts that avoid transmitting vibrations from equipment to the structure, and avoids the phase of structural natural frequencies or vibrations excited by machinery (e.g. main generators) with the frequencies excited by the equipment or natural frequencies of the equipment/ mounts. No SEWACO system must influence the OPV in any way that prevents the fulfilment of such requirement.

6 Construction related requirements

6.1 Classification

The OPV and its systems (except SEWACO) will be classified according to the DNV (DNV, formerly DNV GL, is an international accredited registrar and classification society headquartered in Høvik, Norway) rules for classification of Naval Vessels, with ⚡ 1AN Patrol L classification for unrestricted service with additional notations for damage stability (SDS), structural design (RDS), fire safety (SFP) and electromagnetic compatibility (EMC). No SEWACO system must influence the OPV in any way that prevents the attribution of such a classification.

6.2 Design engineering rules

The design and engineering rules must comply with the Class rules identified in the previous paragraph (6.17.4), the recommendations of the International Maritime Organization (IMO), International Association of Classification Societies (IACS) recommendations, European Union (EU) Directives and other Standards mentioned in this document. In the case of any contradictions in between the different rules, END USER to decide which requirements will be followed.

6.3 Structural works

Structural works of any kind must be done using certified materials, by certified workers, and using welding certified procedures by a classification society belonging to IACS (certificates to be presented upon request), taking into account the following rules/ standards/ recommendations and OPV details drawings:

- a. Structural steel grade A must be used, or Stainless steel AISI 316L, except if otherwise approved by the END USER;
- b. **IACS 47 Shipbuilding and Repair Quality Standards** - standard level or superior;
- c. **IACS URW** – Requirements concerning Materials and Welding;
- d. OPV Structural details drawing;
- e. OPV Welding table;
- f. OPV Details of structural reinforcements of auxiliary systems (piping and cabling) penetrations drawing;
- g. There should be no contact between different materials to avoid galvanic corrosion.

6.4 Piping works

Piping works of any kind must be done using certified materials, by certified workers, and using welding certified procedures by a classification society belonging to IACS (certificates to be presented upon request), taking into account the following rules/ standards/ recommendations and OPV details drawings:

- a. IACS Unified Requirements P1: Rules for pipes, and P2: Rules for piping design, construction and testing;
- b. IACS URW – Requirements concerning Materials and Welding;
- c. OPV Details of structural components passageways and penetration elements for auxiliary systems;
- d. OPV Fixation of auxiliary systems details drawing;
- e. OPV Pipes fabrication details and standard accessories drawing;
- f. OPV Pipes insulation details and standard insulation materials drawing;
- g. There should be no contact between different materials to avoid galvanic corrosion;

- h. Materials to be used in the different auxiliary systems are specified in section [6.107.10](#), any other materials are subjected to END USER approval.

6.4.1 Auxiliary systems – salt-water

The OPV has a fire-fighting salt-water circuit permanently pressurized to 9 bar that must not be used for normal refrigeration purposes.

Any salt-water refrigeration requirements must be identified as soon as possible and subjected to END USER approval.

6.4.2 Auxiliary systems – fresh water

The OPV has a fresh drinking water circuit that must not be used for refrigeration purposes.

The OPV has a chilled water closed circuit that can be used for refrigeration purposes. Any chilled water refrigeration requirements must be identified as soon as possible and subjected to End User approval (see section [4.75.7](#)).

6.4.3 Auxiliary systems – compressed air

All electronic equipment compressed air requirements must be identified and should be compatible with the pressures available onboard or, alternatively, provide the necessary reductions. Available compressed air pressures onboard:

- a. Main circuit of 330 bar;
- b. Circuit branch for engine start of 30 bar or 40 bar;
- c. Circuit branch for general use of 6 bar.

6.4.4 Fixed fire extinguishing systems

The electric and electronic equipment own fire-extinguishing system (if required) must be compatible with following OPV installed fire-extinguishing systems:

- a. HiFog type or equivalent to machine rooms, and other compartments (unless incompatibilities are identified);
- b. CO₂ for the three electronic equipment rooms and Main Switchboard rooms;
- c. Fire trace type or equivalent for Load Centers and UPS;
- d. Condensed aerosol fire suppression systems applied to specific equipment;
- e. Salt water flooding applied to magazines and explosives stores.
- f. Any other systems, must be subject to END USER approval, and comply with SOLAS requirements and Classification Society rules, in accordance with their application.

6.5 Habitability

All structural, piping, electrical and outfitting works must be done maintaining the following habitability and ergonomic standards, safety directives and detailed OPV requirements:

- a. **ANEP – 24**: Guidelines for Ship Board Habitability;
- b. **ANEP – 26**: Ergonomic data for Shipboard Space Design in NATO Surface Ships

- c. All equipment must comply with the safety rules identified in **EU directive 2006/42/EC** – Machinery Directive, as long as their performance is not affected;
- d. Corridors outside compartments must have a minimum width of 1500 mm and height of 2100 mm, unless otherwise approved by the END USER;
- e. Passageways inside the compartments must have a minimum width of 660 mm and height of 1900 mm, unless otherwise approved by the END USER;
- f. Doors must have a minimum width of 660 mm and height of 1680 mm, unless otherwise approved by the END USER;
- g. Hatches must have round corners and a minimum size of 600 mm x 600 mm, unless otherwise approved by the END USER.

6.6 Outfitting works

Outfitting works must be done using **certified** materials, taking into account the following rules/ standards/ recommendations and OPV details drawings:

- a. All non-metallic materials must be **certified** according **IMO MSC.307(88) Fire test Procedure (FTP) code certification** and must be applied according to the OPV fire class location (*released to the supplier upon specific written again*);
- b. OPV Pavement types, location and installation details drawing (*released to the supplier upon specific written again*);
- c. OPV Bulkheads and ceiling insulation types, location and installation details drawing (*released to the supplier upon specific written again*);
- d. OPV Panels and decorative ceilings types, location and installation details drawing (*released to the supplier upon specific written again*);
- e. OPV Furniture materials, shape and installation details drawing (*released to the supplier upon specific written again*);
- f. OPV decorating plan (*released to the supplier upon specific written again*).

6.6.1 Protective surface treatments - Galvanization

Galvanized surfaces must have a minimum galvanized surface of 50 microns and must comply with the following standards and guidelines:

- a. ISO 14713-2 - Zinc coatings — Guidelines and recommendations for the protection against corrosion of iron and steel in structures — Part 2: Hot dip galvanizing;
- b. ISO 1461 - Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods;
- c. Pipes must only be galvanized after molding.

6.6.2 Protective Surface treatments – Painting

Painting systems applied to the OPV or to any of its equipment must be approved by the END USER, must have an operational life of 15 years with maintenance intervals not less than 5 years, and comply with the following standards and requirements:

- a. Corrosion protection level CX, according to **ISO 12944** (unless otherwise approved by the END USER);
- b. Steel preparation according to OPV standards, according to **ISO 8501-3** (OPV standards released to the supplier upon specific written again);
- c. Steel grade preparation St 3 or Sa 2.5, according to **ISO 8501-1**;
- d. **AEP- 59** – Application Process for Optimum Paint and Coatings Systems' Performance;
- e. **AEP- 60** – Performance Requirements for Exterior Topsides Coatings;
- f. **AEP- 61** – Performance Requirements for Underwater Hull Paint Systems;
- g. Application and quality verification according to **ISO 19840**.

6.6.3 Color of painted surfaces

Unless otherwise approved by the END USER, the colours to be applied on the ships, according to location, must be as below:

- a. Open deck structures – bulkheads and vertical structures grey colour BS631, pavement BS693 (including top of the bridge);
- b. Open deck equipment – grey colour BS631 or Black (RAL to be defined);
- c. Interior located switchboards – RAL 7035
- d. Interior located equipment (except switchboards) – according to the OPV decorating plan (released to the supplier upon specific written again).

6.7 Signaling, Nameplates and product markings

Labels and warning signs must be applied following international standards recommendations and the contractors experience, good practices and the following requirements:

- a. Signals and labels must be provided in Portuguese or English language;
- b. Open-deck installed equipment must not have any visible references to manufacturer or suppliers;
- c. Signals must comply, with **ISO 3864**, and **IMO/ MSC.A.1116(30) - 2017** Escape Route Signs and Equipment Location Markings;
- d. All electrical and electronic equipment with voltage above 50V must be properly marked with voltage value and danger of electrocution;
- e. All batteries storage compartments must be properly signaled;
- f. All electric equipment and systems must have all its power sources identified;
- g. All electric and electronic equipment with high-capacity capacitors must be properly identified;

- h. Equipment and equipment components must have identification plates (identifying its serial number, model, manufacturer and main characteristic), made in stainless steel AISI 316 L (in the exterior) or gravoply (in the interior), with round corners and securely fasten.

6.8 Vibration

Equipment Vibrations measured in all three axis must not surpass the limit values established by the classification society special vibration notations in machinery and components.

Preferably, vibrations must not surpass platform equipment requirements indicated in Table 18, defined while sailing at any propulsion regime, in wind force 3 Beaufort scale.

Table ~~648~~ – Equipment vibrations requirements

Equipment	Frequency range	Vibration values
Electric motors and centrifugal ventilators	2.0 – 100 Hz	5 mm/s
Pumps and centrifugal compressors	2.0 – 100 Hz	5 mm/s
Air Reductions	5.0 – 1000 Hz	5 mm/s
Hydraulic pumps and reciprocating compressors	3.2 – 100 Hz	10 mm/s

6.9 Accessibility

Equipment and systems must have access for operation and maintenance, observing the following requirements, which are going to be used to design the OPV internal layout:

- a. Space necessary for operation of equipment and systems must be assured, taking into consideration the habitability and ergonomic requirements stated in [6.57-5](#);
- b. Space around equipment necessary to maintain them (maintenance envelope), to fasten them to foundations, for ventilation and to operate peripheral circuits must be assured;
- c. Equipment and systems components subjected to periodical maintenance or catastrophic failure will be able to be removed from inside the OPV without any cut on its structure, namely racks and electronic equipment installed in the Computer Center, Operations Center, Communications room, Cypher room, and Mast.

6.9.1 Access – dimensions for operation

Access dimensions for operation of equipment, systems and peripheral circuits' components must comply with [ANEP 24](#) and [ANEP 26](#), as well as Classification Society rules.

6.9.2 Access – dimensions for maintenance

Dimensions of equipment and systems components subjected to maintenance must be, as much as possible, limited to be moved through the passageways mentioned in [6.57-5](#). Components with larger dimensions must be subject to END USER approval.

6.9.3 Transport

Equipment exceeding 10 kg must be fitted with handgrips or other provisions for transportation.

Equipment Exceeding 45 kg must be fitted with hoisting facilities.

During transportation, buttons and protruding parts must be sufficiently protected against damage.

6.10 Materials

Materials safety sheet must be delivered to the END USER for all applicable material and equipment, being possible for the END USER to reject materials based on the safety sheet content.

6.10.1 Piping materials

Piping materials must be **certified** and adequate for their use in accordance with the following guidelines:

- a. Salt-water piping must be made of CuNiFe (CuNi in the reverse osmosis system), valves made of bronze or monel, other accessories may be made of CuNiFe, bronze or monel;
- b. Compressed air and breathing air circuits piping must be made of stainless steel AIS 316L, as well as valves and other accessories;
- c. Hydraulic circuits must have pipes, valves and other accessories made of AISI 316L stainless steel, with joints protected with greased anti-corrosion tape in synthetic fiber and coated with neutral Vaseline;
- d. HiFog type fire extinguishing system must have pipes, valves and other accessories made of AISI 316L stainless steel seamless;
- e. All flexibles pipes and pipe extension joints must be certified to the working fluid, pressure and temperature of the circuit.

6.10.2 Outfitting materials

Outfitting materials must be **certified** and adequate to use in naval construction, namely:

- a. All furniture must be made of Aluminum or any other non-combustible material. Wooden furniture must be avoided;
- b. All insulation material, deck coverings, panels, ceiling, fabrics and other outfit material, must be non-combustible, fire retardant and non-toxic in the presence of flame. All must present the certificates in accordance with **IMO MSC.307(88) (2010 FTP CODE) issued by a Classification Society belonging to IACS**;
- c. All piping insulation materials must be adequate for the temperature insulation required and approved by the END USER.

6.10.3 Dangerous materials

The following materials must not be applied in the construction, or be part of any equipment or system:

- a. Asbestos and asbestos containing materials;
- b. Ozone Depleting like CFK11, CFK12 and Halon;

- c. Mercury and mercury-containing materials;
- d. Cadmium and cadmium-containing materials;
- e. Polycyclic aromatic hydrogen carbons, polychlorobiphenyls (PCB's) and polychlorotrifenyls (PCT's);
- f. Any substances known to be Carcinogenic, Reprotoxic, or Radioactive substances;
- g. Any refrigeration fluid that is not approved ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers), or that have the potential to be explosive in the presence of flame;
- h. Other hazardous substances used in electrical and electronic equipment specified in the Directive 011/ 65/ EU of the European Parliament.

7 Power and signaling requirements

7.1 Electrical installation

The OPV electrical installation must comply with the following requirements:

- a. Design rules establish by the International Electrotechnical Commission (IEC);
- b. **IEEE 45** - Recommended Practice for Electric Installations on Shipboard;
- c. **STANAG 1008** - Characteristics of shipboard 440V/230V/115V 60Hz, 440V/115V 400Hz and 24/28Vdc Electrical Power Systems in warships of the NATO navies;
- d. **ANEP 100** - Characteristics of shipboard 440V/230V/115V 60Hz ; 440V/115V 400Hz and 24/28Vdc Electrical Power Systems in warships of the NATO navies.

7.1.1 Available Power Supplies

The OPV has the following segregated power supply networks available:

- a. 440V, 60 Hz, three phase; unearthed;
- b. 115V, 60 Hz, three phase; unearthed;
- c. 115V, 60 Hz, two phase; unearthed;
- d. 230V, 60 Hz, two phase; unearthed;
- e. Other power supplies may be considered, subject to END USER approval.

7.1.2 Electric power limits

Any OPV equipment or system, individually, should not require more power than 50% of one of the smallest generators (approximately 250 kVA), during all stages of its operation. Any equipment that has a higher consumption must be identified as soon as possible, and subject to END USER approval.

7.1.3 Electric power quality

OPV electric power quality must comply with the STANAG 1008 standard. Any equipment or system that require more restrictive energy quality parameters must have its own protection component (without interfering with ship electrical installation).

7.1.4 Electric installation material requirements

Electric installation components must comply with the following requirements:

- a. Components made of aluminium or any aluminium alloy will not be accepted as part of the electric installation, but it may be considered as part of the equipment;
- b. Non-metallic components must comply with **UL94 V0** - Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliances testing;

7.1.5 Insulation Measurement

Equipment and Systems with electrical motors above 30 kW insulation resistance must be monitored and in the eventuality of low insulation resistance, an alarm should be actuated.

7.1.6 Distribution and protection

The electrical installation must provide protection for each equipment or system by means of switchboard components dimensioned in accordance with the equipment/ systems characteristics and power cabling characteristics. The protections will be designed in accordance with a selectivity study and short-circuit calculations (IEC 61363). Other protections must be subjected to END USER approval.

7.2 Electromagnetic Compatibility (EMC)/ Electromagnetic Interference (EMI)

7.2.1 General requirements

The OPV systems installed must comply with the following electromagnetic compatibility and electromagnetic interference standards:

- a. IEC 61000: Electromagnetic Compatibility (EMC);
- b. IEC 60533: Electrical and electronic installations in ships - Electromagnetic compatibility (EMC) - Ships with a metallic hull;
- c. IEC 60945: Maritime navigation and radio communication equipment and systems - General requirements - Methods of testing and required test results.

7.2.2 Specific requirements

For specific equipment, the mentioned standards must be applied to the OPV equipment:

- a. Command and control equipment and systems, computer networks - **MIL-STD-461**: Electromagnetic Interference Characteristics Requirements for Equipment; alternatively, the equipment and systems may be properly shielded;
- b. Command and Control of electric motors – **IEC 61800-3**;
- c. Uninterruptible power supply units – **IEC 62040-2**;
- d. Lighting components - European Standard (EN) **55015**;
- e. Lighting components near Navigation equipment - **IEC 60945**.

7.3 Electromagnetic Radiation (EMR) and Radiation Hazards (RADAHZ)

The OPV systems, electric and electronic equipment must be taken into account on the selection and allocation of the equipment, taking into account **MIL-STD-464**: Electromagnetic Environmental Effects, Requirements for Systems, and AECP-2: Naval Radio and Radar Radiation Hazards Manual.

- a. All of the following areas, and area limits, must be identified and characterized:
- b. Hazards of Electromagnetic Radiation to Personnel (HERP);
- c. Hazards of Electromagnetic Radiation to flammable liquids and fuels (HERF);
- d. Hazards of Electromagnetic Radiation to ordinances and ammunitions (HERO);
- e. Hazards of Electromagnetic Radiation to equipment (HERE).

7.3.1 Navigation systems Magnetic interference

The OPV Bridge top is built in Stainless Steel AISI 316-L to avoid magnetic interference with navigation equipment. Accordingly, no equipment must be installed in this location without prior knowledge and approval from the END USER.

7.4 Earthing

7.4.1 Safety earthing

All OPV electric and electronic equipment and components (including switchboards, switches and sockets) must have earth connection according with the following guidelines:

- a. Earth connection must be done to the steel structure and not to any panel/ ceiling, or other outfitting material;
- b. The earth must be made through an electrical cable with ring terminals, contact washer and locking system, fastened to the electrical component on one side and to the steel structure on the other, properly protected against corrosion.

7.4.2 ESD earthing points

Each cabinet with ESD sensitive devices must have two ESD earthing points (resistance to earth 1 M Ω) and must be clearly marked in accordance with **IEC 61340-5**.

7.4.3 EMC earthing

OPV electric and electronic equipment must be done in accordance with OEM instructions.

7.5 Cabling

7.5.1 General requirements

All cables must be defined by the electric and electronic equipment manufacturer, complying with the bellow general requirements:

- a. Will be flame retardant or above;
- b. Must comply with "low smoke" requirements;
- c. Must be halogen free;

- d. Must be dully marked in accordance with the equipment manufacturers technical documents;
- e. Expectation can be made for data communication cables like Category Cable (CAT), Field Bus cable and optical fiber.

7.5.2 Cable core list

A core list must be delivered, providing information on the cable core's utilization, including the following information:

- a. Cable and line identification;
- b. **Component/ Equipment/ System of origin and of destination;**
- c. Terminals of origin and of destination;
- d. Cable type and manufacturer identification.

Preferably, spare wires must be available in each signalling multi-core cable to allow repairs.

7.5.3 Connectors

Connectors must be equipped with EMC earthing cones. For making the connections between equipment, the equipment must be provided with receptacles. The appropriate mating connectors must be delivered by the supplier. Receptacles (with exception of those inside the equipment) which are not used must be provided with EMC and mechanically protective caps. Any exception must be approved by the END USER.

7.5.4 Cable glands

Cable glands must be equipped with EMC earthing cones. Glands, which are not used, must be provided with water-tight covers. Glands must be in accordance with DIN 89280.

7.5.5 Fiber optic cables and interfaces

Fiber optic cables must enter cabinets, junction panels and applicable equipment through cable glands. The fiber optic cores must be separately connected to the opto-electrical interface via miniature optical connectors. The optical mating connectors must be delivered by the supplier.

7.6 Switchboards and panels

7.6.1 General requirements

All distribution switchboards and electrical panels must have a safety system so that access doors do not close accidentally when opened.