Antarctic Research Vessel (ARV)

Polar Operations Design Features Report

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1. Executive Summary

The Polar Operations Design Features Report summarizes how IMO Polar Code compliance for the Antarctic Research Vessel (ARV) is met. This report does not cover the operational plan for compliance, and should not be considered synonymous with the Polar Code-required Polar Water Operational Manual (PWOM) (Chapter 2 of the Polar Code). This report does not cover Voyage Planning, and Manning and Training, as these elements (Chapters 11 and 12, respectively) of the Polar Code are not part of the ship's design. This report serves to verify Polar Code requirement compliance for the following topics discussed in the IMO Polar Code:

- Ship Structure
- Subdivision and Stability
- Watertight and Weathertight Integrity
- Machinery Installations
- Fire Safety and Protection
- Life-Saving Appliances and Arrangements
- Safety of Navigation
- Communication.

1.1. Definitions

For the purpose of complying with the Polar Code, the ARV is considered a Category A ship.

When referenced herein, "the Organization" refers to the International Maritime Organization (IMO).

When referenced herein, "the Administration", refers to the United States Coast Guard (USCG).

In accordance with the ABS Guide for Vessels Operating in Low Temperatures (ABS LTE Guide), IMO Polar Code, and the ARV Performance Specification (P-SPEC), vessel environmental design temperatures are as listed in Table 1 below.

Table 1: ARV Environmental Design Temperatures

Nomenclature	Temperature (°F)	Governed By	Specified By
Design Service Temperature	-31	ABS LTE Guide	ARV P-SPEC, Table 7
Minimum Anticipated Temperature	-49	ABS LTE Guide	ARV P-SPEC, Table 7
Polar Service Temperature	-49	IMO Polar Code	ARV P-SPEC, Section 044

1.2. Acronyms

ABS	American Bureau of Shipping
ARV	Antarctic Research Vessel
ASC	Antarctic Support Contractor
GNSS	Global Navigation Satellite System
HSVA	Hamburgische Schiffbau-Versuchsanstalt
IMO	International Maritime Organization
LTE	Low Temperature Environment
MHz	Megahertz
MVR	Marine Vessel Rules
NSF	National Science Foundation
P-SPEC	Performance Specification
PC3	Polar Class 3
PWOM	Polar Water Operational Manual
SAR	Search and Rescue
SOLAS	Safety of Life at Sea
TMAS	Telemedical Assistance Service
USCG	United States Coast Guard

2. Ship Structure

2.1. Functional Requirements

The Polar Code requires that the material and scantlings of the structure retain their structural integrity due to changes in environmental loads and conditions. As a ship intended to operate in low air temperature, the materials used shall be suitable for operation at the ship's Polar Service Temperature, and the structure of the ship shall be designed to resist both global and local structural loads anticipated under the foreseen ice conditions.

2.2. Regulations

2.2.1. Materials of Exposed Structure

To comply with the functional requirements, materials of exposed structures in ships shall be approved by the Administration, or a recognized organization accepted by it, taking into account standards acceptable to the International Maritime Organization (IMO), or other standards offering an equivalent level of safety based on the Polar Service Temperature.

ARV shall be constructed from High Strength Steel (H36). The exact ductility / toughness grade of the steel (AH36, DH36, EH36, FH36) is dependent on the type of structure (primary member, secondary member, etc.), location on ship (bottom plating, strength deck), and thickness. The ABS Marine Vessel Rules (MVR), Reference (1), provides requirements for the required ductility / toughness grade in Part 3, Chapter 1, Section 2, Subsection 3. Additionally, due to its designation as Polar Class 3, the MVR provides additional grade requirements in Part 6, Chapter 1, Section 2, Subsection 23. The material grade for strength (H36 Steel) is specified on the Reference (2) through (9) scantling drawings, listed below. The exact ductility / toughness grades are partially defined as well, but will be fully defined on the scantling drawings during a later design phase.

Table 2: Scantling Drawing List

Deliverable No.	Drawing Name	Reference
5E1-001-R001	Structural Design Report	(2)
5E1-110-D001	Hull Structure – Shell Expansion	(3)
5E1-117-D001	Hull Structure - Midship Section	(4)
5E1-130-D001	Hull Structure - Deck and Platforms	(5)
5E1-150-D001	Superstructure Structure	(6)
5E1-117-D101	Hull Structure - Typical Sections	(7)
5E1-116-D101	Hull Structure - Profiles Drawing	(8)
5E1-120-D001	Hull Structure - Misc. Bulkheads	(9)

2.2.2. Scantlings

To comply with the functional requirements, scantlings of Category A ships shall be approved by the Administration, or a recognized organization accepted by it, taking into account standards acceptable to the Organization or other standards offering an equivalent level of safety.

The scantlings have been designed to meet the structural requirements of the MVR, Reference (1), Part 6, for Polar Class 3 (PC3) notation. The scantling sizes reflected in the Reference (3) through (9) drawings, as well as the Reference (2) structural report, meet the Polar Class 3 requirements.

3. Subdivision and Stability

3.1. Functional Requirements

The Polar Code requires that ships shall have sufficient stability in intact conditions when subject to ice accretion. Additionally, Category A ships constructed on or after 1 January 2017 shall have sufficient residual stability to sustain ice-related damages.

3.2. Regulations

3.2.1. Stability in Intact Conditions

3.2.1.1. Calculations

To comply with the functional requirements, for ships operating in areas and during periods where ice accretion is likely to occur, the following icing allowance were made in the stability calculations:

- 30 kg/m^2 on exposed weather decks and gangways
- 7.5 kg/m^2 for the projected lateral area of each side of the ship above the water plane
- The projected lateral area of discontinuous surfaces of rail, sundry booms, spars (except masts), and rigging of ships having no sails and the projected lateral area of other small objects shall be computed by increasing the total projected area of continuous surfaces by 5% and the static moments of this area by 10%.

Throughout the design process of the ARV, the projected loading conditions analyzed in the Intact and Damage Stability Report, Reference (10), include these topside icing allowances based on areas provided by the General Arrangement, Reference (11). The ARV design complies with these requirements.

3.2.1.2. Design

Ships operating in areas and during periods where ice accretion is likely to occur shall be designed to minimize the accretion of ice.

The ARV shall be equipped with such means for removing ice as the Administration may require; for example, electrical and pneumatic devices, and/or special tools such as axes or wooden clubs for removing ice from bulwarks, rails and erections.

3.2.1.3. Outfitting

Ships operating in areas and during periods where ice accretion is likely to occur shall be equipped with such means for removing ice as the Administration may require.

The ARV features several locations suitable for the stowage of equipment to be used for the removal of ice. These locations may be found on the General Arrangement, Reference (11). Main Deck locations include the Staging Bay, Bosun Shop, and Carpenter Shop. Other stowage locations include a Bosun Locker on the 02 Level and a Deck Gear Locker on the 04 Level.

3.2.2. Stability in Damaged Conditions

To comply with functional requirements, Category A ships constructed on or after 1 January 2017 shall be able to withstand flooding resulting from hull penetration due to ice impact. The residual stability following ice damage shall be such that the factor, s_i, as defined in Safety of Life at Sea (SOLAS) regulations II-1/7-2.2 and II-1/7-2.3, is equal to one (1) for all loading conditions used to calculate the attained subdivision index in SOLAS regulation II-1/7. The ice damage extents to be assumed when demonstrating compliance with the Polar Code are:

- The longitudinal extent is 4.5% of the upper ice waterline length if centered forward of the maximum breadth on the upper ice waterline, and 1.5% of upper ice waterline length otherwise, and shall be assumed at any longitudinal position along the ship's length
- The transverse penetration extent is 760 mm (30 in), measured normal to the shell over the full extent of the damage
- The vertical extent is the lesser of 20% of the upper ice waterline draught or the longitudinal extent, and shall be assumed at any vertical position between the keel and 120% of the upper ice waterline draught.

Throughout the design process of ARV, the extent of ice damage analyzed in the Intact and Damage Stability Report, Reference (10), includes the criteria provided by IMO Polar Code utilizing the Lines Plan, Reference (12), and General Arrangement, Reference (11). The ARV design complies with these requirements.

4. Watertight and Weathertight Integrity

4.1. Functional Requirements

The Polar Code requires that all closing appliances and doors relevant to watertight and weathertight integrity of the ship shall be operable to maintain watertight and weathertight integrity.

4.2. Regulations

4.2.1. Hatches and Doors

To comply with the functional requirements, ships operating in areas and during periods where ice accretion is likely to occur shall be provided with means to remove or prevent ice and snow accretion around hatches and doors. If the hatches or doors are hydraulically operated, means shall be provided to prevent freezing or excessive viscosity of liquids.

To ensure that doors and hatches remain functional, it is recommended that a detailed schedule of accesses be developed. The schedule of accesses should provide details to ensure functionality of access is maintained during icing events. These details may feature recommendations such as those contained in the ABS Guide for Vessels Operating in Low Temperature Environments, Reference (13), including selecting materials for hatch and door seals that remain pliant at the Minimum Anticipated Temperature.

4.2.2. Human Operation

Watertight and weathertight doors, hatches, and closing devices which are not within a habitable environment, and require access while at sea, shall be designed to be operated by personnel wearing heavy winter clothing including thick mittens.

To ensure that doors and hatches remain operable by personal wearing heavy winter clothing, it is recommended a detailed schedule of accesses be developed. The schedule of accesses should provide details to ensure functionality of access is maintained while wearing heavy winter clothing. The ABS guide for Vessels Operating in Low Temperature Environments, Reference (13), provides recommended details of the protective and functional properties of outdoor work garments that may be considered while detailing access functionality.

5. Machinery Installations

5.1. Functional Requirements

The Polar Code requires that machinery installations are capable of delivering the required functionality necessary for safe operation of ships.

Machinery installations shall provide functionality under the anticipated environmental conditions, taking into account: ice accretion and/or snow accumulation; ice ingestion from seawater; freezing and increased viscosity of liquids; seawater intake temperature; snow ingestion; cold and dense inlet air; loss of performance of batteries or other stored energy devices; and loads imposed directly by ice interaction.

Materials used shall be suitable for operation at the ship's Polar Service Temperature.

5.2. Regulations

5.2.1. Machinery Installations and Associated Equipment

To comply with the functional requirements, machinery installations and associated equipment shall provide functionality under the anticipated environmental conditions and shall be protected against the effect of ice accretion and/or snow accumulation, ice ingestion from sea water, freezing and increased viscosity of liquids, seawater intake temperature and snow ingestion. Working liquids shall be maintained in a viscosity range that ensures operation of the machinery, and seawater supplies for machinery systems shall be designed to prevent ingestion of ice, or otherwise arranged to ensure functionality.

Seawater systems draw their supply from the sea around the vessel, and therefore shall be designed to reduce the risk of the inlets becoming blocked by ice or ice forming within them. This is accomplished by:

- Location – Placing sea chests and sea bays low in the vessel and away from ice flow lines;
- Configuration – Using weirs, strainers, and other means to separate ice from water
- Heating – Normally by re-circulating discharged (hot side) water from cooling systems into the inlet areas.

These design features are cited / incorporated on the following references:

Table 3: Sea Chest / Sea Bay Drawing List

Deliverable No.	Drawing Name	Reference
5E1-520-D001	Seawater Service System	(14)
5E1-524-D001	Science Seawater System	(15)

5.2.2. Exposed Machinery and Electrical Installations

To comply with the functional requirements, exposed machinery and electrical installations shall function at the Polar Service Temperature. The materials of exposed machinery and foundations shall be approved by the Administration, or a recognized organization accepted by it, taking into account standards acceptable to the Organization or other standards offering an equivalent level of safety based on the Polar Service Temperature.

Exposed machinery shall be suitable for operation at the Minimum Anticipated Temperature. The materials subjected to the Minimum Anticipated Temperature are to meet the requirements of Section 2, Subsection 3 and Section 4, Subsections 1 through 6 of ABS Guide for Vessels Operating in Low Temperature Environments, Reference (13). Section 1, Table 1 lists design temperature requirements for various systems, equipment, and components. This requirement will be flowed to the vendors in the purchase specification for the equipment.

Electrical equipment on exposed areas, such as the anchor windlass and mooring winches, will be specified for the operating temperatures expected on exposed areas and will have appropriate enclosures. Electrical heaters will be provided to prevent condensation. Heat tracing cable and deicing resistors may also be included. The main mast where antennas and other electrical equipment will be heat traced to prevent ice accumulation.

5.2.3. Internal Combustion Engines

In order to comply with the functional requirements, means shall be provided to ensure that combustion air for internal combustion engines driving essential machinery is maintained at a temperature in compliance with the criteria provided by the engine manufacturer.

The combustion air system is to be based on the Minimum Anticipated Temperature of the outside air. Means will be provided to pre-heat combustion air for proper functioning of the main propulsion, auxiliary, and emergency generator internal combustion engines, as shown on the Waste Heat Recovery & Hot Water Heating System, Reference (16), and the Machinery Space Ventilation Diagram, Reference (17). Combustion air for internal combustion engines shall comply with the requirements of ABS Guide for Vessels Operating in Low Temperature Environments Section 2, Subsection 2.2, Reference (13). These requirements will be included in the vendor purchase specification.

5.2.4. Propulsors

In order to comply with the functional requirements, scantlings of propeller blades, propulsion line, steering equipment and other appendages of Category A ships shall be approved by the Administration, or a recognized organization accepted by it, taking into account standards acceptable to the Organization or other standards offering an equivalent level of safety.

The ARV will be utilizing the industry standards from ABB Propulsion Machinery Ice Class Azipods. The ARV will use the VI1800 Azipod model which is ice classed for PC3. This satisfies the ice breaking requirements of 4.5 ft of continuous level ice with 12 inches of snow cover. ABB is contracted to design the propeller to handle the open water performance and the ice interactions loads, which were model tested at HSVA. The selected propulsor configuration is further detailed in the Propulsion System Report, Reference (18).

6. Fire Safety / Protection

6.1. Functional Requirements

The Polar Code requires that fire safety systems and appliances be effective and operable, and that means of escape remain available so that persons on board can safely and swiftly escape to the lifeboat and life raft embarkation deck under the expected environmental conditions.

All components of fire safety systems and appliances, if installed in exposed positions, shall be protected from ice accretion and snow accumulation. Local equipment and machinery controls shall be arranged so as to avoid freezing, snow accumulation and ice accretion, and their location shall remain accessible at all times. The design of fire safety systems and appliances shall take into consideration the need for persons to wear bulky and cumbersome cold weather gear, where appropriate. Means shall be provided to remove or prevent ice and snow accretion from accesses. Extinguishing media shall be suitable for intended operation. All components of fire safety systems and appliances shall be designed to ensure availability and effectiveness down to the Polar Service Temperature. Materials used in exposed fire safety systems shall be suitable for operation at the Polar Service Temperature.

6.2. Regulations

6.2.1. Fire Safety System Components

In order to comply with requirements, fire safety system isolating and pressure/vacuum valves in exposed locations are to be protected from ice accretion and remain accessible at all times, and all two-way portable radio communication equipment shall be operable at the Polar Service Temperature.

Exterior firemain piping and valves shall be fitted with heat tracing and insulation. Fire hydrants located in the weather shall be provided with isolation valves and drain valves in a nearby heated space. See Reference (19) for the Firemain System configuration details.

Where ice accretion is a possibility, heat tracing will be installed to ensure proper operation of equipment.

Two-way radios with batteries suitable for low temperatures will be specified.

6.2.2. Firemain

In order to comply with requirements, fire pumps (including emergency fire pumps), water mist, and water spray pumps shall be located in compartments maintained above freezing. The firemain is to be arranged so that exposed sections can be isolated, and means of draining of exposed sections shall be provided. Where fixed water-based firefighting systems are located in a space separate from the main fire pumps and use their own independent sea suction, this sea suction shall also be capable of being cleared of ice accumulation. Fire hoses and nozzles need not be connected to the fire main at all times, and may be stored in protected locations near the hydrants.

Fire pumps, including emergency fire pumps, will be located in heated compartments. The pumps and their auxiliaries in the compartment are to be adequately protected from freezing when subjected to the lowest anticipated temperature. Means for isolation and draining of

firemain branches located in the weather shall be provided by a cutout valve and drain cocks located within a nearby heated space. Weathertight enclosures shall be provided for all fire stations exposed to the weather. These arrangements are / will be depicted on the Firemain System Diagram. See Reference (19) for further details.

Seawater systems draw their supply from the sea bay, and therefore will not be using their own independent sea chests. The fixed water-based firefighting system is shown in detail on Reference (20), Fire Extinguishing Systems.

6.2.3. Firefighting Equipment

In order to comply with requirements, firefighter's outfits shall be stored in warm locations on the ship. Portable and semi-portable extinguishers shall be located in positions protected from freezing temperatures, as far as practical. Locations subject to freezing are to be provided with extinguishers capable of operation down to the Polar Service Temperature.

The ARV includes locations, such as the Main Deck Damage Control Locker, suitable for the stowage of the required firefighting equipment. These locations may be found on the General Arrangement, Reference (11).

6.2.4. Materials

Materials of exposed fire safety systems shall be approved by the Administration, or a recognized organization accepted by it, taking into account standards acceptable to the Organization, or other standards offering an equivalent level of safety based on the Polar Service Temperature.

Fire extinguishing systems are to be designed or located so that they are not made inaccessible or inoperable by ice or snow accumulation or the lowest anticipated temperature. The materials are to meet the requirements of Section 2, Subsection 3 and Section 4, Subsection 6 of ABS Guide for Vessels Operating in Low Temperature Environments. See References (19) and (20) for the Firemain System and Fire Extinguishing System, respectively.

7. Life Saving Appliances and Arrangements

7.1. Functional Requirements

The Polar Code requires ships provide for safe escape, evacuation, and survival. Exposed escape routes shall remain accessible and safe, taking into consideration the potential icing of structures and snow accumulation. Survival craft and muster and embarkation arrangements shall provide safe abandonment of ship, taking into consideration the possible adverse environmental conditions during an emergency. All life-saving appliances and associated equipment shall provide safe evacuation and be functional under the possible adverse environmental conditions during the maximum expected time of rescue. Adequate thermal protection shall be provided for all persons on board, taking into account the intended voyage, the anticipated weather conditions (cold and wind), and the potential for immersion in polar water, where applicable. Life-saving appliances and associated equipment shall take account of the potential of operation in long periods of darkness, taking into consideration the intended voyage. Taking into account the presence of any hazards, resources shall be provided to support survival following abandoning ship, whether to the water, to ice, or to land, for the maximum expected time of rescue.

A habitable environment shall be provided. This environment shall include: protection of persons from the effects of cold, wind, and sun; space to accommodate persons equipped with thermal protection adequate for the environment; a means to provide sustenance; safe access and exit points; and a means to communicate with rescue assets.

7.2. Regulations

7.2.1. Escape

In order to comply with the requirements, means shall be provided to remove or prevent ice and snow accretion from escape routes, muster stations, embarkation areas, survival craft, its launching appliances and access to survival craft. Exposed escape routes shall be arranged so as not to hinder passage by persons wearing suitable polar clothing. The adequacy of embarkation arrangements shall be assessed, having full regard to any effect of persons wearing additional polar clothing.

The primary means of escape from the ARV while at sea is via lifeboat. Lifeboats are located in recessed and protected boat pockets. The pockets are accessible via interior passageways that branch from main longitudinal passageways. Vestibules and doors are provided. Pathways for emergency egress are kept clear using electric deck heating and stair heating through cabling or heating pads, as shown on the Deck De-Icing Plan [Mechanical], Reference (21). The General Arrangement, Reference (11), and Lifesaving Drawing, Reference (22), both contain additional details.

7.2.2. Evacuation

In order to comply with the requirements, means to ensure the safe evacuation of persons, including the safe deployment of survival equipment, when operating in ice-covered waters or directly onto the ice, as applicable, shall be provided. If additional devices requiring a source of power are used for evacuation, this source of power shall be able to operate independently of the ship's main source of power.

The ARV features an accommodation ladder that may be used to evacuate the vessel directly onto the ice. The General Arrangement, Reference (11), and Lifesaving Drawing, Reference (22), both contain additional details of the location and means of escape routing to this ladder.

All evacuation routes will have heating pads and/or heat tracing to prevent ice accretion. These systems will be fed by the ship's main electrical plant and by the emergency generator to ensure continued operation.

7.2.3. Personal Survival Equipment

In order to comply with the requirements, a properly sized immersion suit or a thermal protective aid shall be provided for each person on board. And where immersion suits are required, they shall be of the insulated type. Searchlights suitable for continuous use to facilitate identification of ice shall be provided for each lifeboat.

The ARV features several locations, such as the 02 Level Life Saving Gear Locker, suitable for the stowage of the required personal survival equipment. The General Arrangement, Reference (11), and Lifesaving Drawing, Reference (22), both contain additional details of the stowage locations. The detailed specifications for each lifeboat will include the requirements for each to be outfitted in accordance with the applicable regulations.

7.2.4. Lifeboats

In order to comply with the functional requirements, no lifeboat shall be of any type other than partially or totally enclosed type. Life-saving appliances and group survival equipment that provide effective protection against direct wind chill shall be provided for all persons on board. Personal survival equipment in combination with life-saving appliances or group survival equipment providing sufficient thermal insulation to maintain the core temperature of persons shall be provided, along with personal survival equipment that provides sufficient protection to prevent frostbite of all extremities.

The ARV General Arrangement, Reference (11), provides two (2) totally enclosed davit-launched lifeboats. The detailed specifications for each lifeboat will include the requirements for each to be outfitted in accordance with the applicable regulations.

7.2.5. Abandonment

If the PWOM identifies a potential of abandonment onto ice or land, the following shall apply:

- Group survival equipment shall be carried, unless an equivalent level of functionality for survival is provided by the ship's normal life-saving appliances;
- Personal and group survival equipment sufficient for 110% of the persons on board shall be stowed in easily accessible locations, as close as practical to the muster or embarkation stations
- Containers for group survival equipment shall be designed to be easily movable over the ice and be floatable
- Means shall be identified of ensuring that group survival equipment is accessible following abandonment

- The survival craft and launching appliances shall have sufficient capacity to accommodate the additional equipment.

The ARV features several locations, such as the 02 Level Life Saving Gear Locker, suitable for the stowage of the required survival equipment. The General Arrangement, Reference (11), and Lifesaving Drawing, Reference (22), both contain additional details of the stowage locations. The detailed specifications for each survival craft will include the requirements for each to be outfitted in accordance with the applicable regulations.

8. Safety of Navigation

8.1. Functional Requirements

In order to achieve safe navigation, ships shall have the ability to receive up-to-date information including ice information for safe navigation. The navigational equipment and systems shall be designed, constructed, and installed to retain their functionality under the expected environmental conditions in the area of operation. Systems for providing reference headings and position fixing shall be suitable for the intended areas. Ships shall have the ability to visually detect ice when operating in darkness. Ships involved in operations with an icebreaker escort shall have suitable means to indicate when the ship is stopped.

8.2. Regulations

8.2.1. Nautical Information

In order to comply with the functional requirements, the ship shall have means of receiving and displaying current information on ice conditions in the area of operation.

The ARV features equipment to obtain the current nautical information such as a stand-alone Polarimetric Ice Navigation Radar. Details of the equipment to be included on the ARV may be found on the Topside Arrangement, Reference (23).

8.2.2. Navigational Equipment Functionality

The ship shall have either two (2) independent echo-sounding devices or one (1) echo-sounding device with two (2) separate independent transducers. The ship shall comply with SOLAS regulation V/22.1.9.4, and, depending on the bridge configuration, have a clear view astern.

The ARV navigation bridge has been located to provide the required visibility. Details of bridge location and sightlines are contained in the ARV General Arrangement, Reference (11), and Topside Arrangement, Reference (23).

Means to prevent the accumulation of ice on antennas required for navigation and communication shall be provided. Any equipment required by SOLAS chapter V or this chapter with sensors that project below the hull shall be protected against ice. The bridge wings shall be enclosed or designed to protect navigational equipment and operating personnel.

The ARV features enclosed bridge wings as shown on General Arrangement, Reference (11). The detailed specifications for each required navigation and communication antenna featured on the Topside Arrangement, Reference (23), will include the regulatory required means to prevent ice accumulation.

The ship shall have two (2) non-magnetic means to determine and display its heading. Both means shall be independent and shall be connected to the ship's main and emergency source of power. The ship shall be fitted with at least one Global Navigation Satellite System (GNSS) compass or equivalent, which shall be connected to the ship's main and emergency source of power, should it proceed to latitudes over 80 degrees.

The ARV navigation bridge shown on the General Arrangement, Reference (11), will be specified to contain the navigational equipment required by the regulations.

8.2.3. Additional Navigational Equipment

The ship shall be equipped with two (2) remotely rotatable, narrow-beam search lights controllable from the bridge to provide lighting over an arc of 360 degrees, or other means to visually detect ice.

The ship shall be equipped with a manually initiated flashing red light visible from astern to indicate when the ship is stopped. This light shall have a range of visibility of at least two (2) nautical miles, and the horizontal and vertical arcs of visibility shall conform to the stern light specifications required by the International Regulations for Preventing Collisions at Sea.

Navigational equipment will be specified on the Topside Arrangement, Reference (23), throughout the design process. Additional required ice lighting will be located and detailed in future design stages.

9. Communication

9.1. Functional Requirements

The Polar Code requires effective communication for ships and survival craft during normal operation and in emergency situations.

9.2. Regulations

9.2.1. Ship Communication

To comply with the functional requirements, communication equipment on board shall have the capabilities for ship-to-ship and ship-to-shore communication, taking into account the limitations of communications systems in high latitudes and the anticipated low temperature.

Ships intended to provide icebreaking escort shall be equipped with a sound signaling system mounted to face astern to indicate escort and emergency maneuvers to following ships as described in the International Code of Signals.

Two-way on-scene and Search and Rescue (SAR) coordination communication capability in ships shall include voice and/or data communications with relevant rescue coordination centers, and equipment for voice communications with aircraft on 121.5 and 123.1 MHz.

The communication equipment shall provide for two-way voice and data communication with a Telemedical Assistance Service (TMAS).

The ARV will feature all regulatory required means of communication, and all antennas are to be arranged in the Topside Arrangement, Reference (23).

9.2.2. Survival Craft and Rescue Boat Communications Capabilities

All rescue boats and lifeboats, whenever released for evacuation, shall:

- Carry one device for transmitting ship to shore alerts
- Carry one device for transmitting signals in order to be located
- Carry one device for transmitting and receiving on-scene communications.

All other survival craft shall:

- Carry one device for transmitting signals in order to be located
- Carry one device for transmitting and receiving on-scene communications.

The ARV General Arrangement, Reference (11), provides the location of each survival craft. The detailed specifications for each will include the requirements for each to be outfitted in accordance with the applicable regulations.

Procedures shall be developed and implemented such that mandatory communication equipment for use in survival craft, including life rafts, and rescue boats, are available for operation during the maximum expected time of rescue. Battery life shall be considered.

10. Conclusions

This report summarizes how the Antarctic Research Vessel design shall comply with the design requirements of the IMO Polar Code for the following topics:

- Ship Structure
- Subdivision and Stability
- Watertight and Weathertight Integrity
- Machinery Installations
- Fire Safety and Protection
- Life-Saving Appliances and Arrangements
- Safety of Navigation
- Communication

11. References

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(22) ARV Lifesaving Drawing, 5E1-403-D001, Rev (P2), January 2023

(23) ARV Topside Arrangement, 5E1-002-D101, Rev (P3), August 2023