Technical Requirements of the

New Swedish Heavy Polar Icebreaking Research Vessel

Rev. 4: 2025-06-24

Rev. 3: 2025-05-28

Rev. 2: 2025-01-12

Rev. 1: 2024-10-23

2024-06-13

POLARFORSKNINGS SEKRETARIATET
SWEDISH POLAR RESEARCH SECRETARIAT

Technical Requirements

Heavy Polar Icebreaking Research Vessel

Concept illustration of the new polar research vessel. Illustration by Peter Mild.

General

The vessel is a Heavy Polar Icebreaking Research Vessel designed for year around Research, Icebreaking, Ice Management and Escort operations in Polar (Arctic and Antarctic) environment. It is also designed and suitable for open water operations world-wide.

The vessel to be built and equipped for following primary roles:

- Research operations in polar areas,
- Icebreaking in polar waters including multi-year ice,
- Escorting and assisting vessels under polar conditions,
- Ice management operations,
- Re-supply for both onshore and offshore operations in Polar areas.

As an example, the vessel should be capable to escort and assist other vessels during a

fibre-optic cable-laying operation as well as during maintenance and repair year around of such fibre-optic cable.

The vessel is optimized for low environmental impact operation. Power plant to be a redundant, IMO DP-2, dual-fuel, methanol/diesel gen-set machinery. A battery energy storage system to be installed for emission free operation, spinning reserve and peak-shaving. Polar environment to be specially considered.

The vessel is double-hulled, with forecastle and accommodation forward. Special attention has been paid to the design of the vessel for minimizing ice accretion and all exterior working positions are also to be protected as far as possible.

The technical requirements in this document are defined in dialogue with the Swedish Polar Research community, the Swedish Armed Forces, Swedish Agency for Marine and Water Management.

These Technical Requirements describe the functional capacities of the vessel. After Agencies acceptance and approval alternative solutions and arrangements can be considered as long as it is verified that these Technical Requirements are fulfilled.

(Dimensions and capacities below are not finally decided, only given as guidance)

Main Dimensions

Length over all	about	140.0	meters
Length in waterline	about	137.0	meters
Breadth at dwl, midships	about	28.0	meters
Breadth maximum	about	32.0	meters
Draught, at design waterline	about	10.5	meters
Draught, scantling	about	11.0	meters
Depth to main deck	about	15.0	meters

Capacities

Methanol	about	4000	m3
Marine DO	about	10000	m3
Lubrication oil	about	TBD	m3
Water ballast	about	TBD	m3
Potable water	about	450	m3
Sludge	about	300	m3
Bilge	about	500	m3
Grey water	about	1500	m3
Heli fuel	about	30	m3

No oil pollutant or waste liquid tanks are located adjacent to the shell, except grey water tanks. Methanol tanks to be arranged as efficiently as possible to optimize capacity.

The vessel to be arranged for “Ship To Ship” bunkering operations.

Cargo Space

There is an open cargo deck aft with a total area of abt. 2000 m^2 with a capacity of minimum 150 TEU. Fittings for both 20ft and 40ft containers to be provided. Additional fittings for 10 pcs of 10ft containers to be fitted. Lashing arrangement and equipment for possible double stacking to be provided. Utilities for containerized laboratories to be provided in at least 20 positions (10 SB and 10 PS) on aft deck supplying gas, electricity, hydraulic power, IT, water, sewage etc.

Endurance

Endurance in polar operations to be at least 100 days. Basis average propulsion power of 50 %. 120 persons onboard in 76 cabins and zero dumping principles. The vessel to have methanol tank capacity for at least 25 days operation at an average propulsion power of 50%.

Economical cruising speed in open water 12 knots.

Environmental conditions

The vessel, machinery and accommodation will be designed for operation in the following ambient conditions:

Ambient conditions	
Design temperature	+40°C to -50C
Minimum ambient air temperature	-50°C
Sea water temperature	+32°C to -2°C
Polar Service Temperature (PST)*	-50°C

*as defined in the Polar Code

Accommodation

	Cabins	**Beds**
Captain Class with bedroom	2	2
Owner Class with bedroom	2	2
Senior Officer with bedroom	12	12
Crew single	16	16
Special personal	44	88
Total	**76**	**120**

Registration

The vessel to be registered in Sweden and operated under the Swedish flag. The Classification Society shall be delegated as Regulatory Organization (RO) for statutory rules as far as allowed by flag.

Classification and Authorities

General

The vessel shall meet all regulatory requirements for world-wide operations.

All relevant rules and regulations are to be complied with as far as they are in force at the date of the contract and/or known to be applicable to the subject vessel.

Classification

The vessel is to be designed and built under survey of an IACS Classification society with the following notations or equivalent: DNV ✠1A, Icebreaker, PC2, POLAR(A, -50°C), DAT(-27°C), E0, DPS(2), DYNPOS(AUTR), NAUT(OSV), RP(m,TBD), LFL fuelled, Shore Power, DAV(PC2, Icebreaker), CRANE, Cyber secure (Essential), SILENT(R) Recyclable, HELDK (SH), COMF(C-3, V-3), Clean(Design), ECA(SOx-A), ER(SCR, Tier III) Battery(Power), BIS, BWM(T), SPS, LCS(DC)

Rules and Regulations

The vessel is to meet the requirements of relevant rules and conventions.

National rules

The vessel is to meet the requirements of national rules of Sweden and EU.

Certificates in general

All necessary certificates for world-wide operation of the ship to be supplied.

Performance

Hull Form

Bow form to be designed for icebreaking and ramming in multi-year ice and still maintaining favorable sea keeping and open water resistance characteristics.

Aft ship form to be designed for icebreaking with one centerline propeller with a nozzle and two azimuthing pods.

Hull form to be designed taking into consideration ice movement around hull for minimum of ice interaction with the propulsors.

Foreship to be wider than the aft ship to provide better maneuvering capability during icebreaking.

Model tests

The following model tests shall be performed:

- Resistance and self propulsion tests
- Maneuvering tests
- Roll decay test
- Ice model test

Sea Keeping

Special consideration shall be paid to sea keeping performance of the Vessel to maintain sufficient behavior also in rough seas in DP-operations and during transit.

In normal loading conditions in open water, the rolling period to be not less than 12 sec.

Open Water Performance

The vessel shall have the following performance in open water conditions:

- maximum speed in open water in trial conditions to be at least 17 knots at 85 % of propulsion power.

Ice Performance

The vessel to have following performance in ice conditions with ice flexural strength 500 kPa:

- to break 1.8 m level ice at a continuous speed of 5 knots ahead
- to break 1.2 m level ice at a continuous speed of 3 knots astern
- continuous operation in 2.5 m level ice with ice flexural strength 700 kPa

Towing performance

The vessel shall be capable of towing a vessel. Towing point to be forward of the propulsors to allow for good maneuvering. Care shall be taken to allow the towing line to run over the aft deck without coming into conflict with equipment installed on deck.

Hull

The vessel to have double hull and double bottom were practicable. Transverse frame and longitudinal stiffener spacing to be abt 800 mm. The entire vessel including superstructure to be constructed with a system of continuous longitudinal, transversal bulkheads and decks to provide a robust and vibration free design.

Ice strengthening

The hull structures to be dimensioned to meet the requirements of IACS Ice class PC2 with additional strengthening in the stern and other hull areas exposed to ice forces. The hull to withstand ramming of multi-year ice.

Materials

Generally High Tensile steel and Extra High Tensile steel up to the yield strength of 500 MPa is to be used for side shell and framing constructions, in cargo deck constructions or in other parts of the vessel where advantageous to the design and production friendliness.

The minimum ambient air temperature as in General, Environmental conditions is to be accounted for when selecting steel grades for outer hull and deckhouse structures.

Main Deck

Main cargo deck is to be strengthened for 10 ton/m² cargo load.
Suitable number and positioning of fitting for lashing of cargo on main deck including containers shall be provided.

Heeling/Stabilizing Tanks

Two (2) combined heeling and stabilizing tanks shall be provided. Heeling system to be able to heel the vessel 4 degrees to PS and SB.

Water Lubrication System

A water lubrication system to be arranged in the bow.
Heat traced nozzles to be fitted in bow for a water capacity of about 25000 m^3/h.

Moon Pool

One moon pool size 7.2 x 7.2 m shall be arranged in the midship area. Moon pool to be provided with a remote controlled hatch at the bottom of the vessel and a weathertight hatch at main deck level with corresponding strength. Moon pool to be provided with an indoor working area. This working area shall have a side shell door (4 x 4 m) enabling deployment of equipment. Foundations to be prepared for installment of traverse. Typical equipment include CTD-carousels, AUVs, ROVs, etc.

Wet laboratory space (150 m2) indoor next to moon pool.

Acoustic Instruments (reserved space)

Space to be allocated for a full ocean depth Multi-Beam Sonar system and other acoustic instruments in double bottom hull. This space to be connected with required cables to a dedicated instrumentation room and the bridge. The sensor array should be located close to the bow and avoid areas of high ice pressures. The sensor array is placed in front of any propellers, azipods and other obstacles that disturb the water flow. The sensor array should be located to avoid interferences and EMC problems, from e.g. pumps, pipes, inverters, etc . The detailed sensor arrangement shall be to Agencies acceptance and approval. A sea chest for sound velocity measurements is required.

Painting General

All steel and equipment to be protected by painting suitable for the harsh polar environment. The detailed painting specification to highest standards shall be to Agencies approval.

In surface preparation and steel work the standard SFS 8145 or other mutually agreed international or national standard is to be followed.

Abrasion Resistant Icebreaker Paint

Outside of hull, moon pool, sea chests:

Pre-treatment:	SFS 8145-05
Painting:	1 x epoxy solvent free 500 µm

Cathodic Protection

The complete underwater hull and propulsors are to be protected by an impressed current system. The system to incorporate a rectifier supplying an automatically regulated direct current to permanent anodes distributing protective current to the submerged structure of the vessel. Sensor electrodes to regulate the current to a magnitude, which meets requirements for cathodic protection under varying conditions.

Ship’s Equipment

Bow Thrusters

Two (2) transversal bow thrusters of about 1500 kW power, diameter 2.4 m in tunnel is to be installed in the bow.Dynamic Positioning (DP-2) System

A dynamic positioning system according to DP2 requirements of IMO and Classification Society shall be provided. Two computer systems are to be arranged in the wheelhouse technical space.

An independent backup joystick system with automatic heading control to be included.

A DP-capability analysis shall be performed to document vessel DP-capability. Analysis shall be done as per DNVGL-ST-0111 and for elements A, B, C and D.

Bridge Layout

The vessel to be equipped with an integrated bridge system to facilitate safe navigation in ice. The bridge system should be based on unrestricted visual sight from the bridge, careful layout of interaction devices, and integration of electronic equipment. Full maneuvering station on starboard bridge wing and slave station on port side.

Space on the bridge to be allocated for working stations for example for meteorologists, Multibeam-operators, Air-Traffic-Control center and other functions .

Aft Bridge

An additional maneuvering station to be arranged on the aft part of the superstructure with full view on aft deck (not on main bridge deck level). The operator shall have full view forward via a camera system.

Communication Equipment

One (1) complete communication station system according to GMDSS A4,
2 Inmarsat C Standard, V-sat, etc. Communication capacity during operation in polar areas to be specially considered.

Anchoring and Mooring Equipment

The vessel to be equipped with anchor winches, anchors, and anchor chain in accordance with Classification requirements.

Mooring winches and deck mooring equipment to Classification requirements.

Deck Cranes

One (1) Electro- hydraulic deck crane of knuckle boom type with integrated hydraulic power unit shall be arranged on starboard side of the Vessel.
The crane shall have capacity of 25 tonnes /15 m outreach and 15 tonnes /25 m outreach. Hoisting speed 30 m/min at full load. Deck crane shall be radio remote operated. The crane shall be designed for ship-ship and ship-shore operations. Approved for man-riding.

One (1) Electro- hydraulic deck / provision crane of knuckle boom type with integrated hydraulic power unit to be arranged on starboard side of vessel, being able to handle provision and accommodation ladder. The crane to have a capacity of 8.0 tonnes at 12 m outreach

One (1) Electro- hydraulic deck crane of knuckle boom type with integrated hydraulic power unit shall be installed aft with the capacity of 50 tonnes /30 m outreach.

Cranes shall be arranged to give as full coverage of the vessel as possible and suitable for on and off loading operations.

A-Frames

A-frames to be installed on main deck aft.

Safety working load (SWL) for the A-frames to be 60 respective 25 tonnes.

Winches

Both fixed installed winch systems for ordinary use and modular, containerized, winch systems for extraordinary requirements will be used onboard. A winch control room with a good overview of the aft deck and A-frames to be arranged.

Foremast

A foldable foremast to be installed. This foremast to be arranged for installation of scientific equipment at a height of at least 25 m above sea level.

Foredeck, launch platform

An open launch area (10 x 10 m) for drone and balloon operations shall be arranged.

Hatch in the bow

A hatch in the bow to be arranged suitable for ice-surveillance equipment.

Mast on bridge roof

The top mast on the bridge roof to be provided with a platform suitable for installation of meteorological sensors. Arrangement to be of Agencies approval.

Bridge roof

Space for 2 x 20’ containers on the bridge roof.

Aft Deck

The aft deck shall be a flexible work space where containers and equipment can be arranged according to needs of the operations.

Work Boats

Cradles to accommodate two work boats 10m long and 4m wide, including electricity and water to be arranged. Easy access to the work boats in their cradles from laboratories and aft deck. Work boats to be launched with deck crane to either side or aft of the vessel.

IT & scientific equipment

Climate-controlled server-rooms and telecom closets with enough power and cooling to be able to build a ship wide network to all areas primarily based on single mode fibre (SMF).

Network cable conduits should also be prepared to all areas of the vessel for future use including the bridge roof/monkey island to be able to install for example antennas.

Helicopter deck + hangar

Helicopter deck + hangar to fit 2 helicopters with folded blades to be arranged.

Helicopter service systems such as re-fuelling system to be provided. Standard aviation fuel.

Helicopter weight abt 11 tonnes and rotor diameter 16,5m.

Life Saving Equipment

Lifesaving appliances to be provided for 120 persons.

Two (2) fully enclosed lifeboat according to regulations.

Two (2) fast rescue boats with inboard engine

Life rafts for 100 % of persons each side shall be provided. Survival suits.
Other equipment according to regulations.

De-icing and Winterization

De-Icing and low temperature (-50 °C) measures shall be built to classification requirements.

All materials and liquids exposed to low temperature shall be suitable for the purpose.

Electric heating for railings, stairs, escape ways, air pipes etc. defined in the Rules to be provided.

Sufficient amount of hot water and steam outlets with hoses for de-icing to be provided to cover the whole vessel.

Accommodation

- Accommodation to be of high West European standard.
- All cabins to have private WC/shower.
- One lift for crew to be provided. Full HVAC in accommodation.
- Changing rooms with showers to arranged to avoid dirty clothing in the accommodation

Mechanical ventilation for all service rooms.

Meeting rooms, recreation and lounge

- Auditorium for 50 persons.
- Gym with space
- Sauna

Sanitary Systems etc.

The vessel shall have a combined fresh water and drinking water system and technical water system.

Toilet seats in cabin WCs to be vacuum type, wall mounted for easy cleaning.

Sewage treatment system.

An automatic biological sewage treatment plant with integrated vacuum generating unit is to be provided.

Waste management and handling system of ship generated garbage.

A well ventilated room with necessary equipment for efficient garbage handling to be arranged .

Miscellaneous

In order to not interfere with air quality measurements all ventilation outlet openings shall be arranged aft of the superstructure. Emissions from the funnels to be directed aft as well.

Machinery – electrical

General

The vessel has a diesel-electric power plant and propulsion system with medium-speed main diesel AC generators producing electricity for the propulsion units and other onboard consumers. In addition, there is one medium-speed harbor generator, and a separate emergency diesel generator. The vessel shall have a battery energy storage system for emission free operation, spinning reserve and peak-shaving. The battery to be charged both from the diesel-electric power plant and from shore while moored at quay side.
The power plant is designed to be redundant with the main generators, transformers, switchboards and other equipment divided into, at least, two separate engine rooms with dedicated pump rooms and auxiliary systems.

The propulsion system consists of two azimuthing thrusters with stainless steel fixed pitch propellers and one centerline propeller with a duct for increased propulsion efficiency especially in icebreaking operation.

Main Engines

Dual fuel main diesel engines are to be installed.

Propeller Plant

Two (2) azimuthing thrusters, each 11 MW. The propulsion units are strengthened for astern icebreaking operations.
One (1) stainless steel propeller with a nozzle at centerline, 12 MW.
The propulsors are driven by frequency-controlled AC electric
motors.
Installed propulsion power capacity to be verified to meet Ice
Performance minimum requirements.

Boilers

Exhaust gas boilers and two (2) oil fired water boilers.

Aux. Engines

One medium-speed harbor generator that can be used to produce electricity when the vessel is stationary with main propulsion offline.

Emergency Generator

One (1) emergency generator, diesel driven.

Battery Energy Storage System

The battery energy storage system to have a capacity sufficient for 6 hours emission free operation at zero speed in polar conditions or at least 5 MWh. The battery energy storage system to deliver spinning reserve and peak-shaving.

Non-interruptible power system

Redundant central UPS-systems for scientific equipment to be installed.

Electrical Shore Connection

Electrical shore connection to be arranged with shore connection cabinet and space for cables and cable drums.

Seawater Cooling System

The vessel to have two (2) high-capacity ice chests for sea water intake connected with a cross-over canal.

Seawater System for Science

The vessel to have a separate ice sea chest for supply of water for science.

Minimum capacity: 100 liter/min. All infrastructure installed with easy access for maintenance. Sea water connections to all wetlabs adjacent to the moon pool.

Water Maker

Two (2) freshwater generators with sufficient capacity to be installed.

Science and research operations

General

Swedish Polar Research Secretariat (SPRS) is mandated to co-ordinate and promote Swedish polar research. The agency's primary mission is to organize and support research expeditions to the polar regions and manage research infrastructure. SPRS have been organizing Polar Research expeditions with icebreaker Oden since 1991 and supported a wide variety of research requirements. The flexibility, inventive and wide spectra of logistical support is a key capability of the new polar icebreaker.

Operations

The vessel shall be able to host projects that for example require:

- Coring equipment for coring sediments cores on water depths up to 6500 m
- Seismic equipment
- Atmospheric instruments might be mounted onboard the vessel, on the helicopter, drones or on zeppelins (up to 1500 m up into the air). The zeppelins can be anchored on the vessel and winched up/down in coordination with potential helicopter/drone operations
- Trawling equipment
- ROV/AUV deployments
- Drone operations
- CTD water sampling and measurements
- Deployments/recovery of various buoy systems
- 1-2 helicopters to be used for aerial work. Terrestrial field campaigns require two helicopters for rescue capability.
- Various operations in work boats and on ice with staff and equipment.
- Etc.

Above bullet list describes planned research activities. The activities require either installation of systems or preparations for later installations, i.e. after delivery of vessel. Before signing of contract between Owner and Yard these systems will be defined by Polar and incorporated in the Yard specification by Owner, additional operations that require installations may be added to the list during this phase.

For further reference research activities relevant to the use of the Vessel, please review selected Scope of Work documents from previous expeditions.

Concept illustration of the new polar research vessel. Illustration by Peter Mild.