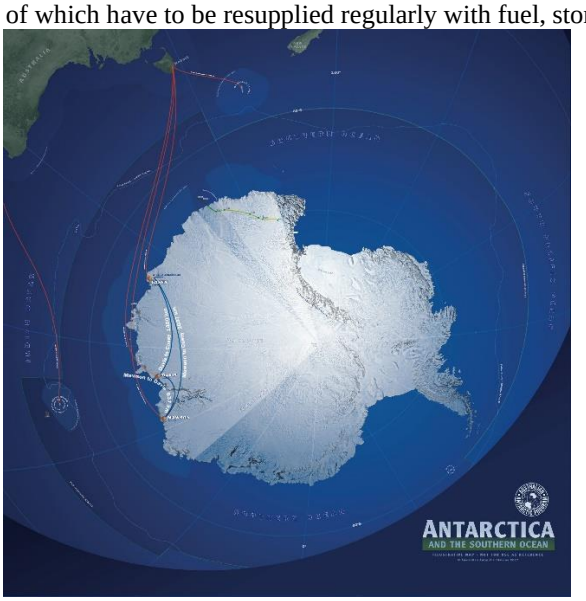
Technical Meeting – 1 July 2020

Clive Evans, Maritime Systems Lead—Research Supply Icebreaker Project, Australian Antarctic Division, gave a presentation on *RSV* Nuyina*: Australia's New Icebreaking Research and Supply Vessel* as a webinar hosted by Engineers Australia with Phil Helmore as MC on 1 July. This was our third webinar presentation, and attracted 250+ registrations, with 180+ actually participating on the evening.

Introduction

Clive began his presentation with a video introduction to the Australian Antarctic Program and the research and supply operations involved. This was followed with photos and more-detailed descriptions.

Australia has three permanent research stations in Antarctica, at Casey, Davis and Mawson, and a permanent base on Macquarie Island, all of which have to be resupplied regularly with fuel, stores and solid cargo.



Australian Antarctic Program stations
(Map courtesy Australian Antarctic Program)

Australian Antarctic station Casey
(Photo courtesy Australian Antarctic Program)

Aurora Australis resupplying Casey using landing craft
(Photo courtesy David Barringhaus)

Australian Antarctic station Davis
(Photo courtesy Australian Antarctic Program)

Aurora Australis resupplying Davis using helicopter
(Photo courtesy William de Bruyn)

Aurora Australis resupplying a new crane to Davis
(Photo courtesy Mark Horstman)

Australian Antarctic station Mawson
(Photo courtesy Australian Antarctic Program)

Aurora Australis resupplying Mawson
(Photo courtesy Noel Tennant)

Australian Antarctic station Macquarie Island
(Photo courtesy Barry Becker)

Aurora Australis resupplying Macquarie Island
(Photo courtesy Jeremy Smith)

Another task is for the transfer of expeditioners. Some arrive on an Airbus A319 which lands on the Wilkins runway close to Casey station, a four-hour flight from Hobart. However, most expeditioners arrive by ship, typically a ten-day trip, but can be delivered to any of the stations.

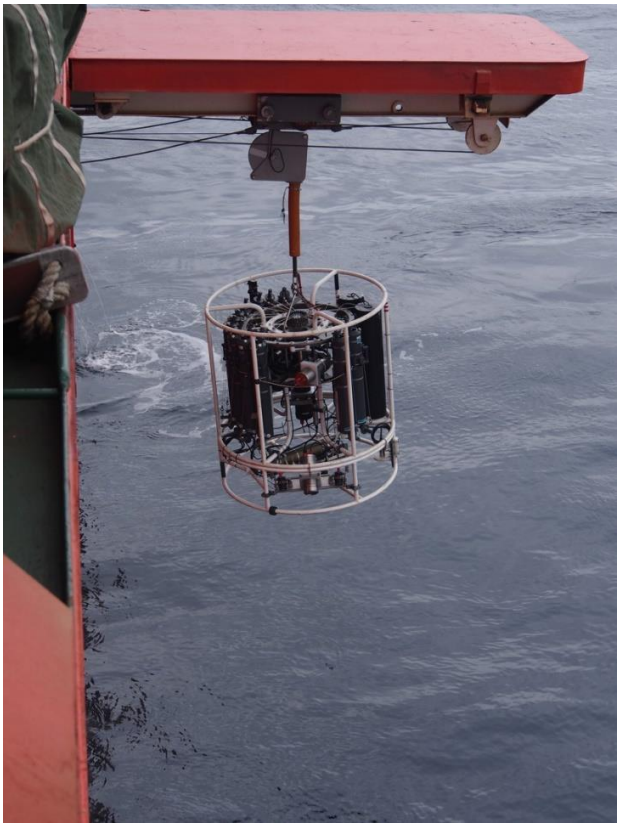
Aurora Australis delivering expeditioners ashore
(Photo courtesy Jason Mundy)

Importantly, the research-and-supply vessel provides medical facilities.

Medical facilities on board *Aurora Australis*
(Photo courtesy Jason Mundy)

The vessel is also a platform for marine-science research, including stern trawling for fish sampling, CTD (conductivity, temperature and depth) measurements, monitoring krill (at the base of the food chain), observing resident mammals (whales, seals, etc.), and monitoring the atmosphere and light.

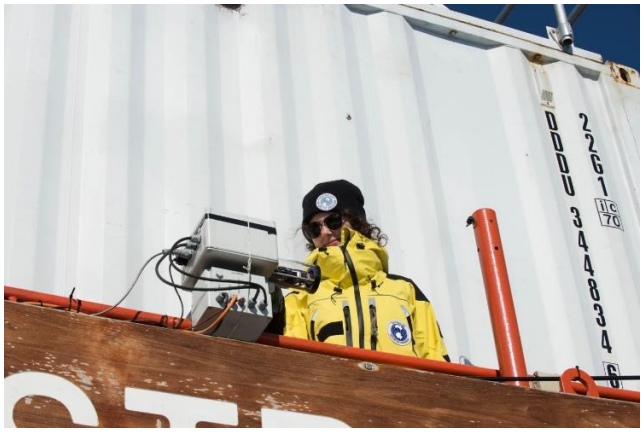
Stern trawl gear on board *Aurora Australis*
(Photo courtesy Australian Antarctic Project)



Deploying the CTD monitoring equipment from *Aurora Australis*
(Photo courtesy Wendy Pyper)

Krill close up
(Photo courtesy Steve Brookes)

Marine mammal observation
(Photo courtesy Myriam Schuller)



Monitoring the atmosphere and light
(Photo courtesy Rowan Butler)

A secondary task of the research-and -supply vessel is in a Government-support role, such as for humanitarian or disaster-relief operations.

Drivers for a New Shipping Capability
Drivers for a new ship include:

- *Aurora Australis* has now done 30 seasons in the Southern Ocean and Antarctica, and is at the end of its useful life.
- Australia's Antarctic Strategy and the 20-year Action Plan requires increased cargo capacity to deliver the whole programme of asset replacement and station resupply.
- Increased cargo capacity will lead to a change in voyages from 'one voyage, one station' to multiple stations per voyage.
- This change will allow more operational days to be available for marine science, which is severely limited on *Aurora Australis*.
- More operational days for marine science results in greatly improved science facilities.

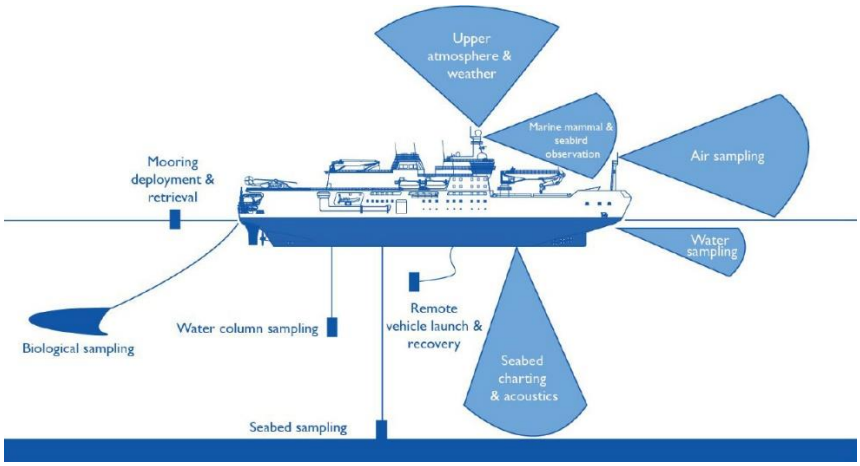
RSV *Nuyina*
The name *Nuyina* is the word in the palawa kani language of the Tasmanian Aborigines for the southern lights. The name was suggested by school students in a competition, and is jointly attributed to students from St Virgil's College in Hobart and Secret Harbour Primary School near Perth, WA. The name *Nuyina* evokes the names of previous ships involved in Australian Antarctic research and investigation:
Aurora Australis (1989–2020), Australia's current icebreaking research and resupply vessel; and
Aurora (1876–1918), used by Sir Douglas Mawson for exploring the continent (1910–14) and Sir Ernest Shackleton.
Here Clive showed a photograph of *Aurora Australis* berthed in Hobart, with an image of *Nuyina* positioned for comparison.

Aurora Australis and *Nuyina*
(Photo and image courtesy Australian Antarctic Project)

Principal particulars of *Nuyina* are

Length OA	160.3 m
Beam	25.6 m
Draft	9.30 m
Displacement	25 500 t
Crew	32
Passengers	117
Main engines	2×MAN 32/44CR 16V each 9.6 MW
Power take-in	2×Advanced Electric Drive each 3.7 MW
Propulsion power	26.6 MW
Installed power	30.2 MW
Speed (service)	12 kn
(maximum)	16+ kn
Range	16 000+ n miles
Endurance	90 days
Seakeeping	DEF(AUST)5000
Icebreaking	1.65 m @ 3 kn
Dynamic positioning	2 (SS4, BF 8)
Silent R notation	@ 8 kn

RSV *Nuyina*
(Diagram courtesy Australian Antarctic Project)



Science capability on board RSV *Nuyina*
(Drawing courtesy Australian Antarctic Project)

RSV *Nuyina* Construction Update

Following contractual agreement on 28 April 2016 with DMS Maritime (now Serco Defence) for delivery, operation and maintenance, the ship's design and construction was contracted to Damen Group. Concept design was contracted to naval architects Knud E. Hansen of Denmark. The keel laying took place in August 2017 at Damen's Galați shipyard in Romania. Coins from Denmark, Netherlands, Romania, and Australia were welded to the keel as part of the keel laying.

Keel-laying ceremony of RSV *Nuyina*
(Photo courtesy Australian Antarctic Project)

Here Clive showed video footage from a drone flyover of *Nuyina* alongside at Damen's shipyard in Galati in April 2020.

Harbour-acceptance trials are currently underway in Galati. Sea trials are expected to commence in the Black Sea later this year, followed by special trials (i.e. icebreaking) above the Arctic Circle in late 2020, with delivery to Hobart in early 2021.

Contract

The AAD signed a Design Build Operate and Maintain (DBOM) contract with DMS Maritime (now Serco Defence) in April 2016.

There were 1202 Functional Performance Specification (FPS) items included in the contract, and these remain for the duration of the contract. A technical specification for the construction of the vessel was not developed. Each FPS item has a series of verification strategies including design, harbour-acceptance trials, ship-acceptance trials, and the special sea trials (icebreaking). Each FPS continues into the operate and maintenance phases where Serco Defence will operate the ship for the first ten years.

Strengths of the DBOM model include:

- Certainty of fixed price and defined performance over the length of the contract, which is important for government procurements of this scale.
- An AAD full-time equivalent team of 6 people would not be able to deliver this project without a prime contractor.
- *Nuyina* remains a Commonwealth asset and AAD maintains a small team into the O&M phase. This provides a greater connection to ship operations than the current time-charter arrangement.

Challenges inherent in the DBOM model include:

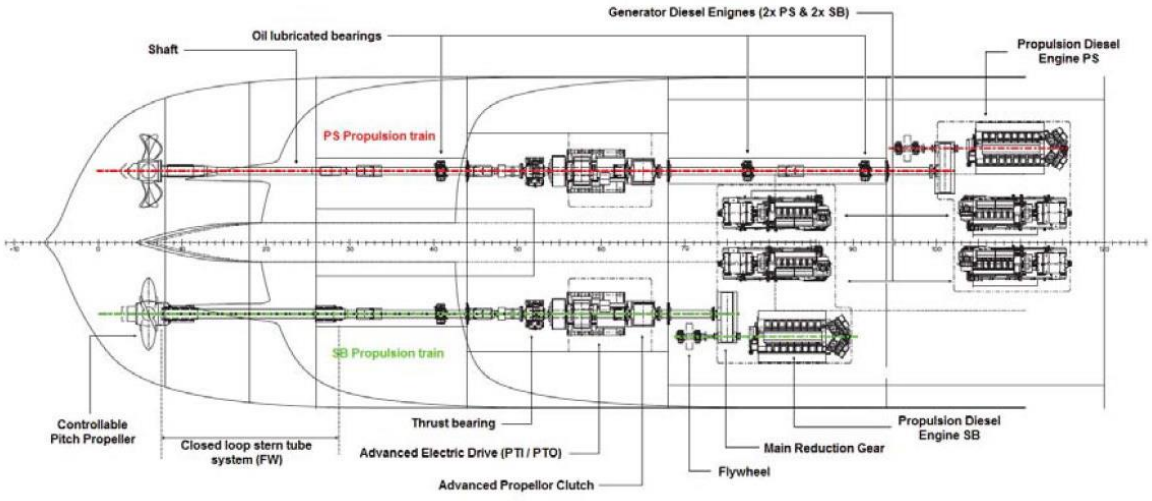
- The tri-partite arrangement of Damen Schelde Naval Shipbuilding, Serco and the AAD is further complicated by Damen subcontractors Damen Galati (DSGa) and *their* subcontractors. This can be challenging for technical meetings.
- There can be too much emphasis on the FPS requirements. Shipbuilding best practice and quality are also critical items.
- The AAD team (including contractors) is slightly larger than envisaged, due to the quantity of information transferred between the parties.

Propulsion System Design

Design drivers for the propulsion system included requirements for:

- Redundancy.
- Heavy icebreaking performance with ice milling at 3 kn.
- Ability to mill ice astern.
- Acceptable performance in open water transit up to 16 kn.
- Large variation in hotel load impacts on the propulsion system.
- LR Class Notations DP(AA), CAC(2), PSMR*, ECO (NOX-2, SOX)
- IMO Tier 2
- DNV Silent R (equivalence)

Here Clive showed a slide of *Nuyina*'s propulsion train.



Nuyina's propulsion train machinery
(Drawing courtesy Australian Antarctic Project)

The port and starboard propulsion trains are completely separate, with the main propulsion engines in different compartments and isolated from each other, providing propulsion redundancy.

For heavy icebreaking, the vessel has two MAN 32/44CR 16V propulsion engines, each rated at 9.6 MW, plus two Advanced Electric Drive PTIs, each rated at 3.7 MW, giving a total propulsion power of 26.6 MW. Aft of the main reduction gear on each propulsion engine is an inertia flywheel for ice milling, and the controllable-pitch propellers have the strength required for milling. The vessel also has the ability to mill ice astern, with an ice knife and the propellers so designed.

Controllable-pitch propellers are essential for this type of vessel, as the speed of advance for free running and icebreaking vary enormously.

Here Clive showed a video of icebreaking model tests undertaken in the ice towing tank at Hamburgische Schiffbau-Versuchsanstalt (HSVA) in Hamburg. The video was taken from underneath the ice, and showed the bow cleaving the ice cleanly.

The hotel loads on the vessel are subject to large variations due to winterisation, heating, ventilation and air conditioning; and the vessel systems, and this impacts the propulsion system. Generating power is provided by two Bergen C25 33L9A gensets each rated at 3 MW in the aft engine room, plus one Bergen C25 33L9A rated at 3 MW and one Bergen C25 33L6A rated at 2 MW in the forward engine room. In addition, the two PTIs in the port and starboard propulsion trains can also be used as power take-offs, each rated at 3.2 MW.

There are some unusual consequences of the propulsion-system design:

- Waste-heat recovery economisers are only fitted to the gensets; this enhances the most efficient mode for open water as diesel-electric, since this 'free energy' is lost if diesel-mechanical is selected.
- The main engines are actually rarely used, which means that the regulations on service tank and oily bilge capacity are skewed high, so a special dispensation was required for lower capacities.

- The very high installed power gives a potential open-water speed well in excess of 16 kn; this causes potential classification-society rule difficulties in that the speed of entry for manoeuvres is not realistic, and the scantling speed and maximum speed differ.

Wet Well Sampling Space

Th wet well sampling space will be fitted with three filter tables and a fish-egg sampler for the collection of live samples of krill and other species for scientific purposes, both to understand known and unknown species from live samples, and to understand populations.

Nuyina's wet well sampling space
(Photo courtesy Australian Antarctic Project)

The space is located below the waterline, and is destined to handle up to 370 t/h of sea water, potentially at –2°C. How to ensure adequate drainage? The initial design proposed using floor plates as a buffer between inlet flow and drainage. However, AAD was concerned that the inlets would not shut off in time to prevent flooding, so now there is a drain tank of 30 t capacity which can be drained in 5 min using either of a pair of 500 m^3/h pumps (to provide redundancy). These pumps are actually the biggest on board, and can double as bilge pumps if required.

Nuyina's drain pumps for the wet well sampling space
(Photo courtesy Australian Antarctic Project)

Resupply

Nuyina is capable of several types of resupply operation to suit the four Antarctic stations.
For resupplying a station whilst dynamically positioned offshore, the design considerations include:

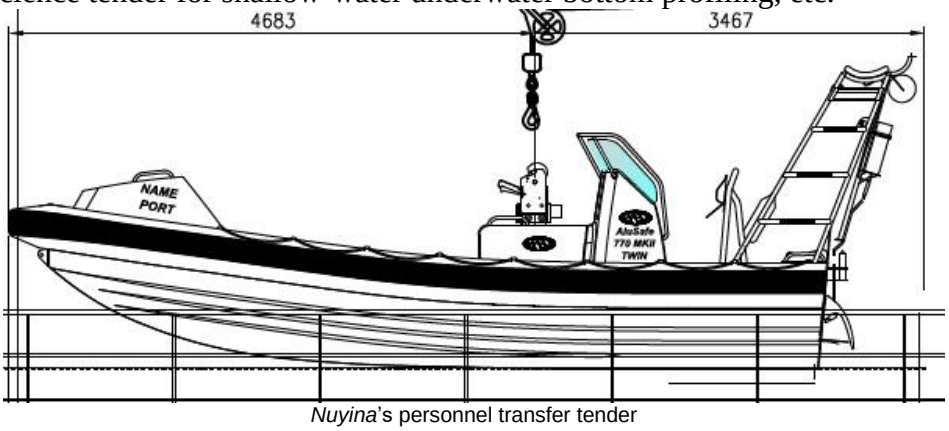
- The main cargo cranes have counter-ballast for easier simultaneous helicopter operations and comfort onboard.

- The hatches are required to be open at sea, and this has serious consequences for the assignment of the load line and, again, a special dispensation was required.
- The landing barge must be lifted on and off *Nuyina* and refuelled afloat.

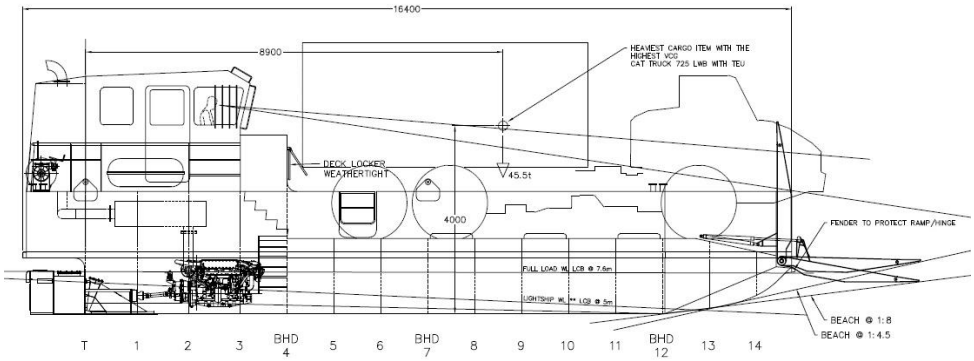
When a station is locked in due to ice, *Nuyina* can respond by either moving the cargo at the top of the hold (intended for the locked-in station) internally to allow other stations to be resupplied earlier, or the cargo can be prepared for helicopter resupply to the locked-in station via the helideck and winch-only point simultaneously.

Nuyina carries three watercraft types for various operations (including resupply):

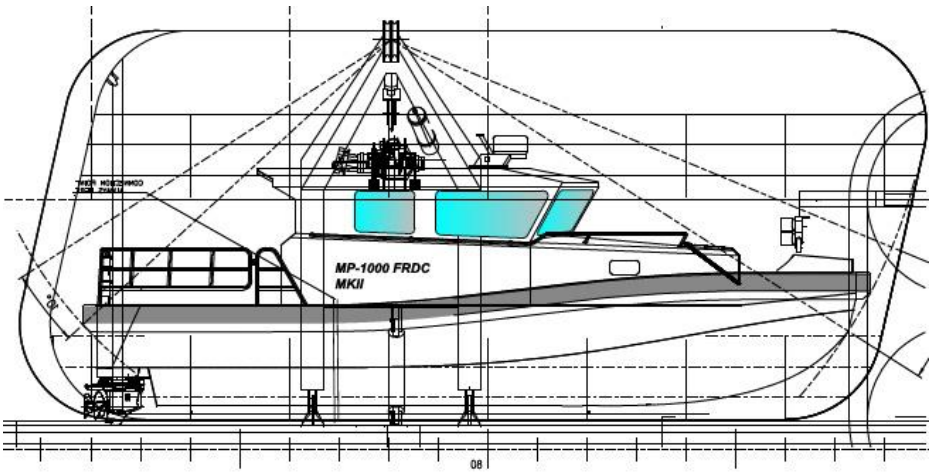
- 3×Personnel transfer tenders for transfer of expeditioners to a station (8 at a time).
- Landing barges for lo-ro transfer of construction vehicles and a Hydrema 20 ft container handler to stations on the continent.
- 1×Science tender for shallow-water underwater bottom profiling, etc.



Nuyina's personnel transfer tender
(Drawing courtesy Australian Antarctic Project)



Nuyina's landing barge
(Drawing courtesy Australian Antarctic Project)



Nuyina's landing barge
(Drawing courtesy Australian Antarctic Project)

Conclusion

In summary, *Nuyina* is not just a modernised *Aurora Australis*; *Nuyina* has vastly increased capacity in all areas, particularly in the ability to deliver marine science. It is a very significant investment in Australia's Antarctic Program. This much complexity in a relatively small platform led to numerous design challenges, and will require smart operating in the future to utilise *Nuyina*'s full capability. All this makes it one of most eagerly anticipated ships in recent years.

Questions

Question time was lengthy and elicited many more interesting points.

The certificate was subsequently posted to Clive, and the "thank you" bottle of wine delivered via an eGift card.

Clive's presentation was recorded, and is now available to webinar registrants on the Engineers Australia On Demand website.