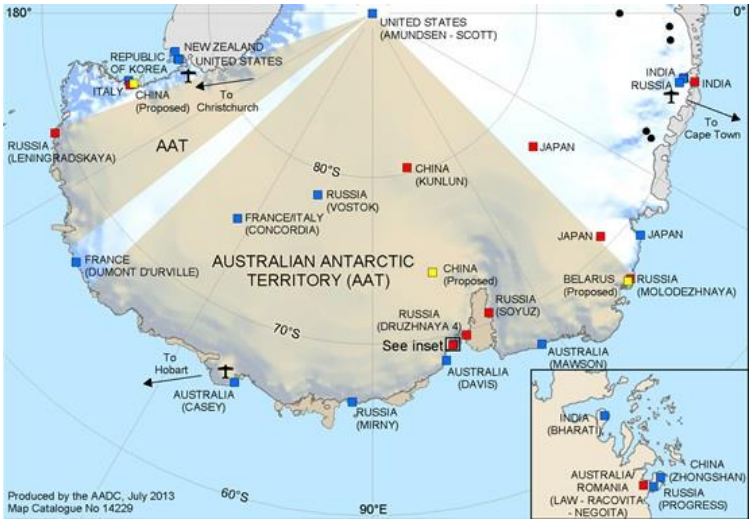
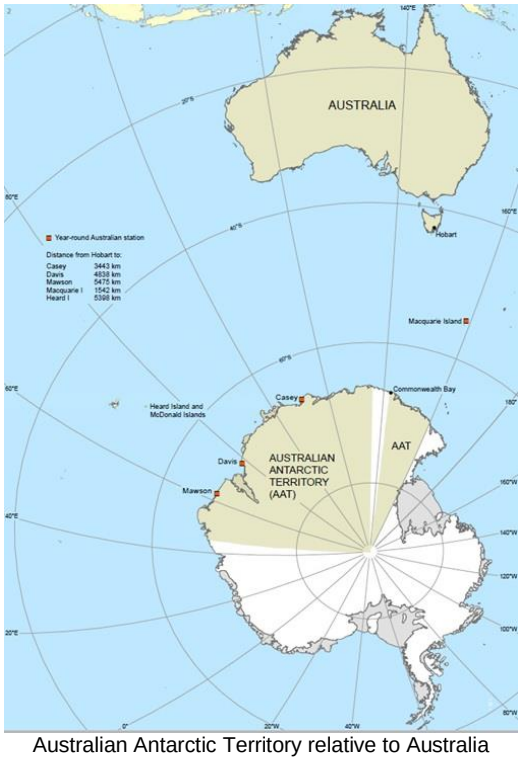
Nick Browne, Research Supply Icebreaker Project Manager, Australian Antarctic Division, gave a presentation on *Australia's New Antarctic Vessel* to a joint meeting with the IMarEST attended by 46 on 7 September in the Harricks Auditorium at Engineers Australia, Chatswood. This was the fifth-highest attendance of the 93 presentations held in Chatswood.

Introduction

Nick began his presentation by saying that the project began in 2010–11 with discussion with the Commonwealth Government about the need to replace the ageing icebreaker *Aurora Australis* for research and re-supply of stations in the Australian Antarctic Territory (AAT). He went on to describe the AAT and our three coastal stations there, Casey, Davis and Mawson. Other stations within the AAT belong to other countries, but Australia projects its presence into the territory, which is the largest in Antarctica. In addition, a wedge out of the AAT is claimed by France. Mawson Station is the furthest from Hobart, requiring a 14-day transit voyage for re-supply, while Casey is the closest, requiring a 7-day transit voyage.



Australian Antarctic Territory
(Map courtesy AAD Data Centre)



Australian Antarctic Territory relative to Australia
(Map courtesy AAD Data Centre)

Australian Antarctic Strategy

Australia's Antarctic strategy and 20-year action plan [*see www.antarctica.gov.au/about-us/publications/20-year-australian-antarctic-strategic*-plan — Ed.] was announced the day before the contract for the new ice-breaker was signed. The report provides a blueprint for Australia's future engagement in Antarctica and options to expand Tasmania's role as a leading Antarctic science and logistics hub. It examines the challenges ahead and provides recommendations on how the Federal and State Governments, working with business, researchers and the wider community can achieve that outcome. The report was prepared by Dr Tony Press, former Director of the Australian Antarctic Division and former CEO of the Antarctic Climate and Ecosystems Cooperative Research Centre.

The modernisation program examines the shipping, aviation, station, traverse and other requirements. Shipping forms the backbone of the Australian Antarctic Program.

Seed funding is provided for year-round inter-continental aviation access, where only summer access is possible at present to the Wilkins Runway near Casey.

Station infrastructure is being investigated, as our stations are now 40 years old. The locations are being checked, their footprints, and what would new stations look like?

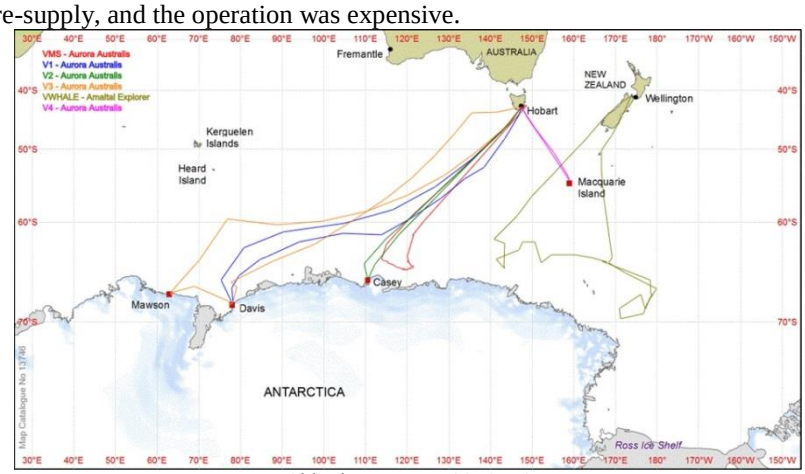
Under traverse, we also want an inland presence in the AAT, as the UK, USA and France are quite active in this area.

In other areas, we are looking at small UAV or drone-type operations to help the reconnaissance for ice leads for navigation, rather than using helicopters which are more expensive to purchase and operate.

Shipping Season

Nick then showed a slide of the 2012–13 shipping season as an example.

However, there is always the A (Antarctica) Factor: If something can go wrong, then it will! The shipping season can be unpredictable, and this can be expensive. At Mawson one year, the ship could not get into the usual position (within 100 m of the shore) due to the ice not breaking out and so, instead of fuel being transferred by hose, it had to be ferried to the station by helicopter, 1 t at a time. This meant that the station did not receive a full re-supply, and the operation was expensive.



Shipping season 2012–13
(Map courtesy Nick Browne)

In 2012–13, Voyage 1 by *Aurora Australis* was to Davis to get in early, and making use of the ice by setting the ship in 1.5 m thick ice and using 1.5 t vehicles for transfer of supplies. Voyage 2 was for re-supply of Casey, using every cubic metre of cargo and fuel capacity to keep Casey supplied for 12 months. Voyage 3 was for re-supply of Davis and Mawson. Voyage 4 was a short voyage to Macquarie Island. This is not always done by *Aurora Australis*, but sometimes by the French vessel *Astrolabe.* Macquarie Island is visited late in the season due to the birds breeding there earlier. There is no sea ice at Macquarie, and so no problem with the season.

At Davis Station, the ship breaks ice to approximately 1 n mile offshore. The ice is tested, and trucks drive cargo from ship to store. Refuelling is conducted by hose across the sea ice. Helicopters may be used, but are always carried as cargo for transfer to the station.

At Casey Station, the ship about 1n mile offshore. Barges are used to transfer cargo ashore, and tenders transfer personnel. Refuelling is conducted with a floating hose across the water. Casey is the largest AAT cargo resupply, currently 800 t of dry cargo and 900°000 L of bulk fuel.

At Mawson Station, the ship is moored with shore lines within 100 m of the shore (or sometimes closer!) Barges are used to transfer cargo ashore, and tenders transfer personnel. Refuelling is conducted with floating hose across the water.

At Macquarie Island, the ship is anchored offshore in Buckles Bay. LARCs are used to transfer cargo ashore, and IRBs transfer personnel. Helicopters may be used to transfer personnel and sling-load cargo. Refuelling is conducted with hose across the water.
Heard and McDonald Islands are sub-Antarctic islands in the Southern Ocean, and there is a periodic requirement to support landings and summer science research parties. Unlike the others, there is no permanent occupancy, and occupancy is limited to field huts. There is an ocean roadstead anchorage, and LARCs and IRBs are used for cargo and personnel, with surf landings! There is no ship-to-shore refuelling.

Aurora Australis and the Need for Replacement

RSV *Aurora Australis* is the main platform for resupplying our research stations and conducting scientific research. She is owned and operated by P&O Maritime Services and chartered by the Australian Antarctic Division of the Department of the Environment and Energy. She was launched in 1987 and commenced operational service in 1990. A Life-Extension Refurbishment Program (LERP) was completed during 2012–15 to ensure continued support to the Australian Antarctic Program. In 2020 the vessel will reach 30 years age, and new Antarctic shipping capability is required.
Principal particulars of the vessel are

Length	94.91 m
Beam	20.3 m
Depth	10.43 m
Draught	7.86 m
Tonnage	6574 GT
Displacement	8289 t
Passengers	116
Crew	24
Capacity	1800 m^3 break bulk cargo
	1000 m^3 supply fuel in tanks
	29 TEU
Aircraft carried	Up to 4 helicopters
Aviation facilities	Hangar and helideck
Installed Power	Wärtsilä 16V32D 5500 kW and
	Wärtsilä 12V32D 4500 kW
Propulsion	Controllable-pitch propeller in nozzle
Thrusters	One bow, two stern
Speed (maximum)	16.8 kn
(cruising)	13 kn
(icebreaking)	2.5 kn in 1.23 m ice
Ice class	LR 1A Super Icebreaker

Aurora Australis was introduced to work in conjunction with cargo ship *Icebird* and to increase the number of days for scientific research to 60. She worked in conjunction with other leased ships for 18 out of the first 23 years of service to meet overall logistic needs of the research stations. The mean number of days funded during the period 2000–01 to 2011–12 was 239, consisting of 166 days on resupply and 73 days on scientific research. She has operated primarily as a single-ship service since the introduction of the Airlink (Airbus A319 aircraft) between Hobart and Wilkins Runway in the 2007–08 season.
Aurora Australis has had several single points of failure, including the single main cargo crane, the single shaft/CP propeller, and the single rudder. There is limited volumetric cargo deadweight capacity of approximately 1800 m^3/700 t with maximum fuel bunkers on board. There is limited icebreaking capability to deal with an increasingly-complex Antarctic sea-ice environment. The modern-day equivalent is the South African vessel *Agulhas II* at 135 m length [40% longer—Ed.], reflective of modern day design practices. Due to the constraints and limitations, *Aurora Australis* does not provide a reasonable point of reference or comparison for the new vessel. Notwithstanding these limitations, the Aurora Australis has been the flagship icebreaker for Australia's Antarctic Program for the last 26 years and provided excellent service.

Project Assumptions

Assumptions for the vessel replacement project included the following:

- Shipping capability will have a 30-year service life, and will be owned and flagged by the Commonwealth of Australia.
- Shipping capability will be primarily provided by means of a single multi-purpose icebreaking vessel to support the AAP.
- The preferred means of supplying logistics flow to Antarctica is by a combination of shipping and aviation links.

- Shipping capability will be responsible for the primary mission of scientific research and annual station resupply.
- Shipping capability will be responsible for secondary missions including emergency response and support for other agencies.

Antarctic vessels spend most of their time on re-supply operations, but can also do research–which is the primary aim of the stations.

Project Scope

The required project outcome was stated as

"The provision of a sustainable, modern and efficient sea transport capability to the AAD for the next 30 years beyond the retirement date of the RSV *Aurora Australis*."

Project Output 1 — Compliance
Project Output 2 — A Research Supply Icebreaker
Project Output 3 — Associated Infrastructure and Equipment
Project Output 4 — Contractor Services
Project Output 5 — Transition / Change Management

Procurement Process

The procurement process consisted of a non-binding RFP (request for procurement) to produce a shortlist of respondents who were subsequently invited to respond to a prequalified RFT (request for tender).

The procurement process commenced with release of the RFP in January 2013, continued with release of the RFT in July 2014, and concluded in April 2016 when the Department of Environment and Energy signed a contract with DMS Maritime for the procurement of a new vessel under a DBOM (design, build, operate and maintain) contract. The design process is currently underway and the new vessel is expected to be delivered in mid-2020. The initial operation and maintenance term of the contract is 10 years.

Here Nick showed a video [*available on the AAD website* — Ed.] of the procurement process. DMS Maritime (as the primary contractor) has sub-contracted the design and build to Damen Schelde in the Netherlands, with DMS providing the project management. The design concept was completed by Knud E. Hansen (a Damen company) , with Damen Schelde now being responsible for the final design. The Damen Shipyard in Galati, n the Danube River in Romania, will complete the detail design and build the vessel.

New Antarctic Vessel

Principal particulars of the new vessel are

Length	156.0 m
Breadth	25.6 m
Draught	9.3 m
Displacement	14 700 t lightship 23 800 t full load
Special personnel	116
Total complement	150
Range	16000+ n miles
Endurance	90 days

The base crew is 29, but there is flexibility between the special personnel and the crew, with the cabins meeting the MLC requirements for either one or two occupants.

In comparison with *Aurora Australis*, we see the following:

Item	**New Antarctic vessel**	***Aurora Australis***
Length	156 m	95 m
Expeditioners	116	116
Containers	96	24
Cargo	1200 t	800 t
Cargo hold space	5030 m^3	1790 m^3
Fuel	1.9 ML (incl. 0.5 ML aviation)	1.1 ML

Regulatory

The vessel will be flagged under Commonwealth of Australia and certified as a Special Purpose Ship under the IMO SPS Code 2008 and will be IMO Polar Code compliant.

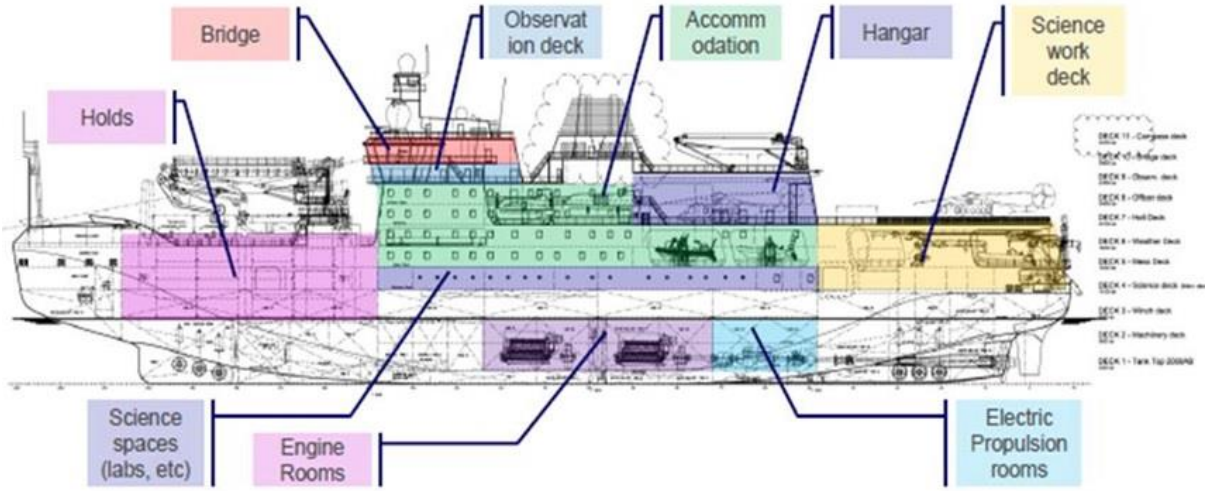
Lloyd's Register have been contracted by Damen to class the vessel with the following class notations:

✠100A1 Research/Supply Ship, Icebreaker(+), Ice Class PC3, *IWS, Helideck, TA3, Winterisation H(-40)*, D(-30)**, S(B), ECO (BIO, BWT, GW, NOX-2, OW, P, R, SOX, IHM, SEEMP, EnMS, IBTS), LA

✠LMC, UMS, DP(AA), CAC(2), PSMR* Shipright (SERS, ES, SCM)

DNV Silent R notation standards applied to acoustic noise

Functional Zones
Here Nick put up a slide showing the main functional zones on board the vessel.



Functional zones on the new Antarctic vessel
(Drawing courtesy Australian Antarctic Division)

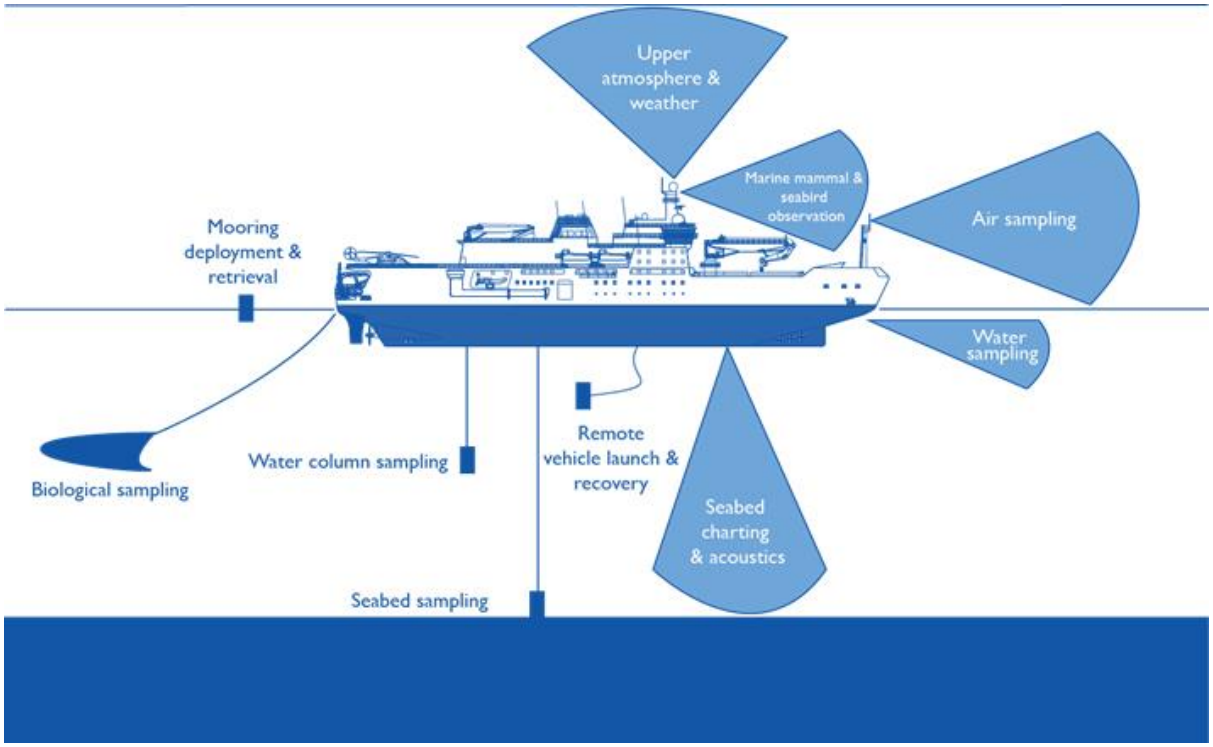
Power
For the propulsion system, the vessel has two direct-drive diesel engines of 9.6 MW each and two electric motors of 3.7 MW each, giving a total propulsion power of 26.6 MW. However, the installed power includes two direct-drive diesel engines of 9.6 MW each, three diesel gensets of 3.0 MW each, and one diesel genset of 2.0 MW, giving a total installed power of 30.2 MW.

Icebreaking Capability
The vessel will be capable of continuous icebreaking at a speed of 3 kn in an ice thickness of 1.65 m with a snow loading of 0.3 m, with ice of flexural strength minimum 500 kPa. The level of propeller-ice interaction is critical to full-scale performance. Model testing has been done both ahead and astern in level ice, but also testing ridge performance and manoeuvring. In 10/10 ice (i.e. full ice coverage) there is no interaction with the propellers, but in 8/10 coverage, the flow is asymmetrical and so there is some interaction with the propellers. The ice knife at the forward end of the underwater body is good for breaking the flexural strength of the ice.

Cargo Capacity
The vessel has two main cargo holds. No.1 Cargo Hold is configured for efficient TEU storage (48 TEU plus wing space) and rated for dangerous goods. No.2 Cargo Hold is configured for flexible break-bulk and general cargos (48 TEU plus wing space). There are two main cargo cranes, each of 55 t SWL. These are offshore rated and can be used in up to Sea State 4 for operations at Macquarie Island.

Helicopter Capability
The vessel has a flight deck and hangar aft which are suitable for four light helicopters (represented by the Eurocopter AS350B3), or two medium helicopters (represented by the Sikorsky S-92). Forward there is a winch-only position on the No.1 Hold Hatch Cover which has suitable clearances for light and medium helicopter winch operations.

Scientific Research
The vessel is jam-packed full of scientific instruments for sampling and research: radars, air sampling, water-column sampling, trawling, etc. Here Nick showed a slide of some of the capabilities of the vessel.



Scientific research capability on the new Antarctic vessel
(Diagram courtesy Australian Antarctic Division)

Acoustic Noise Performance
Low acoustic noise is critical for effective scientific research operations and is measured as underwater radiated noise and self-noise (at the location of the ships transducers). This was a major driver for the design and arrangement of the propulsion system, and is in direct conflict with the requirements for icebreaking! Cavitation played a significant part in the design of the propellers.

Science Working Deck
The science working deck is aft (under the main deck), and covers approximately 500 m^2. There are eight designated science container laboratory positions. Large trawl-net drums are located aft on the Mezzanine Deck. Access is provided to the stern-quarter towing booms and stern A-frame which has a 30 t static SWL and 10 t dynamic SWL.

Moon Pool
The vessel has a moon pool located amidships, located asymmetrically on the starboard side of the vessel's centreline. Deployment of CTD (conductivity, temperature and depth) sampling devices, nets, grabs, ROVs, etc., can all be within the dimensional constraints (3.2 m). There is an internal wave-damping system on the sides of the moon pool. This is supported by a cursor frame system for bottom deployments, and there are non-watertight closing arrangements on the bottom shell and at Deck 4 level.

CTD Deployment
The CTD hangar position is located amidships on the starboard side. There are two CTD winches capable of deployment to a depth of 7500 m, and a CTD overhead crane with a telescopic boom for side deployments. The side-shell opening doors are in two sections (upper and lower) for protection. The moon-pool cursor frame is used for bottom deployments. Operations can be carried out in up to the top of Sea State 6 (6 m waves) and Beaufort Force 8 (34–40 kn).

Drop Keels
Two drop keels are fitted forward of midships, located asymmetrically on the starboard side of the vessel's centreline. Dimensions are length 3.9 m × width 1.4 m × height 6 m. At full extension the projection is 3 m below the hull, with several incremental positions. There are non-watertight closing arrangements on the bottom shell, and temporary positions for short-term installation of sensors of up to 1 × 2 m. Operations can be carried out at up to 16 kn, with activation at up to 4 kn.

Design and Build Process
Design of the vessel included basic engineering design, CFD modelling and optimisation, and extensive model-testing program, and the detailed engineering design.
Construction at the Damen shipyard in Galati, Romania will be in individual blocks (110+) which will be fabricated in module halls. These blocks will be consolidated over 58 building steps. Over 8000 t of steel will go into the construction of the vessel.
Galati is approximately 200 km up the Danube River from the Black Sea, so sea trials will take place in the Black Sea, covering usual scope of testing. Special sea trials will then take place in the North Sea and the Norwegian and Greenland Seas, covering deep-water tests, acoustic noise trials, and icebreaking trials, i.e. replicating Antarctic conditions as closely as possible without having to go there.

Build Strategy
Nick then showed a video of the proposed construction process, including an overview of the shipyard at Galati, surface treatment of steel as it arrives in the yard, transport of build sections to the build location, block outfitting, hull assembly in the dry dock, installation of the shafts, propellers and rudders, floating of the hull and movement to the wet dock, assembly of the superstructure, turning of the vessel for crane access to the other end, movement of the ship to the quay, installation of the cranes, setting-to-work of equipment, sea trials, transport to Bergen, Norway, and special sea trials, the inspection docking, ship acceptance procedure, transit to Hobart, and final acceptance.

Conclusion
Australia has set in motion an acquisition process for new Antarctic vessel to replace the ageing *Aurora Australis* which will deliver a significantly larger and more-capable vessel, and which will demonstrate commitment to Australian Antarctic Territory, the Casey, Davis, Mawson and the island stations, and project her presence inland on the territory.

Questions
Question time was lengthy and elicited some further interesting points.
A side air-bubbling system to reduce friction with the ice was considered but not adopted. The Japanese icebreaker *Shirase* has this system, but experience with it has been mixed, i.e. it has not been a total success. They were looking to reduce complexity on the new vessel, and it was considered not worth the risk.
The scientific research capability for the new vessel was benchmarked against CSIRO's new research vessel, *Investigator*, and the new vessel can continue research south from where *Investigator* leaves off. In the re-supply area, the new vessel is state-of-the-art. She is different to the South African vessel *Agulhas II*, because they only have two stations to service, they are closer together, and they can use the ice shelf. The propulsion system is good—they worked closely with the contractor to mitigate the risks. In the area of icebreaking, if we achieve everything predicted, then we will have an icebreaker for heavier ice than most, and more quietly.
In the class notations the safety case, common in the defence industry, was not required by the AAD. The class notations were to meet the commercial requirement of class and flag. Safety was considered in the design of the vessel. The safety case was not considered the best value, where you populate a matrix with hazards and then put mitigations in place post-design completion. The focus in design is to eliminate safety hazards in the first place.
The requirements for the new vessel were not based on *Aurora Australis*, but by looking at shipping as a whole and building into the new vessel. Some things were not done in *Aurora Australis* which we now have the opportunity to do, as well as crystal-balling the future. *Aurora Australis* was examined closely for lessons learned and problems.
The capital cost of the vessel is of the order of $500 million, but there is a range of considerations for the capability of the vessel, such as fitting for, but not with (yet!) This vessel represents a significant investment, and re-affirms our presence in Antarctica by having a ship as the collaborator of choice.
The colour of the ship shown in videos (orange/red) was produced as part of the tender; the final colour has not been decided. The naming of the vessel will be run in the fourth school term this year, and the likelihood is that they will pick the five best submissions and make a decision!
The vote of thanks was proposed, and the certificates and "thank you" bottles of wine presented, by Adrian Broadbent. The vote was carried with acclamation.