Glosten

PROJECT MEMORANDUM

Status Update – Deck De-icing Systems Study	*29 September 2020*
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Progress Update

A literature search was conducted on the topic of ice accretion in high latitudes and various methods and technologies to mitigate and remove ice accumulation on vessel superstructures. The following are the types of de-icing technologies under evaluation. Research into each of these technologies is ongoing:

- Deck heat traced deck plates or mats
- Under-deck electrical heat tracing systems
- Under-deck waste heat hydronic systems
- Oil-fired boiler/steam piping systems (also under deck)

In addition to literature review, Glosten is corresponding with vendors to gather cost and energy-efficiency data on a range of products.

Glosten is also corresponding with owner/operators of cargo and oceanographic research vessels that routinely operate in polar regions to gain insight on their practical experience with various de-icing system types and their associated energy demands and costs, including the Director of Arctic Operations at Fednav and the Vice President of Operations at Vard Marine, who was instrumental in the development of the IMO Polar Code.

Regulatory rules and guides were also reviewed, including IACS Polar Class Rules, the ABS Guide for Vessels Operating in Low Temperature Environments (LTE Guide), and DNVGL Offshore Standard No. DNVGL-OS-A201, *Winterization for Cold Climate Operations*.

Calculations are being made to compare the life-cycle cost of various systems. All areas of the external decks on the Antarctic Research Vessel (ARV) were identified where installed de-icing systems may be desirable or appropriate based on class guidance, our understanding of the basic operating requirements of the vessel, and our present knowledge and experience with such systems. This included all external weather decks, ladders/stairways, and bridge wings.

The identified areas where then divided into two basic categories: working decks and non-working decks. It was assumed that underdeck heating systems (e.g. waste heat hydronic systems) are most appropriate in these areas since heat traced deck plates and mats are more susceptible to damage from impact, pressure, and abrasion. For the non-working decks, it was assumed that heat traced deck plates or mats will be used. It is acknowledged that, ultimately, a different system type may be selected for each of these areas; but for the purposes of this study, this division of the exterior decks allows for an initial energy demand and cost comparison between two basic types in a combined solution that are known to be in use on similar vessels.

As more information is gathered on the various system types, these calculations will be expanded to compare more than two types of de-icing systems.

Capital costs and energy requirements for each de-icing system type was acquired from vendors. Daily operating costs are being calculated based on energy required and deck area being serviced by each system type.

Key Findings

Installed de-icing systems for Polar Class vessels are not mandated by class rules. Rather, there is extensive class guidance on the use of de-icing systems, which are non-binding standards (i.e. recommendations). However, the recent implementation of the IMO Polar Code complicates the picture considerably.

Under the Polar Code, ships operating in the Arctic and Antarctic must carry a valid Polar Ship Certificate issued by class, which essentially constitutes class approval for the intended polar water operations of a specific vessel. It certifies that the vessel has been surveyed in accordance with the applicable safety-related provisions of the Code. Issuance of the certificate requires the completion of an Environmental Hazards Assessment and Operational Assessment, which are used in conjunction to inform the development of a ship-specific Polar Water Operations Manual (PWOM).   The PWOM is the document in which the operator must outline measures and procedures to be used to mitigate hazards from sea ice, ice accretion, and low ambient air temperatures. If the measures and procedures (including the use of de-icing systems), are deemed inadequate for the nature of the operations, class can deny issuance of the Polar Ship Certificate until their concerns and recommendations are addressed. Nevertheless, this leaves the operator with a fair amount of discretion about the type(s), location, and extent of de-icing systems to have in place.

Some operators prefer to install extensive de-icing systems, while others are much more selective. Some operators, including both Fednav and the Canadian Coast Guard (largely) use none at all, instead opting to minimize the probability of superstructure icing through a combination of structural design decisions and operational measures. Some examples are provided below.

Architectural measures to reduce the likelihood of superstructure icing include:

- Positioning the house as far forward as possible to minimize exposed weather decks forward.
- Covering the foredeck with a whaleback fo’c’sle.
- Making muster stations and walkways internal to the vessel or fully covered/enclosed to the extent possible.
- Eliminating exposed weather decks where they are not critical – e.g. 02 decks or higher.
- Extending overhead over external walkways where possible.
- Minimizing exposed exterior ladders and stairways.
- Designing high freeboard in exposed areas.

Operational measures to reduce the likelihood of superstructure icing include:

- Limiting operating seasons to calendar dates with warmer ambient air temperatures
- Reducing speed
- Altering course
- Temporarily ceasing operations / transiting to areas with warmer air masses

In various discussions with vendors, operators, and peers, feedback was consistent. The most salient points are provided below:

- To reduce potentially very high capital and operating costs, operators should be extremely selective about where they choose to design for and/or specify deck heating systems of any kind.
- Because the cost and/or electrical load of these systems is so high, operators, to the maximum extent possible, should strive to minimize the need and extent of de-icing systems through structural/architectural measures.
- Under-deck heating systems are recommended for working decks where cargo and/or equipment may be landed, stowed, or handled. Because such systems are installed beneath the deck plating, they remain well protected from activities on deck.
- In the interest of reducing complexity, engineering effort, and capital costs, it is generally regarded as impractical to install under deck waste heat hydronic or steam piping above the main deck level. If under deck de-icing is required on 02 decks (or higher), electric heat tracing is preferable.
- The best places to install above deck, electric heat-traced systems are exterior areas that must be kept clear to access emergency/lifesaving equipment, evacuation routes, etc.
- The power demand for above deck, electric heat-traced systems (e.g. rubber mats or aluminum plates) can be tremendous if all areas are active at the same time. Moreover, circumstances where this is necessary to keep the decks ice free are rare. For this reason, electric heat-traced systems should be set up zonally, such that certain areas of the decks can be active, while others are turned off (e.g. in cases where the vessel is operating with wind on one side only).
- Helicopter and UAV landing decks are generally problematic for installed de-icing systems of any kind for the following reasons: 1) deck impact from helicopter operations requires an under deck solution; 2) helicopter landing decks are often elevated decks, making the use of steam or hydronic piping impractical; and, 3) helicopter landing decks are generally very exposed and afforded little insulation from adjacent structure, making the power demand for de-icing systems in these areas extremely high. Chemical or manual de-icing systems and methods are recommended (e.g. chemical de-icers, steam lances, and manual tools).

New "intelligent" de-icing systems are now commercially available, designed specifically to reduce the energy demand of operating electric heat-traced systems in icing conditions. Such systems use a network of active ice sensors installed around the vessel that detect when ice is forming. A sophisticated control system then distributes electrical power, as necessary, to specific areas (zones) of the vessel where ice is forming, while other areas remain inactive. At present, Starkice is the only vendor of de-icing systems with this level of functionality.

Next Steps

Next steps include:

- Continued information gathering from vendors and shipyards
- Refinement of life cycle cost calculations.
- (Recommended) Meet with the Leidos team to go over our work on this task to date and reach agreement on assumptions to be used, especially the extent of installed de-icing on upper level decks.