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Review of the Technical Specifications for the BCFS Intermediate Class Ferry and the provisions of the BC Ferry Commission Order 13-01

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1 INTRODUCTION

The BC Ferry Commission has retained 3GA Marine Ltd (3GA) to provide an opinion on the Technical Specifications that British Columbia Ferry Services, Inc. (BCFS) have developed to define the next generation Intermediate Class Ferry with respect to implementing the provision of the Commission's Order 13-01 issued 19th July 2013.

The subject provision states;

Prior to issuing a Request for Proposals for the design and build of the proposed new vessels, BC Ferries must satisfy the commissioner that:

i. a fuel efficiency target has been included in the technical specifications for the proposed new vessels and reflected in the procurement documents; and
ii. the concerns of ferry users regarding the open deck design of the new vessels have been taken into account when finalizing the technical specifications for the new vessels and such design will have no significant impact on service levels on the routes where these vessels will be deployed.

The Commissioner`s charge to 3GA Marine is;

1. The contractor will review and assess the design and technical specifications contained in BC Ferries' procurement documents for the proposed three new Intermediate Class Vessels. The assessment will be based on whether the specifications have addressed the major concerns of ferry users regarding comfort and reliability of the new vessels in adverse weather conditions. Based on BC Ferries' application to the Ferry Commission for approval the new vessels are to be designed such that there will be no additional cancellations due to adverse weather conditions as has been experienced by the existing vessels operating on Routes 9 and 17.

This report provides a review of the BCFS document "STANDARD INTERMEDIATE CLASS FERRY (ICF), 125/145 AEQ Variant, Ro/Ro Passenger Vessel - Statement of Operational Requirements" Rev. 1 dated November 2013 (SOR)

2 BCFS RESPONSE TO ORDER 13- 01

BCFS response to the application provision was addressed by letter to the Commissioner and included the relevant SOR sections that were added to address the provision. Extracts from the letter are provided here;

2.1 Fuel Efficiency

Letter Rob Clarke BCFS to the Commissioner

"With respect to the fuel efficiency target BCF will be using a life cycle cost approach in its financial option and fuel will be a significant factor. Based on our experience with the current vessels, the business case included an overall projected fuel efficiency target of approximately 15 % which was based on a diesel to diesel replacement option. However, the current BCF requirement specifies a dual fuel diesel and Liquid Natural Gas engine, which is less efficient than a diesel only engine. Accordingly, the fuel efficiency target for the dual fuel engine is lower and is expected to result in a predicted fuel efficiency of 6.5 %, which is included in the RFP technical specifications."

Noted SOR clause

SOR-16 Endurance and Fuel Efficiency

The Vessel shall be capable of operating for seven (7) days standard duty cycle on LNG without refuelling; there shall be sufficient diesel carried for four (4) days standard duty cycle when running the DF engines on diesel only. The design deadweight shall be based on this operating cycle, exclusive of any reserve.

The systems are to be designed to the following utilization profile:

16-1 Utilization Profile

• 5500 hours annual operation
• 16 hour operational day consisting of: 35% in dock/loading/unloading/stand-by 10% docking manoeuvring (harbour mode) 30% transit mode – 13.5 knots 25% transit mode – 15.5 knots + 1 hour start up

Freshwater capacity shall accommodate a five (5) day cycle. Sewage holding tank capacity will be sufficient for a two day off loading cycle with peak passenger loading as defined in **SOR-90**.

Storing capacity for catering and retail stock shall be designed for weekly replenishment.

The Vessel shall be designed for efficient operation for the utilization profile in Table 16-1, on the Routes specified in **SOR-60**. BCF is seeking to reduce the fuel consumption from about 3.4 million litres of diesel annually on each route, which equates to 5.4 million equivalent litres of LNG. The Shipyard shall demonstrate the expected fuel consumption and associated savings with its proposed design, with a target reduction of at least 6.5%.

2.2 Spray on deck

Letter Rob Clarke BCFS to the Commissioner

"Regarding sea spray, the vessel design specifications include the requirement for sufficiently sized and designed bulwarks to ensure that vehicle deck(s) are free from sea spray 95 % of the time in normal operating conditions up to Beaufort Sea State 5, which specifies a wave height of 2 meters."

Noted SOR clause

SOR-21 Vehicle Deck Layout

The Vessel will be configured for unobstructed traffic flow over the vehicle decks, with bow and stern loading. An open deck configuration with high bulwarks and enclosed ends provided by weathertight visors is required. The bulwarks must be of sufficient height to reasonably ensure that vehicle deck(s) are free from sea spray 95 % of the time in normal operating conditions up to Beaufort Sea State 5.

3 REVIEW

3.1 3GA Opinion on the 13-01 fuel provision

BCFS have included in the technical statement of requirements a definite and defined life cycle fuel usage target and demand that it be demonstrated by simulation prior to ship build.

The target translates to 221,000 litres for diesel fuel (or the LNG equivalent) per operating year of 324 days, i.e. the designer is given an annual fuel consumption number to achieve and an operational profile to assume.

The method of derivation of the 6.5% target is stated in the covering letter as being taken from an assumed improvement of 15% available through engine technology development given the current asset's age and the technology available to a new engine. This is then offset by an 8.5% reduction in efficiency through the use of LNG as a fuel. These are both conservative values; the overall improvement in ship and propulsion system design will be able to achieve a 15% reduction especially as the target relates to whole ship performance (hull form and propeller design) and not just engine improvements. The offsetting negative efficiency attributed to LNG is less easily defined especially on a service profile that constantly changes power levels. This is because fuel efficiency in duel fuel engines at varying power outputs is not easily established and the designer will have to contend with differing ratios of diesel and LNG[1]. LNG engine development is relatively new however and the technology is constantly improving, the shipyard designer will rely heavily on simulation data from the engine supplier. 8.5% is however a conservative number.

This offsetting 8.5% must also account for efficiency differences in electric versus direct diesel engine propulsion concepts.

There is no specific fuel consumption improvement demanded in the SOR i.e. it does not say that the new ship shall consume any given percentage less fuel than the existing ship does at a given speed and load etc. Consequently fuel efficiency improvement will be established by simulation and verified over time once in service.

There is uncertainty in the fuel consumption that will be finally achieved by the new vessels. This is inherent in the translation of ship power usage to an operational profile and this uncertainty is outside the control of the designer, i.e. actual fuel will be a function of what the operator does with the ship. By setting the operational profile BCFS has provided a baseline from which to simulate the life cycle consumption and make comparative assessment of competing designs.

[1] A duel fuel engine uses a small amount of diesel fuel to initiate the ignition of the air / gas mixture in the engine. At fully rated loads this can be as low as 1% of the total fuel however at lower loads the % of diesel used increases significantly.

3.2 Conclusion:

The 13-01 Order approval provision relating to fuel efficiency has been addressed in the technical procurement documents.

Give the current 3.4 million litres of fuel is typical of the 5500 hours of operation profile experienced by both the existing and new vessels then the SOR demand will achieve an overall fuel consumption reduction.

3.3 3GA Opinion on the 13-10 spray on deck provision.

The deck layout requirement in SOR 21 requires the designer to configure the vessel with features that will mitigate the issue of water spray on deck.

In addition to the SOR references made in the BCFS letter to the commissioner, the summary section of the SOR (Introduction page 2) also refers to this issue and includes a requirement to demonstrate compliance in the design process, viz:

> "Seakeeping must be suitable for winter crossing of the Strait of Georgia without excessive motion, ***spray ingress***, or deck immersion issues. This shall be demonstrated by the Shipyard during pre-contract simulation tests."

However those sections of the SOR which describe the tests and the simulation model (SOR 13, 14, 19) do not refer to spray ingress testing or simulations.

The issue of comfort and reliability is not directly addressed by the BCFS's response to the Order 13-01 approval provision (Mr Clarke's letter does not specifically address additional cancelations on routes 9 and 17), however the SOR does include clauses which do address the issue, namely SOR 13 and 15.2. These performance criteria are for motions, seakeeping and passenger comfort and make reference to a sea condition demand for operations within the route 9,17 operational areas (reference 16) and also to a table which is derived from the Heavy Weather Matrix that currently defines the operational window of the vessels on these routes.

The SOR clauses do not demand any analysis of the frequency of cancelation, it is implied that ensuring that the vessel has acceptable motion characteristics and is controllable in conditions exceeding the current Heavy Weather Matrix will effectively ensure compliance with this approval provision.

The SOR 21 provides a target for spray on deck but the document does not state how the designer is to demonstrate the performance of his design either in the design phase or in operation. It is my opinion that the prescription of a full bow visor and bulwarks on the vessel will enable a design to meet the defined performance criteria but that there are no readily available or common established techniques available that will measure this directly in quantitative terms.

Simulating spray on deck is not a precise science, there are several techniques used to predict the probability of spray when associated with ship icing in a seaway, most however are empirical in nature and in a brief search, I could find little literature on the simulation of actual spray over bulwarks applicable to restricted service ferry type vessels. The phenomenon is directly related to wind velocity and techniques such as that referenced in the footnote[2] reference examine wind flow over the ship structure.

The demand matrix defined in the above SOR's address the more easily simulated performance conditions of motions and deck wetness (deck immersion) primarily when in beam seas. It is probable that spray issues will be most prevalent on the deck when operating in head to quartering seas and conditions may have to be defined if the simulations described in the introduction are conducted.

In all practical terms, if the deck is protected by wind shielding structure as demanded by SOR 21, then spray will be minimized. Establishing that such protection eliminates the probability of spray in a time domain is not practical and as noted in the SOR, it can only be considered "reasonable". 95% absence over time is reasonable.

BCFS have indicated in verbal conversation with 3GA, that they would not cancel any sailing for spray ingress reasons, cancelation are based on safety concerns and spray is not seen as presenting danger to ship or passengers.

Note: there is some inconsistency across the SOR and response letter regarding wave / wind condition values which may need review; Letter states Sea State 5 and height 2 meters, SOR 13 refers to 2.1 and 2.2 m wave heights and winds of 33 to 40 knots, SOR 21 refers to Beaufort Sea State 5 and the Heavy Weather Matrix refers to winds up to 33 knots at Beaufort 7 with waves up to 2.1 meters. Spray conditions will be heavily influenced by the wind.

[2] Full-scale 3D CFD Simulation of Spray Impingement on a Vessel Produced by Ship-wave Interaction, Anton Kulyakhtin (Norway) et.al., 21st IAHR International Symposium on Ice (Dalian).

3.4 Conclusion:

The 13-01 Order approval provision relating to open deck configuration and operability has been addressed in the SOR in 2 ways;

1) By asking the designer to consider the issue of spray and by prescribing the bow and bulwark concept.

   The spray on deck criterion of "vehicle deck(s) are free from sea spray 95 % of the time in normal operating conditions up to Beaufort Sea State 5" is achievable in an open deck configuration by the incorporation of weathertight bulwarks and bow visors, consequently spray on deck will not affect the ability of the vessel to sail in conditions where it might otherwise transit safely.

   It must be acknowledged that there will always be a potential for sea spray to be experienced on an open deck however such conditions can be predicted from experience and users forewarned.

   It is recommended that BCFS enter into discussions with the shipyard during contract negotiations to establish a methodology that will demonstrate either by simulation or by empirical comparison with other applications, that the criteria established in SOR 21 for spray on deck is achieved by their design.

2) By stating a design demand that ensures the vessel will be operable and comfortable in weather conditions that are more severe than those which define the current vessel's operational weather window.

   The designer is required to demonstrate by simulation his compliance with this performance objective and thus demonstrate that the vessel will not exhibit and increased number of weather related voyage cancelation.

The clauses of the technical specification provided reasonable criteria to ensure that the spray on deck will not be excessive and will not impact levels of service.