SSC Project Recommendation for FY 2020

Design and In-Service Considerations of Aluminum Sensitization on High Speed Vessel

1.0 OBJECTIVE.

1.1 The object of this project is to develop a material degradation model using existing measured data on an aluminum high speed vessel. Degree of aluminum sensitization, level of stress/strain and temperature will be the key factors considered in the model.

1.2 This project is also aiming at providing guidance on design practice and structural monitoring of aluminum vessels to minimize the risk and impact of aluminum sensitization, thus prolong the life of aluminum structures.

2.0 BACKGROUND.

2.1 Aluminum has gained popularity as a structural material for high speed vessels where lightweight structure is important to meet design goals. In many cases, those aluminum vessels have served well for several decades of use without any serious structural problems. However, in recent years, serious cracking has been observed on some aluminum high speed vessels and majority of the cracking has been documented as Stress Corrosion Cracking (SCC). Aluminum alloys, especially those with high magnesium content, when exposed to a temperature characterized as a sensitizing temperature, become particularly susceptible to intergranular corrosion. During sensitization, excess magnesium precipitates out of solution as a secondary phase, Mg_2Al_3 or β-phase, in the grain boundaries of the metal. β-phase is an electrochemically active phase. The aluminum is considered sensitized when the β-phase forms as a continuous and complete network on the grain boundaries. Since β-phase is anodic to the Al matrix, under corrosive environment, sensitized aluminum is prone to develop SCC when subject to certain stress.

2.2 To better address the issue of SCC, it is very important to have a good understanding of aluminum sensitization. Efforts have been made on material property and behavior, such as test standards of sensitization, kinetics of sensitization, and repair techniques for sensitized material. This proposed project is trying to fill the gap by taking aluminum sensitization into consideration during design phase.

2.3 Structural health monitoring systems have seen application to some aluminum vessels. The data resulting from the monitoring system can be used to improve the efficiency of operations, maintenance, repair, and replacement of the structure based on reliable and objective information. This project will leverage the findings from the real time measured data on a high speed aluminum vessel. Sensors have been installed on this vessel to keep the vessel operating within the operation envelope, to obtain the vessel response to sea loads, and to understand the effect of heat on material sensitization. Types of sensors include pressure transducer, accelerometer, MRU motion reference unit, long based strain gauge, strain gauge, sea state monitor/wave radar, thermocouple, wind sensor and altimeter. Those data will be used to develop material degradation model and calibrate structural analysis results.

2.4 Cracks found during operation require structure repair or replacement, which may lead to interruption of service and high cost. This project is generated to focus on considerations of aluminum sensitization during design phase based on material degradation model developed through real measured data. Critical areas obtained from initial structural analysis can be used to categorize the cracks found in inspection reports. Cracks due to aluminum sensitization will be identified and used as the basis for material degradation model and calibration. By incorporating the material degradation model in the design, a sensitization area can be identified to build the structure monitoring plan. This project will benefit new and existing high speed aluminum vessels

by mitigating the development of SCC due to aluminum sensitization and extend the service life of aluminum structure.

3.0 REQUIREMENTS.

3.1 Scope.

3.1.1 The Contractor shall perform a literature review on aluminum sensitization and design consideration of aluminum sensitization on high speed vessel.

3.1.2 The Contractor shall identify and develop methodologies by leveraging the findings from the existing measured data of a sample vessel to establish the material degradation model.

3.1.3 The Contractor shall identify a methodology to incorporate the material degradation model to structural analysis to better predict the time to failure and identify the area of sensitization.

3.1.4 The Contractor shall address the procedure of developing a structural monitoring plan based on the results of previous studies.

3.2 Tasks.

3.2.1 The Contractor shall undertake a comprehensive literature review of relevant technical documents.

3.2.2 The Contractor shall evaluate existing inspection reports and measurement data for the study vessel.

3.2.3 The Contractor shall review the existing FE model and identify the critical stress area based on structural analysis.

3.2.4 The Contractor shall categorize the cracks and identify the cracks due to aluminum sensitization.

3.2.5 The Contractor shall develop the material degradation model based on the measurement data on locations where Stress Corrosion Cracking (SCC) was developed due to aluminum sensitization.

3.2.6 The Contractor shall identify the methodology to incorporate the material degradation model in structural analysis.

3.2.7 The Contractor shall calibrate structural analysis with the measure data.

3.2.8 The Contractor shall develop guidance of structural monitoring based on the results of previous tasks.

3.3 Project Timeline.

	Month											
Task	1	2	3	4	5	6	7	8	9	10	11	12
3.2.1												
3.2.2												
3.2.3												
3.2.4												
3.2.5												
3.2.6												
3.2.7												
3.2.8												
Report												

4.0 GOVERNMENT FURNISHED INFORMATION.

4.1 Standards for the Preparation and Publication of SSC Technical Reports.

5.0 DELIVERY REQUIREMENTS.

5.1 The Contractor shall provide quarterly progress reports to the Project Technical Committee, the Ship Structure Committee Executive Director, and the Contract Specialist.

5.2 The Contractor shall provide a print ready master final report and an electronic copy, including the above deliverables, formatted as per the SSC Report Style Manual.

6.0 PERIOD OF PERFORMANCE.

6.1 Project Initiation Date: date of award.

6.2 Project Completion Date: *12* months from the date of award.

7.0 GOVERNMENT ESTIMATE. These contractor direct costs are based on previous project participation expenses.

7.1 Project Duration: *12* months.

7.2 Total Estimate: $100,000

8.0 REFERENCES.

8.1 ABS Guide for Building and Classing High Speed Craft

9.0 SUGGESTED CONTRACTING STRATEGY.

9.1 Direct contracting with American Bureau of Shipping.