Javier Bru Roncallo

6th EMSHIP cycle: October 2015 – February 2017

Master Thesis

Guidelines for Hull Condition Assessment Applicable to Single Skin Bulk Carriers on International Trade

Supervisor: Dr. Zbigniew Sekulski, West Pomeranian University of Technology, Poland
Internship Tutor: Eng. Juan Jose Moron, OMCS CLASS, Panama
Reviewer: Prof. Robert Bonsart, Rostock University, Germany

Szczecin, January 2017
CONTENTS:

1. INTRODUCTION & OBJECTIVES

2. INTERSHIP COMPANY & THESIS METHODOLOGY

3. BULK CARRIER SAFETY RECORDS

4. FACTORS INFLUENCING THE CONDITION OF THE SHIP HULL

5. SINGLE SKIN BULK CARRIER HULL STRUCTURES

6. ANALYSIS OF OMCS CLASS BULK CARRIER FLEET

7. SUMMARY OF OMCS CLASS GUIDELINES

8. CONCLUSIONS

9. REFERENCES
1. INTRODUCTION & OBJECTIVES

1) To develop a documentation aide in the form of clear procedures and guidelines for hull condition assessment
2) To be used internally and exclusively by Overseas Marine Certification Services (OMCS CLASS)
3) To aid to hull surveyors during their inspections for conducting their inspections
   • As informed as possible
   • Making standardize and sensible decisions
   • Optimizing their time by focusing on structural areas prone to failure or degradation.

WHY?
Ship Dimensions + Safety Concerns & Difficult Access to Ship Structure
+ Commercial Pressure + Harsh Operational Requirements

= DISASTERS & MANY TECHNICAL/OPERATIONAL CHALLENGES!

Ship hull structure assessment is a process to determine the reliability of the existing structure in terms of carrying current and future loads and to fulfil its task for a given period. With main objectives:

1) The assurance of structural safety and serviceability (SAFETY)
2) The minimisation of costs and repair time. (COMMERCIAL)
2. INTERSHIP COMPANY & THESIS METHODOLOGY

A) Bibliographic Review (IMO, IACS, INTERCARGO, OMCS CLASS, Flag Administrations & PSC Regimes circulars)

B) Survey history information review of 10 single skin bulk carriers classified by OMCS CLASS up to the last two SS.

1) Class survey statements,  
2) Transfer of class information,  
3) Hull related deficiencies and/or conditions of class,  
4) PSC detention records,  
5) Thickness measurement reports and finding,  
6) ESP survey reports.

C) Supplemented by on the field inspections that were carried out along with OMCS CLASS Surveyors.
3. BULK CARRIERS SAFETY RECORD

Between 1983 & June 1997, 73 bulk carriers were lost due to known or probable structural failure and more than 40 suffered severe damages. 70% of the total losses had three common factors:

- ship with age > 18 years
- carrying heavy ore cargoes
- suffered water flooding of the cargo holds during bad weather conditions

Poor safety record and innumerable accidents recorded coupled with the type of cargoes and hardships of its operational life; triggered the maritime community to REACT!

Special attention to the design, construction (Common Structural Rules) and overall the scope and quality of the inspections (Enhanced Survey Program) of the bulk carriers.

As per Clarkson Research, in 2016 were more than 10,000 bulk carriers of different sizes in service trading around the world.
4. Factors Influencing the Condition of a Bulk Carrier Hull

1) Ship Age

Total losses of bulk carriers > 500 GT ((IUMI), 2016)

Class NK PSC Detention Statistics by Age

OMCS CLASS BIGGEST PROBLEM
Average Age of 24 years

2) Protective Coating

- Water Ballast Tanks (The single largest surface area)
- Recent Requirement July 2008 (15 Years Target)
- Grading Required (GOOD, FAIR, POOR)

- Coating degradation due to inadequate surface preparation and paint application, loss of coating flexibility over time causing cracking and debonding.
3) Corrosion Wastage

- The most important causes of structural damages and wears of a ship structure
- General, Pitting, Stress Corrosion Cracking, Microbiological and Erosion Corrosion

*Uniform corrosion of unprotected ballast tanks (A.R.R. of 0.2 - 0.4 mm)*

Factors influencing corrosion rates: corrosion protection effectiveness, stress, heat, humidity, oxygen content, type of cargoes (acidity of the cargo), frequency of ballasting, sludge/scale accumulation, frequency and method of tank cleaning, trade route, corrosion films, speed of flow, and enclosed atmospheric environment.

4) Cracking & Deformations (Most Noticeable Damages)

- Cracks found at locations where stress concentration, fatigue. Timely repairs important!
- Deformations: Buckling and Bending (structural overloads (heavy weather, poor design, improper loading, accidents)

5) Mechanical Damages due to Wear & Tear

- Bulk Carriers have one of the toughest operational life of all commercial vessels.
- During the loading (cargo drop) and unloading (grabs, bulldozers)
- Corrosive Cargo
5. SINGLE SKIN BULK CARRIER HULL STRUCTURES

Some unique characteristics that influence and affect the condition of the hull:

✓ Large net load on double bottom
✓ High shear stresses on the shell sides
✓ Sensitive to leakage and prone to total structural loss
✓ High loading rate, transverse strength
✓ Green seas among others

Seven (7) main structural regions:

✓ Side
✓ Bottom
✓ Deck
✓ Corrugated transverse bulkhead
✓ Topside tank
✓ Hopper tank
✓ Hatch coaming and cover
Guidelines for Hull Condition Assessment Applicable to Single Skin Bulk Carriers on International Trade

- Longitudinal Stiffeners
- Inner Bottom Plating (Tank Top)
- Transverse web frame
- Upper Supporting Brackets
- Bottom Plating
- Longitudinal Girders
- Floors
- Slopping Plate & longitudinal stiffeners
- Vertical side frames lower supporting brackets
- Side & Bilge plating & longitudinal stiffeners
- Hatch end coaming, web & flange
- Hatch end bracket
- Hatch end coaming, web & flange
- Hatch end corner bracket
- Corrugated Bulkhead
- Lower Stool
- Upper Stool
- DECK
- DECK
### 6. ANALYSIS OF OMCS CLASS BULK CARRIER FLEET

<table>
<thead>
<tr>
<th></th>
<th>Average Grt</th>
<th>Average DWT</th>
<th>Average Length</th>
<th>Average Ageing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Averages of Ten (10) Vessels Reviewed</td>
<td>18,419 tons</td>
<td>24,054 tons</td>
<td>173 m</td>
<td>23.8 years</td>
</tr>
</tbody>
</table>

#### Status of Protective coatings

- **Topside Tanks**
  - GOOD: 10%
  - FAIR: 10%
  - POOR: 80%

- **Hooper Tanks**
  - GOOD: 20%
  - FAIR: 20%
  - POOR: 60%

- **Double Bottom Tanks**
  - GOOD: 10%
  - FAIR: 30%
  - POOR: 60%

- **Fresh Water Tanks**
  - GOOD: 55%
  - FAIR: 27%
  - POOR: 18%

Ballast tanks, the corrosive protection system for the most part consist only of the presence of sacrificial anodes since the coating condition was rated POOR for most them. In particular, topside tanks were the ones worst rated.
• Most common defects found were corrosion and cracks at areas of stress concentration
• All existing vessels (Built under IACS)
• TOCA enforcement could be improved

Most Common Defects found on OMCS CLASS Bulk Carriers

1. Generalized and localized corrosion of cargo hold side shell frames and brackets.
2. Cracking at cargo hold side shell frame bracket toes.
3. Excessive corrosion on hatch covers.
4. Operational damages (grab & bulldozer) to the side shell frames lower brackets, inner bottom plating, hopper and lower stool plating. (Deformations (buckling and indentations))
5. Cracking at intersection of the inner bottom plating and the hopper plating.
6. Cracking at fore and aft extremities of topside tank structures.
7. Excessive corrosion within topside tanks (Frames, longitudinal stiffeners and brackets).
8. Excessive corrosion within Hopper and Double Bottom tanks (Frames, longitudinal stiffeners and brackets).
9. General corrosion and cracking of transverse bulkheads.
10. Cracking of hatch coamings & hatch corners.
7. SUMMARY OF OMCS CLASS GUIDELINES (APPENDIXES OF THE THESIS)

- Two (2) Confidential Appendixes to the master thesis. Ninety-five (95) pages guidelines developed
- Covering topics from surveyor safety, ESP survey requirements, Defects, Thickness measurements among others
- Expose the different main hull structural regions where damages have been recorded on OMCS CLASS bulk carriers, focusing on the main features of the structural items of each region.

1. General (Objective, Aim, Definitions)
2. OMCS CLASS Surveyor (PPE, Virtues, Etiquette, Code of Ethics)
3. Hull Survey Requirements (ESP, Close-ups, UTM)
4. Hull Survey Planning & Preparation (Meetings, UTM, Aloft)
5. Hull Survey Execution & Examinations (Defects (Corrosion, Deformations, Cracks), Hose Test, Areas of Concern)
Guidelines for Hull Condition Assessment Applicable to Single Skin Bulk Carriers on International Trade

Areas of Concern

- Excessive corrosion at the mid-height and at the bottom of bulkheads
- Shear Buckling Region
- Areas prone to excessive corrosion
- Web Frame Buckling
- Web Frame Shearing
- Area of Side Shell Prone to Contact Damage, Wastage and Operational Damages
8. CONCLUSIONS

• Due to the great dimensions of the bulk carriers’ hull structures, the dangers and difficulties to access the different elements, the commercial pressure inherited in the maritime operations and the very short time allocated make the hull inspection on board bulk carriers very challenging. Thus, highlighting the importance to have standardized and detailed procedures and guidelines for hull condition assessment surveys of bulk carriers.

• In the classification business the competence and knowledge of the on field surveyors (Boots on the Ground) are of paramount importance.

• Thus the creation of specific guidelines that focus on the particular problems that OMCS CLASS bulk carrier faces could be of great assistance to the company.

• A similar study is recommended to be performed on the Oil Tanker fleet of OMCS CLASS that is also subject to the requirements of the ESP Code 2011 and the results to be adhered to these propose guidelines.
9. REFERENCES

- (IACS), (2015). *Guidelines For Coating Maintenance & Repairs For Ballast Tanks And Combined Cargo/Ballast Tanks On Oil Tankers*.
Dziękuję Ci!