COATINGS AND PERMANENT MEANS OF ACCESS – THE ANTI-CORROSION CHALLENGES.

(DOI No: 10.3940/rina.ijme.2011.a4.216)

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SUMMARY

The introduction of new regulations for Means of Access (MA) has led to an increase in the number and complexity of access openings, an increase in the size of the access openings in the ship's structure, and a stricter maintenance regime which presents new challenges throughout the life of modern vessels. Several of the major issues at the design stage of Permanent Means of Access (PMA); the construction of ships; the application of protective coatings during new building, together with coating maintenance during the service lifetime; problems related to cleaning holds after cargoes have been removed; action by the Butterworth crude oil washing action and the challenges of maintenance in ballast tanks, are discussed in this paper.

1. INTRODUCTION

As part of SOLAS Chapter II-1 Regulation 3-6 and the revised Technical Provisions for means of access for inspection resolution MSC.178(78) [1] together with MSC.1/Circ. 1176, new regulations have been introduced to allow close-up surveys, inspection, maintenance and repairs of protective coatings as specified in SOLAS II-1/3-2.1.1 [2] and MSC.1/Circ. 1333 [3]. This has been achieved by increasing the number of Permanent Means of Access (PMA) over and above the Means of Access (MA) that were previously required in ships. Ballast tanks and cargo tanks have all had additional PMA structures included in their design since 1st January 2005. Where a permanent means of access may be susceptible to damage during normal cargo loading and unloading operations, or where it is impracticable to fit permanent means of access, the Administration may allow, in lieu thereof, the provision of movable or portable means of access, as specified in the technical provisions.

Whilst the concept of increased PMA has many positive attributes, the practical issues of incorporating these new structures presents many problems throughout the life of the vessels.

2. DESIGN

The new PMA have to remain in place for the lifetime of the vessel and therefore need to be well designed, constructed, installed, and maintained. As per SOLAS II-1/3-6-4.1 the ship is to be provided with a "Ship Structural Access Manual" that will include inspections by the crew, the port state control, and class surveyors to maintain serviceability and repair of any substantial damage from corrosion. This is part of the statutory survey of the ship as well as part of the safety construction survey. In addition, a periodic inspection by a competent authorised person from the crew members will be carried out, and the results will be recorded in the Ship's Safety Management System and Ship Structure Access Manual. IACS Recommendation 90 Access Manual offers a detailed description on this issue.

The design of the PMA has thus far proven to be challenging for the designers, builders and the end users. The introduction of the MSC.215(82) Performance Standard of Protective Coatings (PSPC) [4] recommends that the coatings of the PMA must provide access for inspection, to the best extent possible, to the parts that are not integral to the ship's structure, such as rails, independent platforms, ladders, etc. The sections of the PMA that are part of the structural strength element are to be coated to the same standard as the adjacent structures. This has resulted in different parts of the PMA being coated to different standards and in turn, this will affect the longevity of the coatings and the structures.

The addition of such structures into the ballast and cargo tanks can exert significant influence on the flexibility, stresses, strains, and strength of the bulkheads and longitudinal stiffeners to which they are attached. The design of the floors and inner bottom with regard to the regulation manhole openings as specified in SOLAS II-1 Reg. 3-6-5.1 & 3-6-5.2 may also be affected. This can influence and affect the performance of the ship during service.

Oil tankers and product carriers of Panamax size and below, have their double bottoms designed (as in bulk carriers), with double bottom longitudinal girders, with floors arranged between girders, and ballast lines arranged along the ship's length. In this situation, the designer runs into a problem as to the number and position of the access manholes to ensure that there is safe access of 800mm x 600mm, (for instance) to both sides of the ballast line within the space formed by the floors and double bottom girders.

The reason is that safe access should be provided in all spaces including those with obstructions, such as ballast lines, to facilitate close-up inspection of primary

structural members, coatings and the ballast line itself. In the double bottom ballast tanks the access spaces between the ballast line (if fitted) and the inner and outer bottom longitudinal may not be sufficient in size (minimum width of 600mm) to achieve safe access over and/or under the ballast lines.

Thus, additional 800mm x 600mm manholes may be required to be provided in the floors and/or double bottom girders to ensure that a stretcher and/or a person, (allowing for an oversize person too), wearing a self-contained air-breathing apparatus can escape from the space under consideration. This may produce significant alteration to the design of the floors and/or girders, as such holes diminish the strength of the respective members in both shear and buckling failure modes.

A similar design problem occurs at the lower end of the side transverse web in way of the double side skin area just above the upper end of the lower hopper. This is a classic problem that several designers addressed from the structural point of view, but not from the corrosion aspect. Work in 2003 [5] showed that it is more difficult for hard coatings to resist high shear and buckling as well as high strain and in these areas (as shown in figure 1), such forces are predominant.

The reason is that hard epoxy coating formulations, PSPC, required by SOLAS II-1 Part A Reg. 3-2 PSPC are not tested for flexibility as these tests are not mandatory. In this regard the designer may have to consider the provision of T-Ring stiffeners around the opening to ensure that the required coatings target life expectancy of 15 years in these critical areas will be achieved.

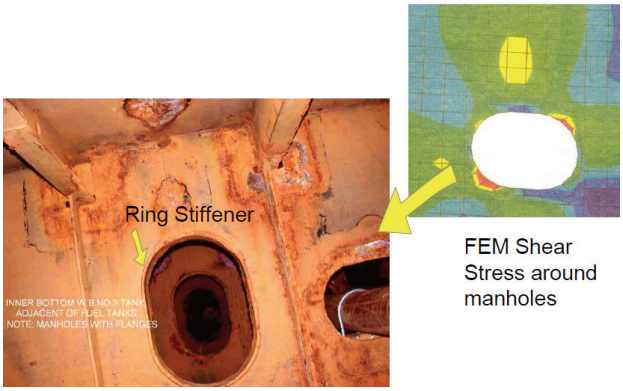

Figure 1: Behaviour of openings in double bottom ballast tanks with and without ring stiffeners

SOLAS II-1/Reg. 3-6/4.2 requires that the ship's structure access manual provides identification of the "critical structural areas". These are defined as locations that have been identified by "advanced calculation techniques" (as per IACS UI SC191 [6]). PMA applies to cargo tanks, ballast tanks, and other spaces where the critical areas have specific survey requirements and assessment criteria as indicated in Table 1 of MSC.1/Circ 1330. However, in cargo tanks and ballast tanks within the cargo area of a tanker outside 0.4L (i.e. in way of the foremost and aftermost cargo tanks) this has not yet been established in the IASC Common Structural Rules (CSR) for oil tankers.

The CSR methodology for the 3D 3-tanks length of FEA is still outstanding, although the CSR for oil tankers have been in force since 2006. ABS have published a guidance notes for the "Strength Assessment of the Cargo Tank Structures Beyond the 0.4L Amidships in Oil Carriers 150m or more in length" [7]. The ABS guidance describes the FE model and approach for the specific shape of the vessel in way of the foremost cargo tank and fore peak structure, as well as the aftermost cargo tank and forward end of this cargo tank, as shown in figure 2 below.

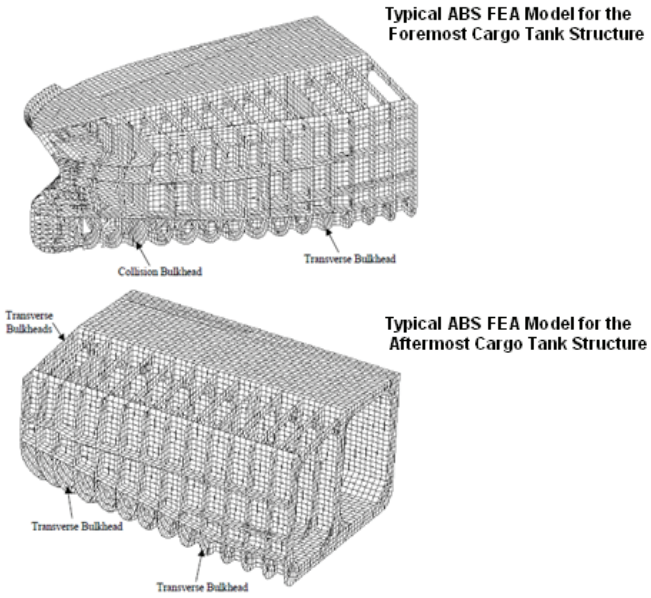

Figure 2. A typical ABS Guide FEA model of the aftermost and foremost cargo tanks where the critical areas required to be derived

3. CONSTRUCTION.

3.1 SURFACE PREPARATION

One of the major coating problems that was evident during inspections of older ships was the breakdown of coatings and the subsequent corrosion of cut edges and welds. The introduction of the recent PSPC regulations in ballast tanks now requires that all edges are rounded to a radius of 2mm and that stripe coats are applied to significantly build up the thickness of paint on the edges.

This has resulted in significantly improved preparation standards for edges and welds and has allowed more effective coating applications to occur.

3.2 PAINTING OF PMA

In order to obtain a long service life, the coating on the PMA should be applied to the same standards as for the ballast tanks themselves. Photograph 1 shows a well prepared ballast tank.

Photograph 1. Ballast tank with well prepared PMA.

4. SERVICE PERFORMANCE

4.1 BALLAST TANKS

The presence of the stiffening in ballast tanks allows the cargo holds and tanks to consist of mainly smooth, flat surfaces. This aids the removal of cargoes and cleaning of the holds.

The addition of PMA into ballast tanks, for example in the double side skin of tankers, creates many more edges and welds to protect and many more potential sites for mechanical damage and touch up work during construction.

If the PMA is not well maintained, premature paint failure and corrosion can cause corrosion that may well propagate to the adjacent structure. As stated above, the PMA is part of the statutory requirements and any premature coatings failures may interrupt the ship's operation by the port authorities and be off hire at a cost to the owners and operators.

Many of the PMA are constructed from galvanised steel to provide an enhanced life to the structure. However, the galvanised surfaces must be carefully prepared and painted, otherwise the zinc on the PMA can act as part of the ballast tanks cathodic protection system, as shown in photograph 2.

In these cases, the galvanised layer dissolves sacrificially to protect the steel. This forces the coating off the PMA and allows premature corrosion of these structures. The inclusion of additional sacrificial anodes may be required specifically to protect the PMA.

Photograph 2. Corroding zinc on the PMA itself is removing the paint.

Maintenance and repair of the coatings on PMA will become increasingly difficult with time in service due to the problems of successfully painting corroding zinc layers. This is in addition to the many other difficulties encountered in painting complex structures under service conditions. Such problems include cleaning, surface preparation, paint application, and paint curing. All of these are difficult to achieve well whilst at sea.

4.2 CARGO TANKS

PMA in the cargo tanks, in product carriers, chemical and oil tankers will also experience similar problems to those on bulk carriers.

Cleaning patterns and washing of the additional structure in the tanks will need to be checked to ensure that residue of cargoes are not trapped and acting as sources of contamination or corrosion.

Good maintenance and repair of the paint is essential to prevent metal loss due to corrosion, as shown in photograph 3.

Photograph 3. Corroded PMA.

For ships with cargoes that have the possibility of high microbe content, such as sour oils, the presence of PMA may increase the risk of providing suitable environments

for microbes such as sulphate reducing bacteria (SRB) to establish colonies and therefore allow microbially induced corrosion to occur at areas of breakdown or damage in the coating.

Periodic examination of areas that are sheltered from the washing systems would be advisable to ensure that localised corrosion of the PMA is not occurring.

5. CONCLUSIONS

The introduction of Permanent Means of Access into ballast and cargo tanks in oil carriers allows enhanced inspection of the condition of the steel and the paintwork to take place.

It also provides good access to these areas to carry out maintenance and repair work on coatings before paint breakdown and corrosion occur. This should allow ballast tanks to remain in GOOD condition.

However, the PMA themselves also require a high level of maintenance due to their inclusion in the ships' construction and their inclusion as part of the statutory and/or safety construction survey. In addition, the International Safety Management Code requires that companies should establish procedures to ensure that the ship is maintained in conformity with the provisions of the relevant rules and regulations and that these procedures are included in the safety management system of the ship.

PMA in cargo spaces require checking for cargo retention, mechanical damage and cargo induced corrosion. PMA in ballast tanks require checking to ensure that the coatings remain in good condition so as to prevent the PMA themselves becoming part of the cathodic protection system of the ballast tanks.

6. REFERENCES

1. SOLAS Ch. II-1/Reg. 3-6 Access to and within spaces in the cargo area of oil tankers and bulk carriers
2. SOLAS Ch. II-1/Regulation 3-2 Corrosion Prevention in seawater Ballast Tanks
3. MSC1/Circ. 1330 Guidelines for maintenance and repair for protective coatings
4. MSC.215(82) Performance Standard of Protective Coatings (PSPC) for dedicated sea water ballast tanks in all type of ships and double-side skin spaces of bulk carriers
5. Peter D Contraros – "The Domino Effect Coating Breakdown – Corrosion – Structural Failure leading to Possible Design Ramifications" – Lloyds List Corrosion Conference, April 2003
6. IACS UI SC191 Application of SOLAS Regulation II-1/3-6 (Resolution MSC.134(76) and Technical Pro9vision on PMA (Res. MSC.133(76)
7. ABS – 2004 Guidance for the Strength Assessment of the Cargo Tanks 0.4L of amidships for Oil Carriers 150m or more in length

