ELECTRONIC INSPECTION DATA MANAGEMENT FOR SALT WATER BALLAST TANKS

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ABSTRACT

The requirement of the IMO PSPC regulations for ballast tank coatings includes the creation and maintenance of a coatings technical file containing inspection records for the ballast tank coating process from start to finish. To complete this file in a timely and cost effective manner, digital inspection data must be stored and retrieved during the painting process in such a way that it does not delay the build of the ship or leads to extra work on behalf of the inspectors.

Electronic gauges are available for measuring surface profile peak-to-valley height, for monitoring relative humidity, temperature and dewpoint and for dry film thickness measurement. Some of these gauges now feature Bluetooth® wireless communication while others offer data upload via USB connection. Collating and archiving the data from these and other measurement and inspection tools is required to produce a coatings technical file

This paper describes a software-based solution that interfaces remotely with the digital gauges that are available for surface profile, climatic condition monitoring and coating thickness to collect and report on the data that these gauges collect while also allowing manually collected date to be recorded and associated with the relevant inspection tasks.

The use of the various electronic gauges will be discussed and the structure of the software solution will be fully described.

INTRODUCTION

The International Maritime Organisation (IMO) regulation for the Performance Standard for Protective Coatings (PSPC) for Salt Water Ballast Tanks, Resolutions MSC.215 (82/84), came into full effect from 1st July 2008 for new ship builds, bringing with it a number of challenges for the coatings inspector (although it was introduced under the IACS Common Structural Rules in January 2008).

The regulation is intended to ensure that the coatings applied to the ballast tank during the build of a ship achieve a target life of 15 years and coating inspection processes are fully documented in a Coatings Technical File that is passed to the owner of the ship at the completion of the build.

Historically information on the coatings and the inspection process have been collected separately and the inspection process has been documented in the inspector's note books and even by the paint company's technical representative in the dockyard. This information has then, generally, been manually transferred into a paperwork system or input manually into a yard or paint company database. The requirements of the Technical Coating File lend themselves to a direct software-based solution. This will provide improved accuracy, reduce costs, save time, improve retrieval and simplify the mandatory audit process.

This paper describes the capabilities and use of the ElcoShip software programme including the transfer of readings from certain inspection gauges.

THE PROBLEM

The typical dimensions of a Very Large Crude Carrier (VLCC) are[i]:

Length:	470m (1,542ft)
Draft:	20m (66ft)
Beam:	60m (197)

The total ballast tank coating area onboard a VLCC is approximately 300,000m^2 (greater than 3,000,000ft^2)[ii].

Using the SSPC PA2 standard for coating thickness measurement, each flat area requires five spot readings - each the average of three readings per 10m^2 or 100ft^2

Taking into account the typical dimensions of a VLCC, the outer surface area of the ship is approximately 52,000m^2 (558,000 ft^2). If we assume that there are two coating layers applied, inspecting the vessel's outer surfaces alone, under SSPC PA2, would require 156,000 individual coating thickness readings to be taken and recorded. This increases to 167,400 when using Imperial unit of area measurement within SSPC PA2. This does not take into account any complex areas or the superstructure itself.

According to the IMO regulations the following dry film thickness verification regime is to be adopted for the inspection of ballast tanks:

- one gauge reading per 5m^2 (54ft^2) on flat surface areas;
- one gauge reading at 2 or 3m (6.5 – 10 feet) intervals and as close as possible to tank boundaries, but not further than 15mm (0.6 inch) from edges of tank boundaries;
- around openings one gauge reading from each side of the opening;
- additional spot checks are to be taken to verify coating thickness for any area considered necessary by the coating inspector.

Additional inspection requirements are listed for longitudinal and transverse stiffener members, primary support members and complex areas (specifically large brackets of primary support members).

Using the lowest possible estimate, this indicates that a minimum of 300,000 coating thickness readings which must be taken and recorded to meet the obligation of the IMO PSPC for Salt Water Ballast Tanks regulation. This is a SOLAS (Safety Of Life At Sea) regulation, making this a legal requirement.

So the imperative for coating thickness measurement is, in essence, is similar to the number of readings you are required to take when using SSPC PA2[iii] for the outer hull surfaces alone. This of course does not take into account any internal surfaces, cargo holds, fixtures and fitting or any complex areas under consideration.

The IMO regulation does not stop at coating thickness, it also requires the inspection of surface profile and cleanliness, weld condition, coating damage together with the recording of temperature, relative humidity, dewpoint and weather conditions, where appropriate, during the application process and for the paint cure, at each stage of the build process. Cumulatively this is a significant quantity of data.

In addition not all coating inspection processes for ballast tank coatings have measurements associated with them. Some inspections rely on the judgement of the inspector in respect of a standard, for example the rust cleanliness assessment after blasting is by reference to the Swedish Rust Standard, EN ISO 8501. Records of this type of inspection require the inspector's signature for verification and traceability.

Taken all together, the quantity and type of information that needs to be collected to satisfy the requirement to produce a coating technical file for the ballast tank coatings is extensive. The further requirement to be able to track the individual ballast tank areas of the ship and the reworks that may required to achieve satisfactory coatings means that a document archiving and retrieval method is applied. The ability to subsequently use this data to assist in the required through-life maintenance is also a great benefit to the owner.

THE NEED

The IMO regulations are very specific in respect of the information that must be included in the coating technical file. The IACS Q & A and Common Interpretations Document, 19th August 2008 lists fifty-seven IMO PSPC references including the following documentary requirements and measurements:

Edges and sharp edges (stripe coats)
Coating Specification
Approved paint and manufacturer list
Coating system type approval certificate
Wet Film Thickness
Steel Surface Cleanliness
Measurement of Salt
Shop Primer
Damage
Dust
Dry Film Thickness
Approved Coating Inspectors
Oil & Grease Contamination
Daily Log
Audit Records

Each of these topics is associated with an inspection task and an inspection record, together with a checklist of other documents that form the requirement for the Coating Technical File, specifically for ballast tanks.

These records need to be capable of being audited, as the build proceeds and after the build is complete and there must be provision for dealing with non-conformances and, where applicable, rework.

The key to the creation of the Coating Technical File is the ability to plan for and manage the coating inspection process from start to finish for at least the ballast tank coating processes but also for the rest of the ship build bearing in mind that the coatings in other areas of the ship such as cargo holds, void spaces, et. Will be included in the IMO Regulations in the future. It is also the case that some method for dealing with the maintenance of ballast tank coatings will be developed within the next five years.

It has been calculated that the maximum number of coating thickness gauge readings that can be reported on a single A4 sheet is 650 readings. Therefore, if the number of readings required to inspect the ballast tanks is of the order of 300,000, the hard copy of the coating thickness section of the CTF will be at least 450 pages, excluding significant rework. This does not of course include copies of the coating material data sheets or the coating specification information.

THE SOLUTION

In order to collate all the information and records so that a coating technical file can be prepared easily and navigated for audit purposes, the use of a computer database is essential. There are several additional advantages that arise from this approach, including direct communication with the database where measurement data is acquired using an electronic gauge with a data output feature, the ability to store technical datasheets for the coating materials for reference, the opportunity to identify the location of the ballast tanks on a drawing of the ship for convenience and the means of associating photographic images with the data.

ElcoShip® has been developed to provide a framework for the planning and recording of coating inspection tasks associated with a particular ship by name. The software is divided in to 7 sections to aid the planning and creation of inspection tasks, with a further 5 operational features for managing the inspection tasks and creating the coating technical files.

Once created, the inspection tasks can be scheduled and allocated to a specific inspector and the system can implement this process using Personal Digital Assistants (PDA's) so that the work can be allocated and carried out remotely from the computer for maximum efficiency.

The seven sections are as follows:

Coating Library – creation and maintenance of the approved coatings by supplier

Coating System – creation of the coating systems in use for different areas of the ship

Register of Inspectors – details of all the inspectors allocated to the ship and their access permissions

Inspection Regimes – individual inspection points that can be grouped together as required.

Ship Structure – details of the ship with drawings and ship parts linked to the coatings

Inspection Tasks – individual inspection tasks with record of completed tasks and links to rework

Daily Log – additional inspection information recorded by the system administrator on a daily basis

The five operational features are:

Inspection PDAs – manages the individual PDA's allocated to the inspectors

Outstanding PDA Inspections – ad hoc inspection task records that require consolidation in the overall inspection plan

Coatings Technical File – the function that validates and creates the coating technical files for either the ballast tanks (IMO regulations) or the rest of the ship

Status – automatic record of software activity

Change Log – automatic record of activity by ship structure or by inspector

OPERATION OF ElcoShip® SOFTWARE

In order to populate the database with the information required for the Coatings Technical File, key data is required for the different sections of ElcoShip. The starting point is the coating library where all the coatings approved for use on the ship and particularly for the ballast tanks are entered. Each coating is entered and filed by Manufacturer, with the system creating unique identification for the individual record. Key information, such as manufacturer, product name and product ID together with mandatory detail such as nominal wet film and dry film thickness, nominal profile height, and nominal climatic conditions (air temperature, surface temperature and humidity) as detailed in the manufacturers technical datasheets, is entered here.

The coating record has fields for notes and electronic files such as data sheets and reference documents and, where appropriate, a coating approval number.

These individual coating record are issued and these issues can be updated as the ship build proceeds, if for example, the specification of a particular coating is changed, the change can be recorded and the record updated and a new issue created. The software will then track tasks carried out using the first issue of the coating and the more recent tasks carried out using the up-issued coating material.

The coatings are then arranged as systems using the Coating System function. Each coating system that is created has a unique identification and is stored by description and group. The group may be a ballast tank coating system, for example. The coating steps are then specified and this may be a stripe coat and two full coats using a particular coating with alternating colours to aid inspection.

The Register of Inspectors creates an individual inspector's record together with the inspector's account type to set the access permissions to the software. An individual inspector can be linked to a contractor and the record is password protected so that data submitted by the inspector has to be confirmed by use of the password. The register page has fields for an electronic signature to record the signature that will be used on the PDA to complete inspection tasks and file space for a photograph and a copy of the inspector's certificate. There is also a non-mandatory field to record the certificate expiry date to track the validity of an inspector's status over time. Inspectors can have their status changed and can become inactive if they are not able to work on an inspection plan for some reason, e.g. ill health.

The Inspection Regimes function is used to group inspection requirements together for maximum efficiency. For example, if a surface were being inspected for profile then it would be sensible to consider inspecting for rust removal, dust, and oil and grease contamination at the same time. By grouping the individual inspections as a regime the system will combine these tasks, while leaving the possibility of planning a single task if a rework is required, for example.

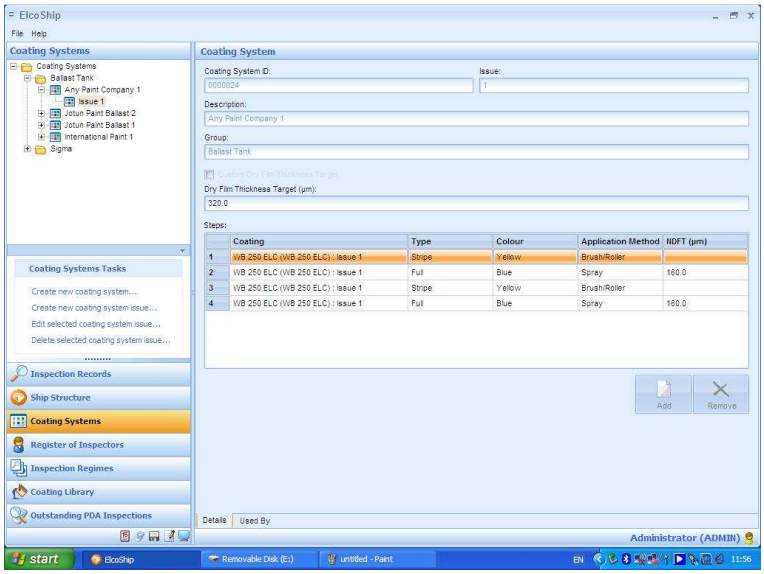

Figure 1 - An Example of the Coatings Systems Screen
Showing a typical coating system for ballast tanks

Having set up the coatings library, the coating system and the register of inspectors the task of recording the ship structure and the ship parts needs to be carried out to provide a basis for planning the inspection tasks.

The Ship Structure allows a new ship to be created with an automatic and unique ID together with the relevant detail such as hull number/IMO number, the customer's name and the ships name. Non-mandatory information such as the contract date, the keel-laying date, the planned launch and delivery dates can be entered in the appropriate fields. Mandatory information for creating of a new ship includes the gross tonnage, the deadweight, the length (OA and BP), the beam, the draft and the depth.

There are fields within the Ship Structure records for general comments, general ship documents, coating technical file audits and coating technical file approvals documents.

Drawings in JPG format can be associated with the Ship Structure record and the areas of the ship can be highlighted as part of the ship part definition. Each Ship Part is created within the build structure of shop primer, units, unit joins, blocks, block joins, super blocks, erection joins with a special file for ballast tanks. The individual Ship Parts can be allocated to a preferred inspector and the coating system for the surfaces in the Ship Part defined with the location of the Ships Part.

At this point, selecting the Ships Part and Inspection Records allows a new Inspection Record to be created for the Ships Part and the selected surfaces. This record then becomes an inspection task that can be schedules as part of the overall plan or completed either directly on the computer running ElcoShip or more likely by e-mailing or transferring the task to an Inspector's PDA for completion at the location of the work. By using the e-mail option the Inspector can be given work and respond with completed tasks without visiting the planning office.

The Daily Log is initiated for any day when an inspection task is completed. If the Daily Log is opened a list of the completed inspections can be viewed and additional comments can be added with support files, such as photographs, for the user to confirm by password and electronic signature.

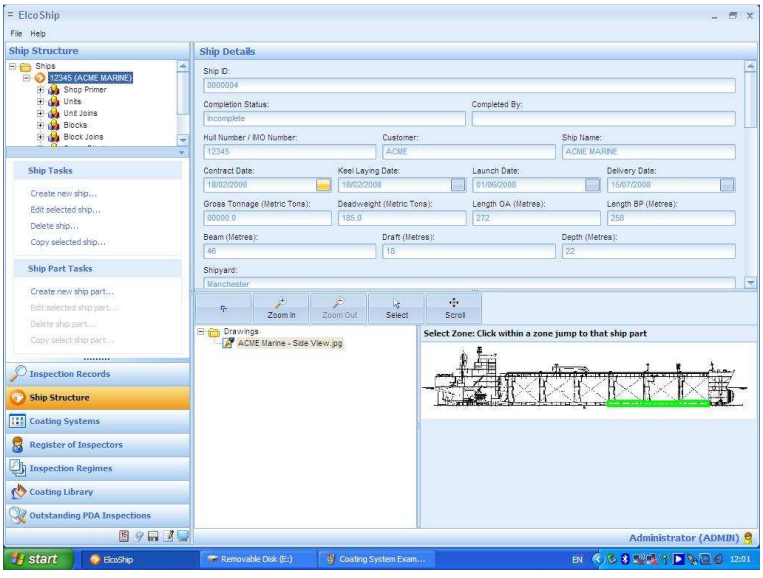

Figure 2 - An Example of the Ship Structure Screen
Showing the ballast tank areas marked in green as ship parts

THE INSPECTION PROCESS

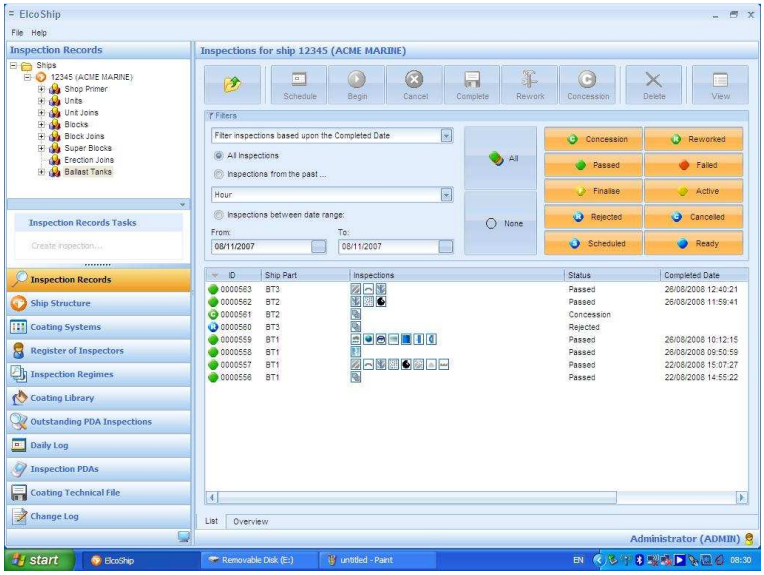

Figure 3 - An Example of the Inspection Records Screen Showing completed inspection tasks

To maximise the flexibility of the database inspections can be recorded using a hard copy printout of the inspection task or by transferring the task electronically to a PDA or even by completing the selected task within ElcoMaster on the computer. It is envisaged that the most convenient and efficient way in which inspections can be completed is by transferring the chosen tasks to the PDA allocated to the chosen inspector. The PDA operates using a programme called ElcoShip Mobile running under Microsoft Windows Mobile on any suitable PDA.

The PDA user has the opportunity to decline a particular task with a reason if the task cannot be completed as intended. The ElcoShip administrator can then re-allocate the inspection task to another member of the team.

If an inspection task is completed using a hardcopy the finished document has to be scanned to create an electronic file that can be associated with the inspection task for the administrator to complete the task and create a record for that inspection.

However, tasks completed using the PDA can transfer the record to ElcoShip along with any readings from electronic gauges and if appropriate photographs of the area being inspected. Gauges with Bluetooth® enabled data transfer can upload a batch of readings associated with an inspection record so that the task is automatically completed the next time the PDA next communicates with the programme.

The PDA user can also schedule a new task in the field if required urgently and then back-schedule it into the system.

The inspection tasks are colour coded on ElcoShip, using blue for tasks that are ready for completion, yellow for active tasks, green for successfully completed tasks and red for failed inspections. Green tasks can also be marked as tasks passed on concession, the green marker contains a white letter C, or passed after rework, in which case the marker contains a white letter R.

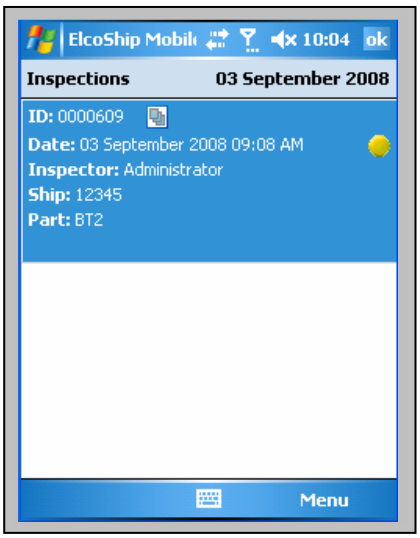

Figure 4 – An Example of the PDA Screen Showing an Inspection Task ready to be opened for completion

THE COATING TECHNICAL FILE

The Coating Technical File button has options to validate the ship data and to create the Coating Technical File. Any incomplete inspection tasks will prevent the validation process being completed and prevent the CTF from being created. This process ensures that there can be no additions relevant to the CTF after it has been created,

It is possible to create a coating report for an incomplete ship but the IMO PSPC Report will not run if there are incomplete inspections. The report window has the option to exclude ship drawings if this information is to be kept secure.

The CTF can take the form of a printed report or it can be converted to PDF format for electronic copying.

CONCLUSIONS

The International Maritime Organisation (IMO) regulation for the Performance Standard for Protective Coatings (PSPC) for Salt Water Ballast Tanks, Resolutions MSC.215 (82/84) has introduced, as law, the need to inspect ballast tank coatings, record the results of these inspections and produce a Coatings Technical File for the full ballast tank coating process at every stage of the build of a ship.

In order to manage the considerable quantity of data generated during these inspections and allow simple and effective navigation of the data for audit purposes, a computer database solution is indicated.

With the introduction of the ElcoShip software, Elcometer Limited has provided a link between coating inspection processes and the organisation of the resulting data that builds on a proven ability to store and upload measurement data collected by electronic gauges.

This data transfer and management has been augmented by a system for planning and completing non-measurement inspections such as surface condition assessment, dust testing and salt contamination determination which rely on the inspector’s judgement or on a measurement that cannot be transferred electronically.

The system uses a link to a Personal Digital Assistant (PDA) to allow the inspection reporting to be carried out in real time, subject to the ability of the PDA to communicate with the host computer. In any event the inspection tasks can be allocated to specific inspectors and completed without the need for direct communication with the host computer during the inspection. It was with the needs of the Marine Inspector in mind that the small and compact PDA was chosen, as this does not add significantly to the kit that the inspector is required to carry on the ship.

During the ship building process the ElcoShip software allows the inspection tasks to be monitored and there is provision for changes to materials and processes during the build while maintaining the integrity of data already collected.

It is envisaged that there will be an increase in the number of areas of new build ship to which this degree of inspection and data recording will be required and it is already apparent that void spaces and cargo holds are already being considered for inclusion as areas where the PSPC requirements will apply.

ElcoShip provides a solution to the management of coating inspection data for the areas of the ship cover by the new regulations but also allows other areas of the ship to be recorded and monitored in the same way. The system is designed to remove the need for extensive paper records and to make the review and audit processes both simple and effective

REFERENCES

[i] www.wikipedia.com; March 2008

[ii] J. Eliasson & D Rauta; The New IMO Ballast Tank Coating Standard – What Does It Mean? Journal for Protective Coatings & Linings, May 2007

[iii] SSPC-PA 2, Measurement of Dry Coating Thickness With Magnetic Gages