A BALLAST TANK COATING INSPECTION DATA MANAGEMENT SYSTEM

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ABSTRACT:

The coating process has long been considered to have less importance than other engineering activities that go into the manufacture and maintenance of a ship. This is often reflected by the relatively slow development in coating and surface preparation technology in comparison to other shipyard engineering processes, and the lack of hard data about the installation and subsequent maintenance of the system.

The entry into force of the IMO MSC.216(82), more commonly referred to as the Performance Standard for Protective Coatings (PSPC) is challenging the status quo. Firstly by making the application and performance of the water ballast tank coating system subject to Safety of Life at Sea (SOLAS) regulations. This implies that poor performance of the coating system in the ballast tanks could result in a condition of class. Secondly by placing the coating process in shipyards under greater scrutiny.

The key to the measurement of performance of any system is the ability to collect and analyze data to identify trends/patterns and causes of failures in the field and to have this data in a form that can be readily used to improve future decision making.

This paper sets out to examine the challenges of data collection as set out by the PSPC and suggests a possible solution to assist with these demands.

Keywords: coating inspection, software, coating technical file, data logging, ballast tanks, paperless QA, PSPC, CTF, IMO

INTRODUCTION

The International Maritime Organization (IMO) regulation for the Performance Standard for Protective Coatings (PSPC) for Salt Water Ballast Tanks, Resolutions MSC.215 (82) and MSC.215 (84), came into full effect for all tankers and bulk carriers built under the Common Structural rules (CSR) contracted as of December 26, 2006, and from 1st July 2008 for all new ships contracted after that date, bringing with it a number of challenges for the installation and maintenance of coating systems (although it was introduced under the International Association of Classification Societies (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. In addition the performance of the coating system is already a condition of class under the Enhanced Survey Program (ESP). With the PSPC is incorporated in the SOLAS regulations the issues becomes even more important, indicating the performance the ballast tank coating as critical to the safety of life at sea, just as important as ships life boat or fire fighting equipment.

One key aspect of the PSPC requirement is the need for the shipyard to deliver the vessel complete with a Coating Technical File (CTF). This SOLAS document is aimed at providing a record of the coating process for the ballast tanks from the application of shop primer, through to the delivery of the vessel (it will also ultimately have to incorporate the maintenance of these tanks through life – this will be covered by a future regulation).

Data about the coating process is currently collected by a number of parties:

- The Shipyard, QC Department and Contractor
- The Paint Supplier
- The Ship Owner

However in the experience of the Authors, if a subsequent failure occurs the data is either inadequate or not available to the failure investigators. Paint Suppliers are reluctant to release their records and so often, as a vessel may pass through several owners and paint schemes in a 15 year life, it is not often clear what coating products are on the vessel and what conditions were prevalent during the application that may provide an indication as to causes of failure and so help to improve subsequent product development, application procedures etc.

The CTF is aimed at providing a record or set of data of the application process that would be audited by a 3rd Party (Maritime Administration of the Flag State or Classification Societies (RO) acting on their behalf).

The mass of data to be collected will also pose a challenge to the 3rd Party auditor to review and in the event of a failure to be able to effectively track the sequence of event that took place for the coating of a particular area. Note. However, that the PSPC does not require data to be collected to facilitate future failure analysis. There is though an opportunity to gather such data, beyond what PSPC requires, to facilitate such future analysis work. As the inspection tasks are already part of the process it will not add cost to retain all the data for future analysis.

This paper describes the possible benefits of using a computer-based tool that gives a direct link between the vessel structure and the data collection and subsequent retrieval and analysis.

THE PROBLEM

The total ballast tank coating area onboard a Very Large Crude-oil Carrier (VLCC) is approximately 300,000m^2 (greater than 3,000,000ft^2)[1].

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 to meet the obligation of the IMO PSPC for Salt Water Ballast Tanks regulation. To this must be added the other requirements for measurement and data gathering such as surface preparation data collection and climatic data.

Not only should the data be collected, but it should also be organized in a manner that enables it easy auditing, retrieval and subsequent analysis.

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. These requirements are stated within Table 1 of the regulation and clearly identified on the daily log samples provided in the annex. The daily log suggested by the regulation implies that the “approved inspector should review this or data presented otherwise and help the shipyard summarize it into a Coating Technical File (CTF).

While there is still much discussion as to the final form a CTF will have to take, with estimates ranging from a 6 page document to a filing cabinet of information, it is clear that, in some form or another, the data will need to be collected and stored and audited. In dealing with data collection of large quantities of data, computer based systems have proven to be the best format of storing, retrieving and analyzing data.

The data to be collected is both quantitative and qualitative and can be from both digital and non-digital systems. Thus any solution in terms of software needs to be able to handle all these needs.

Once the vessel is in service then the history of the new build coating will need to be available to the crew to the ship owner in the office and to the auditor. These needs again point to a computer/internet-based solution. This paper sets out to define the need and propose the key elements of a computer-based solution.

THE NEED

The PSPC regulations are not 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, as identified in section 6 of table 1 of the standard:

Edges and sharp edges (stripe coats)
Coating Specification
Approved paint and manufacturer list
Coating system type approval certificate
Wet Film Thickness (not mentioned in the PSPC)
Steel Surface Cleanliness
Measurement of Salt
Shop Primer
Damage (not mentioned in the PSPC)
Dust
Dry Film Thickness
Approved Coating Inspectors
Oil & Grease Contamination (not mentioned in the PSPC)
Daily Log (suggested only in the PSPC)
Audit Records (suggested document only in the PSPC)

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.

It is the duty of the inspector to validate conformity. That the work has conformed to the minimum requirements in the standard must be documented. What is not needed if for each and every reading and each and every measurement to be documented in the CTF. Just as each weld and each plate thickness on each area is carefully specified and must be confirmed by the Classification Society and a Certificate Of Fitness issued under SOLAS for the ship – there is no need to report each time the Classification Society Surveyor measure a weld or

plate. There are though some specific items listed in the PSPC that must be included in the CTF, and that is different from common practice. However the detail of 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. It is likely that the CTF on board the vessel if in 'Hard Copy" will only be required to have a subset of this data, however somewhere a full set of data will could and maybe should to be collected and stored in a similar manner as records for say a life boat, or other documents, drawing, manuals, etc. that are commonly stored at the yard, or in the owners warehouse.

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. Of course having organized the system to handle ballast tanks, it is clearly relatively straightforward to apply the approach to 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 regulations for dealing with the maintenance of ballast tank coatings and those in other areas 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. 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 other data collection readings or any significant rework or non-compliances. This does not of course include copies of the coating material data sheets or the coating specification information.

There is still yet no firm guideline from IMO/IACS on the final format of the CTF and the content, with discussions on-going. However the authors have now discussed the issue with 3 of the larger classification societies and confirmed that there is far from a unified approach or agreement as to what may need to be in the CTF and what may need to be available for Auditing and reporting purposes. This uncertainty is less significant if the bulk of the CTF is in an electronic format with only the key elements summarized in a hard copy o the CTF on board the vessel. To mandate such a collection of useless data to be included in the CTF would be less than intelligent, and that is clearly not the intent of IMO.

A document of that sort of size will be unwieldy and difficult to audit and maintain, again indicating that a computer based system would be better suited to the task. This would enable quick retrieval of data for auditing and easy customization of the output to comply with a possible variety of needs for CTF formats if a unified version is not agreed upon. In this way the CTF can be compared to a ships stability booklet, where the format of each booklet can be different but the core data is contained in all formats. The data needed from that measuring mass are minimum, mean and maximum values for each main area inspected, and that is where computerized data collection becomes really cost efficient in that this extracted data can be released in seconds, rather than the inspector calculating by hand for a much longer time. Further, the 90/10 rule (mentioned in the PSPC) is also validated very quickly be a computer.

At present at paint inspector is typically effective (inspecting) for about 4-5 hours per day, with the rest of the time being spent traveling between the office and tasks or in the office getting information about upcoming inspections or transferring data collected to and from a computer system from his own notebook. This is quite time consuming and labor intensive activity.

Once in the filed the inspector has no way to communicate easily to advise of delays, cancelled inspections or his inability to complete an inspection for any specific reason, this often results in the need to re-schedule and can cause delays or missed inspections.

Thus a better solution is needed not only to gather the data but also to manage the inspection/QC of the coating process as a whole.

THE SOLUTION

In order to collate all the information and records so that a CTF 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.

A research project set up with European Union funding has looked at the paint process for ships with a view to improving efficiency. A key work package within this research project was the ECODock^2 project to develop a specification for a computer system that would meet the requirement for an inspection database. Two major European shipyards and a Classification society supported this work, so that the system specification reflected both regulatory and practical needs. The key aim was to minimize data entry requirements and so, early on in the project it was recognized that the involvement of an inspection equipment supplier would be critical to try and produce a paperless system as far as possible.

To that end at the end of the ECODock project a commercial development phase lasting 2 years took place between the system designers and a leading supplier of inspection equipment to create a more comprehensive and user friendly tool, with a simple aim of reducing the total amount of equipment an inspector would have to carry with them on a particular ballast tank inspection and also to enable effective transfer of data from inspection equipment to the CTF. One of the other perennial problems of coating inspections is that of photographic records. Often considerable time is spent post inspection matching photographs to the records and reporting them. Thus the use of a PDA was included that would act as the key tool for the inspector and that in turn could talk to the measurement equipment and the software on the computer using either e-mail technology or Blue Tooth technology.

SYSTEM OVERVIEW

The system was designed to provide a framework for the planning and recording of coating inspection tasks associated with a particular ship by name/IMO number. 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

As the system developed over a 1.5-year period and with feedback from Paint Suppliers, contractors and other shipyards, insurers and Naval personnel, it became clear that a need for such a product existed irrespective of the demands being placed on shipyards as a result of the PSPC regulation. It was evident that a commercial tool[3] needed to be developed.

OPERATION OF THE 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 the software. The starting point is the coating library where all the coatings approved under the PSPC regulations or have gained Class approval for other applications for use on a 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 surface profile, and nominal climatic conditions (air temperature, surface temperature and relative humidity) as detailed in the manufacturers technical datasheets, is entered here. Importantly the system allows different versions of a coating to be tracked and maintained in the event of a product or data sheet change, so that application records track the correct products in use.

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 ballast tank coating systems, for example. The coating steps are then specified including any stripe coats required.

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 can be confirmed. The register page has fields for an electronic signature to record the signature that will be used on the PDA to complete inspection tasks. The system will also check the validity of the inspector's qualification and alert the inspector when his qualification is due to expire. There is also the ability to make an inspector in active (should they leave the project) while maintaining the integrity of all records and data they collected.

The Inspection Regimes function is used to group individual inspection requirements together for maximum efficiency. For example, if a surface profile were being inspected 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.

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. Of course it is a simple matter to modify this front page to suit any other type of structure to be coated.

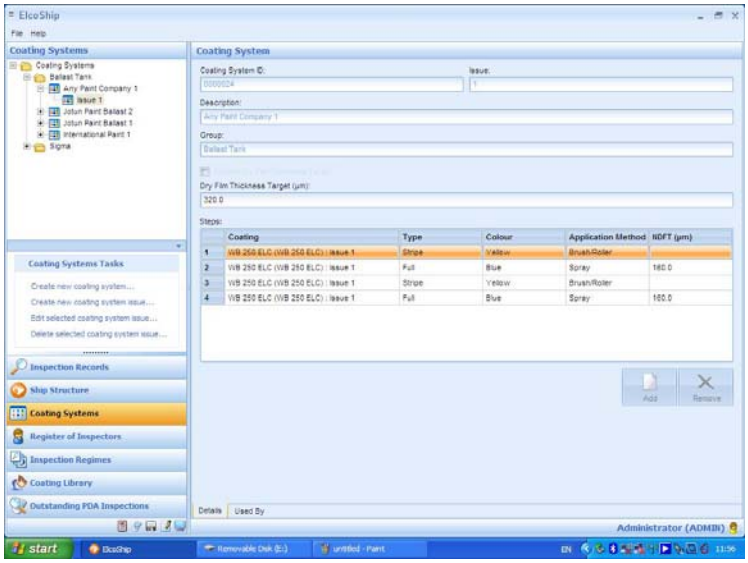

Figure 1 - An Example of the Coatings Systems Screen
Showing a typical coating system for ballast tanks

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 and appropriate inspection regimes can then be assigned to them.

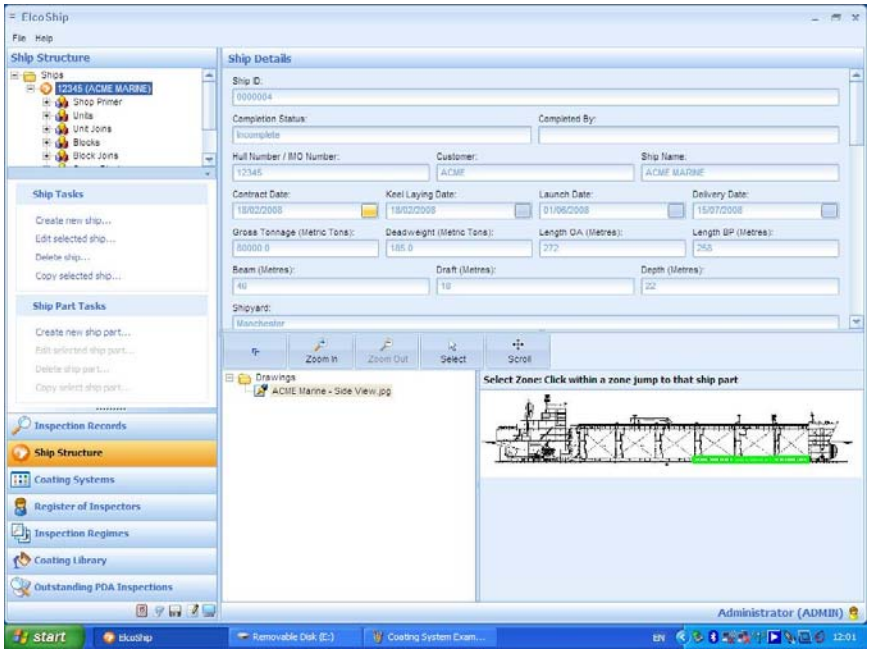

Figure 2 - An Example of the Ship Structure Screen
Showing the ballast tank areas marked in green as ship parts

The inspection tasks can be scheduled as part of the overall plan or completed either directly on the computer running the software 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.

THE INSPECTION PROCESS

To maximize 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 program supplied with the planning tool running under Microsoft Windows Mobile on any suitable PDA.

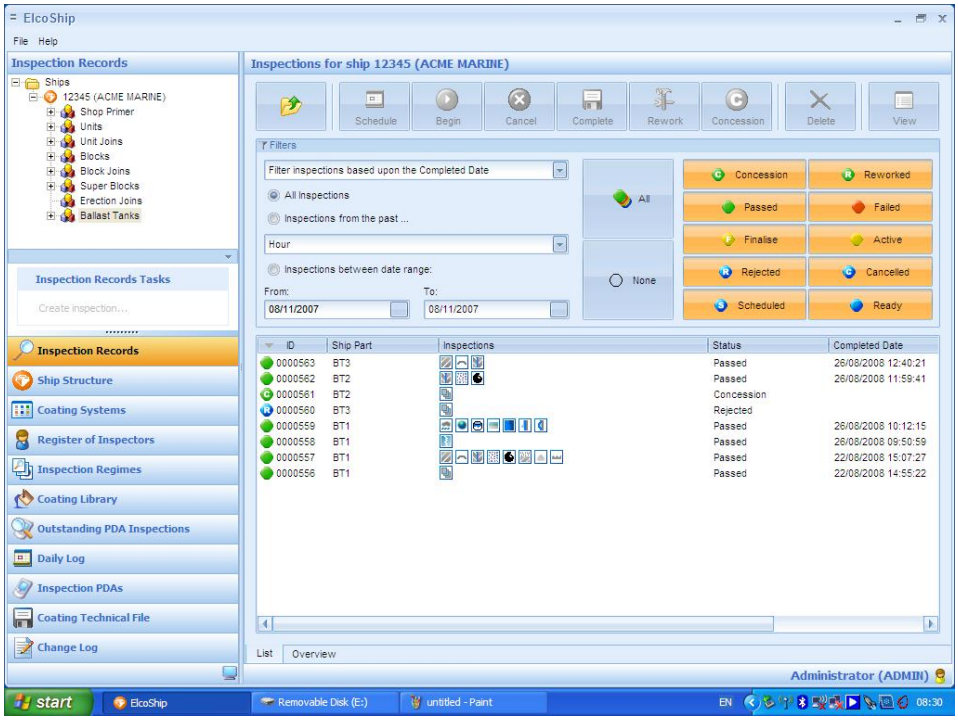

Figure 3 - An Example of the Inspection Records Screen
Showing completed inspection tasks

The PDA user has the opportunity to decline a particular task with a reason if the task cannot be completed as intended. The 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 the database 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 program.

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 color-coded, 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.

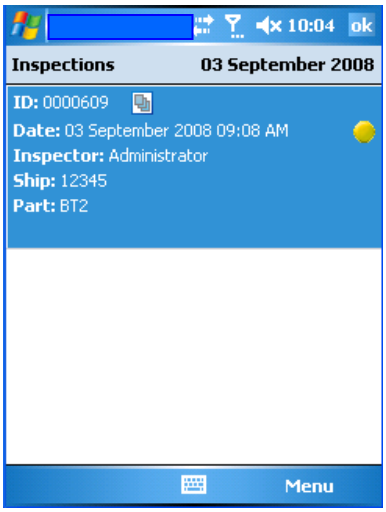

Figure 4 – An Example of the PDA Screen
Showing an Inspection Task ready to be opened for completion

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 Organization (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 as applied on new ships when being built, record the results of these inspections and produce a relevant 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.

Software based solutions would appear to be the most suitable for this as they would have the added benefit of being able to cover the whole vessel and provide a basis for through life maintenance and performance comparison.

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 judgment or on a measurement that cannot be transferred electronically. This should considerably reduce the paperwork requirement of the existing method of working, increasing productivity and meet the needs of the IMO regulations.

The additional benefits would be that data recording in this area will be able to provide the raw information to enable better engineering decisions to be made in the future to improve, the quality of the coating work, improve productivity by reducing man-hours and reduce the cost of the work for yards, and auditors.

REFERENCES

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