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Inspection Methods and Equipment

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The discussion that follows details vessel inspection history, current methodology and future trends. This presentation is given from the viewpoint of inspectors performing visual and ultrasonic surveys to determine structural integrity. A pre-shipyard condition survey on a VLCC will serve as the basis for explanation.

In years past detailed inspection was generally limited to the shipyard period where cleaning and staging of tanks were available, although cursory surveys were performed to serve as a guideline for the shipyard overhaul specification and to satisfy class society and governmental agencies requirements.

Due to increased awareness, available inspection technology, and recent events affecting the marine industry, the need to obtain reliable and meaningful inspection information on a vessel has intensified dramatically. The magnitude of the job for today's inspector is immense and simply gaining access to areas to be inspected is a job in itself. Essentially, the monumental task facing the inspector is to obtain all necessary inspection data, missing nothing, on a vessel that is 3 football fields in length, where weld footage could be calculated in miles, and plate surface areas can be considered in acres. This must be accomplished while wading your way through tons of mud, scale, salt-water, crude oil, and total darkness while often perched precariously 8 stories above the bottom shell.

Historically ship design has not addressed the issues of access and safety during the course of downline inspections, maintenance, and repair. Over the years, different inspection methods have been used to try and overcome the logistical problems. The three most widely used methods utilized all have specific problems associated with them. We have modified mountain climbing gear to help while climbing the tanks yet the method remains extremely dangerous. Rafting of tanks is slow and is difficult to perform while the vessel is underway. Diving of the tanks is fast and relatively safe yet the inspector misses the overall view of the tanks condition due to limited visibility. Several new developments in fail-safe equipment and portable air powered work platforms look promising for increasing personnel safety during the performance of these inspections.

Inspection equipment and methods developed for other industries are beginning to show promise in aiding in the inspection of these vessels such as arrayed multi-processor controlled ultrasonic scanning, remote automated ultrasonic scanning, magnetic flux leakage, tomography, and acoustic emission. Currently, we feel that the most effective inspection utilizes ultrasonic and mechanical measurement techniques, visual and photographic records controlled by a thorough and understood inspection scope which ultimately leads to the production of accurate documentation of the ships condition. When viewing all of the factors contributing to successful vessel inspection such as accurate drawings, dedicated ultrasonic equipment, communication gear, lighting and photographic equipment, the most important factors remain the inspectors' level of expertise and qualification. Today's inspector must be qualified in multiple inspection disciplines, have a thorough knowledge of ship structural components, be able to identify different corrosion and failure mechanisms, evaluate coating condition and cathodic protection systems and produce expert quality photography. Further, he must understand rigging to manipulate his safety gear and must be much more than simply physically fit.

Regardless of inspection method innovation and improvements in techniques that are expected to occur, our biggest problems associated with these inspection projects remain access and personnel safety. These issues must be addressed in modern ship design. Currently we depend on educated physical specimens risking their lives to accomplish what must be done. This of course is not the optimum solution to our problems. For improvements to be realized all parties involved in vessel design and survey, the owners, owner representatives, class societies, insurance companies, and government agencies must be educated on the logistical problems involved and true magnitude of the job of inspecting and assessing the condition of their vessels.

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INSPECTION METHODS AND TECHNIQUES: PAST, PRESENT, AND FUTURE

Introduction

Sometimes we need to look where we came from in order to see more clearly the direction for the future. In the maritime industry change comes slowly. Inspection was based on the requirements of the Classification Societies. Access to upper areas of tanks and holds was difficult.

A new mandate is in effect, based upon Government requirements and Owners' sensitivity to oil spill possibility. More inspection is required, more intensive and extensive. A new philosophy and new techniques must be applied to the inspection problem.

Past and Present Inspection Methods

The first innovation in measuring thickness of hulls, bulkheads, and internal structure came with the introduction of the audiogage. Prior to this ultrasonic method of measuring, the measurements were taken by drilling holes and physically measuring the steel. This method lacked accuracy, required drilling, and welding up the hole and was slow, inconvenient, and costly. The early ultrasonic method had some disadvantages...the measurement location needed to be ground smooth, access to the locations had to be arranged, and a skillful operator was necessary.

The ultrasonic instruments and techniques have evolved to where instant measurements can be taken from relatively rough surfaces. The problems of access still remain.

Ultrasonic thickness measurement of remaining steel thickness is only one form of inspection. The complete marine inspector must be capable of measuring pit depth, coating quality, detecting fractures, excessive surface corrosion, and buckling by visual inspection.

A major problem remains how to access the important upper areas of tanks. The past and present method has been to stage the areas, which gives good access for inspection and repair, but is prohibitively expensive unless mandated for repairs.

Typically, inspectors climb the tanks using the internal structure as hand and foot holds. This was marginally acceptable in the days of smaller tankers such as the T-2 tankers. Longitudinals were conveniently spaced and horizontal webs were common on bulkheads.

Ships continued to get larger since the T-2 and now present cathedral-sized areas for access. Flooding the tanks with water and rafting has become popular. This can be combined with climbing to provide access to most areas of tanks. The most critical underdeck areas are still inaccessible using rafting, due to deep underdeck webs, which would trap the rafter with no safe escape if the raft developed problems. This method is dependent upon pumping ballast from tank to tank, maintaining proper loading of the vessel, and disposal of cargo-contaminated water.

Diving in the tanks has also been tried. The tank is filled and pressed up to the deckhead. The diver can take thickness measurements by ultrasonics and can video the condition for the topside viewing. Safety considerations, decompression requirements, expense, and the ballast problems previously discussed have prevented diving from becoming a popular solution.

The most promising solution to access problems appears to be a variation of staging developed by Stageaway. Professional stage riggers hang portable air-operated platforms in the desired area and total "close-up" inspection and gauging can be accomplished by competent inspectors in the presence of interested witnesses, such as U.S.C.G., Class Surveyors, Owners Representatives, etc. A graphic rendering of this staging is shown in Figure 1.

Redundant safety harnesses and backup systems render this method total security. Four persons can be aboard this platform with at least one being a certified air-operated staging technician. These platforms are equally successful "at sea," alongside docks or in shipyard drydocks. They have the added advantage of permitting simple repairs.

Documentation of Results

As the inspection requirements have increased, so has the inspection data. For effective, easily understood reporting, AutoCad computer programs have been created, which permit entry of information on scale drawings of the ship's internal structure and color-coded graphics to show extent and location of deterioration.

Computer reporting methods give ready comparisons with previous inspections, calculate percentage of wastage, and can be used to prepare repair specifications.

Fractures can be tracked, repairs documented and future fracture locations compared with previous ones.

Future Inspection Methods

Automated ultrasonic inspection technology has been used extensively in the nuclear and petrochemical industries. It offers the possibility of effectively viewing 100% of areas where problems are suspected, for wall thinning, corrosion, and cracking.

Magnetic flux leakage can be applied to the inspection of cargo and ballast piping for locating grooving and pitting on the inner wall.

Infrared thermography is a global method for locating areas with excessive corrosion. Local methods can be used to verify and quantify the results.

Acoustic Emission is in the research and development stage. At least one major oil company has a program in effect to determine the efficiency of its application to ship corrosion detection.

The encouraging signs of improved inspection methods and high level of interest from ships' operators, combined with the increased requirements for inspection, give promise of better, more efficient monitoring of critical areas of the aging tanker fleet.

Skilled, experienced inspectors are a vital part of the inspection function and must be considered as a factor in choosing the method and extent of an inspection.

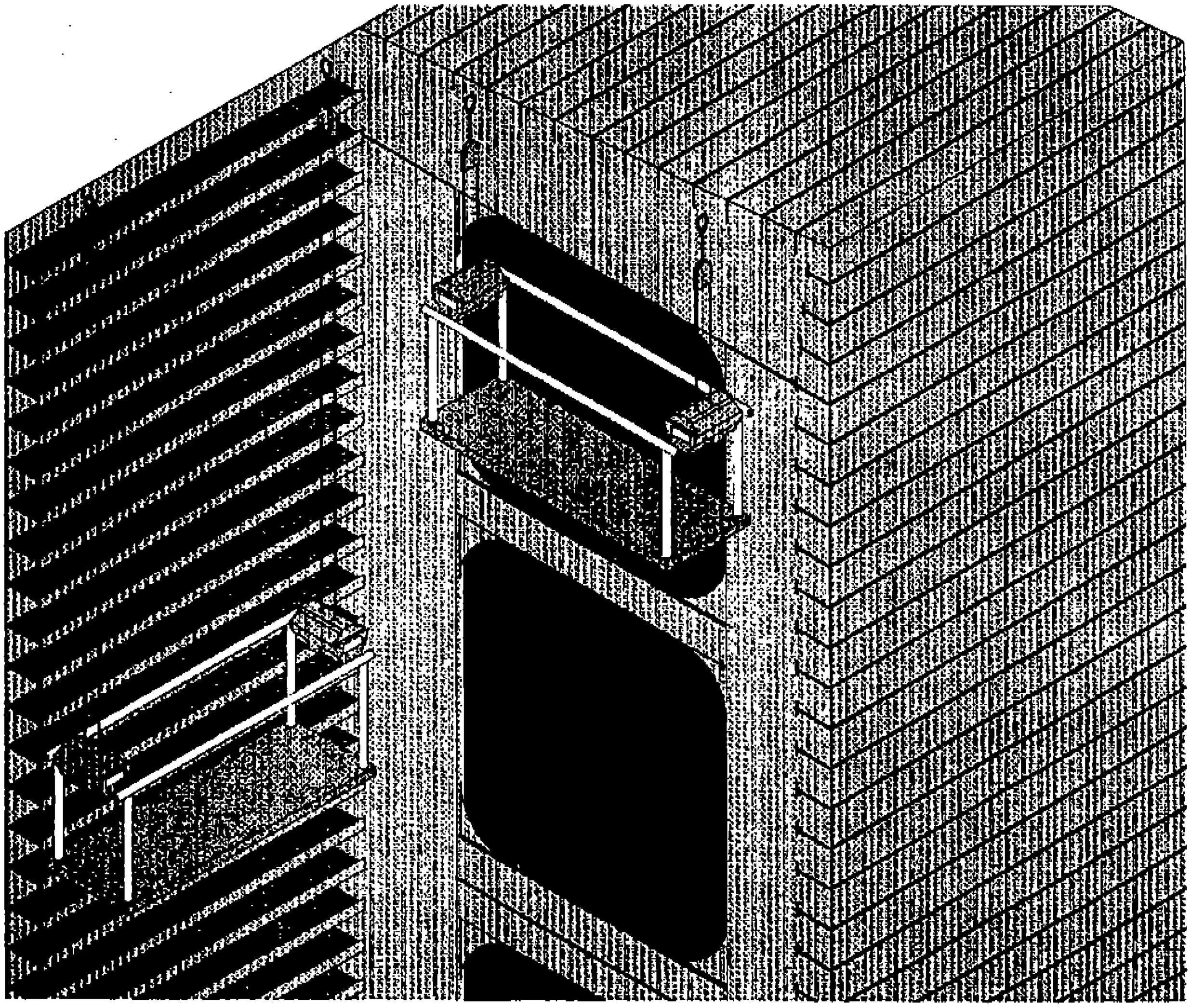

Figure 1
Ship Inspection Staging Operated by Air Controls