iven current market conditions, the desire of owners to keep tight control of maintenance, repair, and drydocking expenses is understandable. By adopting a rationalized approach to the inspection of the hull structure—whether of a ship or an offshore unit—and a methodology on what to inspect, when to inspect, where to inspect, and how much to inspect, owners can take a major step towards more effective maintenance and reduced maintenance and repair (M&R) expenses.

Traditionally shipowners, offshore rig operators, and vessel managers have in-house hull inspection schemes and programs to track, assess, and maintain the hull structure. Inspections to assess hull condition are also performed by many agencies such as classification societies, vetting agencies, and port and flag state authorities. This inspection data tends to be collected in a variety of forms, checksheets, and reports.

Most agencies perform surveys or inspections in a prescriptive manner. The selected compartments are inspected based on experience and work instructions provided to the surveyor or inspector. The presence of critical areas and suspect areas in a compartment may or may not be highlighted in these instructions.

Ideally, the inspection results from the various agencies should be analyzed by the owner and compiled into a repair/drydock specification list. But typically, much of the inspection data may not be formatted in a way, or contain sufficient detail, to allow for easy conversion into a repair specification. At the time of repair there may be some surprises as the compartment condition has not been adequately assessed beforehand.

Rationalized Hull Inspection Systems Can Rein in Repair Bills

By Fernando Lehrer, Director, ABS Product Development, Nautical Systems

Hull Inspection Program

The American Bureau of Shipping (ABS) has addressed this situation through the development of a comprehensive, ship or offshore unit specific, yet easy-to-use, software-based Hull Inspection Program (HIP) for owners. The society also offers an optional notation based on comprehensive guidelines, appropriate training for the crew, and the implementation of the associated software.

It must be emphasized, however, that the responsibility
for the maintenance of the vessel rests, at all times, with the owner. The inspection and maintenance programs offered by ABS are designed to assist the owner but in no way shift that basic responsibility.

An effective inspection regime should help the owner to systematically examine and grade hull structure, and identify and record any defects (anomalies). A program supporting a holistic, proactive, preventative maintenance scheme for the ship should address the following:

- identification of potential problem areas so that preventative measures can be taken;
- focused inspection and condition reporting on structurally critical areas;
- easier development of repair drydock specifications;
- detection of anomalies and maintenance trends across a fleet; and
- more efficient use of inspection results to satisfy other stakeholders (e.g., port or flag states).

The quantifiable attribute for the condition of compartments on a vessel or offshore unit is usually the coating condition and the presence or absence of anomalies, relying on the experience of the inspector to judge those elements. The owner gathers this information, together with detailed specifications for any material replacement or actions to be carried out by a shore or drydock crew.

The approach taken by ABS in its HIP system is to divide each compartment into zones. Each cargo space and ballast tank is typically divided into 14 zones. The forepeak, aftpeak, and other miscellaneous spaces are sub-divided into 2 to 6 zones, depending on complexity.

Critical structural areas (if any) are identified for a compartment/zone based on engineering analysis and in-service experience.

### Traffic Light Warning System

The inspection criteria are graded with a rating from 0 to 6. A traffic light status—red (5 to 6), yellow (3 to 4), and green (0 to 2)—is assigned to each zone for each criterion. These scores are then added for each zone and rolled up to get a normalized score for the compartment.

Each zone is inspected and graded using six inspection criteria:

- coating condition,
- general corrosion,
- pitting/grooving,
- deformation,
- fractures, and
- cleanliness.

The scores for all zones in the compartment for a particular inspection criterion are then normalized, and the aggregate of all the inspection criteria scores for all the zones is the normalized compartment score. "Red" for any inspection criteria indicates a structural deficiency, and the inspector should create an anomaly report. “Yellow” indicates a progression towards an anomalous condition and serves as an early warning and, at the discretion of the inspector/superintendent, may be addressed at the next repair/drydock schedule. Identification of anomalies can assist the operator in managing and controlling the repair specifications and drydock planning.

Within the ABS HIP system, the critical areas are selected based on in-service experience and engineering analysis tools, including finite element analysis. Areas are divided into “typical” critical areas and “specific” critical areas based on a criticality index. Typical critical areas are generic to the type of the ship and are to be inspected randomly by

### Table 1: Traffic Light Rating System for Ship Condition Survey

<table>
<thead>
<tr>
<th>Coating Condition</th>
<th>Rating</th>
<th>Points</th>
<th>Condition Comment</th>
<th>Risk Level</th>
<th>Color code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>Excellent</td>
<td>0</td>
<td>Freshly coated, negligible coating breakdown</td>
<td>Low</td>
<td>Green</td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td>1</td>
<td>Minor spot rusting</td>
<td>Low</td>
<td>Green</td>
</tr>
<tr>
<td></td>
<td>Good-Fair</td>
<td>2</td>
<td>General breakdown of coating over 5%</td>
<td>Low</td>
<td>Green</td>
</tr>
<tr>
<td>Fair</td>
<td>Fair</td>
<td>3</td>
<td>Local breakdown at edges of stiffeners and weld</td>
<td>Medium</td>
<td>Yellow</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>connections (uncoated)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fair-Poor</td>
<td>4</td>
<td>General breakdown of coating over 10%</td>
<td>Medium-High</td>
<td>Red</td>
</tr>
<tr>
<td>Poor</td>
<td>Poor</td>
<td>5</td>
<td>General breakdown of coating over 20%</td>
<td>High</td>
<td>Red</td>
</tr>
<tr>
<td></td>
<td>Worst</td>
<td>6</td>
<td>General breakdown of coating over 30%</td>
<td>Very High</td>
<td>Red</td>
</tr>
</tbody>
</table>
subjecting at least 10 to 25% of the area to close-up visual inspection.

Specific critical areas are defined by the hull structural analysis that identifies those areas with a particularly high risk of failure. Specific critical areas may also be identified where the structure is of unusual design or based on a novel concept.

All areas identified as high risk specific to that particular ship or rig design would require a 100% close visual inspection every time the tank or compartment is entered. The likelihood of failure is evaluated on the basis of a calculated fatigue life or strength or buckling unity check. In addition, the consequence of failure has been ascertained based on the qualitative judgement for the detail in question.

This methodology can be adapted to all the vessels or units in an owner’s fleet with the scoring system allowing for the comparison of the condition of tanks on a specific vessel or against other vessels or units in a fleet. The inspection data collected for a large fleet of similar vessels will permit the owner to identify trends so as to better forecast repair requirements and manage resources.

Conclusion

By adopting a more formalized method for hull inspection, an owner will have begun moving towards a more rationalized approach to structural integrity management. The concept can be applied by a small fleet operator with simple spreadsheets. For an operator with a large fleet, a sophisticated “dashboard” application encourages monitoring the condition of the fleet and identification of systematic problems. In either case, the owner can expect to have better control over the ongoing maintenance and repair of his vessels or offshore units and the attendant costs.
BLACK BEAUTY® abrasives give you the surface profile you need so your customers get the finish they demand.

The best value in the marketplace on a cost per blasted square foot basis.

We offer a range of highly effective grades to prepare all surfaces from new steel to the most challenging corrosion.

1-888-733-3646 | www.blackbeautyabrasive.com

HARSCO MINERALS
Next Generation of High Build Aliphatic Moisture Cure Coatings based on Desmodur® XP 2763

Features:
- High Film Build up to 8 mils DFT, blister-free
- Applicable in high temperature/high humidity environments
- Applicable in low temperature/damp environments
- VOCs - 100 to 340 g/L
- SSPC Paint Spec 38 Weathering compliant
- One-component technology with extended pot life

Markets:
- Bridges & Highways
- Architectural
- Petrochemical
- Water & Waste Water
- Pulp & Paper

Engineered Polyaspartic Coating based on Desmodur® XP 2763 for Industrial Maintenance Coatings

Features:
- Consistent cure over various temperatures and humidities
- Extended recoat
- Fast curing, high build, bubble free & rapid return to service coating for concrete & steel surfaces
- Low VOC's - 100 to 340 g/L
- SSPC Paint Spec 39 weathering compliant

Markets:
- Bridges & Highways
- Architectural
- Petrochemical
- Water & Waste Water
- Power
- Flooring

412-777-3983
www.bayermaterialsciencenafta.com

Click our Reader e-Card at paintsquare.com/ric
Game Changing advances in Polyurethane Coatings Chemistry for the Corrosion Market

Bayer MaterialScience, a pioneer in polyurethane chemistry has long been a leader in providing innovative solutions to coatings formulators. Two exciting improvements for coatings targeted for the Corrosion Protection market include:

1. Improving an already great technology – Polyaspartic Coatings with a new engineered polyisocyanate.
2. Technologies that enable Moisture Cure urethane topcoats to be more robust and easier to use

Today’s applicators, owners and specifiers seek robust, durable coatings that accommodate tight scheduling demands and just-in-time delivery while protecting their assets. Polyaspartic coatings offer owners productivity improvements by speeding the painting process. Bayer MaterialScience recently introduced a new aliphatic polyisocyanate, Desmodur® XP 2763, developed to improve these desired characteristics in polyaspartic coatings. It provides improved application robustness, extended recoat, and improved weathering over the standard polyaspartic coatings on the market today.

What do we mean by application robustness? We mean dramatic improvements in the following areas: improved consistency of cure across a large environmental application range, extended re-coat, 1:1 by volume mix ratios, and rapid re-coat of multi-layered coating systems with improved adhesion characteristics.

The second improvement in coatings targeted to the corrosion protection market relates to moisture cure urethanes (MCUs). MCUs have been widely used in such applications for over 30 years in the northeast and northwest regions of the United States. Historically, applicators found MCU topcoats difficult to apply due to its 2-4 mils dry film thickness requirement. In complex structures, this requirement could lead to putting the topcoat on too thick, resulting in blistering problems. Applicators will now find MCU topcoats easier to apply. Through meticulous resin and formulation development, Bayer MaterialScience has developed new, state-of-the-art, light stable, moisture cure topcoats that can be applied at twice the film build without blistering. We also believe that this technology can now be applied in even more extreme hot and humid environments which will extend the use of MCUs into new geographic regions.

Whether for bridges, stadiums, buildings, flooring or architectural elements, polyaspartic and MCU coatings technology offer application cost savings and fast return to service—all with low VOCs – trademarks of the Proven Power of Polyurethane built on Bayer Technology.
Non-Isocyanate AROFLINT® 2K Resin Systems
For High Performance, Low VOC Coatings
Unique Epoxy-Polyester Resin System

AROFLINT® is a family of versatile epoxy-polyester resin systems designed for high performance coatings where excellent appearance, durability and toughness are required. The unique chemical reaction between the oxirane modified ester and acid functional polyester proceeds at ambient temperature, but can be accelerated by force-drying or baking. These robust systems possess a good combination of the many performance benefits associated with both 2K epoxy and urethane technology – without the risks associated with handling isocyanates.

Applications
Agricultural and construction equipment (ACE)  
Porcelain coatings and bathtub refinish  
Transportation and aerospace coatings  
Commercial, service, recreational and health care facilities  
Industrial maintenance and tank coatings  
Food service and processing facilities  
Public and industrial buildings  
Miscellaneous (oil well equipment, battery racks, wood)

Features & Benefits
Outstanding stain and chemical (acid) resistance  
Brilliant gloss and depth of image for a wet look  
Excellent durability for long-term color and gloss retention  
Easy to touch-up or recoat with minimal surface preparation  
Mildew resistant films that hold up in damp environments  
Low VOC capability to meet 250 g/L requirements  
Non-isocyanate for improved worker safety  
Wide formulating latitude for optimum balance of properties

Performance
Coatings based on AROFLINT 608 100% solids epoxy combined with AROFLINT 809 or 810 HAP's compliant polyesters exhibit good corrosion resistance as illustrated below:

These coatings also have durability approaching that of a 2K urethane. Of the two highlighted AROFLINT systems, the 608 / 809 system offers slightly better durability as shown in the QUV-A340 accelerated weathering graph below. Alternately, the 608 / 810 system offers improved dry time and hardness.

Wide Formulating Latitude
Coatings are generally formulated with excess epoxy for optimum performance and balance of physical and chemical properties. A 1.6:1 stoichiometric epoxy:polyester ratio is a good starting point, however, component ratios can be adjusted to meet specific requirements as summarized in the table below:

Advantages
The distinctive AROFLINT epoxy-polyester resin systems boast an excellent balance of film properties suitable for high performance, low VOC coatings. They are a unique and versatile alternative to 2K urethanes when the end-use application requires good exterior durability along with the chemical and corrosion resistance that only an epoxy system can provide.
Innovative Epoxy Dispersion for Two-Component Protective Coating Systems

BECKOPOX® EP 2384w/57WA is a highly advanced product designed for high performance waterborne ambient cure two-component epoxy monocoats and primers for metallic substrates. It outperforms other waterborne epoxy dispersions, while maintaining very low VOC, especially in corrosion and water resistance. It is well suited for factory applied coatings as well as field applied protective coatings.

For more information visit www.cytec.com or email custinfo@cytec.com
Passion is in our nature.

Dancing around high VOC levels?
Introducing CHROMA-CHEM® 846

CHROMA-CHEM® 846 industrial colorants deliver the high performance standards set by our industry-leading CHROMA-CHEM® 844 with dramatically reduced VOC levels and elimination of APEs.

The state-of-the-art pigments specifically chosen for CHROMA-CHEM® 846 provide broad color space, excellent durability, light fastness, and chemical resistance. Used for both volumetric dispensing and in-plant tinting, CHROMA-CHEM 846 colorants feature best-in-class quality for color retention, dispensability, consistency and film properties in a wide variety of chemistries.

Combined with the 3000+ colors and formulas in the Portfolio of Color® industrial color system, our passion for color and performance is unlimited!

Evonik. Power to create.