

CASE STUDY



A ROYAL SOLUTION

DOC. REF: CS/RC/00232001/MY

CASE STUDY Ref: Coating of Main Transverse and Intermediate Transverse Beams, Splash Zone Area for one of the world's biggest Synchronized Ship Lift Systems

DATE STARTED: 15th March 2002

DATE COMPLETED: 30th November 2003

TOTAL AREA COATED: 50,000m²

RESTRICTED DISTRIBUTION: Reference to part of this report which may lead to misinterpretation is not permissible

THE CLIENT

Name: MMHE Bhd previously known as Malaysia Shipyard and Engineering Bhd (MSE)

Location: Pasir Gudang, Johor, Malaysia

Shareholders: MISC Bhd and Technip FMC PLC (Major)

Project Value: Approx. MYR 2 million (2002 value)

Main facilities Coated: Shipyard Synchronized Ship Lift System comprising 36 Main Transverse Beams and 72 Intermediate Transverse Beams, one of the largest Synchro Ship Lift systems in the world

Total Area Coated: 50,000 m²



THE PROBLEM

Previously installed coating system comprising of MIO Zinc Primer/Top Coat from a major coating manufacturer failed prematurely within 6 months of installation. The challenge was to re-coat all 50,000m2 of coated area while the Ship Lift was fully operational. The coated areas were in the Splash Zones subjected to cyclic wet and dry conditions with salt spray constantly present. Surfaces were completely submerged during Ship Lift Operations.



Picture showing timber Sleepers removed exposing both Main Transverse and Intermediate Transverse Beams. **Date of work commencement 15th March 2002**



Picture showing timber Sleepers removed exposing both Main Transverse and Intermediate Transverse Beams. **Date of work commencement 15th March 2002**



Pictures showing initial substrate conditions with heavy pitting original coating delaminating. **Date of Work commencement 15th March 2002**



Pictures showing Ultra High-Pressure Hydro-blasting to remove completely all remaining original coating system. Surface cleanliness to NACE WJ2. Original surface profile to SA 2 ½ restored. **Date of work commencement 15th March 2002**

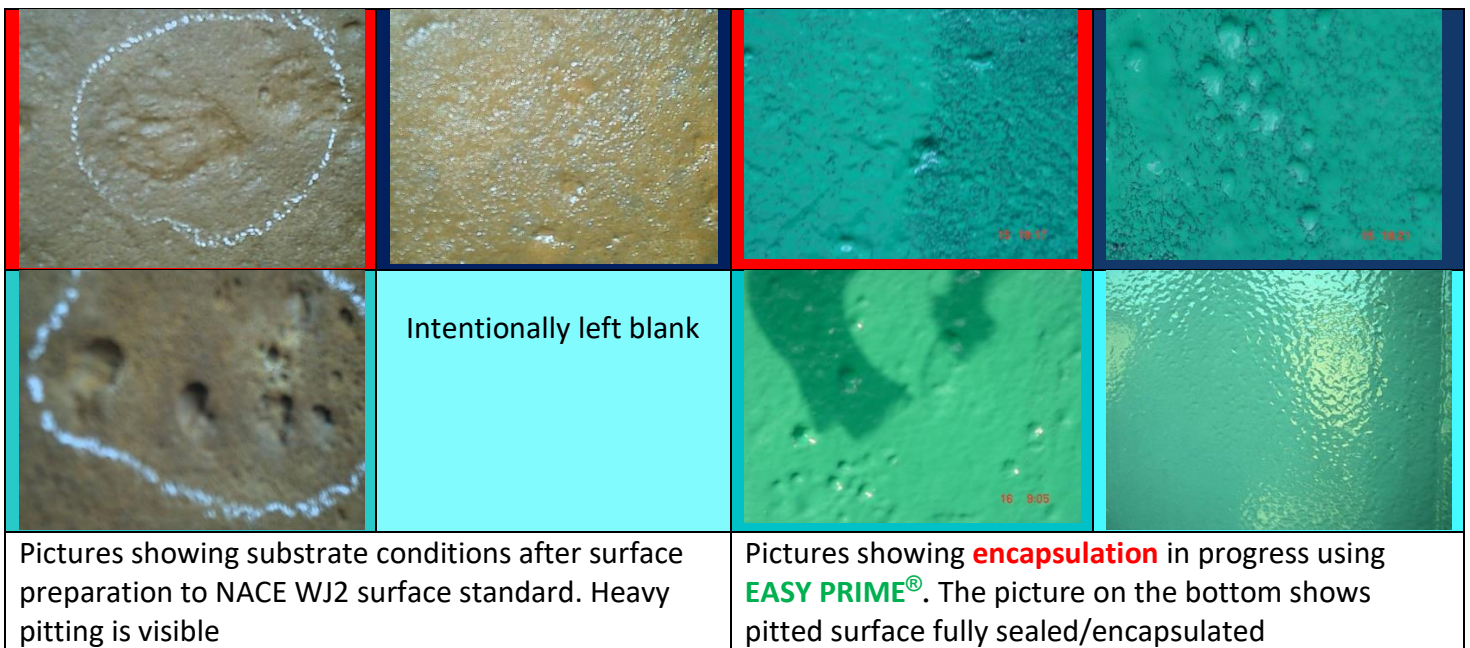
THE SOLUTION

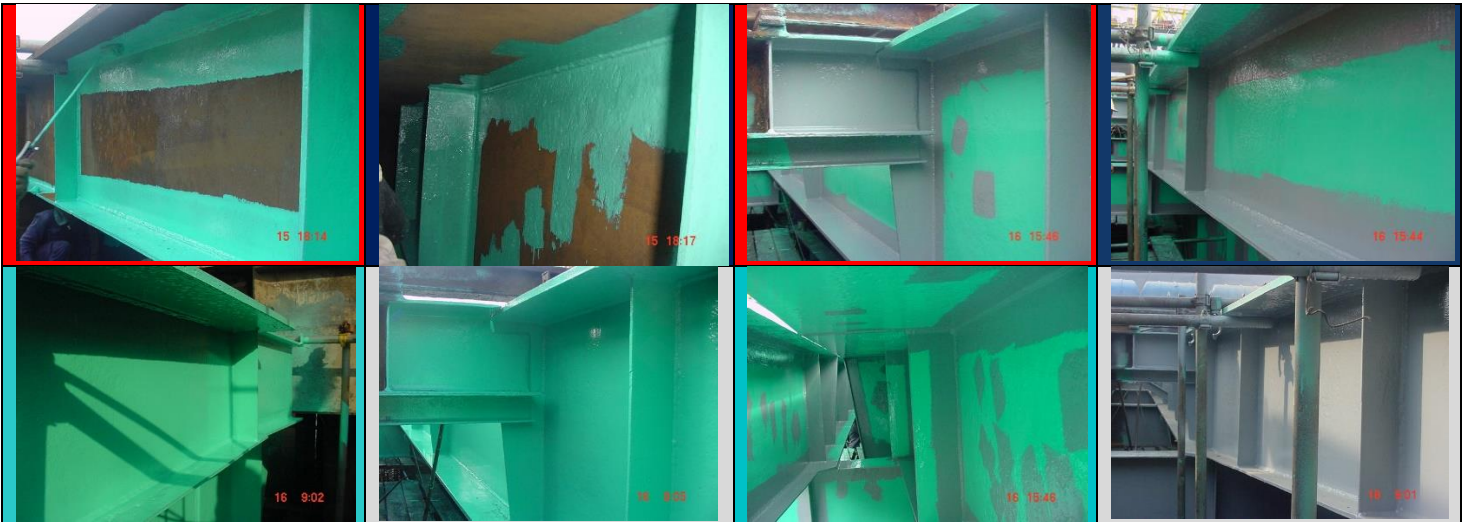
Royal Coatings' solvent free, moisture tolerant and surface tolerant epoxy primer, **EASY PRIME®**, was used to wet out and penetrate deep pits and form an effective surface seal. **EASY GUARD®**, a solvent free surface tolerant and moisture tolerant ceramic epoxy, was used as a barrier coat for long term protection. The abrasion resistance and elastic properties of **EASY GUARD®** enabled the coating system to withstand the cyclic loading stresses that both MTBs and ITBs experience during lifting PANAMAX Class Vessels. **EASY GUARD®** also offers exceptional UV protection for an epoxy coating.

THE TECHNOLOGY

Encapsulation -Wet out and Seal.

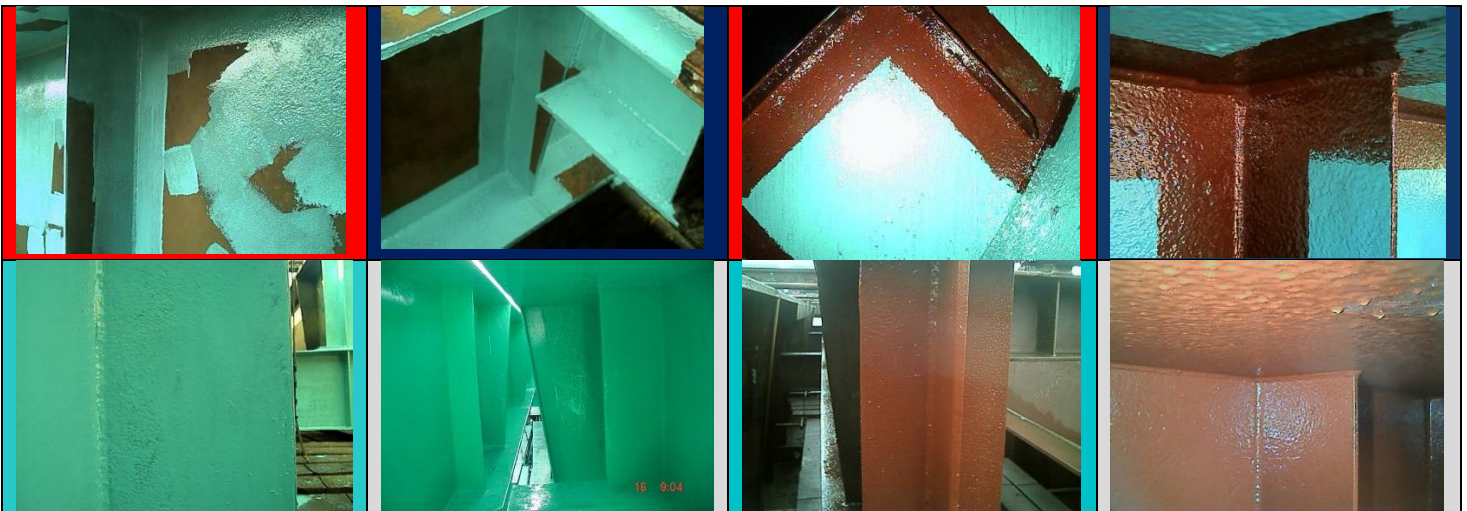
Simply put, in competing solvent-based technologies, resin molecules land on substrate and form a skin/film before penetrating into substrate leading to solvent entrapment in compromised substrates. With Royal Coatings' solvent free epoxy coatings, the rheology is engineered allowing coating to penetrate deep into substrate in order to wet out substrate before film formation thereby sealing compromised surfaces. Tight rust and pits are encapsulated.





Pictures showing Stripe Coating all leading edges, weld seams and heavily pitted areas with **EASY PRIME®** in between full coats.

Pictures showing Stripe Coating all leading edges, weld seams and heavily pitted areas with **EASY GUARD®**, in between full coats



Pictures showing Stripe Coating all leading edges, weld seams and heavily pitted areas with **EASY PRIME®** in between full coats.

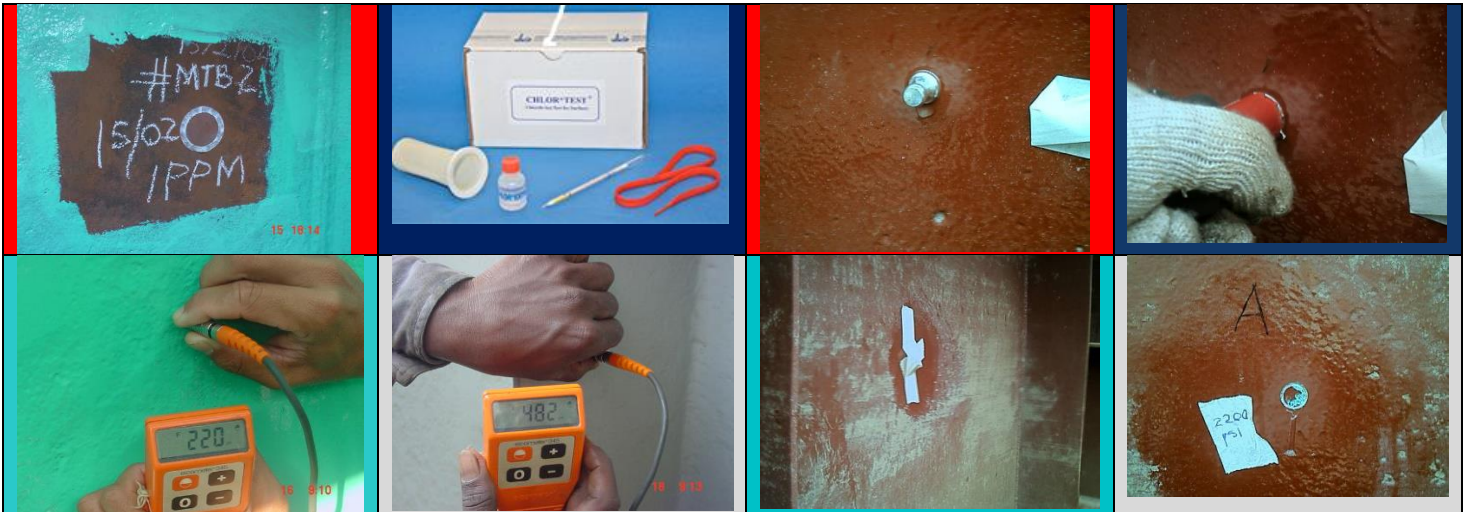
Pictures showing Stripe Coating all leading edges, weld seams and heavily pitted areas with **EASY GUARD®**, in between full coats

THE RESULTS

A comprehensive Inspection and Test Plan (ITP) was implemented to validate coating installation parameters were in compliance with Royal Coatings Paint Specifications and Painting Procedures. The Coating System installed exceeded all specified performance parameters measured and recorded. By today's NORSOK M-501 Standards Ver Feb. 2012 the RCI coating system will qualify as Coating System Nos. 7A, 7B and 7C

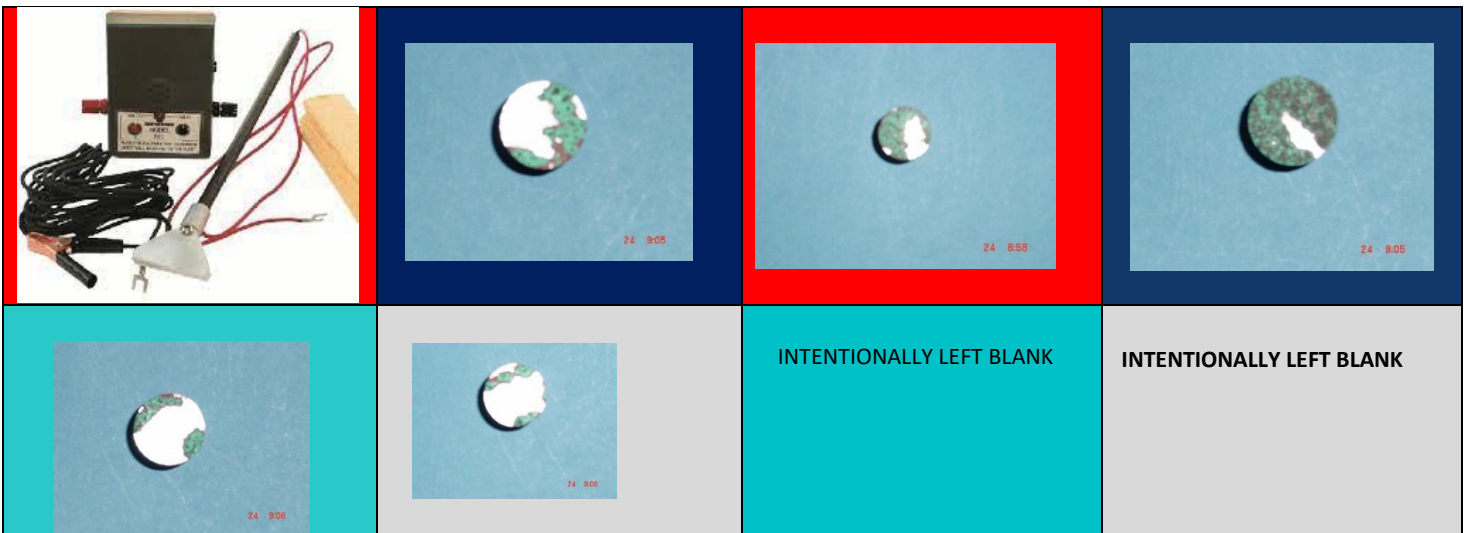
THE BENEFITS

- 1) The Synchro Ship Lift was fully operational throughout coating installation process without disruption to Shipyard activities and delays in project deadlines
- 2) Revenues generated by the Synchro Ship Lift system were not disrupted leading to a positive impact on Company's(Asset Owner) P&L








Pictures showing ITP being carried out. Measurements for Dissolved Salts were carried out using CHLOR*RID test kits. UT Gauges were used to measure DFT's.

Pictures showing Adhesion Pull Off Tests being carried out after coating system installation in accordance with ASTM D4541



Pictures show ITP being implemented using equipment (Tinker and Razor Wet Sponge Holiday Detector) and Dollies after conducting Pull off Tests. Preceding page summarizes Adhesion Pull off Test results on a typical Main Transverse Beam

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Picture	Location	Pull Pressure, psig	Remarks
	Beam No.34. Test site A.	Detach pressure 2,200 psig.	About 60% coating was still intact. Another 35% showed top coat detachment with primer coat still intact. DFT: 450 microns
	Beam No.34. Test site B.	Detach pressure 2,300 psig.	About 40% coating was still intact. 55% showed top coat failure with about 5% showing total failure DFT: 480 microns
	Beam No.34. Test site C.	Detach pressure 2,600 psig	About 15% coating was still intact. Total failure of about 60% with 25% top coat failure DFT: 374 microns
	Beam No.34. Test site D	Detach pressure 1,720 Psig	About 80% coating still intact. Over 15% top coat failure with prime coat still intact. DFT: 386 microns
	Beam No.34. Test site E	Detach pressure of 1,500 psig	About 80% coating still intact. Less than 5% total coating failure. DFT: 408 microns

Pictures show typical Adhesion Pull Test Report issued on MTB No. 34 which was completed in November 2002. The results are reflective of tests done on all the other MTB's and ITB's as well. All results far exceed the current requirements for performance parameters for Coating Systems No.7A, 7B and 7C in today's NORSOK M-501 Ver. Feb 2012

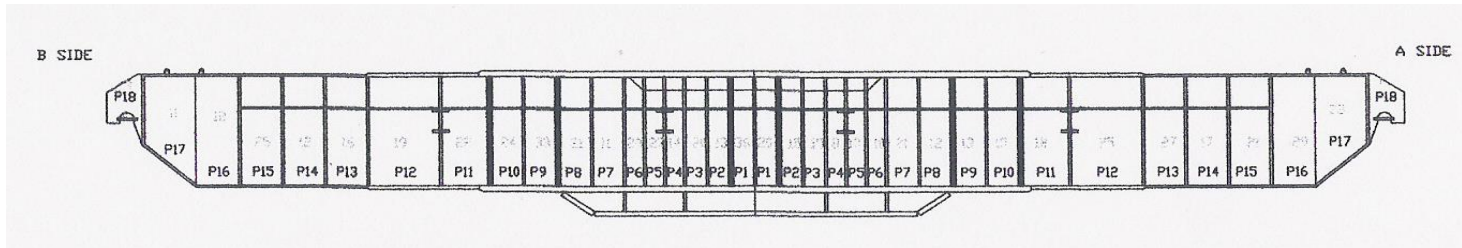
ADDING VALUE

The **Conditional Warranty** of 5 years of coating system service life issued by Royal Coatings Inc. (RCI) in 2002 required the implementation of a yearly routine maintenance program customized to MMHE’s prevailing Asset Operational conditions. Yearly joint inspections were carried out by Royal Coatings Inc. appointed Tech. Rep. and MMHE’s Ship Lift Maintenance Team. Coating breakdown was identified in each beam and the quantum in terms of percentage of total beam area was worked out jointly. If the percentage was less than the minimum 5% breakdown through “fair wear and tear” MMHE with its maintenance team would buy coating products from RCI to carry out coating repair work to make good all breaches in installed coating system. If the coating breakdown exceeded the maximum allowable 5% than RIC would supply the excess coating products FOC to MMHE maintenance crew to carry out coating repair work to make good all breaches in installed coating system

THE RESULTS

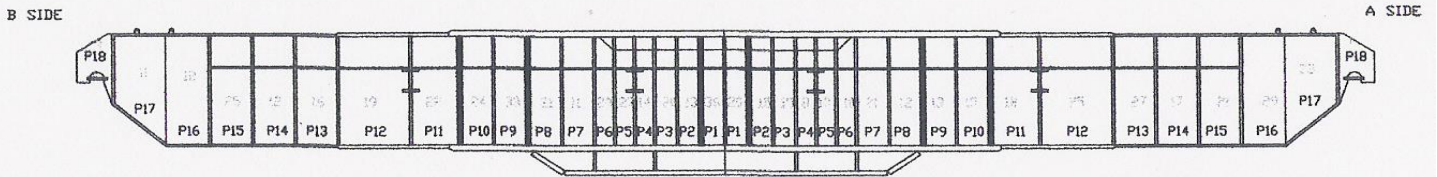
Inspections carried out as part of yearly routine maintenance program for Year 1 and Year 2 of 5 Year service life of coating system found less than 0.5% coating failure for 1st Year and less than 1% coating failure in the 2nd Year of service of the Synchro Ship Lift system. This was well below the 5% of coating breakdown per year of Service life due to “Fair wear and Tear” in RCI’s 5 Year Conditional Warranty. The coating failure was **so minimal that it did not justify carrying out any coating maintenance repair work for Year 1 and Year 2.** Coating Repair maintenance work was only carried out in Year 3 of service and that too the coating breakdown due to “fair wear and tear” was less than 5% for all beams coated. This is a testament to the quality of Royal Coatings Inc.’s products and the installed coating system performance under extreme cyclic loading stresses during ship lift operations and cyclic environmental conditions in Splash Zones

MTB #24 SEA END AREA A SIDE, PICTURE LOCATOR, 3 YEARS INTO COATING SYSTEM SERVICE LIFE



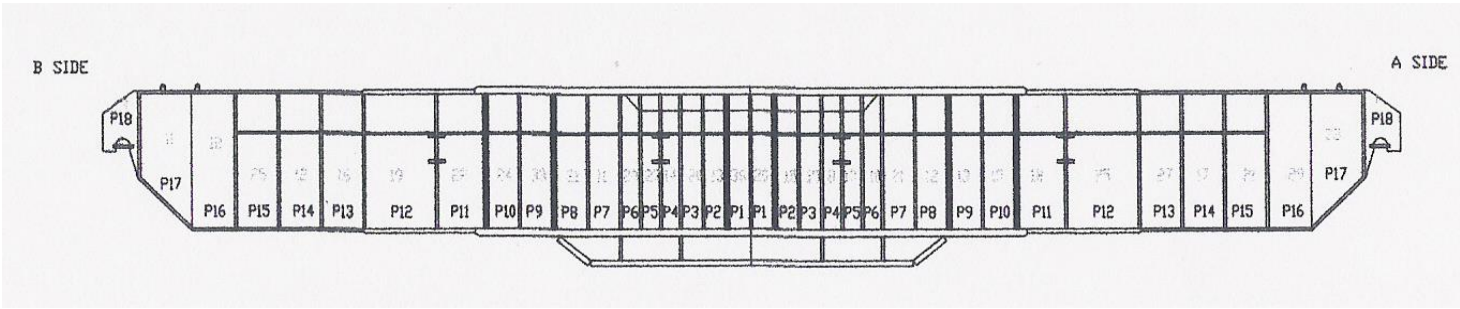
<p>P18A</p>	<p>P17A</p>	<p>P2A</p>	<p>P15A</p>
<p>P14A</p>	<p>P13A</p>	<p>P12A</p>	<p>P11A</p>
<p>Inspection carried out on 22nd Feb.2005. Year 3 in service. Less than 3% coating breakdown, well below threshold value for “Fair Wear and Tear”. MTB # 24 coating condition/breakdown reflective of all MTB’s inspected.</p>		<p>Inspection carried out on 22nd Feb.2005. Year 3 in service. Less than 3% coating breakdown, well below threshold value for “Fair Wear and Tear”. MTB # 24 coating condition/breakdown reflective of all MTB’s inspected</p>	

MTB #24 SEA END AREA A SIDE, PICTURE LOCATOR, 3 YEARS INTO COATING SYSTEM SERVICE LIFE











<p>P10A</p>	<p>P9A</p>	<p>P8A</p>	<p>P7A</p>
<p>P6A</p>	<p>P5A</p>	<p>P4A</p>	<p>P3A</p>
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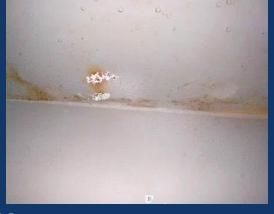
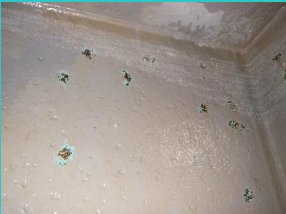



MTB #24 SEA END AREA B SIDE, PICTURE LOCATOR, 3 YEARS INTO COATING SYSTEM SERVICE LIFE











<p>P18B</p>	<p>P17B</p>	<p>P16B</p>	<p>P15B</p>
<p>P14B</p>	<p>P13B</p>	<p>P12B</p>	<p>P11B</p>
<p>Inspection carried out on 28th Jul.2005. Year 3 in service. Less than 3% coating breakdown, well below threshold value for "Fair Wear and Tear". MTB # 24 coating condition/breakdown reflective of all MTB's inspected.</p>			
<p>P10B</p>	<p>P9B</p>	<p>P8B</p>	<p>P7B</p>
<p>P6B</p>	<p>P5B</p>	<p>P4B</p>	<p>P1B</p>
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MTB #24 SEA END AREA A SIDE, PICTURE LOCATOR, AFTER SURFACE PREPARATION, PATCH REPAIR

 <p>P18A</p>	 <p>P17A</p>	 <p>P16A</p>	 <p>P15A</p>
 <p>P14A</p>	 <p>P13A</p>	 <p>P12A</p>	 <p>P11A</p>
<p>Surface preparation work commenced on the 25th of July with affected areas power tooled using needle guns followed by freshwater wash down. Surface standard achieved ST 13. Coating repair done by MMHE Maintenance crew. Coating purchased from Royal Coatings Inc. Agent</p>		<p>Surface preparation work commenced on the 25th of July with affected areas power tooled using needle guns followed by freshwater wash down. Surface standard achieved ST 13. Coating repair done by MMHE Maintenance crew. Coating purchased from Royal Coatings Inc. Agent</p>	







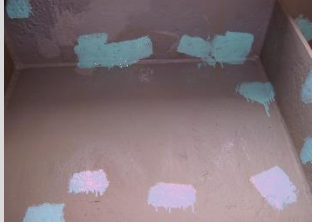
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MTB #24 SEA END AREA A SIDE, PICTURE LOCATOR, EASY PRIME APPLICATION IN PROGRESS

 <p>P18A</p>	 <p>P17A</p>	 <p>P16A</p>	 <p>P15A</p>
 <p>P14A</p>	 <p>P13A</p>	 <p>P12A</p>	 <p>P11A</p>
<p>Easy Prime application carried out on 26th July 2005. . Coating repair done by MMHE Maintenance crew. Coating purchased from Royal Coatings Inc. Agent.</p>		<p>Easy Prime application carried out on 26th July 2005. . Coating repair done by MMHE Maintenance crew. Coating purchased from Royal Coatings Inc. Agent.</p>	

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<p>Easy Prime application carried out on 28th July 2005. Coating repair done by MMHE Maintenance crew. Coating purchased from Royal Coatings Inc. Agent.</p>		<p>Easy Prime application carried out on 28th July 2005. . Coating repair done by MMHE Maintenance crew. Coating purchased from Royal Coatings Inc. Agent.</p>	

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MTB #24 SEA END AREA A SIDE, PICTURE LOCATOR, EASY GUARD APPLICATION IN PROGRESS

 <p>P18A</p>	 <p>P17A</p>	 <p>P16A</p>	 <p>P15A</p>
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<p>Easy Guard application commenced on 31st July 2005. . Coating repair done by MMHE Maintenance crew. Coating purchased from Royal Coatings Inc. Agent.</p>		<p>Easy Guard application commenced on 31st July 2005. . Coating repair done by MMHE Maintenance crew. Coating purchased from Royal Coatings Inc. Agent.</p>	

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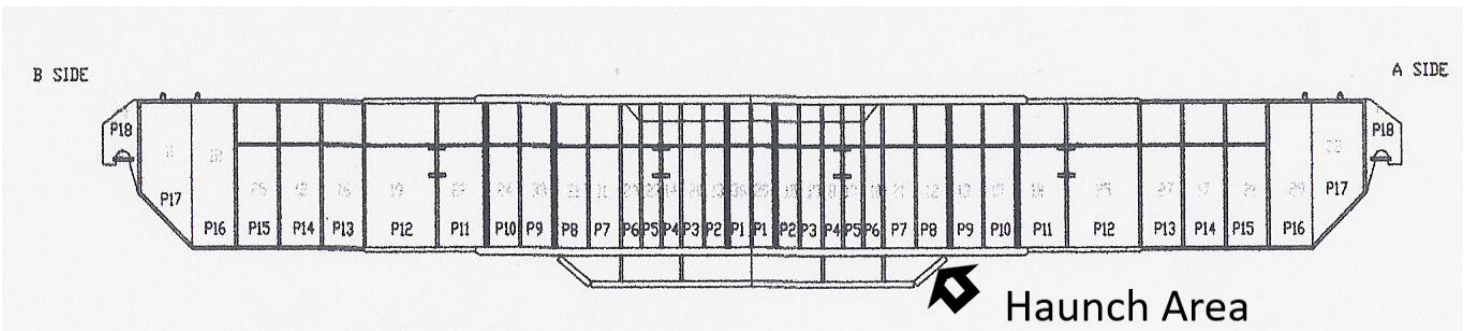
 <p>P18B</p>	 <p>P17B</p>	 <p>P16B</p>	 <p>P15B</p>
 <p>P14B</p>	 <p>P13B</p>	 <p>P12B</p>	 <p>P11B</p>
<p>Easy Guard Application commenced on 2nd August 2005. Coating repair done by MMHE Maintenance crew. Coating purchased from Royal Coatings Inc. Agent.</p>		<p>Easy Guard application commenced on 2nd of August 2005. Coating repair done by MMHE Maintenance crew. Coating purchased from Royal Coatings Inc. Agent.</p>	

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EXTREME PERFORMANCE

The Haunch Area of the MTB falls within the tidal zone and is subjected to heavy fouling. Some areas of the Haunch were left uncoated due to accessibility issues. The Haunch Area was not covered by Royal Coatings Inc.'s limited warranty because of the above reasons. Fouling causes secondary microbial induced corrosion. Even under these extreme conditions the Haunch Area that was coated had very little corrosion.

MTB # 24-HAUNCH AREA, 3 YRS INTO COATING SERVICE LIFE Date of Inspection: 22/02/05



<p>INTENTIONALLY LEFT BLANK</p>	<p>INTENTIONALLY LEFT BLANK</p>		<p>INTENTIONALLY LEFT BLANK</p>
<p>Areas NOT coated due to accessibility issues. Heavy fouling and corrosion. The Haunch Area was not covered by RCI's limited warranty</p>		<p>Areas that were coated with Easy Prime and Easy Guard showing very little corrosion.</p>	

MTB, LAST BEAM SEAWARD END 16 YRS END COATING SERVICE LIFE.

Date of Inspection: 18/03/2018



The Royal Coatings Inc Coating System gave a Service Life of **16 Years** for a **C5-M** Environment (Very High Maintenance Marine-Coastal and offshore areas with high salinity) in accordance with **ISO1 12944-2** Classification of Environments. Factoring in cyclic load stresses, cyclic immersions and only **1 routine maintenance in the 3rd year** of coating service life this performance is exceptional. The above picture shows the last MTB Seaward end where the corrosion was heaviest with nearly 70% coating breakdown after 16 Years



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CONCLUSION

This Case Study has a timeline spanning 16 Years starting in March 2002 till March 2018. The Case Study has an audit trail that records, in summary, the various stages involved in coating installation, coating maintenance and end of coating service life. It also documents Royal Coatings Inc.'s experience in **Engineering Chemistry** that makes it possible to **Develop** the Technology, **Design** the Products and **Deliver** on performance in extreme environments like Splash Zones and Subsea surfaces! For asset owners Royal Coatings Inc. specialist coatings will **Prevent** corrosion, **Protect** environment and **Preserve** critical and valuable assets cost effectively. The wealth of experience gained by Royal Coatings Inc. from this project and similar projects have led to the development of coating products that totally displace water and are also surface tolerant sealing substrates that are not only constantly wet but are also permanently submerged. **Prime 200 MF**, **Flex 200 GF** and **Flex 200 GFCU** are the next generation of "extreme" performance coating products that can be applied directly onto "wet" and submerged surfaces with the simplest of application tool, a brush or roller. **Flex 200 GFCU** is the worlds first Foul Resistant coating that can be applied underwater! Contact us to find out more about our Products and Value Added Services

