An Overview of
Lockheed Martin Marine Systems

US Navy Cathodic Protection Conference
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Lockheed Martin Marine Systems

January 2007
• Introduction
  • Lockheed Martin Marine Systems; San Diego, CA
  • Provide Design, Manufacture and Support Services for Manned & Unmanned Vehicles, and Subsea Equipment
    • US Navy Deep Submergence Rescue Vehicle (DSRV)
    • Land-Air Transportation Systems
    • US Navy Dry Deck Shelter (DDS) Engineering Support
    • Underwater Mateable Connectors & Cables
    • Corrosion Protection Products and Services

Kearny Mesa Offices

Harbor Island Facility (Circa 1970)
• Lockheed Martin Marine Systems
  • US Navy DSRV Support
    • In the early 1960s, Lockheed built the submersible Deep Quest to demonstrate to the Navy the capability to produce a manned submersible.
    • In early 1970s, Lockheed built & delivered two DSRVs to the US Navy. Lockheed (now Lockheed Martin) continues to provide Operation & Maintenance Services for DSRV and Submarine Rescue Program today.

Deep Quest  
DSRV Loading onto Mother Sub
- Lockheed Martin Marine Systems
  - Mark 5 Special Operations Craft
  - Transporter
- Land-Air Transportation Systems
  - DSRV
  - LTV
  - Space Cargo Transport System
• Lockheed Martin Marine Systems
  • Dry Deck Shelter (DDS) Engineering Support
    • Teamed with Oceaneering
    • Field Technician Support for Maintenance & Overhauls
• **Lockheed Martin Marine Systems**
  • Underwater Mateable Connectors & Cables
    • Wetmate Connectors (LM Patents)
      • True Coax Electrical Wetmate
        • Lockheed CM100 Series; 1980’s
      • Electrical Wetmate
        • LM CM 2000 Series; 1997
    • Fiber Optic & Electrical Hybrid Wetmate
      • LM HydraLight Series; 1997
  • Underwater Cables and Harnesses
    • Mechanical Terminations
    • Cable Bend Restrictors
    • Rubber & Polyurethane Molded Harnesses
    • Pressure Balanced Oil Filled (PBOF) Harnesses


- **Lockheed Martin Marine Systems**
  - Corrosion Protection Products and Services
    - Started at Lockheed Aircraft Services in the early 1960s
      - ICCP using Lead-Platinum Anodes (1960’s)
      - ICCP using Stitch-Welded Platinum-Niobium Rod Anodes
        - Patented in 1970; Still in production today
        - Allows flexibility & reduces inventories
        - Can be configured into many shapes and output currents

Niobium Substrate

Platinum Wire
• **Lockheed Martin Marine Systems**
  • Corrosion Protection Products and Services

<table>
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<tr>
<th>ICCP Rod Anode Configurations</th>
<th>Retractable</th>
<th>Pier &amp; Pile</th>
<th>Floating</th>
<th>Ship Hull</th>
<th>Vertical Tension</th>
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• **Lockheed Martin Marine Systems**
  • Corrosion Protection Products and Services
    • ICCP Vertical Tension Anode (VTA) Strings

Typical Rod Anode

Suspension Cable

Upper Anchor

Multiple Anodes

Lower Anchor

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• Lockheed Martin Marine Systems
  • Corrosion Protection Products and Services
    • Vertical Tension Anode (VTA) Strings

(Orange Protective Mesh over Rod Anode for Shipment)

VTA String Boxed For Shipping  VTA Tension Test Setup

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• Lockheed Martin Marine Systems
  • Corrosion Protection Products and Services
    • Vertical Tension Anode (VTA) Strings

Oil Filling of VTA for Pressure Compensation

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• Lockheed Martin Marine Systems
  • Corrosion Protection Products and Services
    • Silver/Silver Chloride Reference Cells
      • Lockheed developed a commercial method for production of Silver/Silver Chloride Reference Electrodes in the mid 1960’s
      • LM developed Reference Cell Assemblies with underwater replaceable element in early 1990’s for use on SEAWOLF class submarines; same basic design is used on VIRGINIA class submarines
      • LM has continued improvement and refinement of the Plating Process; NRL tests judged LM reference cells performed best over numerous other candidate assemblies
• **Lockheed Martin Marine Systems**
  • Corrosion Protection Products and Services
    • **US Navy ICCP Plate & Rod Anodes**
      • LM designed and built prototype Hull Anode Assemblies in the early 1990’s for NRL development tests on USS MIAMI
      • LM designed, qualified and built Hull & Propulsor Anode Assemblies for SEAWOLF class submarines
      • LM designed, qualified and built Hull & Propulsor Ballast Tank Rod Anode Assemblies for VIRGINIA class submarines
• Lockheed Martin Marine Systems
  • Corrosion Protection Products and Services
    • VIRGINIA Class ICCP Hardware Production
      • Five Ship-Sets of Hardware Delivered; Ship-Sets #6 through #10
        Currently in Production
        • Non-Pressure Hull Anodes (NPHA)
        • Pressure Hull Anodes (PHA)
        • Rope Guard Anodes (PA-x)
        • Main Ballast Tank Anodes (MBTA)
        • Non-Pressure Hull Reference Cells (NPHR)
        • Pressure Hull Reference Cells (PHR)
        • Outer Structure Outer Diameter Anodes (PAO)
        • Outer Structure Inner Diameter Reference Cells (PIR)
        • Outer Structure Outer Diameter Reference Cells (POR)
• **Lockheed Martin Marine Systems**
  • **Typical VIRGINIA Anodes & Reference Cells**
• Lockheed Martin Marine Systems
  • Conclusion
    • LMMS has designed, developed, manufactured and maintained a wide variety of Subsea equipment, not just ICCP equipment
    • Our diverse experience allows us to understand the design requirements for ICCP equipment needed to survive the harsh subsea environment