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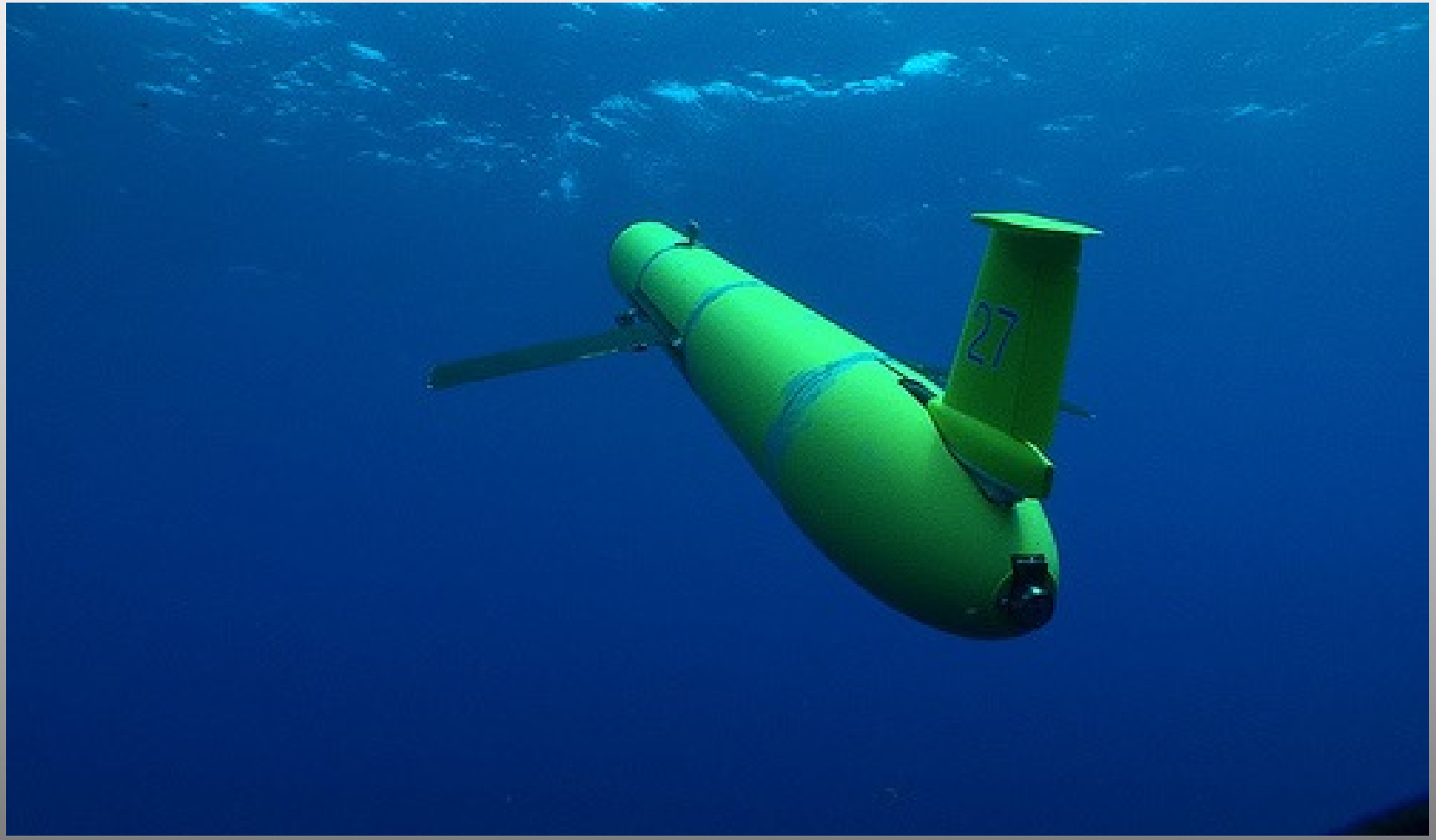
OCEAN INNOVATIONS

Biofouling Considerations and Solutions for Undersea Instruments and Platforms

UNOLS RVTEC Meeting



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Ocean Innovations Company Overview

- **Manage the west coast division of ClearSignal biofouling control coating.**
- **Supply specialized oceanographic equipment for research, commercial, and defense applications.**
- **Quick turnaround custom cable assemblies, junction boxes, and mechanical support.**
- **Subsea cameras, lighting, and pressure relief.**
- **Glass instrumentation and floatation spheres.**
- **Represent leading manufacturers such as SubConn, DeepSea, Nautilus Marine, Novatech, SRS Fusion, Oceanbotix, and many more**

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Severn Marine Technologies Company Overview

- **Supported By Ocean Innovations in San Diego and other Worldwide Representatives**
- **Research, Development and Marketing non-toxic biofouling resistant materials since 1997**
- **Focus on: Seismic, Oil/Gas Energy, Marine instruments**
- **Coating Locations: Houston, San Diego, Norway, Denmark, Australia, UK**

Topics to Discuss

1. Biofouling Protection – General Case

2. Biofouling Protection – Instrument Case

3. Optical Devices

4. Biofouling Protection – Best Practices

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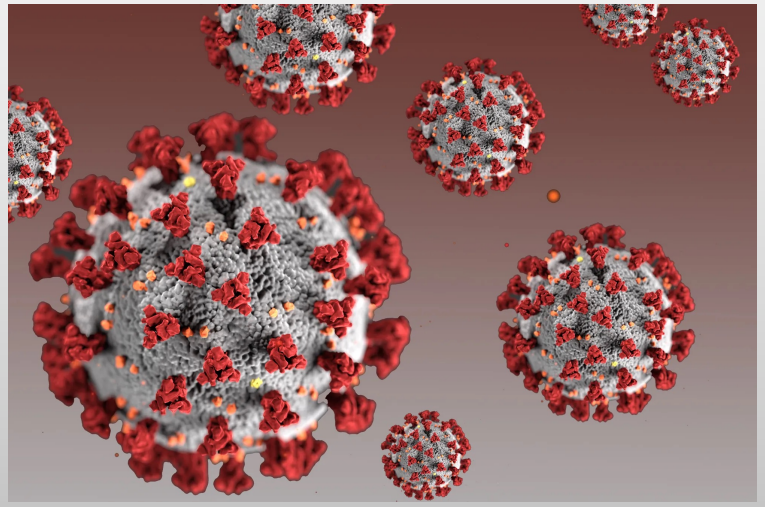
In the Beginning
and can we Outsmart a Barnacle?



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The Problem

The Problem

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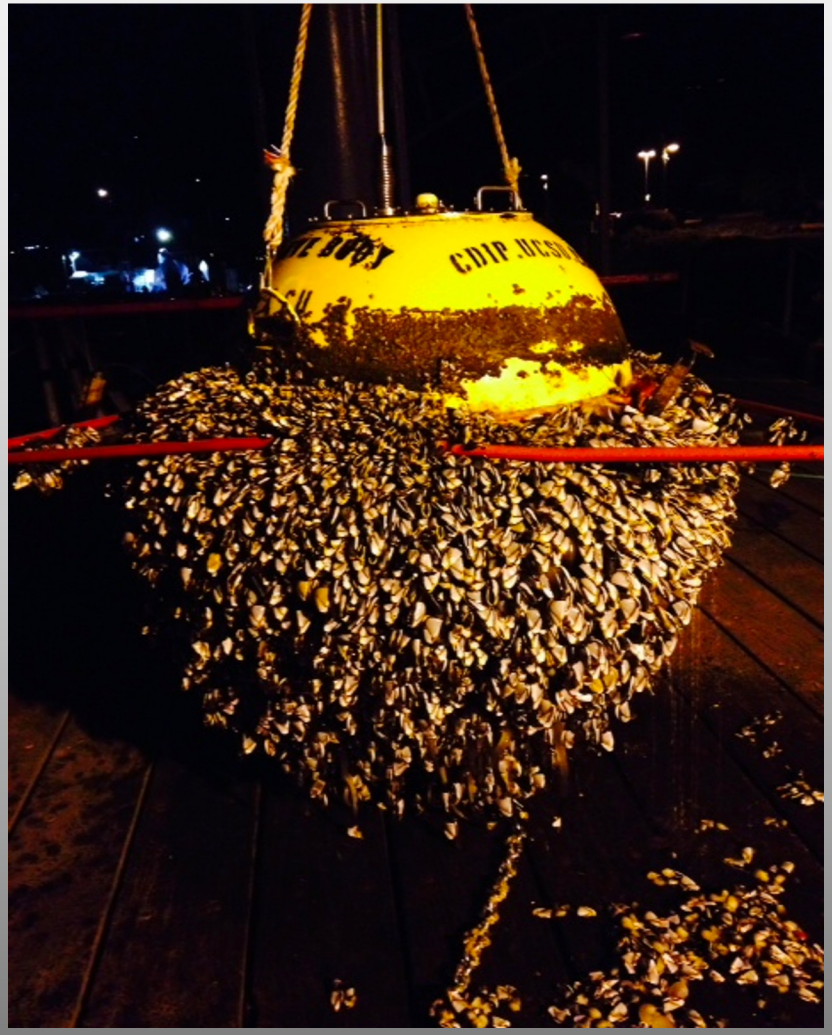
The Problem



The Problem

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The Problem

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The Problem

Instrument Considerations for 2022 and Beyond

With Improved Batteries - Instruments

With Improved Memory – Instruments

Long Term Considerations for Deployments – all Devices

Toxicity/HSE Considerations – all Devices

Biofouling is Becoming a Dominating Limitation.

Traditional Solution- Biocide Paint

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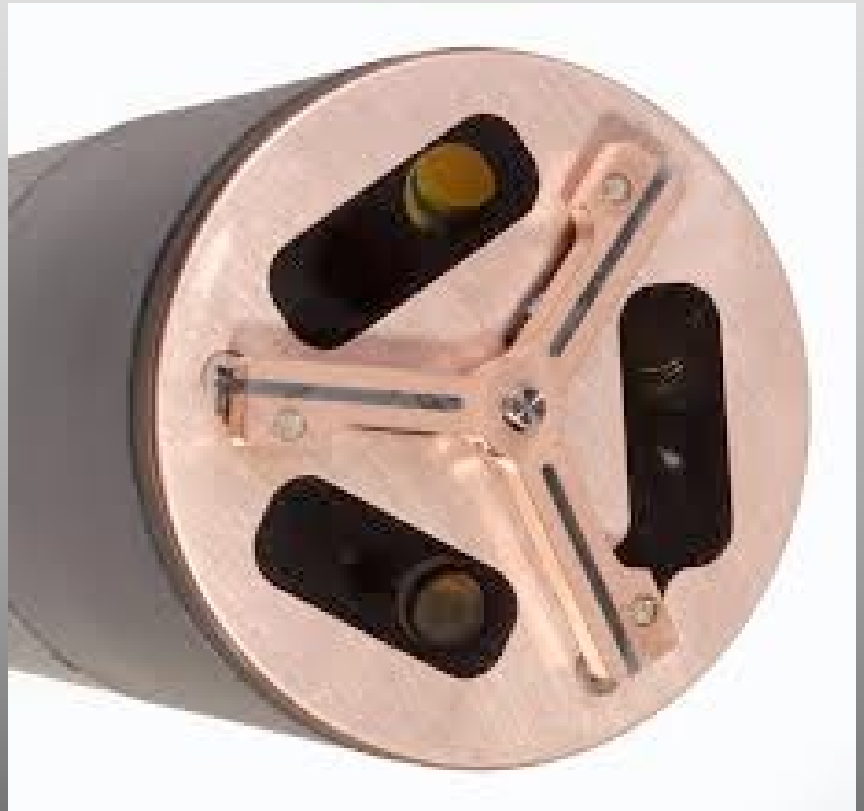
Advanced Solution – Foul Release

Copper Cladding



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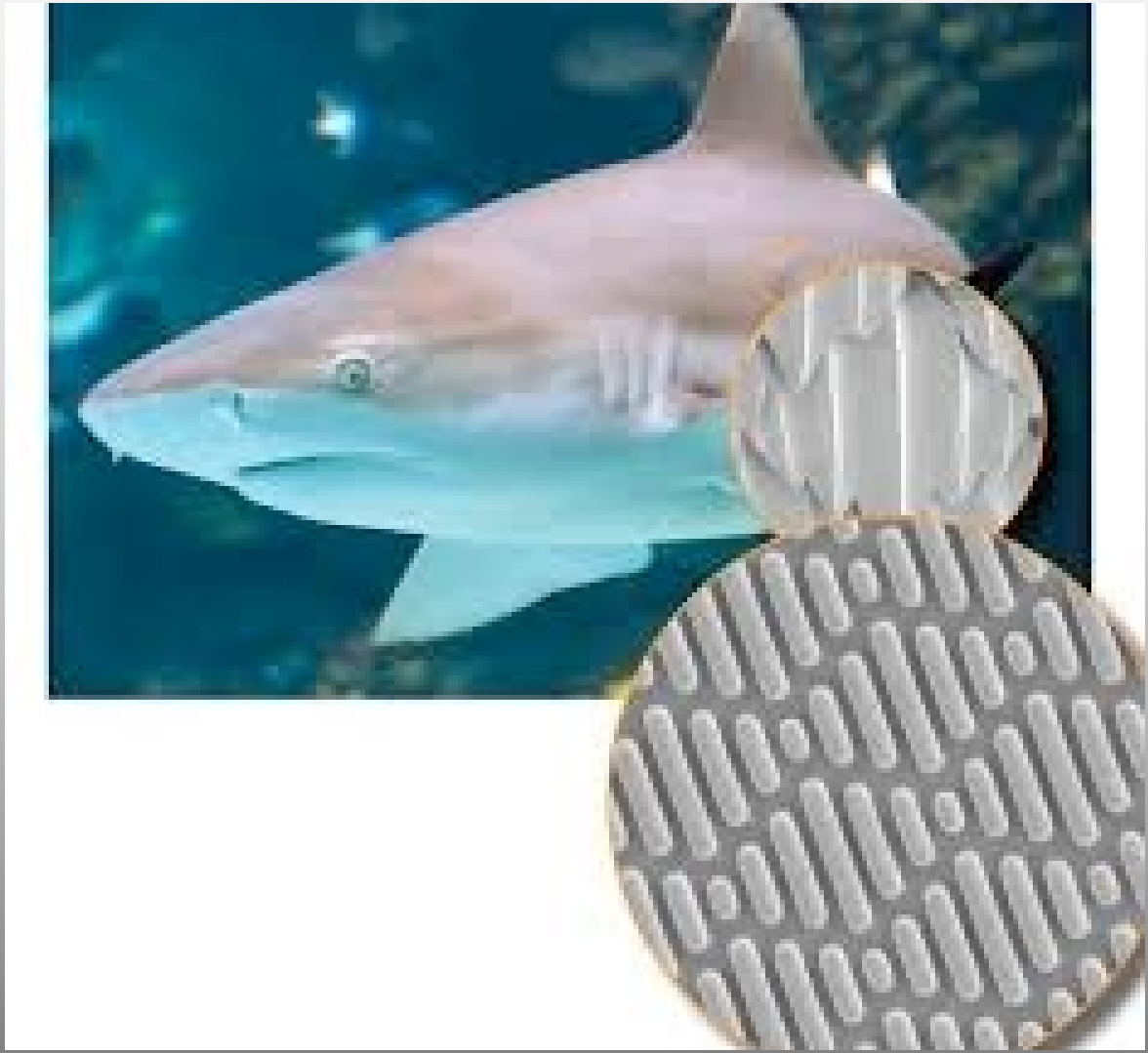
Case History – TBT Biocide

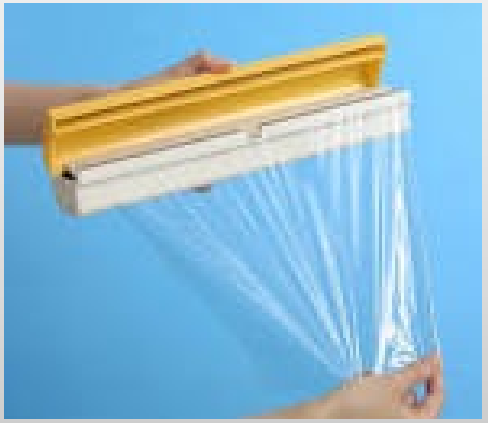
Topography (Sharklet)



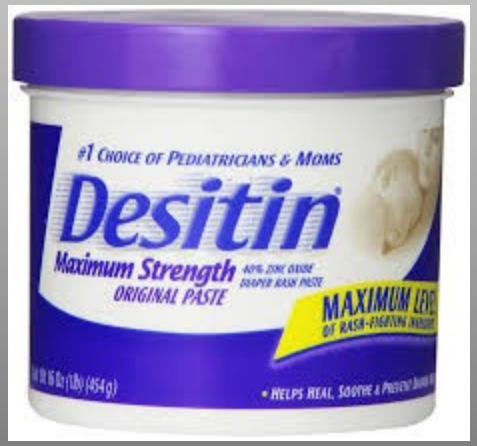
Home Remedies

Tape

Wraps



Grease



Grease Additives

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General Biofouling Control Choices = Foul Release or Biocide

Operational and Performance Considerations Often Favor Foul Release:

Long Duration Missions and Long Term Efficacy

Possible Optical Transparency Requirements

Field Turnaround

HSE – No Toxicity

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Foul Release Use Today

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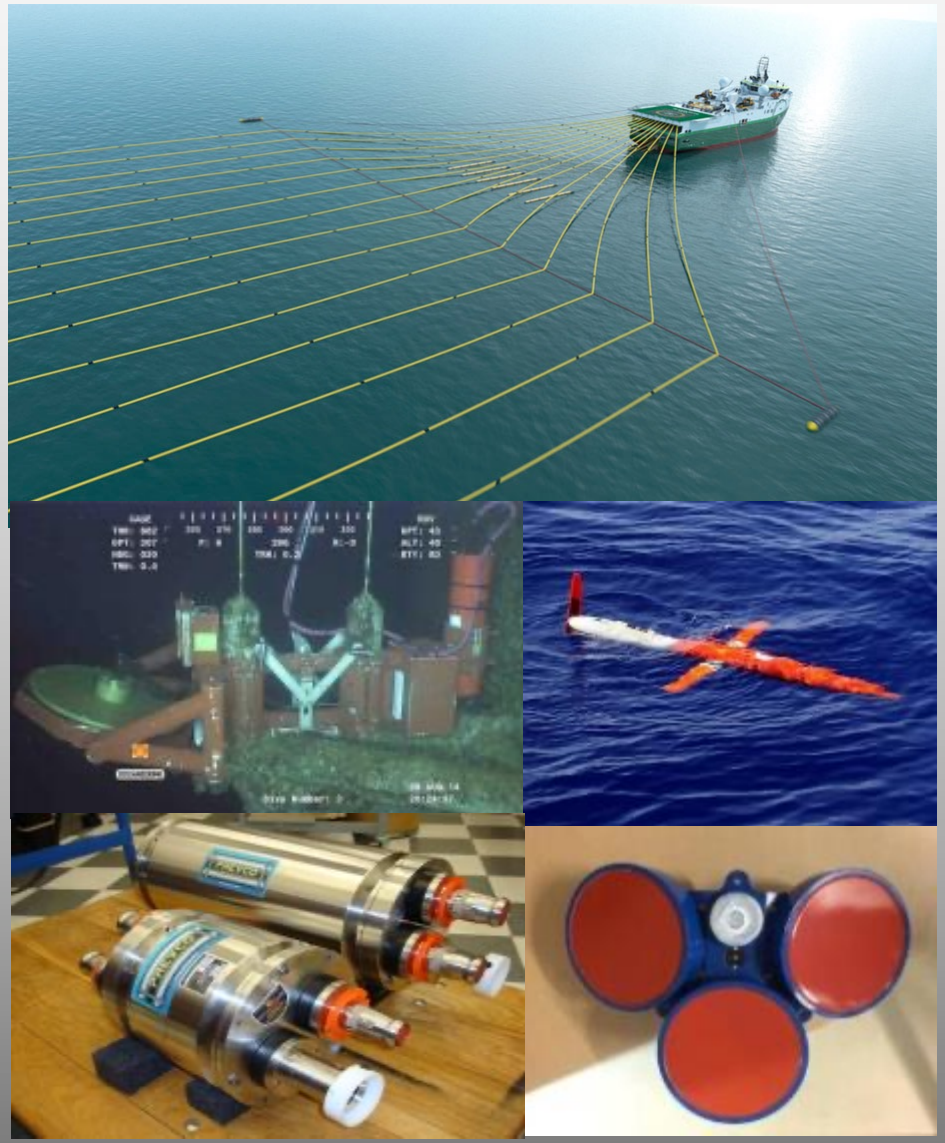
ClearSignal (Severn Marine Technologies)

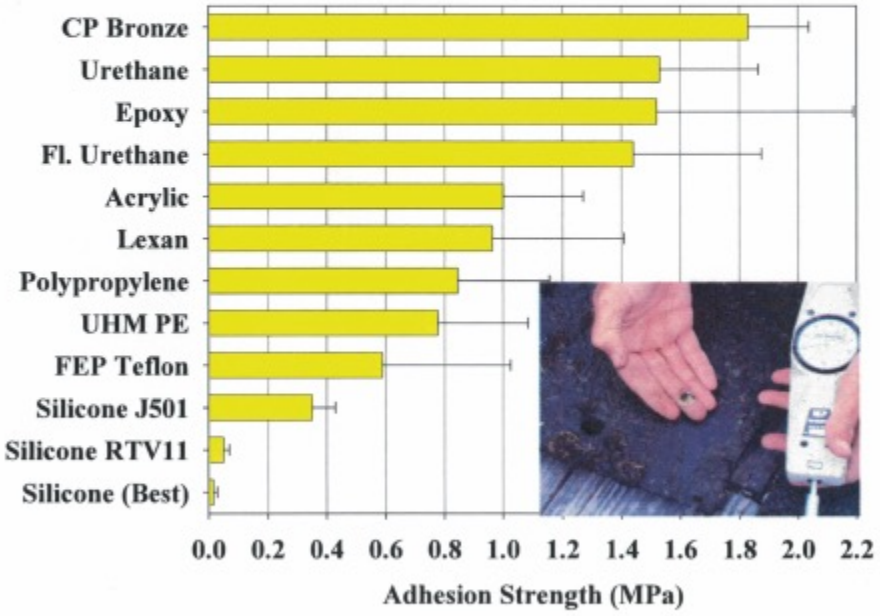


Intersleek (International Paint Co.)

Barnacle Adhesion Method

ASTM D5618-94

To measure shear force required to remove hard fouling



- A shear force is applied to the base of the organism
- The force for removal is measured
- The base area of organism is measured by a scanner
- The shear strength = force / base area

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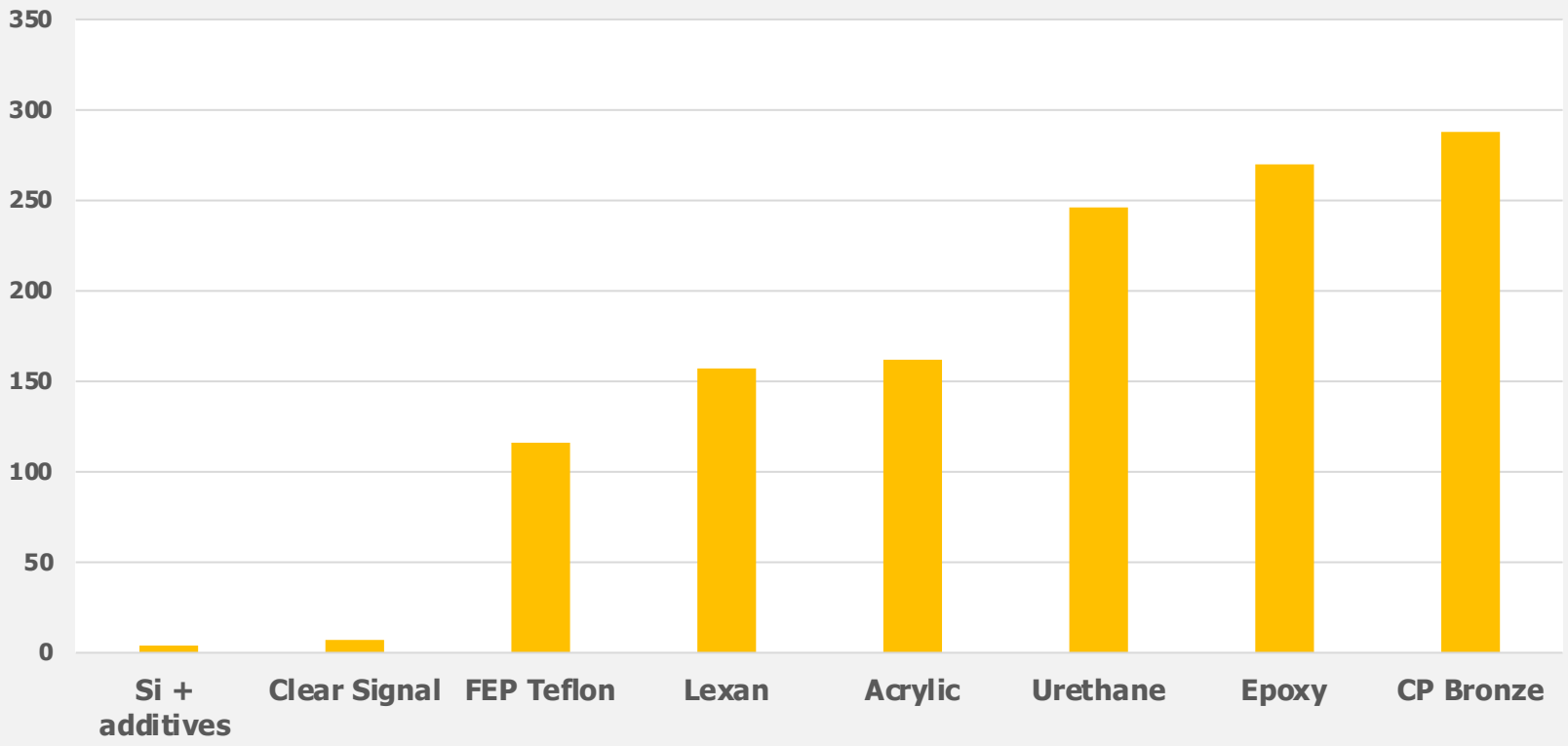
Barnacle Adhesion Method ASTM D-5618-94



All Data From a 2015 Independent Study Performed by the Florida Institute of Technology Utilizing ASTM D-5618-94 Protocol

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Coating Robustness
Failure Containment from Anchor Chain

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Enhanced Wave Measuring Buoy Performance through the use of ClearSignal 2 years Pacific

ClearSignal Coated

Copper Coated

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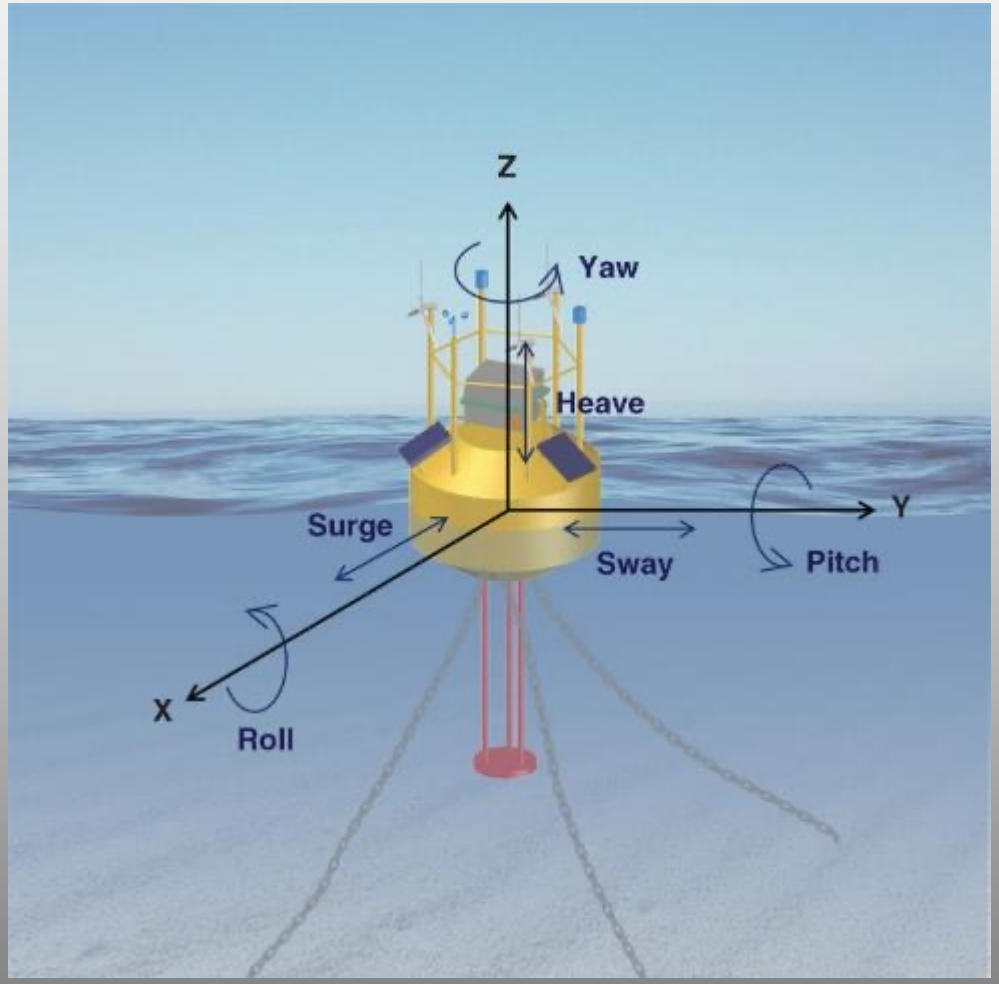
Heave Provides Self Cleaning to Foul Release Coatings



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Biofouling Protection for Marine Instruments

Case History – ClearSignal and Control

Case History (Foul Release - ClearSignal)

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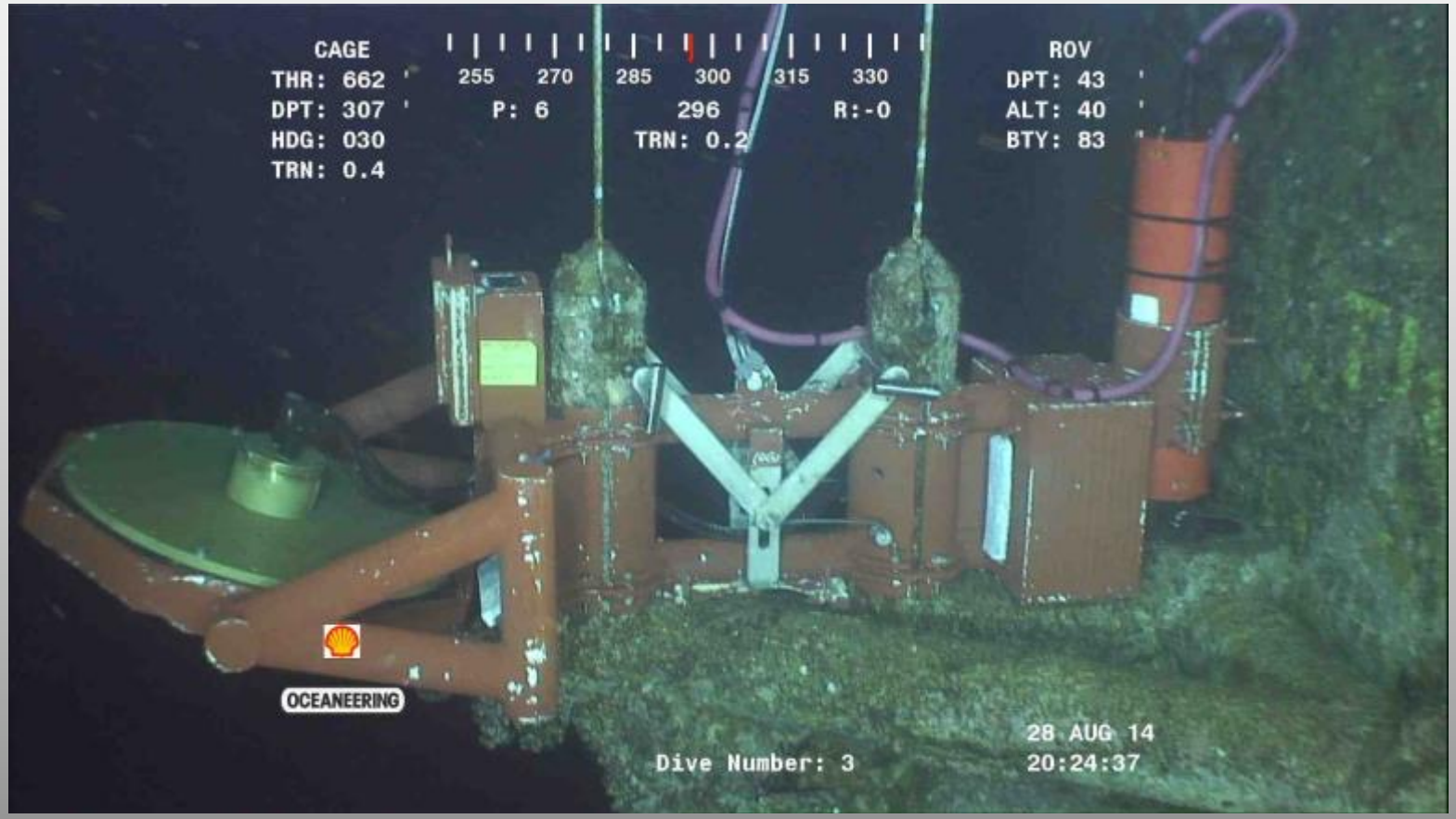
Case History-(Foul Release - ClearSignal)



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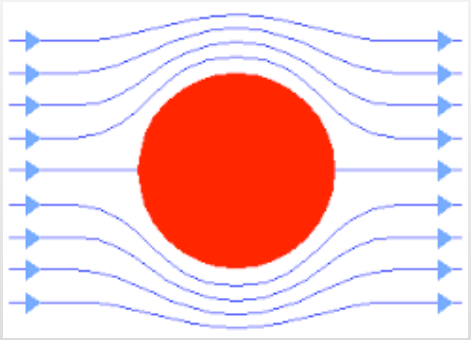
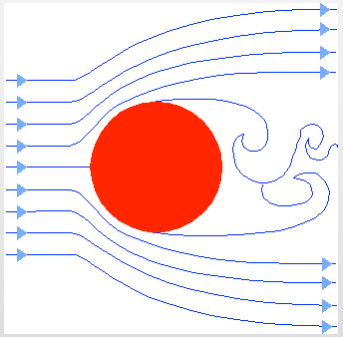
Case History - (Foul Release - ClearSignal)

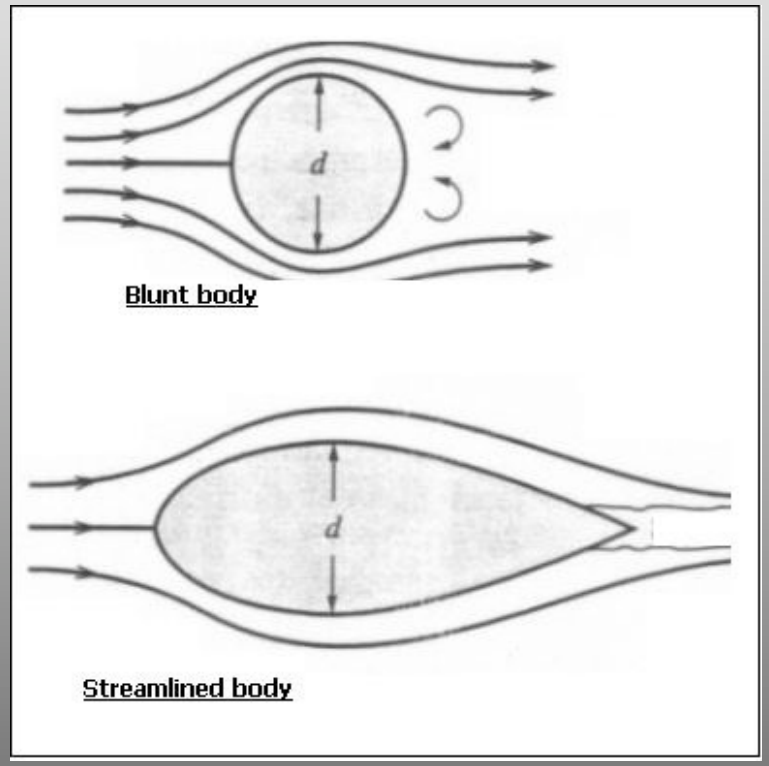
Summary Review

- Foul Release Coatings offer Long Term Protection
- Biofouling and its Prevention is an Adhesion Issue
- Coating Robustness and Adhesion to the Substrate are Critical Factors
- Flow Separation Contributes to Biofouling Settlement
- Buoys in Heave Provide Self Cleaning for Foul Release Coatings

Streamlining







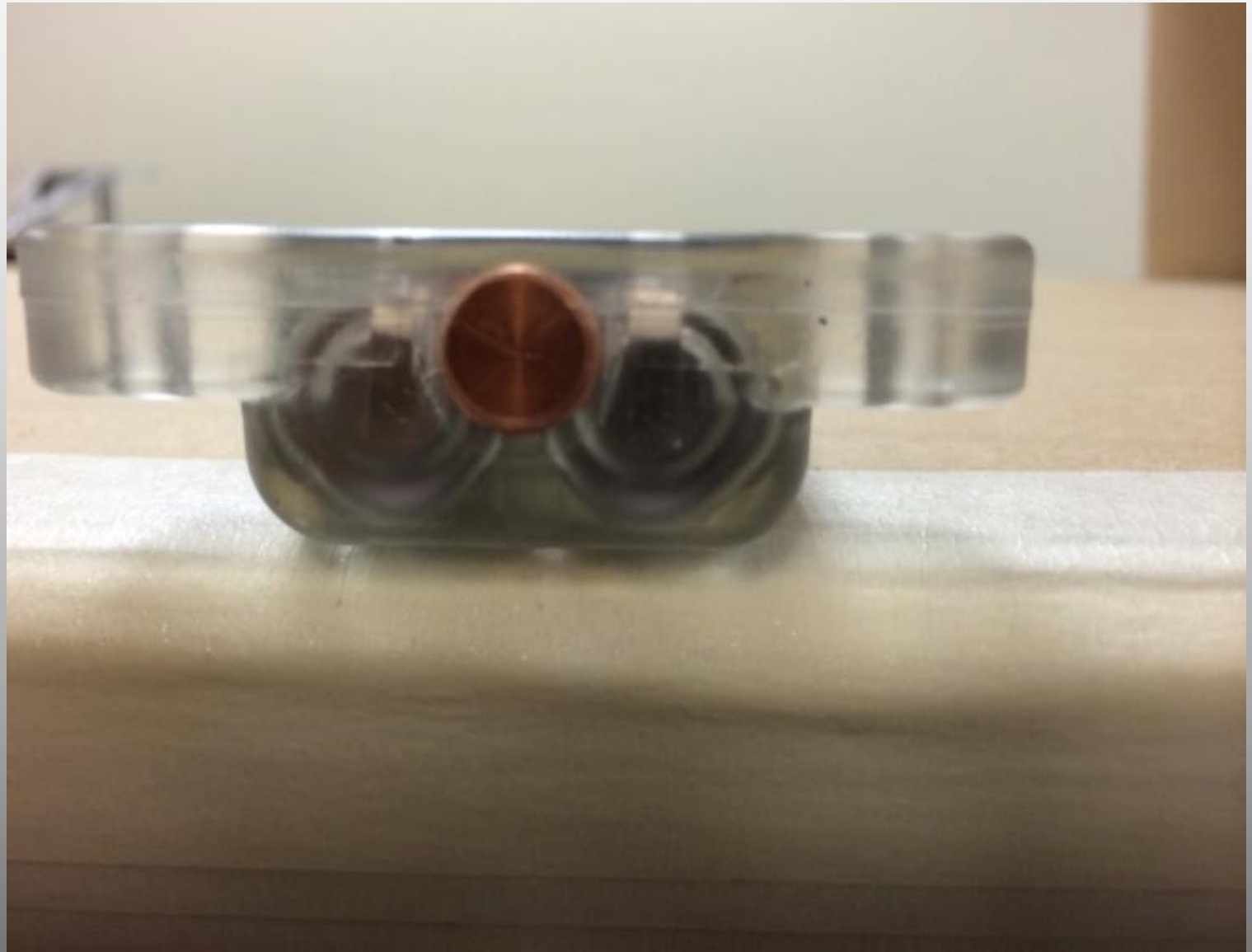
Streamlining

Streamlining

Streamlining

Streamlining

Streamlining



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Protection of Optical Devices

UV(AML System)

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Wiper System

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Case History - Wiper

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Liquid Immersion (Probe Guard)

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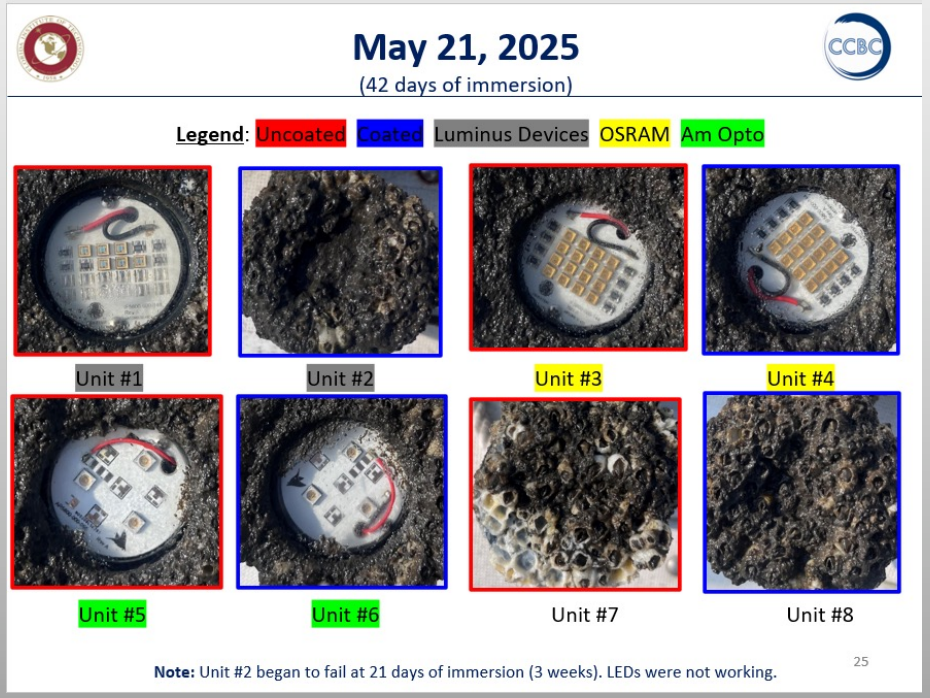
SMT Solution



Conclusions

- **Foul Release for Long Term Deployments (adhesion and durability are key)**
- **Integrated Solutions – (especially for specialized sensor areas)**
- **Implement Streamlining for Low Flow Separation**
- **Best Practices Yield Large Results - Reductions of maintenance by 3X to 10X**
- **Best Practice Guideline Development for Science is Recommended**

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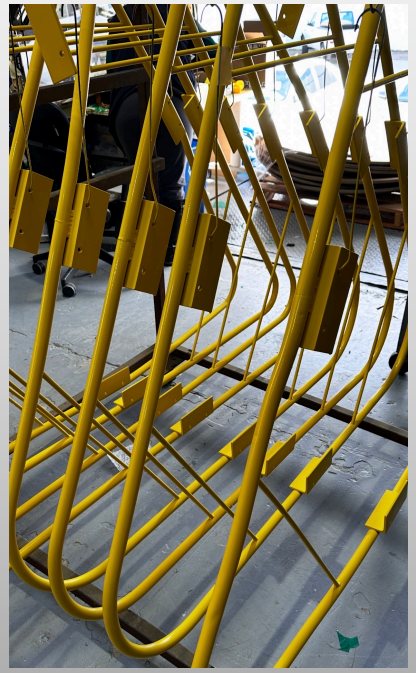
ClearSignal Coating for CDIP Program



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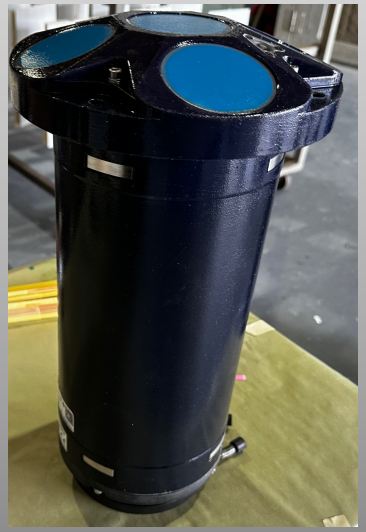
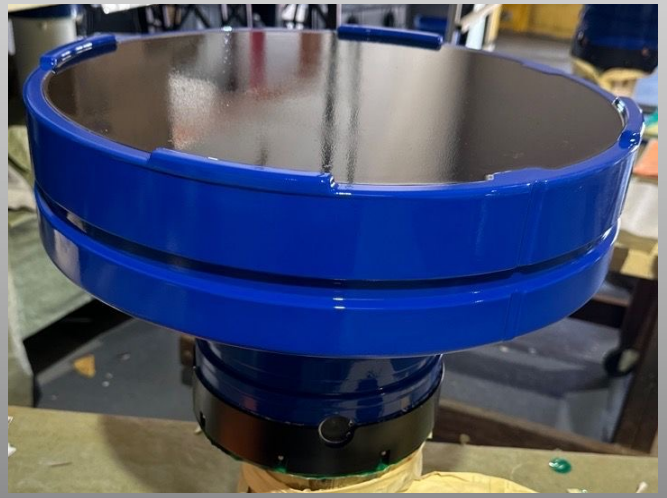
ClearSignal Coating for Various ADCP





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Biofouling Solutions in Action

- Shot from a Deepsea HD MultiSeacam mounted to Scripps Pier
  - housing coated with ClearSignal
  - pulsed UV light for added biofoul control

Scripps Pier Live Cam | Coastal Ocean Observing Lab