NUWC DIVISION, KEYPORT



# NAVSEA Laser Ablation Update

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### AGENDA

- Programmatic Intent
- Test Results
- Environmental Testing
- Operational Demonstration
- Path Forward
- Questions

#### **Programmatic Intent**

- Technology transition of laser ablation to NAVSEA maintenance organizations and requirements for the procurement and sustainment, to include:
  - Material/System selection
  - Path forward for process qualification for various substrates (Tentative plan)
  - Operator training to support shipboard production (Complete; operators trained)
  - Process management (IPI Approved; UIPI draft)
  - Safety precautions and procedures (Complete)
  - Environmental permitting and off-gas characterization (Complete, except for VOC)

### **Programmatic Intent**



### **Test Results**

- **Bending Fatigue**: High cycle fatigue degradation on HY-80 substrates; note that work in this area completed by other organizations on DH-36 has shown no/minimal degradation
- Stress Corrosion Cracking: No impact
- Metallography: Micro-melting and surface cracks present and possible heat affected zone
- Weldability: No contribution to Hydrogen Induced Cracking
- Adhesion: No impact to subsequent coating of ablated surfaces except 100% cleaned Cathodic Disbondment samples; continued evaluation is planned

#### **Test Results**



Cycles to Failure [N]



Condition 2 – Blast + Ablate Large-scale micro-cracking on sample that saw 1 laser pass.



Linkage of cracks and voids.



Condition 1 – Blast (Baseline)









### **Test Results**

- Adhesion Testing
  - Bend
  - Dolly Pull-Off
  - Cathodic Disbondment
  - Knife Cut







- Control weld (blasted surface)
- Control weld (ablated surface)
- Poor quality weld (ablated surface)





### Environmental Results



- Testing performed for: Total Metals/Elements, Semi-Volatile Organic Compounds, Chromium(VI), Aldehydes and small organic species
- Testing in to be collected: Volatile Organic Compounds





## **Operational Demonstration**

- Successfully operated laser ablation equipment; validated IPI and SOP
- Safety enclosure, door interlocks, and status light functioned as expected and supported safe operation
- Collected industrial hygiene data per PSNS new technology requirements
- 6.5 hrs of laser operation

# **OpDemo User Feedback**

- Surprisingly good at cleaning welds
- Easy learning curve
- Better to use optic freehand (i.e. without 'guide')
- Preferred to needle gun due to:
  - Safety, weight, vibration, noise, and worker fatigue
- No/minimal cleanup required
- Light weight PPE
- Liked using the laser equipment
- "Very Satisfying"
- Short umbilical was a hindrance
- "Produces a far cleaner surface 100% clean (LACR) vs 80-90% clean (needle gun)"

- Potential uses
  - Bare metal MRC inspections
  - Exterior Hull
  - Access Cuts
  - Touch up areas after blasting
  - NOT a tool to replace sand blasting

One worker did not realize they had been working for nearly 4 hours with only minimal pauses to let people in and out of the enclosure

## **OpDemo Lessons Learned**

- Production response was that training, IPI, and SOP were adequate to perform work
- Enclosure was affected by wind/air pressure tripping the interlock system
- Removal rate of coating with LA similar to needle gun
- Other thoughts:
  - 18 month (2 FTE) effort to prepare production ready processes
  - Air permit research and development exemption was advantageous
  - Shipyard Technical Insertion Manager (TIM) is an integral interface for new technology demonstrations

# **Path Forward**

- Draft Laser Ablation Memo with new approvals for use on Aircraft Carriers
- Cruciform and butt weld fatigue testing of structural steels
- Axial Fatigue correlation to bending fatigue data of structural steels
- Determine test requirements for component and piping materials
- Evaluate 1000W+ productivity gains and correlation of previous test data
- Support AMPP (formerly SSPC) 'Laser Surface Preparation Standard'
  - SAE MA4872 (Aircraft paint stripping process evaluation) in revision to include Laser Ablation

# Questions