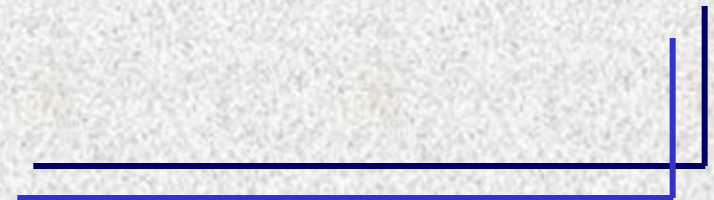




# **UNDERWATER MAINTENANCE AND REPAIR IN LIEU OF DRY DOCKING**

***USS MIDWAY Museum  
Installation of Hull Suction and  
Discharge Blank Patches***





# Overview

- Phoenix – Who we are
- In Water Repair Capabilities – The tool kit
  - Hull Cleaning and Inspection
  - U/W Welding
  - U/W NDT (thickness, flaw detection)
  - Cofferdams
  - U/W Painting
- USS MIDWAY Museum – Hull blanking
  - Background
  - Planning
  - Blank Installation Process
- New Technology
- Summary
- Questions

***Underwater Solutions Worldwide***



# Phoenix

- Founded in 1997
- Employee Owned
- Specializing in Underwater Services – Engineering, Diving and Remote Operated Vehicles
  - Over 86 Underwater Welding Repairs to Active U.S. Navy Ships and Submarines in the past 5 years
  - Underwater Welding -32 Underwater Weld Procedures (NAVSEA, ABS and AWS)
  - Inspection and NDT Services
- U.S. Navy Support Services
  - US Navy Diving Services Contract – since 1997
  - Undersea Operations Contract – since 2001
  - Submarine Rescue Maintenance and Operation – since 2006

***Underwater Solutions Worldwide***



# U/W I, M & R Benefits

## Cost Reduction Over Dry Dock

- No Transit Cost
  - Difficulties of just getting away from the pier
    - Dredging
    - Mooring removal
  - Tugboats
- No Lost Visitor Days
- No Dry Docking Cost – you pay for the work, not the dry dock
- Lower Cost Enables a More Proactive I, M & R Process
- Incremental Process – not all or nothing
  - Phased work based on budget
  - Sequentially address critical need items

***Shift Cost of Repair to the Work – Not the dry dock***



# Getting Started

## Contractor Qualifications

- Corporate
  - Quality Management System
  - Safety Program
  - NDT and Welding Procedures and Qualification
  - Flexibility – Cost & Schedule
- Equipment
  - Surface Supplied Diving System
  - Communications and Video
  - Control Van
  - Support Equipment - Welding, cutting, hydraulic tools
- Personnel
  - Commercial Diver training and qualification
  - NDT Qualification
  - Welding Qualification
  - Experience in the task

**Avoid SCUBA – mitigate risk**

***Hire Professionals –Reduce risk of damage or injury***

## Hull Cleaning - The first step in maintenance and inspection

### ➤ Problem

- Excessive growth prevents inspection and hides serious degradation
- Heavy calcareous growth can lead to coating failure during removal

### ➤ Solution

- Periodic removal of marine growth using either multi-brush or handheld machines

### ➤ Benefit

- Cleaning process allows a thorough inspection

### ➤ Caution and Concerns

- Unqualified operators can severely damage hull coatings

***Hull Cleaning – The key to early problem identification***



# U/W Tool Kit

## Inspection

### ➤ Problem

- Hull thinning due to corrosion (interior and exterior)
- Cracks
- Wasting due to dissimilar metals (weld metal, bronze, brass, stainless steel)

### ➤ Solution

- Visual Inspection (VT) – include color still photographs and video
- Ultrasonic Inspection Thickness (UTG) – wet or dry localized and large scale mapping of plate thickness
- Magnetic Particle Inspection (MT) – wet or dry examination of surface indications
- Ultrasonic Inspection Flaw (UTSW) – wet or dry mapping of indications, detects subsurface cracking

***Inspection - First line of defense***



# U/W Tool Kit

## Inspection –

### ➤ Benefits

- Locate problems when the fix is minor vs. major
- Plan and budget repairs well in advance

### ➤ Caution and Concerns

- Use qualified Inspectors – American Society of Nondestructive Testing (ASNT)
- Use experienced Contractor
- Recognize and separate those areas that need immediate repair from those that are slow to change

***Inspection - First line of defense***



Typical VT Inspection Photo – Coating Deterioration with  
Corrosion

***Inspection - First line of defense***

# U/W Tool Kit



MT Indication of Cracking

***Inspection - First line of defense***

# U/W Tool Kit

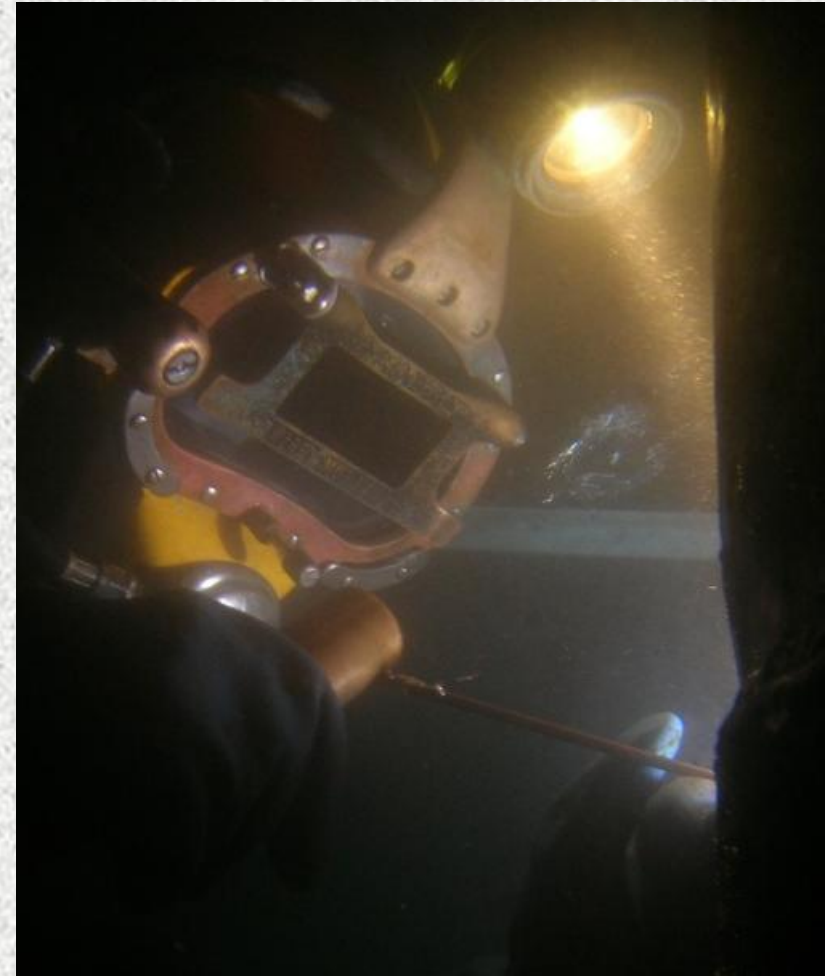
## Underwater Welding – Minor to Major Repair Capability

### ➤ Problem

- Hull plate cracking
- Corrosion – plate thinning or deteriorated welds
- Missing hull plate
- Hull openings not blanked

### ➤ Solution

- Underwater wet welding
- Underwater dry chamber welding



***U/W Welding***

# U/W Tool Kit



Wet Welding – Ideal Conditions!

***U/W Welding***



# U/W Tool Kit

## Wet Welding

- NAVSEA Approved
  - Process for ships in service
  - Blank installation for deactivation
- ABS Approved
- Permanent or Temporary Repair
- Uses
  - Repair of indications
  - Fillet and Groove welds
  - Installation of doubler plates
  - Installation of blank patches
  - Rudder and Bilge Keel Repair (dewater)
  - Broad range of material compatibility (based on Carbon Equivalent)
    - Carbon Steel electrode –
    - High Ni Electrode –

***U/W Wet Welding – Cost effective repairs***

## Wet Welding

### ➤ Benefit

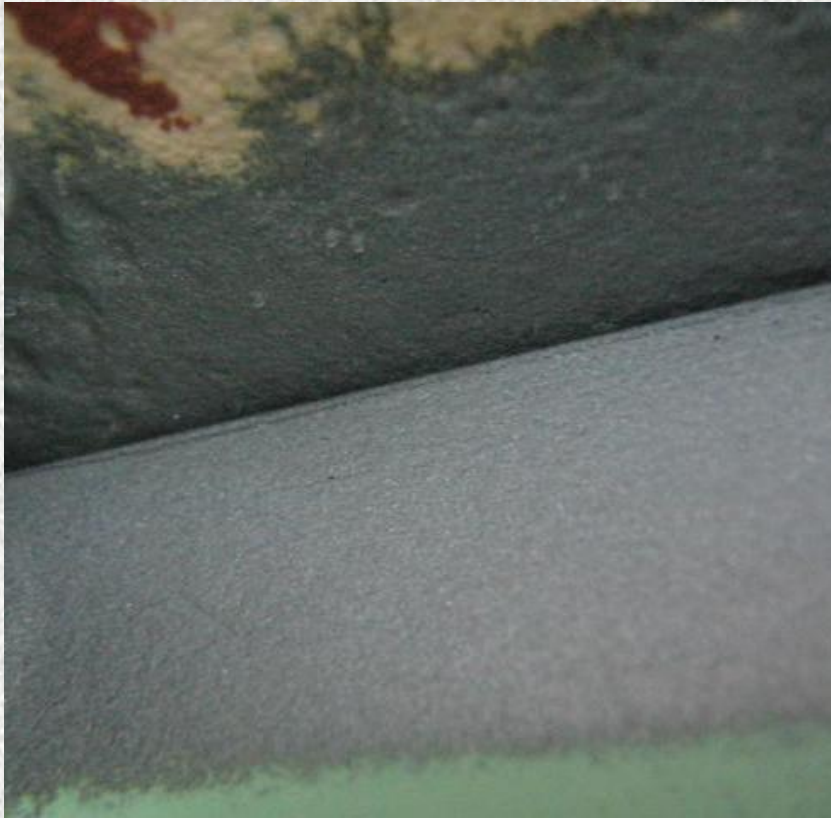
- Relatively low cost
- Easy access to underwater hull and appendages
- Does not require a dry chamber – no fabrication and installation cost

### ➤ Cautions and Concerns

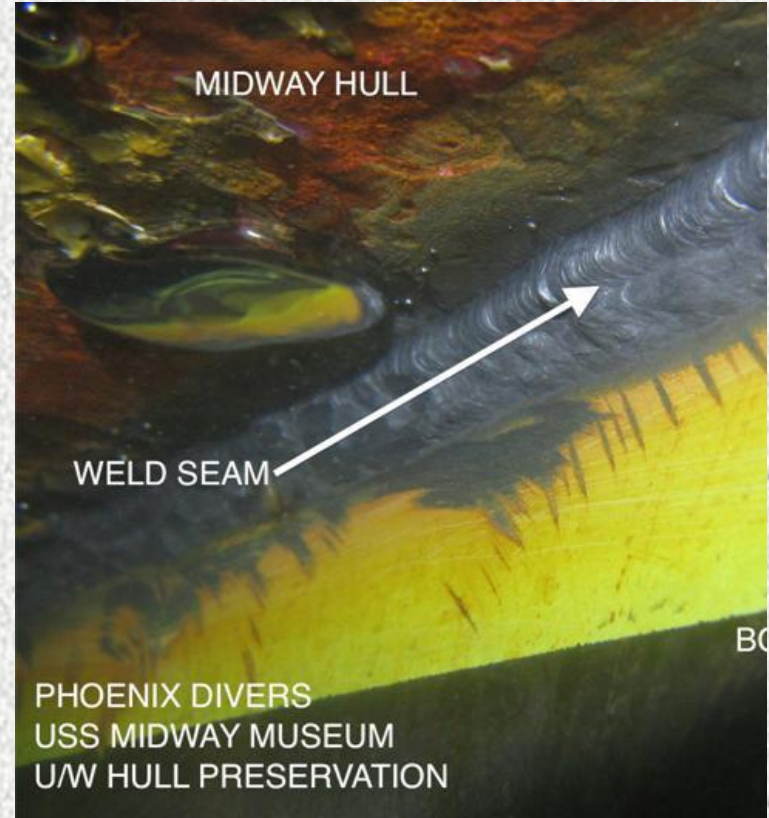
- Requires use of qualified procedures and welders
  - ABS / AWS / NAVSEA
  - Workmanship
- Requires metal sample analysis for procedure selection
- Interior ship space must be gas free, inert, or flooded
- Minimum visibility requirement – may be a problem in brackish water
- Lower quality weld than dry chamber
- Requires preservation (U/W paint)

***U/W Wet Welding – Cost effective repairs***

# U/W Tool Kit



Underwater Welding – Fit Up  
Joint Prep



Underwater Welding –  
Completed Weld

***U/W Wet Welding – Cost effective repairs***



**DDG Rudder Repair in a Dry Chamber**

***Dry Chamber Welding – Equivalent to dry dock***



# U/W Tool Kit

## Dry Chamber Welding

- NAVSEA Approved Process for Ships in Service
- ABS Approved Procedures
- Uses
  - Repair of indications
  - Fillet and Groove welds
  - Installation of doubler plates
  - Installation of blank patches
  - Hull plate replacement
  - Rudder and Bilge Keel repair (dewater)
  - Broad range of material compatibility: Mild Steel to HY-80

***Dry Chamber Welding – Equivalent to dry dock***

## Dry Chamber Welding

### ➤ Benefit

- Repair quality identical to dry dock repair
- Permanent repair
- Cost effective compared to dry docking
- Broad Range of materials

### ➤ Cautions and Concerns

- Requires use of qualified procedures and welders
  - ABS / AWS / NAVSEA
  - Workmanship
- Requires metal sample analysis for procedure selection
- Requires engineered, specialized cofferdam – fabrication, rigging, installation
- Interior space must be gas free / inert
- Requires preservation (U/W paint)

***Dry Chamber Welding – Equivalent to dry dock***

# U/W Tool Kit



Dry Chamber Ready for  
Installation



Weld Prep in Dry Chamber

***Dry Chamber Welding – Equivalent to dry dock***



Dry Chamber Weld – Root Pass with Pre-Heat

***Dry Chamber Welding – Equivalent to dry dock***

# U/W Tool Kit



Completed Weld from Interior of Hull

***Dry Chamber Welding – Equivalent to dry dock***

- Cutting and Burning – Metal Removal

- Problem

- Need for removal of metal (plate, stiffeners, appendages) to facilitate repair

- Solution

- U/W torch: Exothermic rods, tubular rod
  - Bulk removal of metal
- U/W Carbon Arc Gouging
  - Weld Preparation
  - Bulk Removal
- Mechanical Cutting Tools
  - Diamond blade saws
  - Water / Slurry Jets

*Cutting and Burning – Fast and efficient*

# U/W Tool Kit

- Benefit
  - Fast, efficient process for weld prep
- Cautions and Concerns
  - Requires a very experienced operator
  - Explosive gasses are produced – proper protocol and technique required



*Cutting and Burning – Fast and efficient*

## Cofferdams – Open Top, Side Mount and Overhead

- Problem
  - Many repairs cannot be completed in the wet, the area must be dry
- Solution
  - Specially designed temporary enclosures for dewatering and access
- Benefit
  - Allows topside workers or divers to access a dry work area
  - Broad range of maintenance and repair capability
  - Repair quality identical to dry dock repair - permanent repair
  - Cost effective compared to dry docking

***Cofferdams – A dry environment for work***



# U/W Tool Kit

## Cofferdams

### ➤ Cautions and Concerns

- Requires engineered design and quality fabrication
- Requires hull template to fabricate seal surface
- Requires engineered rigging plan
- May require welding padeyes to the underwater hull
- Repair area will require preservation (U/W paint)

***Cofferdams – A dry environment for work***

# U/W Tool Kit



Surface Piercing Cofferdam  
Interior



Rigged for Installation

***Cofferdams – A dry environment for work***

# U/W Tool Kit



Installed – Ready for Work



Repair Underway

***Cofferdams – A dry environment for work***

# U/W Tool Kit



Overhead Cofferdam – Custom Shape to Suit Task

***Cofferdams – A dry environment for work***



# U/W Tool Kit

## U/W Fairing & Coatings

### ➤ Problem

- Long term preservation and inhibiting corrosion
- Patching and fairing to restore contour

### ➤ Solution

- Wet applied and curing epoxy compounds including thin coatings and thick fairing material
- Proven technology – decades of use
- NAVSEA Approved - Hycote, Splash Zone, Belzona (\$\$)

### ➤ Benefits

- Restoration of surface contour
- Preservation
- Can be applied to relatively large areas

### ➤ Cautions and Concerns

- Surface preparation and application
- Water temperature limited for cure

## ***U/W Fairing & Coating Compounds***

# U/W Tool Kit



Hycote Application

***U/W Fairing & Coating Compounds***



# Maintenance & Repair

## Typical U/W Maintenance and Repair Tasks

- Hull Opening Blanking
- Rudder Repair (dewater)
- Rudder Removal
- Propeller Removal
- Hull Plate Insert / Doubler Plates
- Crack Arresting and Repair
- Clad Welding / Surfacing
- Anode Installation
- Impressed Current System Maintenance and Repair
- Painting and Fairing
- Support of Interior Hull Repairs
- Dry Dock Preparation (hull clean, inspection, and work scope)

***Full Spectrum of M & R Capabilities***



# USS Midway Museum

Established in 2004

## Problem

- Hull Blanks not Installed as required by NSTM CH 050
- 285 Total Openings Requiring Blanking
  - Based on existing docking drawing
  - Detailed survey necessary to ensure no ShipAlt's added any openings
- Size Range: 5 ft by 12 ft rectangle to 12 inch diameter

## Solution

- Phased Repair – 3 year effort
- Hull Cleaning Prior to Blank Installation
- Openings Prioritized Based on:
  - Risk of leakage
  - Location to minimize movement of the dive station

## ***Background***



# USS Midway Museum

## Planning and Preparation

- Pier Space / Lay Down Area Not Available – barge required to support diving operations
- Protected Berth For Barge, but Restricted Access for Movement
- Load Out for Entire Ops – minimal restock during work
- Long Lead Items Ordered /On Hand Prior to Mobilization
- Metal Sample Analysis for Electrode Selection – procedure qualification
- Identify and Prepare Affected Interior Space
  - de-water
  - remove fuel
  - gas free

## ***Background***



# USS Midway Museum



***Site Preparation / Mobilization***

# USS Midway Museum

## Dive Station Set Up

- Crane for Handling Blanks
- Dive Gear and Umbilicals
- Welding Machines
- Blanks Painted and Ready to Install
- Small Boat
- Fuel
- Generators / Power
- Fabrication Area
- Cutting and Burning Rig
- Port-a-Johns



## ***Work Site Layout***

# USS Midway Museum



Heavy Fouling and Corrosion in Work Area



Area Prepared to Bare Metal for U/W Coating

## ***Blank Installation - Preparation***

# USS Midway Museum

## Blank Fit Up

- QA Check Point – photograph and VT inspection
- Must Match Curvature and Deformity in Hull
- Gap Must Meet Weld Procedure Requirement
- Tack Weld in Place



## ***Blank Installation***

# USS Midway Museum

## Blank Welding

- QA Check Point – Root pass photograph and VT inspection
- Must Meet Workmanship Requirements

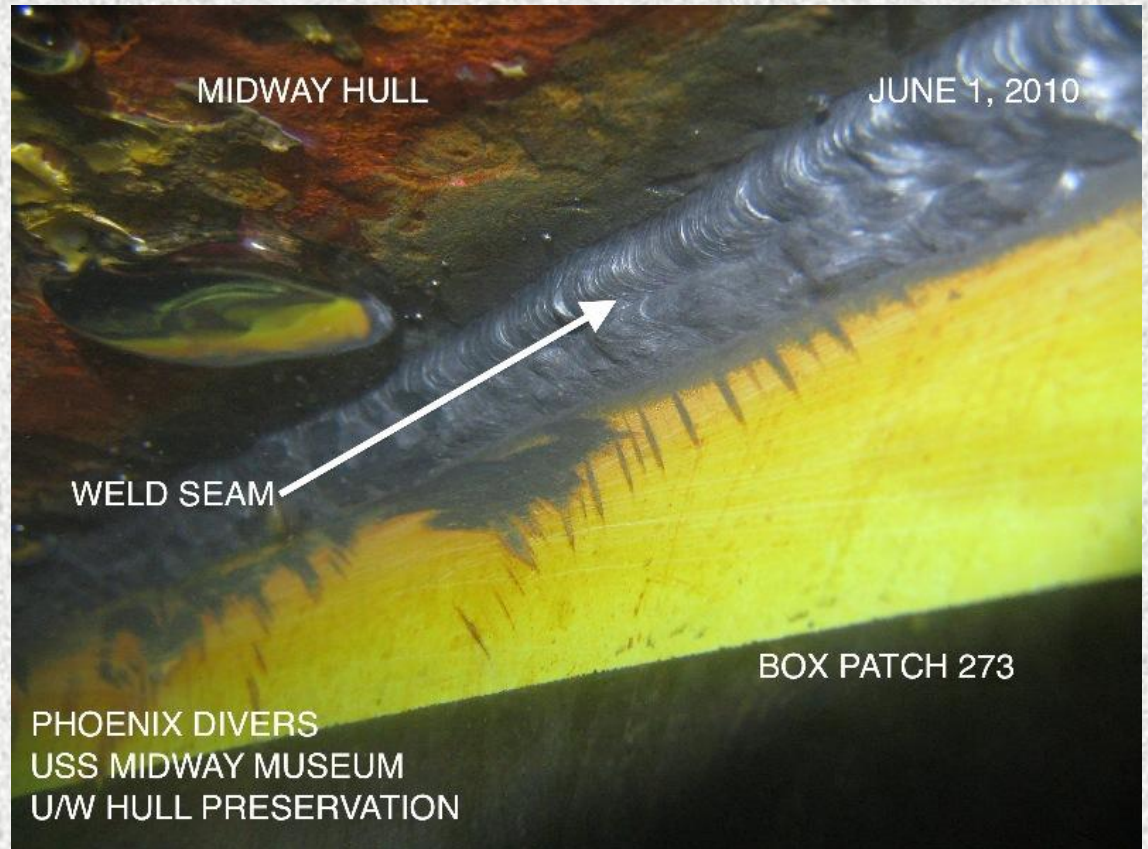


## ***Blank Installation – Root Pass***

# USS Midway Museum

## Blank Welding

- QA Check Point – photograph, VT & MT inspection
- Must Meet Workmanship Requirements

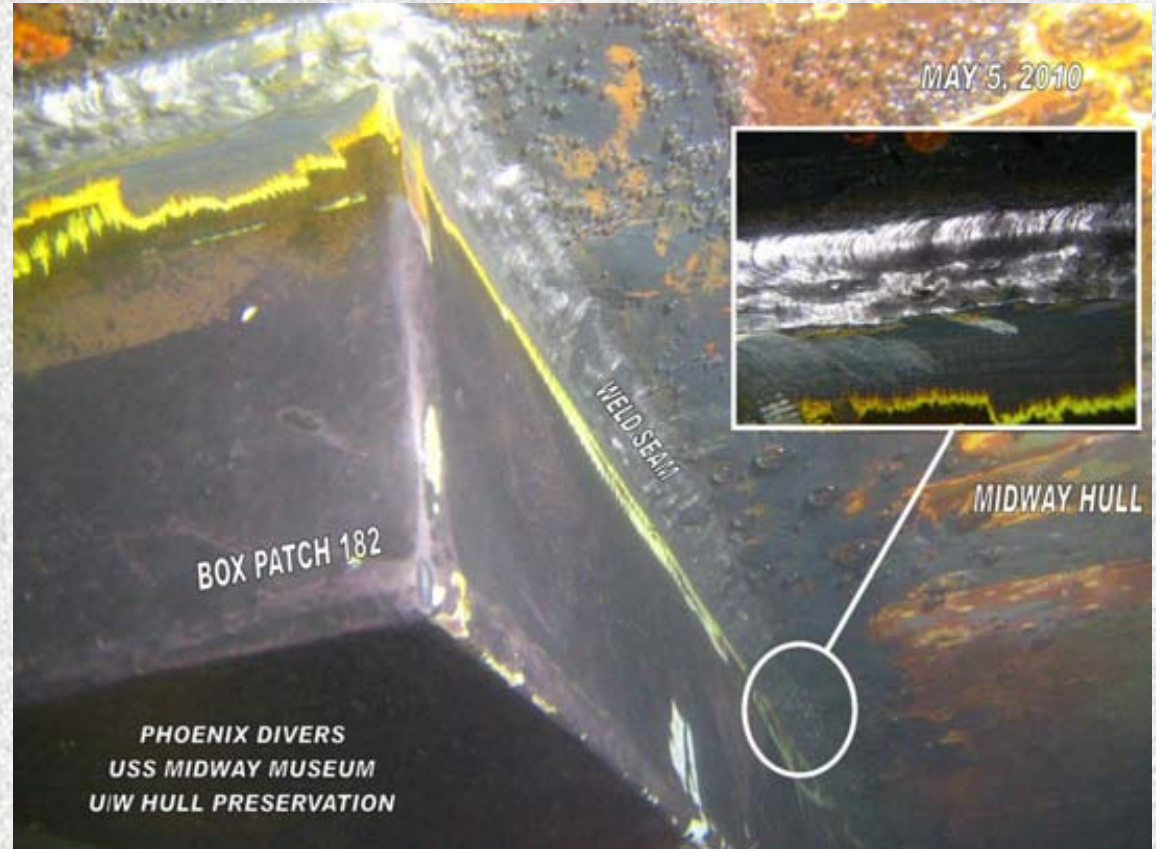


***Blank Installation – Fill Pass***

# USS Midway Museum

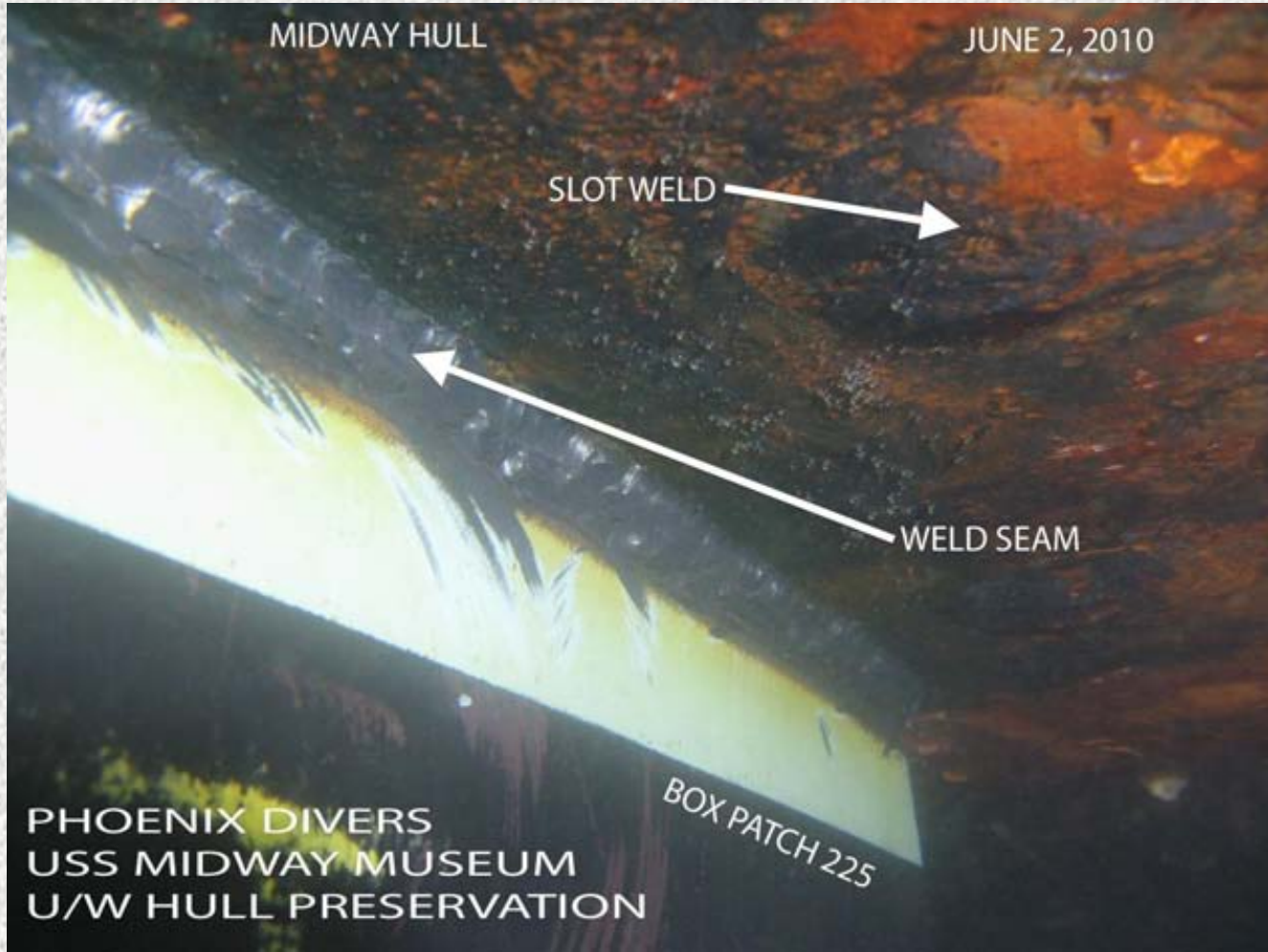
## Blank Pressure Test

- QA Check Point – de-water and purge with dry Nitrogen: must pass 2 psi over ambient pressure test with 10 minute hold, no leaks or pressure drop
- QA Check Point – final video, vent to surface

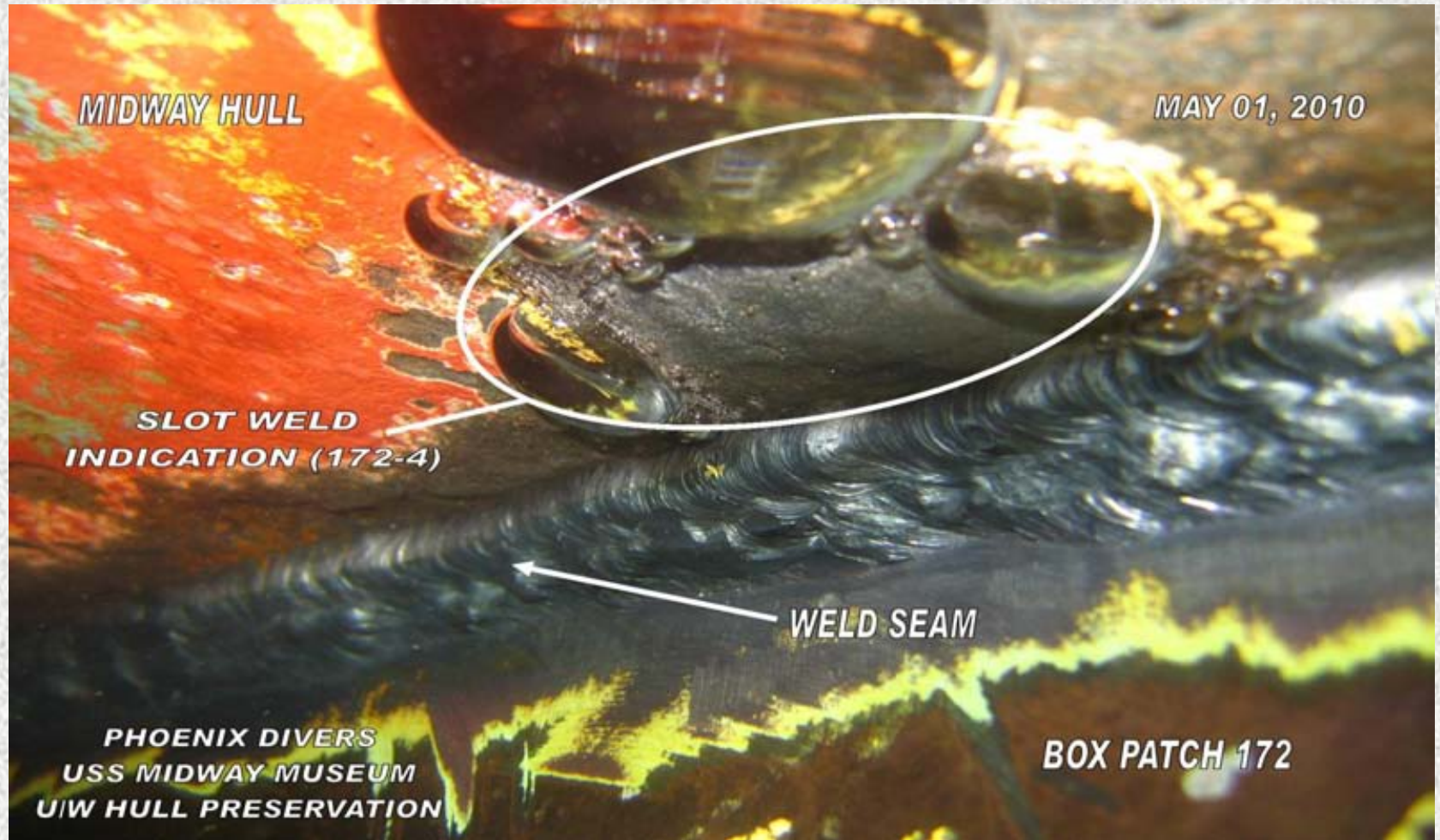


***Blank Installation – Inspection and test***

# USS Midway Museum



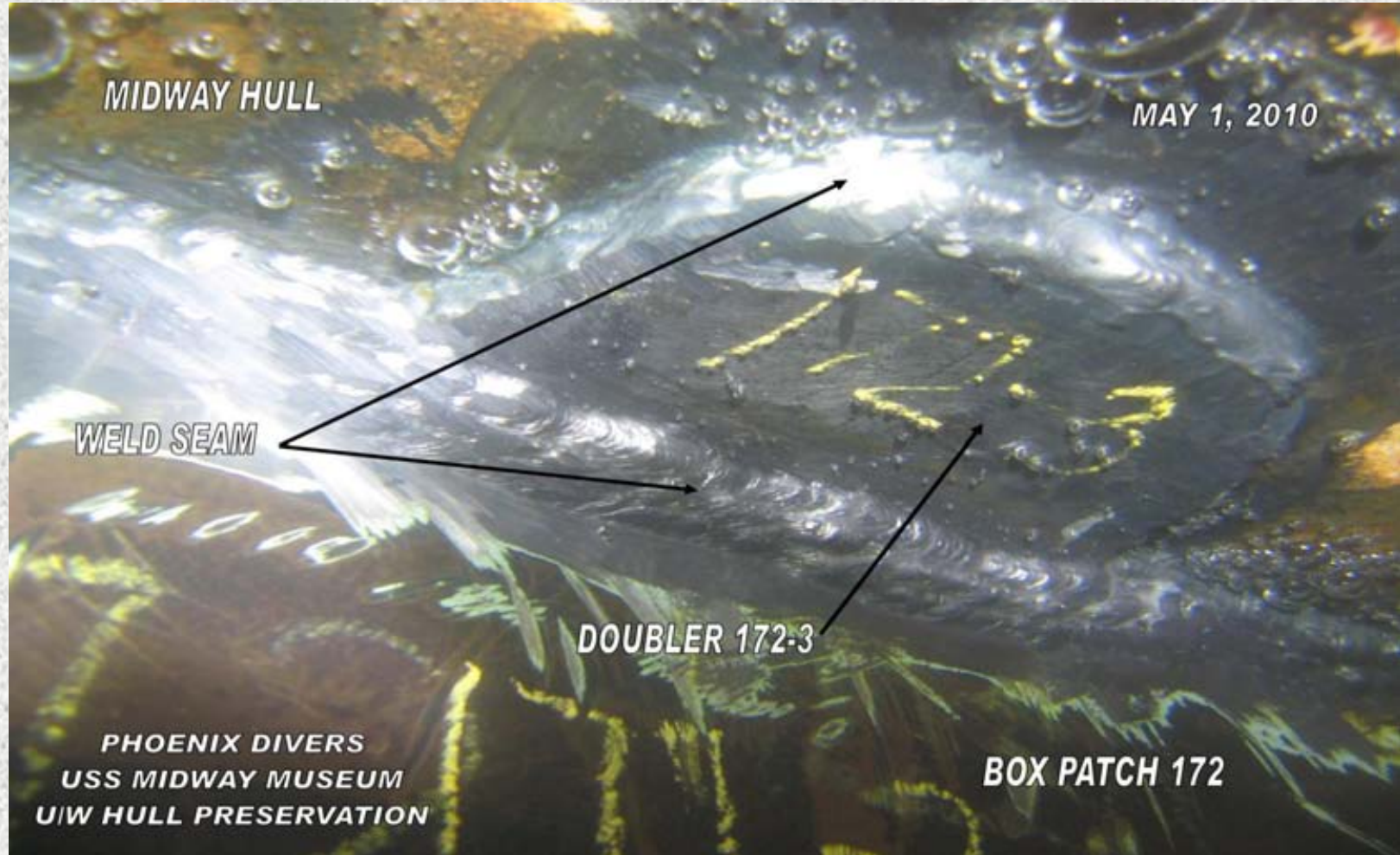
***Blank Installation – Expect the unexpected!***



***Blank Installation – Expect the unexpected!***




***Blank Installation – Expect the unexpected!***



***Blank Installation – Problem solved***

## Communication

- Daily Progress Reports
  - Work completed
  - Work planned
  - Ship's Force assistance required
  - Problems
  
- Must be a Team effort to be cost effective



2222 Service Center  
San Diego, CA 92119  
Tel: (619) 296-6922  
Fax: (619) 296-6922  
Website: [www.phoenixinternational.com](http://www.phoenixinternational.com)

### DAILY SITREP

VESSEL:	EX-USS MIDWAY (CV-41)	DATE:	June 1, 2010
LOCATION:	San Diego	JOB NO:	09175
REPAIR:	Underwater Hull Preservation		

**ACCOMPLISHED:**

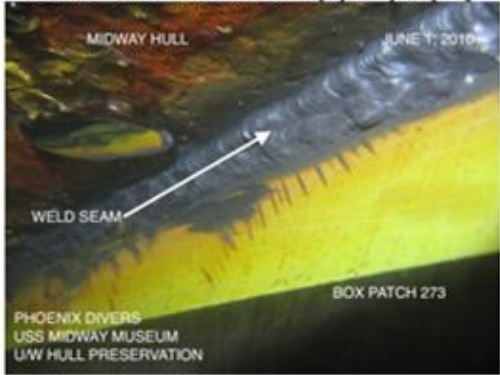
- VT/MT/Pressure Test/Final Video complete on 221, 225 & 273.
- Root complete on 225. Fill & cap 90% complete.
- 479 LNPT complete to date. 96% complete.

**PROBLEMS ENCOUNTERED:**

- None.

**INTENTIONS: (6:30)**

- Complete 225.
- Move camel and dive station FWD. Clean, prep & template opening 249.



MIDWAY HULL      JUNE 1, 2010

WELD SEAM

BOX PATCH 273

PHOENIX DIVERS  
USS MIDWAY MUSEUM  
U/W HULL PRESERVATION

IF YOU ARE NOT AROUND, PLEASE INQUIRE. CYBERSTREET  
PLEASE CALL 619-296-6922 AT 10:15 PM-12:00 AM

FORM: Daily\_SITREP\_100701-01000      Page: 1 of 1      100000-10700

## *Progress Report and SitReps*

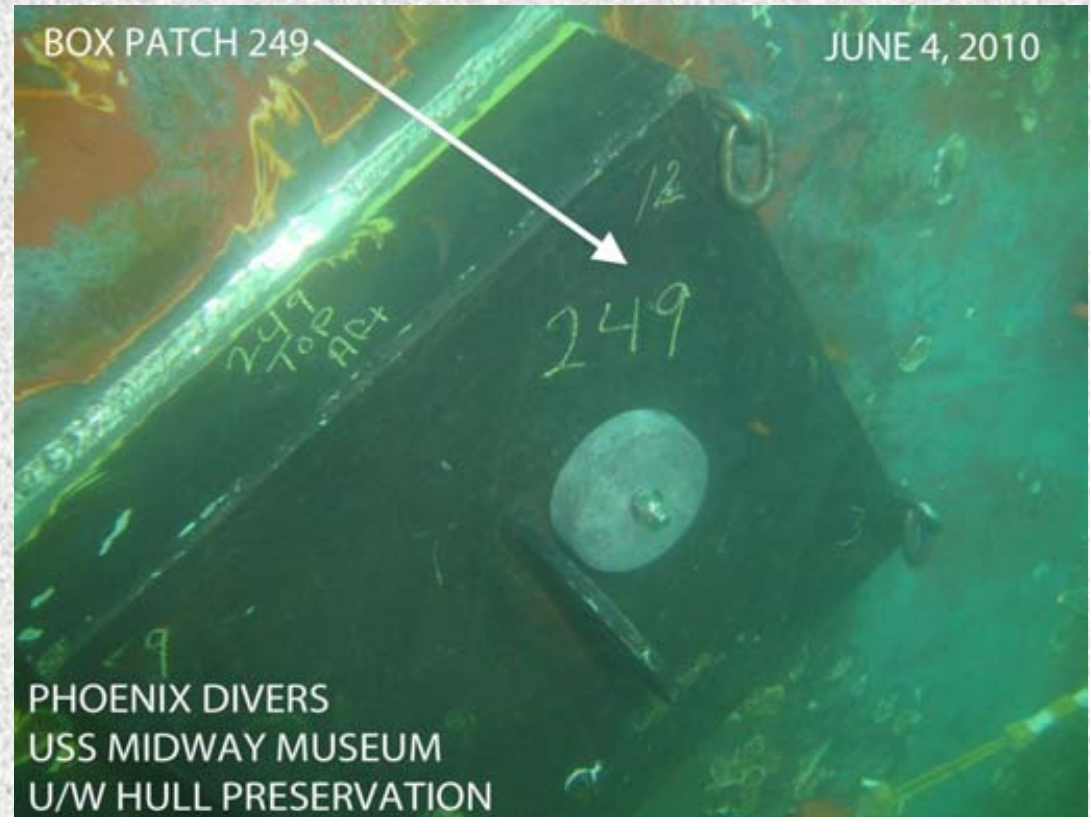
# USS Midway Museum

## Statistics

### ➤ Phoenix Welders

### Performed

- 2,439 hours of bottom time
- Completed 499 linear feet of 3/8 inch wet welds
- Installed 35 Hull Blanks
- Completed 1/3 of total welds required for project completion
- 1807 sq ft of underwater paint applied



**On Schedule and Within Budget**

***Phase One – All milestones completed!***



# New Technology

Technology to Watch – In water technology lags, but keeps a steady pace with surface capabilities

- NDT and Inspection Tools and Techniques
- Welding Advances
- Coatings and Adhesives
- Cathodic Protection

***The Next Generation of Tools***

## In Water Repair in lieu of Dry Docking

- Accepted by Major Classification Societies (ABS & DNV)
- Accepted by the U.S. Navy
- Broad Spectrum of Capabilities
- Significant Cost Savings over Dry Docking
  - No towing or ship movement required
  - No lost revenue – open while repairs are being conducted
  - Phase work to fit annual budget
- Not a Cure All – dry docking may be required
  - Pre docking tasks – at considerable savings
    - Full hull clean
    - Thin hull / corrosion survey
    - Removal of damaged plate or components
    - Defined work package – reduce add on work

***Underwater I, M & R - An affordable solution***



# Conclusion

# Questions?





## UNDERWATER SOLUTIONS WORLDWIDE

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