



# Kinetic Metallization Submarine Component Restoration Repairs

Inovati

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2015 Navy Opportunity Forum

# High-Value Components

- Critical need: repair high-value submarine parts
- Worn components scrapped
- New parts procured
  - Low volume, expensive
  - Excessively long lead times
- Decreased operational readiness



# Potential Beneficiaries of KM Repairs

- Fleet Maintenance Facilities
- Navy Shipyards
- SUBMEPP
- NUWC
- Commanders addressing submarine mission availability



# Current Repair Processes

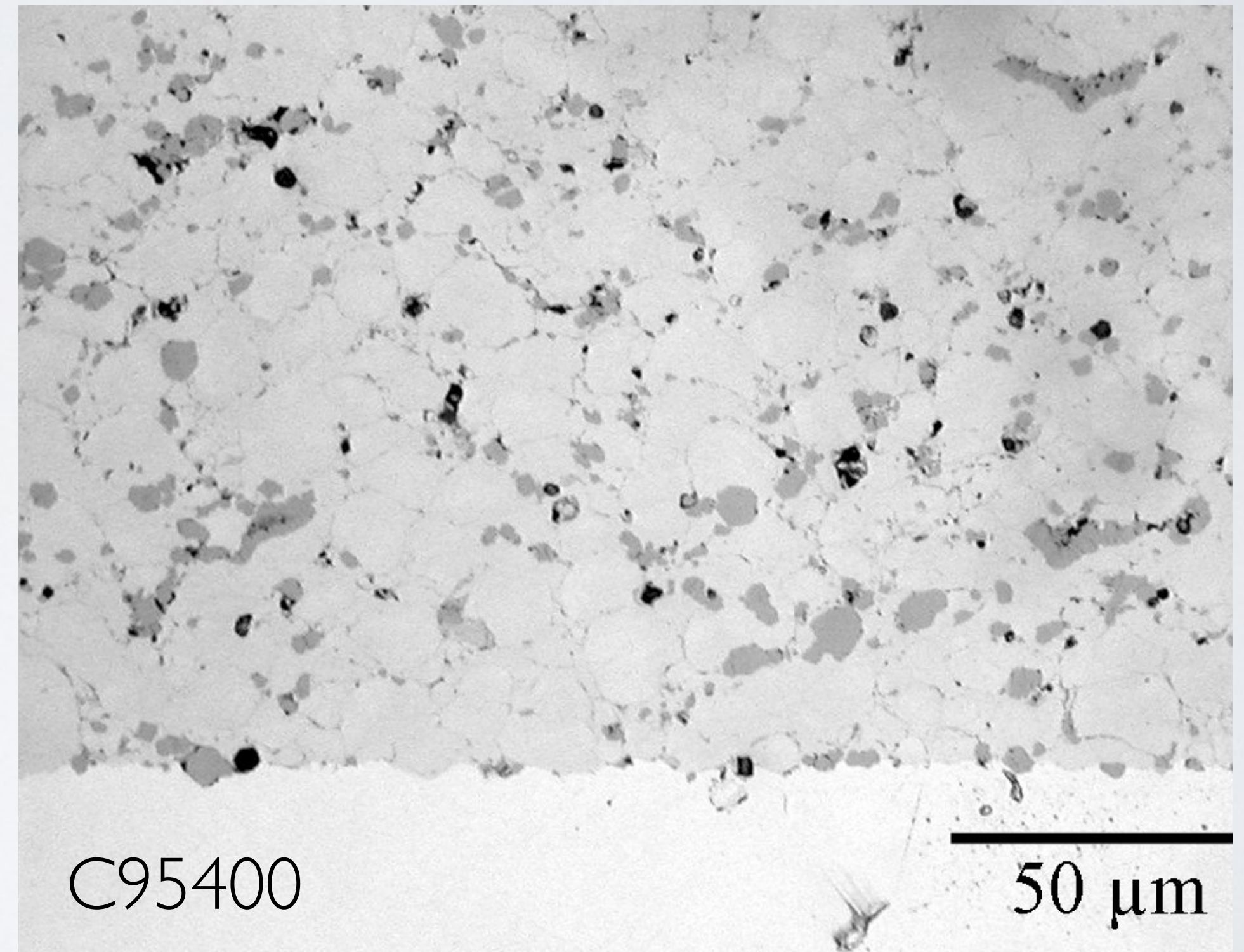
- Most parts are replaced
- Limited repairs with
  - Welding
  - Laser cladding
  - Electroplating



Electroplating

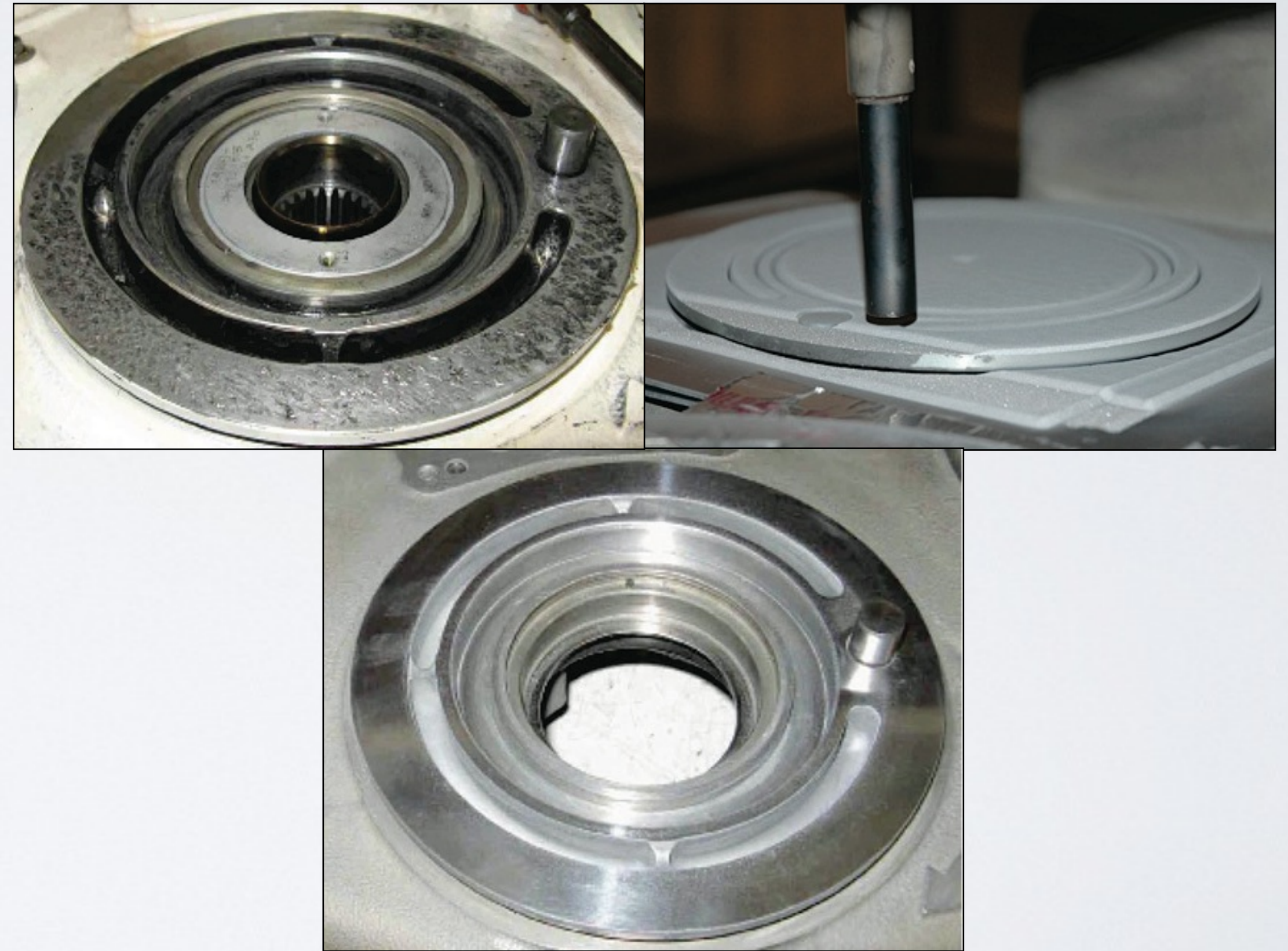
# Repair Requirements

- Restore dimensions to original specifications
- EH&S compliant
- Repair adhesion, material and mechanical properties, machinability
- Corrosion, wear, and erosion resistance



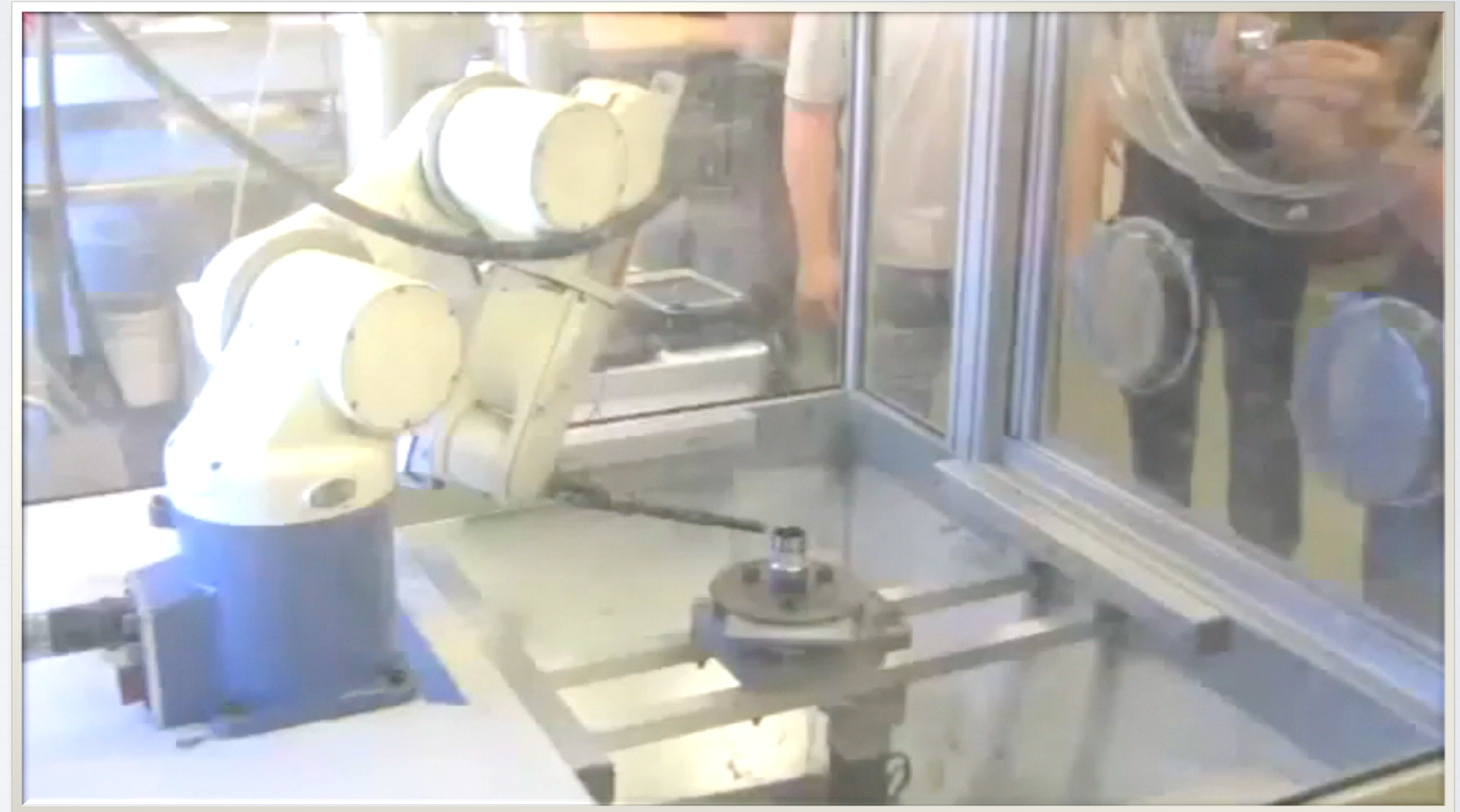
# Kinetic Metallization

- Metal Deposition Process
- Low pressure and temperature
- Meets environmental standards
- Cost-effective
- Dimensional restoration of high-value submarine components



# Kinetic Metallization

- Repairs various component materials
  - Brass
  - Bronze
  - Nickel-copper
  - Titanium
- Applies various repair feedstocks
  - Aluminum Bronze
  - Copper-Nickel
  - Aluminum Alloy
  - Inconel



# Restoring Submarine Components

- Ohio Class
  - Trident trim pump components
- Other SSBN & SSN applications
  - Hydraulic actuators/controllers
  - Seawater pump channel rings
  - Electric motor end bell bores
  - Seawater ball valves & valve bushings
  - Snorkel masts
  - Replacement for copper plating





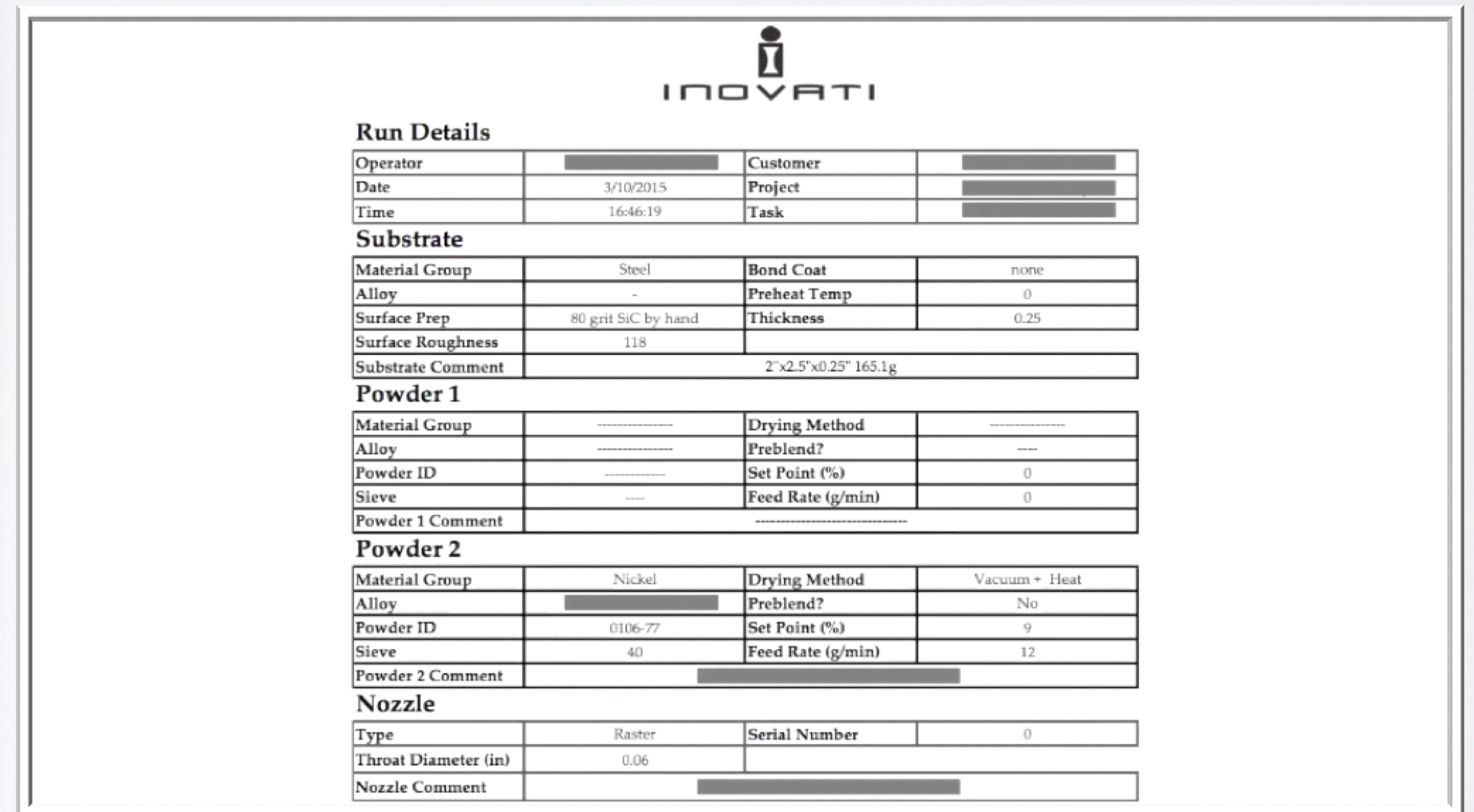


# Kinetic Metallization

| Features                   | Advantages   | Benefits                               |
|----------------------------|--|--|
| Low Temperature Operation  | Enables the repair of components previously not thought possible | Greater availability of parts          |
| KM Sonic Nozzle            | Uses less gas  | Low consumable costs                   |
| Custom Powder Formulations | Repairs can be tailored to any application                       | Meet specific performance requirements |
| Robotic Control            | Enables automated repairs  | Consistent quality parts               |

# Quality Assurance

- Data Integrity
- Historical records
- System health monitoring



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**Run Details**

|          |           |          |  |
|----------|-----------|----------|--|
| Operator |           | Customer |  |
| Date     | 3/10/2015 | Project  |  |
| Time     | 16:46:19  | Task     |  |

**Substrate**

|                   |                      |              |      |
|-------------------|----------------------|--------------|------|
| Material Group    | Steel                | Bond Coat    | none |
| Alloy             | -                    | Preheat Temp | 0    |
| Surface Prep      | 80 grit SiC by hand  | Thickness    | 0.25 |
| Surface Roughness | 118                  |              |      |
| Substrate Comment | 2"x2.5"x0.25" 165.1g |              |      |

**Powder 1**

|                  |       |                   |       |
|------------------|-------|-------------------|-------|
| Material Group   | ----- | Drying Method     | ----- |
| Alloy            | ----- | Preblend?         | ---   |
| Powder ID        | ----- | Set Point (%)     | 0     |
| Sieve            | ---   | Feed Rate (g/min) | 0     |
| Powder 1 Comment | ----- |                   |       |

**Powder 2**

|                  |         |                   |               |
|------------------|---------|-------------------|---------------|
| Material Group   | Nickel  | Drying Method     | Vacuum + Heat |
| Alloy            |         | Preblend?         | No            |
| Powder ID        | 0106-77 | Set Point (%)     | 9             |
| Sieve            | 40      | Feed Rate (g/min) | 12            |
| Powder 2 Comment |         |                   |               |

**Nozzle**

|                      |        |               |   |
|----------------------|--------|---------------|---|
| Type                 | Raster | Serial Number | 0 |
| Throat Diameter (in) | 0.06   |               |   |
| Nozzle Comment       |        |               |   |



# KM vs. Standard Cold Spray

| He, 250C, Cu alloy              |      | Kinetic Metallization<br>100psia | Coldspray (e.g., CGT)<br>300psia |
|---------------------------------|------|----------------------------------|----------------------------------|
| Gas Consumption                 | SCFM | <b>11</b>                        | 135                              |
| Powder Feedrate                 | g/m  | 30                               | 34                               |
| Deposition Efficiency           | %    | 90                               | 90                               |
| Deposition Rate                 | g/m  | 27                               | 30                               |
| Repairs Flying on Navy Aircraft |      | <b>Yes</b>                       | No                               |

# Current State of Development

- Where we are now
  - Developing feedstock materials (TRL6)
  - Characterizing repair material properties (TRL7)
- What is next
  - Install KM system at NUWC Division, Keyport





# Transition to Fleet

| TRL | Milestone  | Estimated Date |
|-----|--|----------------|
| 6   | Develop feedstock for submarine repairs          | 2015           |
| 7   | Characterize repair material properties          | 2015           |
| 8   | Installation of KM system NUWC Division, Keyport | 2015           |
| 9   | Develop KM submarine component repairs           | 2016           |

# Partners and Customers Sought

## Regional Maintenance Centers and Shipyards

- Portsmouth
- Pearl Harbor
- Norfolk
- Puget Sound
- SERMC
- SWRMC
- NWRMC
- MARMC
- RSG Gorton



# Partners and Customers Sought

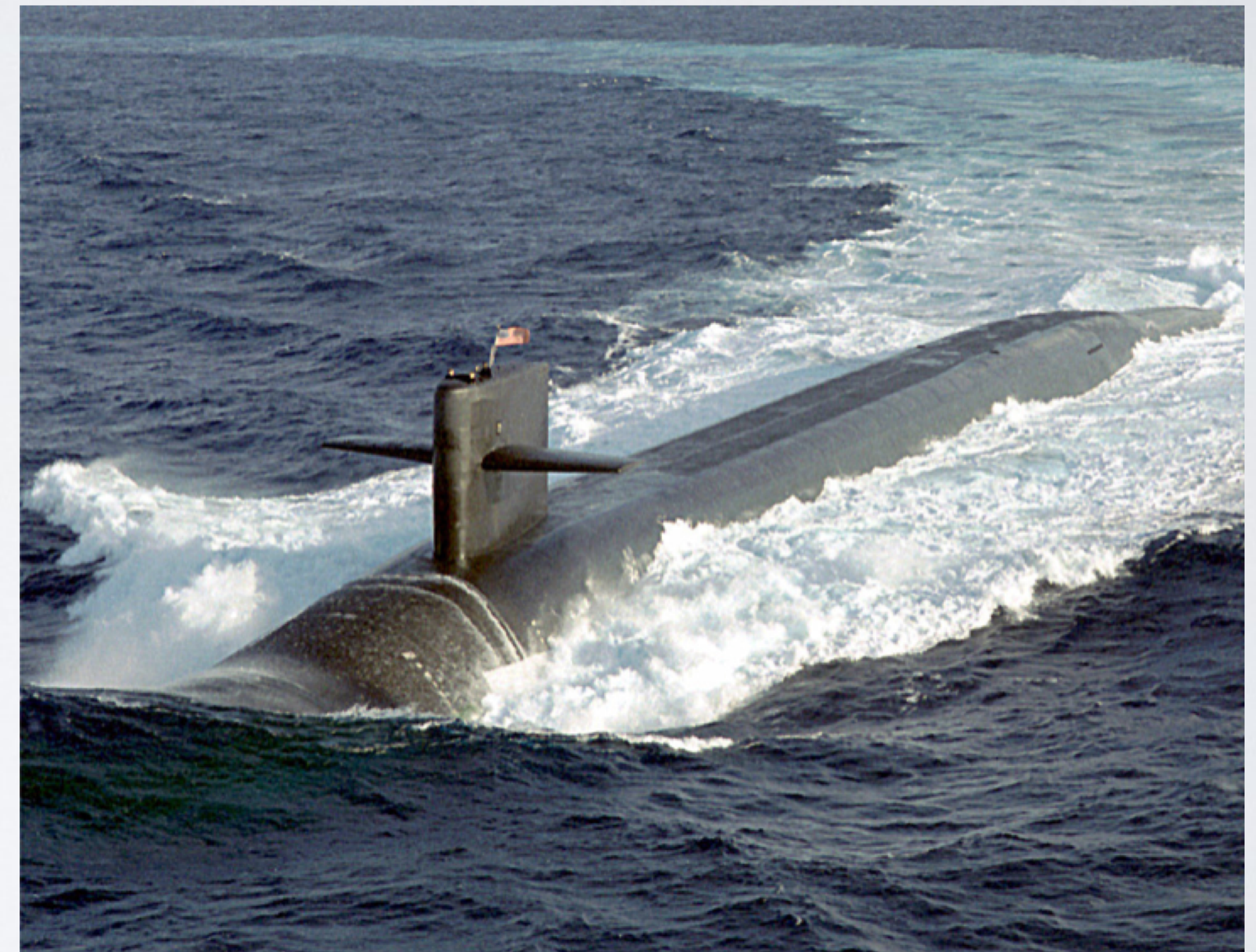
- Ohio Class Program Office
- Virginia Class Program Office
- SUBMEPP
- NUWC
- Providers of Logistics Support Services





# Inovati's Role

- Manufacture, install, lease, and sell
  - KM Systems and KM Feedstock
- Contract component repair
- Applications development, training and customer support
- System and parts repair demonstration







# About Inovati

- Founded 1989
- Manufacturing, production and R&D facilities
  - Santa Barbara, California
- Customers
  - Navy, Air Force, DOE, NASA
  - GE, Chevron, Boeing, others





# Visit us at Booth #

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