Fleet Readiness Center Southwest

Production Cold Spray Repairs for NAVAIR

Presenter: Matthew Minnick, Materials Engineer, Code 43460

Date: May 23, 2018
What is a Fleet Readiness Center (FRC)?

- Maintain, repair, and overhaul Naval aircraft and their components
- Commonly referred to as “depots”
Where are the FRCs?

- Navy and Marine Corps aircraft and systems
- Components and Engines
- Manufacturing
- Engineering and Logistics

FRC Northwest
Whidbey Island
Whidbey Is., WA

FRC Western Pacific
Atsugi
Atsugi, Japan

FRC West
Lemoore
Lemoore, CA

FRC Southwest
North Island
San Diego, CA

FRC Southeast
Jacksonville
Jacksonville, FL

FRC Mid-Atlantic
Oceana
Oceana, VA

FRC East
Cherry Point
Cherry Pt., NC

Commander,
Fleet Readiness Centers
(COMFRC)
What is Cold Spray?

- Metal spray process
- Restores critical dimensions
- Impacts metal particles onto substrate
  - Metallurgical bond

Also known as Gas Dynamic Spraying, Kinetic Metallization (KM), Supersonic Particle Deposition (SPD), High Velocity Powder Deposition, and Kinetic Spraying

Courtesy Army Research Laboratory

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How Does Cold Spray Work?

- Heated carrier gas (Helium or Nitrogen)
- Powder injected at nozzle
- Emerges at sonic or supersonic speeds
- Kinetic energy stored in powder particles deforms and bonds them to surface
• Solid-state process (does not melt particles)
  - Low-porosity, high-quality coating
• Approved repairs restore dimensions, not strength

• Damage (e.g., corrosion, wear, abrasion) of subject parts lends itself well to repair using the cold spray process

• Replacement part is expensive and/or low in supply

• Limited spares and long lead-time causing bottlenecks in the supply system

• Existing repairs have a long turn-around-time (TAT)
• Blanket repair approval for already authorized parts
  – Not for specific quantity or per each unit
  – Local engineering documents provide repair guidance
• No special requirements for using repaired parts
  – Maintainers unaware if part repaired with cold spray
• Quality Control/Assurance inherent in cold spray process
  – Spray parameters are programmed into the cold spray unit
  – Poor quality manifest during application or finish machining
  – Some parts require acceptance testing
FRCSW has seven approved F/A-18 cold spray repairs
FRCSW Production Repaired Parts

- AMAD: Aircraft Mounted Accessory Drive
- MLG: Main Landing Gear

- F/A-18 HORNET
  - MLG Wheel
  - AMAD Gear Box Housing
  - Radar Rack Assembly

- F/A-18 SUPER HORNET
  - Brake Carrier
  - AMAD Main Housing
  - Hydraulic Gear Shaft

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<table>
<thead>
<tr>
<th>Site</th>
<th>Nomenclature</th>
<th>Quantity Recovered as of January 10, 2018</th>
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<tr>
<td>FRCSW</td>
<td>F/A-18E/F/G AMAD Main Housing (Hydraulic Pad)</td>
<td>14</td>
</tr>
<tr>
<td>FRCSW</td>
<td>F/A-18E/F/G AMAD Hydraulic Gear Shaft</td>
<td>47</td>
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<td>F/A-18E/F/G AMAD Main Housing (Internal Gear Damage)</td>
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<tr>
<td>FRCE</td>
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**Total:** 195
## NAVAIR Production Repair Parts

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**Total:** 195

*Prices used in calculations were from IHS Haystack® Gold. They do not include the cost of contracting to buy a new item.*

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* Approved for public release: distribution unlimited.
Total Return on Investment for Approved Repairs

$17.3 Million - $4 Million* = $13.3 Million

Costs Avoided        Technology Investment

* Estimated S&T funding from 219, NPRE, SBIR, and AERMIP from 2006-2016. Cost is for investment on parts approved for repair discussed in this brief, and does not include repairs in development. Cost also includes purchase of systems.
AMAD Housing Hydraulic Pad

Platform: F/A-18E/F and EA-18G
Repair: Fretting damage to sealing surface
Repair Type: Dimensional restoration
Previous Repair: None

Repair Authorized: FRCSW North Island
System: Inovati KM-PCS
Powder: 7075 Aluminum with Nickel
Part Material: Aluminum A357 casting

Fretting Damage

After Repair

Approved for public release: distribution unlimited.
**Repairs AMAD Hydraulic Pads repaired and returned to service**

<table>
<thead>
<tr>
<th>AMAD Repaired</th>
<th>Date Sold by AMAD Shop</th>
<th>Material Sprayed</th>
<th>Date Installed</th>
<th>Hours on Hydraulic Pad as of March 1, 2018</th>
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<tbody>
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Total: 9,965

Performed post-service inspection
Repaired AMAD Hydraulic Pads repaired and returned to service

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May 2011

Cold Spray Repaired

November 2016

Inspection at 1,748 Flight Hours
Platform: F/A-18E/F and EA-18G
Repair: Wear damage to sealing surface
Repair Type: Dimensional restoration
Previous Repair: None

Repair Authorized: FRCSW North Island
System: Inovati KM-PCS
Powder: Tungsten Carbide Cobalt
Part Material: AMS 6265 steel
Brake Carrier

Platform: F/A-18E/F and EA-18G
Repair: Corrosion damage
Repair Type: Dimensional restoration
Previous Repair: Plasma spray

Repair Authorized: FRCSW North Island
System: Inovati KM-PCS
Powder: Aluminum with Chrome
Part Material: Aluminum 2014-T61

Corrosion Damage

After Repair
AMAD Housing PTS Flange

Platform: F/A-18A/B/C/D
Repair: Fretting damage
Repair Type: Dimensional restoration
Previous Repair: Plasma spray

Repair Authorized: FRCSW North Island
System: Inovati KM-PCS
Powder: 7075 Aluminum with Nickel
Part Material: Aluminum A356 casting

After Repair
Platform: F/A-18A/B/C/D/E/F
Repair: Corrosion damage
Repair Type: Dimensional restoration
Previous Repair: None

Repair Authorized: FRCSW North Island
System: Inovati KM-PCS
Powder: Aluminum with Chrome
Part Material: Aluminum 7075-T7351
Platform: F/A-18A/B/C/D
Repair: Mechanical/corrosion damage
Repair Type: Dimensional restoration
Previous Repair: Machine away corrosion

Repair Authorized: FRCSW North Island
System: Inovati KM-PCS
Powder: Aluminum with Chrome
Part Material: Aluminum 2014

Before Repair
AMAD Housing Internal Damage

Platform: F/A-18E/F and EA-18G
Repair: Mechanical damage
Repair Type: Dimensional restoration
Previous Repair: None

Repair Authorized: FRCSW North Island
System: Inovati KM-PCS
Powder: Aluminum with Chrome
Part Material: Aluminum A357 casting

Mechanical Damage

After Repair

Approved for public release: distribution unlimited.
What’s Next?
• Pursuing class-based approval for non-structural repairs
  – Classes such as shafts, sealing surfaces, and surfaces mounted in compression
    • Current approval is on part-by-part basis
  – Cold spray as a regular repair process like plasma spray or chrome plating
• Investigating restoring dimensions to structures within approved blend limits
  – Dimensions lost to corrosion and mechanical damage
  – Not claim strength credit for dimensions restored
• Field-deployable artisans and on-aircraft repair