



Fleet Readiness Center Southwest
Production Cold Spray Repairs for NAVAIR
 Presenter: Matthew Minnick, Materials Engineer, Code 43460

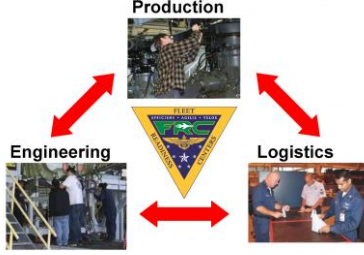
Cold Spray Action Team (CSAT) Event Date: June 19, 2018



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What is a Fleet Readiness Center (FRC)?

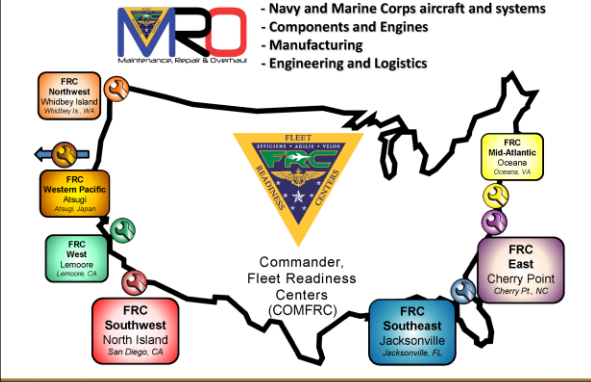
- Maintain, repair, and overhaul Naval aircraft and their components
- Commonly referred to as “depots”



The diagram shows a central FRC logo with three red arrows pointing to boxes labeled 'Production', 'Engineering', and 'Logistics', each containing a small photograph of related activities.

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Where are the FRCs?



MRO
 Maintenance, Repair & Overhaul

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

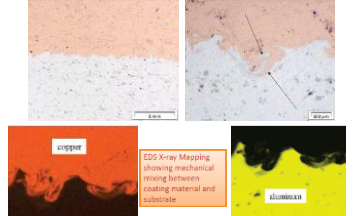
Commander, Fleet Readiness Centers (COMFRC)

- FRC Northwest: Whidbey Island, WA
- FRC Western Pacific: Alameda, CA
- FRC West: Lemoore, CA
- FRC Southwest: North Island, San Diego, CA
- FRC Southeast: Jacksonville, FL
- FRC East: Cherry Point, NC
- FRC Mid-Atlantic: Oceana, VA

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What is Cold Spray?

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


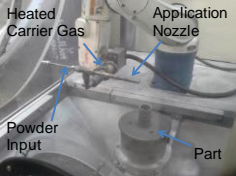


Also known as Gas Dynamic Spraying, Kinetic Metallization (KM), Supersonic Particle Deposition (SPD), High Velocity Powder Deposition, and Kinetic Spraying

Courtesy: Army Research Laboratory

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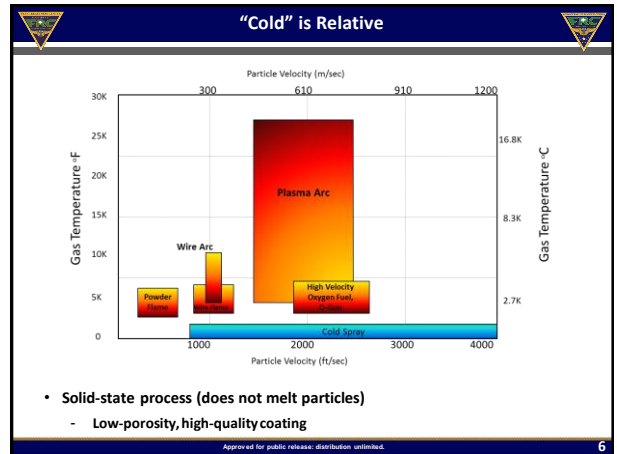
How Does Cold Spray Work?

- 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

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Criteria for Candidate Repair Parts

- 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)**

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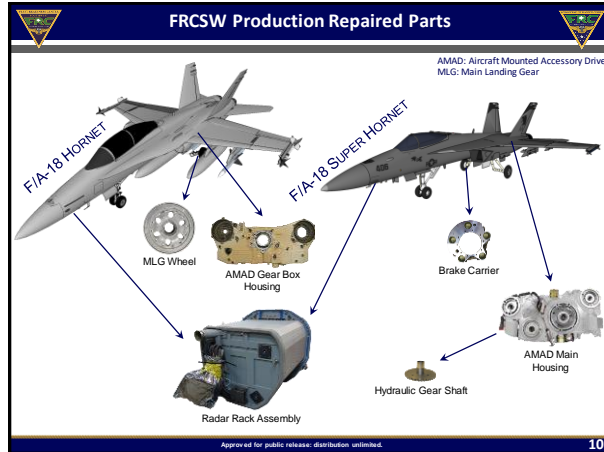
Repair Approval Approach

- 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

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FRCSW has seven approved F/A-18 cold spray repairs



NAVAIR Production Repair Parts

Site	Nomenclature	Quantity Recovered as of January 10, 2018
FRCSW	F/A-18E/F/G AMAD Main Housing (Hydraulic Pad)	14
FRCSW	F/A-18E/F/G AMAD Hydraulic Gear Shaft	47
FRCSW	F/A-18E/F Brake Carrier	83
FRCSW	F/A-18A/B/C/D AMAD Gearbox Housing (PTS Axis)	12
FRCSW	F/A-18A/B/C/D/E/F APG-73 Radar Rack Assembly	21
FRCSW	F/A-18A/B/C/D Outboard Wheel Bolt Spot Face	0
FRCSW	F/A-18E/F/G AMAD Main Housing (Internal Gear Damage)	6
FRCE	H-1 Combining Gear Box	12
Total:		195

AMAD: Aircraft Mounted Accessory Drive
PTS: Powered Take-off Shaft

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\$113 million in costs avoided*

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

Total Return on Investment for Approved Repairs

$\$17.3 \text{ Million} - \$4 \text{ Million}^* = \$13.3 \text{ Million}$

Costs Avoided
Technology Investment

* Estimated S&T funding from Z19, 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.

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Thanks to Our Funding Sponsors

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AMAD Housing Hydraulic Pad

AMAD: Aircraft Mounted Accessory Drive

Platform: F/A-18E/F and EA-18G

Repair: Fretting damage to sealing surface

Repair Type: Dimensional restoration

Previous Repair: None

Repair Authorized: FRCSSW North Island

System: Inovati KM-PCS

Powder: 7075 Aluminum with Nickel

Part Material: Aluminum A357 casting

Fretting Damage
After Repair

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AMAD Housing Hydraulic Pad Repair

AMAD: Aircraft Mounted Accessory Drive

Repaired AMAD Hydraulic Pads repaired and returned to service

AMAD Repaired	Date Sold by AMAD Shop	Material Sprayed	Date Installed	Hours on Hydraulic Pad as of March 1, 2018
1	1/13/2011	6061	5/1/2011	2,579
2	7/9/2011	6061	4/12/2013	1,182
3	8/16/2011	4047	8/30/2011	1,127
4	7/22/2011	4047	9/5/2011	1,748
5	11/28/2011	7075 w/ Ni	1/1/2012	311
6	10/16/2012	7075 w/ Ni	11/5/2012	1,040
7	10/18/2012	7075 w/ Ni	12/18/2013	317
8	6/26/2014	7075 w/ Ni	3/18/2015	919
9	8/29/2016	7075 w/ Ni	12/10/2016	546
10	5/31/2017	4047	10/26/2017	161
11	8/5/2017	7075 w/ Ni		
12	12/7/2017	7075 w/ Ni		
13		7075 w/ Ni		
14		7075 w/ Ni		
Total				9,965

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AMAD Housing Hydraulic Pad Repair

AMAD: Aircraft Mounted Accessory Drive

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1	1/13/2011	6061	5/1/2011	2,579
2	7/9/2011	6061	4/12/2013	1,387
3	8/16/2011	4047	8/30/2011	1,377
4	7/22/2011	4047	9/5/2011	1,748
5	11/28/2011	7075 w/ Ni	1/1/2012	311
6	10/16/2012	7075 w/ Ni	11/5/2012	1,040
7	10/18/2012	7075 w/ Ni	12/18/2013	317
8	6/26/2014	7075 w/ Ni	3/18/2015	919
9	8/29/2016	7075 w/ Ni	12/10/2016	546
10	5/31/2017	4047	10/26/2017	141
11	8/5/2017	7075 w/ Ni		
12	12/7/2017	7075 w/ Ni		
13				
14				
Total				9,965

Performed post-service inspection

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AMAD Housing Hydraulic Pad Repair

AMAD: Aircraft Mounted Accessory Drive

Repaired AMAD Hydraulic Pads repaired and returned to service


AMAD Repaired	Date Sold by AMAD Shop	Material Sprayed	Date Installed	Hours on Hydraulic Pad as of September 1, 2017
4	7/22/2011	4047	9/5/2011	1,748

May 2011



Cold Spray Repaired

November 2016



Inspection at 1,748 Flight Hours

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AMAD Hydraulic Gear Shaft

AMAD: Aircraft Mounted Accessory Drive

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



Damaged Seal Surface



After Cold Spray



Restored Seal Surface

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Brake Carrier

AMAD: Aircraft Mounted Accessory Drive

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

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AMAD Housing PTS Flange

AMAD: Aircraft Mounted Accessory Drive
PTS: Powered Take-off Shaft

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
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After Repair

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APG-73 Radar Rack Assembly

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
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Corrosion Damage



After Repair


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Outboard MLG Wheel Bolt Spot Face

MLG: Main Landing Gear

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
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Before Repair

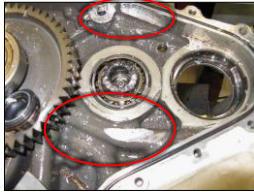
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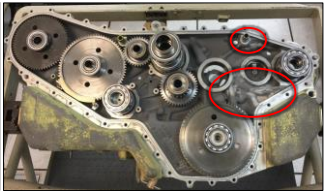
AMAD Housing Internal Damage

AMAD: Aircraft Mounted Accessory Drive

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
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Mechanical Damage



After Repair

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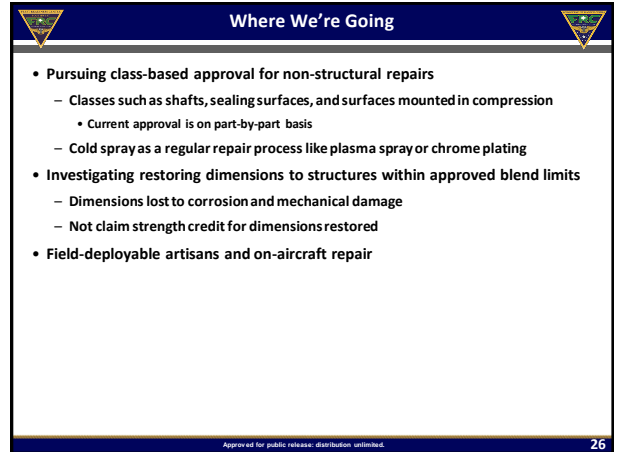
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What's Next?

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Where We're Going

- 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

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