



28th Bomb Wing



AFGSC..... Deter...Assure...Strike!

Win the Fight - Strengthen the Team - Prepare for the Future

Additive Manufacturing Rapid Repair Facility Status Update

Brian L. James
28 MXG/AFETS

In Association with

Jack Rick
VRC Metal Systems. Inc.

- Prepare for the Future -

***Purpose:** To discuss status of Ellsworth Additive Manufacturing Facility (AMRRF) for cold spray repair on non-repairable/non-procurable B-1 components.*



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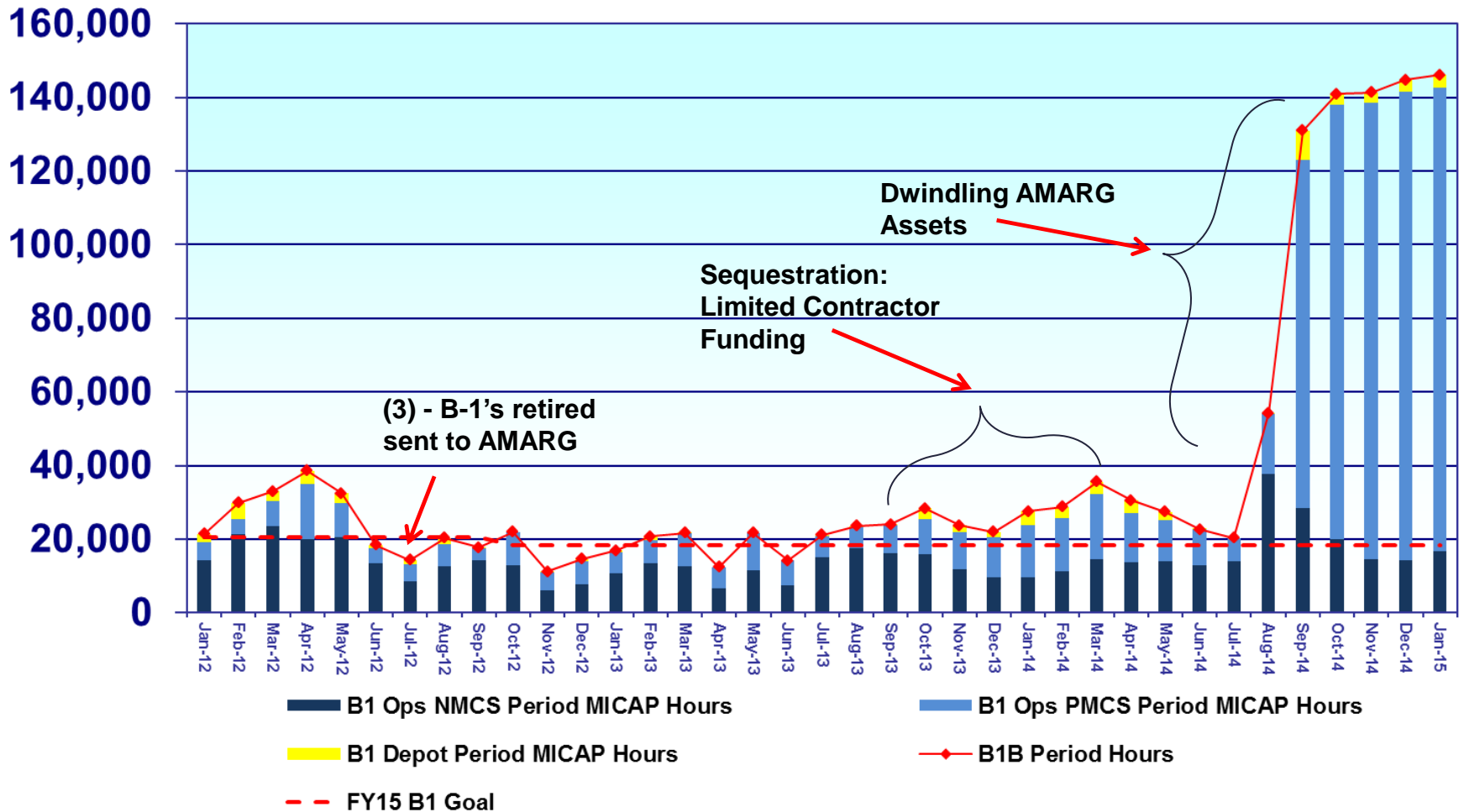
- Prepare for the Future -

***Purpose:** To discuss status of Ellsworth Additive Manufacturing Facility (AMRRF) for cold spray repair on non-repairable/non-procurable B-1 components.*



B-1 (WSDC - 56F) Weapon System MICAP Data

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AMRRF Facility

Mission Statement

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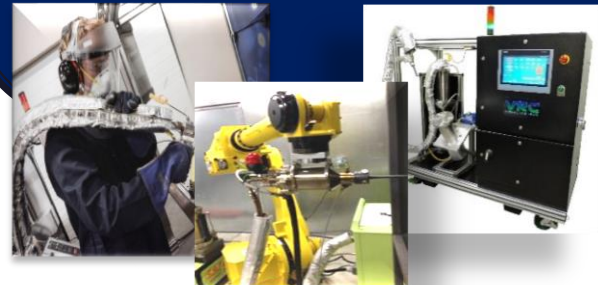
Mission Statement

Utilize advanced
Additive Technologies
to Provide Rapid
Repair of Weapon
Systems Components
To Enhance Combat
Readiness and Reduce
Costs



Vision Statement

Leverage advances in
Additive
Manufacturing
Technologies to
improve weapon
system maintenance
and repair capabilities





AFGSC AMRRF Organizational Chart



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Air Force Globe Strike Command (AFGSC) & Air Force Engineering and Technical Services (AFETS) organizational chart





28BW Additive Manufacture Rapid Repair Facility



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AMRRF Location – North Side of MXS Building 7520



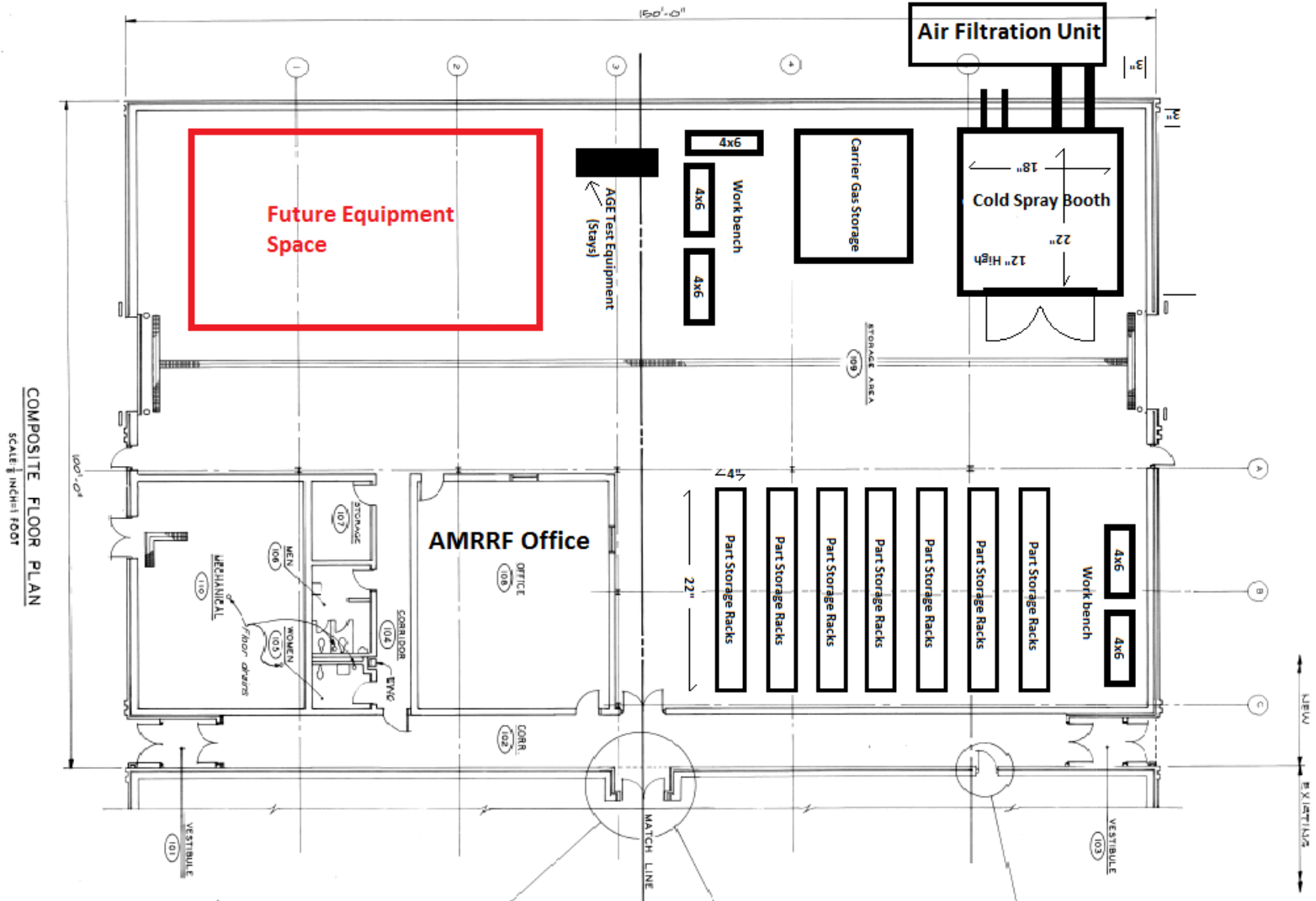


28BW Additive Manufacture Rapid Repair Facility



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AMRRF Layout – North Side of MXS Building 7520





28BW Additive Manufacture Rapid Repair Facility



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AMRRF Office

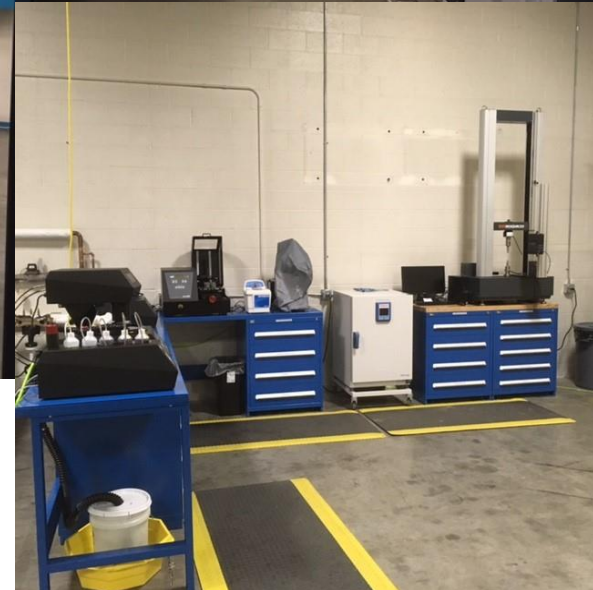
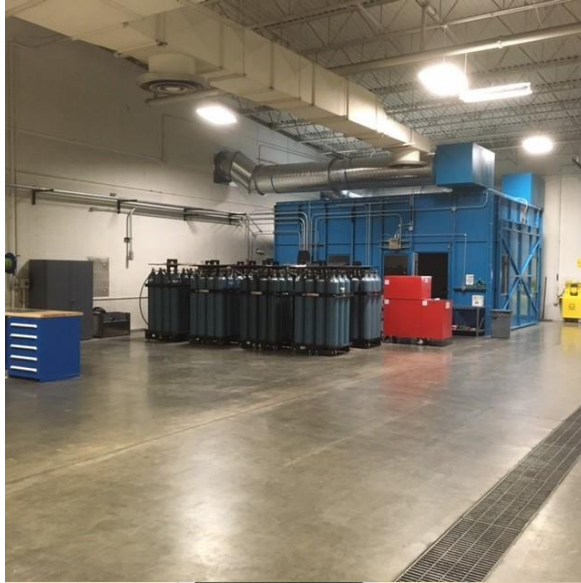


28BW Additive Manufacture Rapid Repair Facility



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AMRRF Floor





AMRRF Facility

Equipment Status



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Project Title	Status	Comp Date	POC	Remarks
Vidmar work surface delivered and installed	▲	10 Oct 2016	MSgt Jack Rick, 28 MXG/WAM	
Lab Test equipment ordered	▲	30 Nov 2016	Ms. April Herington, 28 MXG/RA	Microscope, Load Frame, Vickers hardness tester
GEN III delivered	▲	28 Oct 2016	VRC Metal Systems	
GEN III power and carrier gas booth feed through installed	▲	28 Aug 2016	MSgt Jack Rick, 28 MXG/WAM	
GEN III air line installed in CS booth	▲	2 Oct 2016	Mr. Richard Kenney, 28 CES	
Aquest Corporation. selected to complete PHA	▲	22 Aug 2016	Mr. Steve Roland, Aquest Inc.	
AMRRF PHA awarded	▲	25 Aug 2016	Mr. Brian James, 28 MXG/AFETS	
AMRRF PHA site visit	▲	15 Sep 2016	Mr. Brian James, 28 MXG/AFETS	6-minor discrepancies noted approx. \$20K to correct
AMRRF PHA completed	▲	Est. 24 June 2017	Aquest Corporation	We have received the draft copy

▲ Complete ▼ On-track ▲ Minor Disruption ▼ Major Disruption



AMRRF Facility

Equipment Status



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Project Title	Status	Comp Date	POC	Remarks
Motoman robotic system received and installed	Complete	2 Dec 2016	Jon-Russell Groenewegen, UDRI	
Operating Instruction published	On-track		Capt Tim Aanerud, 28 AMXS	Should be published by 1 July 2017
RIF contract extended	Complete	4 Feb 2017	Vic Champagne ARL/RDRL-WMM-D	This is a no cost 6 month extension
RIF funding extension requested to AFLCMC/EZP	On-track	N/A	Ms. Debbie Naguy, AFLCMC/EZP	Requested \$700K - expected to receive \$500K
AMRRF annual budget submitted to AFLCMC/EZP	Major Disruption		Ms. Debbie Naguy, AFLCMC/EZP	Requested \$1.1M/annually
AMRRF FY17 CAM Request	Major Disruption	1 Oct 16	Ms. Debbie Naguy, AFLCMC/EZP	It was approved by the Chief Engineer, Jeff Vaughn and the finance personnel
AMRRF FY17 CAM contracting/funds distribution mechanism	Major Disruption		Ms. Debbie Naguy, AFLCMC/EZP	

Complete
 On-track
 Minor Disruption
 Major Disruption



Ellsworth AMRRF Operating Budget



Annually

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Projected on-going support requirements and costs – Labor, equipment and tools, materials and consumables

(Monthly Recurring Costs)

- 1 Engineer/1 Technician	\$15,000
- Prototyping/Testing/Evaluation/Qualification	\$14,000
- Fixtures/Materials/Machining (C633 Samples/Spray Coupons)	\$11,000
- GEN III Operating Costs	\$3,000
- Carrier Gas (Helium/Nitrogen)	\$7,500
- Consumables (Hoses/Nozzles/Powder/Etc.)	\$20,000
- Tooling	\$3,000
- General & Administrative	\$6,000
- Training	\$2,000
- Misc. (Shipping & Handling)	\$2,500

RDH Inputs



Total Monthly Cost	\$84,000
	X12 Months
Total Annual Cost	\$1,008,000





RIF Candidate Parts



B-1 Forward Equipment Bay (FEB) Panel

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Chafing Wear on Operational Panel

8 panels per aircraft
Four panels per side
Lt and Rt sides

AI 2024, composite bonded stiffened skin panel

- AI 6061 Repair Developed
- Tested 2014
- Adhesion, Tensile, Micro Exam, Impact
- AFRL Test Report
- 2 tests identified but since have been determined to be acceptable (backside impact & ductility)
- Technical analysis Complete
- Additional tests added 2016
 - Wear
 - Corrosion
 - Additional Impact Samples
 - ECD: July 2016

CS Repaired June 2012
5+ Years, 2363 Flight Hours





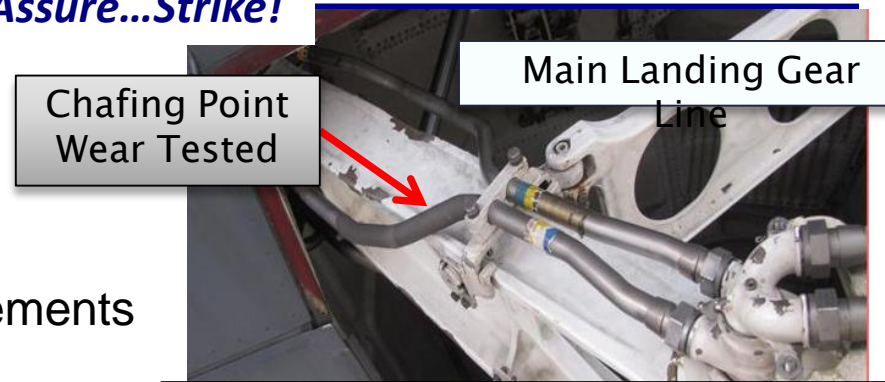
RIF Candidate Parts



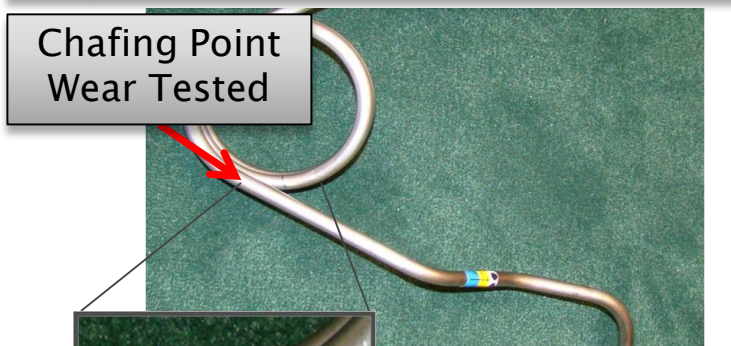
B-1 Hydraulic Tubing Chafing Prevention

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- CP Ti Repair Developed tested 2009-11
- Operational wear test since that time
- Ti 3Al 2.5V process requested
 - Obtained powder
 - Unable to identify qualification requirements
- Switched back to Cp Ti
- New Test plan cut down to fewer tests done on actual tubing
 - Adhesion, Micro, hardness
 - Wear Detection
 - Burst
 - Hydraulic Impulse
 - Pressurized rotating beam
 - ECD August 2016



**CS Applied Jan 2011 (2 A/C)
6+ Years 5379 Combined Flt Hrs**



**CS Applied Mar 2009
8+ Years, 2689 Flight Hours**



Ellsworth AMRRF Projected Parts Flow



Annually

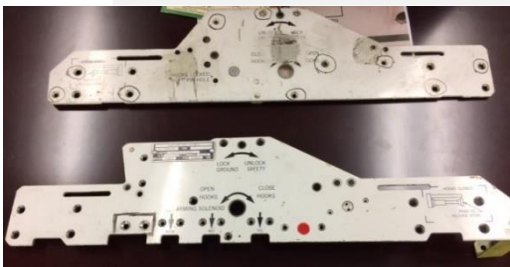
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NOMICLATURE	QUANTITY	ESTIMATED SAVINGS
B-1 FEB PANELS	15	~\$3.4 Million
B-1 HYDRUALIC CHAFFING OVERLAY	200	Mission Support Increase
B-1 BOMB RACKS	10	~\$340,000
B-1 FUEL COOLING	6	~\$48,000
B-1 AEB PANELS	21	~\$2.6 Million
B-1 MISCELLANEOUS AIRCRAFT COMPONENTS	~45	~\$1.2 Million
B-1 POWERED & NON-POWERED AGE (MISCELLANEOUS PARTS)	~50	~\$100,000 + Mission Support Increase
<u>AFGSC LATERIAL SUPPORT</u>		
ICBM CHAFFING PERVENTION	Unknown	
ROTORY WING SUPPORT AIRCRAFT	Unknown	
B-52 MISCELLANOUS PANEL REPAIR	Unknown	

Potential Annual Savings
\$7,688,000

AFREP Credits Returned to
Ellsworth \$6,150,400





AMRRF Facility

Process Hazard Analysis

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Review Cold Spray Safety Report

Dust Hazard Analysis

- Written report (Draft Form)
 - Completed 11 October 2016
- Recommendations implementation plan
- 6 Immediate Action Items Required for NFPA Compliance
 - ① Dust Level sensor & micro-switch into red BOSS secondary explosion damper (NFPA 69)
 - ② Installation of three 8" dia. hard-pipe connections from dust collector hoppers (NFPA 69)
 - ③ Placard the dust collector and outdoor locations with appropriate warning signage (NFPA 484)
 - ④ Amerex ABC dry-chemical suppression system should be clearly marked (NFPA 484)
 - ⑤ The entire dust collection system, including ductwork and filters must be completely bonded and grounded (NFPA 77)
 - ⑥ In-line fixed curved blade spark suppressor assembly to thoroughly agitate / disrupt laminar gas flow in the booth exhaust duct (NFPA 484) (install slated for 16 June 2017)





AMRRF Facility

Key Requirements



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Facility & Installation:

- Operational - 1 July 2017
- Implement PHA NFPA Compliance requirements
- Integrate Robot and VRC GEN III Cold Spray Equipment
- Develop Funding Procurement Procedures



Equipment Maintenance & Repair:

- Develop Maintenance Manuals
- Develop Training Procedures
 - Provided by equipment vendors according to 28 BW Operating Instruction





AMRRF Facility

Key Requirements



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Operation:

- Complete testing on RIF components
 - CET process completed for the initial powder/substrate interaction expected by July 2017
- Focus on repair of AGE and other support equipment until CET process is complete
- Develop Component Induction and Validation Processes
- Exercise all functions required to operate on a federal installation
 - Operating Instructions
 - AFOSH Standard compliance
 - HAZCOM operations
 - Safety, fire prevention, bio-environmental



AMRRF Implementation Strategy



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3 Phase Plan

Phase 1 – Facility Start up

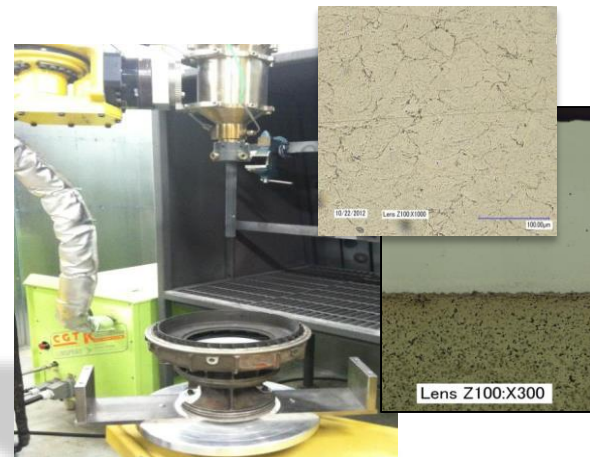
- Utilize existing Contractor procedures and processes for operating the facility until AF personnel system authorizes the manpower slots and AFSCs for trained Air Force personnel.
- Ensures Equipment and Process are fully Debugged and Operational

Phase 2 – Facility Operation and Training Program Development

- Combined Contractor and AF Personnel Running facility and developing the training plan
- Train first Round of AF Personnel

Phase 3 – Facility Operation

- AF Run with Contractor support





Take Away



- **Ellsworth facility is up and running!**
- **The Ellsworth facility is not just for B-1 parts. If you are a DOD entity and are interested in leveraging CS technology, we can help!**
- **Ellsworth paved the way for CS at the operational unit level. We know the roadblocks and pitfalls associated with setting up and operating a facility on a federal installation. If you are interested in following in Ellsworth's footsteps, we can help you!**
- **This facility has the potential to save the DOD millions of dollars annually, as well as increase aircraft/equipment availability and decrease part wait times (MICAP hours). This means better support for the warfighter!**