



# Aviation Engineering Directorate



## *Status of Cold Spray Repair Efforts for Magnesium Transmission Components*



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**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

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**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

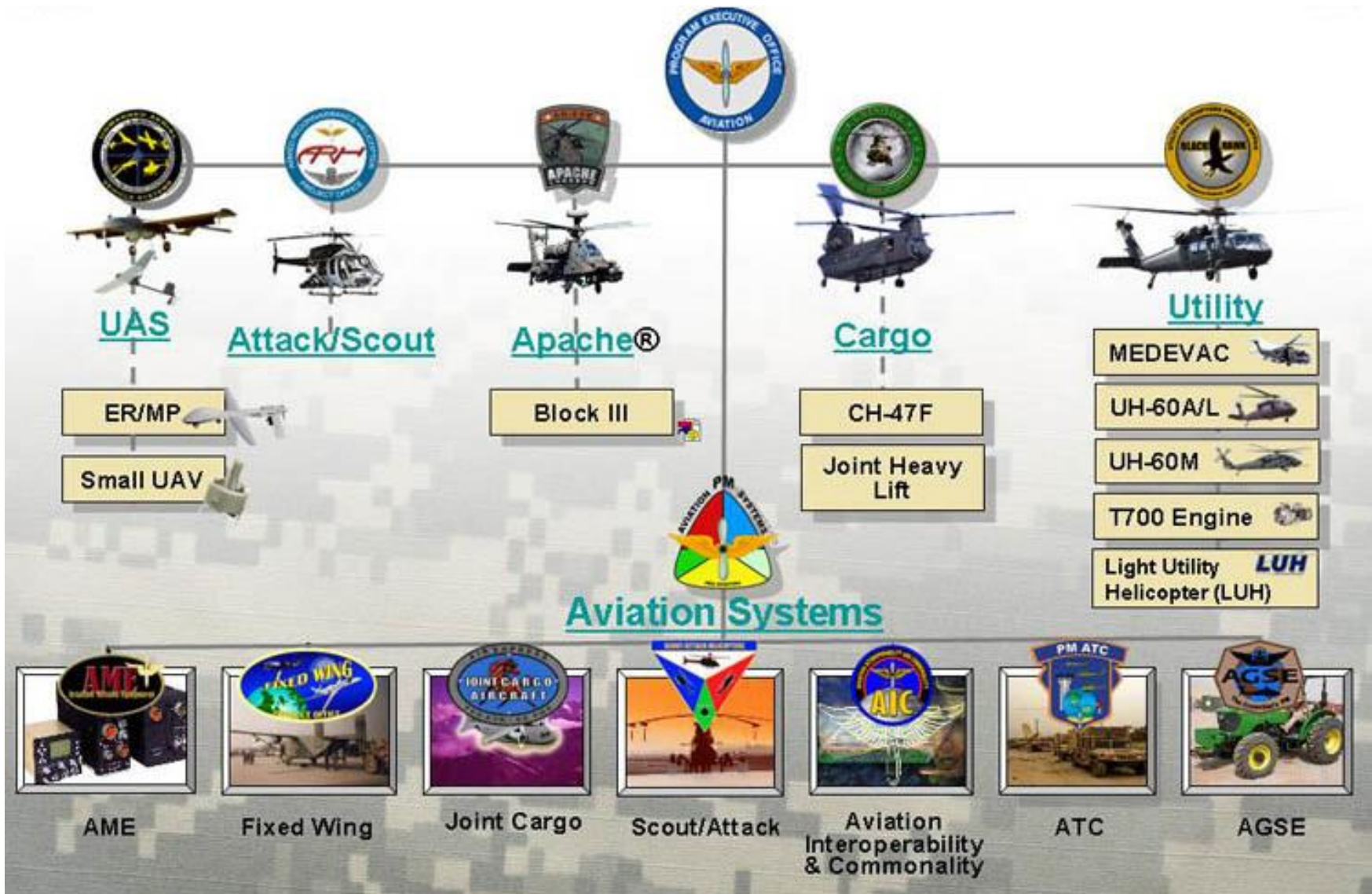


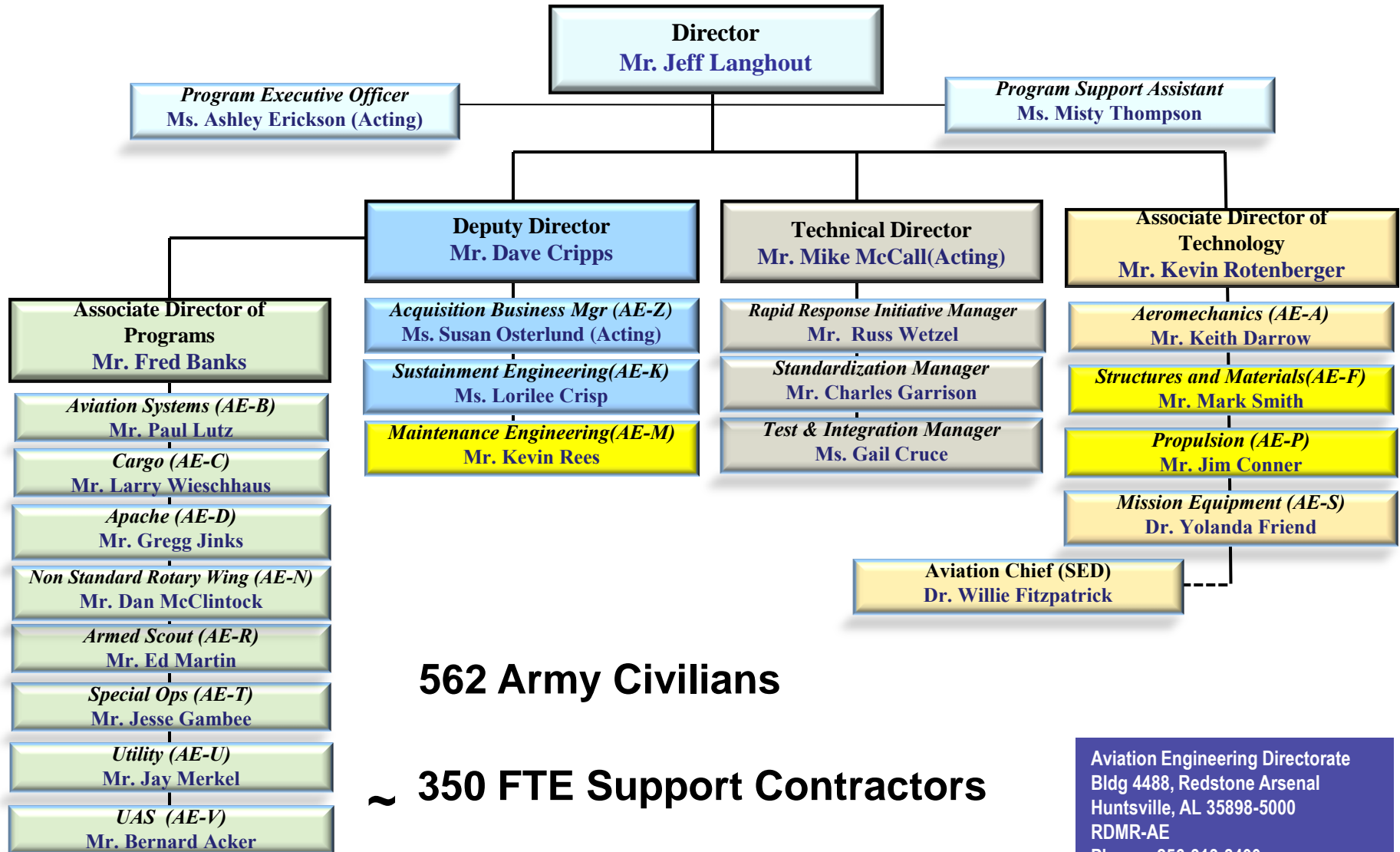
# Cold Spray Efforts - Introduction



- The Materials Branch of the Aviation Engineering Directorate (AEF-M) has notionally approved the use of cold spray repairs as developed by the Army Research Laboratory (ARL) for the repair of magnesium housings and gearboxes currently used in our aviation platforms.
- Groups involved in repair process approval and implementation.
- UH-60 Sump Repair Status
- AH-64 Intermediate Gear Support Repair Status
- Repair Opportunities in CH-47 Platform
- Repair opportunities in OH-58 Platform
- Summary

# PEO Aviation





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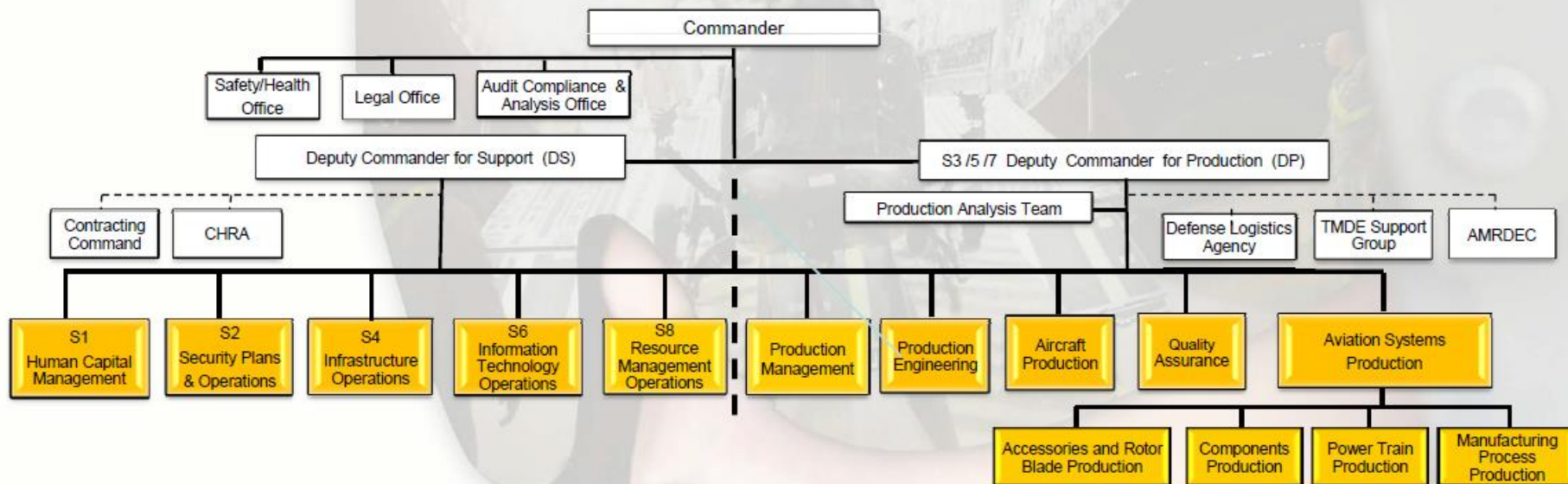


# Corpus Christi Army Depot



## Organization

*1<sup>st</sup> Comprehensive Reorganization in the Depot's 50-year history.*





- **PMO-** Each aircraft has its own Program Management Office; for sump repairs the cognizant organization is the Utility Helicopter Program Office, UH-PO; for the intermediate gear support the Apache Program Office has cognizance. As the “owners” of the aircraft platforms, these offices establish priorities for implementation of new repairs such as cold spray.
- **Systems Engineering:** this group acts as a liaison between the PM’s and AED platform and functional groups. Systems Engineers organize task assignments and consolidate the input of platform and functional groups into a single AED position memo.
- **DMWR – Depot Maintenance Work Requirements:** A document that provides step by step instructions for depot level maintenance efforts.
- **MEO – Maintenance Engineering Order:** Written by AEM, once approved it revises the DMWR.



## **Aviation Engineering Directorate in Cold Spray Approval - Roles and Definitions (continued)**



- **AEF Materials:** has cognizance for all new materials and processes and evaluates them in terms of airworthiness and sustainability.
- **AEP Propulsion:** has structural cognizance for transmission components; in this case, magnesium housings.
- **MED Maintenance Engineering Division:** Identifies repair opportunities in the SAFR inventory and submits MEO's for approval to revise DMWR's when new processes are approved.
- **CCAD:** The Corpus Christi Army Depot is responsible for executing approved repairs either in house or via approved contractors. They also work closely with units and PMO's to determine emerging needs.
- **Summary:** the efforts of seven separate organizations (including ARL) must be coordinated just for the approval of a specific cold spray repair. The logistics for returning a repaired part to active inventory involves many other organizations.

# Candidate Parts for Cold Spray Repairs

- On 26-28 April 2011 a review of rotorcraft parts in the SAFR inventory at CCAD determined that there were \$3.5M in corrosion damaged magnesium parts in the SAFR inventory. The implementation of cold spray provides an opportunity for each aviation platform to salvage a significant portion of the magnesium housings that are currently considered beyond economical repair (BER).

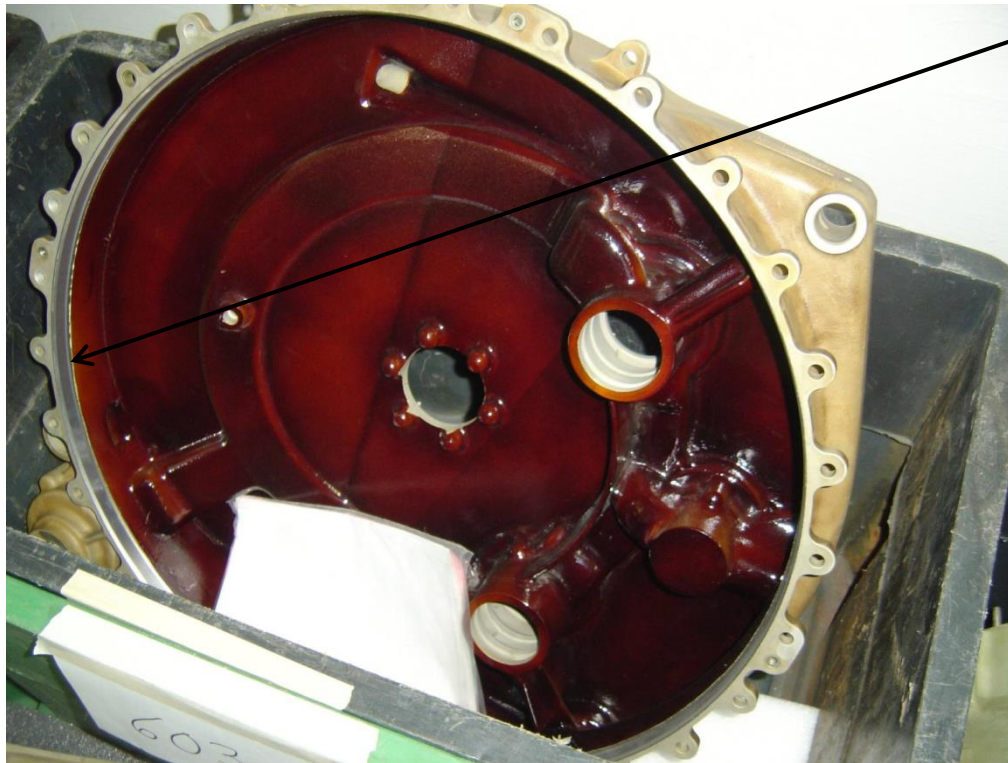




## UH-60 SAFR COMPONENTS WITH POTENTIAL FOR SALVAGE USING COLD SPRAY

PN:	NSN:	NOMEN:	SYSTEM:	Qty	COST/UNIT	Cold Spray Candidate
70351-08134-042	1680-01-093-2328	HOUSING ASSY, LOWER	H60	48	\$12,835.00	Yes
70351-08110-045	1615-01-110-1491	HOUSING ASSY, MAIN MODULE	H60	19	\$34,850.00	Yes
70351-08003-041	1615-01-090-5929	HOUSING ASSY INPUT	H60	14	\$3,381.00	Yes
70358-26607-042	1615-01-266-4509	HOUSING GEARBOX	H60	7	\$1,527.00	Yes
70351-08018-042	1615-01-090-5939	HOUSING ASSY, GEARBOX	H60	6	\$3,077.00	Yes
70351-08102-042	1615-01-092-2006	HOUSING ASSY, INPUT	H60	6	\$456.00	Yes
70357-06305-042	1615-01-125-0779	HOUSING ASSY, GEARBOX, CTR	H60	5	\$4,549.00	Yes
70351-08085-044	1615-01-152-2358	COVER ASSY, LINER AND STUD	H60	5	\$2,673.00	Possible
70358-06609-043	1615-01-376-4398	HOUSING AND LINER ASSY	H60	4	\$2,856.00	Yes
70351-08141-047	2915-01-266-4507	SUMP HOUSING ASSY	H60	4	\$18,751.00	Yes
70351-08015-042	3040-01-095-7220	HOUSING, MECHANICAL DRIVE	H60	4	\$6,583.00	Yes
70351-38110-045	3040-01-371-4276	MAIN XMSN HOUSING	H60	4	\$58,774.00	Yes
70357-06306-041	1615-01-105-6409	HOUSING/LINER ASSY, OUTPUT	H60	1	\$3,546.00	Yes
70358-06609-042	1615-01-134-2542	HOUSING & LINER ASSY	H60	1	\$2,856.00	Yes
70358-06605-042	1680-01-112-2971	HOUSING ASSEMBLY, GEARBOX INPUT	H60	1	\$1,925.00	Yes
INVENTORY VALUE					\$1,749,744.00	

- Sump part number 70351-48140-042.



The O'Ring groove on the large diameter is the focal point of the sump repair



## UH-60 Sump Repair – Current Status



- **AEF and AEP have approved the cold spray repair of the sump to the same levels as the previously approved HVOF repair. The current status of the sump repair is as follows:**
  - a. MEO T 7631B has been issued by MED, it will allow MED to revise DMWR 1-1615-372 to include the cold spray repair of the sump.**
  - b. ARL has received a sump from the SAFR inventory and has completed preparatory machining. Application of the cold spray repair is planned by end of June 2013.**
  - c. A destructive first article examination of the cold spray repaired part is required. The 6061 cold spray microstructure and its interface with the substrate will be evaluated and photographically documented.**



## AH-64 SAFR COMPONENTS WITH POTENTIAL FOR SALVAGE USING COLD SPRAY

PN:	NSN:	NOMEN:	SYSTEM:	Qty	COST/UNIT	Cold Spray Candidate
7-311340011-5	1615-01-433-8519	HOUSING, TRANSMISSION	AH64	39	\$2,588.76	Yes
7-311340012	1615-01-155-6590	TRGB COVER	AH64	17	\$10,053.00	Possible
7-311310018	1615-01-163-0961	COVER ASSY ACCESSORY	AH64	10	\$31,548.75	Possible
7-311310012	1615-01-171-7704	HOUSING ASSY INPUT	AH64	5	\$1,401.00	Yes
7-311340012-5	1615-01-155-6590	TRGB COVER	AH64	3	\$10,053.00	Possible
7-311310011-5	1615-01-252-6377	HOUSING XMSN CASE	AH64	3	\$2,588.76	Yes
7-311310011-9	1615-01-461-5083	HOUSING ASSY, MAIN XMSN	AH64	1	\$38,798.00	Yes
7-311320011-5	2840-01-374-1946	HOUSING, GEARBOX,TUR LH	AH64	1	\$14,639.61	Yes
7-311320011-6	2840-01-375-0814	ENGB HSG R/H	AH64	1	\$20,153.13	Yes
7-311310260	3040-01-171-7855	HOUSING MECH DRIVE	AH64	1	\$605.34	Yes
7-311310015-5	1615-01-215-4786	SUPPORT, GEAR, INTERM	AH64	15	\$14,217.53	Yes
INVENTORY VALUE					\$919,739.45	

# Apache Intermediate Gear Support P/N 7-311310015-5.



The arrow shows the contact surface with witness marks left by the gear teeth. This area is also susceptible to pitting corrosion and fretting damage



- AEF and AEP have notionally approved this cold spray repair of the top land with defects up to .050” in depth.
- Current Status: ARL has completed the cold spray repair of two gear supports from the SAFR inventory and the first article inspection is under way. An additional part has returned to the CCAD labs for their evaluation.



## CH-47 SAFR COMPONENTS WITH POTENTIAL FOR SALVAGE USING COLD SPRAY

PN:	NSN:	NOMEN:	SYSTEM:	Qty	COST/UNIT	Cold Spray Candidate
728676	4140-01-115-3707	IMPELLER FAN AXIAL	CH47	14	\$10,704.95	Possible
145D5302-3	1615-01-114-2154	MAIN HOUSING	CH47	5	\$6,319.00	Yes
145D5314-4	1615-01-116-7083	CARTRIDGE, INPUT	CH47	4	\$6,319.00	Possible
145D2309-3	1615-01-113-0227	AFT HOUSING TRANSMISSION	CH47	3	\$62,276.00	Yes
145D2307-5	1615-01-113-0228	HOUSING MAIN XMSN	CH47	3	\$110,870.00	Yes
145D5322-3	1615-01-113-0242	SUMP COVER	CH47	2	\$19,605.00	Yes
145D5304-3	1615-01-116-2917	HOUSING ASSY TRANSMISSION	CH47	1	\$14,251.00	Yes
145D5307-7	3040-01-315-3975	HOUSING MECHANICAL DRIVE (CARTRIDGE)	CH47	1	\$6,713.00	Yes
INVENTORY VALUE					\$786,352.30	

**CH-47 AFT Transmission Housing, 145D2309-3. Areas of interest for cold spray repair are the generator oil bore and the stud area.**



**CH-47 Combiner Sump Cover, 145D5322-3. Areas of interest for cold spray repair are the bolt holes and facing area**



Pitting  
Corrosion

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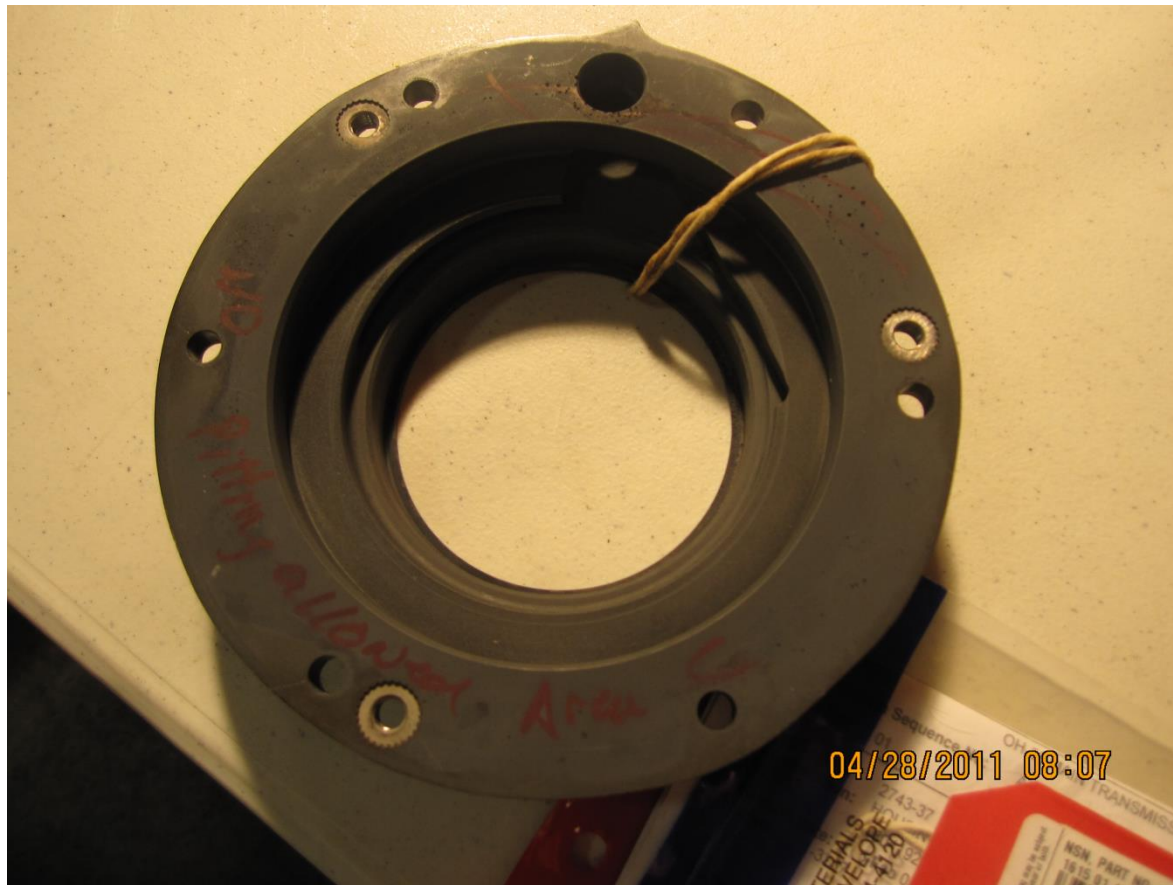


## OH-58 SAFR COMPONENTS WITH POTENTIAL FOR SALVAGE USING COLD SPRAY

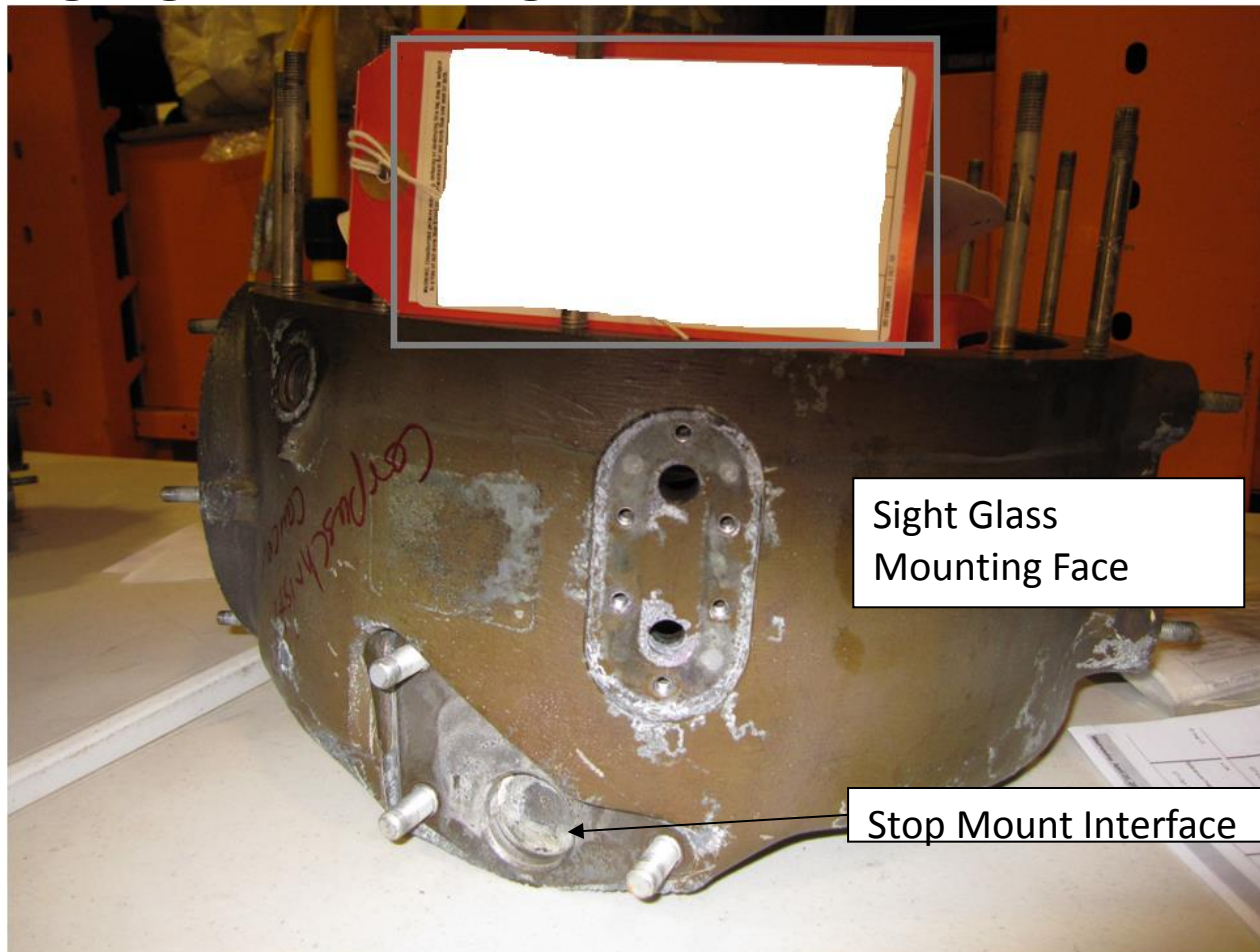
PN:	NSN:	NOMEN:	SYSTEM:	Qty	COST/UNIT	Cold Spray Candidate
400-040-050-113	1615-01-442-2139	CASE ASSY, MAIN TRANSMISSION	OH58	6	\$21,443.00	Yes
406-040-406-101	1615-01-164-6734	CASE ASSY	OH58	4	\$6,769.00	Yes
400-040-050-101	1615-01-226-4685	CASE ASSY, MAIN TRANSMISSION	OH58	3	\$10,512.00	Yes
400-040-055-109	1615-01-475-8955	HOUSING ASSEMBLY	OH58	2	\$1,380.00	Yes
406-040-056-105	3040-01-338-5386	HOUSING MECHANICAL DRIVE	OH58	2	\$5,130.00	Yes
				INVENTORY VALUE	\$200,290.00	



**OH-58 Housing Assembly, 400-040-055-109. Proposed areas for cold spray repair are the bolt holes and the mounting face. The mounting face is subject to pitting**



**OH-58 Main Transmission Case Assembly, 400-040-050-101.**  
**Areas of interest for cold spray repair are the stop mounts and the sight glass mounting face.**





## Additional AED Cold Spray Efforts



- **Cold Spray to Replace Epoxy Repairs:** Task Numbers 118943, 118944, 118946 and 118947 have been initiated to include cold spray repair as a drop in replacement for epoxy repairs for all magnesium housings. AEM identified the current epoxy repairs and submitted MEO's to revise current Depot Maintenance Work Requirements DMWR's.
- **Current status:** All four MEO's have been reviewed and returned to MED for revision.



## Cold Spray Efforts - Summary



- The efforts to approve and implement cold spray repairs for Army Aviation assets are progressing with two non structural repairs approved.
- ARL has completed preparatory machining on a UH-60 sump from the SAFR inventory and plans to complete the cold spray repair by 27 June 2013.
- ARL has completed the cold spray repair of two AH-64 intermediate gear supports with one currently in first article testing and the second unit being evaluated by the CCAD labs. The first article test report will be available by 27 June 2013.
- Successful implementation of the two currently approve non structural repairs will build momentum for the approval of other more complex applications with structural aspects such as the UH-60L lower housing / stud and liner assembly.