



Cold Spray Repairs of Aircraft, Engine and Rotorcraft Components Using a Proven NOT Novel Technology

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14 CFR Parts 23, 25, 27, 29, 33, 35 for Mechanical Systems and Equipment, Powerplant EBUs, Engines, Propellers, Rotorcraft Transmissions, Wheels and Brakes hwmroch@mrotechnologies.com





Select projects completed in 2018:

- 1) The first of many S-61 Stationary Swashplates cold spray replacing plasma spray
- 2) Multiple PT6A Rear Reduction Gearbox Housings cold spray replacing plasma spray
- 3) Multiple PT6A Compressor Air Inlet Housings cold spray replacing plasma spray
- 4) Multiple 107-II Fan Housing and End Bell Repairs cold spray replacing welding
- 5) Multiple Aircraft MLG and NLG Wheels new cold spray and Nanofusion repairs
- 6) The first of many Aircraft Control Tube new cold spray repairs
- 7) Various 54H60 and other Hamilton Standard Propeller Hardware in repair development
- 8) Plus many more...





Premise – Many older technologies are largely outdated in performance, durability and even cost.

Most prominent repairs of aluminum and magnesium components use TIG welding, electroplated coatings, plasma spray or some other thermal spray. Coatings have worked well but were never been ideal. Welding has its own inherent problems.

Welding – generally creates a heat affected zone (HAZ) diminishing original material properties

Thermal spray/plasma spray – hard and durable but their primary pitfall is their brittle nature. They chip and delaminate quite easily. Risk of rework is always high.

Plated coatings – electroplating of aluminum is well understood. Electroplating of magnesium is pretty much nonexistent for engineering coatings. High risks are associated with bath chemistry and the always present potential for scrapping a part.





Primary reasons for our success in the repair of parts using cold spray has been:

1) We have done actual assembly, engine or transmission testing with our team members

2) We are using a cold spray source that has sprayed THE MOST aircraft engine components of any supplier in the "open marketplace" for just major engine OEMS with a total count of over 3000 engine parts to date. This doesn't even include all other applications developed. We use the solution that makes the most sense. So the technology is **PROVEN** <u>NOT</u> NEW and NOVEL. In many cases it is well over 10+ years old. In fact some OEMs already have cold spray listed in their standard practices.

3) Existing OEM repairs in most cases consist of either epoxy patches or plasma spray repairs. Frankly these couldnt pass a thermal shock test let alone a tape test in many cases.

4) Our repairs meet or exceed any FAA requirements or guidance for repairing piece parts.

5) Our repairs are **DOUBLE GREEN** – Green for the reuse of materials and Green back in your pocketbook.





Typical component issues from service include galling, fretting, corrosion, null point dwell, handling damage

On less frequent occasions we have seen the actual **results of poorly designed previous repairs** including "bondo" type repairs, plasma repairs on the substrate which often are poor choices, or even plasma repairs which were allowed to cover up case drains leading to additional substrate corrosion.

Our philosophy is to maintain the maximum substrate material possible without degrading the coating or substrate performance.

Cold spray really is simply another tool in the toolbox for repair engineers that understand what the purpose of the repair is going to be and what the hardware actually does.





ALL PARTS ARE NOT GOOD COLD SPRAY CANDIDATES





BUT FORTUNATELY MANY ARE GOOD DUE TO POORLY DESIGNED REPAIRS.... WHILE THIS SIDE OF THIS DIAPHRAGM LOOKS PERFECTLY GOOD AFTER REPAIR IT COULDN'T HANDLE EVEN A SIMPLE BAKE TO CURE TO THE PAINT





THE OPPOSITE SIDE OF THE DIAPHRAGM. PLASMA SPRAY ALREADY LIFTING BEFORE IT WAS EVEN IN SERVICE - INSTALLED ON AN ENGINE







ANOTHER EXAMPLE OF PLASMA SPRAY FAILURE



THIS REPAIR WAS HALTED BY PWC DUE TO ITS INHERENT PERFORMANCE PROBLEMS

Cold Spray Action Team **2019 INCOMPACTOR ANOTHER EXAMPLE OF PLASMA SPRAY MISAPPLICATION**







AFTER PLASMA REMOVAL A FILLER WAS FOUND AND REMOVED REVEALING A CASE DRAIN WHICH HAD BEEN COMPLETELY COVERED





FINISHED FEATURES AFTER COLD SPRAY AND MACHINING OPERATIONS



FINISH MACHINED RGB FLANGE AND SIDE

FINISHED OD AND SEAL GROOVE ON AIH

DER APPROVED REPAIRS

Cold Spray Action Team 2019 Image: Cold Spray Action Team 2019 Image: Cold Spray Action Team

FINISHED RGB HOUSING AND TYPICAL ORIGINAL PLASMA DELAMINATED VERSION





FINISHED COMPRESSOR AIR INLET HOUSING



DER APPROVED REPAIR



FINISHED PT6A ENGINE SHOWING LOCATION OF REPAIRED PARTS







WHAT HAS BEEN DONE TO TEST THE COLD SPRAY ENGINE PARTS?

1) BASELINE REPAIRS DEVELOPED IN ACCORDANCE WITH FAA GUIDELINES 2) ALL PARTS PREMACHINED AND QUALIFIED **3) ALL PARTS NDT INSPECTED FOR DEFECTS** 4) ALL PARTS COLD SPRAYED USING CHARACTERIZED POWDERS AND EQUIPMENT 5) ALL PARTS POST MACHINED USING BEST PRACTICES ESTABLISHED. MOST SEVERE CONDITION. 6) ALL PARTS NDT INSPECTED FOR DEFECTS 7) SOME PARTS UNDERWENT 400°F HOT SOAK FOLLOWED BY COLD (-10°F) SOAK. SEVERE CONDITION. 8) ALL PARTS POST PROCESSED PER OEM REQUIREMENTS FOR PRIME AND PAINT 9) ALL PARTS CHECKED FOR CONFORMANCE WITH THE ACCEPTED AND APPROVED DATA **10) ALL PARTS CERTIFIED WITH AN 8130-3** 11) ALL PARTS ASSEMBLED INTO AN ENGINE AND UNDERWENT OHM TESTING WITHOUT ISSUE **12) ALL REPORTS FINALIZED AND APPROVED FOR USE BY FAA DER**





S-61 STATIONARY SWASHPLATE REPAIR







S-61 STATIONARY SWASHPLATE FINISHED







SAMPLE MAGNESIUM WHEEL







DER APPROVED REPAIR

MANY, MANY ALUMINUM WHEELS OF ALL SIZES AND VARIED AIRCRAFT HAVE HAD FEATURES REPAIRED





SAMPLE FLIGHT CONTROL TUBE



DER APPROVED REPAIR



SAMPLE VENTILATION FAN HOUSING



DER APPROVED REPAIR





SUMMARY AND QUESTIONS?

REPAIRS SHOWN WERE PERFORMED IN TYPICALLY LESS THAN 2 MONTHS FROM REPAIR CONCEPT TO COMPLETION. **MOST REPAIRS DONT HAVE TO TAKE THAT LONG TO DEVELOP**.

ACTUAL HANDS ON TIME FOR THESE PART PROJECTS IN THE WORST CASE ARE 8 HOURS TO BUILD TOOLING, 4 HRS PREMACHINE, 2 HRS NDT, 4 HRS COLD SPRAY, 8 HRS FINISH MACHINE, 2 HRS FINAL NDT – TOTAL ACTUAL TOUCH TIME 24 HOURS.

IF YOU NEED HELP GETTING YOUR REPAIRS DONE FASTER **WE ARE HERE TO HELP.** POOR ASSUMPTIONS LEAD TO POOR RESULTS. WE CAN HELP YOU AVOID THOSE MISTAKES.

WE TEAM WITH EXPERTS IN COMPONENT REPAIR, OPERATORS, ENGINEERS AND REPAIR STATIONS.

QUESTIONS?