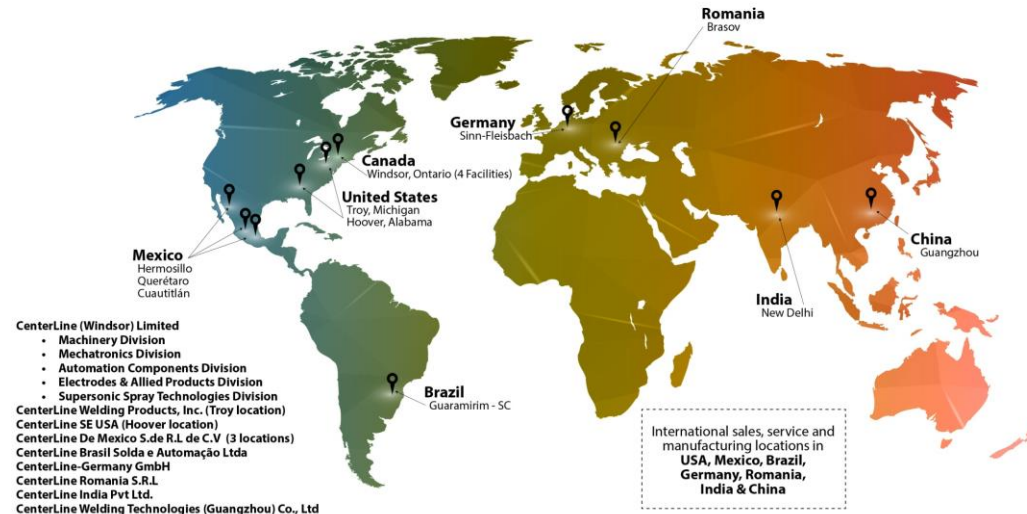


SST™ Cold Spray Technology Keeping Historical Aircraft Airworthy



- Privately held, Windsor Ontario Canada based organization, established in 1957
- Over 43,670 m² (470,000 sq.ft.) of manufacturing space in four (4) facilities in Windsor housing five (5) divisions: **Machinery, Electrodes, Automation Components, Supersonic Spray Technologies (SST) and Mechatronics**
- Expertise in a variety of processes including: **Resistance Welding, GMAW, Metal Forming, Mechanical Assembly, Cold Spray Metal Consolidation**
- Global Reach, with a number of affiliates and sales offices around the World



Since 2003

- Innovating downstream injection cold spray systems
- Today :
 - SST™ PX and EPX cold spray systems
 - SST™ integrated std turnkey solutions
 - SST™ integrated custom solutions
 - SST™ Cold Spray Grade Powders
 - SST™ Accessories, Consumables and spare parts
 - Process Development and Qualification
 - Jobshop Services





- Chipmunk Aircraft named after the squirrel
- Post-war vintage aircraft developed in 1946 by DeHavilland Canada, now part of Bombardier
- Tandem single engine
- Hundreds of Chipmunks remain airworthy around the world, used primarily as a trainer aircraft
- Spare parts for these aircraft are either scarce, price prohibited, or not possible to repair using conventional techniques



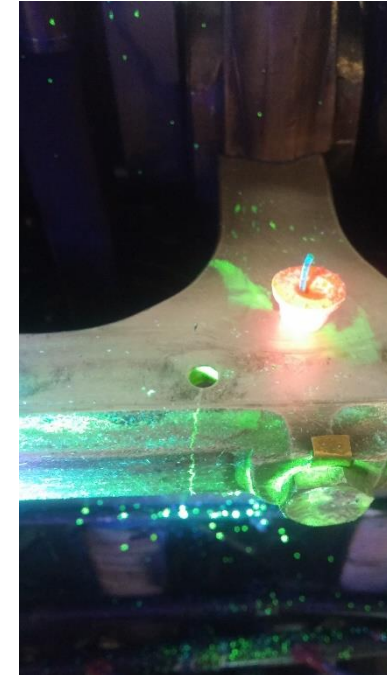
DeHallivand DHC-1 # 054 RCAF Aircraft Gypsy DH Major 10MK1-3A engine

*Canadian Historical Aircraft Association
Maintenance Manual – Transport Canada Approved
- grounded due to engine oil leak*

- ✓ Liquid Penetrant NDT ASME PT-1. 5200 2015 -R1
- ✓ Upper engine cover flange - Magnesium cast alloy
- ✓ Lower Crankcase bolt region - aluminum cast alloy



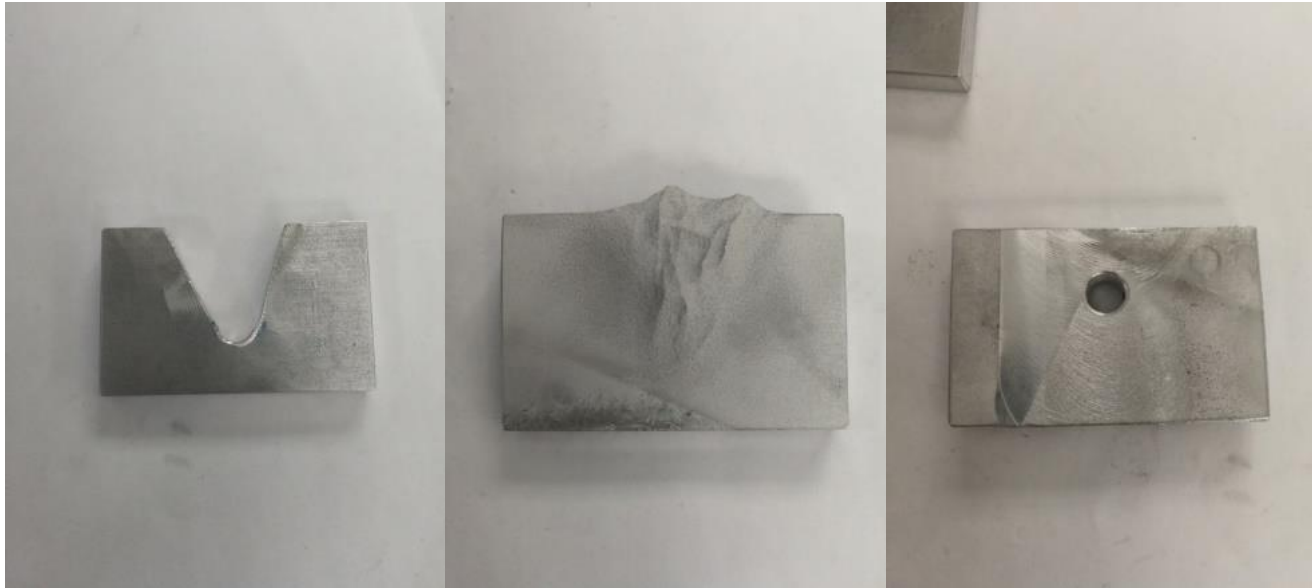
- Crack present at a flange in the upper cover eradicating fastening point to the lower crankcase
- Crack present at the bolt region in the lower crankcase
- Both Magnesium and Aluminum cast alloys would not tolerate elevated temperature repair processes, such as welding



Due to the already weakened material condition, SST recommended that both the cracked flange at the cover as well as the cracked region at the lower crankcase be completely removed. The missing feature would be rebuilt using the SST cold spray process



- Worked with Transport Canada and Fliteline to Design the NEW Repair Procedure
- New Repair Procedure based on MIL-STD-3021 for non-structural repair (2008-2015)
- Required simulation samples for hand free-form spraying
 - ✓ ¼" hole, same distance to edge as in block, cut through at 25 Degree
 - ✓ Hand free-form spray & machine



TC Process Design Repair Doc #1701 Rev 1. 29/11/17

TC Maintenance Manual Supp #1701M Rev 1. 5/12/17

- **SST Series P machine with Manual Spray gun – 2.0mm orifice – UltiLife™ Nozzle**
- Remove damaged sections
- Surface prepare with SST-G0002 to roughen surfaces
- Hand spray damaged areas with SST-A0082 using:
 - Nitrogen
 - 180 psi (12.5 bar) / 425C
- Conventional machining to dimensional tolerances
- CMM dimensional verification
- Assembly and release

Material Properties

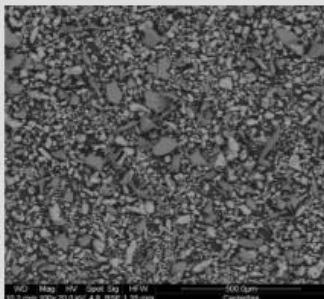
Composition:	Al 99.5% Min., Al ₂ O ₃ 99.0% Min.
Particle Size:	-75 to +5 µm
Characteristics:	Irregular shaped particles for maximum velocity

Typical Coating Properties

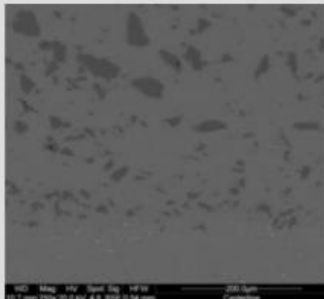
	<u>Series P/PX</u>	<u>Series EP/EPX</u>
Bond Strength*:	> 6000 psi	> 7500 psi
Hardness (Brinell):	57 – 62	60 – 63
Density:	> 99.5%	> 99.5%
Deposition Efficiency:	Up to 20%	Up to 40%
Deposition Rate:	Up to 5 g/min	Up to 30 g/min

**Higher bond strengths can be achieved. Please consult with CenterLine to receive assistance in optimizing the spray parameters.*

Typical Micrograph



SST-A0082 Powder



SST-A0082 Coating on Al6061
(Series EP)

Spray Parameter Ranges

Spray parameters only apply to CenterLine Cold Spray equipment.

	<u>Series P/PX</u>	<u>Series EP/EPX</u>
Temperature:	300 – 500°C	300 – 550°C
Pressure:	100 – 250 psi	100 – 500 psi
Powder Pre-heating:	N/A	N/A
Standoff Distance:	10 – 25 mm	10 – 40 mm
Gas:	Compressed air or Nitrogen	
Feed Rate (gram/min):	12 – 25	12 – 80
Gun Traverse Speed:	10 – 500 mm/s depending on process settings and target coating thickness	
Surface Preparation:	SST-G0002 commercial blast	
Spray Nozzle:	UltiLife™	

Ordering

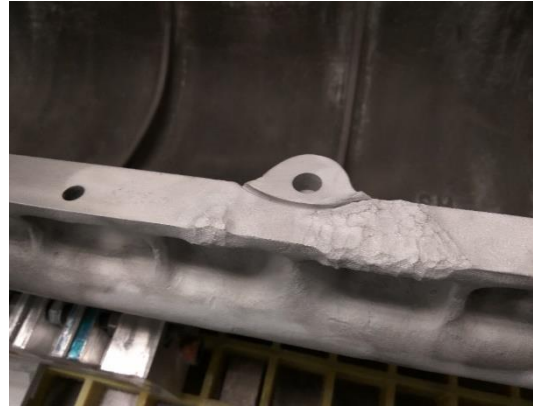
Catalogue Number:	SST-A0082
Standard Packaging:	400 ml or 1 gallon sized container
Selling Unit:	Pound
Material Certification:	Available upon request

To discuss your Cold Spray Application(s), including the optimization of spray parameters for higher coating bond strengths, or for more information about powders and blends, please contact your CenterLine SST representative or visit our website at www.supersonicspray.com.

Before



as sprayed



machined

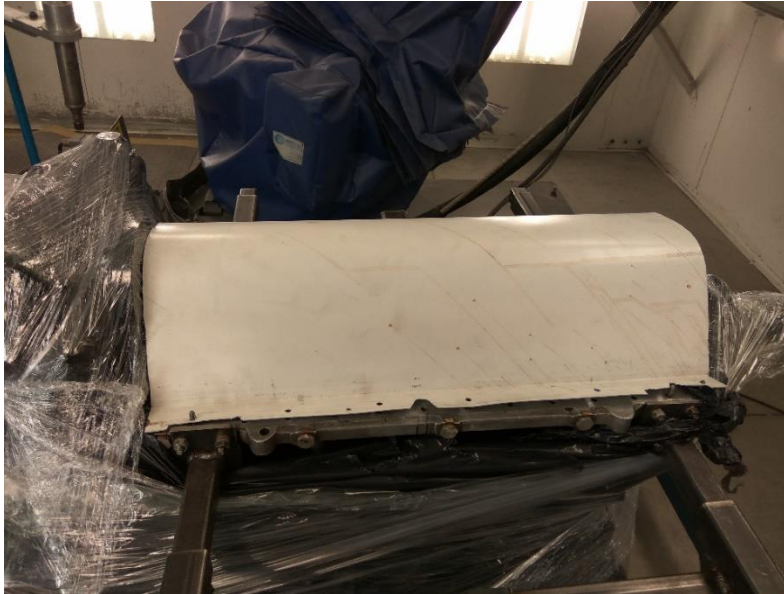


- Masking was not necessary
- Gasket thickness was quite small so distortion was not allowed



In this case masking was necessary to

- ✓ Avoid tear down/disassembly of the engine
- ✓ Protect engine components during spraying and post machining
- ✓ did not have to drain the oil



before

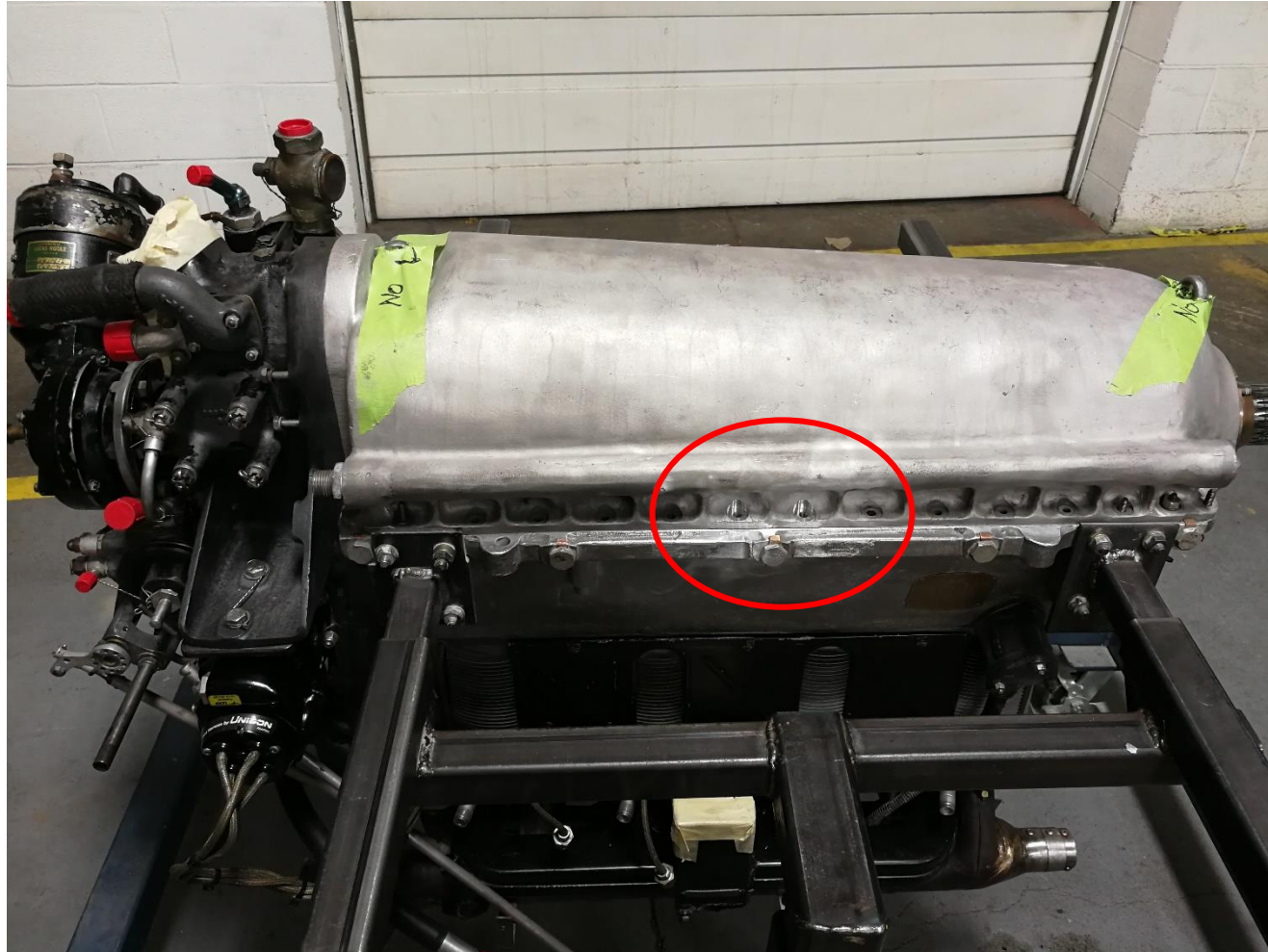


As sprayed



Machined





- ***Engine cover flange repair Approval Summary***
- TC Process Design Repair Document 1701 rev 1. 29/11/17
- TC Maintenance Manual Supplement 1701M rev 1. 5/12/17
- TC–Canadian Aviation Regulation - Approval O-RA17-139 dated 8/12/17
- Once the repair was done the subsequent installation on the engine into the aircraft and return to service of the aircraft was certified by AME/AMO in accordance with the Canadian Aviation Regulations PART V- Standard 571 – Maintenance
- After 50-flight hour the aircraft was re-inspected without any issues

- **SST Cold Spray proved to be a practical simple solution for critical dimensional restoration of hard-to-fix aircraft components**
- **Because adhesion is achieved in the solid state, cold spray is suitable for obtaining well bonded, low porosity, oxide-free deposits onto temperature-sensitive materials such as the ones used in this aircraft**



THANK YOU

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