

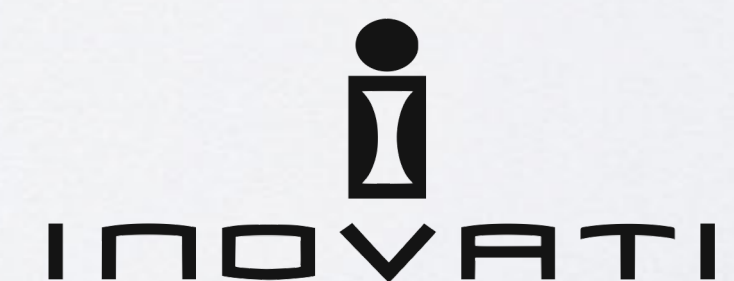
DIMENSIONAL RESTORATION OF
HIGH - VALUED MILITARY
COMPONENTS USING KINETIC
METALLIZATION™

Ralph Tapphorn, Howard Gabel and Travis Crowe

ITSC 2015 Presentation

MILITARY NEED

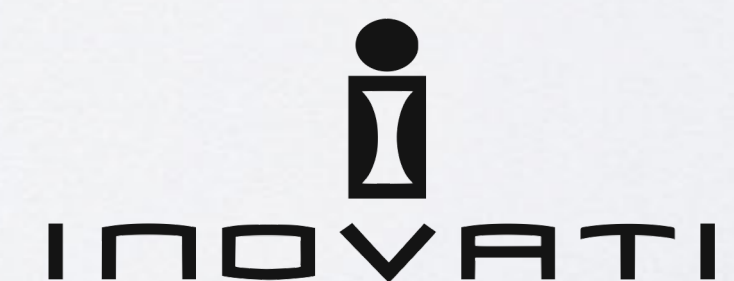
- Corrosion and Wear Protection
- Safe alternative to toxic heavy metals
- Dimensional Restoration of damaged or corroded parts



THE SOLUTION

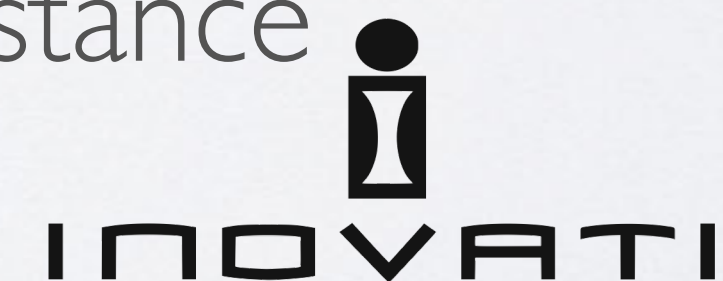
Kinetic Metallization™

- Reclaim High-Value Long-Lead Components
 - Deposit corrosion / wear resistant coatings
 - Replace Toxic Heavy Metals with
 - Non hazardous by products.

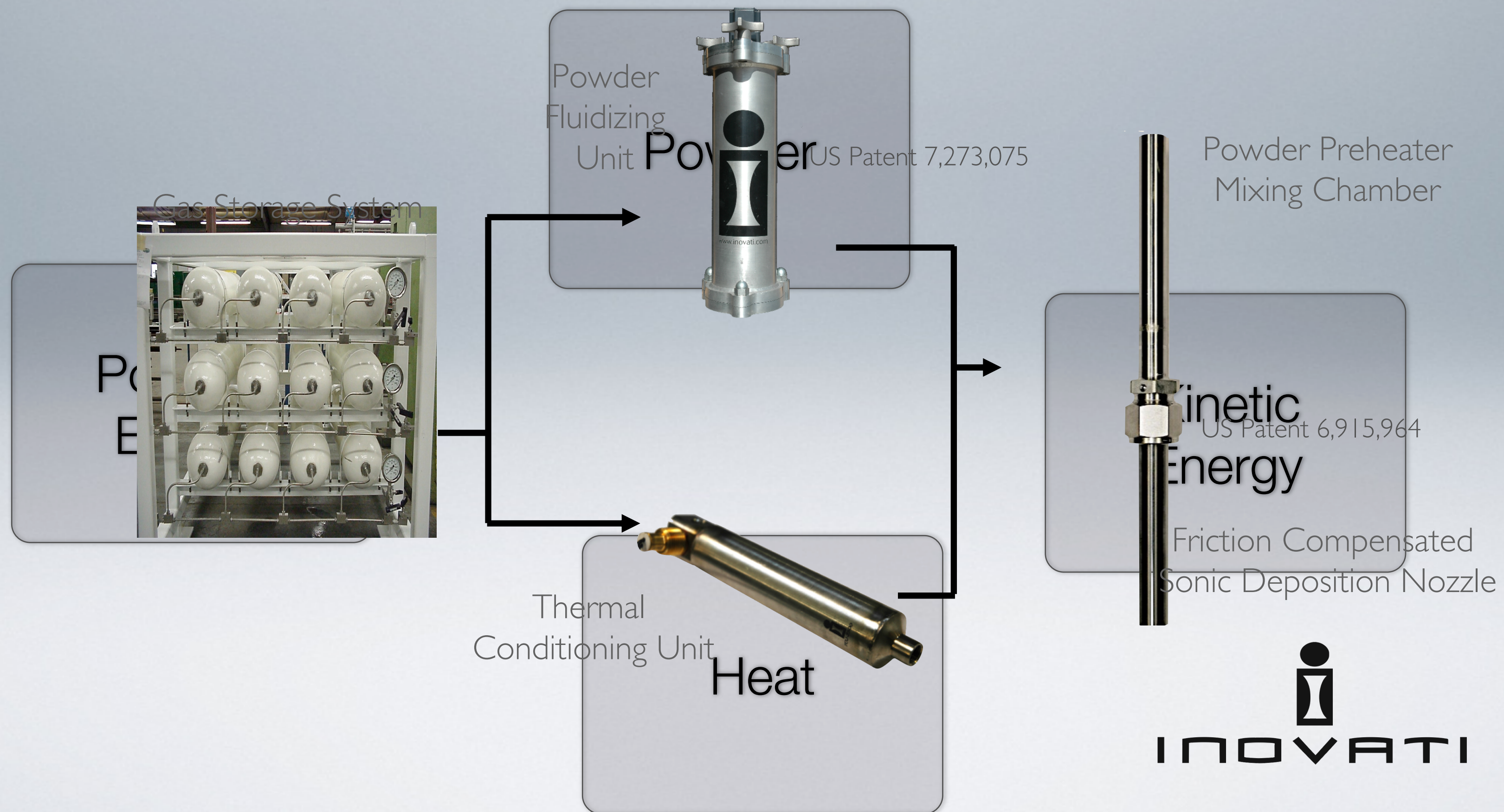


KINETIC METALLIZATION

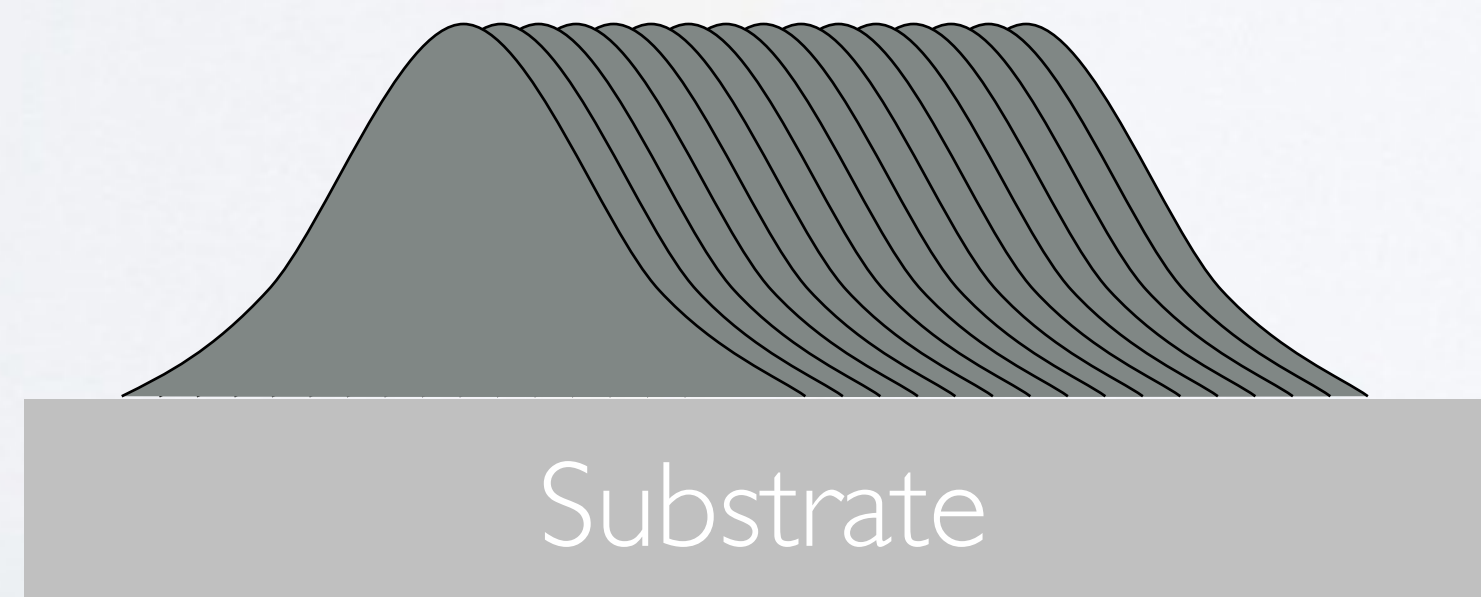
- Solid-state spray deposition process
- Patented sonic nozzle
 - Accelerate particles to high speeds
- Low temperature
- Low pressure
- Low cost
- Metallurgical bond
- Optimized feedstock
 - Machinability
 - Corrosion resistance
 - Wear resistance



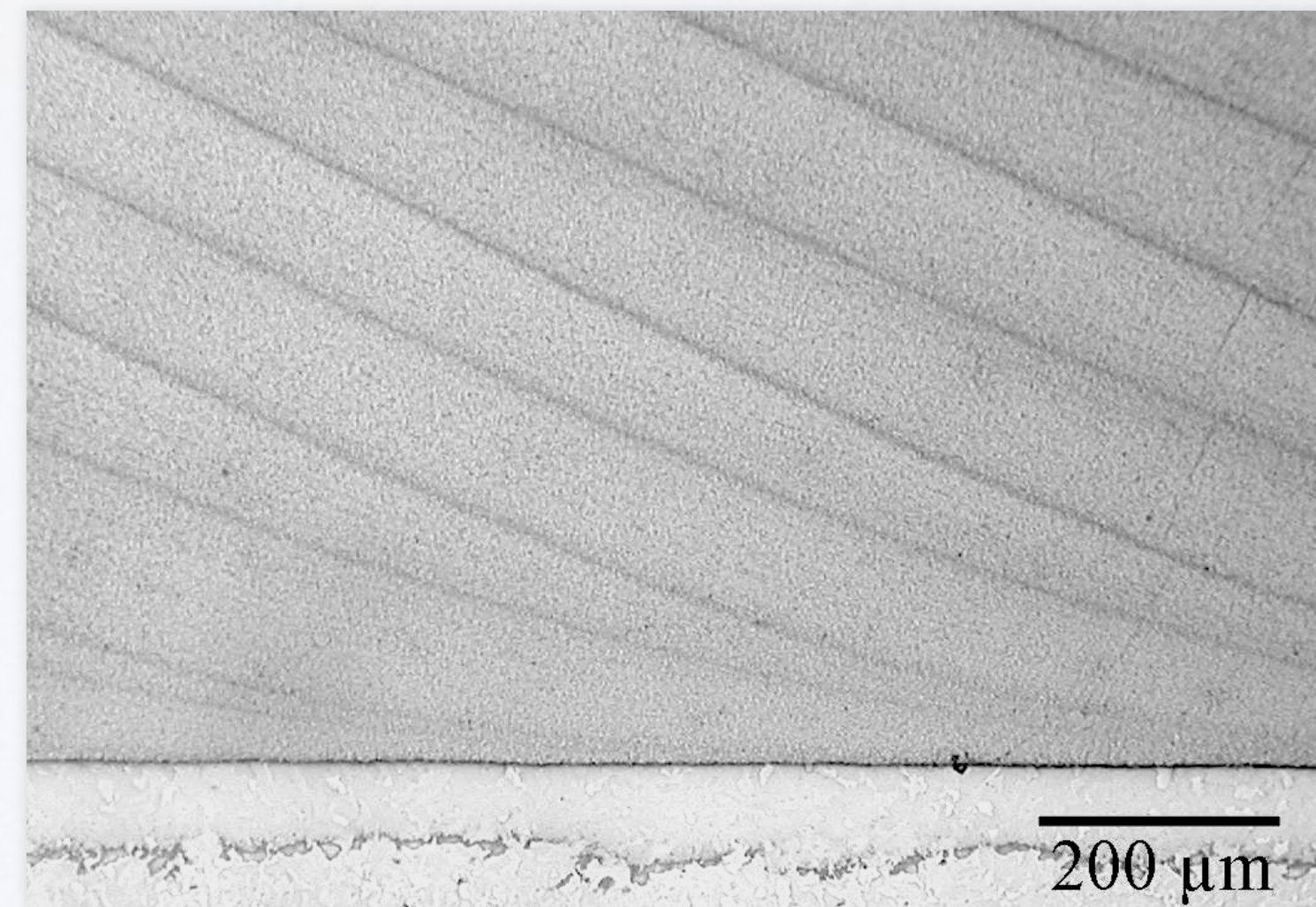
KINETIC METALLIZATION™ PROCESS



- Impact Consolidation Process
 - Feed-stock: fine powder,
 - Accelerant: inert light gas
- Solid-state Consolidation
 - No Melting
 - No Liquid Chemicals



- Environmentally Innocuous
 - No Particle release
 - No Chromate formation
 - No Hazardous Gas Emission
- Enhanced worker safety






POWDER FLUIDIZING UNITS

- Patented Brush-Sieve Design
- Light-weight pressure vessel
- Powder/ Gas flow rate independent
- Powder Size: 500nm - 50 μ m
- Feed Rate: 0-100g/min
- Large Capacity - 4 hour run time




INOVATI

KM QUALITY REPORT



Run Details

Operator	tcrowe	Customer	INOVATI
Date	1/16/15	Project	WC-Co Demo
Time	12:36:03	Task	Sample Coupon

Substrate

Material Group	Steel	Bond Coat	none
Alloy	4130	Preheat Temp	0
Surface Prep	Al2O3 Grit Blast	Thickness (in)	0.04
Surface Roughness	124		
Substrate Comment	3"Wx4"Lx0.40"		

Powder 1

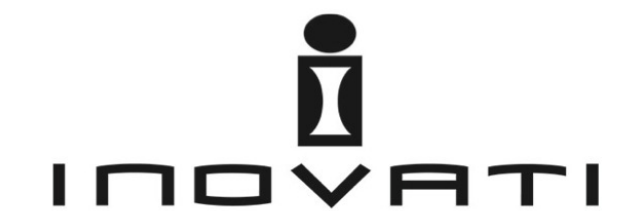
Material Group	Tungsten	Drying Method	None
Alloy	KM HF-10-10	Preblend?	No
Powder ID	0104-67	Set Point (%)	55
Sieve	35	Feed Rate (g/min)	30
Powder 1 Comment	-----		

Powder 2

Material Group	-----	Drying Method	-----
Alloy	-----	Preblend?	---
Powder ID	-----	Set Point (%)	0
Sieve	---	Feed Rate (g/min)	0
Powder 2 Comment	-----		

Nozzle

Type	Straight	Serial Number	1501
Throat Diameter (in)	0.059		
Nozzle Comment	-----		



Gas

PFU Gas	He
TCU Gas	He

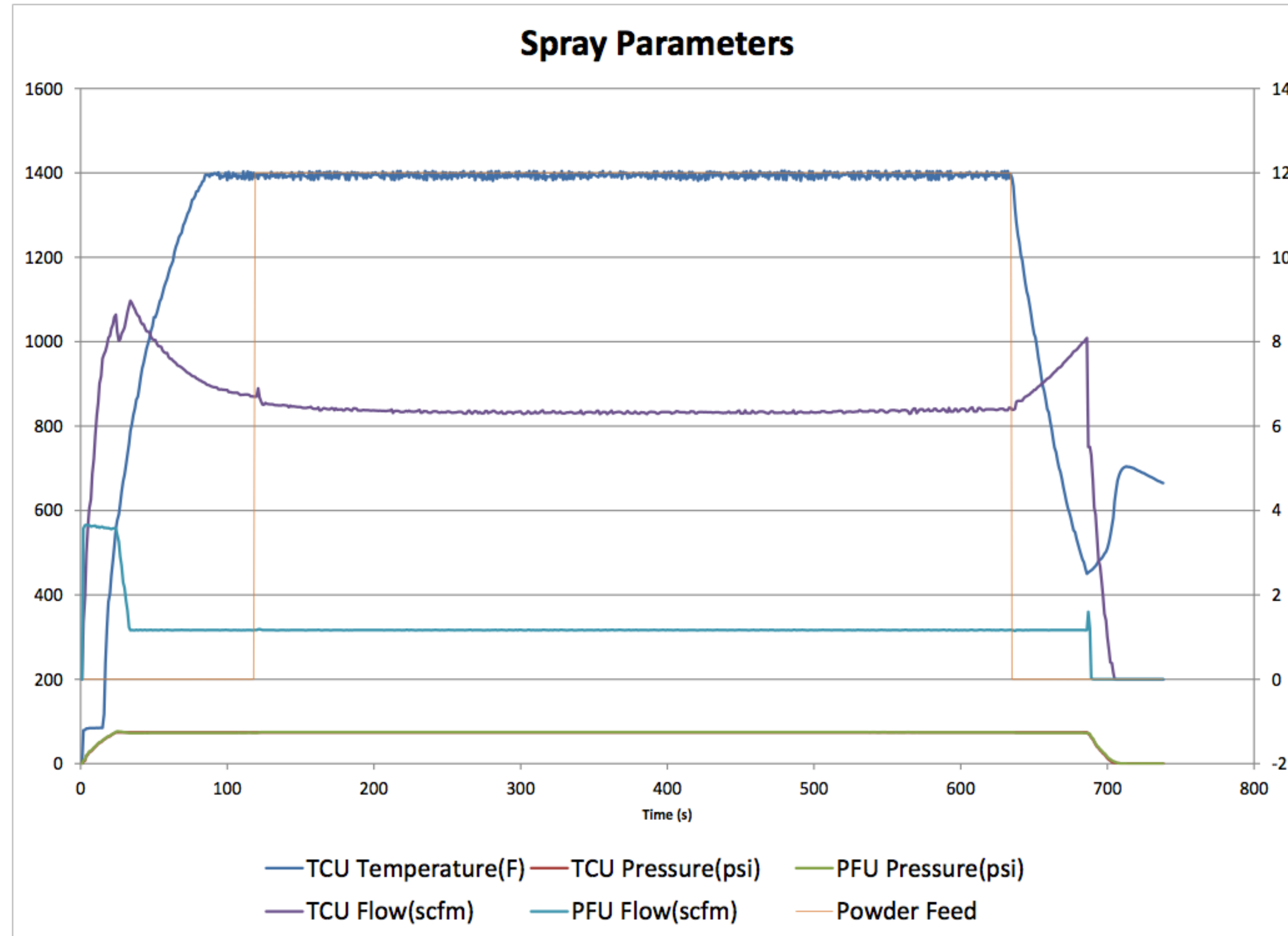
Spray Parameters

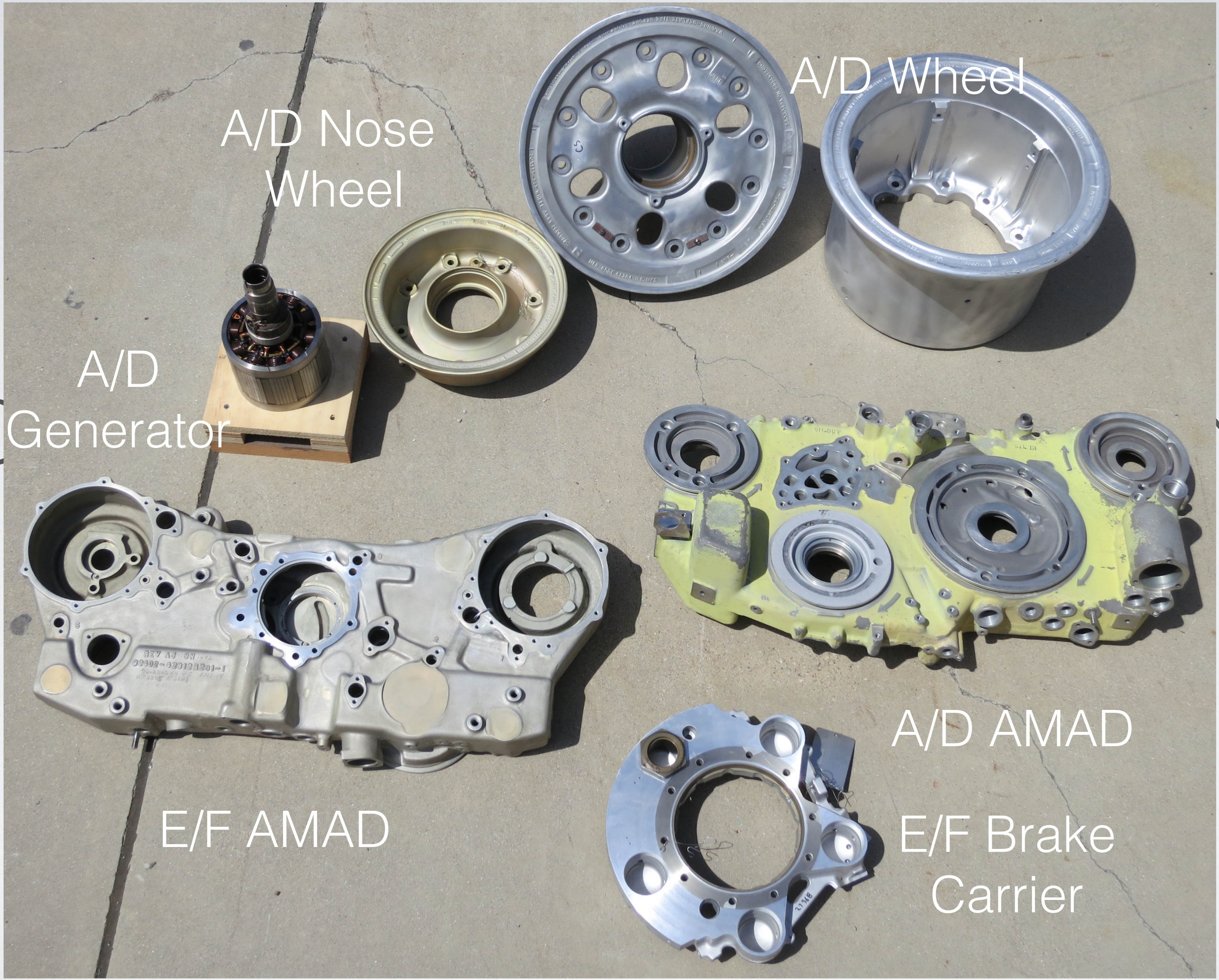
	Units	Set Point	Min	Max	Average	Standard Deviation
Temperature	F	1600	1585.00	1603.00	1,594.46	5.36
Pressure	psig	75	73.77	74.29	73.93	0.07
TCU Flow	SCFM	-----	5.69	6.64	5.82	0.14
PFU Flow	SCFM	-----	1.16	1.18	1.16	0.00
PFU Motor 1	%	55	0.00	55.00	54.69	0.60
PFU Motor 2	%	0	0.00	0.00	0.00	0.00

Robot Parameters

	Units	Set Point
Length	in	4.2
Width	in	1
Substrate Thickness	in	2.02
Standoff	in	0.45
Speed	in/sec	5
Step Size	in	0.01
Strokes	---	1
Layers	---	1
Turn Table Rotation Speed	rpm	0

KM QUALITY CHART





A/D Nose Wheel

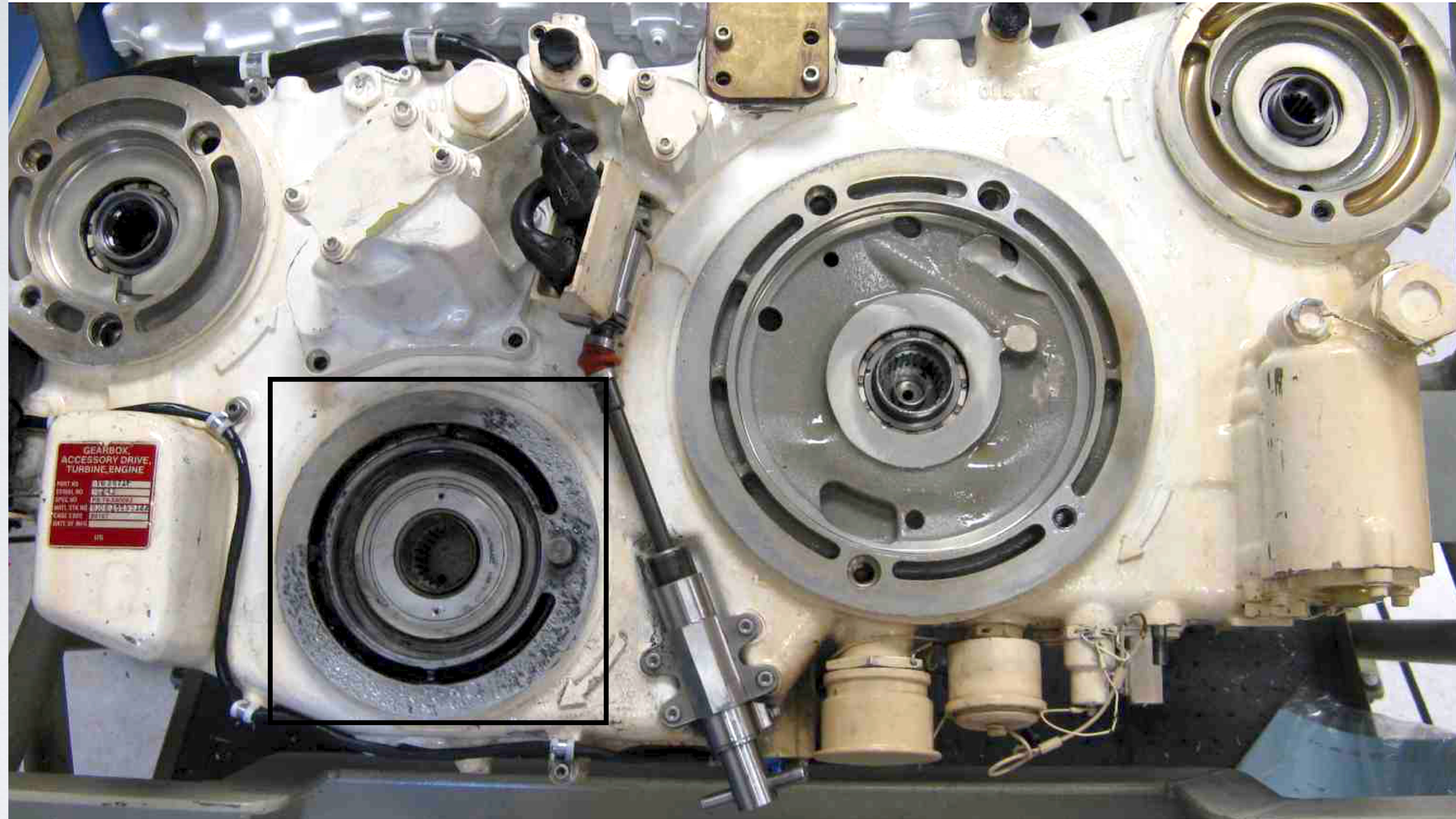
A/D Wheel

A/D Generator

E/F AMAD

A/D AMAD

E/F Brake Carrier



F/A-18 SUPER HORNET AMAD

Aircraft Mounted Accessory Drive (AMAD)


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FRETTING HYDRAULIC PAD





MASK



GUN RASTER



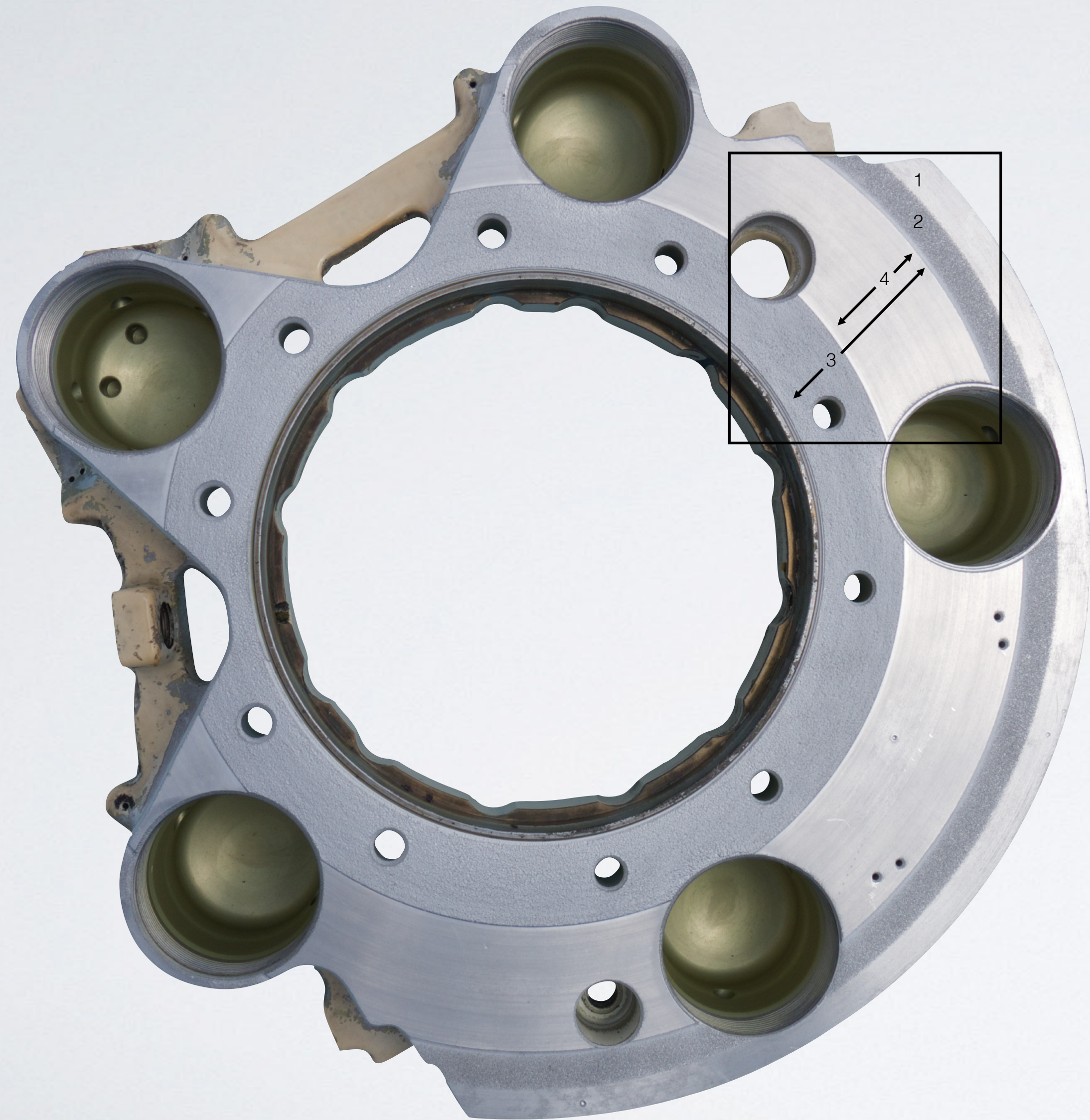
POST DEPOSITION



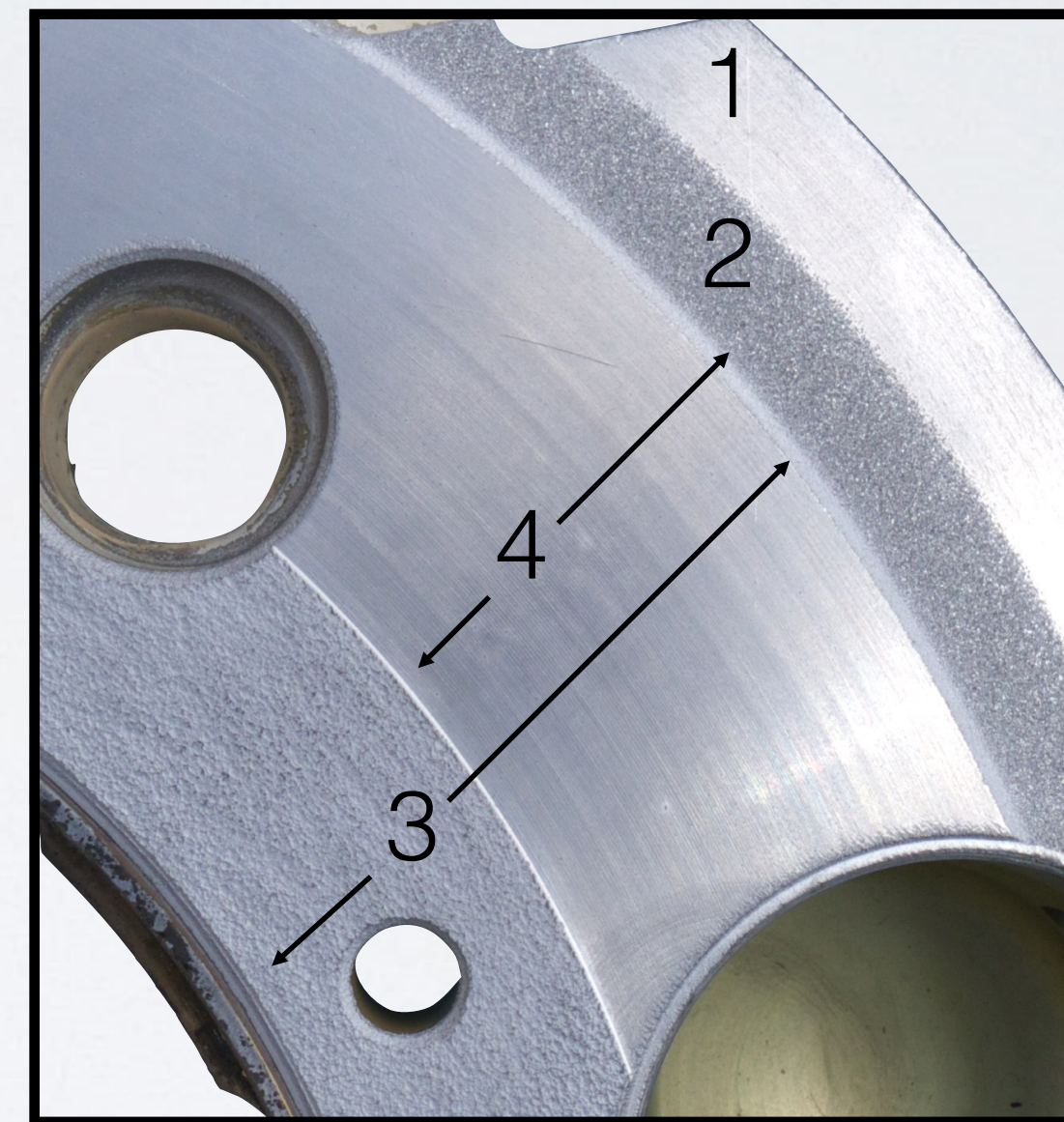
MACHINED



KM Repair F/A-18E/F Brake Carrier



1. Corroded and damaged surface machined down.
2. Surface prepared by grit-blast for KM Repair.
3. Kinetic Metallization repair as deposited.
4. KM repair as machined.

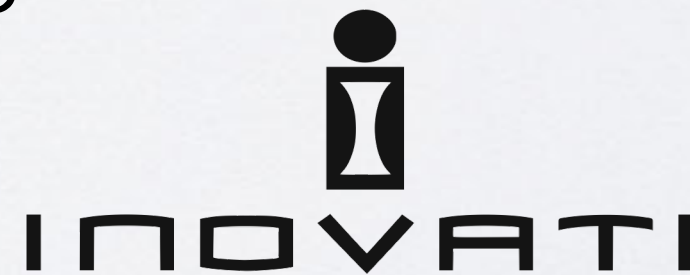


KM Repair F/A-18E/F Hydraulic Pump Gear Shaft

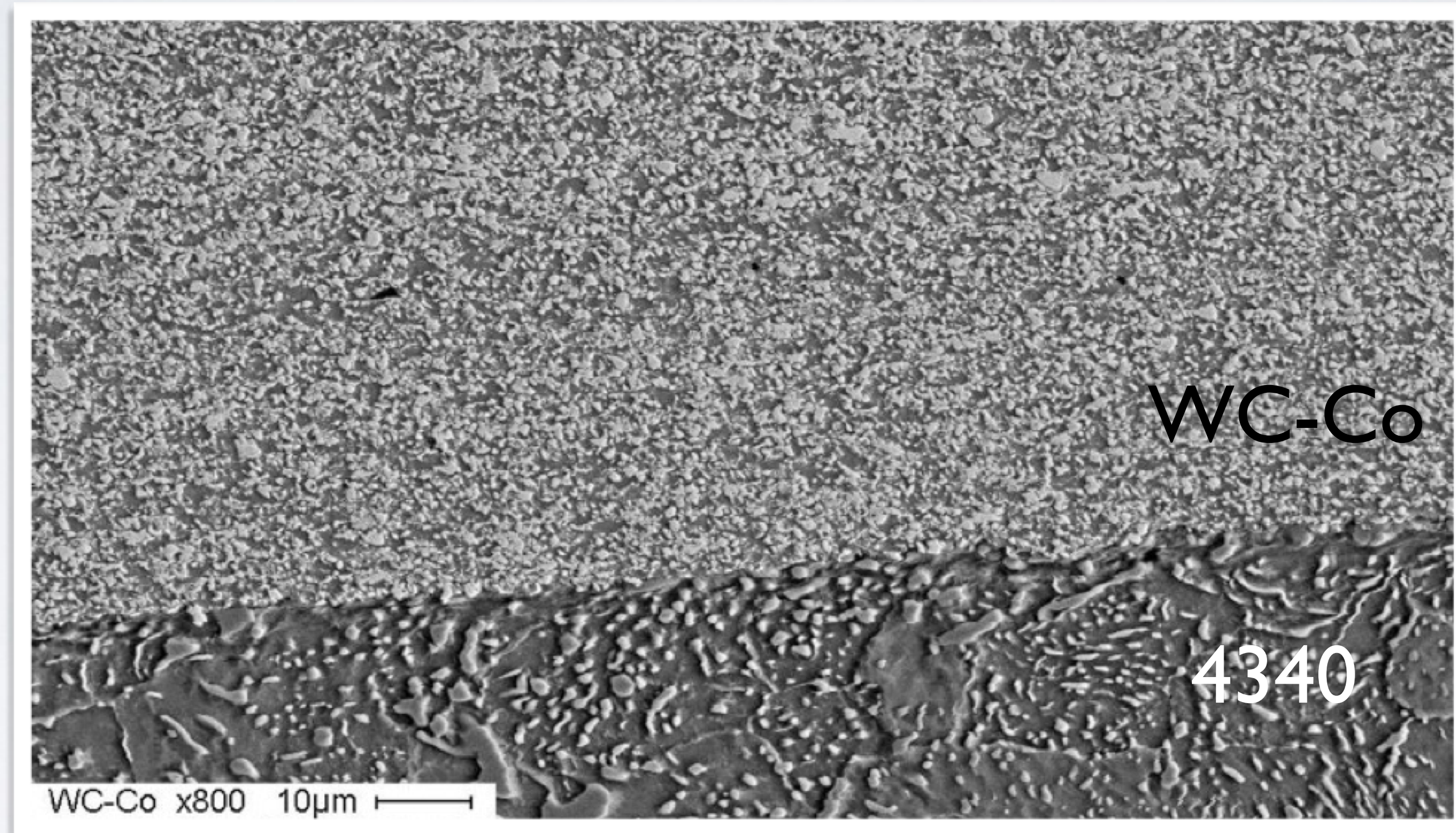
AMS 6265
Hv = 384

WC-Co
Hv = 1000

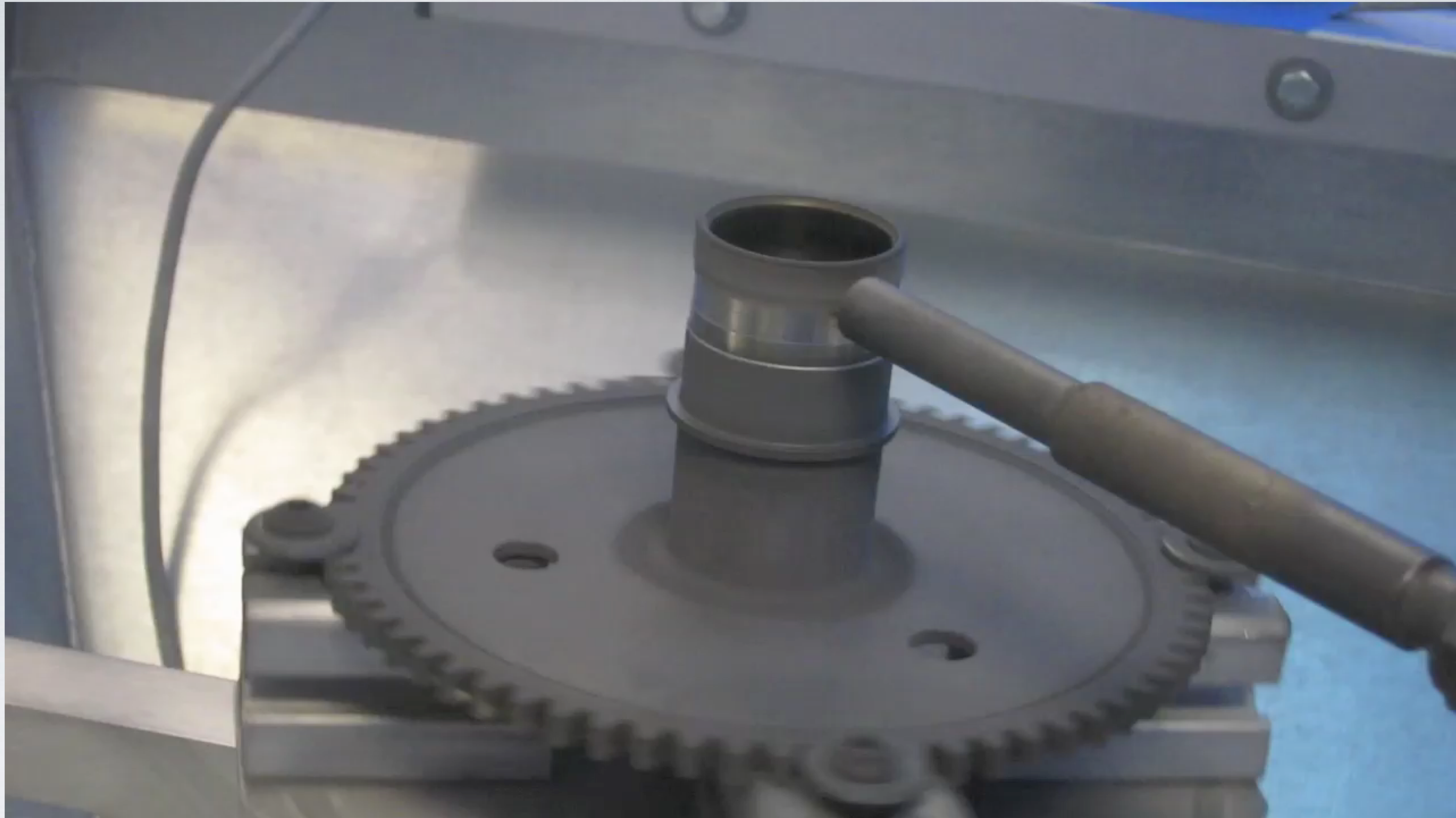
Wear damage removed and replaced
with Tungsten Carbide-Cobalt using
Kinetic Metallization™



KM WC-CO



- Fine grain structure
- 99.9% Dense
- Tunable hardness

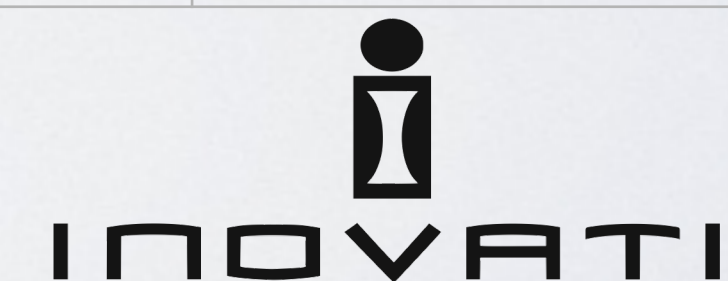



INOVATI

FRCSW ANNUAL SAVINGS

\$3,369,200

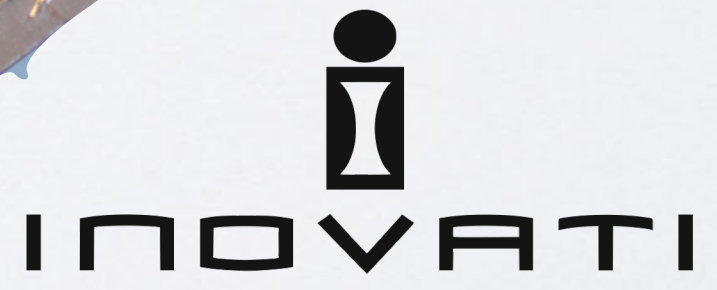
Nomenclature	Part Number	Replacement cost	Qty per year
AMAD Main Housing	Removed at NAVAIR request	\$171,000	2
AMAD Cover Side Housing		\$98,900	2
Spur Gear Shaft		\$8,400	10
C/D AMAD Gearbox Housing		\$32,200	4
E/F GCU Rotor		\$289,900	4
Pivot Connecting Link		\$59,500	6



UPCOMING DEVELOPMENT



E2C HAWKEYE - ROTODOME



Inconel-625 Bore Repair Material



TRIDENT TRIM PUMP

Red Bronze



Side view



Top view

ROTOR

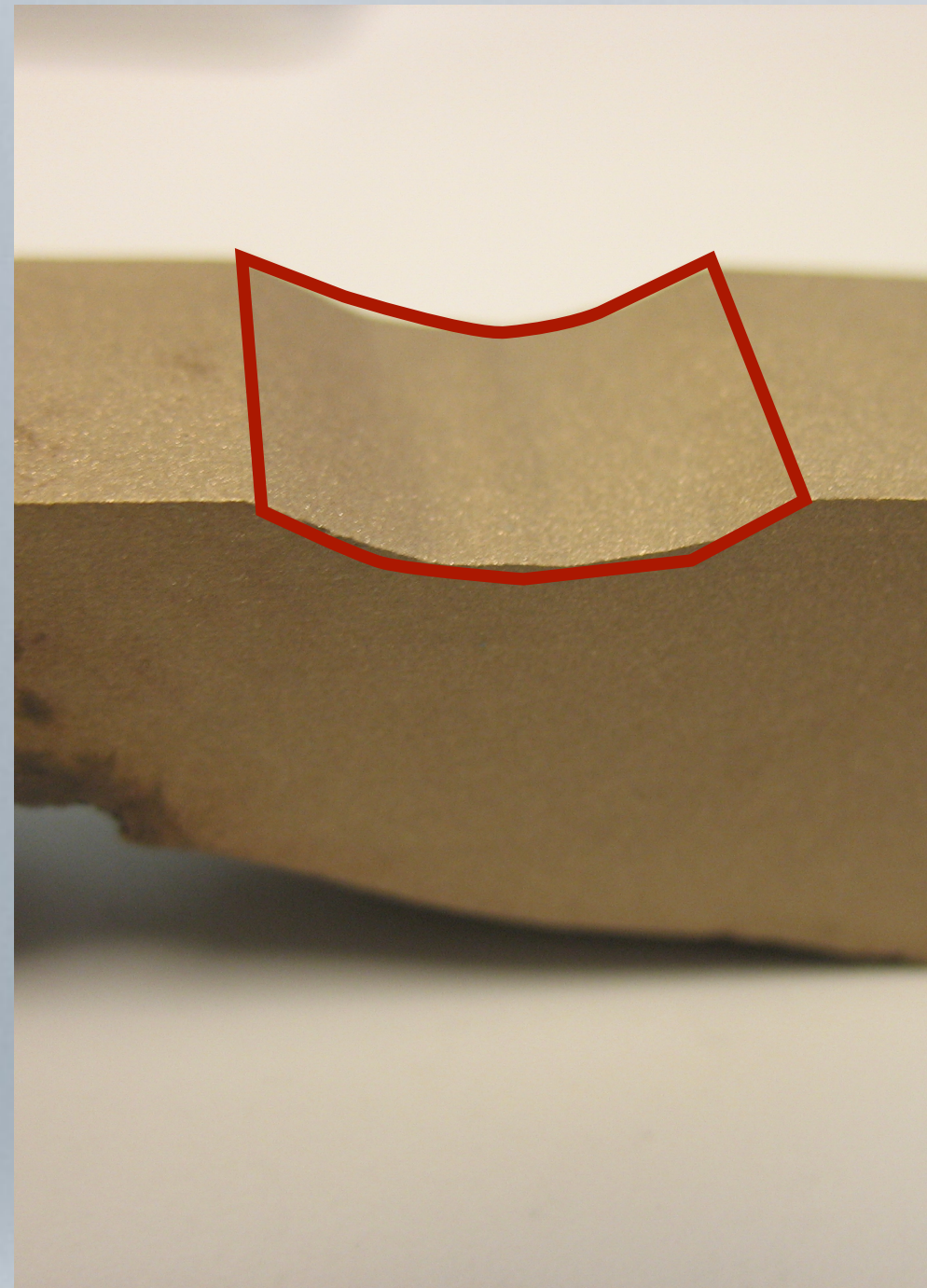


PROBLEM



- Corrosion
- Erosion
- Wear

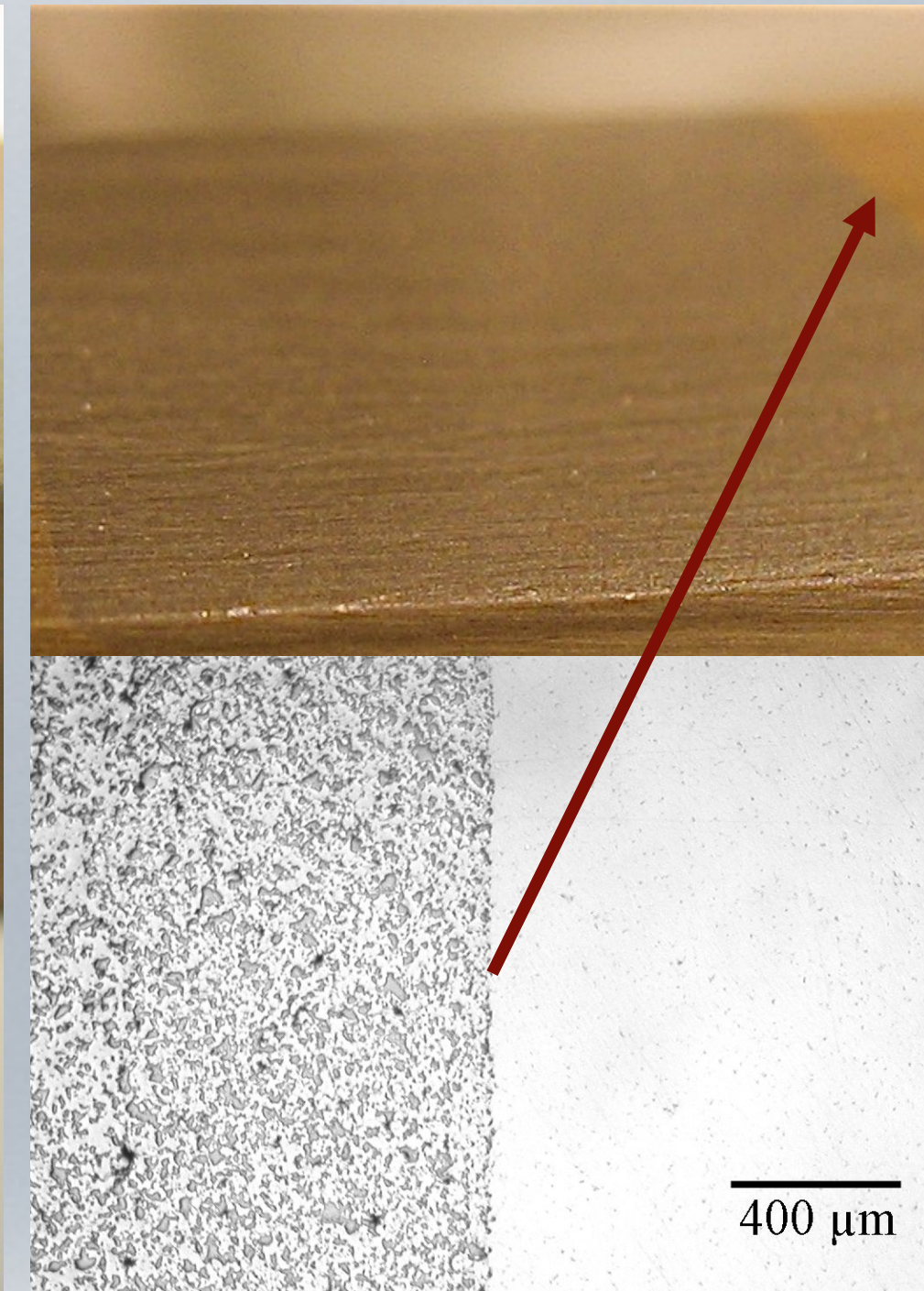
- **Unobtainable**



C92200 Simulated
damage:
machined groove, slope
2:1



KM deposit, ABI Bronze
repair material



Excess repair material
removed (as ground)

SUMMARY

- Kinetic Metallization™ Process & Equipment
 - Qualified method for dimensional restoration
 - High-valued F/A-18 components
 - F/A-18 AMAD Gearbox
 - Hydraulic gear pump shaft
 - E2C rotodome gearbox
- Submarine Trident trim pump parts
 - In development

