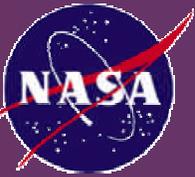


Oxygen Line Cleaning System





Environmental Security
Technology Certification
Program



Aircraft Oxygen Line Cleaning System (OLCS)

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www.jgpp.com

Introduction



- **Why We're Here**
- **Background-- Existing Procedures, History**
- **Program Objectives & System Features**
- **Testing Results**
- **Operational & Cost benefit**
- **Off Equipment Cleaning**
- **Facts to note and Transitioning**
- **Implementation Methods**
- **Summary**

Why We're Here...



- **Technology Transition**
 - **Project Near Completion**
 - **Over \$2M spent on technology development**
 - **Requirement of JG-PP and ESTCP process**
 - **Reduce/eliminate dependence on ODC's**
 - **Reduce O&M costs**

Existing Procedures

- **Alcohol Flush** (Flammable, discontinued)
- **CFC 113** (stockpile dependent)
- **HCFC-141b-** hard to get, purity issues, supplies exhausting, production ceases this year! (Outlawed in Germany 5 Feb '02)
- **Water solutions** (Freeze and corrosion issues)
- No method determined cleanliness!
- Hard to reach lines reportedly ignored

Background/History

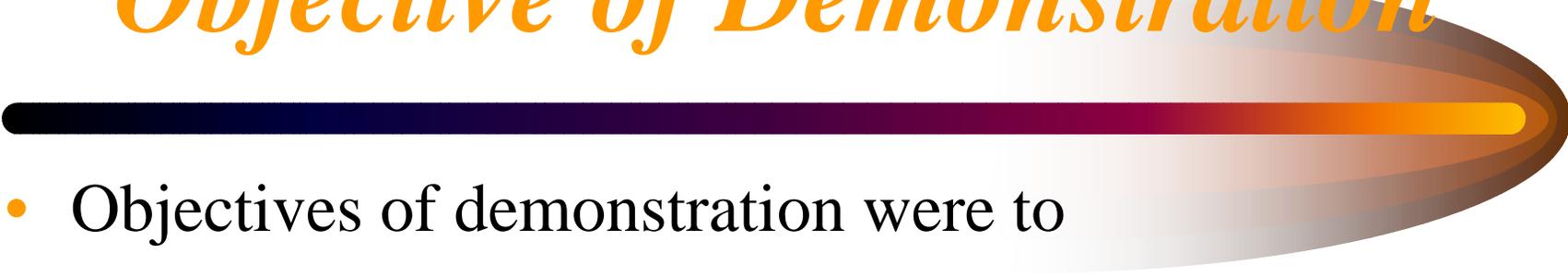


- Predecessor Technology
 - Oxygen Converter Cleaner System (OCCS)
 - OLCs direct follow on of OCCS technology
 - OCCS Technology being upgraded as result of OLCs testing
 - Results will be shown later in presentation

OLCS Background

- Initial development for B-1B Molecular Sieve Oxygen Generator (MSOG) system
 - MSOG failure dusted oxygen plumbing system with Zeolite particles
 - System dismantled, cleaned with CFC-113 (15 gal.)
 - \$1M work effort ~ 3 months + to complete
 - Extensive labor hours and systems check out
- Oxygen Systems-No PDM cleaning cycle
- *We question the cleanliness of all weapon systems oxygen lines - we'll show you why!* ⁷

Objective of Demonstration



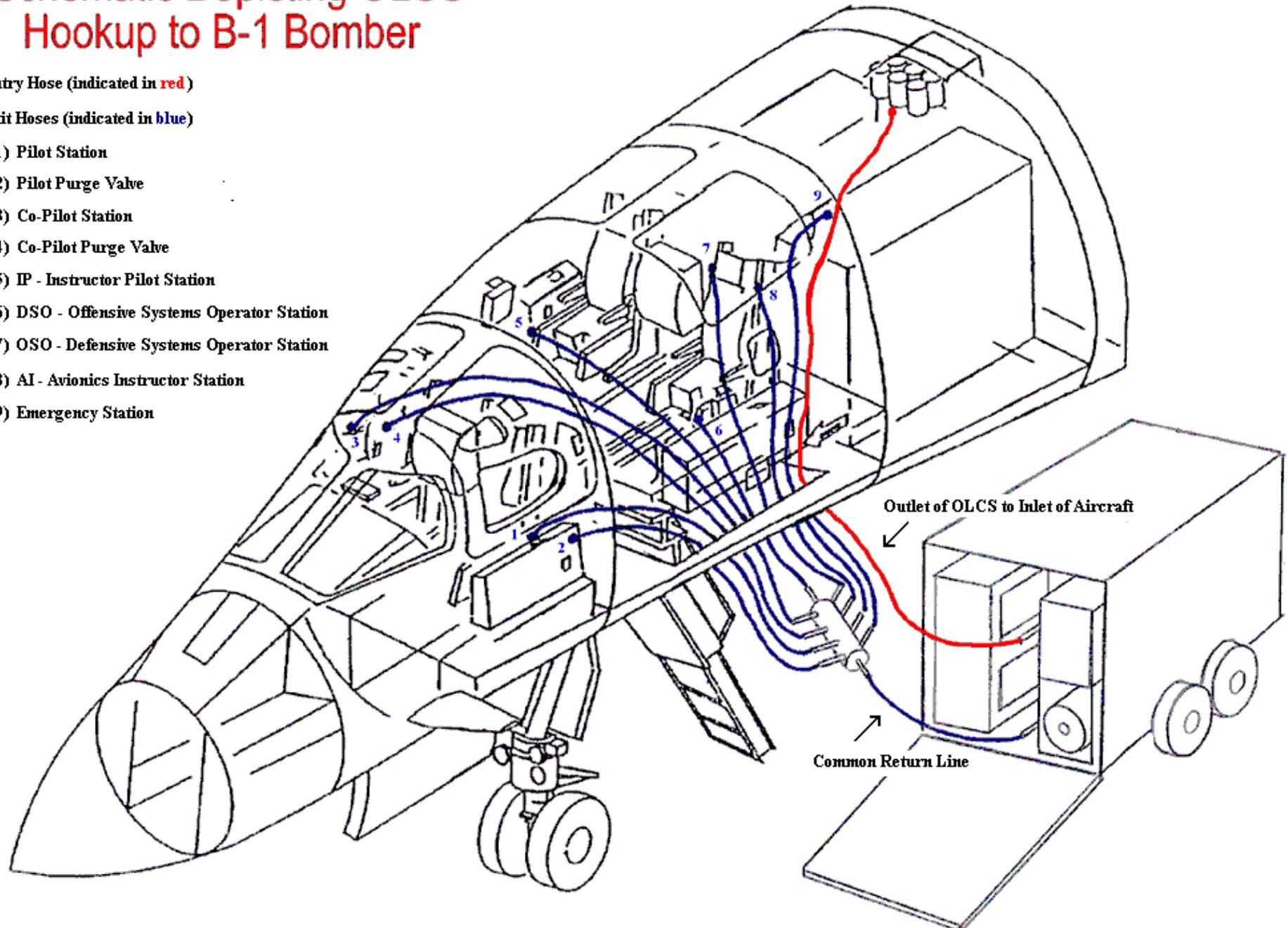
- Objectives of demonstration were to
 - validate oxygen line cleaning prototype
 - prove environmental acceptability
 - prove cost effective alternative to Freon 113
- Lab Testing on a full scale B1 oxygen line system.
 - Versar site near Tinker AFB
- Full scale demonstrations followed on B-1, F-15 and F-16 aircraft. Cleaned oxygen fill and cargo compartment line on C-130 aircraft

Schematic Depicting OLCS Hookup to B-1 Bomber

Entry Hose (indicated in red)

Exit Hoses (indicated in blue)

- 1) Pilot Station
- 2) Pilot Purge Valve
- 3) Co-Pilot Station
- 4) Co-Pilot Purge Valve
- 5) IP - Instructor Pilot Station
- 6) DSO - Offensive Systems Operator Station
- 7) OSO - Defensive Systems Operator Station
- 8) AI - Avionics Instructor Station
- 9) Emergency Station



Control System Features



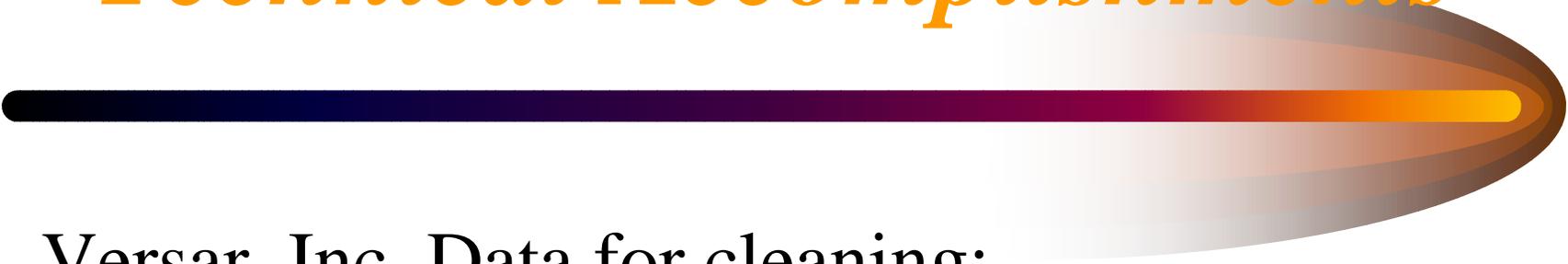
- **OLCS will manage all operations.**
 - Store and pump the solvent.
 - Control operational sequence.
 - Measure cleanliness of oxygen line effluent.
 - Leak test, wash, verify cleanliness, rinse, evaporate, dry, verify **less than** 40 ppm solvent in system and notify operator.
 - Distill and recycle chemicals.

Operation Phases



- Systems Test: Pressure Test and Vacuum Test
- Wash & Rinse (HFE-7100)
- Cleanliness Verification: Particle Counters
- Solvent Removal and Verification: Vacuum Cycle & Air Purge, Halogen Detection

Technical Accomplishments



- Versar, Inc. Data for cleaning:
 - 15-20 feet per second of Shear velocity is required for acceptable cleaning results (additional testing is being accomplished).
- System cleans very well, all aircraft dirtier than expected
- System enhancement throughout program

What We've Found

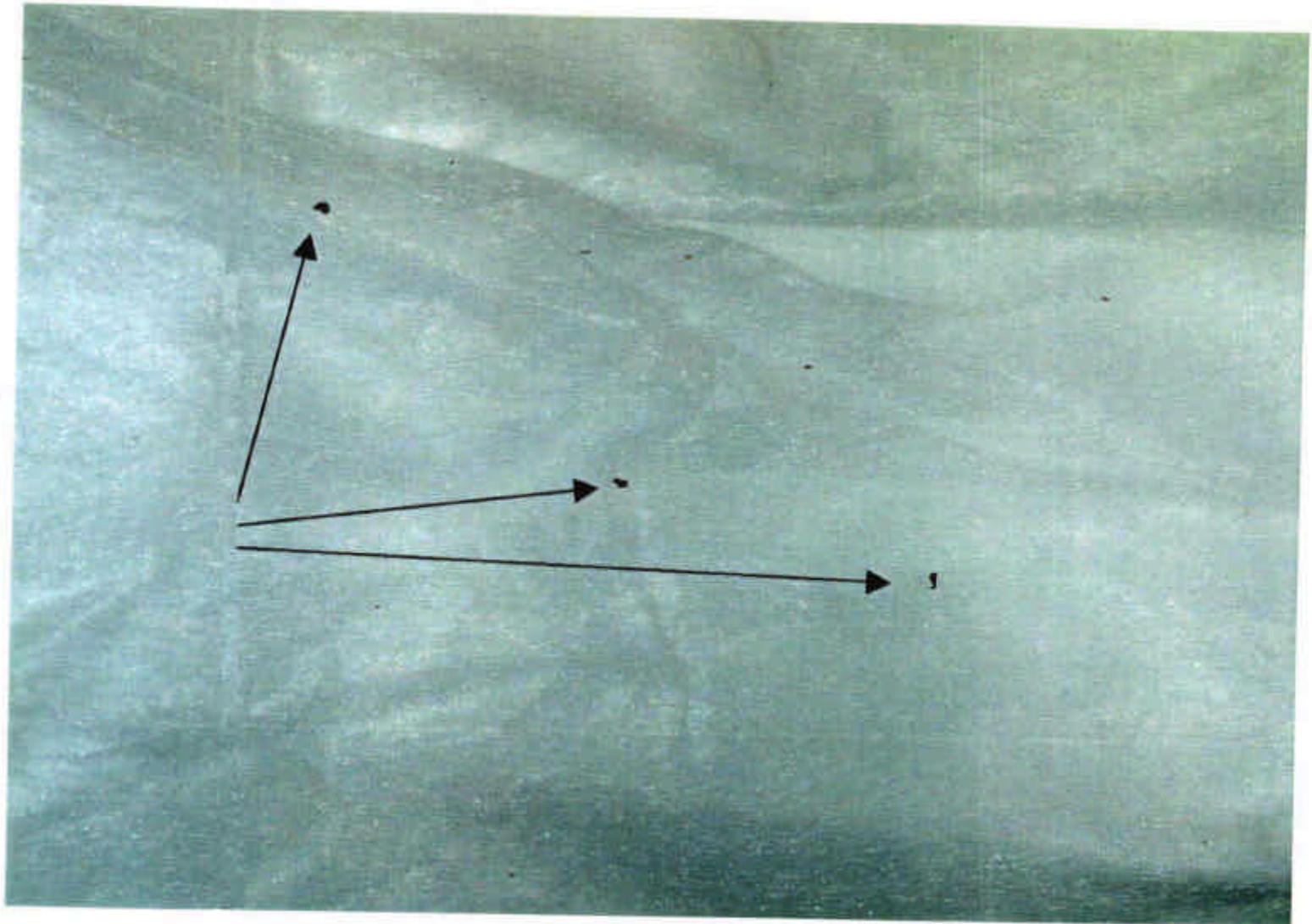
Known Contaminants

- **Teflon**
- **Silicon**
- **Stainless Steel Cuttings**
- **Aluminum Cuttings**
- **Brass Cuttings**
- **High Chrome Steel (melted)**
- **Plastic (rubbery)**
- **“Red” Dirt (unidentifiable) (Iron Oxide?)**
- **Much of this was assumed to have been caused during manufacturing or subsequent servicing throughout life cycle.**

B-1B



Filter sock as received.



Large metal particles on inner sheath.

B-1B Aircraft 03 Nov 01

Blank Filter Patch



← 25 mm →



Blue filter membrane with fine gray Al-Silicate particles extracted from felt.

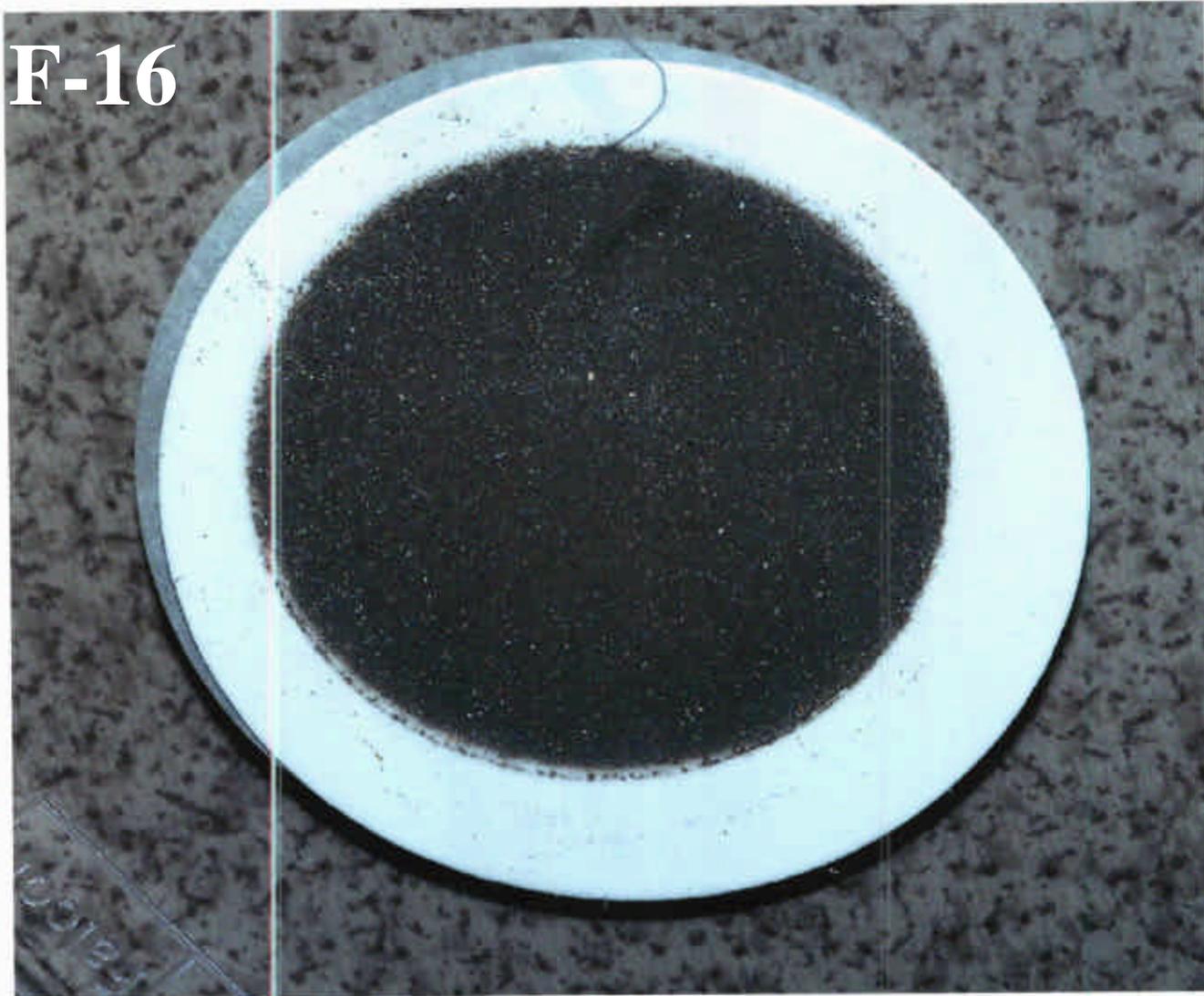
B-1B Aircraft 03 Nov 01

F-15



Filter membrane with fine gray Teflon particles, traces of metal and paint chips extracted from felt.

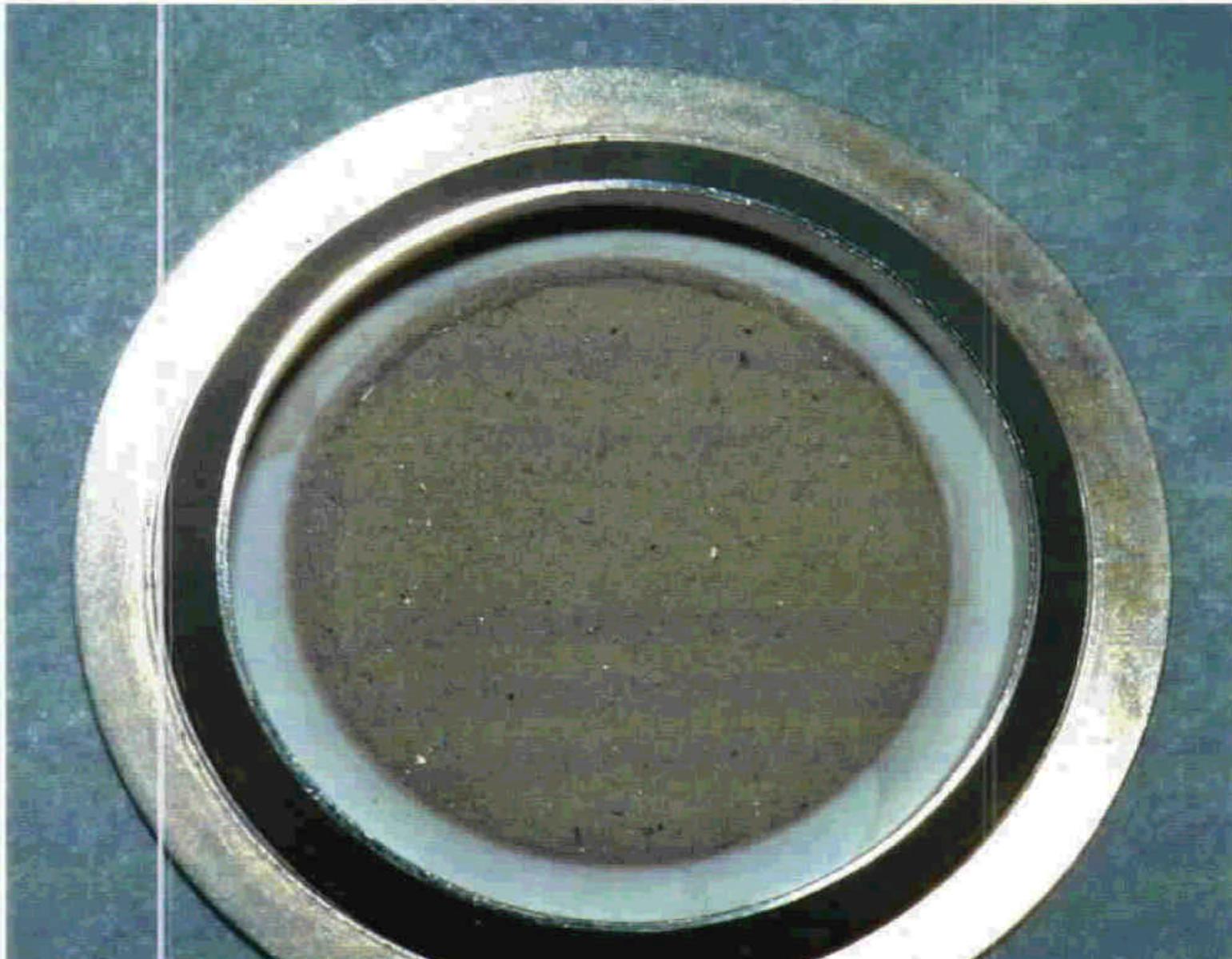
F-16



Filter patch with fine gray particles of Al-silicates and stainless steel extracted from filter sock.

C-130

LOX Servicing Lines (N1159) Filter Patch



C-130

LOX Servicing Lines (N1159) Small Particles on Filter Patch (40X)



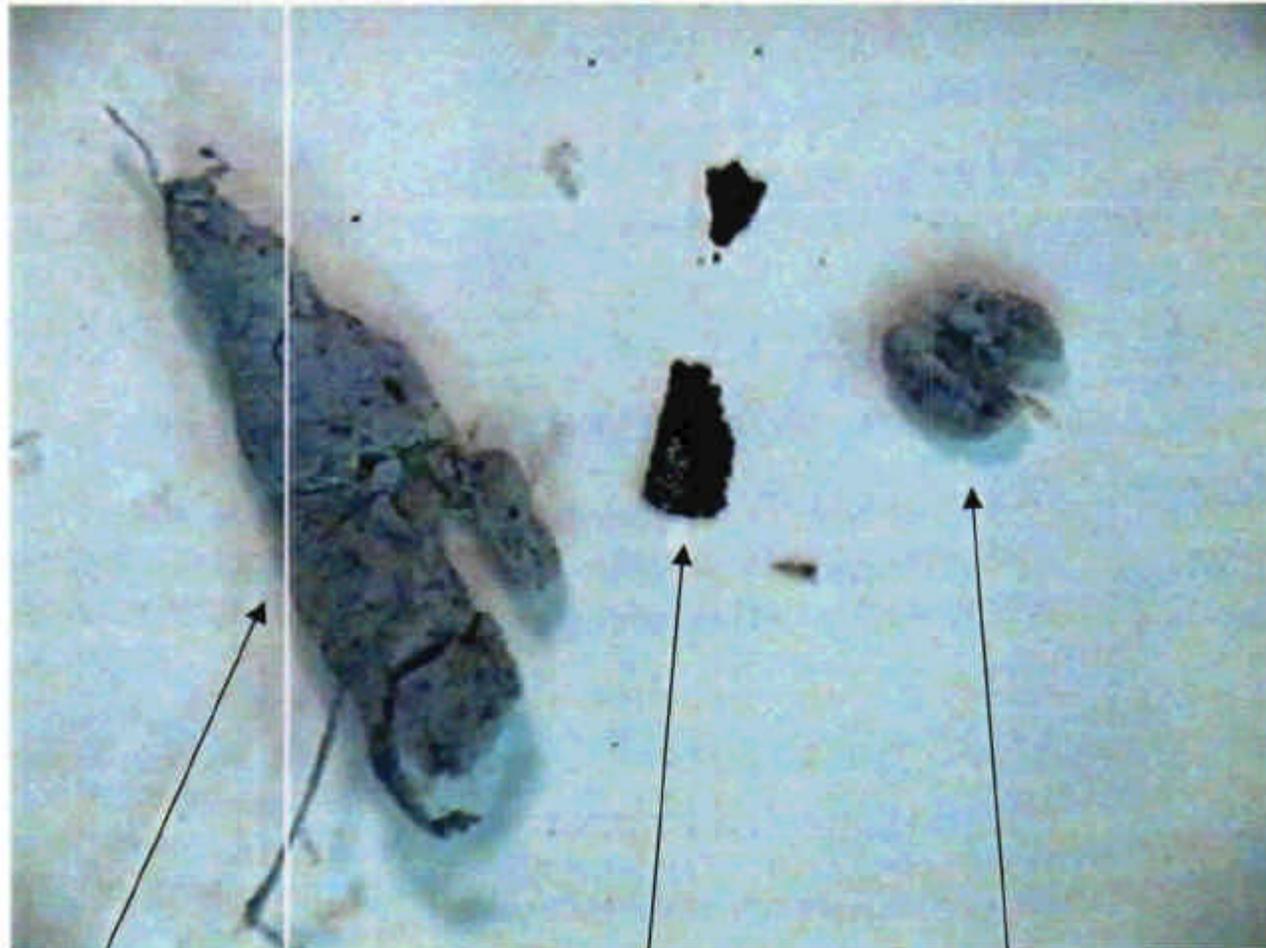
Al Metal Shaving

Steel Metal Globule

Teflon Particles

0.6 mm

C-130 LOX Servicing Lines (N1159) Large Particles (20X)



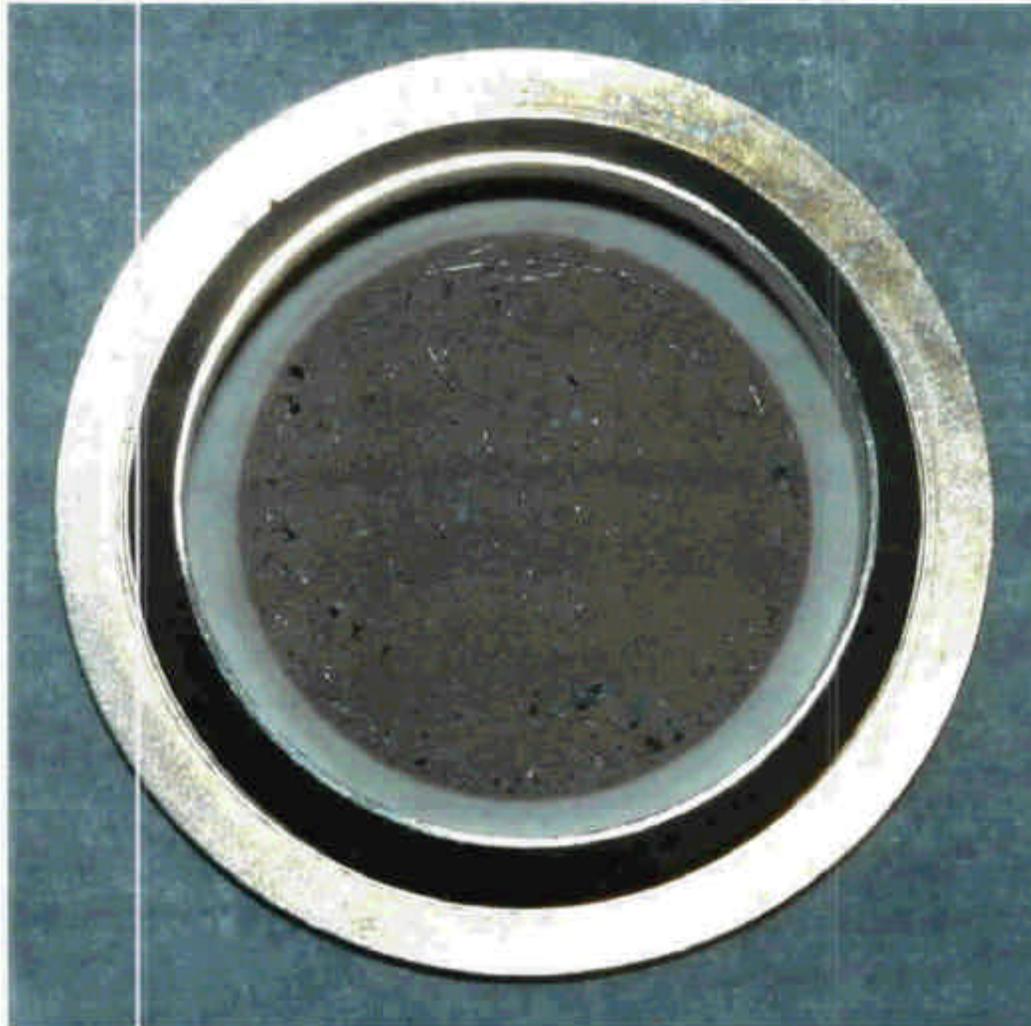
Teflon Ribbon

Zinc Metal Flake

Teflon Particle Clump

← 1 mm →

C-130 O2 Supply Lines (N1160) Filter Patch



← 25 mm →

C-130 O2 Supply Lines (N1160) Small Particles on Filter Patch (40X)



Teflon Particles

Teflon Ribbons

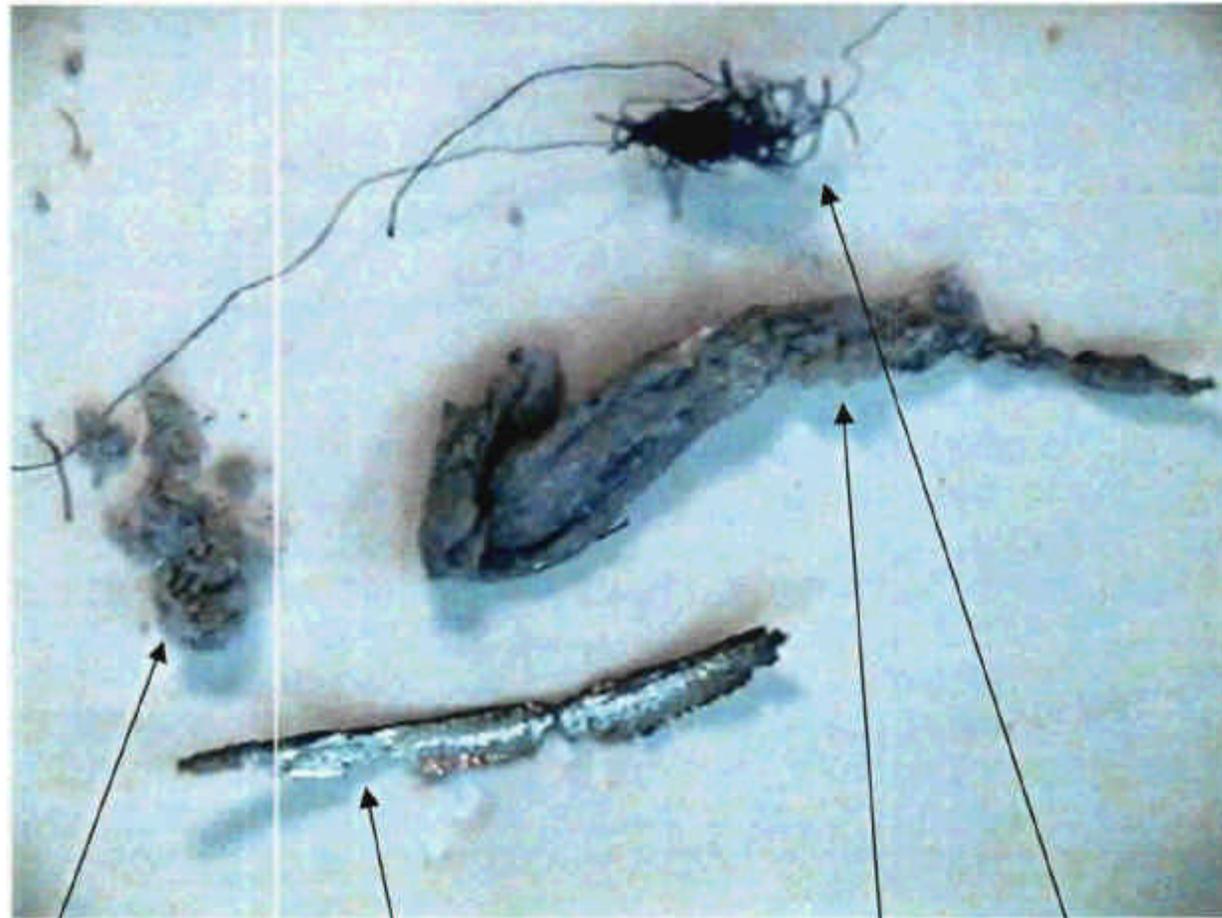
Steel Metal Globules

Al Shaving

← 0.6 mm →

C-130

O2 Supply Lines (N1160) Large Particles (20X)



Teflon Particle Clump

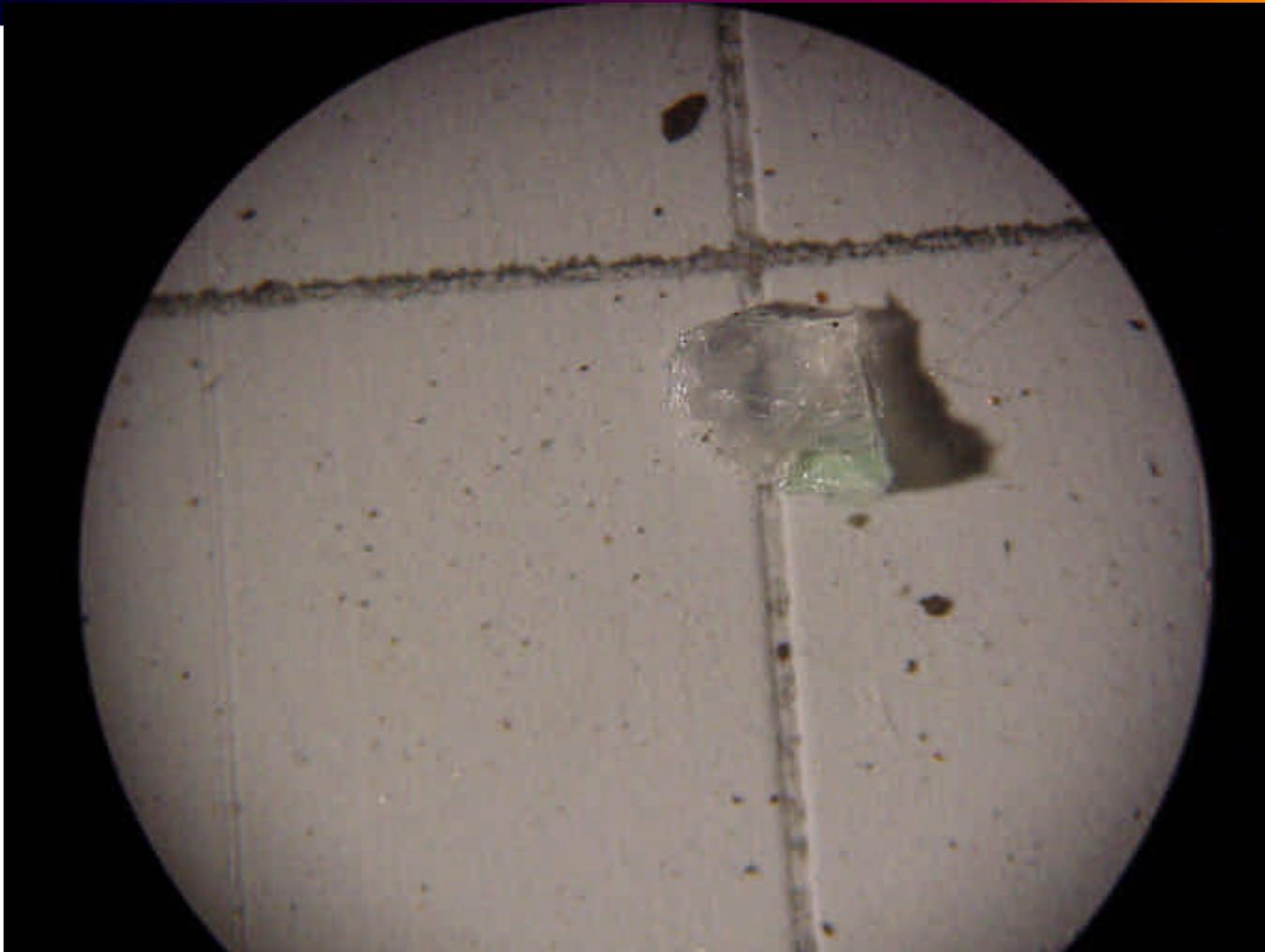
Al Metal Shaving

Teflon Ribbon

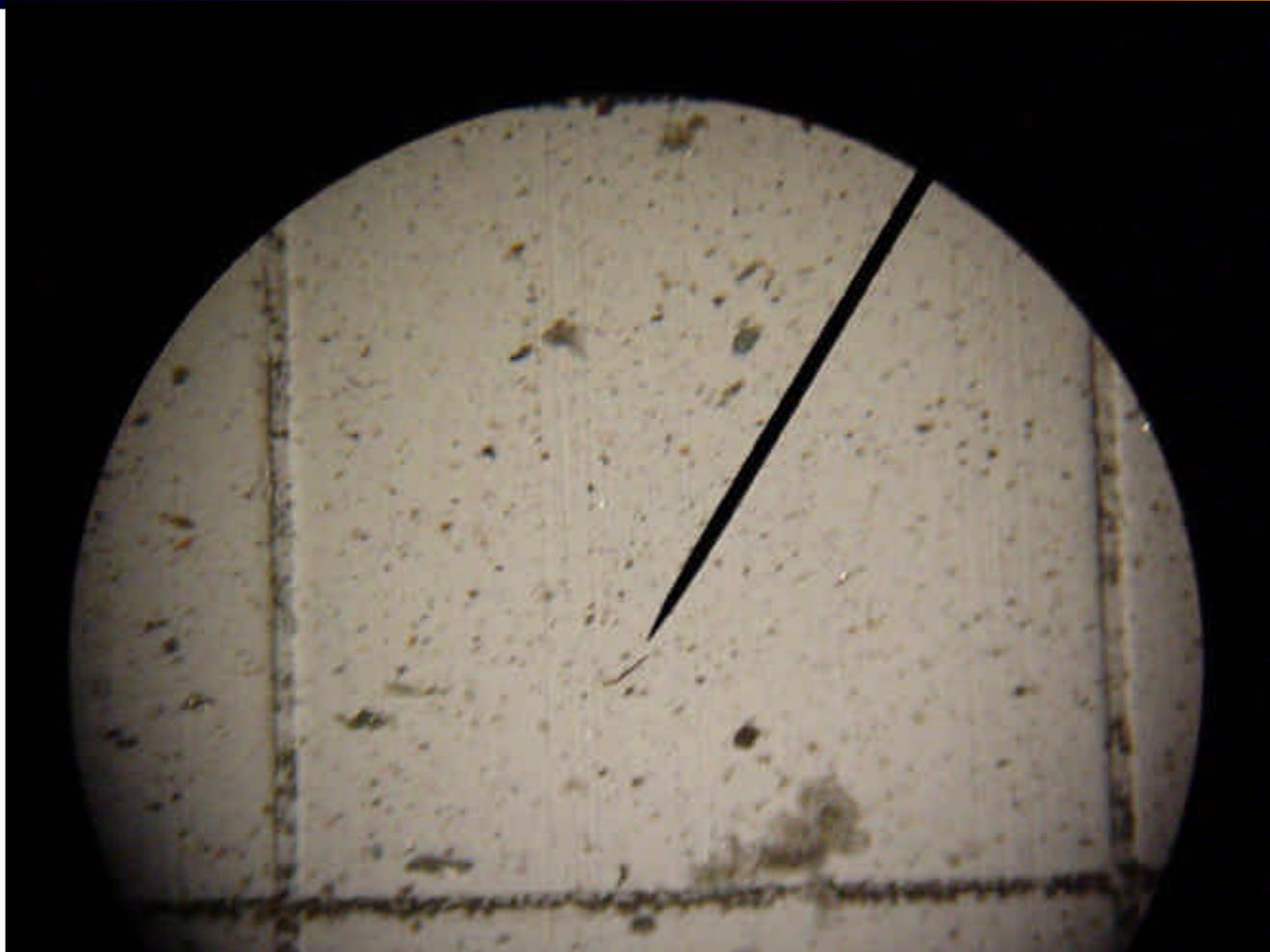
Cellulose Fiber Bundle

4 mm

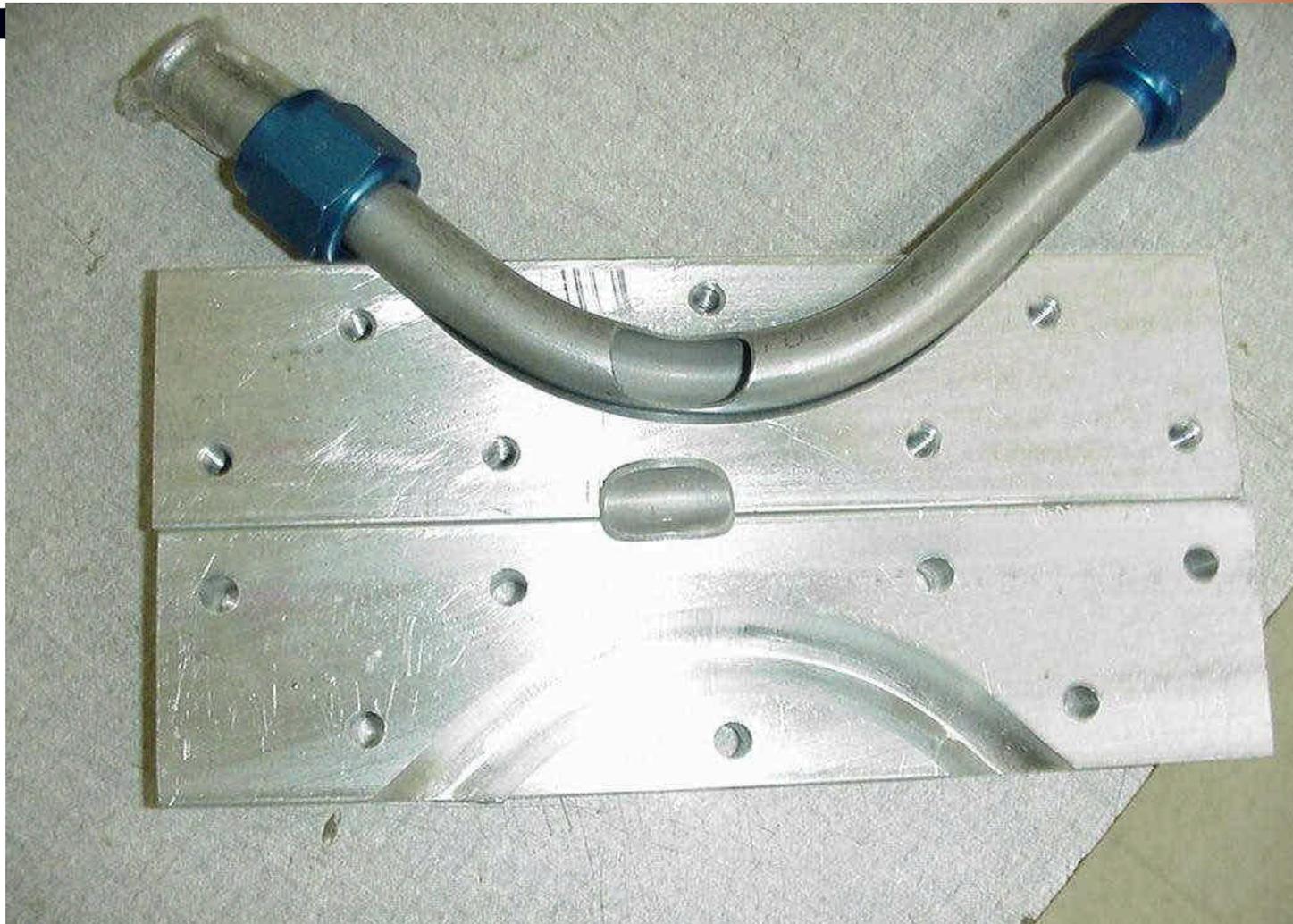
OCCS Converter



Converter

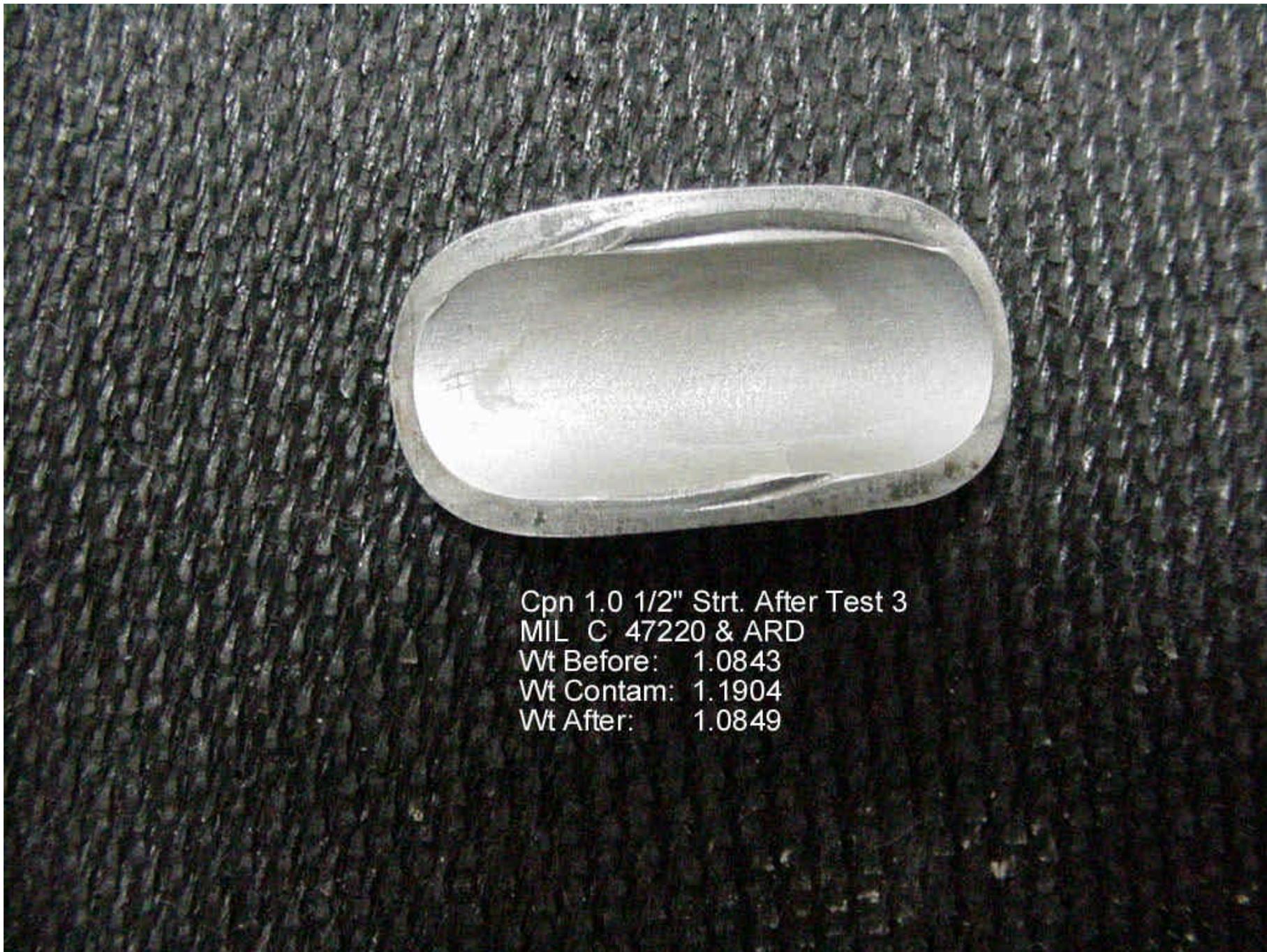


Lab Testing





Cpn 1.0 1/2" sTRT. Contam Test 37
MIL C 47220 & ARD
Wt Before: 1.0843
Wt Contam: 1.1904



Cpn 1.0 1/2" Strt. After Test 3
MIL C 47220 & ARD
Wt Before: 1.0843
Wt Contam: 1.1904
Wt After: 1.0849



Operational Benefits



- **User Friendly**
 - One Operator
 - Touch Screen Technology
 - Press Button to Start Operation
- **Environmentally Friendly**
 - Considered Non-hazardous (No Hazardous Waste)
 - Non-ODC (Closed Loop System)
- **Fully Transportable (Highway, Air or Sea)**
 - Climatic Conditions from 40 F to 120 F

Demonstration/Validation Steps



- Convey the OLCS to Demonstration Aircraft.
- Prepare Aircraft for Cleaning; check for leaks.
- Perform Automated Cleaning Procedure.
 - Takes 1-3 Hours.
 - Self-check for solvent (halides) and contaminants (particle counter)
- Laboratory examination if desired.
- Cost: \$5K/aircraft or \$10K/day at a base

Updated Cost Savings Estimate Return On Investment (ROI)

- Clean system to prevent oxygen regulator failure from particulate contamination damage

- Return On Investment (ROI)

- $6,746 \text{ regulators} \times 0.20^* = 1,349 @ \$1,500$
- $1,349 \times \$1,500/\text{regulator} \times 0.5^{**} = \$1,011,750$
year

* [20% across board due to particulate contamination]

** [assuming that only 50 % of regulator damage will be prevented due to this process (**conservative** estimate based on minimum savings)]

Updated Cost Savings Estimate ROI (Continued)



- Return On Investment (ROI)
 - Based on 3 Year Forecast
 - $\$3,035,025 - \$1,750,000 \text{ inv.} = \$1,200,000^*$
 - %ROI =
 - $\$1,012,000 / \$1,750,000 * 100 = >50\%$ (1st year)
- * Catastrophic not included - One cleaning would save the cost of 2 OLCS units!

Off Equipment Cleaning



- Bench Top Individual Line Cleaning
 - Navy CHOC's System
 - Uses NOC
 - Northrop/B-2 bench top cleaner
 - HFE-7100 or other suitable solvent

Facts To Note...



- **No current Spec - Technology didn't exist**
- **No cleaning requirement - Never cleaned!**
- **Draft submitted for T.O. 15X-1-1**
- **A New Technology, New Capability**
 - **A change in maintenance philosophy!**
- **Reduce O&M costs**
- **Reduce or Eliminate dependence on ODC's**
- **Aircraft safer for aircrews and maintainers**

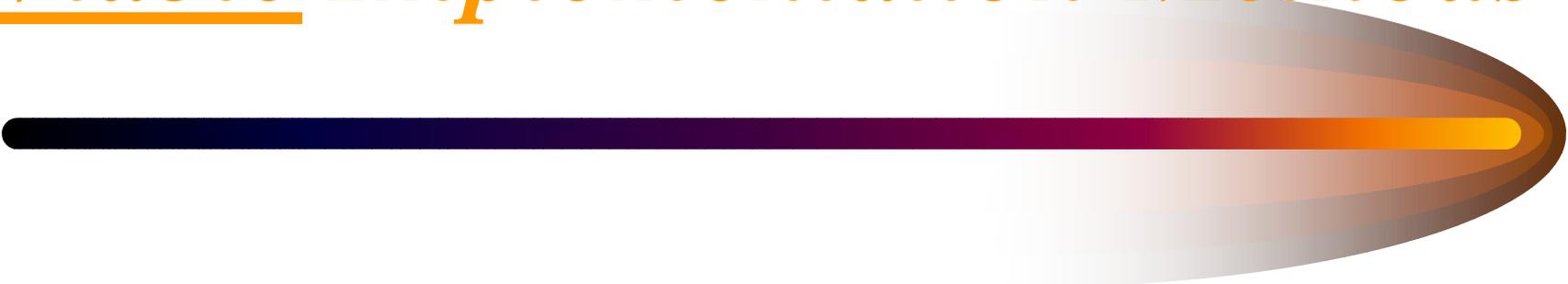
Transition Possibilities



- Investigating Additional Applications:
 - oxygen carts - fires and contamination (funded)
 - oxygen and other gas-containing tanks
 - oxygen lines in medical applications
 - other chemical applications
 - Any type lines can be cleaned with minor adaptations (hydrazine, hydraulic, etc.)

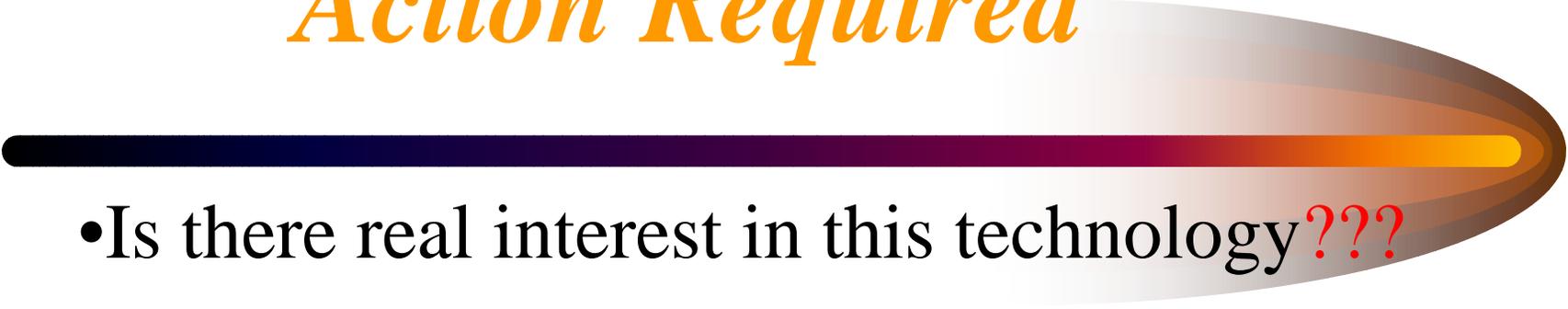


Viabile *Implementation Methods*



- Contract Service
 - Full CLS support on location/On Demand
- Equipment Purchase
 - Govt. owned - Contractor maintained
 - Contractor provided training
- Very expensive if standard AGE procurement
 - Cost prohibitive

Action Required



- Is there real interest in this technology???
- SPO or MAJCOM Involvement
 - direction needed *now!*
- Specifications Initiated
- Technology and costs are time sensitive.

Summary



- Aircraft cleaned were surprisingly dirty
- AF in need of ODC replacements
- Reduce O&M costs
- Large “Ground Swell” of support from field
- Safer operation for aircrew and maintainers
- New Technology available for implementation
 - A new and better maintenance philosophy

Points of Contact

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