



Air Force Research Laboratory Support for Sustainment

A Briefing to the 2011 Corrosion Conference

18 August 2011

Dr. Katherine A. Stevens, SES
Director, Materials &
Manufacturing Directorate

Air Force Research Laboratory

Integrity ★ Service ★ Excellence

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Outline



- **AFRL & its Sustainment Activity Context**
- **Rapid Response System Support**
- **Current Fleet Support**
- **Evolving Corrosion S&T Strategy**
- **Summary**



AFRL Sustainment Perspective



AFRL Sustainment Portfolio



Embedding robust reliability and predictable readiness into current and future fleets to assure maximum mission capability and maintainability while minimizing costs

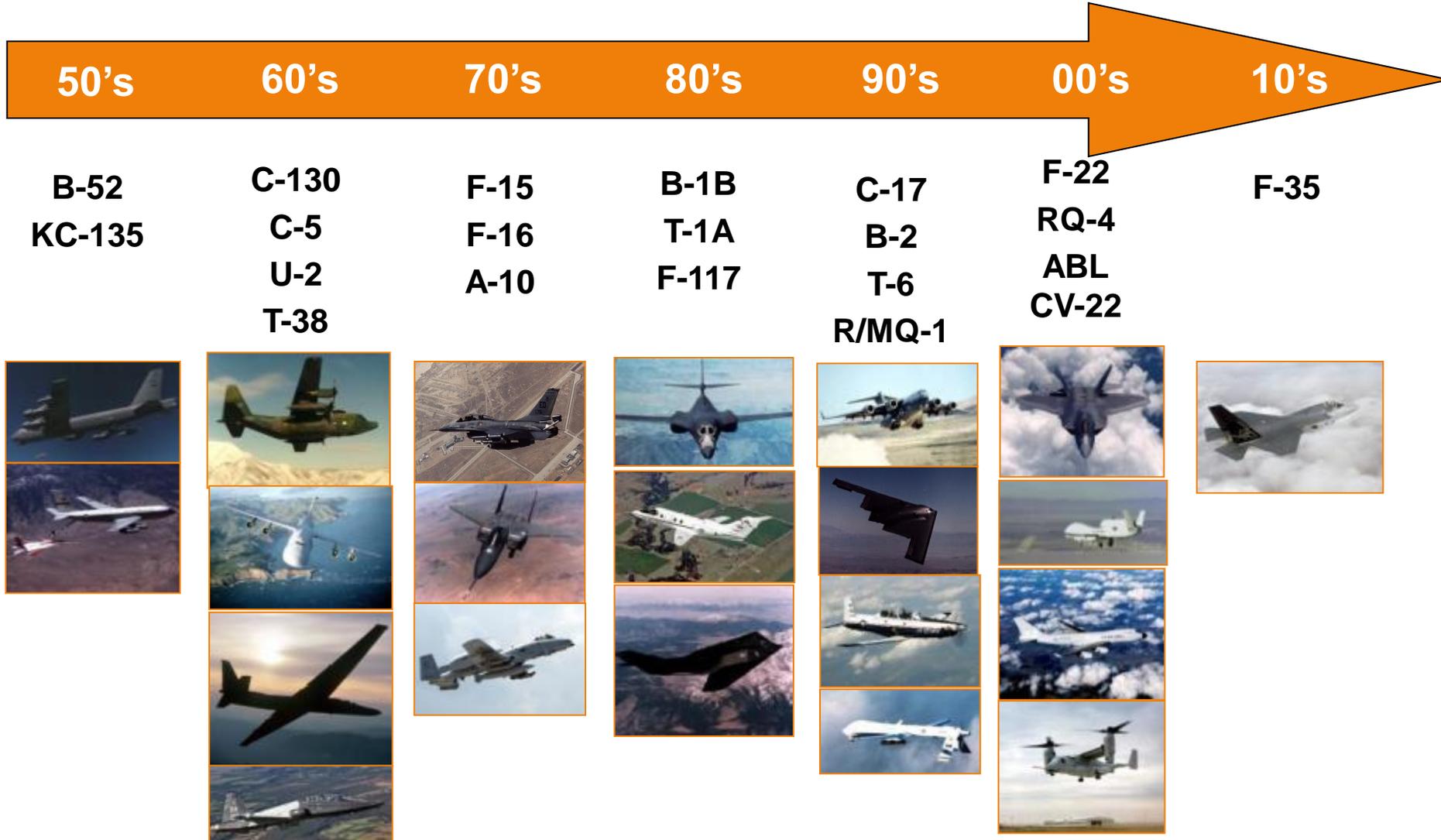
- **AFRL considers Sustainment an integral part of Life-Cycle Management**
 - **AFRL's effort Covers the Entire Product Life Cycle**
- **AFRL investments aimed at meeting MAJCOM needs/strategies**
- **Goals of AFRL Sustainment Investments**
 - **Support Sustainment of Current AF Fleet**
 - **Improve Fleet Health Management**
 - **Enable Robust Design of New Systems**

Technology to increase readiness and reduce life cycle costs of current and future systems





Extending System Life USAF Fleet Timeline





AFRL Sustainment Investment



- Develop Strategic Collaborations
- Leverage External Resources

- Fleet Safety
- Fleet Availability
- Fleet Affordability

**Prioritization
and Program
Development**

- AFRL Expertise
- AFRL Resources Available
- Tech Transition Probability & Partners



AFRL Sustainment Portfolio
Support Sustainment of Current AF Fleet
Improve Fleet Health Management
Enable Robust Design of New Systems

A globe composed of a grid of white dots on a blue background with abstract light patterns.

Rapid Response Systems Support



AFRL Sustainment



AFRL / RX SYSTEMS SUPPORT MISSION

Merge systems engineering application expertise with AFRL technology expertise to provide timely, effective solutions to user needs

VISION

*Now/Near Term Focus
Event Driven Rapid Response
Customer Connected
Implementation Oriented*

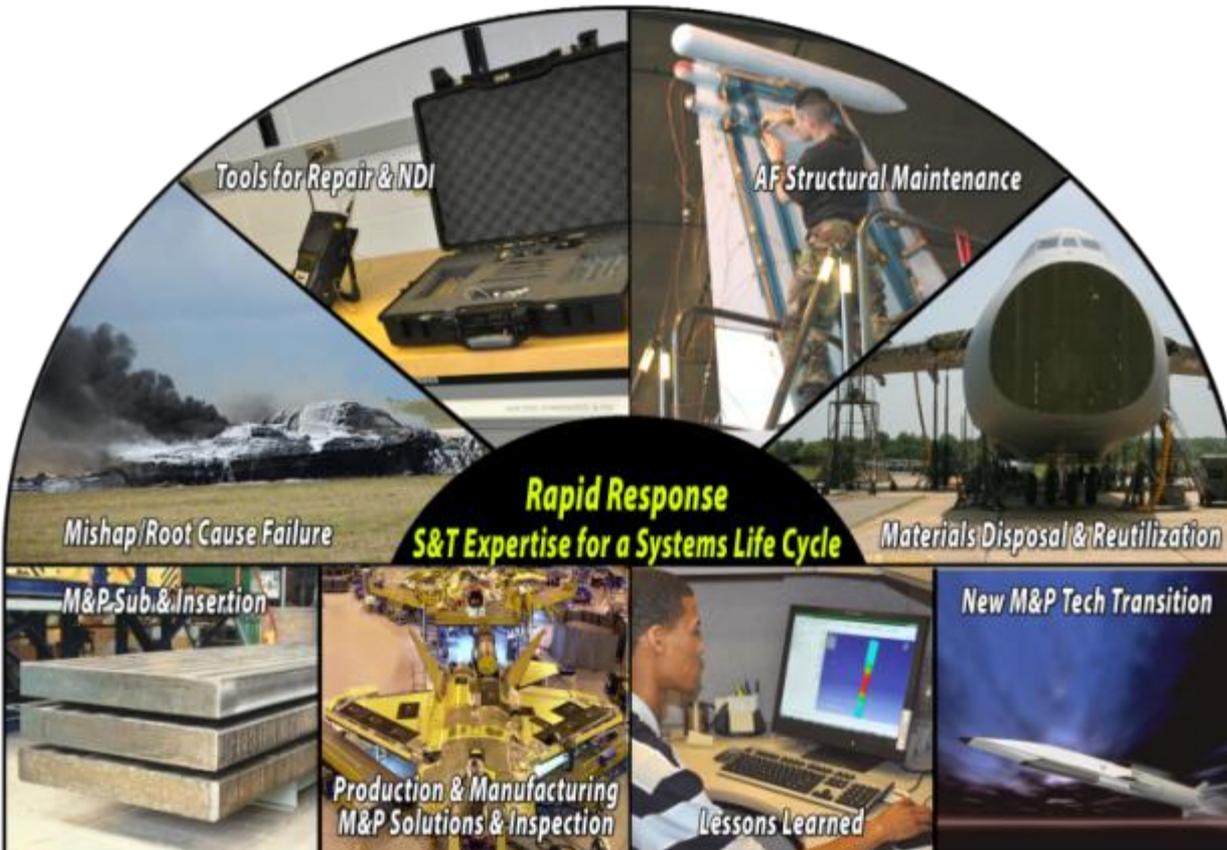
Keep AF Systems Safe, Available, and Affordable



AFRL Systems Support Division (RXS)



Merge systems engineering application expertise with materials and processes (M&P) technology expertise to provide timely, effective solutions to user needs



- MATERIALS INTEGRITY BRANCH (RXSA)
- ACQUISITION SYSTEMS SUPPORT BRANCH (RXSC)
- LOGISTICS SYSTEMS SUPPORT BRANCH (RXSS)
 - Advanced Composites Office (Hill AFB)
 - Coatings Technology Integration Office (WPAFB)
 - Corrosion Prevention & Control Office (Robins AFB)
 - Metals Technology Office (Robins AFB)
 - Nondestructive Inspection Office (Tinker AFB)

Keep AF Systems Safe, Available, and Affordable



Field and O&M Support Current Fleet Sustainment Issues



Mission	Impact/Benefit to the User
<p>Provide technical leadership in pervasive AF structural MX areas to ensure flight <u>safety</u>, reduce <u>cost</u>, improve <u>availability</u>, & <u>reliability</u></p>	<ul style="list-style-type: none"> • Improves fleet availability by sharing MX best practices <ul style="list-style-type: none"> • Optimized C-130 wash schedules to balance mission & corrosion control • Command Corrosion & NDI MX Surveys • 1st AF plan to mitigate latrine corrosion on 11 MDS • Speeds technology transfer form R&D to MX Ops <ul style="list-style-type: none"> • 90% reduction in paint-to-fly time for aircraft • 75% reduction in install time on C-17 antennas • Develops rapid technical solutions to Ops challenges <ul style="list-style-type: none"> • Solved 3 C-130 SATCOM antenna problems
Technology/Solution	
<ul style="list-style-type: none"> • 5 Offices Collocated at ALCs • Engr & Tech Assistance for MX & Sustainment • Maintenance of T.O.s & Reference Mat'l • Field Surveys/SAVs 	



AFRL Sustainment Offices



Mission Scope: *Structural Maintenance Support for Fielded Aircraft Operations* *“The Technical Home Office for 5 AF Maintenance Career Fields”*

Advanced Composites Office (Hill AFB)

- Technical support / consultation **DSN 586-3319**
 - Evaluate, prototype, field test, & transition
- Repair process development
- Facilities and M&P evaluations
- Manage AF Composite Repair, CDDAR TOs
- Composite training support

Nondestructive Inspection Office (Tinker AFB)

- Technical support / consultation **DSN 339-4322**
 - Evaluate, prototype, field test, & transition
- Eng. Authority for centrally procured NDI equipment
- Conduct Worldwide NDI Lab Assessments
- Manage AF NDI TOs
- NDI training support

Corrosion Prevention & Control Office (Robins AFB) **DSN 468-1974**

- Technical support / consultation
 - Evaluate, prototype, field test, and transition
- Conduct Worldwide AF Corrosion Surveys
- Manage AF Corrosion TOs
- Support Weapon System CPABs

Metals Technology Office (Robins AFB)

- Technical support/ consultation
- Standardize equipment, training, processes



Coating Technology Integration Office (WPAFB)

DSN 785-0942

- Technical support / consultation
 - Evaluate, prototype, field test, & transition
 - Repair process development
- Environmental aging test facility

Mission directed by AF/A4M; Programmed and funded by AFMC/A4M; Executed by AFRL/RXSS



USAF Aircraft Latrine Study

Conducted by the AF Corrosion Prevention & Control Office



- **Directed by AFMC/CC**
- **Visited 11 heavies' PDM facilities and SPO engineers**

RECOMMENDED:

- **Creation of Equipment Specialist position in each SPO responsible for lavatory**
- **Immediate action on issues facing C-5, KC-10 & B-52**
 - **Replace existing C-5 lav with COTS system**
 - **Perform engineering study on KC-10 system to fix or replace**
 - **Select & execute B-52 SPO's pick for urinal replacement or install B-1 / B-2 improved toilet**
- **AFMC direct SPOs incorporate all AFCPCO suggestions**
 - **Most AFCPCO suggested material changes, coating stack-ups and use of damming agents are relatively inexpensive and can be implemented immediately**
- **Encourage SPOs to actively engage w/ field units & hold annual CPABs**
 - **CPABs are SPO's best way to gain field insight/collectively solve action items**
- **Encourage MAJCOMs to support CPABs by funding MAJCOM Functional/SME TDYs**
 - **MAJCOM/Wing/SPO Corrosion Mgr involvement paramount for prgm success**
- **Ensure lavatory refurbishment is mandated in all PDM work packages**
- **SPOs working implementation plans and reporting status to AFMC/CC/A4**



AFRL System Support Process



Customer Needs

Operational

- Mat'ls Failure

Maintenance

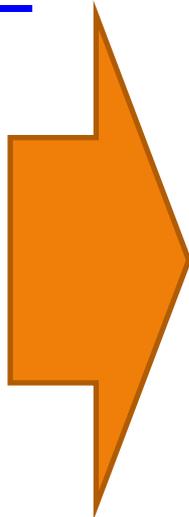
- Repair Issues

Acquisition

- Mat'ls Selection
- Component Design

Tech Development

- Transition Issues
- Improve Sustainability



System Support

- Adhesives / Comp / Elast
- Failure Analysis
- Testing/Evaluation
- Non-Destructive Insp.
- Collocates
- RX R&D Exp.
- RB and RZ R&D Exp.
- AF Structural MX O&M
- Other AFRL TDs



Products

Solutions

- Root Cause
- Repair Technology

Information

- Adv Mat'ls Req'ts
- Unbiased Data

Lessons Learned

- Failure Avoidance
- Adv Tech Transition

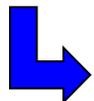
Prototype Systems

- Field/Depot Processes

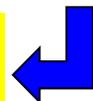
Wide Range of Customers

Broad Expertise Base

Full Spectrum of Products



Credible, Capable – Trusted 3rd Party





AFRL Engineering Expertise and Facilities



- **Rain/Particle Erosion**
- **Nondestructive Inspection**
- **Electronic & Structural Failure Analysis**
- **Electrostatic Discharge Control**
- **Composite Supportability**
- **Adhesive Bonding**
- **Aircraft Wiring**
- **Elastomers & Seals**
- **Materials, Structures & Engine Test & Evaluation capabilities**
- **Coatings (integration/transition/support)**
- **Manufacturing Processes**
- **Air vehicle/Engine Integration and Design**



Systems Support Time Line

Customer Focused S&T Solutions





AFRL Customers and Collaborators



**Over 170 Projects
More than 70 Customers**
2009 Data

- MAJCOMs**
- AFMC
 - AMC
 - ACC
 - AETC
 - AFSPC
 - WR-ALC
 - OC-ALC **ALCs**
 - OO-ALC

- AF Agencies**
- AF Safety Center
 - ASC
 - 46th TW
 - AFRL
 - NASIC
 - OSI

- Others**
- FAA
 - DARPA
 - USCG
 - NTSB

Customers

RX
AFRL
RB RZ

Collaborators

- ASC/EN
- USAFA (CASTLE)
- WR-ALC
- ALCs
- OC-ALC
- OO-ALC
- AFIA

Time Critical AF Mission Support for Acquisition, Operational, and Sustainment Needs

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Current Fleet Support



Improving Maintainability KC-135 Fuel Leaks



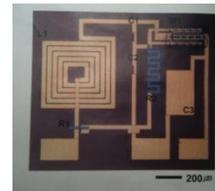
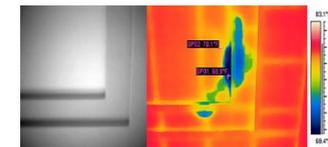
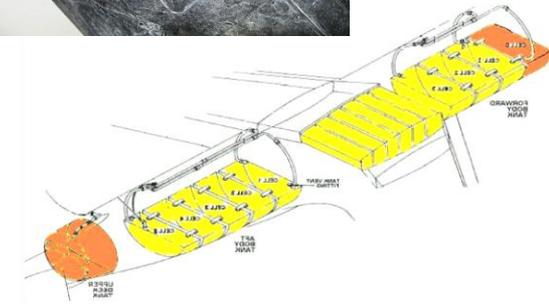
POC: AFRL/RXSA DSN 986-9214

PROBLEM:

- Fuel leaks a significant maintenance driver

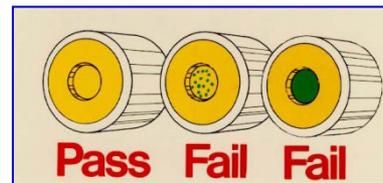
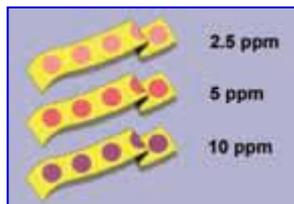
FINDINGS:

- Determining which bladder is leaking is difficult on multi-bladder platforms
- Leak check methods for bladders are primitive, time consuming and inaccurate
- AFRL and ALC team proposed solutions
 - Implement advanced detection techniques
 - Structurally isolate the bladder cavities
 - Develop sensors and tapes to aid in leak path analysis
 - Develop self-healing bladders



STATUS:

- Solutions identified
- Funding being sought for TCTOs and development programs





Improving Maintainability Heat/Blade Removal Tool



Handles



Heat/Blade Kit



Pneumatic Tool

PROBLEM: Environmentally friendly coating and sealant removal for corrosion inspection difficult with current low cost plastic scrapers.

Technology Availability: FY12

POC: AFRL/RXSA DSN 986-9214

APPROACH: Collaboration with AFMC/A7 Environmental Program to demonstrate improved processes using high temperature plastics, such as Ultem® and PEEK, or composites, such as epoxy graphite, develop a durable non-metal blade that retains a sharp cutting edge. Combine these blades with heat and power tools for easy removal of materials.

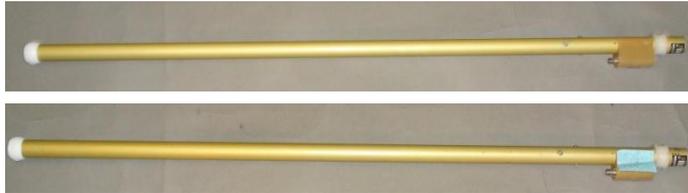
DELIVERABLE:

- Performance data for SPOs to demonstrate worker-friendly handle and durable blade systems and processes for removal of materials on- and off-aircraft.
- Modify power assisted tools that can be adapted to the blades.
- Develop a heated removal process that softens materials prior to removal

PAYOFF: Rapid removal of materials for corrosion inspection without worker injury resulting in lower maintenance costs and aircraft downtime.



Improving Maintainability C-130 Fuel Probe Degradation/Corrosion



PROBLEM:

- Fuel probes for the C-130 are degrading and giving inaccurate fuel level indications in the tanks
- AFRL/RX found corrosion products from fuel residue/build-up on electrical connections are the cause of premature probe failures

DELIVERABLE:

- RX evaluating new probe design with accelerated test methods to validate extended life for probes.
- Test results on redesigned components will provide SPO design data for inserting new probes as preferred spares

IMPACT/PAYOFF:

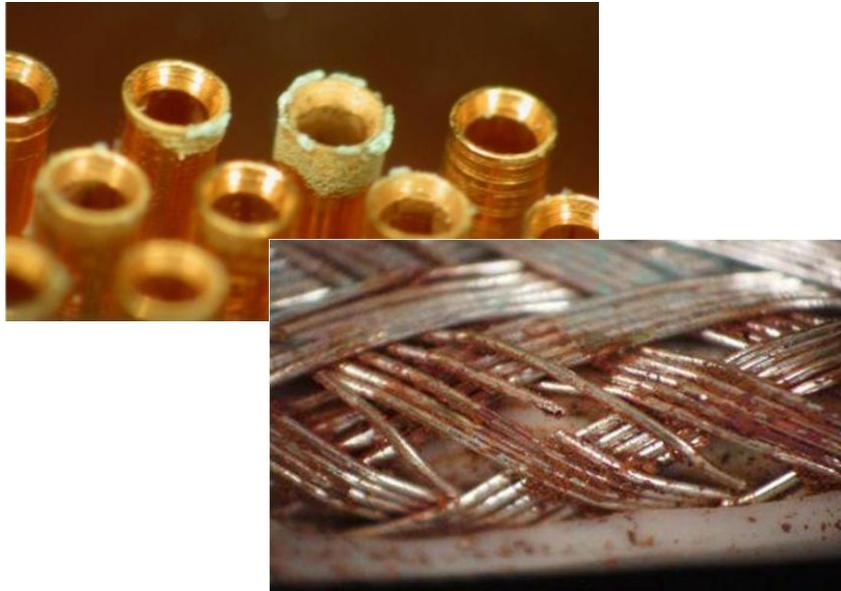
- Significantly reduce field/depot maintenance costs (increased Mean Time Between Failure - MTBF).
- Increased Aircraft Availability by reducing number of repair actions
- Next generation materials can be transitioned to other platforms/systems.

Technology Availability: FY13

POC: AFRL/RXSA DSN 986-9214



Improving Maintainability Wiring Corrosion Low Fluoride Evolution Materials



OBJECTIVES:

- Characterize corrosion mechanisms
- Develop novel test methods that quantify wire corrosion susceptibility
- Develop improved silver plating systems to mitigate corrosion
- Develop new Fluoropolymer insulation systems that don't off gas corrosive materials

DELIVERABLES:

- Improved corrosion resistant wiring
- New wiring plating/insulation
- Insulation specification and industry sources

IMPACT/PAYOFF:

- Impacts systems such as the JSF, F-22 and many USAF missiles and satellites
- Significantly reduces field/depot maintenance costs (increased Mean Time Between Failure – MTBF)

PROBLEM:

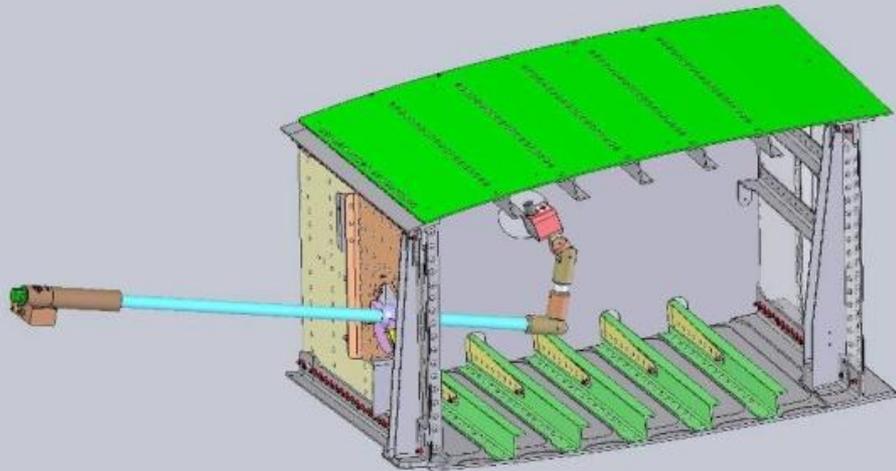
- Silver plated copper wiring susceptible to corrosion (Red Plague)
- Fluoropolymer wire insulations can off gas corrosive material and damage wiring, connectors and fiber optic systems

Technology Availability: FY15

POC AFRL/RXSA DSN 986-9214



Improving Maintainability Surgical NDI/E Methods Development



DELIVERABLE:

- Portable, field level multi-axis segmented sensor placement tool to effectively inspect critical areas inside aircraft structure without disassembly

IMPACT/PAYOFF:

- Increase inspection reliability by minimizing awkward inspector access to constrained areas
- Minimize costly and time consuming disassembly of aircraft for inspection
- Enable pre-induction inspections for realizing HVM objectives

Technology Availability: FY14/15

POC: AFRL/RXLP DSN 785-9803

PROBLEM:

- Critical NDI inspections are required in limited access locations
- Disassembly is costly and time-consuming
- Disassembly introduces potential for additional damage



Material and Design Compliance Environmental Compliance



Objective

Reduce or eliminate chromium, cadmium, nickel, hazardous air pollutants (HAPS), and volatile organic compounds (VOCs) from coatings and related processes.

RX Technology Areas

Organic & Inorganic Coatings
Surface Treatment
NDI
Coating Removal

Benefits

Increased operations capability
Less hazardous waste
Less toxic exposure
Less hazardous air emissions
Reduced cost
Improved performance



Hazardous Cr and Cd Replacements



UV Cured Paint



Laser Paint Stripping



Drivers: EO 13423; CAA, CWA, RCRA, OSHA; Cr6+ minimization/elimination in acquisition policy memorandum from DUSD J.J. Young, Jr; OSD Emerging Contaminants Watch List; foreign environmental regulations.



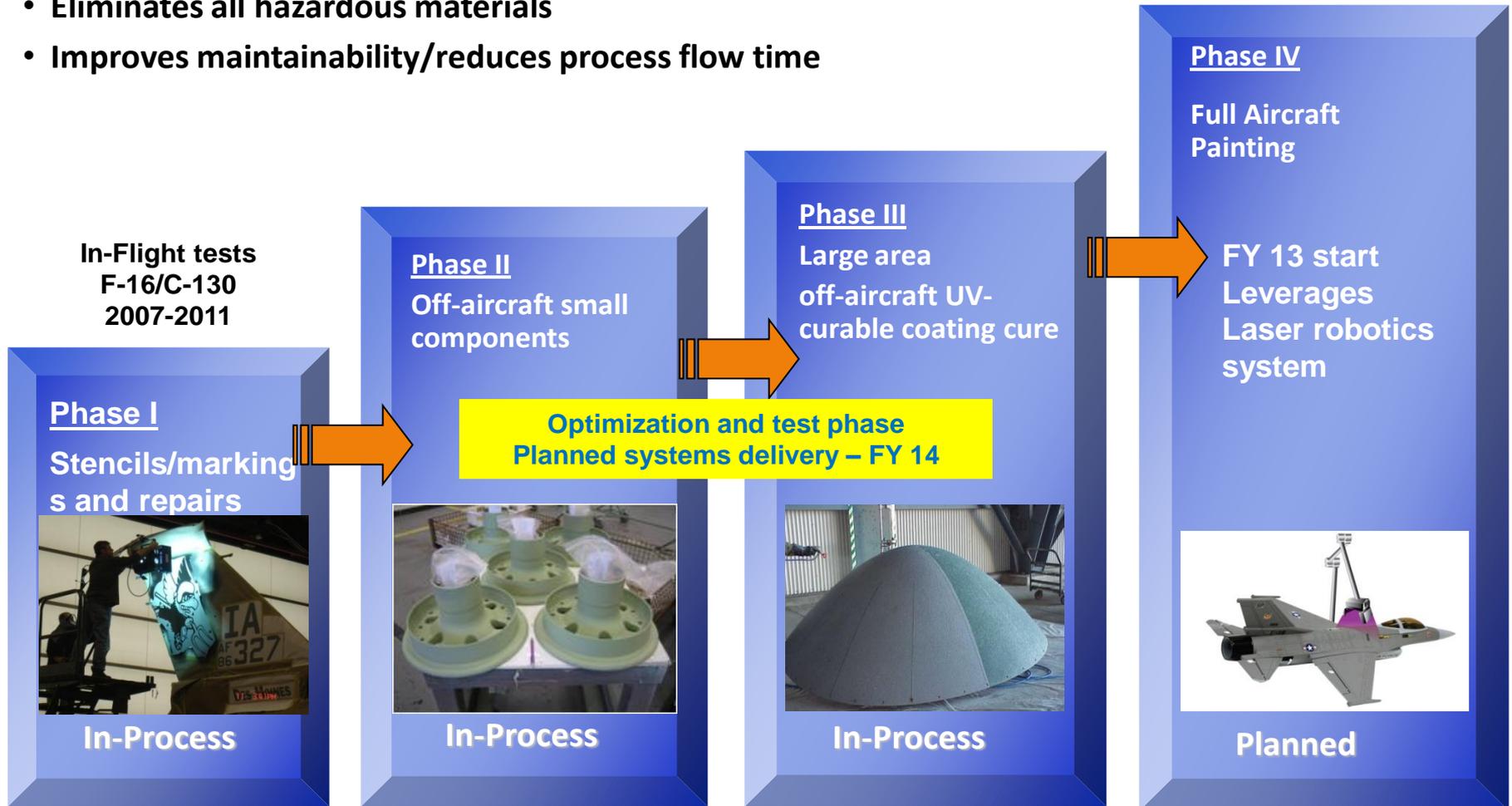
Air Force UV-Curable Program Approach



Funded by AFMC/A7-Pollution Prevention

Step-wise approach utilized to validate and advance UV-curable coatings

- Eliminates all hazardous materials
- Improves maintainability/reduces process flow time



POC: AFRL/RXSC DSN 986-5709



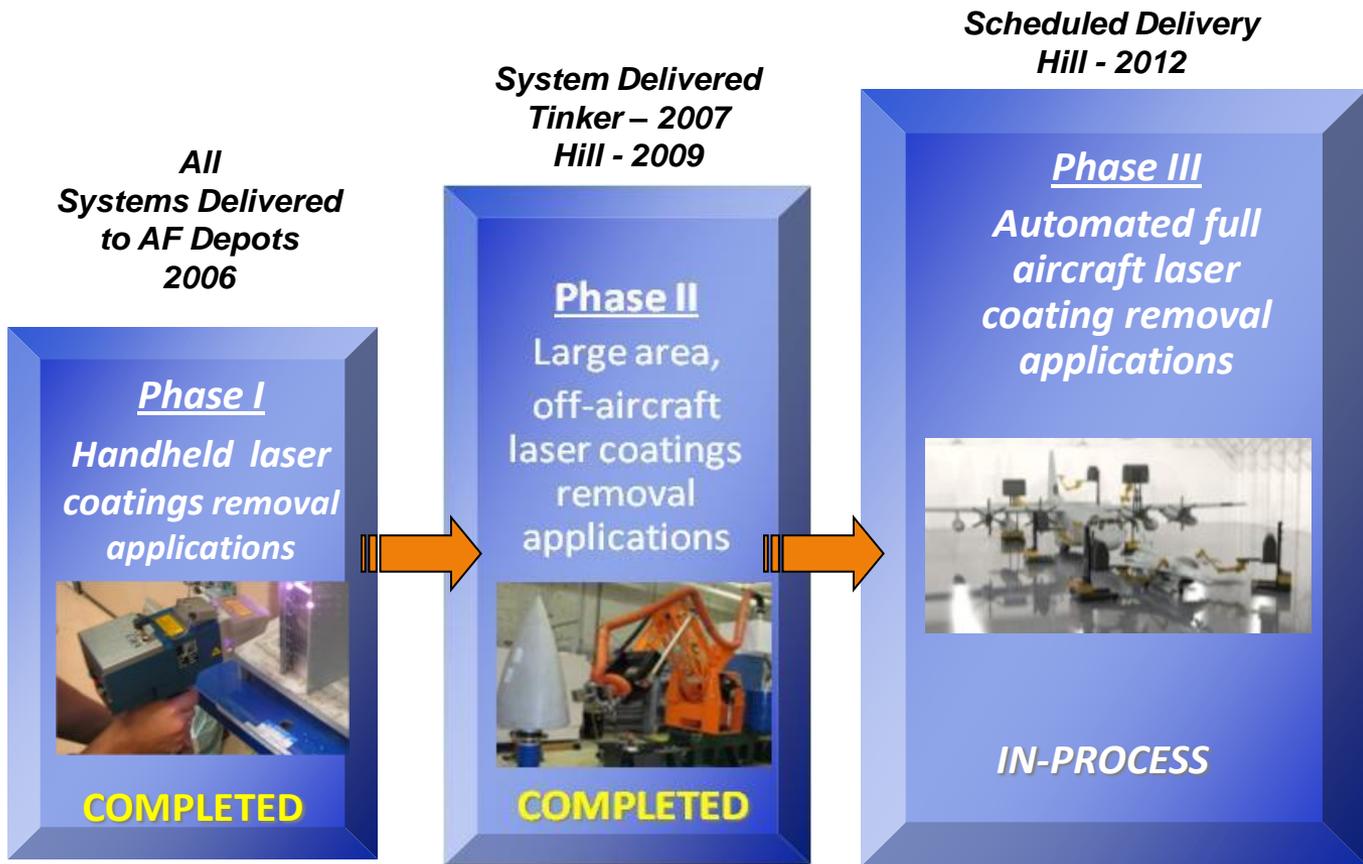
Air Force Laser Program

Funded by AFMC/A7-Pollution Prevention Funds



AFRL and HQ AFMC identified laser technology as a viable alternative and initiated the AF Laser Program

Program Goal: Establish and expand the use of laser technology as a viable alternative technology for depot maintenance operations



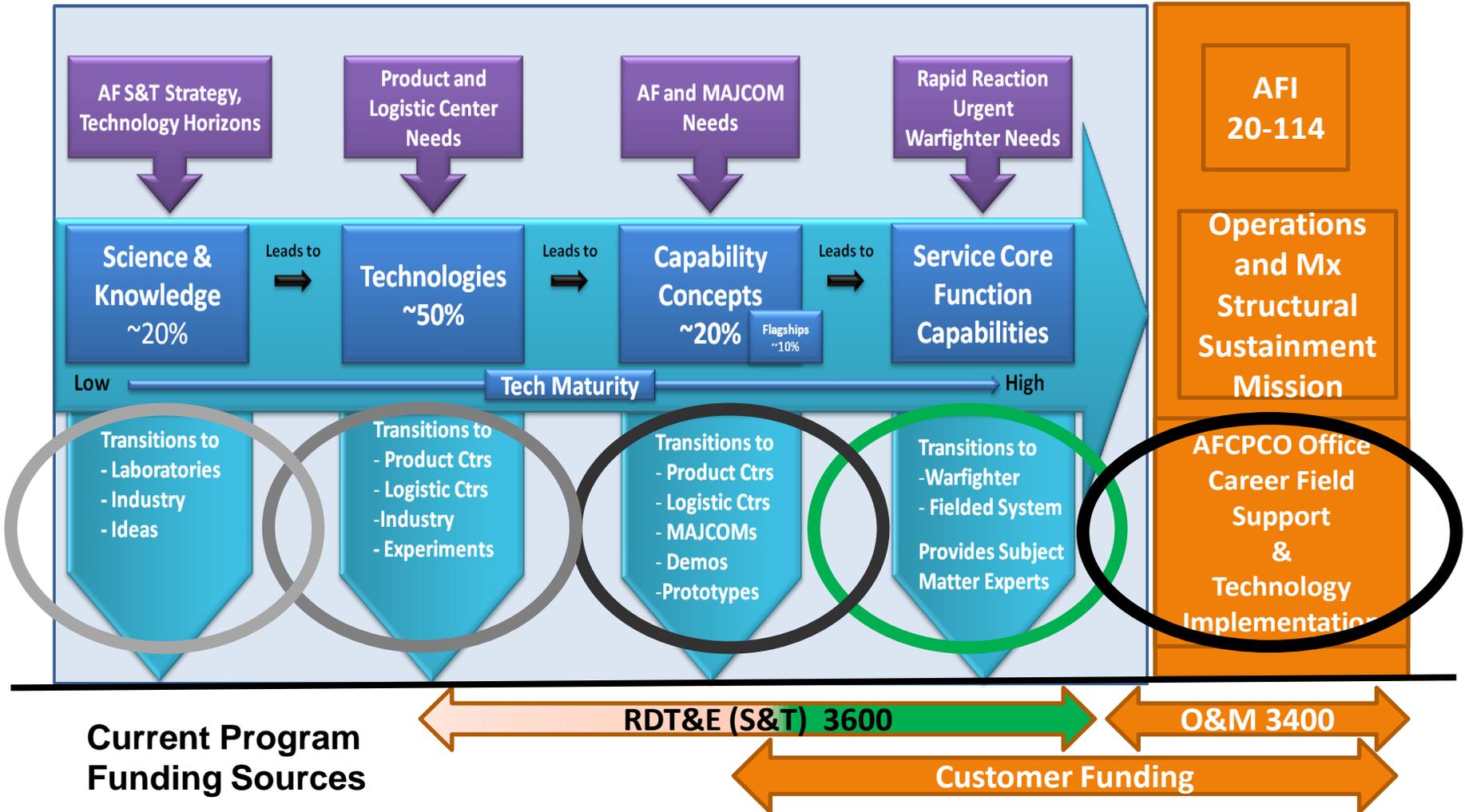
**POC: AFRL/RXSC
DSN 986-5709**

A stylized globe composed of a grid of white dots on a blue background with abstract light streaks. The globe is the central focus, with the dots forming a grid that covers its surface. The background is a deep blue with several bright, glowing light streaks that curve around the globe, creating a sense of motion and technology. The overall aesthetic is clean, modern, and scientific.

S&T Corrosion Study



AFRL Corrosion Activities





Corrosion S&T Study Strategy



- **A targeted study on the potential of S&T to meaningfully impact corrosion problems facing the AF**
- **Assess existing and required corrosion expertise to impact AF enterprise**
- **Identify major cost / mission availability drivers**
- **Identify AFMC priorities with special attention to AF Fleet Viability Board systems projections**
- **Set S&T investment options to deliver immediate/sustained technology to AF corrosion enterprise**
 - **Establish options for rapid response technology demonstration and transition of projects to impact AF fleet**
 - **The corrosion plan strategy also focuses on longer term investments creating science & technologies to enable future capabilities**



Summary



- **AFRL is delivering S&T Expertise & Solutions to the Current AF Fleet**

- **Keeping AF Systems Safe, Available, and Affordable**
 - **Now/Near Term Focus**
 - **Event Driven Rapid Response**
 - **Customer Connected**
 - **Implementation Oriented**

- **Identifying Opportunities for Longer Term S&T Investment**
 - » **Improve Fleet Health Management**
 - » **Enable Robust Design of New Systems**
 - **Accelerate insertion of new materials in legacy**



Back up slides





Summary of Current Fleet Sustainment



AFRL is delivering S&T Expertise & Solutions to the Current AF Fleet

Keeping AF Systems Safe, Available, and Affordable

- ***Now/Near Term Focus***
- ***Event Driven Rapid Response***
- ***Customer Connected***
- ***Implementation Oriented***

Identifying Opportunities for Longer Term S&T Investment

- » ***Improve Fleet Health Management***
 - ***Fleet management tools for safety and Life extension***
- » ***Enable Robust Design of New Systems***
 - ***Accelerate insertion of modern materials in legacy AC***



Desired AF Corrosion Enterprise Characteristics

- **Head Quarters AF & CCPE** - AF Corrosion governance process stability & leadership visibility
 - Policies refined, AF Corrosion Prevention Advisory Board (CPAB) active and staffed
 - Mechanism in place for Integrated Life Cycle Management (ILCM) reporting of Gaps-expertise and resources
 - AF corporate decision/resources allocated to improve AF corrosion enterprise
 - Active/binding processes for functional Acq program AF SME input/lessons learned
 - Development , implementation, sustainment of strategic plan for corrosion
- **AFMC** - Operations & Maintenance – AFI 20-114
 - AFRL Corrosion Prevention & Control Office resourced to match mission requirements
 - Sufficient Staffing/Resources for SMEs presence in Field, Depot and Acquisition Pgms
 - SME Support and governance/standards for weapon systems (CPABs, TOs and Surveys)
- **AFRL** - S&T AFRL Programs (delivering solutions while rebuilding competencies)
 - Funding Initial S&T targeted to high TRL projects - rapid technology impact
 - Labs available for development of AF corrosion expertise and AF SMEs
 - AF Commitment to align long term S&T resources with AF strategic plan objectives
 - Continue to Leverage DoD & other Services S&T investments



Material and Design Compliance

Environmental Compliance



- Reduction of Hazardous Substance (RoHS) and Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) requiring change in traditional materials where aging and performance characteristics are largely unknown
- Impact spans production, manufacturing, quality control, design, test, and maintenance processes

	Substance	Use (non-inclusive)	Impact
RoHS	Lead (Pb)	Aircraft electronics	Significant
	Cadmium (Cd)	Circuit breakers, relays, connectors, wire	Significant
	Hexavalent Chrome	Anti-corrosion primer on airframe structures	Significant
REACH Proposed	Nickel (Ni)	Stainless and magnetic metal alloys	Significant
	Beryllium (Be)	Airframe structures, aircraft wiring, nuclear applications	Significant



Material and Design Compliance Chromated Primer Replacement Summary



- **Some primers have been implemented on some aircraft**
 - **Majority of aircraft are still using chromated primers**
 - **Various primers have been field tested but have not been approved**
 - **Approval must come from the authorizing engineer for individual weapon systems for implementation to occur**
- **Performance of the primer can depend heavily on pretreatment/conversion coating selection**
 - **Focus is shifting to the qualification of complete Cr-free systems, rather than qualifying each component individually**
- **Additional field testing and qualification required to continue Cr-free primer implementation efforts**
 - **Magnesium-based primer has shown great promise in initial testing**