



F-22 SUSTAINABILITY

SUPPORTING MISSION & OPERATIONAL SUCCESS

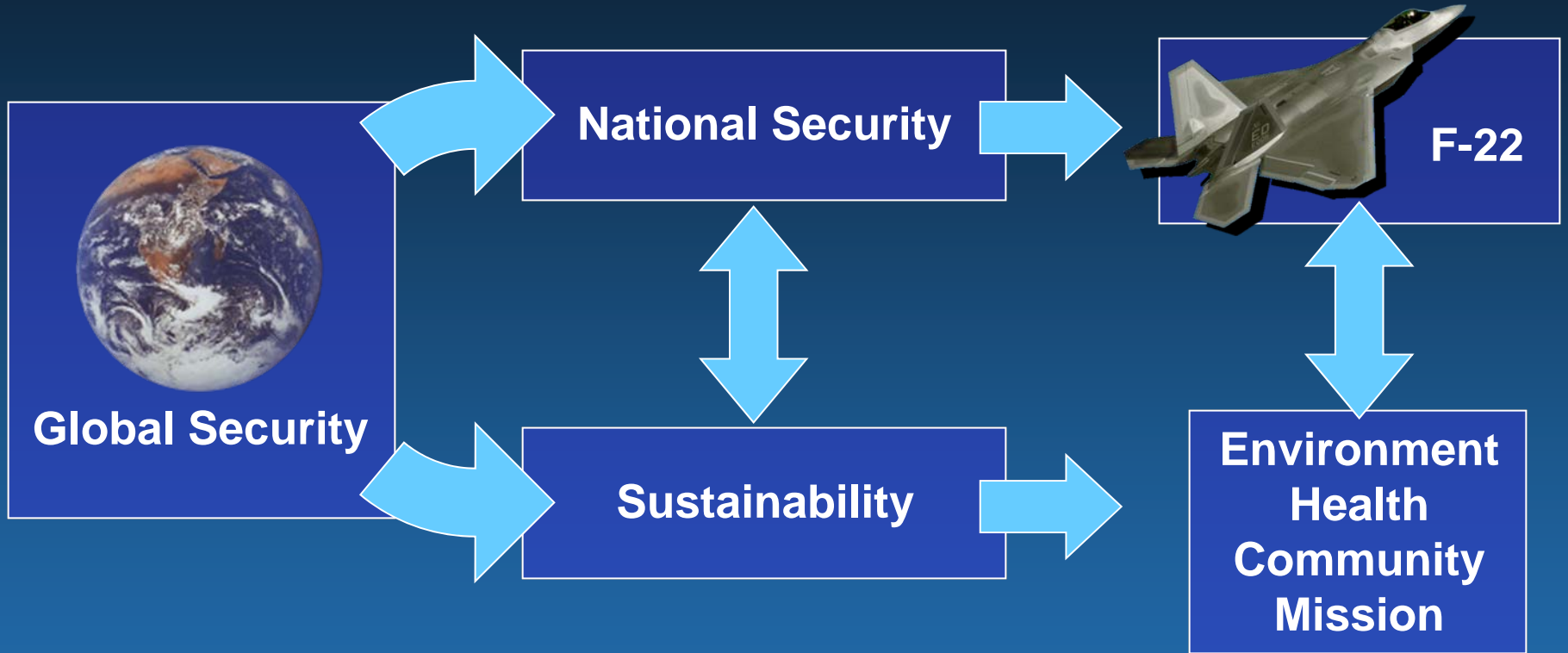


Arline Denny, Lockheed Martin Aeronautics Company
Jared Scott, F-22 System Program Office, USAF

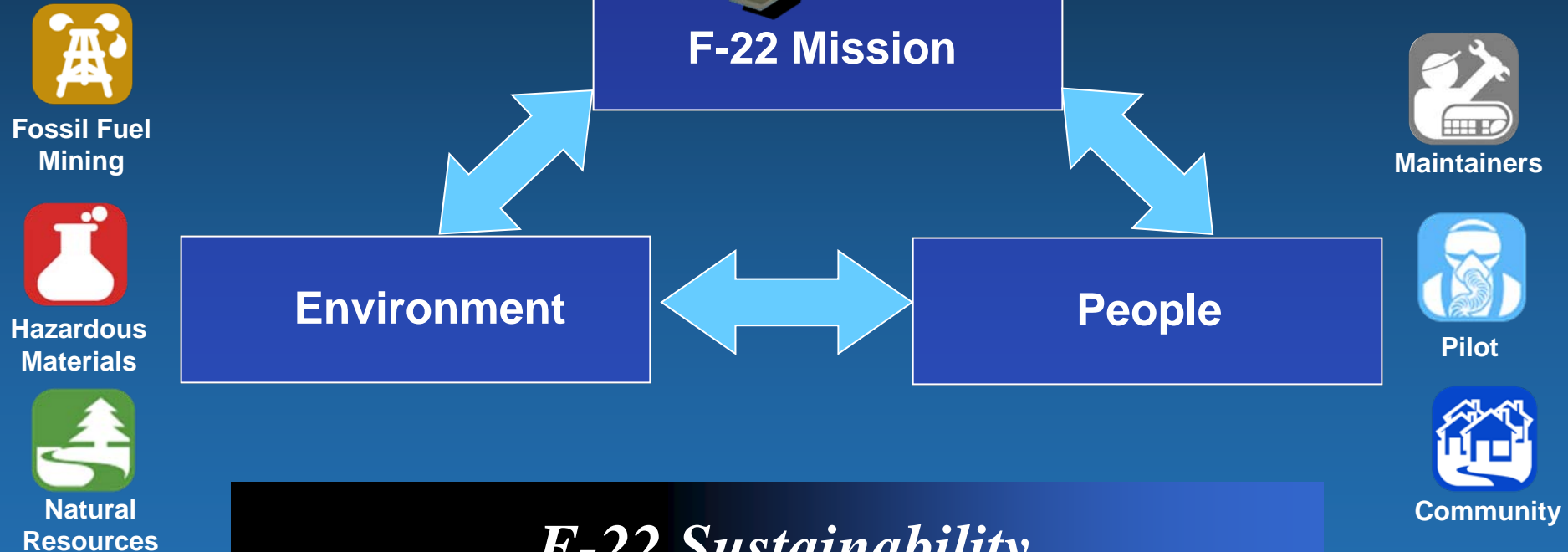


LOCKHEED MARTIN





Think Global → *Act Local*



***F-22 Sustainability
Reducing the ESOH/Community Footprint***



Sustainability Design Challenge

- The Natural Step Model -



Fossil Fuel
Mining

1. Reduce Use of Scarce Substances: Fossil Fuels, Mining



Hazardous
Materials

2. Reduce Use of Hazardous Materials

1&2 Reduce Pollution: Air / Water / Land / Waste
Keep in Technical Loop: Recycle / Reuse



Natural
Resources

3. Resource Use < Regeneration Capability



Community

4. Support Human Needs



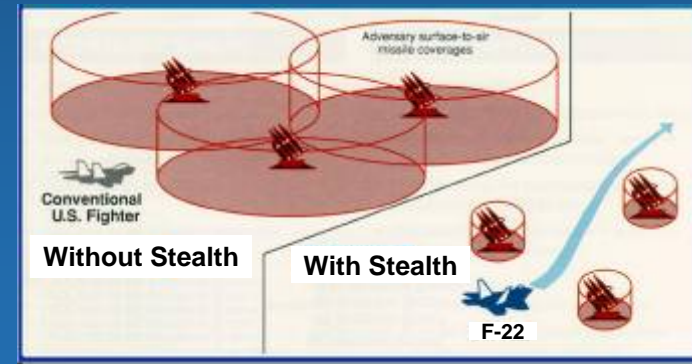
Pilot



Maintainers



- Air Dominance Reduces Aircraft & Resources
 - Covers 3 times area in same time
- Supercruise - Mach 1.5 @ Military Power
 - 60% less fuel than F-15C @ same speed
- Survivability & Air Power
 - Stealth, Integrated Avionics, Maneuverability, Armament



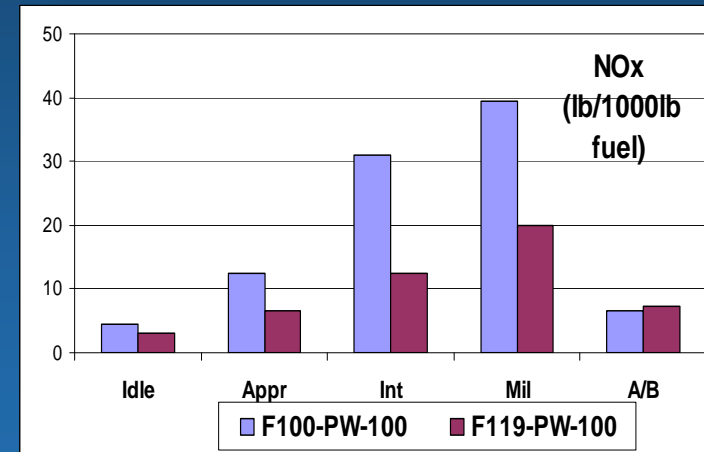


- **Enhanced Engine Management / Diagnostics**
 - *Test Cell Reductions: 50% Reqm'ts, 75% time*
 - *Engine Run-Ups Reduced 95% - No trim checks*
- **Engine Emissions \leq Legacy Systems**
 - *Significant NOx Reductions benefit EIS*



SAVINGS per 2 squadron base yr

- *0.5 M gal fuel \rightarrow \$1.06 M (FY 09 fuel price)*
- *70 tons Criteria Air Pollutants*
- *5.25 K tons CO₂ Greenhouse Gas*



Save 93% Fuel, Emissions, Cost of Engine Runs



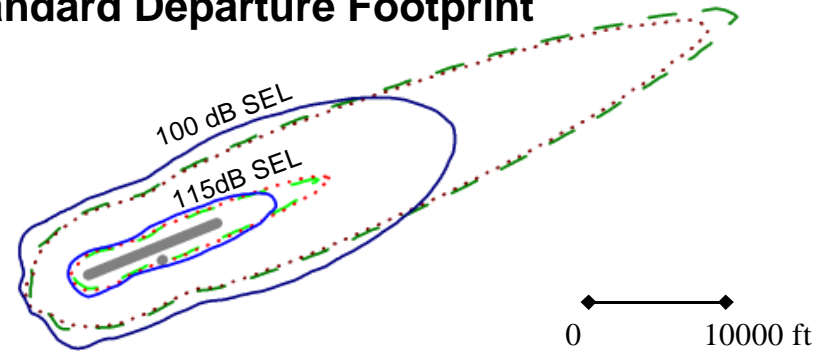
Far Field Noise & Community



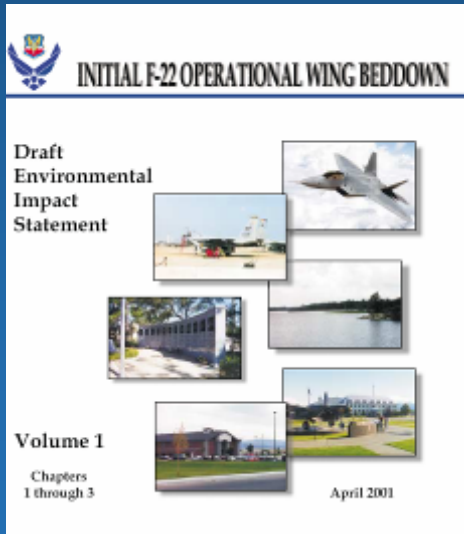
• Far Field Noise

- *Reduced Sound Exposure Footprint*
- *F-22 climbs faster at lower power*
 - ☐ Mil Power Takeoff
 - ☐ Greatly reduced A/B takeoffs

Standard Departure Footprint



**F-22 (Blue Solid), F-18 (Green Dashed),
F-15 (Red Dotted)**



• Environmental Impact Statement

- *Flight test, production acceptance, & beddown*
- *Community involvement*

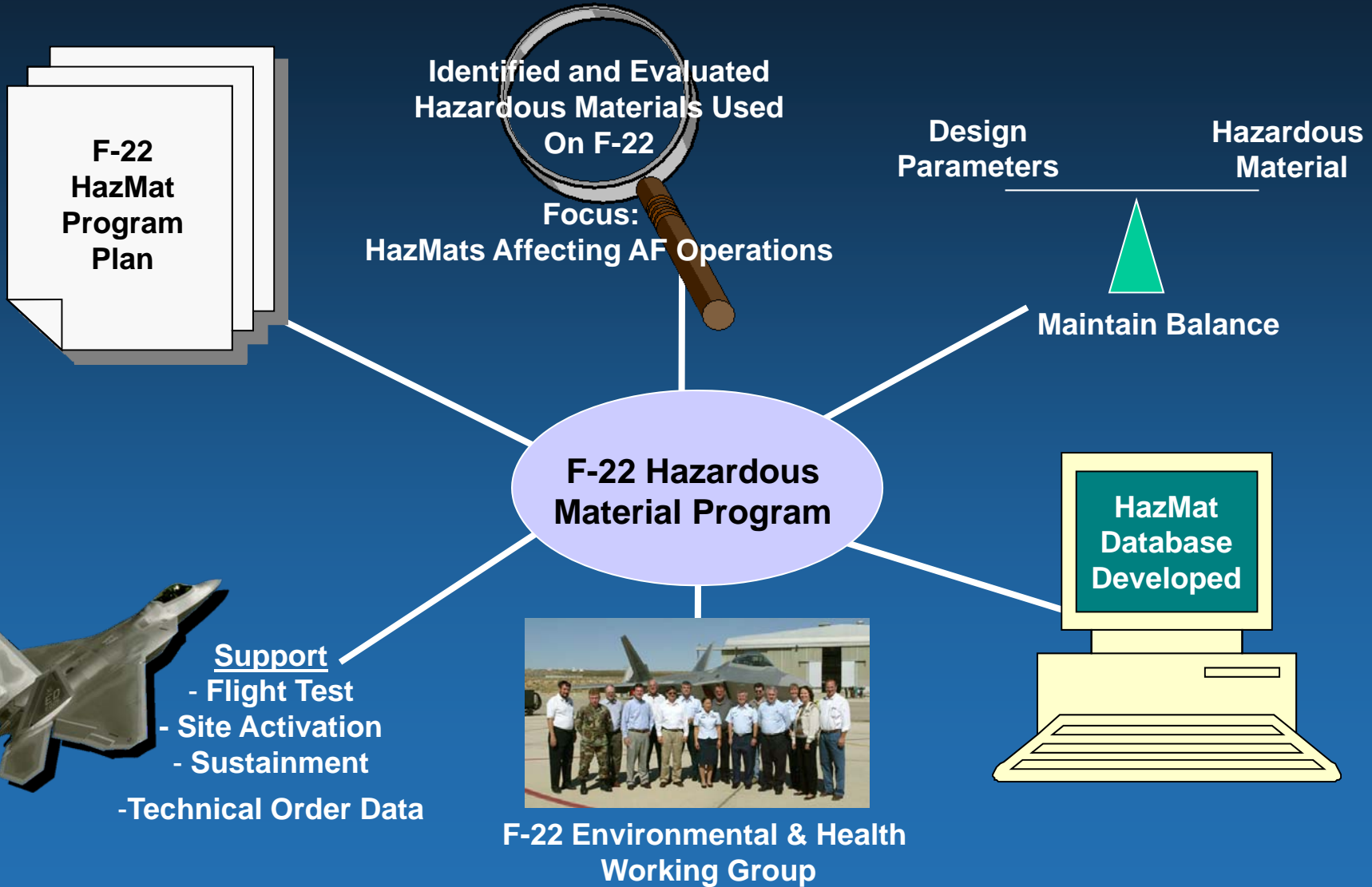


EAFB Threatened Species Study successful

- ☐ Sonic booms not impact Desert Tortoise survival

**Proactively Integrates
Hazardous Material, Environmental & Health Requirements
Throughout
the F-22 Weapon System Life Cycle**







EPA Stratospheric Ozone Protection Award for Leadership in Ozone Layer Protection

Outer Mold Line Repair Coatings & Primers
Reduced VOC, Brush/Roll primary repair
Right sized packaging

**Non-Chrome, Low VOC
Outer Mold Line Primers
(tiecoat, flex, composite)**

Non-Chrome Sealants

NESHAP solvents

**Allow Chromic Acid
Anodizing Alternatives**

**<1% Cadmium
Plated Fasteners**

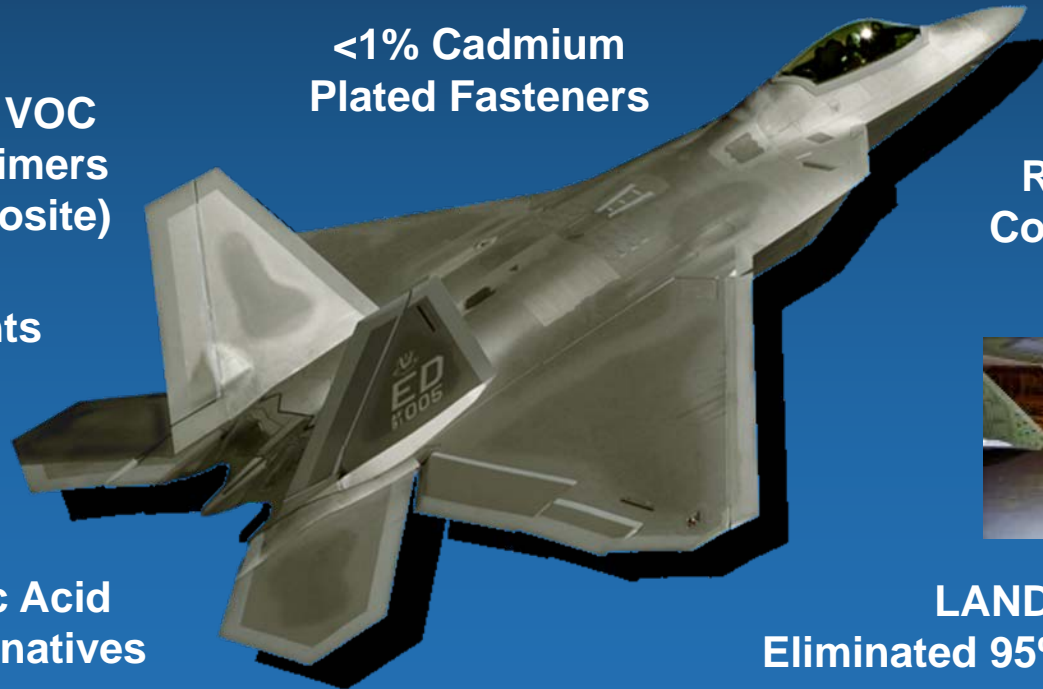
ODC-Free Aircraft & Manufacturing
No Halon, No ODC Refrigerant

**Recycle Selected
Coatings & Sealants**



LANDING GEAR
Eliminated 95% Cadmium Plating

No Methylene Dianiline



Proactive Risk Quantification & Mitigation



Joint Team
 - Customer / Contractor
 - Multifunctional



CONOPS



ESH

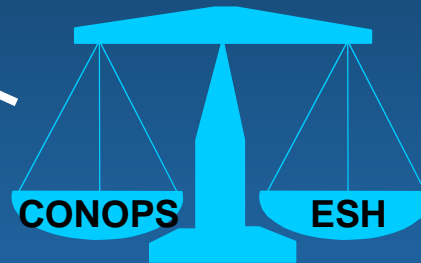
Identify Potential Risk



Define Data Requirements & Joint Test Plan



AF Bases
 - Obtain Permits
 - Continue Monitoring



MAINTAIN BALANCE



Conduct Tests & Quantify Risk



**BMP Req'm'ts:
 Process,
 Monitoring**

Define Best Management Practices

Outer Mold Line Repair Savings - Coating Removal -



CONOPS: Flight Line, Hangar, Paint Facility



- Coating Removal Method:
 - ACC Best Management Practice
 - HEPA vacuum sander; monitoring

Savings

- Eliminated 40% Restoration Panels
- Recycling per 2 squadron base yr
 - \$\$\$ Recycled
 - Eliminated 1.5 tons hazardous waste
- Popup Secondary Containment – Base option



Paint, sealant,
sanding waste



Proactive Improvements Reduce Footprint

Outer Mold Line Repair Savings - Coating Application -



CONOPS: Flight Line, Hangar, Paint Facility

- Repair Coating Application:

- *Primary: Brush/Roll replaced spray*
- *Secondary: Spray in paint facility*



- Reduced Impacts

- *79% Reduced deployment footprint*
- *\$ 2 M per hangar: # facilities, timelines*



- *Outer Mold Line Coatings: Low VOC; Reduced Chrome*

- *Right sized repair kits reduce waste: Qt → 4 & 16oz; Gal → 16 oz & qt*



↓VOC ↓Cr



Proactive Improvements Reduce Footprint



- ACES II Ejection Seat - Improved Protection
- Automated Flight Control Reconfiguration
- Integrated Caution & Warning System with Electronic Checklist



- Reduced Hazardous Material Exposure
 - *Pollution prevention*
 - *Tech Orders - HazMat Warnings, Icons, PPE*
 - *Flight Test Health & Env Test & Evaluations*
- 85% Maintenance Performed @ Ground Level

Pilot Safe – Maintainer Safe



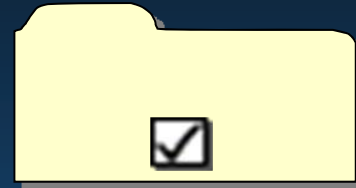
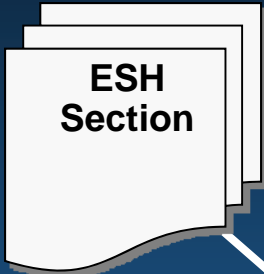
- Near Field Noise (dBA)
 - *Comparable to legacy aircraft*

Power Setting	F-16 P229	F-15C	F-22
Mil Power	145	144	146
Max Power	150	149	150

- Reduced Maintainer Noise Exposure
 - *Eliminated many engine high noise tasks*



ESH Integrated Base Activation Process

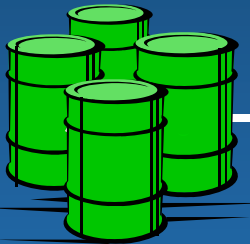


Air Force Base Approval
Of HazMats (Licensing)

Site Activation Plan
Integrated Master Schedule



Site Activation



Waste Stream
Identification

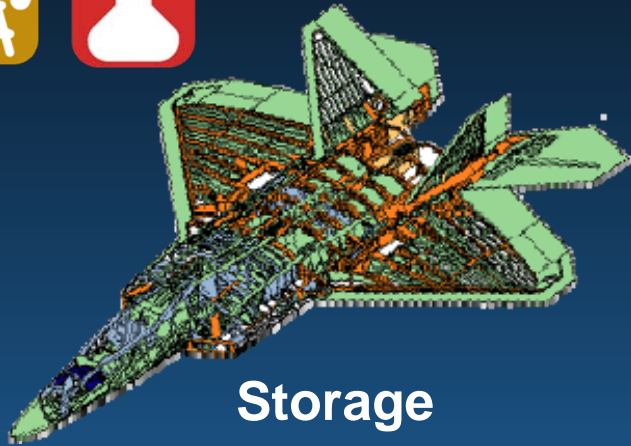


Permits



Industrial Hygiene
Surveillance

Reclaimed Parts & Disposal Reduce Cost & Resource Footprint



Storage

Spare parts

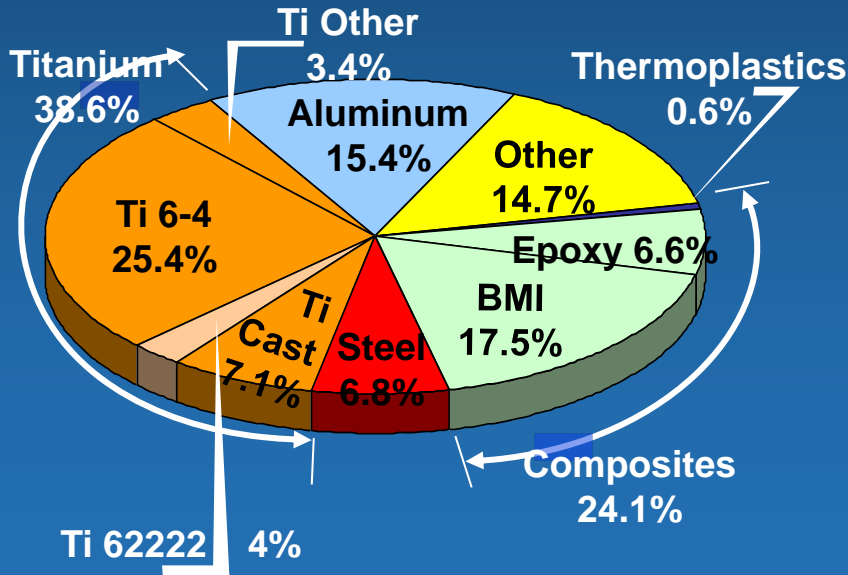


FY 2001 AMARC:
18,896 parts.

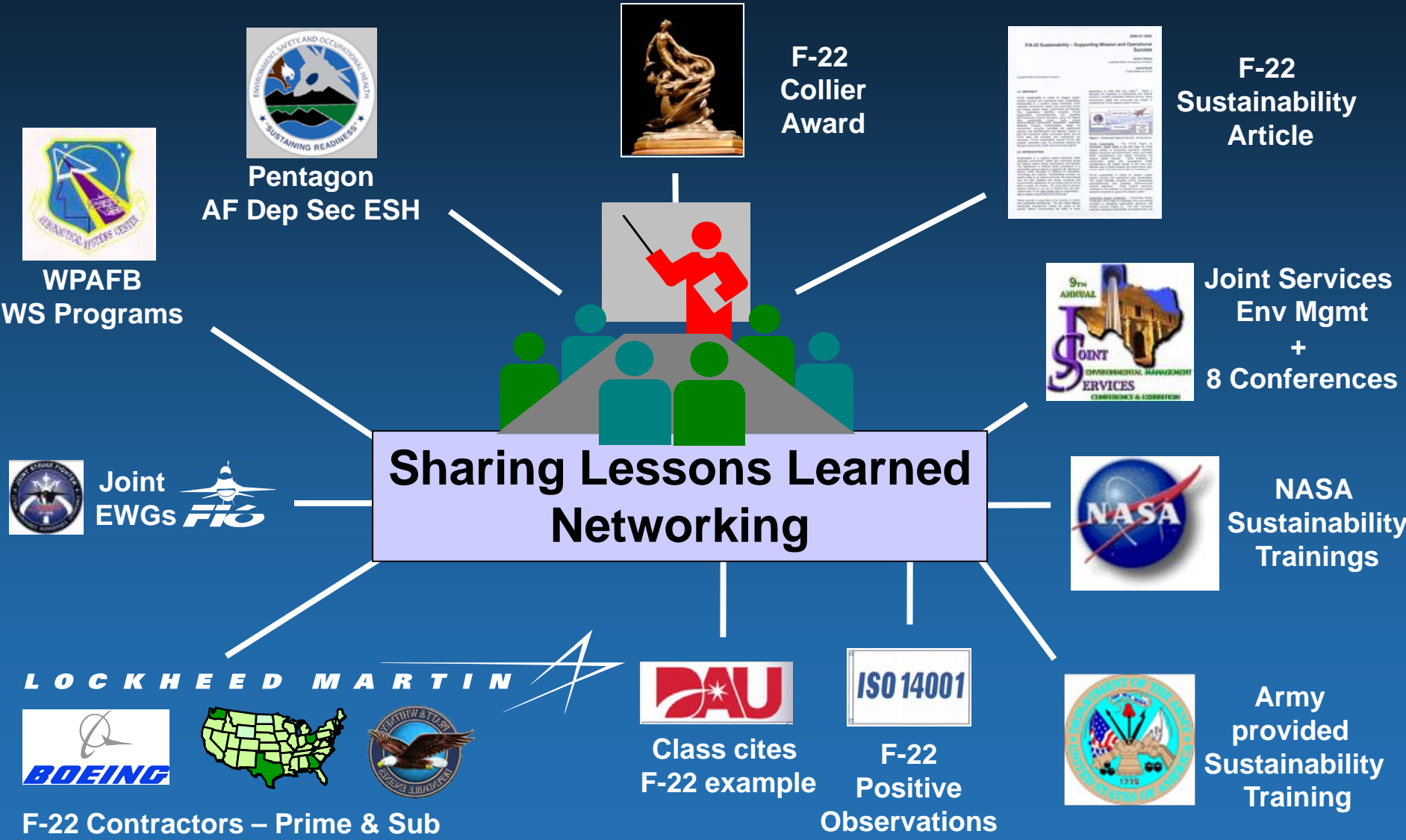


Fleet

Disposal



STRUCTURAL MATERIALS % Wt	TREATMENT
61% Metals	Recycle
24% Composites	AFRL SBIR Development - Destroy LO waste parts / components - Investigate Carbon Recovery





Take Away Themes



- **VISION:** Inspiring Big Picture → Opportunities
- **ACTION:** Integrate Requirements Throughout Lifecycle
- **TEAM:** Customer & Contractor, Integrated Product Teams
- **BALANCE:** Performance & Hazardous Materials
- **FUNDING:** Qualify & Implement New Materials
- **MULTIPLIER:** Share Lessons Learned & Accomplishments

Support the Mission



Reduces Mission Cost



Reduces Mission Restrictions



Promotes Healthy Personnel



Promotes Base Sustainability



Promotes Community Relations



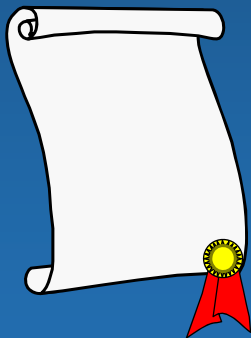
Reduces F-22 Total Ownership Costs



From the Pentagon...



*“There is truly no substitute for seeing first hand the superb attention LM and the Air Force are applying to the environmental, safety, and occupational health facets of this advanced tactical fighter – certainly **cutting edge business practices** and **a model for all our future weapon systems!**”*



Terry A. Yonkers
Former Assistant Deputy Assistant Secretary of Air Force
(Environmental, Safety, and Occupational Health)

DISCUSSION

