ESOH Requirements for UAVs

Boeing – St. Louis
Integrated Defense Systems

Stephen Gaydos
May 22, 2006
## ESOH Requirements for UAVs

**1. REPORT DATE**
22 MAY 2006

**2. REPORT TYPE**

**3. DATES COVERED**
00-00-2006 to 00-00-2006

**4. TITLE AND SUBTITLE**
ESOH Requirements for UAVs

**5a. CONTRACT NUMBER**

**5b. GRANT NUMBER**

**5c. PROGRAM ELEMENT NUMBER**

**5d. PROJECT NUMBER**

**5e. TASK NUMBER**

**5f. WORK UNIT NUMBER**

**6. AUTHOR(S)**

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
Boeing, Integrated Defense Systems, P. O. Box 516, St. Louis, MO, 63166

**8. PERFORMING ORGANIZATION REPORT NUMBER**

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

**10. SPONSOR/MONITOR’S ACRONYM(S)**

**11. SPONSOR/MONITOR’S REPORT NUMBER(S)**

**12. DISTRIBUTION/AVAILABILITY STATEMENT**
Approved for public release; distribution unlimited

**13. SUPPLEMENTARY NOTES**
SERDP/ESTCP Metal Finishing Workshop, May 22 - 23, 2006, Washington, DC. Sponsored by SERDP/ESTCP.

**14. ABSTRACT**

**15. SUBJECT TERMS**

**16. SECURITY CLASSIFICATION OF:**
<table>
<thead>
<tr>
<th>a. REPORT</th>
<th>b. ABSTRACT</th>
<th>c. THIS PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>unclassified</td>
<td>unclassified</td>
<td>unclassified</td>
</tr>
</tbody>
</table>

**17. LIMITATION OF ABSTRACT**
Same as Report (SAR)

**18. NUMBER OF PAGES**
13

**19a. NAME OF RESPONSIBLE PERSON**
UAVs

• Unmanned Air Vehicles
  – Used for Surveillance Missions
Scan Eagle Launch
UCAVs

• Unmanned Combat Air Vehicles
  – Used for Strategic Bombing
X-45 UCAVs
ESOH Requirements for UAVs

• Environment, Safety and Occupational Health (ESOH) Requirements
  – UAV Proposals Meet All Federal, State and Local Regulations Regarding Hazardous Material Usage
    • Thoroughly Reviewed by Boeing
  – Contracts Are Modified and Updated to Reflect the Latest Regulations
    • Boeing Complies with All ESOH Requirements
Chromium and Cadmium Usage on UAVs

• Performance Specifications, System Specifications, Statement of Work for UAVs Do Not Restrict or Prohibit the Use of Cadmium or Chromium
  – Cadmium and Chromium Elimination is Not a Customer Requirement
  – However, Cadmium and Chromium Alternatives Are Used Because of Performance Issues
    • Titanium Landing Gear – *Increased Durability*
    • Stainless Steel Fasteners – *Corrosion Resistance*
    • Composite Structure – *Enhanced Performance*
Nickel and Cr\textsuperscript{+6} Metal Finishing Processes on UAVs

• Nickel Alternatives Are Not Considered Because They Do Not Exist
  – Cobalt Alternatives Are More Toxic Than Nickel
    • EPA and OSHA Will Increase Regulation When Usage Increases

• Cr\textsuperscript{+6} Alternative Processes for Aluminum Are Not Considered Because They Do Not Exist
  – Aluminum Conversion Coating
    • Current Alternatives Do Not Meet MIL-DTL-81706 Corrosion Resistance Requirement on 2024 Aluminum
      – TCP Qualification in Work
  – Anodize Seal
    • Low Chrome Seal - CONTAINS Cr\textsuperscript{+6}
    • No Seal
      – Does Not Meet MIL-A-8625 Salt Spray Requirements
  – Chromic Acid Anodize
    • Still Needed for Parts with Entrapment
UAV Design Objectives

• Majority of Engineering Effort Is Spent on Meeting UAV System Performance Requirements
  – Speed, Altitude, Flight Time, Weight, Performance, Payload, etc.
    • Elimination of Cadmium and Chromium is Not a Priority Item
  – Need to Meet Cost and Schedule Targets
    • High Risk Options Such As Cadmium and Chromium Alternatives Impact Cost and Schedule
“Green” UAVs

• DoD Customers Need to Be Willing to Invest In “Green” UAVs
  – UAV System Requirements Should Prohibit Cadmium and Chromium (and Nickel and Cr\(^{+6}\) Metal Finishing)
    • Need to Eliminate Cadmium and Chromium from Initial Design Phase
    • Customer Needs to Be Willing to Pay Extra and Accept a Delayed Schedule for First Flight
      – Reduce or Modify Requirements
  – Work with OEMs to Build a “Green” UAV
Is Technology Available to Build a “Green” UAV?

• Before Customer Requires a “Green” UAV
  – Make Sure Technology is Available
    • Chrome Plate Replacements?
      – Need Hard Wear Resistant Coatings
        » ID and OD Applications
    • Cadmium Plate Replacements?
      – Need Sacrificial Coatings That Protect Steel and Are Compatible with Aluminum
    • Can Replacements Contain Nickel, Cobalt, Cr$^{+3}$, or Cr$^{0}$ (HVOF Coating WC-Co-Cr)?
Remaining Needs

- Cadmium Plating Replacements
  - Prefer a Non-Embrittling Process
  - Or Need Embrittlement Test Results < 24 Hours
  - Need to Coat Both ID and OD Surfaces
- Chrome Plate Replacements
  - HVOF with Better Adhesion (No Spalling)
  - Non-HVOF Processes (Plating Bath or PVD)
  - Need to Coat Both ID and OD Surfaces
- Non Cr\(^{+6}\) Processes Needed to Work with Non-Cr Primers
  - Use a Coating Systems Approach
- Implementation Issues for Alternatives Exist
Scan Eagle UAV Participating in the UK Ministry of Defence’s Trial Vigilant Viper off the Coast of Scotland