Air Force Materiel Command

Dominant Air Power: Design For Tomorrow…Deliver Today

Developing, Fielding, and Sustaining America's Aerospace Force

303d Aeronautical Systems Wing Unmanned Systems Overview

NTSB UAS Forum

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Integrity - Service - Excellence

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Agenda

- **303d Unmanned Systems**
- **USAF - FAA Airworthiness Comparison**
- **USAF UAS Airworthiness Results**
- **Conclusion**

303 AESW UAS Size Comparison

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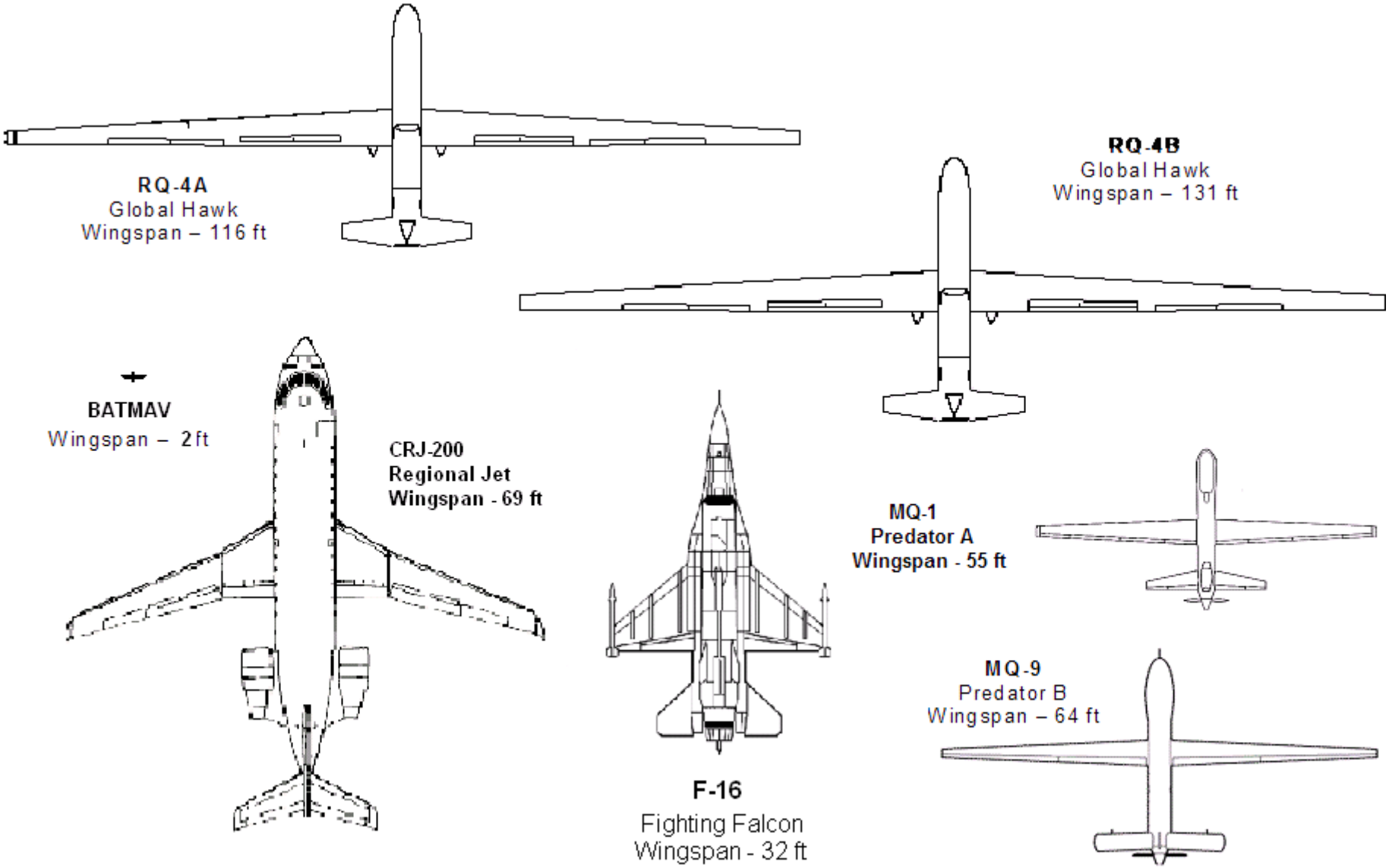

USAF Experience With UAS

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Unmanned Aircraft System	Fleet Hours	% of Fleet Hours (Combat)
MQ-1 Predator	336,900	82%
MQ-9 Reaper	20,300	80%
RQ-4 Global Hawk	21,210	75%

USAF Unmanned Safety Record

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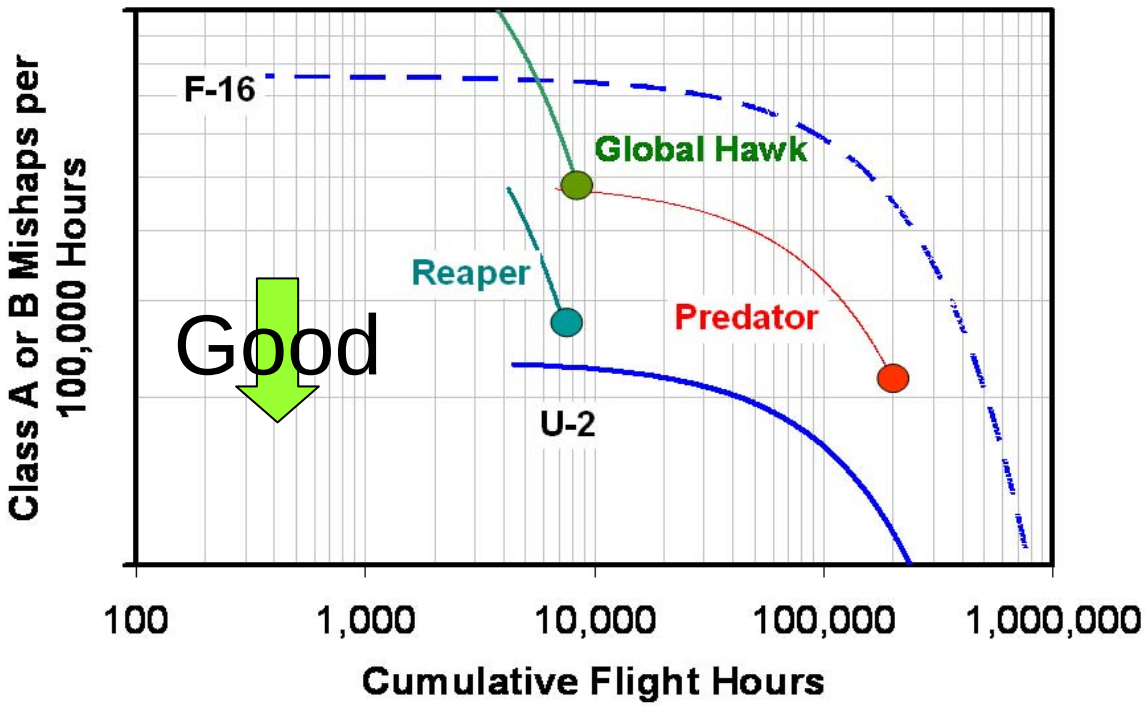
Class A Mishap.

1. Reportable damage of $1,000,000 or more.
2. A fatality or permanent total disability
3. Destruction of an Air Force aircraft, spacecraft, or missile during launch

Class B Mishap

1. Reportable damage of $200,000 or more but less than $1,000,000
2. A permanent partial disability
3. Inpatient hospitalization of three or more personnel



Integrating UAVs into the National Airspace System (NAS)

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DoD-FAA Guidelines

1. **Do no harm** - Avoid enacting regulations for the military user that would later unnecessarily restrict civilian UAV flights
2. **Conform rather than create** - Adapt existing Title 14 Code of Federal Regulations to the greatest extent practicable
3. **Establish the precedent** - Focused on domestic use, any regulations enacted will likely lead, or certainly have to conform to, similar regulations governing UAV flight in international (ICAO) and foreign (specific countries') airspace

USAF Airworthiness

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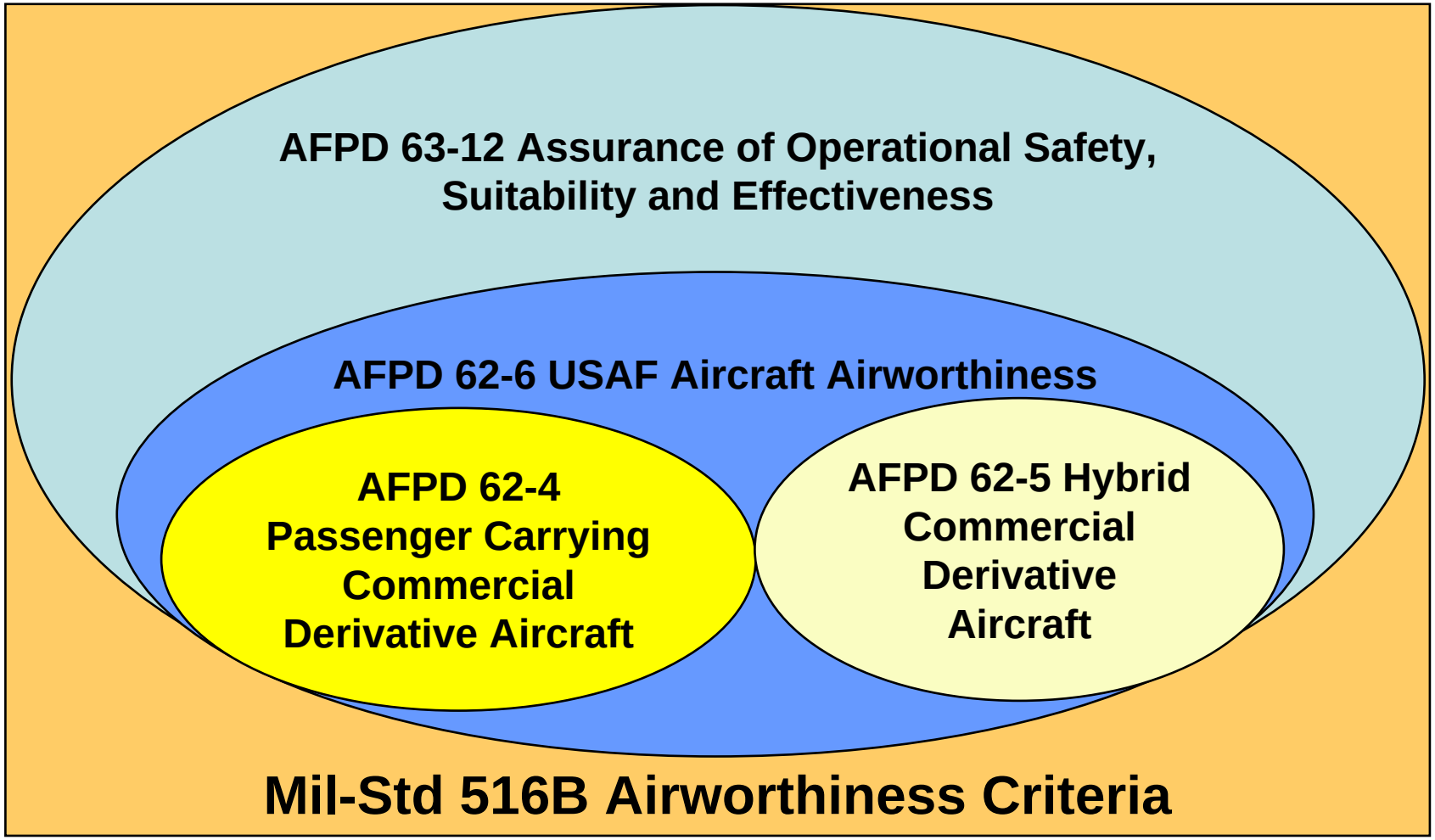

Full | Restricted | SOAR

Step 1 – Determine and Quantify Certification Basis and Standards

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FAA 8110.4B Type Certification Process

Applicant Applies for TC

FAA Establishes Project

AEG Assigns:
FSB Chairman
FOEB Chairman
MRB Chairman

Directorate/ACO Assigns:
Project Manager
Project Team
Project Officer

FAA and Applicant Hold Familiarization/Preliminary TC Board Meeting

FAA Developments Certification Program Plan

FAA Establishes Certification Basis

FAA and Applicant Hold Specialists and Interim TC Meetings as Required

FAA Considers Special Conditioning

USAF Mil-Std-516 Airworthiness Certification Process

Air Force Established Program

Program Office Developments Certification Program Plan

Program Office Tailors Mil Std 516A Airworthiness Certification Criteria (TACC)

ASC/EN and Program Office Hold Specialists and Interim Airworthiness Meetings as Required

ASC/EN Approves TACC

ASC/EN Assigns First Flight Chairman

Step 2 – Prove Design Meets Standards And Is Safe To Fly

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FAA 8110.4B Type Certification Process

FAA Performs Conformity Inspections
(Continues Throughout The TC Process)
(Conformity to Engineering Data)

Engineering Compliance Determinations
(Compliance with FAA Regulations)

FAA Issues Experimental Airworthiness Certificate (If Appropriate)

Pre-Flight TCB Meeting

Applicant Performs Ground Tests, and Flight Tests

FAA Reviews Manufacturer's Flight Test Results

FAA Issues Experimental Airworthiness Certificate
(If Appropriate)

Pre-flight Issues TIA

USAF Mil-Std-516 Airworthiness Certification Process

Program Office Performs Audits
Requirements Reviews
Analyses Review
Drawing Review

Engineering Compliance Determinations
(Compliance with TACC)

First Flight Review (FRR) Meeting

Program Office Issues First Flight Approval
Coordinated with ASC/EN
(Equivalent to FAA Experimental Flight Certificate)

Program Office Executes Development
Testing and Evaluation (DT&E)
(Performed in conjunction with a
Responsible Test Organization (RTO))

Step 3 – Prove As-Built Meets Design And Is Ready for Fielding

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FAA 8110.4B Type Certification Process

- FAA Performs Official Certification Flight Tests and Flight Standards Evaluation
- Functional and Reliability Testing
- FAA Approves Flight Manual and TC Data Sheet and Holds Final TCB Meeting
- AEG Completes Continuing Airworthiness Determination
- **FAA Issues Type Certificate**
- AEG Issues Results of Operational Acceptability Findings
- Aircraft Enters Service
- Post Certification Activities: FAA and Applicant Evaluate Service Difficulties

USAF Mil-Std-516 Airworthiness Certification Process

- OT&E Tests (Performed by Independent Test Organization) Issues Results of Operational Acceptability Findings
- Functional and Reliability Testing
- Program Office Approves Flight Manual and Technical Orders Validated and Verified by User
- Program Office Completes Continuing Airworthiness Determination Coordinates with ASC/EN
- **Program Office Issues Airworthiness Certificate**
- OT&E Issues Results of Operational Acceptability Findings
- Aircraft Enters Service
- Post Certification Activities: Program Office and User Evaluate Service Difficulties

UAS Airworthiness To Date

- Global Hawk RQ-4A "Restricted"
  - Risk Assessment Served As Basis
- Predator MQ-1 "Restricted"
  - Similarity To "Manned A/C" Using 150K+ Fleet Hours And USAF Mishap Data
- Reaper MQ-9 Full Mil-STD-516 Planned
- Global Hawk RQ-4B First Flight Readiness Review Completed
  - Certification In 2009

Continuing Airworthiness

- **USAF Uses Three Primary Processes**
  1. **Reliability/ Trend Analysis**
     - **Automated Tracking Databases**
       - » **Line Replaceable Level In Most Cases**
  2. **Deficiency Reporting System**
     - **User Inputs Based On Their Findings**
     - **Formal Tracking System**
  3. **Aircraft Structural Integrity Program**
     - **Yearly Reviews Of The Process And Results**
- **Air Force Safety Center Safety And Accident Investigation Boards**
  - **Formal Process For Root Cause Evaluation**
  - **Formal Findings**
- **AF UAS's All USAF Manned Life Cycle Management Systems**

Conclusion

- **USAF Has Robust Processes For Manned Aircraft Safety**
- **USAF UAS's Follow These Processes As Well**

Conform Rather Than Create - Adapt Existing Title 14 Code Of Federal Regulations To The Greatest Extent Practicable

BACK UP

UAS Certification Basis Complexity

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Domestic Use UAS Levels	Certifciation Basis: Equivalent FAA - Accidents and Accident Rates by NTSB Classification, 1987 through 2006		Certifciation Basis: USAF Certification Standard				Applicability				UAS Examples
	Certification Standard	Probability of Loss of Airvehicle (PLOA) (Note 3)	Unrestricted /Restricted	Probability of Loss of Airvehicle (PLOA) (note 1)	Restricted to Individual Aircraft and Operating Location (note 2,3)	Minimum Data Required	Airspeed (kts)	Weight (lbs)	Operating Altitude (ft)	Description	
Level 0	Part 103 - Ultralight Vehicles	None	Mil-Std-516	10^{-3}	SOAR (depending on population density)	Simple Failure Modes & Effects Analysis (FEMECA)	≤ 55	≤ 2	≤ 1,200	Systems under 2 lbs, within LOS control, operating in unregulated airspace; < 5 gal fuel	BATMAV
Level 1				10^{-4}				2-20	≤10,000	Systems under 20 lbs, operating below VFR airspace; < 5 gal fuel	Dragon Eye, Swift, Desert Hawk, Raven, Buster
Level 2	Part 23 - Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes	10^{-5}		10^{-5}	SOAR (medium to high risk)	Detailed Failure Modes & Effects Analysis (FEMECA); PLOA Calculation	≤ 250	21-1,320	≤ 18,000	Systems under 1,320 lbs fall under light sport aircraft standards	Tern, Mako, Silver Fox, ScanEagle, Aerosonde
Level 3								1,321-12,500		Systems over 1,320 lbs, operating below Class A airspace	MQ-1B, MQ-1C
Level 4				10^{-6}	SOAR (high risk)	Detailed Failure Modes & Effects Analysis (FEMECA); PLOA Calculation verified by Testings or Detailed Analysis	> 250	≤ 12,500		Systems operating below 10,000 ft MSL with max airspeeds that exceed the limit of 250 kts	
Level 5							Any	≤ 12,500	≥ 18,000	Systems operating at or above 18,000 ft MSL fall under Class A airspace standards	Reaper
Level 6	Part 25 - Airworthiness Standards: Transport Category Airplanes	10^{-7}		10^{-7}			Any	> 12,500	≥ 18,000		RQ-4A, RQ-4B

Note 1 - PLOA is for unlimited overflight, PLOA can be lower depending on population density over which the vehicle flies

Note 2 - Most probable risk profile; actual SOAR certification risk may be higher or lower depending on unique circumstances

Note 3 - PLOA equivalent to a probability of fatality of < 1 in a million

UAS Certification Basis Complexity

- **Large UAS Need to Meet General Aviation Requirements At the Least (ex. Mil-Std-516) with Tailoring**
- **Small UAS Can Be Safely Managed Through A Rigorous Operational Risk Assessment Process (ex. USAF SOAR Process)**
- **Intermediate UAS Fall Somewhere Between The Two**
- **Issue: Tailoring Standards Is Difficult And Sometimes Impossible**
  - **Factors of Safety < 1.5**
  - **Non-standard Manufacturing Methods (ex - Bonded Composite Primary Structure)**