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Department of Energy's Unmanned Aircraft System Lessons Learned

Randy Stewart
SENIOR AVIATION POLICY OFFICER
U.S. DEPARTMENT OF ENERGY
OFFICE OF AVIATION MANAGEMENT

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Objectives:

- DOE's Aviation Organization--Responsibilities
- DOE's philosophy and safety approach to managing manned and unmanned aircraft programs;
- Lessons Learned;
- Policies; and
- Current UAS operations

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DOE Background:

- Approximately 110,000 employees (10,000 Feds /100,000 Contractors)
- Programs
  - Energy Security (Renewable, fossil, nuclear)
  - Scientific Discovery and Innovation (Atmospheric, Biological and Environmental, computing, etc.)
  - Nuclear Security (NNSA and Defense programs)
- 30 Different Field Offices and 13 National Laboratories
- 25 Owned Aircraft (8,000 flight hours per year)
- 3,900 flight hours per year of Commercial Aviation Services (CAS)
- 7 Certificates of Authorization for UAS 2008 -2009

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DOE's Office of Aviation Management:

- Director, serves as the DOE Senior Aviation Management Official.
- Provides recommendations to the Secretary of Energy and the Administrator, National Nuclear Security Administration (NNSA) for the safe, efficient, and reliable management of aircraft used by DOE.
- Develops and implements policies, systems, and practices to maintain the highest standards of aviation safety, effectiveness, and efficiency, that provide for the highest professional standards of aircraft safety, operations, and airworthiness.

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DOE's philosophy and safety approach to managing manned and unmanned aircraft programs

1993 – To Date

- Compliance with all civil aircraft regulations (14 CFR Parts 21, 23, 25, 27, ` 29, 33, 35, 39, 43, 45, 61, 65, 91, 119, and 145.)
- Integrated Safety Management Principles & Core Functions
- 41 CFR Part 102-33, Federal Management Regulation, Aviation Programs
- DOE elements must establish written manuals to address operations, training, safety, and airworthiness programs equal to or stricter than 14 CFR Parts 121 or 135 applicable to the size of aircraft and scope of operations, to mitigate risks.
- Aviation Manager and Safety Officer Functional Qualifications

Results: 92% reduction in fatality rate and 64% reduction in aircraft accident rate per 100,000 flight hours [.67 and 2.0 respectively]

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DOE Unmanned Aircraft (UA) Systems (UAS), Lessons Learned

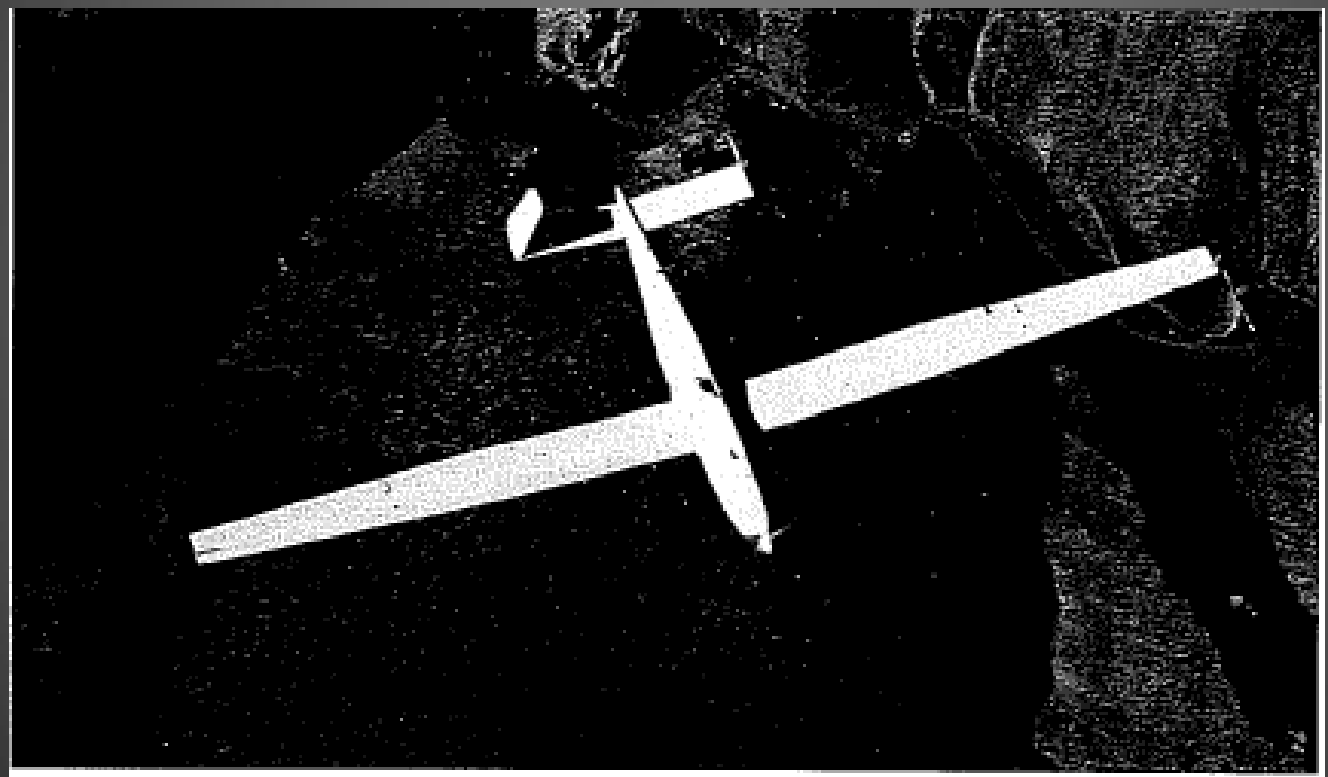

Figure 6. RAPTOR Demonstrator Aircraft

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DOE Unmanned Aircraft (UA) Systems (UAS), Lessons Learned

Figure 7. RAPTOR Demonstrator Aircraft with Safety Pilot on Board

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DOE Unmanned Aircraft (UA) Systems (UAS), Lessons Learned

Figure 9. RAPTOR Demonstrator Aircraft Wreckage

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DOE Unmanned Aircraft (UA) Systems (UAS), Lessons Learned

1994—Lawrence Livermore National Laboratory– Crash

- UA wing came off during flight
- Cost $ 1.4M, does not include investigation costs

- Probable Cause– Manufacturer did not maintain quality control of construction processes to ensure bonding and layup of wing structure.

- Contributing Causes—

  - The "B" system flight control computer displayed unusual downlink data in addition to noisy signals, improperly encoded data streams, and failure to indicate switchover from the "A" autopilot system to the " B system.
  - UA was not built using recognized aviation standards, i.e., 14 CFR Parts 21, 43, 23, 33, or 35.
  - DOE did not have management policies and procedures for the use of UAS.

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DOE Unmanned Aircraft Systems (UAS), Lessons Learned

1994—DOE Corrective Actions

- Held meetings with FAA, DOE, SNL, LLNL, and Office of Science (SC) to:
  - Determine if a UA by definition [Part 1.1] is an “aircraft.”
  - Determine what FAA guidance or policy is available to address airworthiness issues.
- Results–
  - FAA Assistant GC agreed with DOE that a UA was an “Aircraft” as defined by 14 CFR Part 1.1
  - FAA provided DOE with “draft” Unmanned Aerial Vehicle guidance.

- OAM conducts research and develops a list of FAA standards applicable to “any aircraft," manned or unmanned. (6 month effort)

- OAM develops Draft DOE UAV policy.

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DOE asserted the FAA had a regulation that formed the basis for DOE Unmanned Aircraft System (UAS) Policies:

14 CFR Part 21.17 (b) states, “For special classes of aircraft, including the engines and propellers installed thereon (e.g., gliders, airships, and other nonconventional aircraft), for which airworthiness standards have not been issued under this subchapter, the applicable requirements will be the portions of those other airworthiness requirements contained in Parts 23, 25, 27, 29, 31, 33, and 35 found by the Administrator [DOE] to be appropriate for the aircraft and applicable to a specific type design, or such airworthiness criteria as the Administrator [DOE] may find provide an equivalent level of safety to those parts.

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DOE **Current** Unmanned Aircraft Systems (UAS) Definition:

For DOE UAS is a powered aircraft; with a 61-knot or less Vso stall speed as defined in Title 14 CFR Chapter 1, Part 23, Sec. 23.49; or is a rotorcraft with a 6-pound per square foot main rotor disc loading limitation, under sea level standard day conditions; has a vehicle gross weight of 500 pounds to 12,500 pounds; is capable of flight beyond visual line of sight under remote or autonomous control for civil (non-Department of Defense) purposes.

A UAS is not operated for sport or hobby and does not transport passengers or crew. In addition, this definition, for DOE purposes, also means the same as remotely operated aircraft (ROA) and unmanned aerial vehicle (UAV).

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DOE Unmanned Aircraft Systems (UAS), Lessons Learned, Continued

1995—DOE Corrective Actions

- SC and Sandia National Lab request validation of OAM regulatory analysis.
- OAM recommends the following expertise for validation of the OAM regulatory analysis:
  - Flight Test Designated Engineering Representative (DER)
  - Structures DER
  - Powerplant/Propeller DER
  - Systems DER

- Results of DER assessment of the OAM regulatory analysis:
  - The 375 sections of Part 23 DOE identified were 98.5 % complete
  - Part 21.17 can be used as a basis for certification and validation
  - All of Part 43 is applicable
  - All of Parts 33 and 35 are applicable.
  - OAM indentified sections of Part 91 were complete

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DOE Unmanned Aircraft Systems (UAS), Lessons Learned, Continued

1995—DOE Corrective Actions, Continued

- OAM publishes UAV policy memo
- OAM works with Sandia National Lab, SC, and Albuquerque Ops Office to establish a Flight Readiness Review Board (FRRB) for upcoming ALTUS development project. (60,000 feet MSL w/24 hour endurance)
- FRRB uses DOE UAV policies, works with DERs and manufacturer to implement and develop risk assessment for project.
- Manufacturer finds 4 design flaws based on the use of 14 CFR part 23 requirements and makes system changes.
- In order for aircraft design to meet Part 23 criteria Vne must be established at 61 knots, 15 knots below design goal.
- SC transfers project to newly formed Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS)

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DOE Unmanned Aircraft Systems (UAS) Policies

1995—OAM Publishes UAV Policy Memo

2000—OAM Publishes DOE Order 440.2, Aviation Safety
(Incorporates 1995 UAV policies Section 4, Requirements)

2001—OAM Publishes DOE Order 440.2A, Aviation Management and Safety
(Maintains 1995 UAV policies Section 4, Requirements, but changes to ROA)

2002—OAM Publishes DOE Order 440.2B, Aviation Management and Safety
(Maintains 1995 UAV policies Section 4, Requirements, as ROA requirements)

2006—OAM Publishes DOE Order 440.2B Chg 1, Aviation Management and Safety (Maintains 1995 UAV policies Section 4, Requirements, as UAS requirements)

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DOE Unmanned Aircraft Systems (UAS) **Current** Policies:

- FRRB must develop Aviation Safety [Review] Document—Hazard assessment and recommend administrative or engineering controls to mitigate risk.

- Flight Control and Navigation Software Verification and Validation. All UAS flight control and navigation system software verification and validation activities must be performed in accordance with Radio Technical Commission for Aeronautics (RTCA) Design Objective 178B or current RTCA standards or FAA standards or DoD Handbook 516B.

- Airworthiness. A statement indicating compliance with the listed or otherwise identified sections of DOE Order 440.2B Attachment 4 or compliance with 14 CFR Part 21.17 (b), will be submitted by the UAS operator or manufacturer.

DOE Aircraft Accident and Incident Reporting

Aircraft Accident Incident Reporting System (AAIRS)

Applicable Standards:

- **49 CFR Part 830, NTSB Reporting**
- **41 CFR part 102-33.390 Information Reported**
- **DOE O 231.1A Chg 1, Environment, Safety and Health Reporting**
- **DOE O 440.2B, chg1 Section 4 (Requirements) paragraph i. (6)(Safety Program)**
- **Field Element's AIP**

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DOE Tier II UAS

Idaho National Lab

Defense program research

Northrop Grumman Fire Scout
RQ-8A/MQ8-B (Northrop Grumman)
Motor: Rolls Royce Allison 250- C20W
420 Shp
Range: 204 km
Vne: 125+ kts
Ceiling: 20,000 ft
Max payload: 601.1 lbs
MTOW 2652/3160.3 lbs
Rotor diameter: 27.9 feet
length: 23.3 feet
height: 9.7 feet

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DOE Tier II UAS

Idaho National Lab

Defense program research

Hunter UAV RQ5A
Wingspan 29.2 ft
Takeoff Wt 1600 lbs
Max Airspeed 110 kts
Payload 200 lbs (EO/IR)
Altitude 15,000 ft
Endurance 12 hrs
Range 200 km

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AutoCopter Specifications:	
Length:	86.0 inches (2,184.4mm)
Main rotor disk diameter:	77.5 inches (1869mm) R-22 Head 77.75 inches (1975mm) Swing Head
Flight Control:	Operator Directed/Autonomous
Failsafe:	Parachute
Dry Weight:	45.0 lbs (20.41 kg)
Payload:	15.0 lbs (6.8 kg)
Engine:	Gasoline twin cylinder 80 cc
Fuel Tank:	1 gallon
Range:	Approximately 1.5 miles, 20 miles w/ long range data link
Endurance:	50 minutes
Speed:	20-50 mph
Altitude:	Regulated by the FAA to fly below 500 feet

DOE Tier IV UAS

Idaho National Lab

Defense program research

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DOE Tier V UAS

Idaho National Lab

Science program research

APV3 Configuration		Comment
Approximate Speed (stall/cruise/dash)	33/55/90 kts	Stable, includes full flaps for slow speed
Endurance	~6.0 hrs	2 gallons of fuel
Max Ceiling/Max Service	10,000 ft	
Max Payload Weight Wet	~20+ lbs	Removable payload pod can be custom
Payload Volume	~1200+ cu in	Large; removable shell, easy access
Launch	Landing Gear	Manual Pilot
Recovery	Landing Gear	Manual Pilot
Avionics	Cloud Cap	
On-Board Power	On-Board Generation	Currently being worked; two efforts

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The MaxiJoker 2 is an electric helicopter with 5.9 feet rotor diameter, and can lift a weight of 4.42 pounds.

Flight time of 20 minutes

DOE Tier V UAS

Idaho National Lab

Science program research

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DOE **Proposed** Unmanned Aircraft Systems (UAS) Definition:

Unmanned Aircraft (UA) – a device that is used or intended to be used for flight in the air that has no onboard pilot. This includes all classes of airplanes, helicopters, airships, and translational lift aircraft that have no onboard pilot. A UA is an aircraft as defined in 14 CFR 1.1.

Unmanned Aircraft System (UAS) - For the Department of Energy, a UAS is a powered unmanned aircraft, launching device (if any), ground and flight control systems; that is not used for sport or hobby, but for commercial or public purposes to conduct aerial research, aerial photography, aerial survey, or research and development of platforms, sensors, cameras, or other such devices that are operated in the National Airspace System or within DOE or NNSA Restricted Airspace.

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DOE Proposed Unmanned Aircraft Systems (UAS) Definition:

Tier I UAS- A powered unmanned aircraft with a gross weight above 12,501 pounds.

Tier II UAS- A powered unmanned aircraft that has a gross weight of 501 pounds to 12,500 pounds.

Tier III UAS- A powered unmanned aircraft that has a gross weight of 251 to 500 pounds.

Tier IV UAS. A powered unmanned aircraft that has a gross weight of 51 to 250 pounds.

Tier V UAS- A powered unmanned aircraft that has a gross weight of .1 pound to 50 pounds.

End