Airframe Technology Assessment of the Airworthiness of Unmanned Aerial Systems

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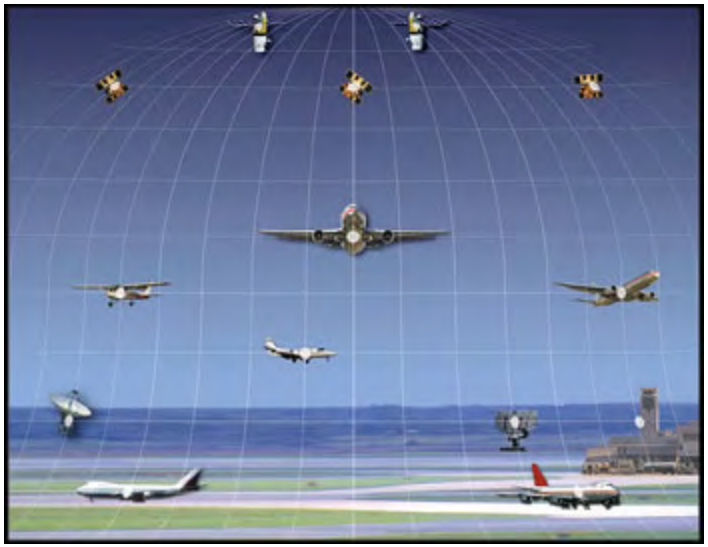
FAA Sponsored Project Information

- Principal Investigators & Researchers
  - John Tomblin, Allison Crockett and Tom Aldag
- FAA Technical Monitor
  - Xiaogong Lee
- Other FAA Personnel Involved
  - Curt Davies and Tong Vu

Objective

- Provide means of assessing airworthiness of operational UAS airframes relative to FAA certified manned aircraft
- Identify gaps that must be addressed prior to FAA certification



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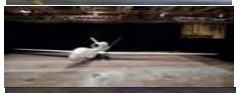
Program Focus

- General design and airworthiness background
- UAS airframe technology survey
- Airframe design regulations and guidance material
- UAS technical design resources

Information Pool

- Product data from manufacturers was pooled to identify grouping
- Key areas of interest:
  - Weight
  - Payload
  - Wingspan
  - Length
  - Cruising speed
  - Operating altitude
  - Endurance

Information Pool

Company	UAV Name	Photo	Weight (lbs)	Payload (lbs)	Length (ft)	Wing Span (ft)	Speed (knots)	Operating Altitude (Typ.)	Endurance	Range km
NORTHROP GRUMMAN	X-47B J UCAS		46,000	4,500	38	62	460	40,000 ft	9 hrs	1850
NORTHROP GRUMMAN	Global Hawk (RQ-4A)		26,700	1950	44.4	116.2	350/340	65,000 ft	32 hrs	22224
NORTHROP GRUMMAN	Global Hawk (RQ-4B)		32,250	3000	47	130.9	340/310	60,000 ft	28 hrs	25000
NORTHROP GRUMMAN	Firebee		3100	100	22.9	12.9	555.81	60000	115 mins	
BOEING	X-45C UCAS		36,500	4,500	39	49	460	40,000 ft	7 hrs	
General Atomics Aeronautical Systems	ALTUS I		2,130	330	22	55	70	45,000 ft	24+ hrs	
General Atomics Aeronautical Systems	ALTUS II		2,130	330	23	55	70	65,000 ft	24+ hrs	
General Atomics Aeronautical Systems	PROWLER II		700	50	13.9	24	172/63	21,000 ft	6 hrs	
General Atomics Aeronautical Systems	MARINER		10,000	3,300	36	86	240	52,000 ft	49+ hrs	
General Atomics Aeronautical Systems	PREDATOR B (MQ-9A)		10,500	750	36	66	220	50,000 ft	30 hrs	
General Atomics Aeronautical Systems	ALTAIR		7,400	700	36	86	220	52,000 ft	32 hrs	

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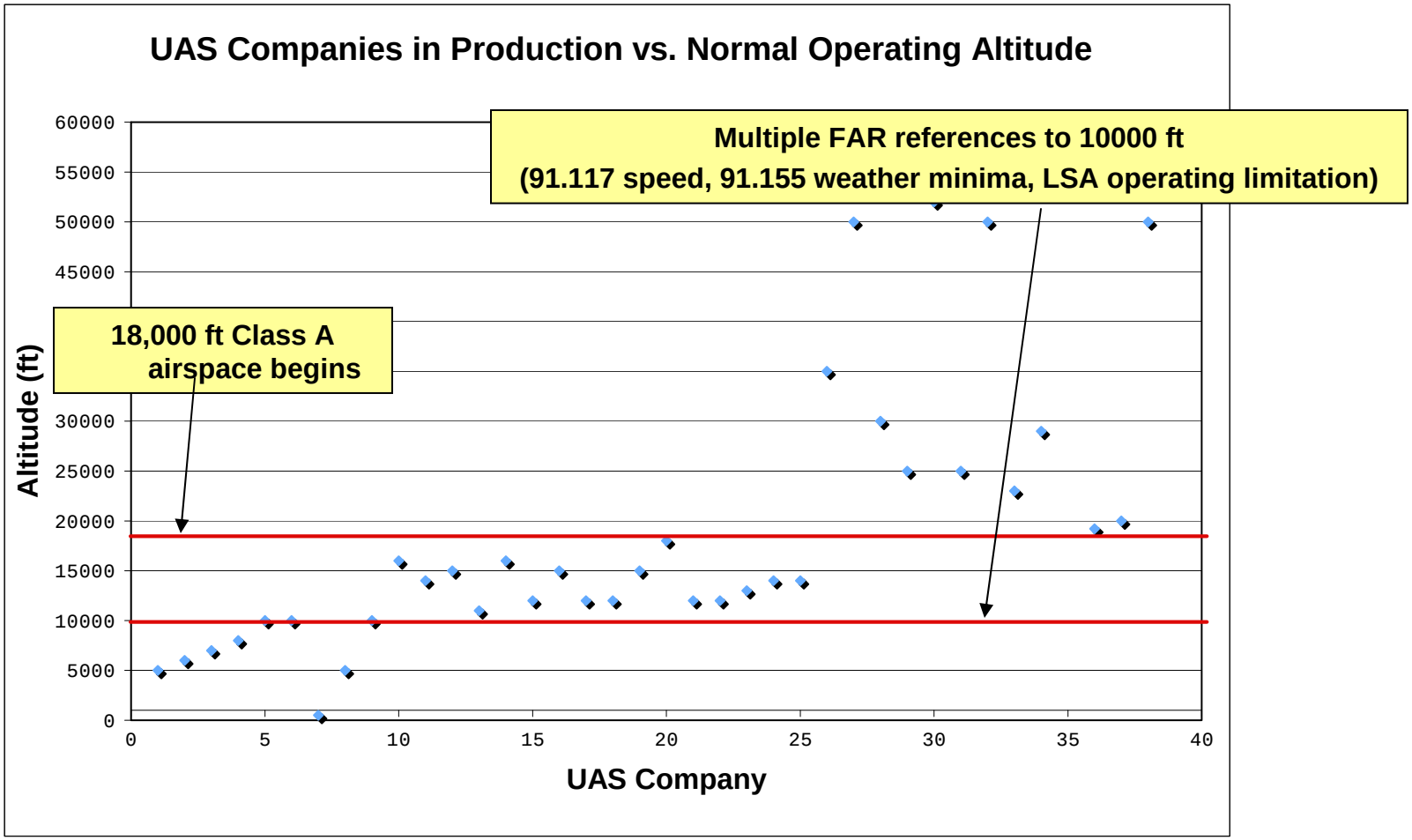
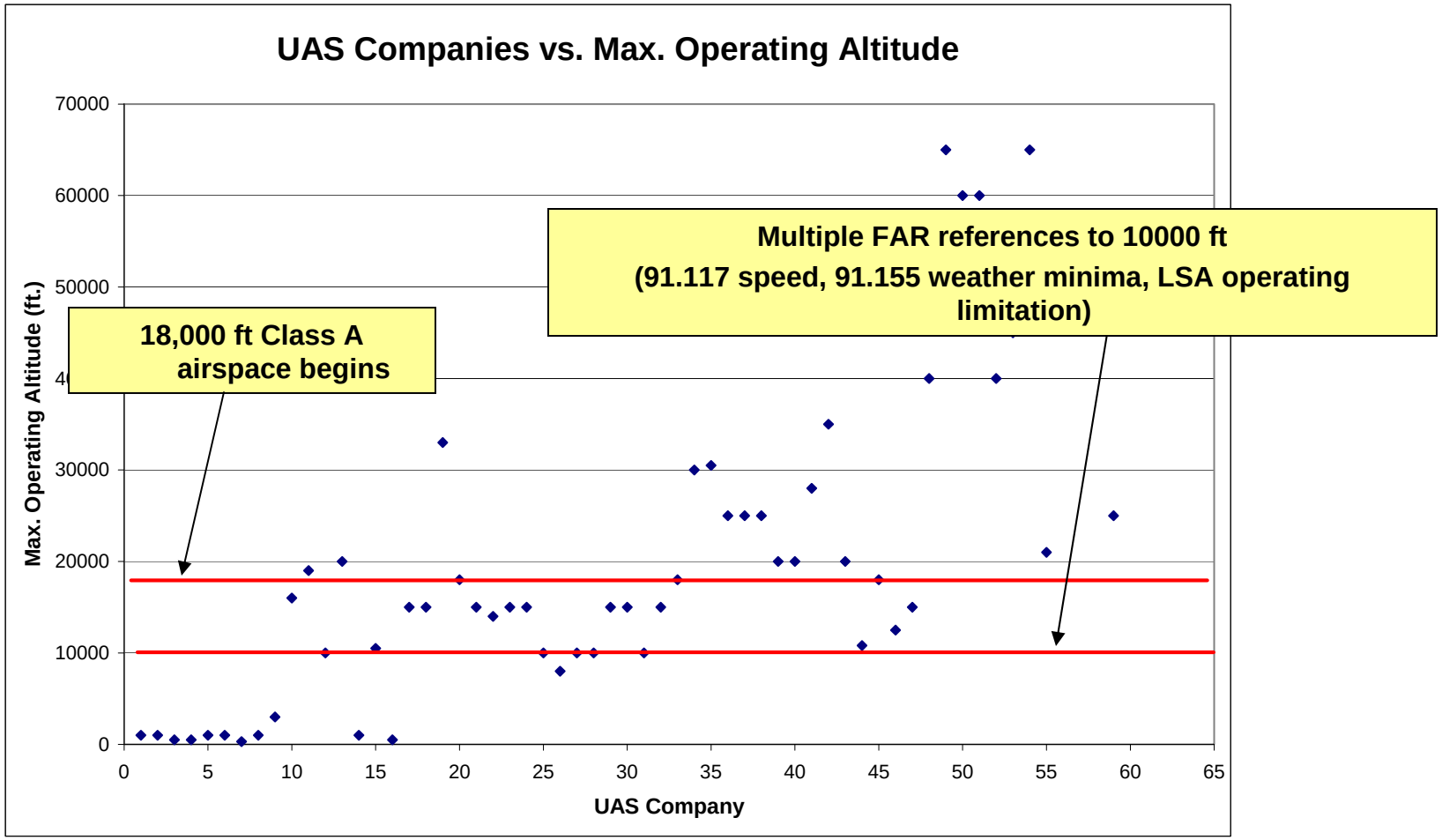
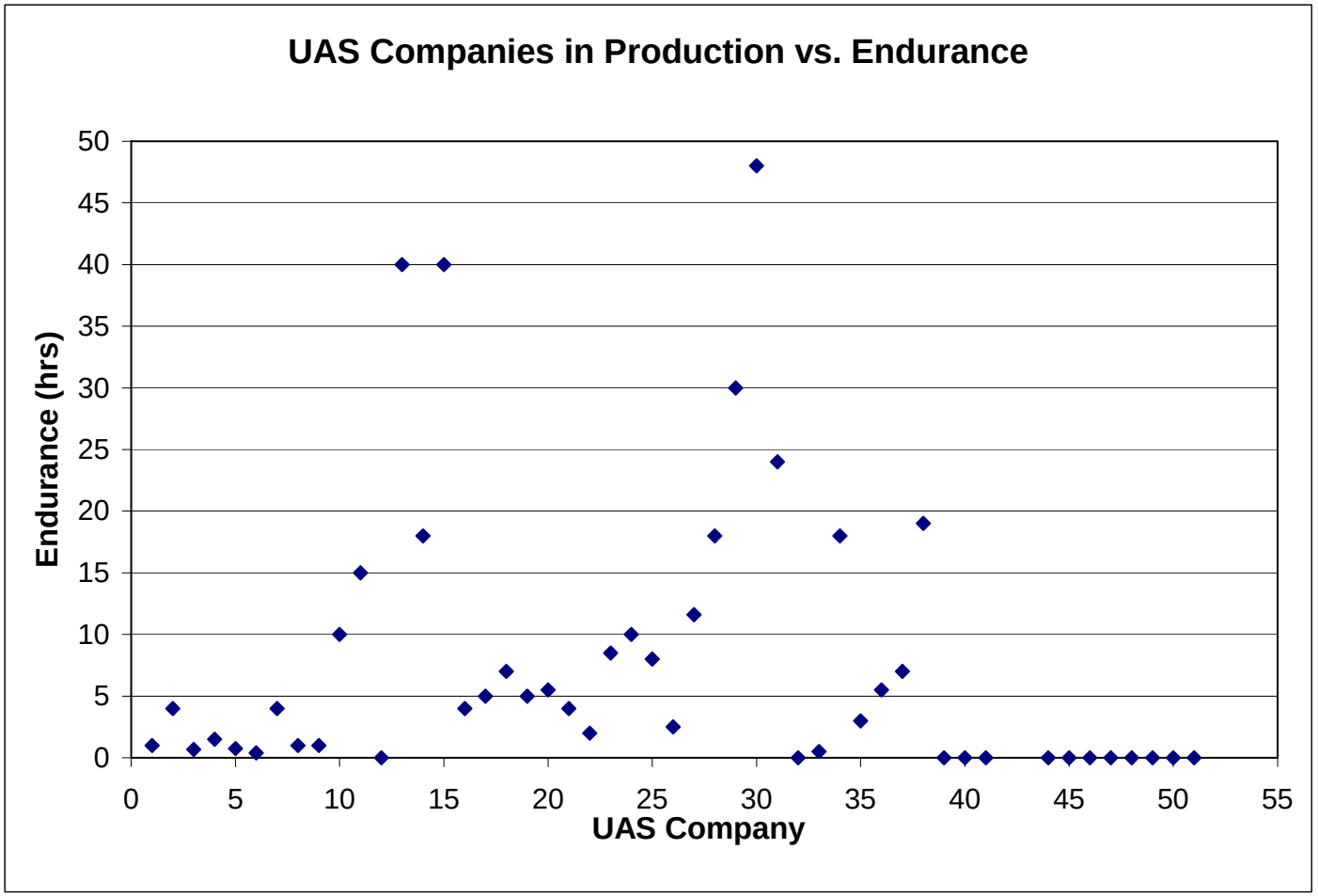
Normal Operating Altitude (ft)



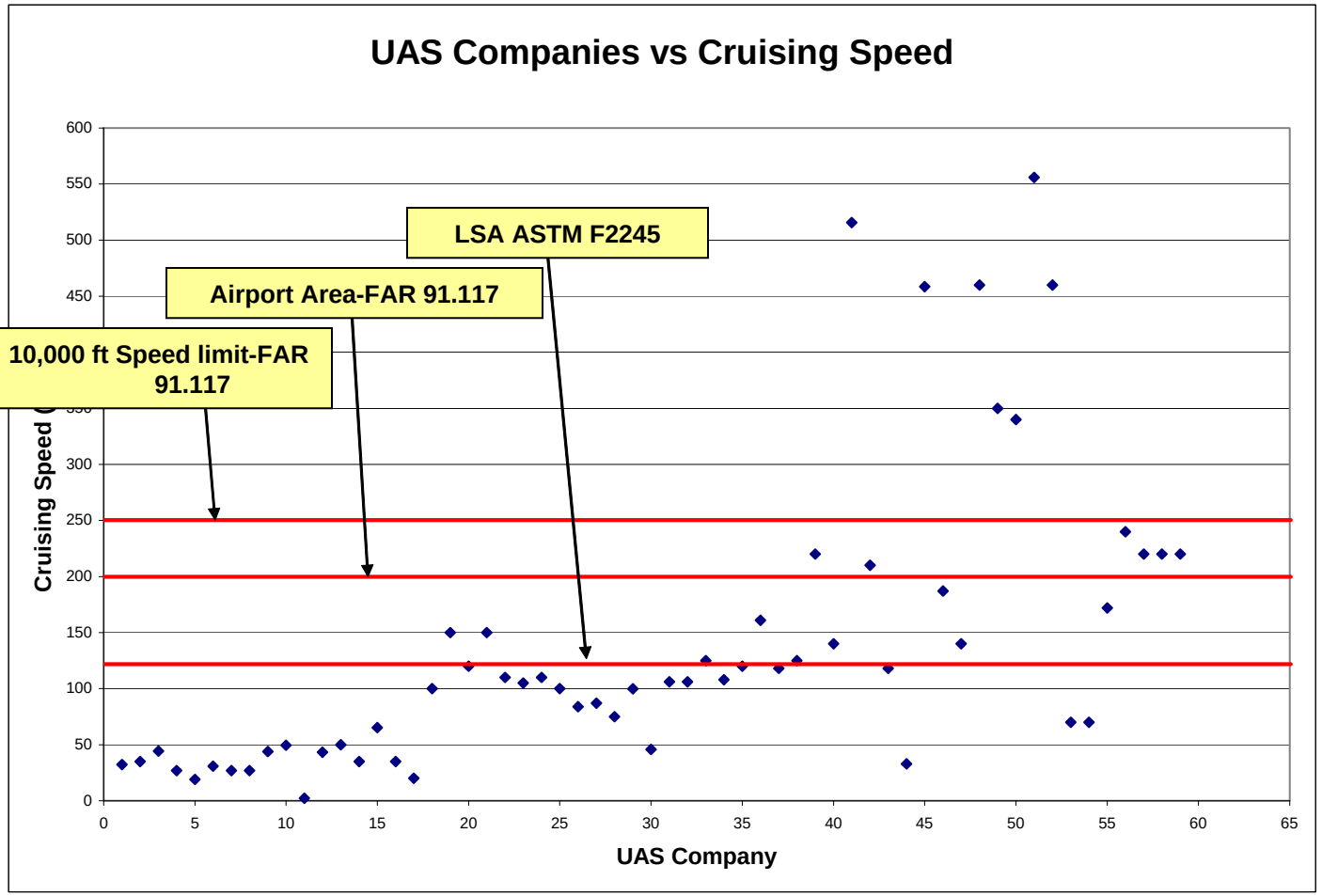
Maximum Operating Altitude (ft)



Endurance (hours)



Cruising Speed (knots)



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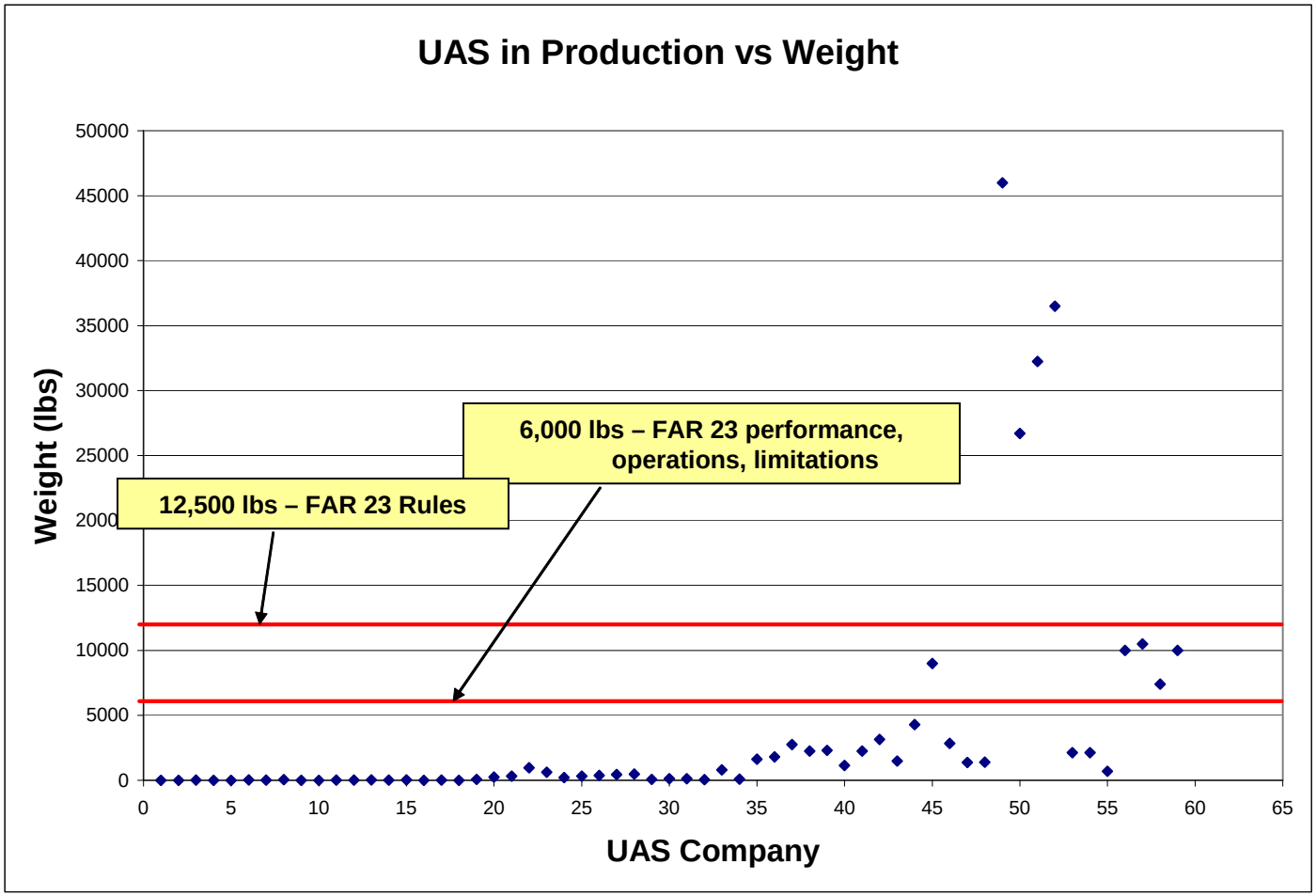
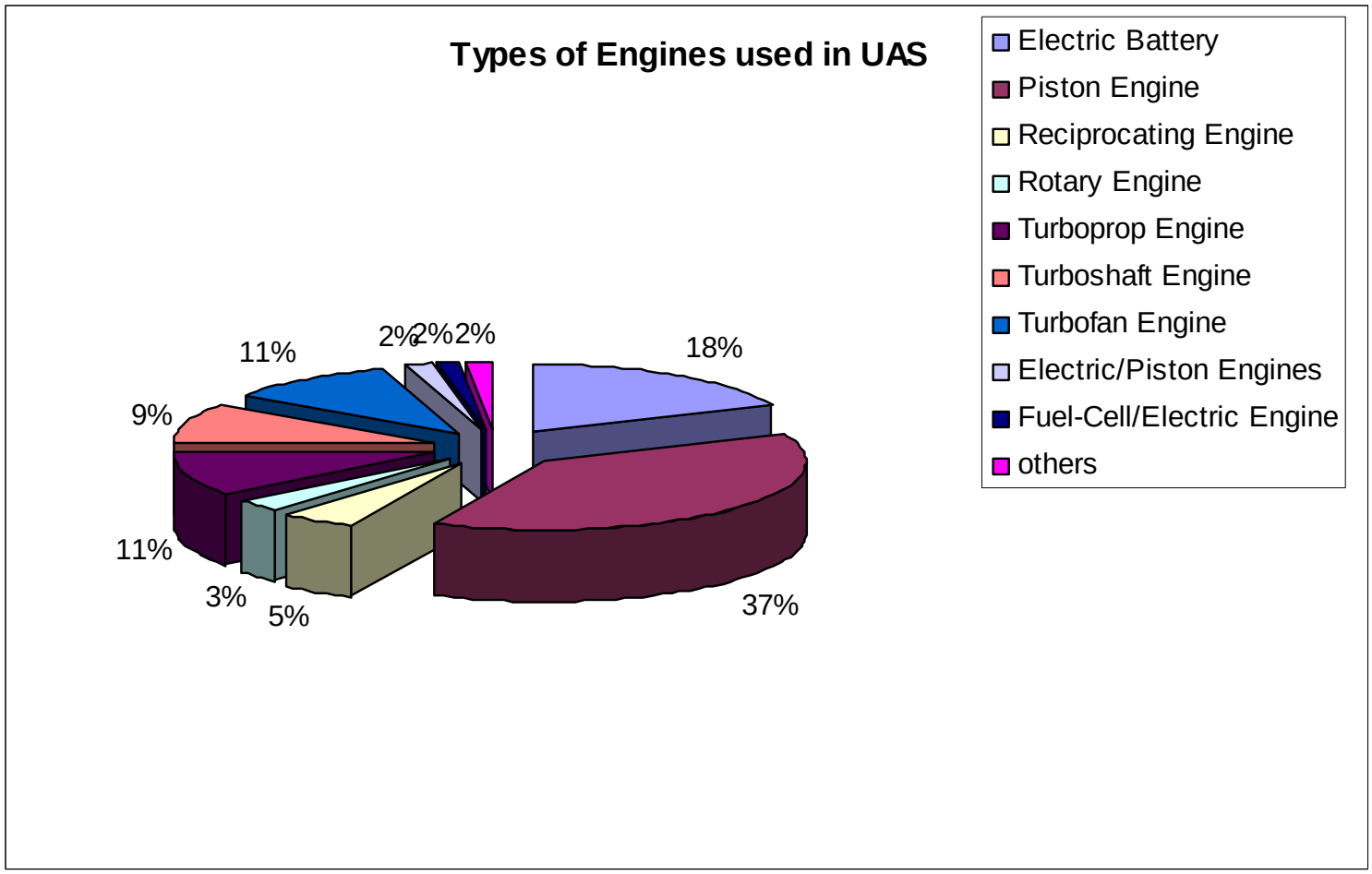
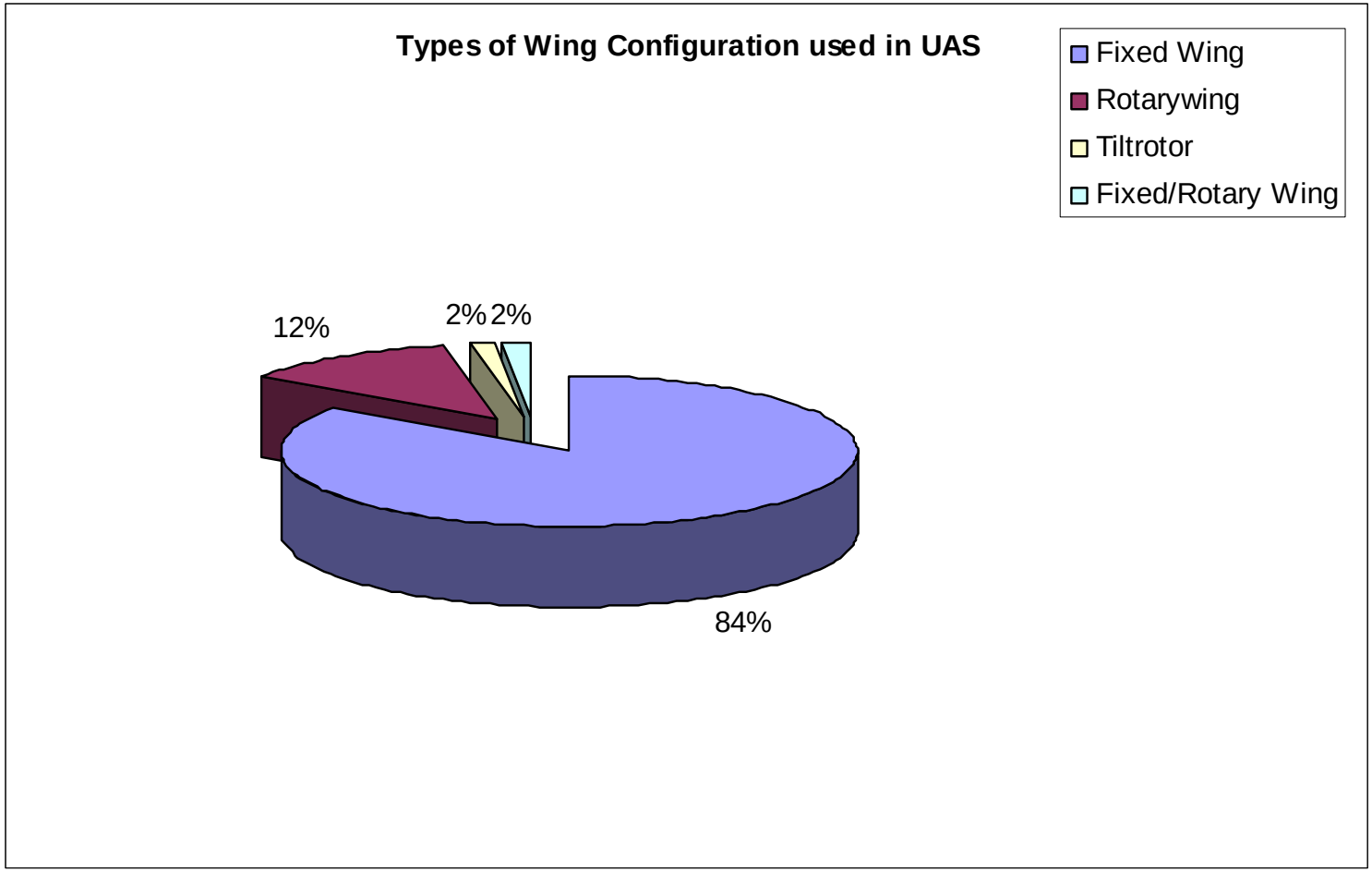
Weight (lbs)


UAS in Production vs Weight
Weight (lbs)
50000
45000
40000
35000
30000
25000
2000
15000
10000
5000
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
UAS Company
6,000 lbs – FAR 23 performance, operations, limitations
12,500 lbs – FAR 23 Rules

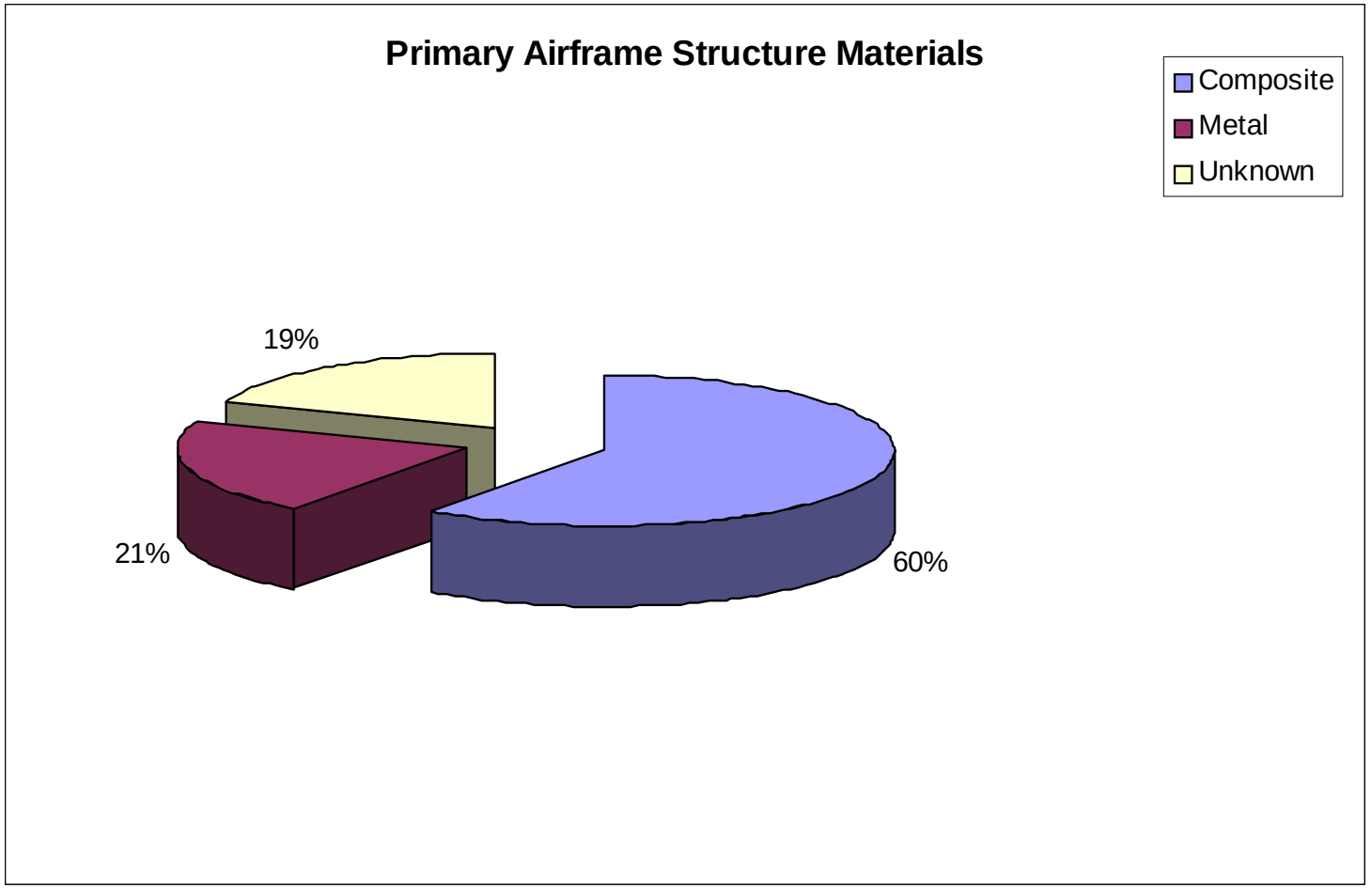
Types of Engines



Wing Configurations

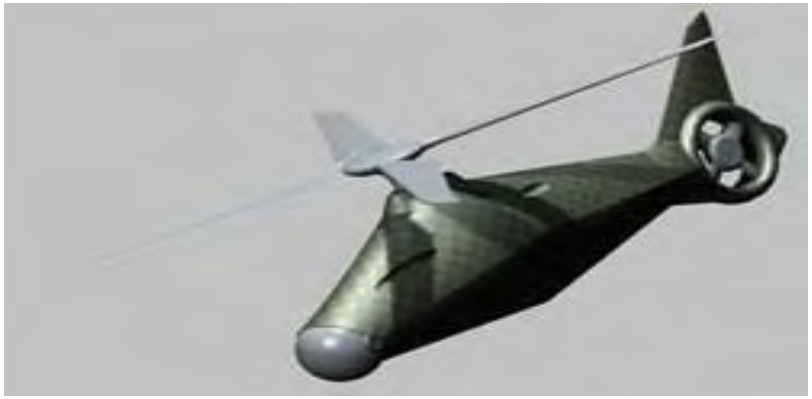


Structural Materials



Airworthiness Information

- High Level Regulations
  - **Title 14 Code of Federal Regulation (14 CFR)**
  - **FAR 21 Certification Procedures for Products and Parts**
  - **FAR 23 Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes**
  - **FAR 25 Airworthiness Standards: Transport Category Airplanes**
  - **FAR 27 Airworthiness Standards: Normal Category Rotorcraft**
  - **FAR 29 Airworthiness Standards: Transport Category Rotorcraft**
  - **FAR 33 Airworthiness Standards: Aircraft Engines**
  - **FAR 35 Airworthiness Standards: Propellers**

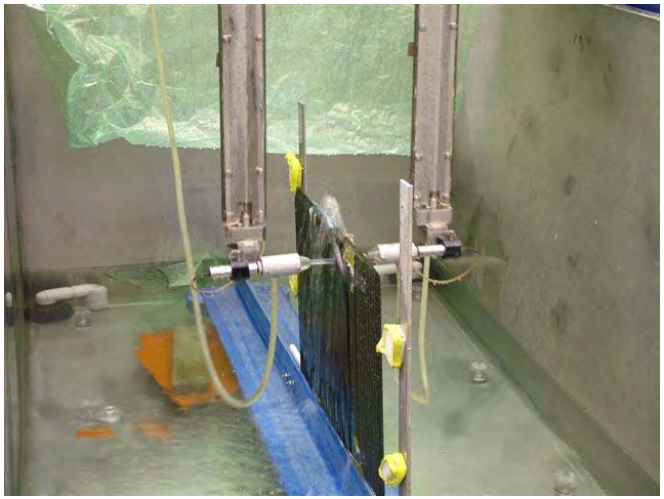


Airworthiness Information

- Initial focus in the following sections of the CFR 14 Part 23 Airworthiness Standards:
  - Subpart C – Structures
    - 23.305 Strength and deformation
    - 23.307 Proof of Structure
    - 23.571 Metallic pressurized cabin structures
    - 23.572 Metallic wing, empennage, and associated structures
    - 23.573 Damage tolerance and fatigue evaluation of structure
  - Subpart D – Design and Construction
    - 23.603 Materials and workmanship
    - 23.605 Fabrication Methods
    - 23.613 Material strength properties and design values

UAS Airframe Technology Survey

- Define metallic and non-metallic performance characteristics
  - Fabrication
  - Joining
  - Durability
  - Repair
  - Strength
  - Fatigue



- Outline differences between UAS and manned aircraft

Airframe Design Regulations and Guidance Material

- Highlight key manned aircraft airframe regulatory materials
  - CFR14 FAR's
  - Advisory Circulars
  - FAA Policy
  - ASTM

Provides a framework to identify gaps between UAS and manned aircraft structures

UAS Technical Design Resources

- List available UAS design guidelines
  - Working groups
  - European
  - Military
- Identify critical gaps to manned airframe structures

Summary of Speed (knots) Regulations

Speed (knots)	Guidance/Regulation	Comments
55	AC 103-7	Ultralight design limitation
120	ASTM 2245-07	LSA design limitation
200	CFR 14 FAR 91.117	Max speed within 4nm of an airport or under Class B airspace
250	CFR 14 FAR 91.117	Max Speed below 10,000 msl
Mach 1	CFR 14 FAR 91.117	Limitation over land because of sonic boom

Summary of Weight (lbs) Regulations

Gross Weight (lbs)	Guidance/Regulation	Comments
254 (empty)	AC 103-7	Ultralight design limitation
1,320	ASTM 2245-07	LSA design limitation
2,700	CFR 14 FAR 21.24	Primary aircraft limitation
6,000	CFR 14 FAR A23.1	Appendix A load criteria
12,500	CFR 14 FAR 23.3	Application of FAR 23
19,000	CFR 14 FAR 23.3	Exception for commuter category within FAR 23

Summary of Altitude (AGL/MSL)

Altitude (agl or msl)	Guidance/Regulation	Comments
400 agl	AC 91-57	Model airplane guidance
1,200 agl	CFR 14 FAR 91.131	Top of uncontrolled airspace except near airports
10,000 msl	CFR 14 FAR 91.117 CFR 14 FAR 91.155	Speed and VFR cloud clearance requirements change
18,000 msl	CFR 14 FAR 91.135	Base of Class A airspace. All A/C on IFR flight plan

A Look Forward

- Benefit to Aviation
  - The unmanned aviation community lacks guidance material to provide the foundation on which UAS vehicles might operate in the NAS similar to manned vehicles
- Future needs
  - Assess the current level of UAS airframe airworthiness relative to manned aircraft airworthiness standards and identify gaps to be addressed

Questions?