AeroTEC Case Study for Test & Certification Opportunities of Electric and Unmanned Aircraft Systems

Revision A
01/30/2019

ABSTRACT

This document provides an overview of the burgeoning electric, hybrid and unmanned aircraft markets and the associated testing and certification efforts that can make entry to market for these vehicles a reality. Some of the leading companies and their efforts in the electric and UAS aircraft industries are highlighted with thoughts on AeroTEC's potential opportunities for involvement. This document provides insight on how AeroTEC can systematically capitalize on this quickly growing area of aviation, while assessing how leveraging current AeroTEC capabilities can provide an entry point into this non-linearly expanding aerospace market. AeroTEC is in a unique position to act as "sole source supplier" of the emerging UAS certification process as the provider for the many new players in the field.

The hope of the authors is that through providing high quality information to the Leadership Team, an informed business decision on company direction on this opportunity can be taken.

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Table of Contents

List of Figures

Nomenclature

Name	Description
ACO	Aircraft Certification Office
AD	Airworthiness Directive
AIAA	American Institute of Aeronautics and Astronautics
ASSURE	Alliance for System Safety of UAS through Research Excellence (FAA)
ASTM F38	American Society for Testing and Materials; Committee 38 on Unmanned Aircraft Systems. Proposed cert basis discussion.
AUVSI	Association for Unmanned Vehicle Systems International
AW	Airworthiness
BVLOS	Beyond Visual Line of Sight
CFR	Code of Federal Regulations
CMACO	Certificate Managing ACO
CONOPS	Concept of Operations
CoE	Washington State Center of Excellence –11 aerospace centers
CoS	Committee of Standards (AIAA)
CoW	Certificate of Waiver
CPN	Certification Project Notification
CTOL	Conventional Takeoff and Landing
DAA	Detect and Avoid
EASA	European Aviation Safety Agency
eVTOL	Electric Vertical Takeoff and Landing
FAA	Federal Aviation Administration
FBO	Fixed-Base Operator
FONSI	Finding of no significant impact
FT	Flight Test
JCAB	Japanese Civil Aviation Bureau
GA	General Aviation
LAANC	Low Altitude Authorization & Notification Capability
MIDO	Manufacturing Inspection District Offices
MOC	Method of Compliance
NAS	National Airspace System
NBAA	National Business Aviation Association
NIAR	National Institute for Aviation Research
N/L	Non-labor
N/R	Non-recurring (cost)
OEM	Original Equipment Manufacturer
OPA	Optionally Piloted Aircraft
ORA	Operational Risk Assessment
RPV	Remotely Piloted Vehicle
SBIR	Space Based Infrared System
sUAS	small UAS; i.e. <55 lbs
STOL	Short Takeoff and Landing

Name	Description
SVP	Standards Validation Project; FAA sponsored research
SWOT	Strengths, Weaknesses, Opportunities, Threats
TC	Type Certificate
TCDS	Type Certification Data Sheet
TFR	Temporary Flight Restrictions
UAS	Unmanned Aerial System
VLOS	Visual Line of Sight
VTOL	Vertical Take-Off and Landing
WTT	Wind Tunnel Test

1 Executive Summary

All market research, public and privately funded, points clearly to the unmanned aerial systems and hybrid-electric/electric aircraft fields as the next great frontier of commercial aviation. However, even highly developed systems still do not have a clear path to certification for the myriad flying systems already undergoing ground and flight testing. Stressing the importance of preparing for this emerging market segment, the US government (FAA) has established seven regional airspace zones throughout the country to serve as national UAS test sites, to include data collection on advancing technologies, CONOPS, testing / validation approaches and how to safely integrate into the National Airspace System.

Some information redacted.

2 Introduction

The unmanned and hybrid-electric/electric aircraft market has become increasingly active – startups are today testing prototypes, electric trainers and UASs are being certified, and the industry's big players are making strategic acquisitions and investments to establish themselves as significant stakeholders in this technological push[1]. It is useful to segment the emerging aviation market into groups: eVTOL, STOL, and CTOL aircraft, each potentially powered via different propulsive technologies. The Unmanned Aerial System (UAS) can fit into any of these categories, and uses both traditional piston and jet engines, as well as an increasing use of electric and other emerging environmentally friendly technologies. The UAS, as a remotely piloted aerial vehicle, is demonstrating expanding roles in defense and growing exponentially [24] into the commercial markets.

Some information redacted.

3 Electric / Hybrid Aircraft Market

The electric / hybrid aircraft market is projected to grow from $99.3 million in 2008 to $121.8 million by the year 2023 at a compound annual growth rate of 4.17% from 2018 to 2023 [18]. Low cost of operation, decreased noise, and reduced maintenance are all helping to drive the market. Entry to the electric/hybrid market will initially take place for light sport (LSA) and Part 23 aircraft, which are classified as aircraft with less than 19 seats and weighing 19,000 pounds or less. Current battery technology + reliable piston engines and certification maturity make these aircraft the inevitable starting point for the development and certification of electric aircraft.

Some information redacted.

[1] Sections 4.3 and 5.1 expand on this comment.

4 UAS Market

The UAS commercial market is better defined as the market encompassing the complex merger of small remotely piloted UAVs (Part 107) and fixed wing (Parts 21, 23, 25) and rotary systems (Part 27, 29, 31). The few UASs which have been certified for commercial use have been certified under a combination of these rules (and others including propulsor systems), and for specific and limited CONOPS.

UAS markets are defined based on such areas as mode of operation, point of sale (OEM vs aftermarket), defense & commercial, consumer, region of the world, MTOW [<55 lbs., mid, >300 lbs., roughly based on handheld drone (Part 107) > ultra-light (Part 21) > heavy], sensor type, system type, fixed-wing, single+multi-rotor, VTOL, VLOS, BLOS and so forth.

The market for unmanned systems goes far beyond the aerospace world of course – although the technologies overlap and create opportunities in otherwise non-competing fields such as construction[2], shipping, railroads, automobiles, flying cars, propulsions technologies (electric / hybrid) not to mention pure autonomous version of pilot-in-the-loop systems, and on and on. All these new entrants are currently maturing and create opportunities and challenges to the traditional T&E community.

Some information redacted.

4.1 AUVSI Assessment of Market

AUVSI is the largest international "all things drones" professional organization in the world. Their assessment for the USA & the State of Washington based on a study commissioned in 2018 is as follows.

Economic and Jobs Impact:

- According to AUVSI's report "The Economic Impact of Unmanned Aircraft Systems Integration in the United States," [27] the UAS industry is poised to help create more than 100,000 jobs and have more than $82 billion in economic impact in the first decade after integration.
- UAS are the fastest growing sector in the aerospace industry. Washington's aerospace industry generated $76 billion in economic activity and supported over 132,000 jobs at over 1,350 establishments in 2012.
- Among the more than 5,500 commercial UAS exemptions, Washington is home to 140 approved operators supporting applications such as agriculture, construction, film and TV, real estate, infrastructure inspections, search and rescue and aerial photography.
- Washington is expected to create over 6,700 jobs in the first three years after UAS integration and add nearly $8 billion in economic impact within a decade.

[2] A very recent (August 15, 2018) Seattle Times story is a great introductory read / example of a UAS market niche in construction [12]

- Washington is home to the Cascade chapter of AUVSI. The 193 individuals and 16 companies that are AUVSI members represent industries such as agriculture and defense/security.

4.2 DOT/FAA Funded Marketing Research

According to the DOT/FAA report released March 16, 2018, the FAA Aerospace Forecast Fiscal Years (FY) 2018-2038 [23] is quoted below. Within this larger document, the "Unmanned Aircraft Systems (UAS)" section is of special interest to this White Paper[3].

> *"The forecast also highlights the phenomenal growth in the use of Unmanned Aircraft Systems (UAS), often referred to as drones. The FAA projects the small model hobbyist UAS fleet to more than double from an estimated 1.1 million vehicles in 2017 to 2.4 million units by 2022. The commercial, small non-model UAS fleet is set to grow from 110,604 in 2017 to 451,800 in 2022. The number of remote pilots is set to increase from 73,673 in 2017 to 301,000 in 2022."*

From the same report, for the commercial market, the increase in UAS registration alone increased from near zero in early 2016 to 110,000 at the end of 2017, with a forecast by 2022 of between ~450,000 and ~717,000 units. The trend, raw numbers and present usage of the UAS fleet is shown in the Appendix.

4.3 NASA Funded Market Research

A readily accessible 2017/2018 NASA funded market study NASA's definition of the Traditional and UAS market and airspace [22] data is referenced here for as objective a source as one could reasonably find. Economic forecasts are shown below for two different market categories as examples, below Forecasts of the other categories are due to be completed for NASA by 3Q 2018.

[3] It is highly recommended the reader go to the source document to read the entire report [23]

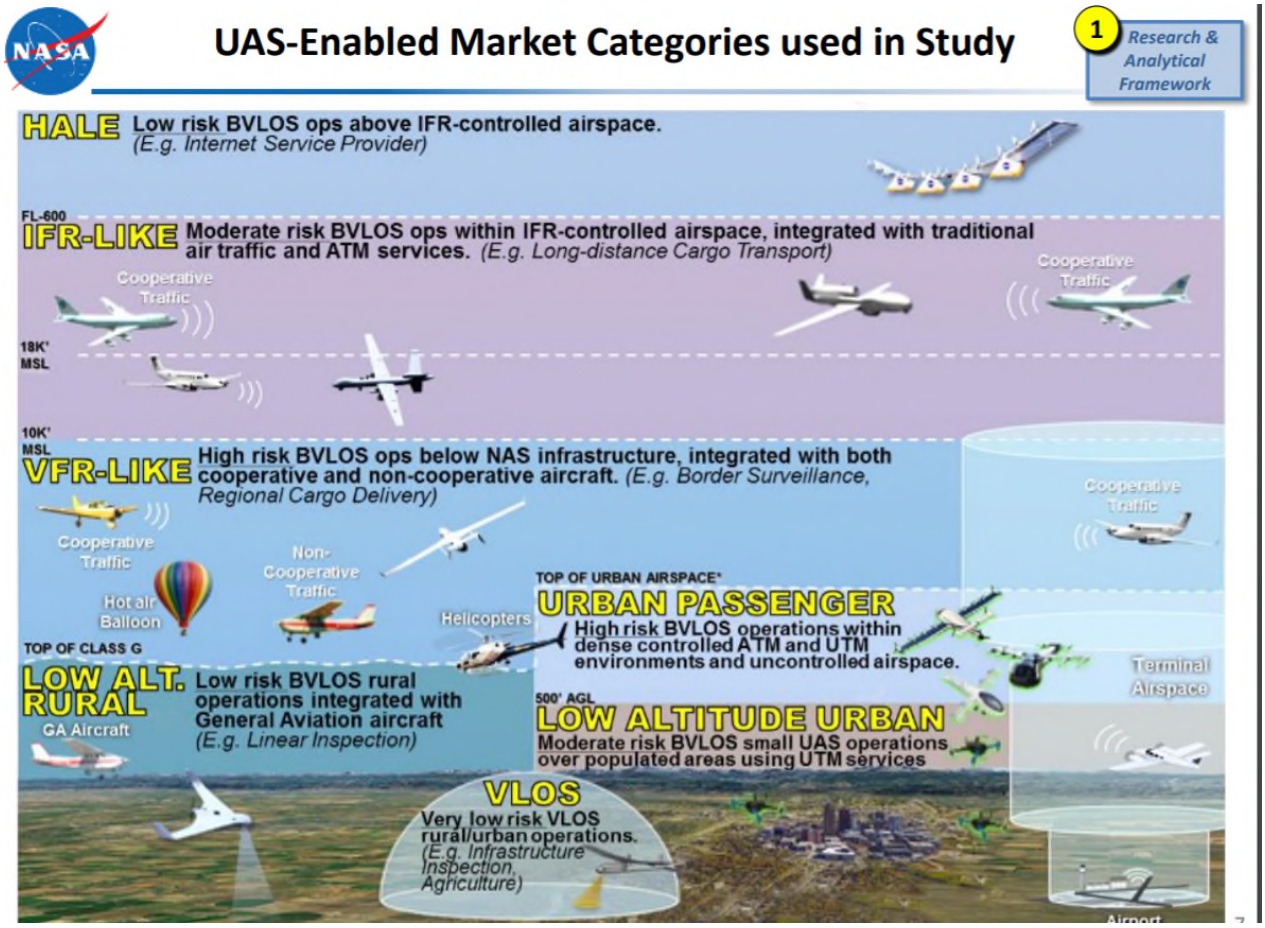

Figure 4-1: UAS Market Categories

Most people today still think of drones as (1) military, (2) toys or (3) inevitable package delivery (e.g. Amazon, Uber). Figure 4-1 shows the various markets being studied and/or pursued well outside this limited scope, defined by airspace.

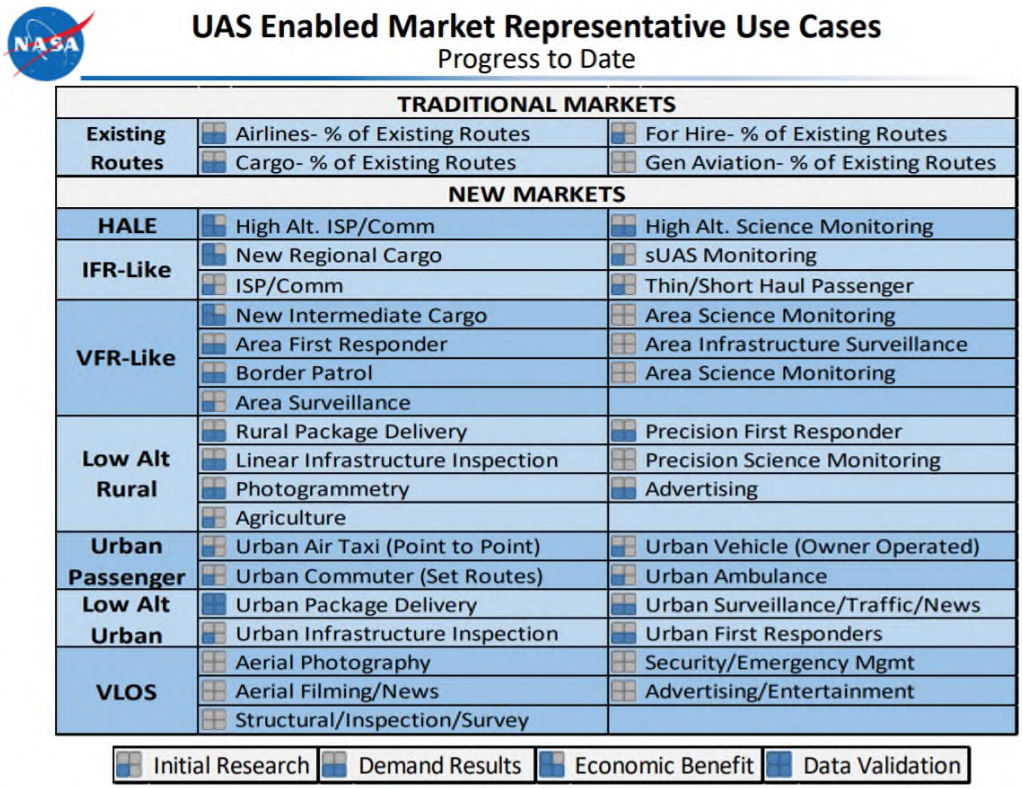

Figure 4-2: Cases for Traditional and New UAS Markets

Figure 4-2 is further definition of the market within the airspace shown in Figure 4-1, along with the state of completeness of the NASA study for each market. For example, the study for "Low Alt Urban" is complete for urban package delivery, while higher altitude VFR and IFR-like regional and intermediate cargo markets show economic benefit yet are awaiting final validation of the data. This full study is due to be released 3Q of this year (2018). Figure 4-3 shows the business case / market for package delivery, as compiled by NASA. Package delivery is where much of the political push is coming from for advancing UAS certification efforts.

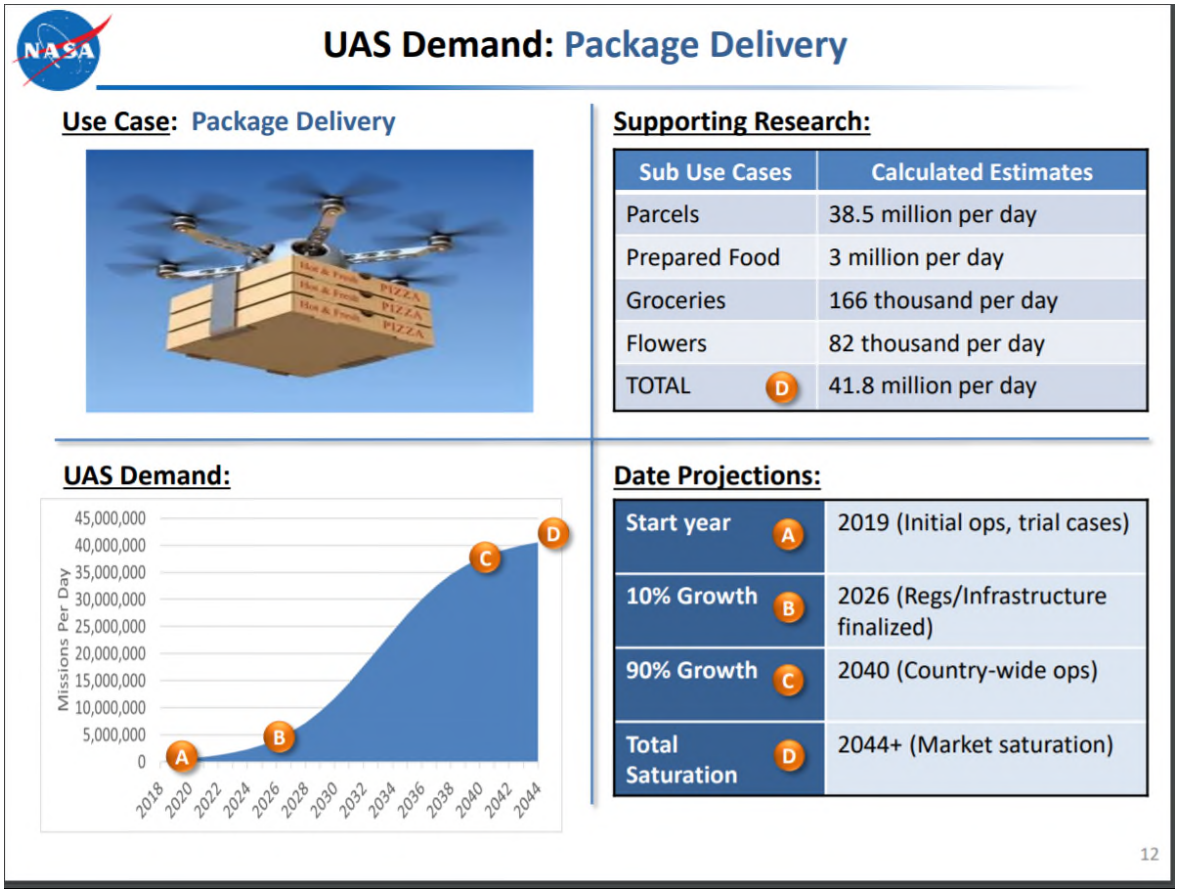

Figure 4-3: UAS Market for Package Delivery

4.4 Privately Funded Marketing Research

Expansive, exhaustive and broadly definitive forecasted economic market analyses are available for a price, typically in the $5,000 range. Marketing firms such as MarketsandMarkets, MTSI, Goldman Sachs, Guinn Partners 2018 Industry Report etc. are used by industry and government.

The market forecasts typically show exponential near-term (2018->2025) growth in the small, under 300lb market. Larger, extended range operations are limited largely by propulsion systems (energy density) and certification / airspace / human acceptance considerations.

Active Customers of the UAS Market – sample list [24]

- Ports, police/fire agencies, private companies
- Electric Utilities: BPA, San Diego Electric, PG&E, etc.
- Construction (high-rise inspection, etc.)
- High Altitude internet / surveillance services
- Railroads using UAVs for track inspection, car inspection, bridge inspection, etc.
- Airlines want to use UAVs for airplane inspection, such as Southwest. They need help developing the process and getting the process approved by MIDO.

- Pipeline transmission companies using UAVs for inspection.
- Military

Some information redacted.

5 UAS Industry Progress

5.1 Notable UAS Companies and Developments

This section highlights leading companies in the UAS aircraft industry and their work. The companies have been categorized based on the type of aircraft that they are working to develop. These companies vary from converting current manned commercial aircraft models towards autonomy; unmanned RPV military into unmanned RPV commercial applications, OPAs - while using the same technology to build a UAS from the ground up. Thoughts on AeroTEC's potential involvement with these companies have been included.

We must find a Customer willing to have AeroTEC take their UAS platform through commercial certification.

Some information redacted.

5.2 Successful UAS certification programs in the USA

- **Insitu ScanEagle 1**
  ScanEagle certified under 21-25 (Restricted Category). FAA Order 8110-56B: Restricted Category TC used as testing basis. Also used pieces of FAA Order 8130.34C. Type Certificate: TYPE CERTIFICATE DATA SHEET No. Q00017LA ScanEagle Q00017LA_Rev_4. The very complex, "hand-worked" roadmap to certification is shown from the TC in Figure 5-1.1 on the following pages. Used draft (unpublished) AC 21-17xx. This is not to say this roadmap will work strictly for others. AeroTEC can help.

- **Insitu ScanEagle-2**
  ScanEagle-2 obtained cert under 21-17(b) special airplane category as direction using 21-25 as basis. Used draft (unpublished) AC 21-17xx.

  Working on -3.

- **AeroVironment**
  AeroVironment's Puma AE certified for commercial operations under Part 21 Special Class, AC 21-17xx (2013)

- **Flight Scan Camcopter**

Flight Scan Camcopter Proposed FAA Rules Dec 2017 under FAA-2017-1058-0001. Rules proposed include a combination of Parts 21, 23, 27, 33, 36.

- **Yamaha**
  Yamaha, the Fazer R (rotorcraft-based UAS crop duster) completing testing. FAA determined Parts 21, 23 and 27 cert criteria did not cover this special class of UAS. Testing to be done derived from Parts 23 and 27, "FAA Airworthiness Criteria: Special Class Airworthiness Criteria for the Yamaha Fazer R2018-09102" and operated under Part 107.

- **GE-owned Avitas Systems**
  The first ever waiver issued by the FAA to fly a drone heavier than 55 pounds beyond visual line of sight (BVLOS) for commercial purposes (October 2018). The company will use the waiver for inspections of well pads and other infrastructure, which support extraction operations being conducted by the Shell Oil Company on terrain that makes inspections using other methods challenging. Avitas will also interpret the data collected and create outputs that Shell can use to determine where they might need to perform maintenance.

- **U.S. Army / National Guard**
  Not all strictly military applications, like Emergency Response or Corps of Engineers, but the U.S. Army and Guard Units support Homeland Security, and there is much knowledge about testing and certification under military rules. There is movement within the Washington Military Department to offload some missions to the commercial side / non-military world (see Appendix E).

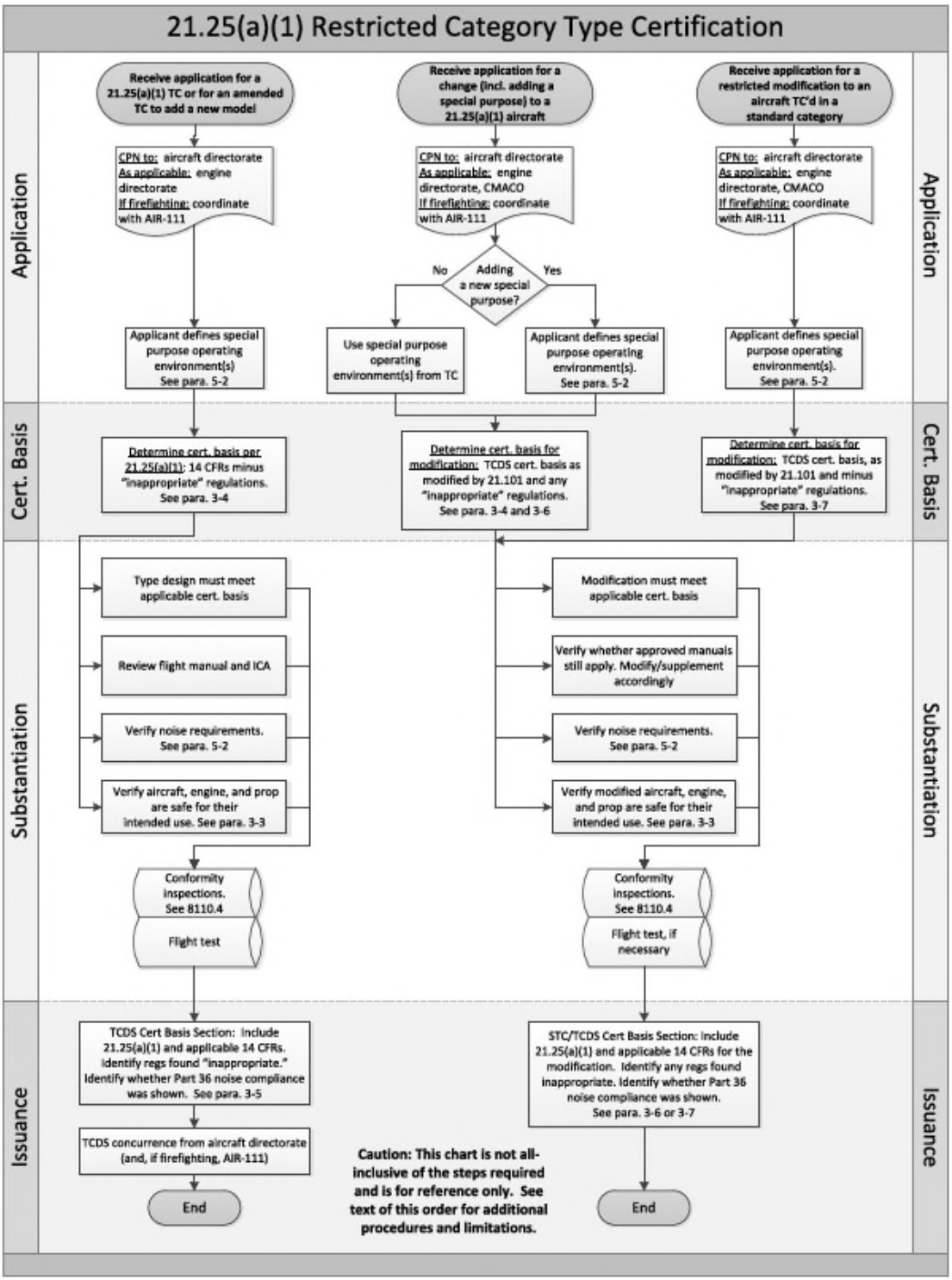

Figure 5-1.1: Schematic from FAA Order 8110-56B Restricted Category TC, Insitu ScanEagle

6 Electric / Hybrid Aircraft Progress

6.1 Successful Certification Programs

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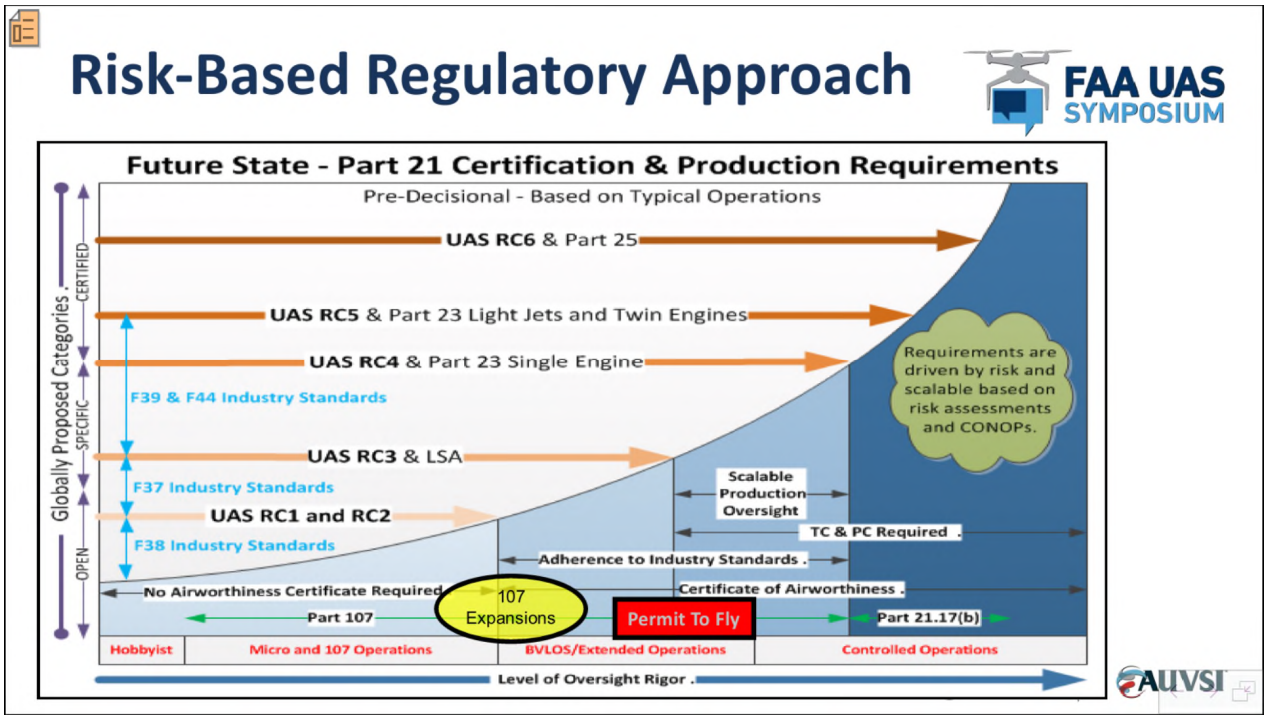

Figure 6-1. Risk-based Regulatory Approach (FAA)

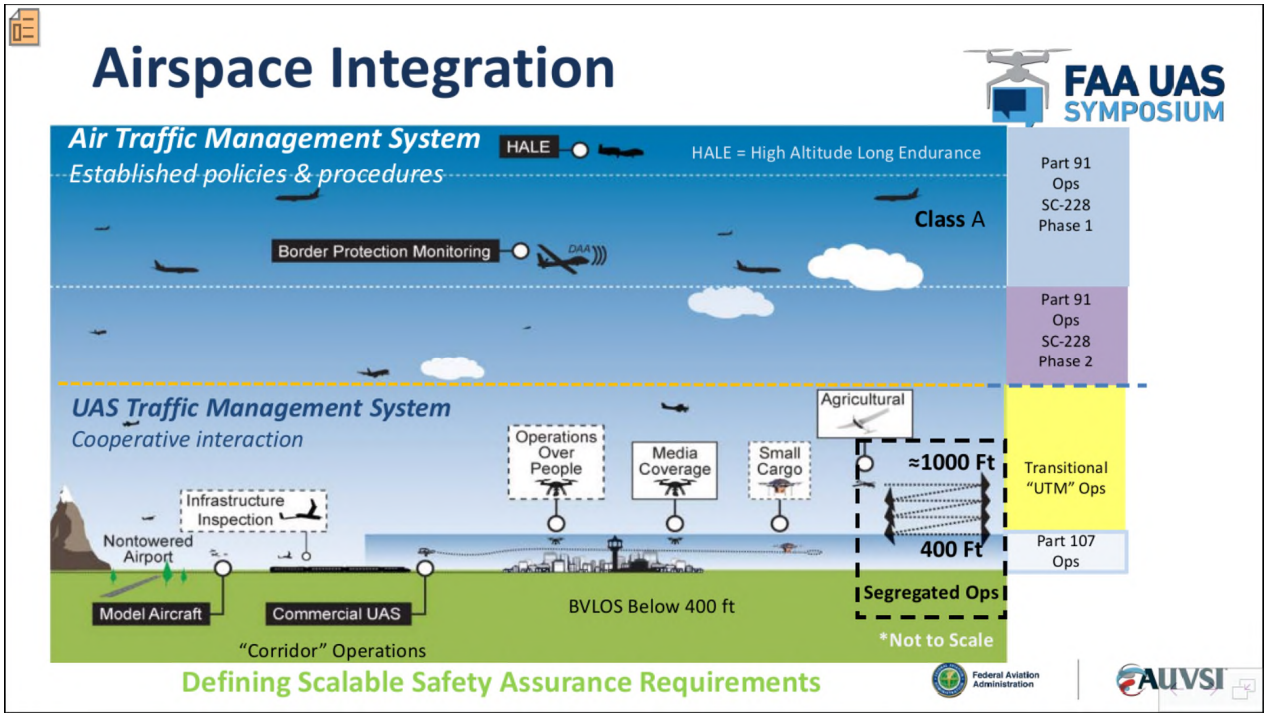

Figure 6-2 Airspace Integration (FAA)

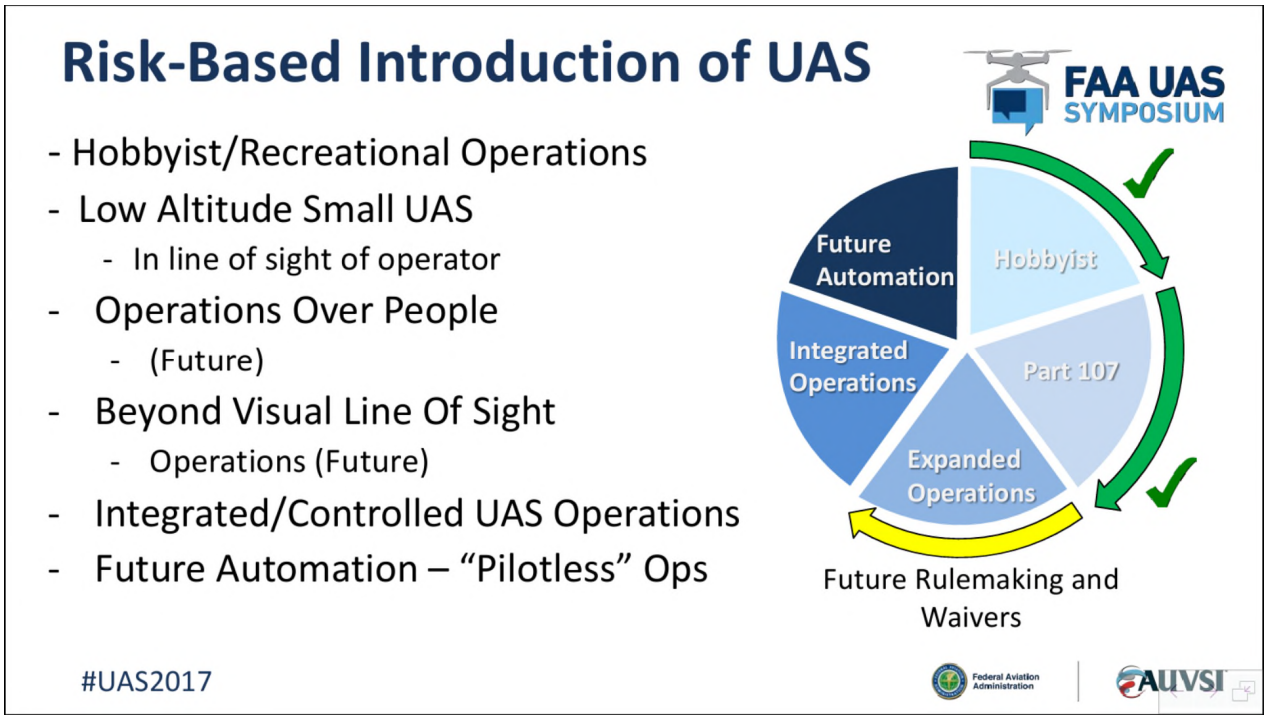

Figure 6-3. Risk-Based Introduction of UAS (FAA)

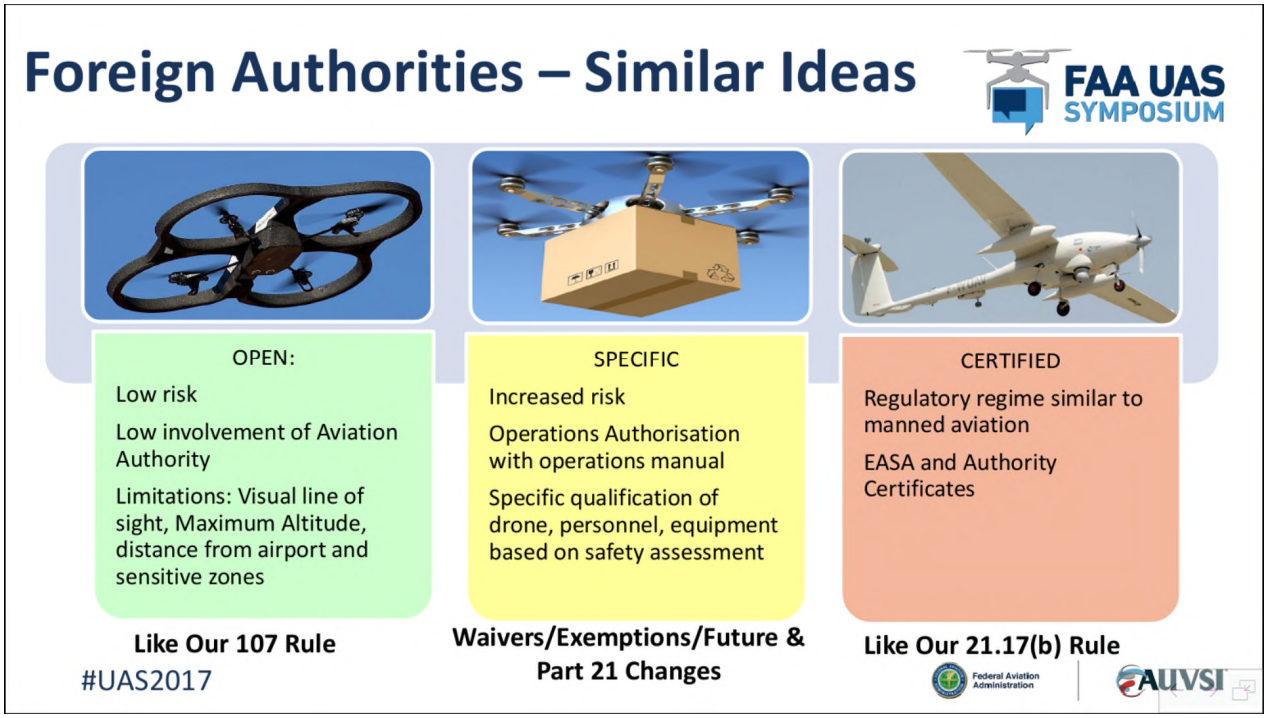

Figure 6-4.Foreign Authorities, Similar Ideas (FAA)

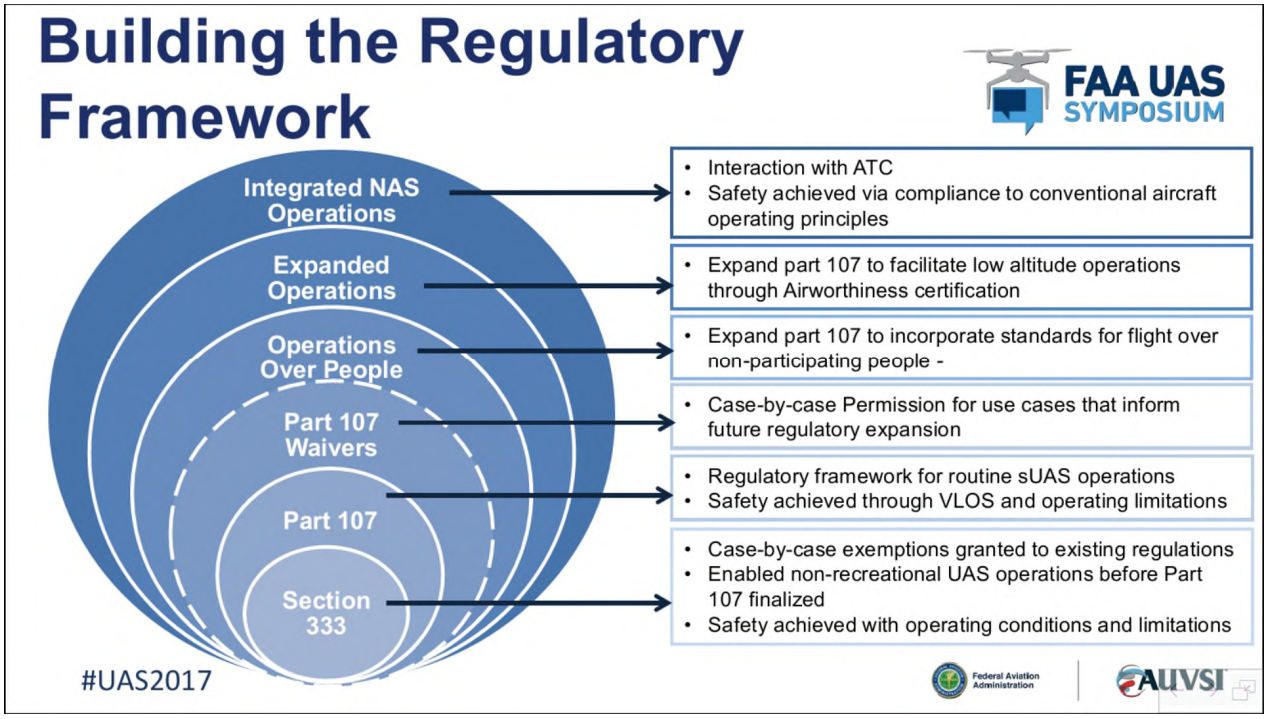

Figure 6-5. Building the Regulatory Framework (FAA)

6.2 Certification Efforts

Some information redacted.

6.3 Notable Companies and Efforts

6.3.1 CTOL Aircraft

Some information redacted.

6.3.2 STOL Aircraft

Some information redacted.

6.3.3 VTOL/eVTOL Aircraft

Some information redacted.

6.3.4 Propulsion Systems

Some information redacted.

7 UAS Civil and Civil Derived Cert Basis Efforts

7.1 FAA-Accepted Restricted Category Type Cert for Civil UAS

Some information redacted.

7.2 Roadmap to UAS Precedent setting Civil Type Certification

Some information redacted.

7.3 Future UAS Cert Logic summarized from 2016 ASSURE Report

Some information redacted.

8 AeroTEC's ability to satisfy UAS and Electric T&E and Certification Efforts.

AeroTEC has expert capabilities on Parts 23, 25, 27, 29 and 36 [and associated ACs and FAA Orders, etc.] as well as those qualified to speak to and assess methods of compliance for TC and STC programs. The UAS platforms already in existence or development are fixed wing, rotary and hybrid – in other words a quasi-mixture of each of the FARs above.

There is significant information obtainable / inferred relating to the successful certification of UAS platforms. The rules are in flux but are all based on existing FAA standards for airworthiness. AeroTEC's expertise would be essential in assisting the many inexperienced companies, both OEM down to start-ups, to work through the highly dynamic UAS certification process. Having a one-stop-shop for this activity would be tremendously time saving and add large value to the industry. The traditional processes are complex; the new rules (such as they exist in draft form) are an order of magnitude more complicated.

Currently, **each entity is approaching the FAA separately to set up a to-date unique cert basis based on their CONOPS.** Many requirements would be similar.

Some information redacted.

8.1 AeroTEC Capabilities

In addition to what is stated on the website, which is extensive, expand to focus on:

1. Mobile telemetry; in addition to onsite capabilities at Moses Lake, we can travel to any UAS test range
2. Located at Grant County airport facility
3. Hangar space (partitionable)
4. In-house expertise for traditional FARs and ACs to handle a mix of requirements for UAS testing
5. Ability to professionally handle a moving FAA/EASA certification target for UAS with the FAA directly
6. In-house development, computational and certification capability for ground and flight test.
7. Remote drone pilot capable (very nearly so; all our pilots are far along on being Part 107 qualified [25]. The piloting experience must be demonstrated to a yet TBD standard.
8. Excellent relationships with FAA (ACOs Los Angeles, Seattle, …) on fixed wing programs
9. Immediate availability of our NBH for internal testing. No FAA involvement required.
10. Relationship with TC, EASA, JCAB
11. Part 145 shop – add not-yet-defined UAS cert

The rules regarding UAS certification are uncertain but are rapidly being formed under tremendous pressure from UAS market, as well as pressure from a more rapidly advancing set of

overseas regulations. This can be seen as a significant roadblock for AeroTEC; getting the inertia heading in the right direction, while dealing with the external regulatory roadblocks. In other words, it will take energy to jump into the race while the starting line is constantly moving.

8.2 AeroTEC Active UAS Associations

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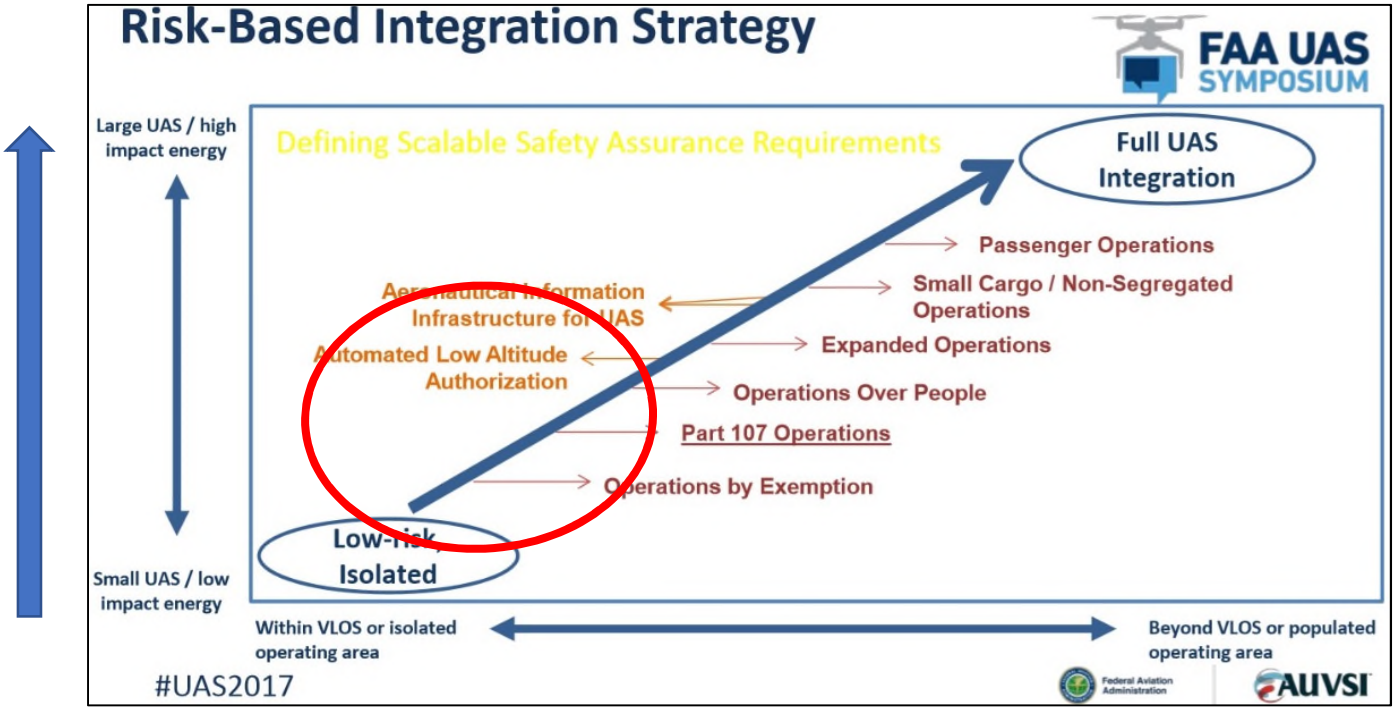


Figure 8-1: Kinetic Energy (KE) vs Risk to People (KQ)

8.3 Costs associated with Conference Memberships

Some information redacted.

9 SWOT Analysis: UAS & Electric Business Development

Some information redacted.

10 Timeline

Some information redacted.

11 Next Steps

11.1 Cost associated with Conference Memberships

Information redacted.

12 "Customer #1"

Some information redacted.

13 "Customer #2"

Bring Customers to the under-development WA State Sunnyside / Anderson Ranch UAS site, assist in other opportunities to proofing out and adequately equipped the site.

Establish / co-locate AeroTEC skills and knowledge base, along with the local talent, at Sunnyside, or recommended Customer site.

To "close the loop" on what Customers want; i.e.

- Aircraft proofing out a system: fly patterns, collect data, post-process, report
  - Aircraft could be proposed AeroTEC flying test bed, manned or unmanned.
- Customer wanting certification or waiver for their new flying UAS concept.
- Take Customer end-to-end (out of development into TRL7 and full TC) at common test range, Sunnyside or elsewhere.

Under development Sunnyside / Anderson WA State site below.

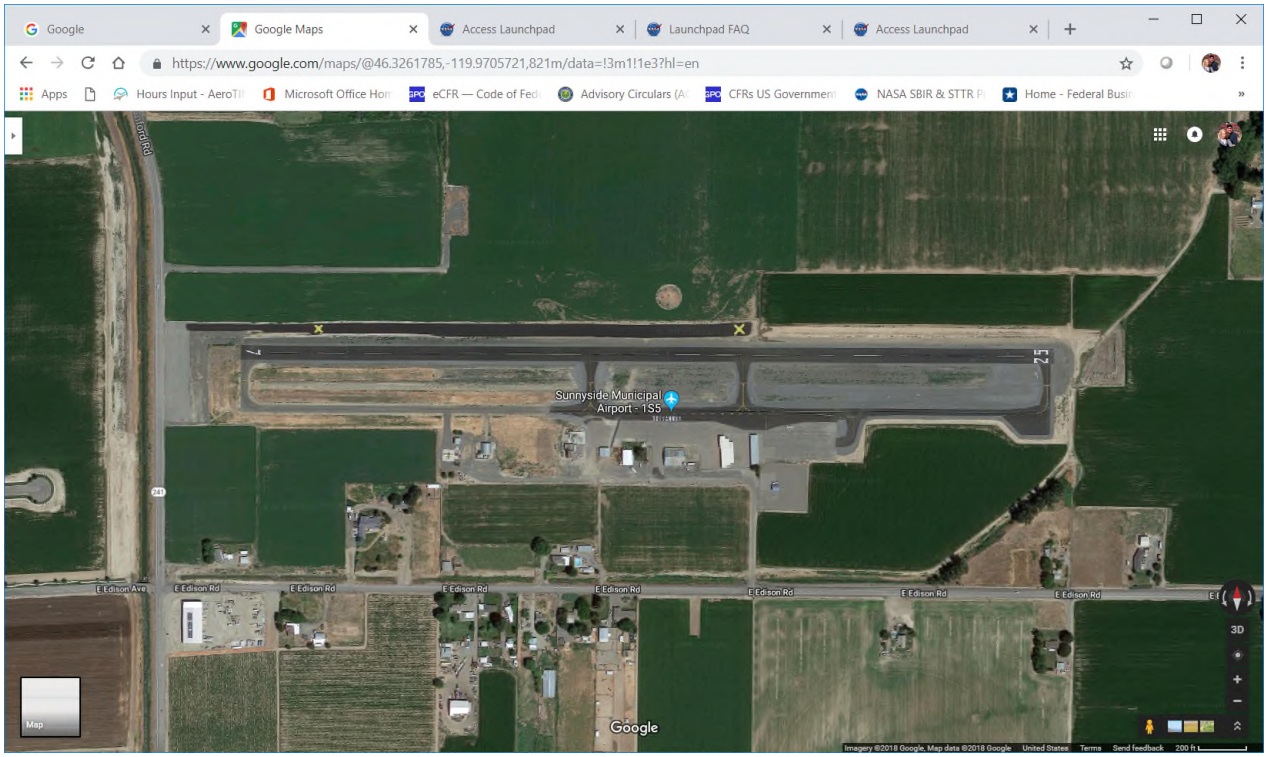


Figure 13-1. Google View of WA UAS Test Range

Some information redacted.

14 “Customer #1.1”

From the perspective of Sunnyside / Center of Excellence for UAS, AeroTEC and/or Aerogene (sub-contractor or subsidiary), are seen as their Customer #1. We can take advantage of this.

AeroTEC could very well be the first real Customer at Sunnyside; help set the standards; spec out infrastructure, develop working relationships with new AeroTEC Customer through analyzing their needs, tap into State and Local funding.

Some information redacted.

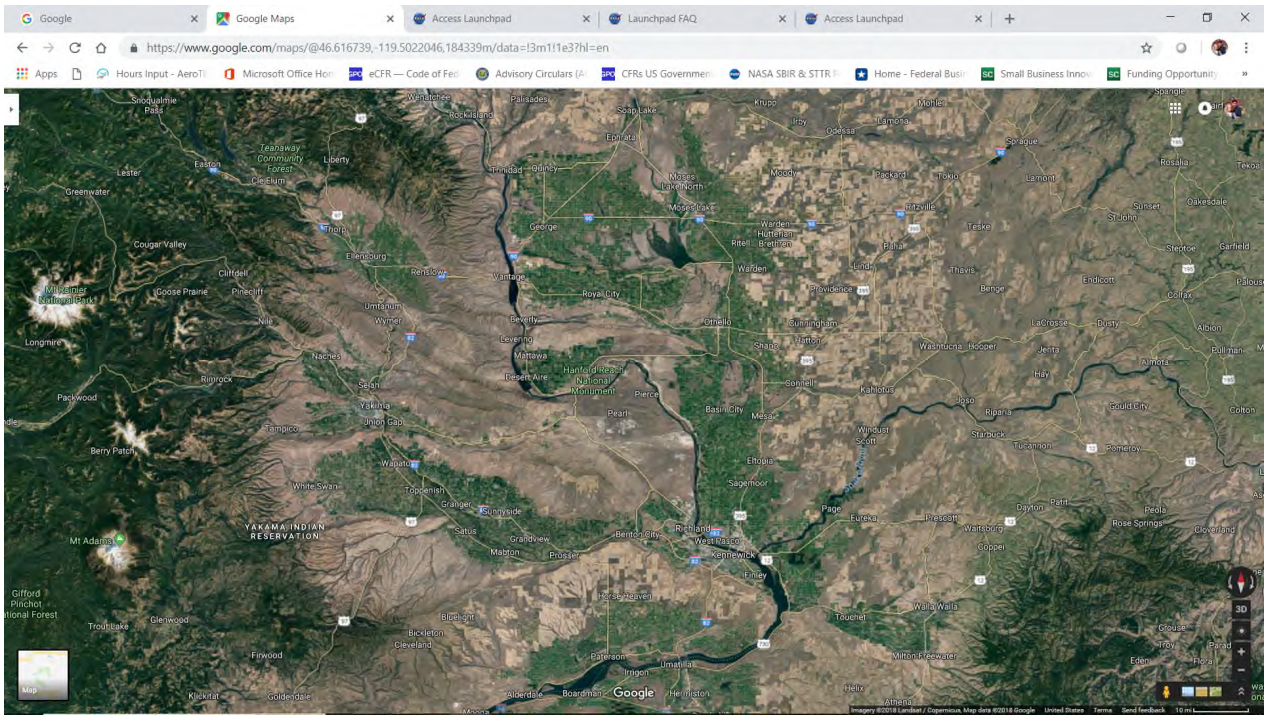
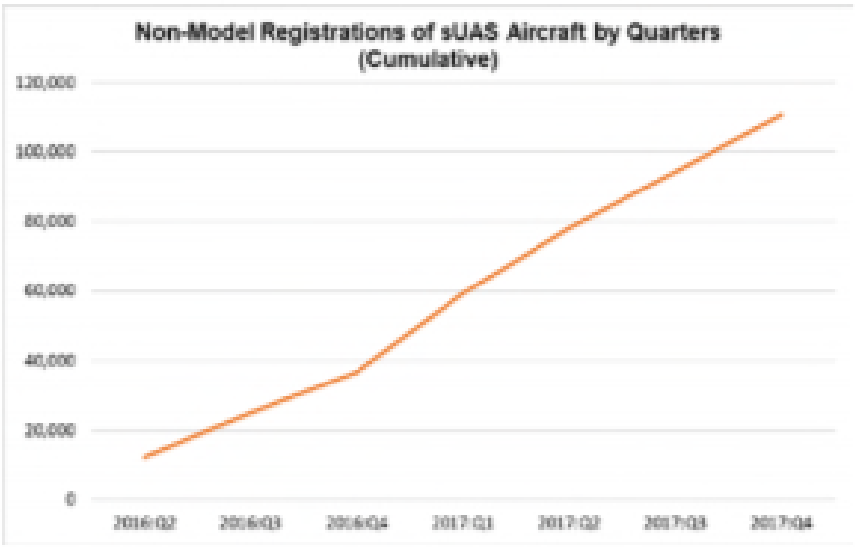


Figure 14-1. Proximity of WA State UAS Test Range to MFC

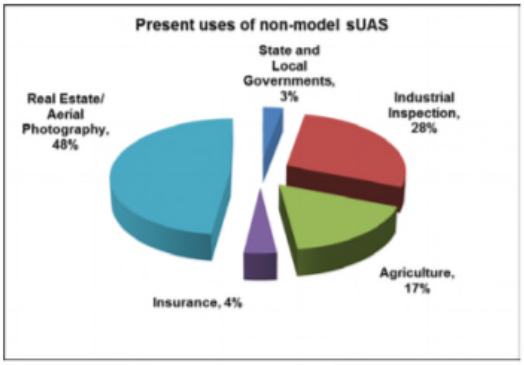
[1] Some information redacted.

Appendix A **Marketing Summaries**

A.1 DOT/FAA Funded Marketing Research



	Total non-Model Fleet (no. of units)	
year	Base	High
2017	110,604	110,604
2018	158,900	168,339
2019	229,400	268,937
2020	312,100	410,862
2021	407,400	604,550
2022	451,800	717,895



Ref: FAA Aerospace Forecast Fiscal Years (FY) 2018-2038

The total sUAS market, hobbyists and commercial, is shown (again from the same FAA report) below. To stress the unsaid, this is only the sUAS (small UAS, <55 lbs.) market.

	Total Model Fleet (Million sUAS Units)		
year	Low	Base	High
2017	1.10	1.10	1.10
2018	1.50	1.60	1.73
2019	1.76	2.00	2.35
2020	1.87	2.20	2.73
2021	1.92	2.30	2.94
2022	1.96	2.40	3.17

Ref: FAA Aerospace Forecast Fiscal Years (FY) 2018-2038

A.2 NASA funded market research charts

Aviation Market Categories used in Study

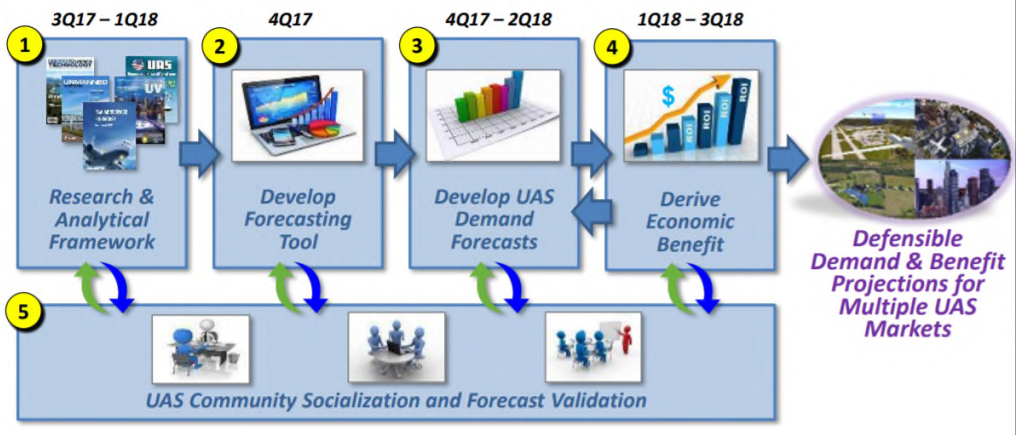
1 Research & Analytical Framework

	Category	Definition
Traditional Markets*	Privately Owned	General Aviation Aircraft owned and operated by individuals or corporations (e.g. Cessna, Piper Cub, Learjet)
	Airlines	Commercial air carriers that offer a service to transport people to and from airports across the country and internationally (e.g. United, American, Delta, SouthWest)
	For Hire	Aircraft that is rented by the hour, day, week to provide a service to anyone willing to pay the negotiated fee (e.g. sightseeing helicopter, NetJets)
	Cargo	Aircraft used to transport freight to and from airports across the country and internationally (e.g. FedEx, DHL, UPS)
New UAS Enabled Markets**	HALE	Expanding unmanned aircraft market that operates over both rural and urban settings, well above traditional manned aircraft at high altitudes (>60K ft), for very long endurance (days/weeks/months) missions.
	IFR-Like	Expanding UAS market that increases traditional densities of the NAS, performs long distance and/or long endurance missions at a higher altitudes (18K ft - 60K ft); integrating exclusively with cooperative aircraft.
	VFR-Like	Early UAS market that will operate BVLOS over rural and populated areas at altitudes below critical NAS infrastructure (10K ft – 18K ft); routinely integrating with cooperative and non-cooperative general aviation aircraft.
	Urban Passenger Transport	Newly emerging market that requires high density VTOL operations for on demand, affordable, quiet, fast, transportation of people in a scalable and conveniently accessible verti-port network .
	Low Altitude Urban	Rapidly expanding market that uses fixed wing and VTOL UAS operating below 400 ft and BVLOS to deliver packages and offer a wide range of services to high density urban settings.
	Low Altitude Rural	Emerging market that includes fixed wing and VTOL UAS, ranging in size and capability, that operate beyond visual line of sight (BVLOS) in Class G airspace and above low-risk rural locations.
	VLOS	Growing existing market, partially enabled by Far Part 107, that includes visual line-of-sight (VLOS) fixed wing and VTOL UAS (<55 lb) operating below 400 ft.

*Traditional Markets are the categories the FAA has historically tracked for manned aviation.
** UAS Enabled Market Categories are based largely on projected topics for periodic policy / regulatory releases

6

Study Approach & Timeline



UAS demand forecast accuracy is highly dependent on the ability to receive quality inputs from the entire UAS community to include: government, industry and broad commercial-user interest groups.

4

Explanation of Risk Based approach to UAS Certification
(Ref: FAA-2017-1058-0001)

Risk Classes based on kinetic energy:

a) Risk Class 1: ≤ 529 Ft-Lb

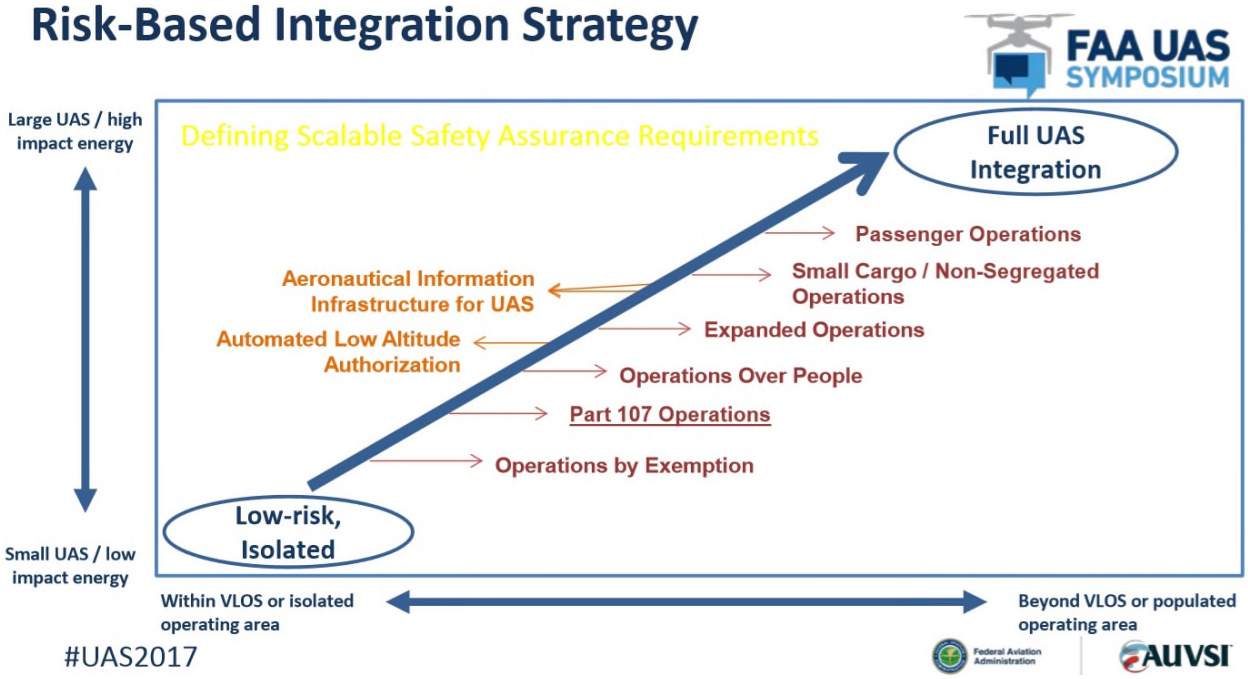
b) Risk Class 2: ≥ 530 to ≤ 24,999 Ft-Lb

c) Risk Class 3: ≥ 25,000 to ≤ 799,999 Ft-Lb

d) Risk Class 4: ≥ 800,000 to ≤ 5,999,999 Ft-Lb

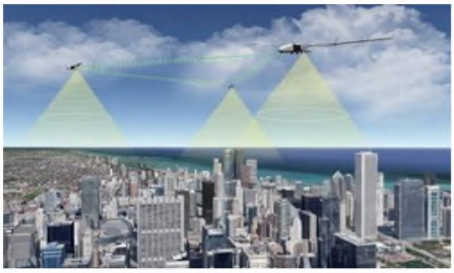
e) Risk Class 5: ≥ 6,000,000 to ≤ 49,999,999 Ft-Lb

f) Risk Class 6: ≥ 50,000,000 Ft-Lb

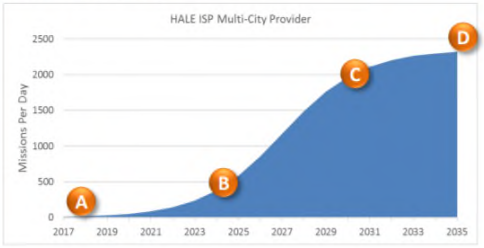


UAS Demand: HALE Internet Service Provider

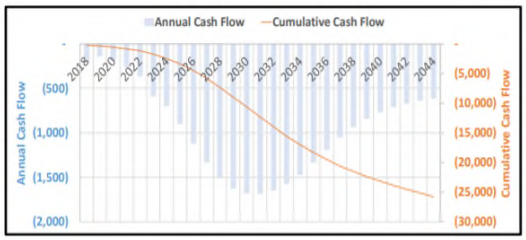
Use Case: HALE Internet Service Provider



UAS Demand:



Economic Benefit:



Key Findings:

- The Internet Service Provider (ISP) Use Case does not close for a single payload HALE system
- For this Use Case to be viable, consider the following:
  - Add additional payloads to have multiple funding streams
  - Charge higher service charge (may not be feasible if there are cheaper alternatives)
  - Business case may be limited to areas of world without existing infrastructure.

A.3 Privately funded: Goldman Sachs Forecasts [24]

Some information redacted.

Appendix B **Facilities**

Wide Body Hangar

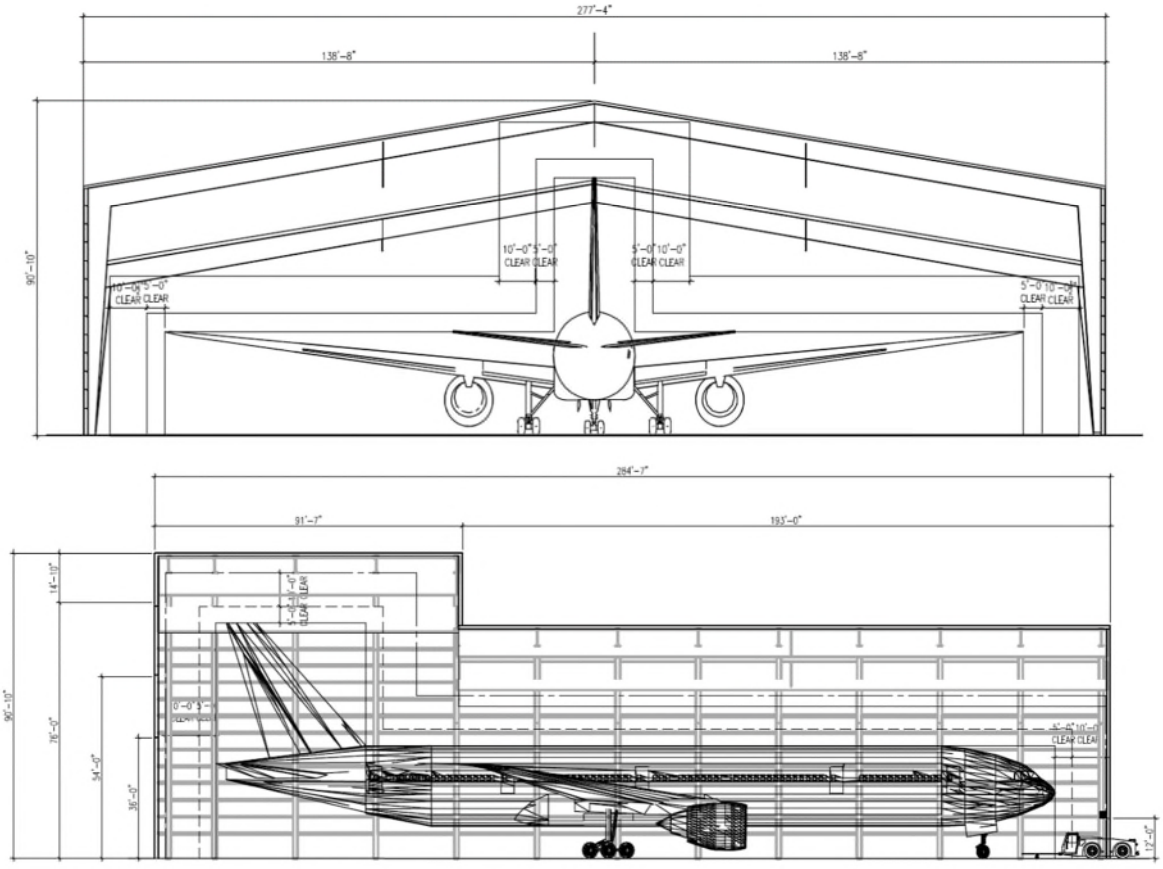


Figure 14-2: Front and side view of the Wide Body Hangar

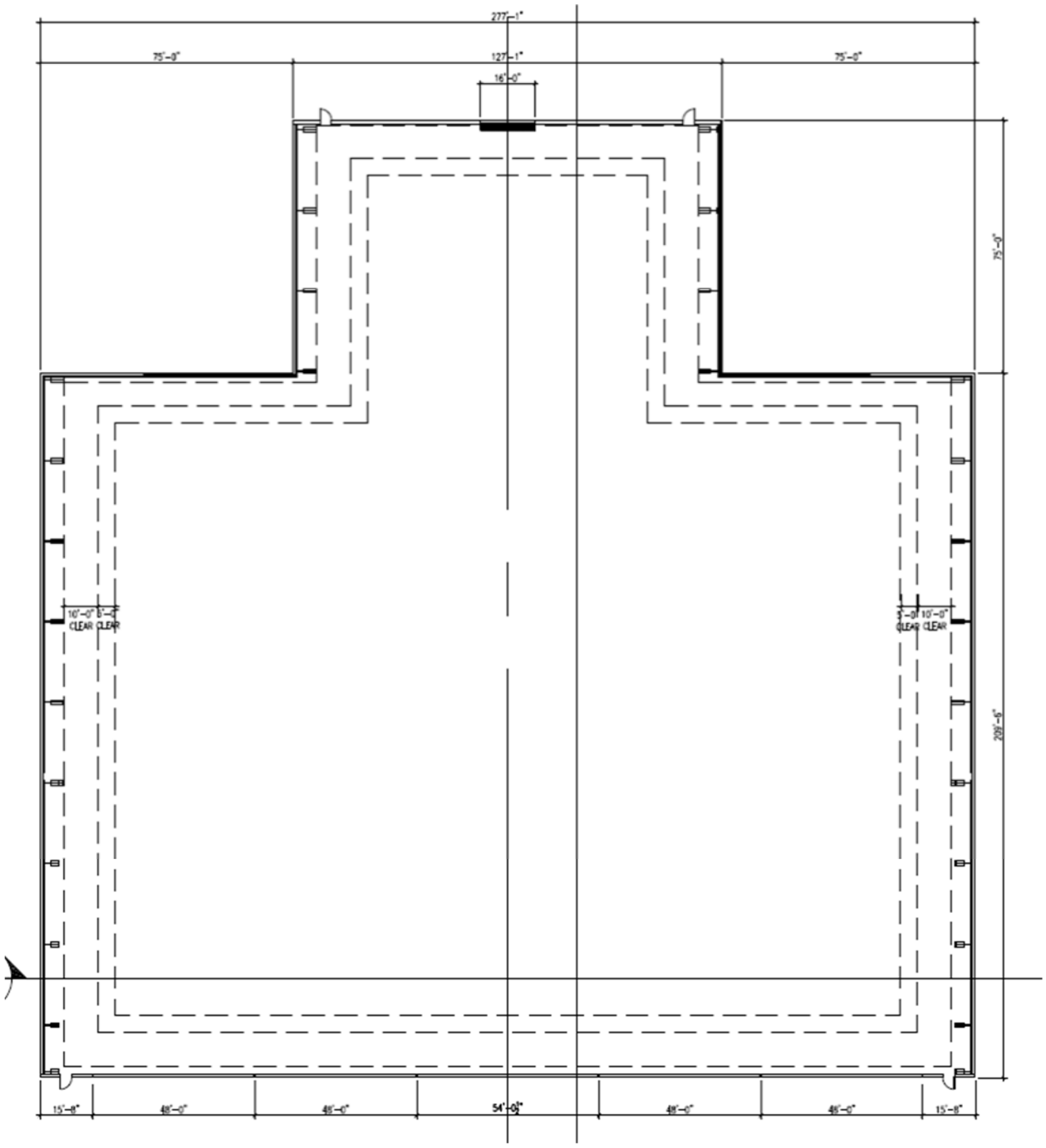


Figure 14-3: Top View of the Wide Body Hangar

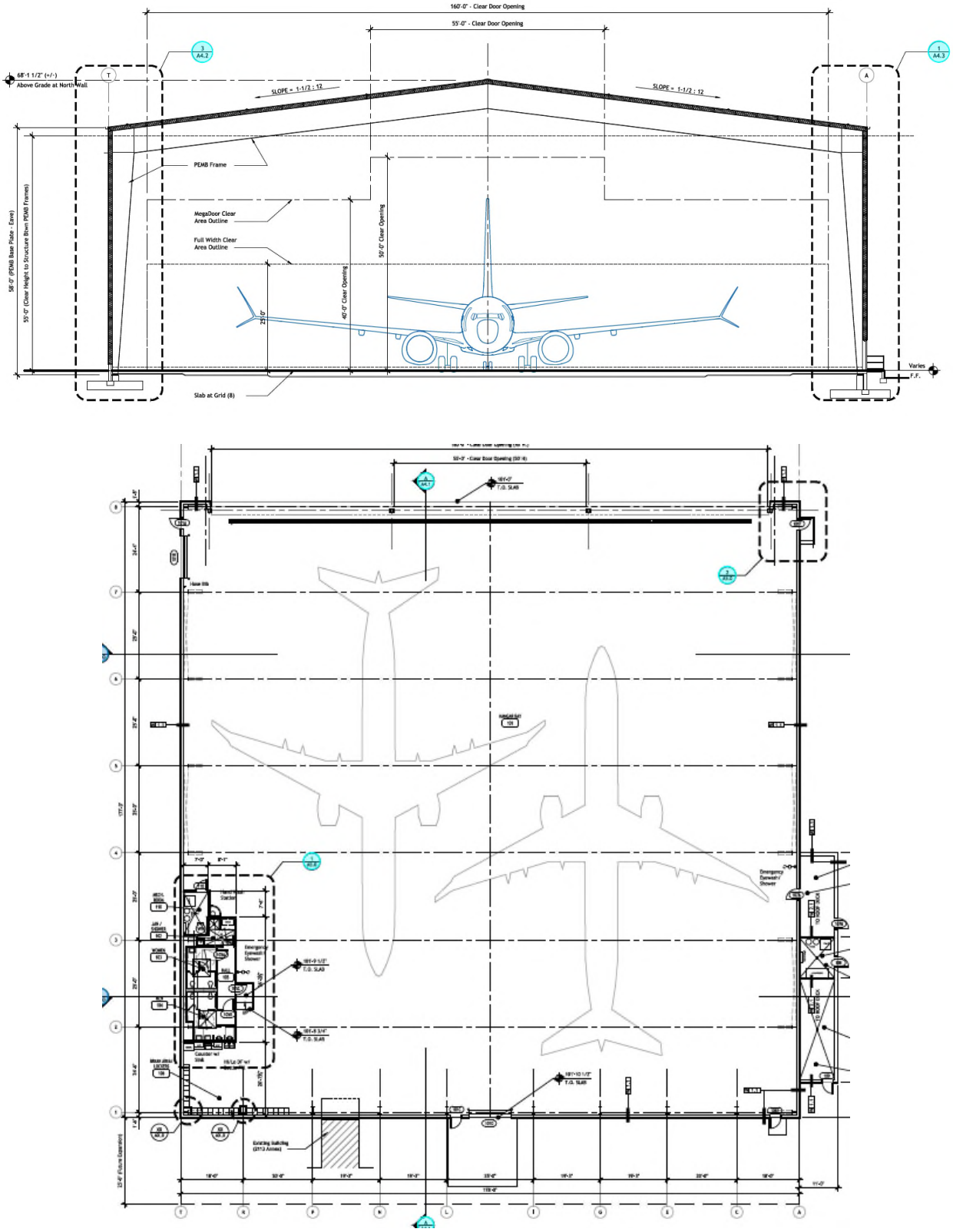


Figure 14-4: Front and top views of the Narrow Body Hangar. Front view width is 160ft.

Appendix C AeroTEC Core Competencies

- Vertically Integrated
- Problem Solving (Get ‘er done)
- Lean & Efficient
- End-to-end Service
- Complete Product Development Cycle
- Program Definition
- Requirements Definition
- Program Management
- Detailed Program Planning
- Initial Validation Testing
- Wind Tunnel Model Fabrication
- Wind Tunnel Testing
- Simulation and Analysis
- Advanced CFD Capability
- Detailed Design
- Extensive DER Coverage
- Complete Engineering Support
    - Flight Sciences, Avionics, Interiors, Electrical Power, Powerplant, Fuel Systems, ECS, Mechanical, Structures,
    - Design capabilities
    - Rapid prototyping
    - Ice shape design, build, test and analysis for full and sub-scale
- Final Testing
    - Flight Testing & Pilot Capabilities
    - Ground Testing
    - Moses Lake Flight Center
    - DER test pilots
    - FTEs
    - Instrumentation
    - Airborne Data System
    - Static and portable telemetry and data services
    - Flight data analysis
- Proprietary & Customizable Software Tools
- Certified Solutions
- Certification Deliverables
    - Navigating the FAA Universe in the most efficient way possible
    - How to get the ‘right’ data for the FAA
    - How to get the ‘right’ data for Customers
    - Expectations in terms of when to include the FAA, when witnessing is required

- Sustaining Support

Avionics - Expanded

1. Communications
    a. ACARS (Aircraft Communications Addressing and Reporting System)
    b. CPDLC (Controller-Pilot Data Link Communications)
    c. SATCOM Audio/Data Link (Satellite Communications)
    d. SELCAL (Selective Calling)
    e. VHF (Very High Frequency)
    f. CVR (Cockpit Voice Recorder)
2. Indicating and Recording
    a. Displays
    b. FDR (Flight Data Recorder)
    c. QAR (Quick Access Recorder)
    d. CAS (Crew Alerting System)
3. Navigation
    a. SFIS (Standby Flight Instrument System)
    b. GPS (Global Positioning System)
    c. DME (Distance Measuring Equipment)
    d. IRS (Inertial Reference System)
    e. RALT (Radio Altimeter)
    f. TAWS (Terrain Awareness and Warning System)
    g. ILS (Instrument Landing System)
    h. FMS (Flight Management System)
    i. TCAS (Traffic Collision Avoidance System)
    j. XPDR (Transponder) with and without ADS-B Out/In (Automatic Dependent Surveillance-Broadcast)
    k. WXR (Weather Radar) with and without PWS (Predictive Wind Shear)
4. Cabin Systems
    a. CDSS (Cockpit Door Surveillance System)
    b. PACIS (Passenger Address and Cabin Interphone System)
    c. PBS (Public Briefing System)
    d. IFE (In Flight Entertainment)
5. Maintenance
    a. OMS (On-Board Maintenance System)
6. Information
    a. IMS (information Management System)

Any of the above may require specific equipment and personnel for testing

Appendix D 14 CFR 21-25

§ 21.25 Issue of type certificate: Restricted category aircraft.

(a) An applicant is entitled to a type certificate for an aircraft in the restricted category for special purpose operations if he shows compliance with the applicable noise requirements of Part 36 of this chapter, and if he shows that no feature or characteristic of the aircraft makes it unsafe when it is operated under the limitations prescribed for its intended use, and that the aircraft -

(1) Meets the airworthiness requirements of an aircraft category except those requirements that the FAA finds inappropriate for the special purpose for which the aircraft is to be used; or

(2) Is of a type that has been manufactured in accordance with the requirements of and accepted for use by, an Armed Force of the United States and has been later modified for a special purpose.

(b) For the purposes of this section, "special purpose operations" includes -

(1) Agricultural (spraying, dusting, and seeding, and livestock and predatory animal control);

(2) Forest and wildlife conservation;

(3) Aerial surveying (photography, mapping, and oil and mineral exploration);

(4) Patrolling (pipelines, power lines, and canals);

(5) Weather control (cloud seeding);

(6) Aerial advertising (skywriting, banner towing, airborne signs and public address systems); and

(7) Any other operation specified by the FAA.

Appendix E **Washington Military Department**

Some information redacted.