

CERTIFICATION AND REGULATORY APPROACH

Clearly, much of the existing body of aviation regulations can be applied directly or with little modification to UAVs. Nevertheless, additional regulatory guidance in many areas is a requirement for the industry to reach its full development potential.

Many current aviation regulations could be construed as applying to UAVs explicitly or implicitly (Figure 5). For example:

- Many UAVs fly with engines, propellers, avionics, control surface actuators, and other components for which TSO exist. Apart from a requirement to integrate these components in accordance with provisions in the type certificate, they can be used in a wide variety of aircraft, including UAVs, without being separately certified. Therefore, the TSO process explicitly applies to UAV components.
- Certain UAVs have characteristics sufficiently similar to existing types of aircraft that much of the certification process for an aircraft of that type could be applied. As a specific example, many UAVs, including the General Atomics Altair, have characteristics of a powered glider. Implicitly, much of the powered glider type certification process may apply.
- Civil aircraft are required to be highly visible to other aircraft. This also would apply to UAVs.

Some regulations for conventional aircraft clearly do not apply to UAVs and probably can be dismissed easily (Figure 5). For example:

- There is no need to supply supplemental oxygen.
- There is no need to regulate the visibility of cockpit instruments.
- For many UAVs, there may be no need to regulate minimum physical requirements for crew members.

Existing FAR are a good starting point for the development of comprehensive regulations for UAVs. Nevertheless, there are clear areas in which new or highly modified regulations may be required (Figure 5). For example:

- Performance standards and redundancy requirements for command and control functions may be needed.
- Performance standards for systems to detect, see, and avoid other aircraft may be needed.
- Performance standards may be needed to ensure that UAVs comply in a timely manner with instructions from air traffic controllers.
- Minimum qualifications for flight crew members must be developed. When, if ever, does a flight controller need to be a rated pilot, for example?

Yet another area of regulatory interest not fully covered in today's regulatory environment has to do with protection of persons and property on the ground. The hierarchy of concern with piloted aircraft is first to protect occupants of the aircraft, then occupants of other aircraft, and finally persons and property on the ground. There are a few specific regulations pertaining to protection of persons on the ground, for example, specifications for minimum over-flight altitudes of inhabited areas. In general, however,



EXAMPLES OF APPLICABLE EXISTING FEDERAL AVIATION REGULATIONS & PROCESSES



EXAMPLES OF NON-APPLICABLE EXISTING FEDERAL AVIATION REGULATIONS & PROCESSES



EXAMPLES OF NEW OR MODIFIED REQUIREMENTS

Applicability of FARs and Processes

protection of persons on the ground is a direct consequence of protecting the occupants of the aircraft. For a UAV, there is no one on board to protect and so protection of persons on other aircraft and on the ground takes on greater relative importance. As a consequence, it may be reasonable to require a flight termination system (FTS) on certain classes of UAVs or to place tighter restrictions compared with manned aircraft on areas in which UAV flight is allowed.

Routine civil UAV flights in the NAS, other than within restricted and warning areas, will require fundamental assurance that these aircraft will not cause unsafe conditions to exist with manned aircraft or people/property on the ground.

To give the FAA reasonable confidence in its ability to respond to safety concerns and to be able to define and establish an acceptable operating civil environment for UAVs, the following major considerations should be individually and collectively addressed:

1. aircraft type design, production, and airworthiness certification by the FAA to meet, at the minimum, acceptable criteria that can provide an equivalent level of safety
2. pilots (operators) that have been "licensed" by the FAA and meet certain qualifications standards and prescribed medical requirements
3. operations with aircraft safety enhancing equipment (e.g., anti-

- collision lights, navigational instruments and equipment, threat collision avoidance equipment, as well as appropriate fully developed DSA and OTH subsystems and equipment, etc.)
4. compliance with specified FAA operating rules and regulations, flight manual imposed limitations, and any other prescribed aircraft operating limitations and conditions to ensure airworthiness criteria exist that provide equivalent levels of certitude and safety

There are additional factors unique to the operation of UAVs that also must be addressed from an operational environment perspective to ensure a reasonable and measurable level of safety:

1. a secured command and control frequency, without possibility of interference from outside sources
2. guaranteed reliability and imposed failsafe criteria to control the UAV when it uses satellite connectivity to provide command and control functions for either normal operations or safety of flight (emergency) conditions
3. contingency plans in the event of loss of link, including safe abort capability and/or return to base capability.

The ERAST Certification IPT will work closely with key FAA individuals in the review of this document. The IPT also will assist in improving internal FAA communication between the Aircraft Certification Service, the Flight Standards Service, and the ATS on UAV safety issues and concerns. The IPT will strive to give the FAA assurance and reasonable confidence that UAVs will not cause unsafe conditions.

Particular emphasis will be placed on working with the Aircraft Certification Service personnel located at FAA Headquarters in Washington D.C. (i.e., the Aircraft Engineering Division, AIR-100, and the Production and Airworthiness Division, AIR-200). This work will identify existing regulatory material and certification processes, procedures, and airworthiness and operational requirements that may be considered appropriate. The work will define other rule -making processes and procedural activities that may be necessary in the future to enable HALE UAVs to operate routinely in the NAS.

The rule-making process will address minimum performance standards for new DSA and satellite OTH subsystems. The research and development of appropriate DSA and satellite OTH subsystems and equipment will be major considerations in the HALE UAV certification process. The IPT believes that supporting a customer-focused process will directly benefit the overall program. This will get FAA groups involved in an individual and collective manner and establish an environment for safely operating UAVs in the NAS. A UAV Operations Concept acceptable to the FAA will be developed addressing issues and concerns without imposing unsafe conditions to unmanned aircraft or to life or property on the ground.

The IPT also recognizes international aspects of aviation regulations and is fully committed to working with the FAA, other CAAs, the Joint Aviation Authorities (JAA) of Europe, and the ICAO on civil certification and application matters.

One goal of the IPT is to identify customers and initiate improvements throughout the process. The IPT will solicit inputs from various FAA departments on safety issues

and concerns regarding the operation of UAVs in the NAS. Once these issues and concerns have been identified, the IPT will present a synopsis of the areas, generate problem definitions, and develop an objective analysis of the circumstances surrounding UAV operations in the NAS.

A close working relationship with the FAA is a final significant approach element. Frequent interaction with the FAA will be necessary to meet the goal of routine UAV flight in the NAS. The roadmap was developed to match the FAA organizational structure to optimize communications. Proposed also in the roadmap are meetings with specific FAA elements to perform pre-coordination and plans to formalize anticipated required interaction during the certification process. Much of this pre-work has been accomplished and is now in place.

2.0 HALE UAV CERTIFICATION PROCESS AND OUTCOMES

The recommended HALE UAV certification process requires obtaining the following certificates in the sequence listed:

1. 1. Registration Certificate
2. 2. Experimental Certificate
3. 3. Type Certificate in the Special Class Category
4. 4. Approved Production Inspection Certificate
5. 5. Special Airworthiness Certificate
6. 6. Standard Airworthiness Certificate
7. 7. Air Operating Certificate
8. 8. International Civil Aviation Organization Certificate

The benefits, limitations, and required steps for each certitude level are shown in Table 1.

Benefits, Limitations, and Steps Required to Achieve Certitude

Level of Certitude	Benefits and Limitations	Steps to Achieve Level
Level 1 (2 months) Aircraft Registration Certificate	• Prerequisite for any and all airworthiness certifications	• Apply for U.S. Registration Number per FAR Part 47 • Obtain U.S. Identification Number from the FAA Aircraft Registry – Submit proof of ownership – File Aircraft Registration Application (Form 8050-1)
Level 2 (3 months) Experimental Certificate	• Permits operation of R&D or to show compliance with regulations • Initial flights confined to assigned test areas • May not carry property for hire	• Brief cognizant FAA organizations • Submit application
Level 3 (3 years) Special Class Type Certificate	• Establishes proposed initial design concept • Establishes Type Certification basis • Establishes Designated	• Brief cognizant FAA organizations • Develop, submit, and seek FAA approval of HALE UAV Issue Paper • Conduct detailed system assessment

	Airworthiness Representative (DAR) and Designated Engineering Representative (DER)	– Provide detailed aircraft information
Level 4 (6 months) Production under Type Certificate Only	• Develops production guidelines – Simpler than standard Production Certificate • Suited for limited production runs	• Analyze manufacturer’s quality control and inspection systems • Perform complete analysis of all aspects of production • Submit to FAA inspections
Level 5 (6 months) Special Airworthiness Certificate	• Provides much greater operating flexibility compared with COA	• File application – Identify special-purpose operations – Aircraft must be equipped for instrument flight rules (IFR) operation per FAR 91.205 – Aircraft must be equipped with Mode C transponder and flight data recorder – Aircraft must be equipped with anticollision and position lights – Enabling technologies must be integrated and substantiated

Level of Certitude	Benefits and Limitations	Steps to Achieve Level
Level 6 (9 months) Standard Airworthiness Certificate	• Eliminated limitations associated with COA and Special Airworthiness Certificate • Imposes minimum number of restriction • Permits operation under FAR Part 91	• File application • Submit to FAA inspection • Substantiate operation of enabling technology subsystems
Level 7 (6 months) Air Operating Certificate	• Provides unified approach to Flight Standards – Operational suitability – Operator requirements – Equipment requirements – Maintenance requirements	• Work with Flight Standards Evaluation Group and Flight Standards Service to develop requirements • File application
Level 8 (3-4 years) International Civil Aviation Organization Certification	• Establishes method for certification in ICAO Member States • Streamlined methods may be faster than U.S. certification • Member States may “opt out” of adoption	• Work closely with ICAO personnel to – Develop Terms of Reference – Develop design concepts and criteria – Develop minimum certification envelope – Develop safety requirements • Work closely with ICAO personnel to develop complete technical publication package

CERTIFICATION PRODUCTS

The requirement for certifying civil aircraft dates back to the Air Commerce Act of 1926. This act subsequently was superseded by the Federal Aviation Act of 1958,

which in turn, created the FAA.

A brief overview of the FAA Aircraft Certification Process is best accomplished by reviewing its certification products. Section 603 of the Federal Aviation Act provides for the issuance of aircraft certificates by the Administrator. Three specific kinds of certificates are addressed generically:

1. *Type Certificates* (Section 603(a)) to approve the designs of aircraft, aircraft engines, propellers, and appliances. It is noted that appliances normally are approved via the FAA Technical Standard Order Authorization (TSOA) process.
2. *Production Certificates* (Section 603(b)) to approve the quality control system for the manufacture of products for which a type certificate has been issued.
3. *Airworthiness Certificates* (Section 603(c)) for completed aircraft when the Administrator determines that the particular aircraft conforms to the type certificate and, after inspection, finds that the aircraft is in a safe-operation condition.

Before issuing any of these certificates, the FAA is required to make certain "findings" or determinations. In the case of type certificates, the FAA must find that the aircraft, aircraft engine, propeller, or appliance is of proper design, material, specification, construction, and performance for safe operation, and that it (the design) meets the minimum established standards, rules, and regulations. Even though the Federal Aviation Act is quite explicit that a finding is required, the Act permits the FAA to exercise discretion (i.e., words to the effect "as the Administrator deems reasonably necessary in the interest of safety") in determining the levels of direct FAA involvement and in determining what constitutes competent evidence for making the required findings.

It is important to note that the Federal Aviation Act requires that a type certificate be issued as a prerequisite for issuing either a production certificate or an airworthiness certificate. However, a production certificate is not a prerequisite for issuing an airworthiness certificate. This all is given final meaning for enforcement purposes by Section 610(a)(1) of the Federal Aviation Act, which stipulates that it shall be unlawful for any person to operate in air commerce any civil aircraft for which there is not currently in effect an airworthiness certificate. As we will see later, the airworthiness certificate is also the prime focus for civil international aviation and the ICAO.

In the FAA airworthiness regulatory system, type certification (design approval) and production certification (manufacturing quality control system approval) are related but in fact separate and distinct program functions. The clear separation between the type design approval process and the quality control system approval process is unique to the U.S. airworthiness regulatory system. Many foreign airworthiness authorities do not have a system to separate these responsibilities.

Products may be manufactured without a production certificate under the provisions of FAR 21, Subpart F, *Production Under Type Certificate Only*, by establishing what is commonly called an *Approved Production Inspection System* (APIS). Some

manufacturers have elected to obtain an APIS by meeting the *Production Under Type Certificate Only* regulations, particularly when very slow production rates are envisioned. Under the APIS, the production process is not approved (e.g., tooling, facility layout, process specifications, etc.). The APIS, in this case, simply approves the manufacturer's quality control system, put in place to ensure that the product is manufactured to conform to its approved type design. Any processes or manufacturing procedures critical to the design are defined and approved as part of the type design configuration (i.e., under the type certificate).