



Designation: F3705 – 25

Standard Guide for Testing Detect and Avoid Systems for Unmanned Aircraft Systems¹

This standard is issued under the fixed designation F3705; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide applies to unmanned aircraft (UA) with a maximum dimension (for example, wingspan, disk diameter) ≤ 25 ft (≤ 7.68 m) operating at airspeeds below 100 kts and of any configuration or category. It is meant to be applied in a “lower risk” (low- and medium-risk airspace as described by Joint Authorities for Rulemaking on Unmanned Systems (JARUS)) airspace environment with assumed infrequent encounters with crewed aircraft; this is typically in Classes G and E airspace (below about 1200 ft (366 m) above ground level (AGL)), Classes B, C, and D (below approximately 400 ft to 500 ft (122 m to 152 m) AGL) below obstacle clearance surface (FAA Order 8260.3, as amended), or within low-altitude authorization and notification capability (LAANC) designated areas at or below the altitude specified in the facility map, or equivalent airspace internationally.

1.1.1 Traffic encountered is expected to be mixed cooperative and non-cooperative traffic, instrument flight rules (IFR), and visual flight rules (VFR) and to include mostly low-altitude flying aircraft, such as rotorcraft, small general aviation, crop dusters, ultralights, and light sport aircraft.

NOTE 1—In the context of this guide, small general aviation aircraft are defined as fixed-wing single-engine aircraft. It is important to make this distinction as later sections, which include guidance on simulation and testing, have many references to fixed-wing single-engine aircraft.

1.1.2 This scope of air traffic includes, but is not limited to, airspace where nearly all aircraft are required to be equipped and broadcast position with a cooperative surveillance system (for example, Automatic Dependent Surveillance-Broadcast (ADS-B) out broadcast within a Mode C veil regulated by the Federal Aviation Administration (FAA) by 14 CFR 91.225).

1.2 Ultimate determination of applicability will be governed by the appropriate civil aviation authority (CAA).

1.3 While some architectures may have limitations because of external conditions, this guide applies to daytime and

nighttime, as well as visual meteorological conditions (VMC) and instrument meteorological conditions (IMC).

1.4 This guide is applicable to the avoidance of crewed aircraft by unmanned aircraft systems (UAS), not UA-to-UA or primary effects of terrain/obstacle/airspace avoidance (both to be addressed in future efforts). The avoidance of unmanned aircraft by crewed aircraft is also not addressed. Likewise, birds or natural hazard (for example, weather, clouds) avoidance requirements are not addressed.

NOTE 2—Primary effects of terrain/obstacle/airspace are not considered. The secondary effects that affect the ability of the ownship to maneuver safely from intruding aircraft are considered. For example, a secondary effect may be an obstacle such as a tower in a shielded airspace that would be collided with if the ownship maneuvers into it.

1.5 In this guide, a specific detect-and-avoid (DAA) architecture is not defined and is architecture agnostic. It will, however, reference defined specific safety performance thresholds for a DAA system and present the verification process for the system to ensure safe operation.

1.6 In this guide, methods are detailed by which compliance to the requirements given in Specification **F3442/F3442M** should be demonstrated. Applicants may provide alternative guides for demonstrating compliance.

1.6.1 In this guide, the focus is on the testing of the key components of a DAA implementation, like surveillance, alerting, guidance, operator response, and so on. This takes the form of unit tests of software and hardware components, as well as fully integrated tests in simulation and real environments.

1.6.2 There exists a related topic in the form of ongoing monitoring of the performance of a fielded DAA implementation for the purposes of longitudinal testing, continual safety monitoring, maintenance, iterative improvement, and accumulation of archival data for various purposes. Aspects of the design, implementation, and testing that fall into this category are considered to be part of the topic of flight operations quality assurance (FOQA).

1.6.3 The need for and objectives of FOQA for DAA are not discussed within this guide.

1.7 This guide is expected to be used by diverse contributors or actors including, but not limited to:

¹ This guide is under the jurisdiction of ASTM Committee **F38** on Unmanned Aircraft Systems and is the direct responsibility of Subcommittee **F38.01** on Airworthiness.

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- 1.7.1 DAA system designers and integrators,
- 1.7.2 Sensor suppliers,
- 1.7.3 UA developers,
- 1.7.4 Control station designers,
- 1.7.5 UAS service suppliers, and
- 1.7.6 Flight control designers.

1.8 Except for DAA system integrators for whom all the “shalls” in this guide apply, not all aspects of this guide are universally relevant. Nonetheless, familiarity with the entire guide will inform all actors/contributors of how their contributions affect the overall DAA capability and is strongly recommended. This guide has been purposefully designed within the broader context of the ASTM Committee F38 library. When applying this guide, it is essential to consider and integrate all relevant ASTM Committee F38 standards to ensure its comprehensive and accurate implementation.

1.9 When intending to use the information provided in this guide as a means of compliance for operational or design approval, or both, it is crucial to consult with the respective oversight authorities (for example, CAA) regarding its acceptable use and application. To find out which oversight authorities have accepted this guide (in whole or in part) as an acceptable means of compliance to their regulatory requirements (hereinafter, “the Rules”), please refer to the ASTM Committee F38 webpage (www.ASTM.org/COMMITTEE/F38.htm).

1.10 *Units*—The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.11 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.12 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 When external standards, documents, or studies are referenced in this guide, the latest revision applies unless otherwise stated herein. Standards referenced should not be considered normative unless explicitly stated.

- 2.2 *ASTM Standards*:²
 - F3060 Terminology for Aircraft**
 - F3341/F3341M Terminology for Unmanned Aircraft Systems**
 - F3442/F3442M Specification for Detect and Avoid System Performance Requirements**
- 2.3 *FAA Standard*:³
 - Order 8260.3F U.S. Standard for Terminal Instrument Procedures (TERPS)**
- 2.4 *ICAO Standards*:⁴
 - Annex 10 Aeronautical Telecommunications**
 - Annex 11 Air Traffic Services**
- 2.5 *JARUS Guidelines*:⁵
 - JAR-DEL-WG6-D.04 Guidelines on Specific Operations Risk Assessment (SORA)**
- 2.6 *RTCA Standards*:⁶
 - DO-160 Environmental Conditions and Test Procedures for Airborne Equipment**
 - DO-365 Minimum Operational Performance Standards (MOPS) for Detect and Avoid (DAA) Systems**
 - DO-396 Minimum Operational Performance Standards for Airborne Collision Avoidance System sXu (ACAS sXu)**
- 2.7 *Federal Regulations*:⁷
 - 14 CFR Part 1.1 General Definitions**
 - 14 CFR Part 91.111 Operating Near Other Aircraft**
 - 14 CFR Part 91.113 Right-of-way Rules: Except Water Operations**
 - 14 CFR Part 91.117 Aircraft Speed**
 - 14 CFR Part 91.225 Automatic Dependent Surveillance-Broadcast (ADS-B) Out Equipment and Use**
 - 14 CFR Part 107.37 Operation Near Aircraft; Right-of-way Rules**
 - U.S. Public Law 112-95 Part 331 Definitions**⁸

3. Terminology

3.1 *Unique and Common Terminology*—Terminology used in multiple standards is defined in Terminologies **F3341/F3341M** and **F3060**.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

³ Available from Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, <http://www.faa.gov>.

⁴ Available from International Civil Aviation Organization, https://www.icao.int/safety/airnavigation/nationalitymarks/annexes_booklet_en.pdf.

⁵ Available from the Joint Authorities for Rulemaking of Unmanned Systems (JARUS), [jar_doc_06_jarus_sora_v2.0.pdf](http://jarus.org/jar_doc_06_jarus_sora_v2.0.pdf) (jarus-rpas.org).

⁶ Available from the Radio Technical Commission for Aeronautics (RTCA), <https://my.rtc.org>.

⁷ Available from the National Archives and Records Administration, <https://www.ecfr.gov>.

⁸ Available from <https://www.congress.gov/112/plaws/pub195/PLAW-112pub195.pdf>.