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# Standard Guide for Unmanned Aircraft System (UAS) Maintenance Technician Qualification<sup>1</sup>

This standard is issued under the fixed designation F3600; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## INTRODUCTION

This guide outlines the subject, performance, and task knowledge requirements for the repair and maintenance of UAS. Using ASTM F2909, Standard Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems, as a basis for the types of activities required to maintain UAS, it was decided that the most efficient and comprehensive approach was to determine the knowledge, skills, and abilities (KSAs) a technician would require to reliably and consistently perform these tasks outlined in this new guide.

The guide was written and organized to facilitate UAS manufacturers, operators, and educators to develop curricula for technician training that spans the spectrum of UAS, ranging from very basic multi-rotor platforms to complex aircraft integrated into the global airspace. The aircraft types addressed have been grouped into three classes of aircraft based on the level of complexity. To determine the level of instruction required to train technicians on maintenance tasks for a given aircraft type, one simply identifies the appropriate class of aircraft and refers to the KSA requirements for that class of UAS.

Great effort was taken to ensure that this guide is global in nature. While UAS regulations, standards, and other reference documents from around the world were evaluated for relevancy, specific mention of those documents' oversight requirements were not included in this guide.

## 1. Scope

1.1 The purpose of this guide is to address the fundamental subject knowledge, task performance, and task knowledge activities and functions for unmanned aircraft system professionals to be titled unmanned aircraft system technician.

1.2 Technician qualifications include:

1.2.1 Type ratings on specific systems or families of systems can draw appropriate technical content from this guide, as needed, to be applicable to specific models;

1.2.2 The minimum knowledge, skills, and abilities to perform maintenance on Class 1 UAS;

1.2.3 The minimum knowledge, skills, and abilities to perform maintenance on Class 2 UAS; and

1.2.4 The minimum knowledge, skills, and abilities to perform maintenance on Class 3 UAS.

1.3 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee F46 on Aerospace Personnel and is the direct responsibility of Subcommittee F46.06 on Autonomous and Electric Aircraft Maintenance Personnel.

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1.4 *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.*

1.5 *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 *ASTM Standards:*<sup>2</sup>

F2909 Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems

F3060 Terminology for Aircraft

F3341 Terminology for Unmanned Aircraft Systems

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

F3366 [Specification for General Maintenance Manual \(GMM\) for a small Unmanned Aircraft System \(sUAS\)](#)  
F3376 [Guide for Core Competencies for Aviation Maintenance Personnel](#)

### 3. Terminology

3.1 *Unique and Common Terminology*—Terminology used in multiple standards is defined in [F3341](#), UAS Terminology Standard and [F3060](#), Aircraft Terminology Standard. Terminology that is unique to this guide is defined in this section.

3.1.1 *unmanned aircraft system, UAS, n*—refers to the entire system to include the aircraft, control station, data links, and peripheral equipment.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *airworthiness, n*—within this guide, refers to a state of readiness whereby the system meets all manufacturer specifications for safe operations.

### 4. Significance and Use

4.1 This guide is intended to be used to assess competencies of qualified individuals who wish to become certified as a UAS Technician through a certification program.

4.2 This guide is intended to be used in concert with a certification provider's structure and materials for management, exam delivery, and candidate preparation.

4.3 This guide is intended to be used in conjunction with any civil aviation authority's (CAA's) guidance or regulations.

4.4 In this guide, a classification system is used based on the equipage of the entire UAS. The purpose of this classification

system is to train technicians on the knowledge necessary to maintain the UAS based on the equipage of the entire system. UAS Technicians are commonly responsible for maintaining not just the unmanned aircraft itself, but the control station, data links, and peripheral equipment (off-aircraft equipment) as well. As the level of complexity increases, so must the UAS Technician's scope of knowledge. This classification system is presented in [Table 1](#).

4.5 Full system classification relies on the highest classification of the individual components of the system.

4.6 This classification model is used as a guide for typical systems of a UAS, not a definitive list.

4.7 For technicians who maintain more than a single model of UAS, a class qualification is recommended ([Tables 2-4](#)).

### 5. Test Knowledge Requirements

5.1 The subject, performance, and task knowledge areas shall be assessed by levels (referenced in [Table 5](#)) of competency in the exam items.

### 6. Prerequisite Requirement

6.1 It is recommended that all aerospace maintenance technicians meet the specifications outlined in [Guide F3376](#).

### 7. Keywords

7.1 advanced aviation; certification; drone; personnel; remotely piloted aircraft system; repairman's certificate; RPAS; UAS; UAS technician; uncrewed aircraft; unmanned aircraft system; unmanned aircraft system technician

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**TABLE 1 UAS Classification System**

Components	Class 1	Class 2	Class 3
<b>Aircraft</b>			
Landing Gear	Fixed or Electronically Retracted		Fixed, or Retractable by means of Hydraulics/Pneumatics/Electronic
Braking	Throttle Control	Arresting Wire or Active Braking	
Engine	<60 V electric or fuel cell, 2-stroke	>60-599 V electric, piston, or fuel cell. Typically, 2-stroke, rotary, or modular turbine.	>599 V electric, turbine, piston
Maintenance	Maintenance is typically line-replaceable unit remove/replace airframe, propellers, or other electronic and electromechanical devices.	Maintenance includes line-replaceable unit remove/replace for most components. Repair tends to be more common than replacing airframe.	Maintenance of these systems is comparable to manned aircraft with the addition of systems unique to unmanned aircraft systems. Engines comparable to manned aircraft.
Structure	Remove and replace, some gluing of foams, or taping of composites.	Repairs of advanced composites or metal structures is common. Sanding, grinding, potting cores, elevated cures, bending, and riveting.	
<b>Control Station</b>			
Configuration	Consumer electronic devices	Portable or fixed, multi-user workstation	Portable or fixed, redundant, multi-user workstation, typically dual configurable
Software	Software relies on an application to support function, but also has the greatest variability for open systems for larger variation for configuration.	Software is typically a combination of open systems and closed systems for some flight-critical items allowing the most variation for configuration.	Software is typically a closed system designed for specific hardware devices, resembling manned aviation's approach for operations/maintenance.
Networking	Not necessary for flight	Simple networking including hubs, switches, and/or routers is generally necessary.	Computer networking and the use of hubs, switches, or routers is typical.
Maintenance	Typically cycling power or manipulating settings within a mobile app.	Maintenance is typically remove/replace for hardware components and reinstall for software. Multiple "boxes" with specialty functions may be integrated into the control station.	Maintenance requires computer troubleshooting, line-replaceable unit subcomponents, and typical aviation manuals.
Data links	Radio line-of-sight	Can be a combination of visual line-of-sight, radio line-of-sight, cellular, or satellite relay.	Communications are typically between the unmanned aircraft and control station including radio line-of-sight, cellular and/or satellite relay links, and even ground/air relay links. Mechanized, tracking antenna are common.
Handover	Atypical or simplified	Complex handover events are possible but not standard.	Complex handover events for extended operations are standard.
<b>Support Equipment</b>			
Launch	None or bungee	Typically, launcher-assisted via pneumatics/hydraulics	Typical manned aviation equipage
Recovery	None	Parachute, vertical take-off and landing (VTOL), airborne capture, rolling landing, or arresting gear.	Comparable to manned aviation
External power	Not typically used	Typically incorporates ground power units; may be electric or small combustion engine.	Typical manned aviation equipage
Engine support	No equipment typically necessary	Gas engines use fuel/defuel devices, fuel storage, external power for starting, and sometimes a unique device to help start the engine: electric pump, compressed air.	Comparable to manned aircraft
<b>Manuals</b>			
Component maintenance manual	Typically, a single manual focused on operations.	X	X
Engine maintenance manual		X	X
Aircraft maintenance manual		X	X
Illustrated Parts Catalogue		X	X

**TABLE 2 Class 1 UAS**

Knowledge Level (Table 5)	SUBJECT
<b>Fundamentals of Electricity and Electronics</b>	
2	Identify circuit protection/termination devices and demonstrate how they are used.
1	Identify the hazards for electric shocks rescue and understand procedures for obtaining first aid.
1	Identify basic procedures and terms about handling electrostatic sensitive device (ESD): electrostatic-discharge-sensitive equipment or parts, or both.
2	Apply/calculate and measure Ohm's law in direct current (DC) series and parallel circuits.
1	Apply/calculate and measure Ohm's law in alternating current (AC) series and parallel circuits.
1	Apply/calculate and measure Kirchhoff's law in DC and AC circuits.
2	Apply/calculate and measure power in series and parallel circuits.
1	Understand and identify different types of electronic filters.
2	Apply digital data bus theory to understand interconnectivity and signal flow on the UAS.
<b>Weight and Balance</b>	
2	Understand the need for and perform weight and balance.
1	Understand basic considerations for payload integration.
<b>Ground Operations and Servicing</b>	
1	Understand common ground-handling practices.
2	Define and apply foreign object elimination practices.
2	Demonstrate the use of a safety data sheet.
1	Define common facts and practices regarding fuel use and servicing in unmanned systems.
<b>Cleaning and Corrosion Control</b>	
1	Identify common aircraft corrosion.
2	Select and use the proper aircraft and component cleaning agent.
<b>Physics for Aviation</b>	
1	Understand and define different types of major operational stresses such as tension, compression, torsion, shear, and bending.
1	Understand the four forces of flight (gravity, lift, thrust, and drag).
1	Define Bernoulli's Principle.
1	Understand airframe structures and the impacts to the physics of flight.
1	Define velocity acceleration and Newton's Laws of Motion.
<b>Human Factors</b>	
2	Identify and mitigate the human factors associated with unmanned systems.
<b>Nonmetallic Structures</b>	
2	Inspect, maintain, fabricate, and repair or replace commonly used composite material structures.
<b>Flight Controls</b>	
2	Inspect, maintain, troubleshoot, and repair common unmanned fixed-wing, flight controls.
2	Inspect maintain, troubleshoot, and repair common unmanned aircraft flight control surfaces and actuators.
2	Perform aircraft rigging checks and adjustments.
<b>Airframe Inspection</b>	
2	Inspect, service, and perform minor repairs to aircraft primary structure and aircraft components in accordance with approved/accepted data.
<b>Landing Gear Systems</b>	
2	Inspect, maintain, and repair common landing gear systems.
<b>Hydraulic and Pneumatic Systems</b>	
2	Inspect and perform minor repairs and replacement (as required) of fluid lines and fittings.
<b>Communication and Navigation Systems</b>	
1	Identify basic facts regarding avionics environmental factors.
1	Identify implications of radio frequency (RF) principles in relation to UAS command and control.
2	Identify common antennae used in UAS applications and demonstrate proper mounting and bonding of antennae (ground and air based).
1	Identify hazards associated with RF transmission.
<b>Aircraft Fuel Systems</b>	
1	Inspect, maintain, service, and repair fuel systems used in unmanned aircraft (UA).
<b>Aircraft Electrical Systems</b>	
2	Troubleshoot/define electrical power conversion circuits methods.
2	Understand and troubleshoot AC power generation and distribution.
2	Inspect, troubleshoot, and repair electrical production, regulation, and distribution devices.
2	Identify, inspect, and perform EWIS maintenance and terminations.
2	Demonstrate the ability to terminate cables with common connectors and identify facts about common cables used in UAS.

**TABLE 2** *Continued*

Knowledge Level (Table 5)	SUBJECT
<b>Rotorcraft Fundamentals</b>	
2	Inspect, maintain, troubleshoot, and repair common unmanned rotary wing, aircraft components.
2	Inspect, maintain, troubleshoot, and repair common, unmanned rotary wing, flight controls.
2	Inspect, maintain, troubleshoot, and repair common unmanned rotor systems.
<b>Powerplant Theory and Maintenance</b>	
2	Inspect, maintain, troubleshoot, and repair common unmanned aircraft propulsion systems.
2	Inspection, installation, and removal of engine and accessories.
2	Inspection and troubleshooting of aircraft engine and engine instrumentation and ignition systems.
2	Inspect, maintain, troubleshoot, and repair common unmanned propellers.
<b>Command and Control</b>	
1	Describe different types of control station (CS) configurations and capabilities.
1	Understand CS airworthiness criteria.
1	Describe UAS flight management systems and modes of operation to include autonomous and semi-autonomous.
<b>Data Links</b>	
1	Understand the interdependent relationship between the control station, datalink station, and aircraft.
<b>UAS General Maintenance Actions</b>	
1	Understand the principles of UAS assembly and disassembly.
2	Inspect, maintain, troubleshoot, and repair common unmanned aircraft components.
2	Understand and apply fault isolation techniques/aircraft and ground control units.
1	Understand importance of systems check/aircraft and ground control unit.
1	Understand troubleshooting system basics and using approved procedures.
1	Understand and compare different launch and recovery systems.
1	Identify common principles of preflight and function checks for UAS.
2	Identify hazards and demonstrate basic safety practices related to the maintenance and operation of UAS.
1	Identify hazards associated with laser systems.
1	Identify sources of hazardous noise to the crew and public.
1	Identify methods used to mitigate hazardous noise.
1	Identify hazards associated with ballistic parachute systems.
2	Use industry standard test equipment (continuity tester, digital multimeter, and so forth).
<b>Fundamentals of Information Technology</b>	
1	Define and Identify computer and networking fundamentals.
1	Describe cryptology applications.
1	Understand basic concepts of cyber security.

**TABLE 3 Class 2 UAS**

Knowledge Level	SUBJECT
<b>Fundamentals of Electricity and Electronics</b>	
2	Identify circuit protection/termination devices and demonstrate how they are used.
1	Identify the hazards for electric shocks rescue and understand procedures for obtaining first aid.
1	Identify basic procedures and terms about handling ESD: electrostatic-discharge-sensitive equipment or parts, or both.
2	Apply/calculate and measure Ohm's law in DC series and parallel circuits.
2	Apply/calculate and measure Ohm's law in AC series and parallel circuits.
2	Apply/calculate and measure Kirchhoff's law in DC and AC circuits.
2	Apply/calculate and measure power in series and parallel circuits.
1	Understand and identify analog circuit and devices.
1	Understand and identify different types of power supply circuits.
1	Understand power supply circuits in relation to overall system operation.
1	Understand and identify different types of electronic filters.
1	Identify the purpose and application of oscillators.
1	Identify and understand wave-shaping circuits.
2	Identify, understand, and test analog solid-state devices.
1	Understand different types of digital numbering systems.
1	Understand, identify, and analyze different types of digital logic gates.
2	Apply digital data bus theory to understand interconnectivity and signal flow on the UAS.
<b>Weight and Balance</b>	
2	Understand the need for and perform weight and balance.
1	Understand basic considerations for payload integration.
<b>Ground Operations and Servicing</b>	
2	Understand common ground handling practices.
2	Define and apply foreign object elimination practices.
2	Demonstrate the use of a safety data sheet.
3	Securing the aircraft after assembly.
1	Define common facts and practices regarding fuel use and servicing in unmanned systems.
<b>Cleaning and Corrosion Control</b>	
1	Identify common aircraft corrosion.
2	Select and use the proper aircraft and component cleaning agent.
<b>Physics for Aviation</b>	
1	Understand and define different types of major operational stresses such as tension, compression, torsion, shear, and bending.
2	Understand the four forces of flight (gravity, lift, thrust, and drag).
1	Define Bernoulli's Principle.
1	Understand airframe structures and the impacts to the physics of flight.
1	Define velocity acceleration and Newton's Laws of Motion.
<b>Human Factors</b>	
2	Identify and mitigate the human factors associated with unmanned systems.
<b>Metallic Structures</b>	
2	Inspect, maintain, fabricate, and repair or replace basic metallic structures.
<b>Nonmetallic Structures</b>	
2	Inspect, maintain, fabricate, and repair or replace commonly used composite material structures.
<b>Flight Controls</b>	
2	Inspect, maintain, troubleshoot, and repair common unmanned fixed-wing, flight controls.
2	Inspect, maintain, troubleshoot, and repair common unmanned aircraft flight control surfaces and actuators.
2	Perform aircraft rigging checks and adjustments.
<b>Airframe Inspection</b>	
2	Inspect, service, and perform minor repairs to aircraft primary structure and aircraft components in accordance with approved/accepted data.
<b>Landing Gear Systems</b>	
2	Inspect, service, and maintain aircraft landing gear systems (including retractable gear and skid systems), wheels, brakes, and tires.
<b>Hydraulic and Pneumatic Systems</b>	
3	Inspect and perform minor repairs and replacement (as required) of fluid lines and fittings.
1	Understand hazards related to compressed gases.
<b>Communication and Navigation Systems</b>	
1	Identify basic facts regarding avionics environmental factors.
1	Identify basic facts and terms about flight monitoring systems.
1	Identify implications of RF principles in relation to UAS command and control.
2	Identify common antennae used in UAS applications and demonstrate proper mounting and bonding of antennae (ground and air based).
1	Identify hazards associated with RF transmission.
1	Understand the hazards association with ground operation of airborne weather radar for UAS.

**TABLE 3** *Continued*

Knowledge Level	SUBJECT
<b>Aircraft Fuel Systems</b>	
2	Inspect, maintain, service, and repair fuel systems used in UA.
<b>Aircraft Electrical Systems</b>	
2	Troubleshoot/define electrical power conversion circuits methods.
2	Understand and troubleshoot AC power generation and distribution.
2	Inspect, troubleshoot, and repair electrical production, regulation, and distribution devices.
2	Identify, inspect, and perform EWIS maintenance and terminations.
2	Demonstrate the ability to terminate cables with common connectors and identify facts about common cables used in UAS.
<b>Rotorcraft Fundamentals</b>	
2	Inspect, maintain, troubleshoot, and repair common unmanned rotary wing, aircraft components.
2	Inspect, maintain, troubleshoot, and repair common, unmanned rotary wing, flight controls.
2	Inspect, maintain, troubleshoot, and repair common unmanned rotor systems.
<b>Powerplant Theory and Maintenance</b>	
2	Inspect, maintain, troubleshoot, and repair common unmanned aircraft propulsion systems.
2	Inspection, installation, and removal of engine and accessories.
2	Inspection and troubleshooting of aircraft engine and engine instrumentation and ignition systems.
2	Inspect, maintain, troubleshoot, and repair common unmanned propellers.
<b>Command and Control</b>	
1	Identify and understand control station power generation.
1	Describe common UAS maintenance terminals/workstation.
1	Describe different control modes and levels of interoperability.
1	Describe different types of CS configurations and capabilities.
1	Understand CS airworthiness criteria.
1	Describe UAS flight management systems and modes of operation to include autonomous and semi-autonomous.
1	Identify common CS operational checks performed as part of a preflight.
<b>Data Links</b>	
1	Understand the interdependent relationship between the CS, datalink station, and aircraft.
<b>UAS General Maintenance Actions</b>	
1	Understand the principles of UAS assembly and disassembly.
1	Understand theory of preflight inspection/aircraft and ground control unit.
2	Inspect, maintain, troubleshoot, and repair common unmanned aircraft components.
2	Understand and apply fault isolation techniques/aircraft and ground control units.
1	Understand importance of systems check/aircraft and ground control unit.
1	Understand troubleshooting system basics and using approved procedures.
1	Understand and compare different launch and recovery systems.
1	Identify common principles of preflight and function checks for UAS.
2	Identify hazards and demonstrate basic safety practices related to the maintenance and operation of UAS.
1	Identify hazards associated with laser systems.
1	Identify sources of hazardous noise to the crew and public.
1	Identify methods used to mitigate hazardous noise.
1	Identify hazards associated with ballistic parachute systems.
2	Use industry standard test equipment (continuity tester, digital multimeter, and so forth).
2	Use specialized test equipment (oscilloscope, function generator, signal analyzer, and so forth).
2	Use aviation test equipment (pitot static tester, transponder tester, and so forth).
<b>Fundamentals of Information Technology</b>	
1	Define and identify computer and networking fundamentals.
1	Describe cryptology applications.
1	Identify different types of network fault isolation.
1	Describe network management.
1	Understand basic concepts of cyber security.
1	Describe differences and similarities between public and private networks.