HSAC UNMANNED AERIAL SYSTEMS GUIDELINES

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PREFACE

An upsurge in commercial Remotely Piloted Aircraft (RPA) activity and an ever-increasing number of manufacturers and operators led to the establishment of these guidelines for Remotely Piloted Aircraft Systems (RPAS, also referred to as Unmanned Aircraft Systems or UAS). The original version, *HSAC RP UASRP 15-1*, was adopted in February 2015. At that time, it was possibly the only guideline document for commercial use of RPAS, and certainly the most comprehensive. Today it remains as relevant as it was then and is especially appropriate for operations that may take place in a higher risk environment.

Since the original release, the RPAS industry has exploded and there are now dozens of industry standards. Some cover only specific applications while others are more generally applicable but only cover specific topics, e.g., Operational Risk Assessment, Training Materials, etc. Several of the new standards are referenced in these guidelines.

At the time of the first release, commercial RPAS operations in the US required special authorization[1] from the FAA with each applicant having to submit what was essentially a safety case for specific operations. In December 2020, an update to 14CFR FAR §107 FAA regulations governing RPAS under 55 pounds became effective.

KEY TERMS

A few terms used in this document should be clarified up-front. Also see the *Definitions* section at the end of the document.

[1] As per the FAA Reauthorization Act of 2012, Section 333.

Competent Aviation Authority	A person in the organization that is operating or subcontracting the RPAS work who has been designated as having the authority to approve or disapprove RPAS operations. Typical titles for these positions are Aviation Technical Advisor (ATA), Operations Director or Chief Pilot. When an organization is performing its own operations, the Competent Aviation Authority with be part of that organization. When operations are subcontracted, the Competent Aviation Authority will be part of the contracting organization.
Governing Aviation Authority (GAA)	A generic term referring to countries' government aviation regulatory authority for aviation, i.e., CASA in Australia, the FAA in the United States, Transport Canada in Canada, etc. (Note that the term *Civil Aviation Authority* (CAA) is often used as a generic term with the same meaning and is also the name of specific countries' GAAs, e.g., the UK's aviation authority is called the Civil Aviation Authority. We use Governing Aviation Authority here to avoid confusion with specific countries' CAAs.)
Remotely Piloted Aircraft (RPA)	This term is used synonymously with Unmanned Aerial Vehicle (UAV). ICAO's definition of RPA is, "An aircraft where the flying pilot is not on board the aircraft."[2]
Remotely Piloted Aircraft Systems (RPAS)	This term is used synonymously with Unmanned Aircraft Systems (UAS) and its usage is becoming more common. It highlights the fact that a person is piloting the aircraft, albeit remotely, in contrast to fully autonomous flight. ICAO's definition of RPAS is, "A set of configurable elements consisting of a remotely-piloted aircraft, its associated control station(s), the required command and control links and any other system elements as may be required, at any point during flight operation."[3]
Safety Case	An explanation of why an operation is safe. Exceptions to regulations or standards often require approval of a Safety Case by the regulatory authority and/or the Competent Aviation Authority. The level of complexity of the safety case should be commensurate with the risk and complexity of the operation. A safety case for allowing a minor exception to a standard in a low-risk operation may only require a page or two laying out why the exception does not add any notable risk.

[2] ICAO Circular 328 AN/190

[3] ICAO Cir 328 AN/190

	Other exceptions may require a rigorous formal approach including a Concept of Operations (CONOPS) and Operational Risk Assessment (ORA). Standards for ORAs include: a. JARUS Guidelines on Specific Operation Risk Assessment (SORA). b. ASTM F3178-16 Standard Practice for Operational Risk Assessment of Small Unmanned Aircraft Systems (sUAS).

PURPOSE

To serve as a basis for:

- Developing further guidelines or internal company standards, and
- Evaluating and managing service providers.

SCOPE

These guidelines consider the entire system, not just the aircraft itself. They are not exhaustive, nor should they be considered the only source of reference.

BASICS

1. A RPAS has four subsystems:
    a. Aircraft
    b. Data links (control and downlink(sensor))
    c. Ground control equipment
    d. Pilot/Operator
2. RPAS can vary in size from those weighing less than a pound to some the size of a commercial jet. Regardless of the size, the basic guidelines outlined below should be considered.
3. RPAS may be controlled manually by a pilot or autonomously through use of programing and autopilot. Semi-autonomous operation is also common, where the RPAS's flight path is programmed, but the Remote Pilot in Command (RPIC) manually controls some phases of flight such as takeoff and landing.
4. In general, RPAS operations can occur:
    a. Within visual line of sight (VLOS)
    b. Within extended visual line of sight (EVLOS) (yet still within electronic line of sight of the ground control station)
    c. Beyond visual line of sight (BVLOS)

    These three types of operations are discussed later in this document and in the appendices.

GENERAL RULES

Regulatory Compliance and Related Guidance

1. RPAS should be operated in accordance with all applicable local, state, and federal regulatory requirements, including especially:

a. The aviation regulations of the country operations are taking place in[4]
b. Any conditions or limitations of GAA-issued Operating Certificates, Certificates of Waiver and Authorization, etc., when operating under such certificates
c. Applicable federal, state and local environmental laws
d. Applicable privacy laws - note that these vary significantly between different states/provinces, boroughs/counties, and towns/cities

2. Offshore RPAS operations should comply with the requirements above as well as any other regulations for the area of operation.[5]
3. Offshore RPAS operations outside a county's territorial waters (i.e., beyond the 12NM limit) should be compliant with *ICAO 10019 Manual on Remotely Piloted Aircraft Systems AN/507*.[6]
4. Operators should maintain documentation of system operating certification (where applicable), including flight operations manual, maintenance manual/log, aircraft flight manuals and pilot certifications issued by the Governing Aviation Authority (GAA)[7] as required for each operation. These documents should be available for reference at the point of control of the RPAS operation.
5. The following guidelines reflect the regulations governing RPAS in some countries, but should be followed whether required by GAAs or not:
    a. **In situations where manned aircraft pose a potential conflict with RPAS operations, manned aircraft have the right-of way and RPAS operations should be terminated until the potential conflict has passed.**[8]
    b. All RPAS operations should be controlled by a Pilot in Command (PIC).[9] Completely autonomous RPAS operations should not be conducted.
    c. RPAS operations should be conducted with anti-collision lighting:[10]
        i. When operating during civil twilight or night
        ii. When operating in controlled airspace
        iii. When operating within 3NM of an aerodrome
        iv. Preferably at all times
    d. Operations should not be conducted (or should be ceased) when visibility is less than 3 miles from the control station.[11]
    e. RPAS should not be flown less than 500' below or within 2000' horizontally of any clouds.[12]
    f. Operations should not be conducted above 400 feet above ground level or, when flying within 400 feet of a structure, not more than 400 feet above that structure.[13] Where the success of the

[4] Australia: CASR Part 101; Canada: SOR-96-433 Part IX; UK: CAP 722; USA: For RPAS weighing less than 55lbs, 14CFR Part 107, or for heavier RPAS, the provisions of a USC 49 §44807 Certificate of Authorization (COA)
[5] USA: Applicable USCG and BSEE requirements for offshore work.
[6] USA: neither FAA Part 107 nor USC 49 §44807 COAs apply beyond the 12 nm limit.
[7] USA: FAA- issued Remote Pilot Certificate
[8] USA: FAR §107.37(a) requires this, but it is waivable under §107.205 (f). Such waivers should not be sought.
[9] USA: FAR §107.19 (a)
[10] USA: FAR §107. 29(b) requires anti-collision lights only during civil twilight. FAA Final Rule for Operation of sUAS Over People modifies FAR §107 and allows night operations with updated initial or recurrent pilot testing and anti-collision lighting requirements.
[11] USA: FAR §107.51(c)
[12] USA: FAR §10751(d)
[13] Canada: SOR 96-433 §901.25 (1); USA: FAR §107.51(b) specifies higher limits for flying above structures, but the limits in these guidelines should be followed.

operation requires flight at higher altitudes, a waiver from the applicable regulation should be obtained and a safety case should be presented for approval to the Competent Aviation Authority.

g. RPAS speed should not exceed 100 mph (87 knots).[14]
h. RPAS should not be flown over anyone who is not directly participating in the operation. Ensure compliance to any regulatory and OEM kinetic energy limits when operating around people.
i. RPAS should not be operated from a moving vehicle unless the operation is over a sparsely populated area.[15]
j. Hazardous materials should never be carried aboard RPAS.[16]
k. Appropriate air traffic control should be immediately notified in the event of any emergency, loss of command link, loss of visual contact, or any other malfunction that would impact safety or operations.

Airworthiness

1. RPAS should be accepted as being airworthy by the Competent Aviation Authority. Guidance on how to make this determination can be found in *Appendix A - Determination of Airworthiness*.
2. RPAS should be maintained in an airworthy condition under a continuing airworthiness program. See the *Maintenance* section later in this document for more information.
3. Automatic flight termination and/or flight recovery systems should be considered as determined by the safety case
4. RPAS should provide the operator with status of the aircraft to include at least:
    a. An indication of remaining power (this can be indirect, such as throttle required to maintain altitude, etc.)
    b. An indication of the command-and-control radio link quality
    c. An indication of the quality of the GPS signal if GPS is used
    d. When any of (a), (b) or (c) are in states that could adversely affect the flight, the system should alert the operator
    e. An indication of whether the RPA is in a normal or other state, i.e., executing a return-to-base, etc. If the system leaves the normal state other than by operator command, the system should alert the operator
    f. Position and altitude of the RPA
5. RPAS should be painted, marked and/or lit to be highly visible.
6. For some operating environments, RPAS with Detect and Avoid systems should be considered. See *Appendix B - Detect and Avoid Systems* for more information.

Safety Management System

1. The RPAS operator should have in place a Safety Management System (SMS) applicable to RPAS operations.[17]

[14] USA: FAR §107.51(a)
[15] USA: FAR §107.25
[16] USA: FAR §107.36; definition of hazardous material is in 49 CFR §171.8
[17] Although many of the elements in these RPAS guidelines can be incorporated directly into a Safety Management System, they do not constitute a complete SMS. The RPAS operator should maintain a comprehensive SMS that seamlessly integrates RPAS operations.

2. The SMS should be consistent with International Association of Oil and Gas Producers (IOGP) Report 590, May 2017 - Aircraft Management Guidelines §590-B and include all SMS elements found in ICAO Annex 19 Appendix 2.
3. The pilot selection process should be embedded in the SMS (or referenced in the SMS if it is in a separate document).
4. The Quality Assurance program should be utilized as a part of the overall safety management system (SMS) and appropriate for the size of the organization.
5. The Policy section of the SMS should include an item prohibiting anyone to act as a crew member who is under the influence of alcohol or a drug that affects the person's faculties contrary to safety. Suggested limits on alcohol consumption are (a) no consumption within 8 hours prior to duty, and (b) a blood alcohol concentration no greater than 0.04 grams/deciliter per 210ml of breath.[18]

Operations Manual

1. All operators should have a flight operations manual accepted by the Competent Aviation Authority. At a minimum, the manual should include:
   a) Procedures and checklist information for pre-flight, in flight, post flight, emergency procedures;
   b) Limitations;
   c) Information on aircraft systems and performance;
   d) Detailed RPAS type training and recurrent training policies and adequate systems in place for undertaking periodic competency checks for each RPAS operative grade/team member;
   e) A fatigue management program for flight crew (see more on this in the OPERATIONS section below).

Hazard Identification and Risk Assessment

Hazard Register / Hazard Reporting

1. The RPAS operator should have an established hazard register and hazard identification process (pre-flight, during and post-flight).
2. The RPAS operator should have a hazard reporting system allowing personnel to report any type of hazard, anonymously if so desired.
3. All identified hazards should be addressed through processes defined in the SMS.

Operation Risk Assessment

1. A hazard analysis should be completed prior to beginning flight operations in a new location, when the work environment changes (e.g. new structures, SIMOPS, etc.), or when a new RPAS is employed at an existing location.
   a) The RPAS operations team, assisted by the site manager, should obtain a full and detailed information about the site/installation/MODU/vessel to familiarize themselves with the layout, topography, processes and hazardous areas
   b) The main risks of the overall operation as well as those of each specific task (taking into account the ongoing activity at/on the installation) should be identified, documented and mitigated, as appropriate

[18] Based on US 14CFR §91.17 (a)

c) All risks should be evaluated according to a Risk Assessment Matrix (RAM), and the results of any risk controls should be evaluated through a Gap Analysis process.
   i) Detailed guidance on risk assessment processes can be found in:
      (1) IOGP Report 590, May 2017 - Aircraft Management Guidelines §590-B (4) Hazard/Risk Management process provides detailed guidance on this process
      (2) JARUS JAR-DEL-WG6-D.04 Specific Operations Risk Assessment (SORA)
      (3) ASTM F3178-16 Standard Practice for Operational Risk Assessment of Small Unmanned Aircraft Systems

Incident Reporting

1. The RPAS operators should have an incident reporting system that tracks and reports all mishaps, potential mishaps, control link events, and near misses. This system should provide for analysis and improvements made as a part of the operator's Safety Management System (SMS). All mishaps, incidents and anomalies should be tracked and reported to the respective entity's aviation advisor and civilian aviation authorities when necessary.

Intrinsic Safety

1. When RPAS may be operated in the vicinity of facilities where explosive vapors could be present, the business line organization chartering or operating the RPAS should consider the level of intrinsic safety required. This should be included in the risk assessment.
2. Hazards associated with the design and operation of the RPAS airframe and payload should also be identified and mitigated, as appropriate. For example, RPAS motors, electrical and electronic equipment are not intrinsically safe.
3. Gas detection sensors/alarms should be considered for use around area of operation of RPAS.

Offshore / Helideck Operations

Note for Offshore Operations in the Gulf of Mexico:
The BSEE and USCG should be notified if the helideck will be closed or open during UAS operations.

Notifying BSEE directly of UAS operations may allow the scheduling/rescheduling of inspections to avoid facilities that have ongoing UAS operations. The HSAC NOTAM guidance and other applicable Recommended Practices should be adhered to for UAS operations that could pose a potential hazard to manned aircraft operations.

Fatigue Management

1. Crew rest and crew mission day requirements, including consecutive days worked should be consistent with the International Association of Oil and Gas Producer's (IOGP) Aircraft Management Guidelines (AMG) 590-D §1.6 and compliant with applicable regulatory requirements. At a minimum,
   a. No PIC or reserve pilot should be at the controls of an RPAS for more than eight (8) hours in one day to include no longer than three (3) hours in succession
   b. RPAS crews should have the opportunity of no less than ten (10) hours of uninterrupted rest prior to flight operations

c. Crew mission day should not exceed 14 hours
d. RPAS service providers should have a comprehensive aircrew fatigue management program as a part of their Safety Management Systems or Operations Manual, applicable to all aircrew (including the visual observer)

Certificates of Insurance

1. The organization chartering or operating the RPAS should determine whether the level of insurance covering the operation is in line with that organization's risk management guidelines. Note that general liability policies usually do not cover aviation operations.

Management of Change

1. Each organization should have a management of change process that defines standard actions and responsible parties for key changes in personnel, equipment, or mission.

Audits

1. The Competent Aviation Authority should ensure that internal and subcontracted operators have passed aviation safety audits.
2. Initial audits should be performed prior to commencement of operations, then at least once per year, or as appropriate for the organization.
3. These audits should be carried out by qualified and competent in-house or third-party auditors using as a basis, the processes set out in *IOGP Report 590, May 2017 – Aircraft Management Guidelines §590-B (6)*.
4. Audits should include verification that the operations group complies with these guidelines.

CREW

Qualifications

Pilots

1. All RPAS pilots should hold a pilot license/certificate appropriate to the type of operation to be conducted, issued by the GAA where available. In countries where the GAA does not issue such credentials, pilots should be trained and evaluated to a standard that meets or exceed the requirements of an ICAO Member State where RPAS licenses or certificates are issued.[19]
2. Pilot experience required should depend on the risk level of the operation.
    a. For the lowest risk, least complex operations, pilots should have at least 5 hours as PIC
    b. Required experience should increase with the risk and complexity of the operation
3. Additionally, for higher risk or specialized operations, consider requiring that the PIC hold a Private or Commercial pilot license/certificate possibly with an instrument rating.
4. For further guidance, see *Appendix C - Recommendations on Additional Crew Qualifications*.

Visual Observers

1. Visual Observers (VOs) should be trained in areas such as:

[19] e.g., Canada: SOR-96-433 §901.55, §901.64; USA: FAR §107 Subpart B

a. Crew Resource Management
b. Aviation terminology
c. Visual Flight Rules (VFR)
d. Airspace requirements
e. Applicable aviation regulatory requirements

2. The training required for visual observers may depend on the environment and type of operation; for example, there may not be a need to train VOs in aviation terminology in situations where aviation-band radios are not necessary.

Medical

1. Operations should only be allowed if all crew members (pilots, visual observers and payload operators if applicable) assert that they are in physical and mental condition sufficient to perform their duties in the environment of the operation to be conducted. For further guidance, see *Appendix C - Recommendations on Additional Crew Qualifications*.

Recency

1. RPAS operators should provide documentation showing the pilots maintain an appropriate level of recent pilot experience in the RPAS being operated or in a flight simulation training device (FSTD).
    a. At a minimum, the RPAS Pilot(s) should conduct three takeoffs (launch) and three landings (recovery) in the specific RPAS make and model within the previous 90 days, or as prescribed by the operator/applicant's recurrent training and currency program

Mobility & Non-Aviation Qualifications

1. All RPAS crew members:
    a. Should meet necessary mobility requirements
    b. Should be in possession of valid and up to date certificates required for access to the area of operations where applicable, e.g., TWIC, BOSIET, HUET, Offshore medical

Exceptions

1. Exceptions to the qualifications in this section may be made upon approval of the Competent Aviation Authority after reviewing a safety case submitted by the operator.
    a. The safety case should consider among other things:
        i. Applicable civil aviation regulations and other legal requirements
        ii. The potential for the RPAS to interact with manned aircraft
        iii. The size and capability of the RPAS
        iv. The risk of the overall operation
        v. Company policies, e.g., regarding Mobility & Non-Aviation Qualifications
    b. When airspace and/or traffic separation are concerns, a commercial/instrument pilot's assessment of the airspace, risks and recommended mitigations should be included in the safety case

Training

1. In addition to the training required for a pilot certificate, RPAS PICs should have the following training (or GAA-recognized equivalent):

a. Crew Resource Management;
b. Normal, abnormal, and emergency procedures in all specific details of the RPAS being operated
c. Manufacturer-specific training (or a GAA accepted equivalent);
d. Night training as required;
e. Demonstrated proficiency in both day and night flight operations as appropriate;
f. Defined interval testing on the RPAS being operated (i.e., semi-annual, quarterly, etc.)

2. RPAS pilots should meet applicable GAA training and testing requirements for each class or type of RPAS they will operate. The licensing should be appropriate and as required by aircraft type certification or determination of airworthiness. RPAS type or class ratings may be determined on the basis of individual type in the case of larger aircraft, or by class for smaller ones under 55 pounds.
3. All operators should have a training program to verify the air crew and observers meet the applicable GAA requirements. The training program should be appropriate for each aircrew role, the environment and mission the operator is expected to perform and consider:
    a. The RPAS operator should structure their training and competence assessment policies to embrace both modular fixed experience (hours based) and integrated ab-initio training (competency based)
    b. The RPAS operator should maintain an up-to-date record of qualifications, training and competence assessments for each individual RPAS pilot/crew member assigned to RPAS duties. The training program at a minimum should cover currency, evaluation, emergency procedure
    c. Training requirements should exist for the specific RPAS on unmanned vehicles over 55 pounds maximum takeoff weight (MTOW), however training programs on RPAS under 55 pounds MTOW can be designed for similar types of systems (i.e., quadcopters under five pounds)
    d. Training programs should comply or be consistent with manufacturer's recommended training programs
4. A member of the RPAS operations team should attend a formal permit to work training course (e.g., OPITO VO TRAINING).

OPERATIONS

General

Visual Line of Sight

1. Operations should generally be conducted within Visual Line of Sight (VLOS). VLOS means that the PIC and visual observer are able to maintain direct, unaided (other than corrective lenses) visual contact with the unmanned aircraft sufficient to monitor its flight path in relation to other aircraft, persons, vessels, vehicles and structures for the purpose of avoiding collisions.
2. Operations within VLOS operations are normally accepted out to a maximum distance of one-quarter nautical mile horizontally and 400 ft. vertically from the RPAS pilot, depending on the size and visibility of

the aircraft.

3. Operations not within VLOS may be conducted under certain circumstances. See *Appendix D – Extended Visual Line of Sight Operations* or *Appendix E – Beyond Visual Line of Sight Operations* for more information.

Visual Observers

1. All RPAS operations (including night operations), except those Beyond Visual Line of Sight, which are discussed in *or Appendix E – Beyond Visual Line of Sight Operations*, should utilize one or more trained visual observers to assist the PIC with see-and-avoid responsibilities by scanning the area around the aircraft for intruder traffic and assisting the PIC with navigational awareness.
2. The visual observer(s) should have a reliable method of instantaneous communications with the PIC such as two-way radios. Cellular phones are not considered reliable for this purpose.
3. The PIC and visual observer(s) together should have a view of the area that is sufficient to allow enough time for the PIC to de-conflict as required.
4. Visual observers should:
    a. Be designated as such and not share in any other duties associated with the flight
    b. Be in communication with PIC either within speaking distance or with a portable radio
    c. Establish an observation position having a clear view of the RPAS operating area
    d. Be briefed on the hazards specific to the flight, their duties as VO, lost link procedures and procedures for lost communications with the PIC (when radios are used) prior to the flight
    e. Continuously scan the airspace for, and keep the pilot informed of, possible collision hazards such as aircraft, power lines, crane/venting booms, birds, approaching workboats (when working underneath an offshore facility) and weather conditions
5. When multiple visual observers are being used, it is important for the PIC to know which visual observer(s) have direct visual contact on the aircraft.
6. Visual Observers should only be responsible for observing one aircraft at a time.

Supplemental Pilots

1. Supplemental pilots are those pilots assigned RPAS flight duty to augment the PIC. It is possible for operators to have both an internal and an external RPAS pilot. The supplemental pilot can assume either of these positions.

Lost Link Procedures

1. There are many acceptable approaches to satisfy lost link requirements. The intent of any lost link procedure is to ensure airborne operations remain predictable.
2. Lost link procedures should comply with any regulatory requirements and the lost link solution will need to comply with the last Air Traffic Control (ATC) clearance if applicable.
3. The appropriate ATC facility should be notified immediately if applicable.
4. Lost link procedures should avoid flight over any populated areas and hazards, as well as any frequently travelled flight paths.
5. Lost link procedures should ensure that the aircraft can be safely recovered.
6. The time and duration of each lost link event should be recorded by the operator and reported through the incident reporting process.

7. The designated return site should be clear of any personnel and hazards in the event of an immediate lost link return to base and landing.

Weather Observation

1. A reliable method of determining wind speed, ceiling and visibility should be used.
2. Weather observations should be taken near enough to the operation that it is certain that they are valid; for example, an airport's observations can be used if the airport is within several miles and the conditions appear to be uniform.
3. Ceiling may be determined by the temperature/dew point spread.

Sterile Cockpit

1. RPAS operations should be conducted with sterile cockpit procedures active during critical phases of flight. These include taxi and ground operations involving aircraft movement, take-off and landing, as well as all other flight operations in which safety or mission accomplishment might be compromised by distractions.

Cell Phones, etc.

1. The use of cell phones and other electronic devices during flight operations should be restricted to any required communications with Air Traffic Control and other communications pertinent the operational control of the RPAS. Cell phones should not be used as the primary means of communication between visual observers and pilots.

Aircraft-Band Radio Communications

1. Radio communications with air traffic control agencies or manned aircraft are generally not required when operating in uncontrolled airspace. In cases where communications over an aircraft-band VHF radio are required, such as when flying in controlled airspace near an airport, the agency issuing the authorization to fly will specify the requirement and include any procedures or restrictions for use.

Operation of Multiple Aircraft

2. Where allowed by the GAA, a PIC may control more than one RPA, depending on the level of autonomy.[20]

Notifications

1. When required, UAS Operating Area (UOA) NOTAMS should be filed online (https://www.1800wxbrief.com/Website/uoa) at least 24 hours prior to the operation, or through the LAANC system.

Standby Equipment

Especially for operations other than at very low risk levels, consider keeping standby equipment at the control station such as:

1. Backup Ground Control Station (GCS)
2. Backup communications equipment for the GCS-RPA link, including transmitters, cables, and antennae
3. Backup power systems

[20] USA: requires a waiver from FAR §107.35

GPS Service Availability Prediction

1. Consider checking for predicted GPS outages up to 24 hours in advance of operations.[21]

Materials Handling

1. All RPAS operators should be equipped with any specialized equipment that may be required in the event of a mishap. For example, some composite material may require specific handling and equipment when the integrity of the composite is compromised.

Battery Handling

1. All RPAS operators should have a battery safety program that is consistent with battery OEM user's manual and includes:
    a. Readily available Material Safety Data Sheets and other documentation such as manufacturer's recommended charging procedures, storage, and operating temperatures, etc.
    b. Battery charging procedures that ensure safety in the case of a battery fire, e.g., in fire-proof containers, or when in the field, away from people, equipment, brush/trees, etc.
    c. Battery storage plans that include storage in fireproof containers
    d. Battery inspection procedures and requirements
    e. Method(s) to determine battery charge
    f. Procedures for thermal runaway
    g. Recommended procedures for safe transportation of the batteries that are compliant with applicable regulations and work site requirements:
        i. Equipment classified as dangerous goods should be transported in accordance with FAA, IATA regulations for air cargo, and International Maritime Dangerous Goods regulations for marine cargo transfers
2. RPAS operators should log information about each battery by serial number, consider including:
    a. When charging, date, initial and final charge state
        i. If available, wattage and number of milliamp-hours used to charge
    b. When flying, date, initial and final charge state
    c. When draining (e.g., for long-term storage or transport); method used to drain, date, initial and final charge states

Concept of Operations

1. Consider requiring the operator to submit for approval a Concept of Operations (CONOPS) for operations:
    a. At a new site or a site which has changed significantly since a previous CONOPS was developed
    b. Using a significantly different RPAS or sensors
    c. Significantly different than previous operations at that site in any other way
2. The level of complexity of the CONOPS should be commensurate with the risk and complexity of the operation.
3. A standard for CONOPS is contained in Section 6 of ASTM F3178-16 Standard Practice for Operational

[21] USA: https://sapt.faa.gov/default.php provides a tool capable of doing this

Risk Assessment of Small Unmanned Aircraft Systems (sUAS).

4. See also the *Preflight Planning* section below. Much of the information specified there would be documented in a CONOPS.

Night Operations

1. Night operations may be considered if the operator provides a safety case and sufficient mitigation to avoid collision hazards at night.
2. Night operations in many countries require special authorization from the GAA.[22]
3. External pilots and observers should be in place 30 minutes prior to night operations to ensure dark adaptation.
4. The remote pilot in command must meet GAA night operations training requirements, such as an initial knowledge test or online recurrent training, and
5. The small, unmanned aircraft must have lighted anti-collision lighting visible for at least three (3) statute miles that has a flash rate sufficient to avoid a collision.
6.

Preflight Procedures

Pre-flight Planning

1. At a minimum, pre-flight planning should include the following:
   a) Determine airspace type and restrictions (i.e., VFR corridors, TFRs, MOAs etc.)
   b) Determine distance and direction to nearest aerodromes/heliports, associated restrictions
      i) If within 5NM of an airport, determine approaches, departures, traffic patterns, expected traffic and precautions to be taken
   c) Determine and verify a method of communications with ATC for required notifications such as lost link and if required, pre-launch and post-landing, i.e., verify that ATC phone number and/or VHF frequency is available and that the crew has a communications method that will be reliable and effective from the operations site
      i) Note that hand-held VHF radios typically transmit at very low powers and cannot be used effectively to transmit ground-to-ground or over any significant distance
   d) Determine method of contacting emergency personnel in the area, e.g., fire, ambulance, etc.
   e) Identify other hazards unique to the mission and mitigations including at least:
      i) Potential sources of radio interference
      ii) Obstacles
      iii) Expected wildlife (e.g., birds)
   f) Identify any environmental or privacy laws applicable to the mission and plan accordingly
   g) Identify public or residential areas near the flight path and mitigations for potential hazards, noise abatement and/or privacy issues
   h) Determine likelihood of people not associated with the mission passing under or near the flight path and determine mitigations
   i) Estimate flight durations and fuel/battery requirements

[22] USA: waiver to FAR §107.29

j) Verify that weight and balance will be within limits specified by the manufacturer and that the weight will be within regulatory limits
k) Ensure that procedures are established for:[23]
   i) lost-link/return-to-base, ensuring that the RPA's flight path will not create a hazard
   ii) control station failure, including power, transceivers, cables, and antennas[24]
   iii) early termination of the flight
   iv) aircraft failure in-flight
   v) fly-away
l) Determine launch, landing and alternate landing sites including a method to ensure that the landing sites remain free of people, vehicles, etc. during the flight
m) Check weather
n) Check NOTAMs
o) File NOTAM(s) if applicable

2. Most of the information in (1) other than weather and current NOTAMS could be documented in a CONOPS (see the section on *Concept of Operations* above).

Pre-flight Brief

1. All RPAS operations should include a pre-flight brief. The briefing should include at a minimum:
   a. Mission overview, including at least mission altitude and flight path and risk assessment to include site specific safety requirements
   b. Role designations and duties (PIC, VOs, etc.)
   c. Permit to Work (if applicable)
   d. Airspace and restrictions, including for nearby airports and expected traffic
   e. GAA waivers and associated requirements or limitations (if applicable)
   f. Applicable NOTAMs, both for the current operation and those filed by other users of the airspace
   g. FSS/ATC notifications as required.
   h. De-confliction plans for intruding aircraft
   i. Aviation-band frequencies to be used
   j. If visual observers will be communicating with the PIC by radio, frequencies to be used for those radios
   k. Hazards unique to the mission
   l. Environmental, noise and/or privacy issues
   m. Weather (current and forecast ceiling, visibility and winds)
   n. Lost Link, divert and flight termination procedures
   o. Flight time and fuel/battery requirements
   p. Fuel reserves/minimum voltage requirements
   q. Location of any emergency equipment

[23] Canada: SOR 96-433 §901.23 (1)(b)
[24] Options include letting the RPAS execute a pre-programmed return-to-base, activating backup components and continuing the flight, etc.

Pre-Flight Actions

1. Immediately prior to each launch, the PIC should:
    a. Perform a pre-flight inspection/checklist
    b. Validate firmware
    c. Visually inspect airframe condition
    d. Run system diagnostics
    e. Conduct engine run test
    f. Check battery, sensors, GPS signal strength, command-and-control link, etc.
    g. Verify positions of, and communications with, the visual observer(s)
    h. Announce intention to launch on appropriate aircraft-band frequency if applicable
    i. Confirm no persons, vehicles or obstacles have entered the launch/landing area(s)
    j. Confirm that there is no conflicting air traffic

MAINTENANCE

Maintenance Programs

A maintenance program should be in place to ensure that, for each aircraft type, the manufacturer's Maintenance Manuals, Instructions for Continued Airworthiness, Service Bulletins, recommended inspection procedures and intervals and other procedures and recommendations are adhered to.

1. This program should comply with applicable GAA regulations.
2. Maintenance should only be performed by properly trained personnel.
    a) If the manufacturer offers training and certification for maintenance staff, maintenance should only be performed by personnel so certified
3. The program should, at a minimum:
    a) Have a maintenance policy and a procedures manual approved by a relevant authority within the operator's company
    b) Include a pre-flight and post flight inspection of the ~~vehicle~~ entire RPAS and have an associated logbook to track inspections
    c) Incorporate a logbook to track flight hours and any inspection/replacement times and life limited items (e.g., batteries, rotors)
    d) Maintain a record of malfunctions (i.e., loss of link), anomalies and damaged parts
    e) Include a maintenance training and evaluation program for each operated system
    f) Include both field and depot level maintenance intervals
    g) Include a process for reporting unusual discrepancies or potentially dangerous anomalies to the manufacturer
4. If the manufacturer offers certification of customer maintenance programs, the program should be so certified.

Changes

1. When software or hardware changes are made, the operator should:
    a) Ensure that the changes have no negative effect on operations via:
        i) Thorough review of documentation provided by the manufacturer in the case of changes

provided by them (e.g., software/hardware upgrades, service bulletin instructions, etc.).

ii) Test flights exercising all flight regimes

b) Document all hardware and software changes in the aircraft maintenance logbooks

Minimum Essential Subsystem List

2. When provided by the OEM, the minimum essential subsystem list (MESL) or similar list should be complied with.

COMMUNICATIONS

RPAS/Ground Control Station Link

1. The control link communications are essential with all RPAS operations. Every effort should be made to ensure positive control of the RPAS at all times.
2. RPAS should be operated in a reliable radio frequency environment that minimizes the probability of lost link and Radio Frequency (RF) interference with nearby systems.
3. All frequencies used should be licensed by the appropriate authority (typically the FCC) and coordinated with other nearby users through working with that authority and others as appropriate (for example, staff responsible for communications at a site).
4. The RPAS should be operated in strict compliance with all provisions and conditions contained within the frequency band assigned and authorized.
5. RPAS operators should have a valid communications plan that considers:
   a) A spectrum analysis to determine frequency strength and integrity, and areas of possible interference prior to RPAS operations
   b) A GPS RAIM check
   c) At a minimum, identification and assessment of possible sources radio frequency (RF) interference such as microwave antennas and high voltage lines prior to commencing operations
   d) Encryption of all command and return links when possible, or when sensitive information is being collected
   e) Immediate availability of secondary power supplies for the Control Station and all transceivers and antennas (as mentioned under Standby Equipment above)

On-Site Personnel Communications

1. Sufficient communications capabilities between all crew members and other personnel associated with the operation should in-place to ensure that operations cease (“stop-work”) in the event of an inbound aircraft or other event that may not be planned and require an emergency termination of the RPAS flight.
2. A formal means of communication should be in place between:
   a) The RPAS pilot and payload operator
   b) The PIC/RPAS pilot and visual observer(s)
   c) The RPAS operation and the installation (i.e., radio room and/or central control room)
   Note: Communications between the RPAS operation and installation may be controlled by the observer. Cellular phones are normally not sufficient for compliance.

ATC Communications

1. There should be a verified reliable and effective means of communications with ATC for required notifications such as pre-launch, post-landing or loss of link.

EMERGENCY RESPONSE PLANNING

1. A formal emergency response plan should be in place for all flight operations. An incident response checklist contained in the flight operations manual, should be followed in the event of an incident or accident.
    a. At a minimum, a notification checklist should exist for each operation which includes local, state, and government agencies, along with stakeholders to be contacted in the event of an incident

Appendix A - Determination of Airworthiness

These methods of determining airworthiness begin with the highest, most preferred standard followed by lower standards. For many RPAS, the higher standards are not yet available or feasible.

1. RPAS with an Airworthiness Certificate issued by the GAA are preferred.
    a. Airworthiness Certificates are generally not required for small RPAS operations, e.g., those governed by FAR §107; however, may be required by the limitations specified on waivers issued under §107.205; e.g., waivers to §107.31 Visual line of sight operations. They may also be required for operations under a USC §44807 COA
    b. Very few RPAS have been issued airworthiness certificates by the GAAs including the FAA
    c. Operators using RPAS with Airworthiness Certificates should demonstrate to a competent authority in the company operating/chartering the RPAS that:
        i. The RPAS manufacturer's Instructions for Continued Airworthiness have been complied with
        ii. Any limitations on the Airworthiness Certificate will be complied with during the operation
2. For operations using RPAS without Airworthiness Certificates, consider RPAS which were designed and manufactured according to FAA §23 or a standard intended to serve as an Alternate Means of Compliance to §23 such as:
    a. ASTM F2910-14 Standard Specification for Design and Construction of Small Unmanned Aircraft Systems (for all types of RPAS under 55lbs)
    b. JARUS CS-LURS Certification Specification for Light Unmanned Rotorcraft Systems (for conventional helicopter RPAS up to 1653lbs)
    c. JARUS CS-LARS Certification Specification for Light Unmanned Aeroplane Systems (for fixed-wing RPAS up to 1653lbs)
3. If RPAS compliant with neither (1) nor (2) are available or practical to utilize for a given operation:
    a. Consider aircraft that have a strong track record for high reliability and safety established over time in military or commercial service
4. RPAS should only be used that have been:
    a. Designed to minimize the potential for a failure of any component that will prevent continued safe flight and/or recovery of the vehicle

b. Meet the manufacturer's technical design specifications
c. Be in airworthy condition and be maintained under continuing airworthiness program which includes following the manufacturers maintenance instructions including any service bulletins. Also see the Maintenance section in this document

Appendix B – Detect and Avoid Recommendations

These detect and avoid methods begin with the most preferred method followed by less ideal methods. For many RPAS, the most preferred methods are not yet available or feasible.

1. As of late 2019, the FAA has approved several BVLOS operations using a commercially available detect and avoid system.[25]
2. Ensure compliance with GAA requirements for remote identification.
3. Other types of on-board detect and avoid technologies, e.g., acoustic systems, are being researched and developed. ASTM and JARUS are both developing standards for such systems.[26]
4. If it is not practical to utilize an on-board Separation Assurance technology, consider:
    a. A system that receives ADS-B and TIS-B[27] information at the ground station and integrates it into the ground-station's display
    b. An ADS-B "In" receiver connected to a visual display at the ground station. If this is used, it is important that the person operating the RPAS is not distracted by it during flight. It is preferred that a Supplemental Pilot or trained Visual Observer monitor such displays
5. Note that GAAs including the FAA along with NASA, are working with several industry partners, are developing an Unmanned Traffic Management System (UTM). As UTM systems become commercially available, they should be considered to aid in traffic separation.

Appendix C - Recommendations for Additional Crew Qualifications.

Pilot in Command

Qualifications

1. Ideally, the Pilot in Command (PIC) should hold:
    a. An FAA Private Pilot Certificate (or higher) when RPAS operations are conducted:
        i. In controlled airspace (which also requires approval from ATC or a waiver to FAR §107.41)
        ii. Within 3 nautical miles of any airport or heliport
        iii. When operating with a waiver from any provision of FAR §107.51 Operating Limitations for Small Unmanned Aircraft other than (i) above
    b. An FAA Commercial Pilot Certificate with an Instrument Rating (or higher) when operations are conducted:
        i. Beyond visual line of sight (which also requires a waiver from FAR §107.31)

[25] See irisonboard.com

[26] ASTM WK62668 New Specification for Detect and Avoid Performance Requirements; ASTM WK62669 New Test Method for Detect and Avoid; JARUS Detect and Avoid (JAR-DEL WG 4)

[27] TIS-B is Traffic Information Services-Broadcast. It broadcasts the position and altitude of non-ADS-B equipped aircraft from ground stations and is not available in rural locations at low altitudes such as on the ground

ii. Above 400’ AGL or more than 400’ above a structure (which also requires a waiver from FAR §107.51 (b) and/or (2)(c)
iii. Under a USC §44807 COA, i.e., outside of FAR §107 if determined appropriate for the operation’s level of risk

Experience

Conditions	Total RPAS Time (hours)	Time in Type (hours)
1. Within VLOS, 2. Daytime, 3. No higher than 400’ AGL, 4. 100’ or more from people not involved in the operation, 5. Not over populated areas, 6. Not in controlled airspace and 7. 3NM or more from any airport or heliport	5	5
Outside of 1-7 above	20	10
EVLOS, BVLOS, above 55lbs	100	20

Medical

1. Ideally, RPAS pilots should hold:
    a. For low-risk operations, documentation of a physical exam by a state licensed physician meeting the FAA BasicMed requirements laid out in FAA Form 8700-2 Section 3 within the previous 5 years[28]
    b. For medium-risk operations, a valid FAA Third Class Medical Certificate issued under FAR §67 or an FAA-recognized equivalent
    c. For high-risk operations, a valid FAA Second Class Medical Certificate issued under FAR §67 or an FAA-recognized equivalent
2. Ideally, Visual Observers should meet the medical qualification recommended for RPAS pilots above

Appendix D – Extended Visual Line of Sight Operations

1. Extended Visual Line of Sight (EVLOS) operations are operations where the PIC is still able to comply with his collision avoidance responsibilities, but the need for the remote pilot to maintain direct visual contact

[28] BasicMed only applies to pilots who have held an FAA Medical Certificate issued under FAR §67; therefore, this requirement is stated such that a physical exam equivalent to the BasicMed exam will suffice

with the unmanned aircraft is achieved through visual observation by the PIC and/or Visual Observers.

2. EVLOS operations require an exemption from FAR §107.31.
3. The operator should submit a safety case including a risk assessment for the EVLOS operation. Factors taken into consideration should include:
    a. Procedures for avoiding collisions
    b. Operating range limits - suitable radio equipment should be fitted in order to be able to effect positive control over the unmanned aircraft at all times
    c. Contingency plans for loss of link event
    d. Aircraft size and configuration
    e. Aircraft color, markings, and lighting
    f. Aircraft aids to observation
    g. Meteorological conditions and visibility, including background conditions (cloud/blue sky)
    h. The positions of deployed observers and their ability to maintain visual contact with the aircraft from these positions

Appendix E - Beyond Visual Line of Sight Operations

1. Beyond Visual Line of Sight Operation (BVLOS) are operations where none of the flight crew, including Visual Observers maintain visual contact with the aircraft.
2. Operations beyond visual line of sight are not recommended unless an approved method of aerial separation and collision avoidance exists, and the operations are in accordance with the FAA's requirements. See *Appendix B – Detect and Avoid Recommendations*.
3. BVLOS operations require a waiver under FAR §107.31.[29] For operations not subject to FAR §107 (e.g. using aircraft over 55lbs), a USC 49 §44807 COA would be required.
    a. Standards for development of the documentation to request BVLOS operations include:
        i. JARUS Guidelines on Specific Operation Risk Assessment (SORA)[30]
        ii. ASTM F3196-18 Standard Practice for Seeking Approval for Beyond Visual Line of Sight (BVLOS) Small Unmanned Aircraft System (sUAS) Operations
4. RPAS Operators should consult the FAA to verify what documentation they require for approval of an exemption.
5. RPAS flown Beyond Visual Line of Sight should use "detect and avoid" technology on the aircraft. See Appendix A, Detect and Avoid Recommendations for further information.
6. The operator should submit a safety case including a risk assessment for the BVLOS operation.[31] Factors taken into consideration should include:
    a. Procedures for avoiding collisions including Detect and Avoid Technologies mentioned above
    b. Operating range limits - suitable radio equipment should be fitted in order to effect positive control over the unmanned aircraft at all times
    c. Contingency plans for loss of link event
    d. Aircraft size and configuration
    e. Aircraft color, markings, and lighting

[29] Currently, these are rarely issued

[30] Australia's CASA now requires applicants for BVLOS flights to use the JARUS SORA

[31] In most cases, the application to the FAA for BVLOS authorization will include this and much more

f. Aircraft aids to observation
g. Meteorological conditions and visibility (to manned aircraft), including background conditions (cloud/blue sky)
h. The use of deployed observers to view the aircraft during portions of its flight or at checkpoints

Definitions

The following definitions are used by the FAA's Unmanned Aircraft Systems (RPAS) Integration Office and many RPAS organizations to describe relevant differences between RPAS operations and those of manned aircraft. Other organizations, such as the International Civil Aviation Organization (ICAO) and RTCA, Inc., have also developed acronyms and definitions which may differ from those used by the Federal Aviation Administration (FAA). Aviation safety inspectors (ASI) may wish to refer to the current version of ICAO Circular 328, Unmanned Aircraft Systems (RPAS) and RTCA Guidance DO-304, Guidance Material and Considerations for Unmanned Aircraft Systems, until harmonization of terminology is achieved.

1. **Aircraft.** A device used or intended to be used for flight in the air, including unmanned aircraft (UA).
2. **Airworthiness.** A condition in which the RPAS (including the aircraft, airframe, engine, propeller, accessories, appliances, and control station (CS)) conforms to its type certificate (TC), if applicable, and is in condition for safe operation.
3. **Airworthiness Certification.** A repeatable process that results in a documented decision that an aircraft system has been judged to be Airworthy. It is intended to verify that the aircraft system can be safely maintained and safely operated by fleet pilots within its described and documented operational envelope.
4. **Airworthiness Statement.** Document required from public RPAS applicants during a Certificate of Waiver or Authorization (COA) application process which confirms aircraft airworthiness.
5. **Certificate of Waiver or Authorization (COA).** An FAA grant of approval for a specific operation. COAs may be used as an authorization, issued by the Air Traffic Organization (ATO), to a public operator for a specific UA activity. COAs for civil and commercial operations are only for aircraft that have received an airworthiness certificate from Aircraft Certification Service (AIR). Provisions or limitations may be imposed as part of the approval process to ensure the UA can operate safely with other airspace users.
6. **Chase Aircraft.** A manned aircraft flying in close proximity to a UA that carries a qualified observer and/or UA pilot for the purpose of seeing and avoiding other aircraft and obstacles.
7. **Civil Aircraft.** Aircraft other than public aircraft.
8. **Congested Area.** A congested area is determined on a case-by-case basis. The determination should take into consideration all circumstances, not only the size of an area and the number of homes or structures (e.g., whether the buildings are occupied, or people are otherwise present, such as on roads).
9. **Cooperative Aircraft.** Aircraft that have an electronic means of identification (i.e., a transponder or Automatic Dependent Surveillance—Broadcast (ADS-B) transceiver) aboard in operation.
10. **Crewmember (RPAS).** In addition to the crewmembers identified in Title 14 of the Code of Federal Regulations (14 CFR) part 1, a RPAS flight crew member includes pilots, sensor/payload operators, and visual observers (VO), but may include other persons as appropriate or required to ensure safe operation of the aircraft.
11. **Crew Resource Management (CRM).** The effective use of all available resources including human, hardware, and information resources.
12. **Daisy-Chaining.** The use of multiple, successive observers to extend the flight of a UA beyond the direct visual line-of-sight of any other pilot in command (PIC) or VO.
13. **Due Regard.** A phase of flight wherein an aircraft commander of a State-operated aircraft assumes responsibility to separate his or her aircraft from all other aircraft.
14. **Experimental Certificate.** A type of Special Airworthiness Certificate issued for the purposes of research and development (R&D), crew training, exhibition, and market survey as defined in 14 CFR part 21, § 21.191(a), (c), and (f). (NOTE: According to 14 CFR part 91, § 91.319(a)(2), experimental aircraft may not be used for carrying persons or property for compensation or hire.) Commercial RPAS operations cannot be conducted with an experimental certificate.

15. **External Pilot.** A RPAS pilot who flies from outside a control station with direct visual contact with the aircraft.
16. **FAA-Recognized Equivalent.** An FAA recognition that a public agency may exercise its own internal processes regarding airworthiness and pilot, aircrew, and maintenance personnel certification and training; furthermore, the agency has determined that its RPAS is capable of safe operation in the National Airspace System (NAS) when conducting public aircraft operations under Title 49 of the United States Code (49 U.S.C.) §§ 40102(a)(41) and 40125.
17. **Flight Termination.** The intentional and deliberate process of performing controlled flight into terrain (CFIT). Flight termination should be executed in the event that all other contingencies have been exhausted, and further flight of the aircraft cannot be safely achieved, or other potential hazards exist that require immediate discontinuation of flight.
18. **Flyaway.** An interruption or loss of the control link, or when the pilot is unable to effect control of the aircraft and, as a result, the UA is not operating in a predicable or planned manner.
19. **Governing Aviation Authority.** A generic term referring to countries' government aviation regulatory authority for aviation, i.e., CASA in Australia, the FAA in the United States, Transport Canada in Canada, etc. (Note that the term *Civil Aviation Authority* (CAA) is often used as a generic term with the same meaning and is also the name of specific countries' GAAs, e.g., the UK's aviation authority is called the Civil Aviation Authority. We use Governing Aviation Authority here to avoid confusion with specific countries' CAAs.)
20. **Internal Pilot.** A RPAS pilot who flies from inside a control station without direct visual contact with the aircraft.
21. **Lost Link.** The loss of command-and-control link contact with the remotely piloted aircraft such that the remote pilot can no longer manage the aircraft's flight.
22. **Non-Cooperative Aircraft.** Aircraft that do not have an electronic means of identification (e.g., a transponder) aboard or that have inoperative equipment because of malfunction or deliberate action.
23. **Observer.** A trained person who assists a RPAS pilot in the duties associated with collision avoidance and navigational awareness through electronic or visual means. Collision avoidance includes, but is not limited to, avoidance of other traffic, clouds, obstructions, terrain and navigational awareness. A visual observer (VO) is a trained person who assists the RPAS pilot by visual means in the duties associated with collision avoidance. A VO includes the OPA pilot when the OPA is being operated as a RPAS.
24. **Off-Airport.** Any location used to launch or recover aircraft that is not considered an airport (e.g., an open field).
25. **Optionally Piloted Aircraft (OPA).** An aircraft that is integrated with RPAS technology and still retains the capability of being flown by an onboard pilot using conventional control methods (see OPA Safety Pilot, below).
26. **OPA Safety Pilot.** The PIC that is responsible for ensuring the safe operation of an Optionally Piloted Aircraft (OPA), whether under remote control or onboard control, for the purposes of overriding the automated control system in the case of malfunction or any other hazardous situation.
27. **Pilot Duty Period.** The period beginning when a flight crew member is required to report for duty with the intention of conducting a flight and ending when the aircraft is parked after the last flight. It includes the period of time before a flight or between flights that a pilot is working without an intervening rest period.
28. **Pilot in Command (PIC).** The person who has final authority and responsibility for the operation and safety of flight, has been designated as PIC before or during the flight, and holds the appropriate category, class, and type rating, if applicable, for the conduct of the flight. The responsibility and authority of the PIC as described by § 91.3 apply to the UA PIC. The PIC position may rotate duties as necessary with equally qualified pilots. The individual designated as PIC may change during flight. (NOTE: The PIC can only be the PIC for one aircraft at a time. For an OPA, the PIC should meet RPAS guidance requirements for training, pilot licensing, and medical requirements when operating an OPA as a RPAS.)
29. **Safety Risk Management (SRM).** A formalized, proactive approach to system safety. SRM is a methodology that ensures hazards are identified; risks are analyzed, assessed, and prioritized; and results are documented for decision-makers to transfer, eliminate, accept, or mitigate risk.
30. **Scheduled Maintenance (Routine).** The performance of maintenance tasks at prescribed intervals.
31. **Supplemental Pilot.** Pilots assigned RPAS flight duties to augment the PIC. It is common for operators to have both an internal and an external RPAS pilot. The supplemental pilot can assume either of these positions. The supplemental pilot may also assume duties of the PIC if the specified qualifications are met.
32. **Unmanned Aircraft (UA).** A device used or intended to be used for flight in the air that has no onboard pilot. This device excludes missiles, weapons, or exploding warheads, but includes all classes of airplanes, helicopters, airships, and powered-lift aircraft without an onboard pilot. RPAS do not include traditional balloons (refer to 14 CFR part 101), rockets, and unpowered gliders.

33. **Unmanned Aircraft System (RPAS).** A UA and its associated elements related to safe operations, which may include control stations (ground-, ship-, or air-based), control links, support equipment, payloads, Flight Termination Systems (FTS), and launch/recovery equipment.
34. **Unscheduled Maintenance (Nonroutine).** The performance of maintenance tasks when mechanical irregularities occur.
35. **Visual Line of Sight (VLOS).** Unaided (corrective lenses and/or sunglasses exempted) visual contact between a PIC or a VO and a UA sufficient to maintain safe operational control of the aircraft, know its location, and be able to scan the airspace in which it is operating to see and avoid other air traffic or objects aloft or on the ground