Annex to Knowledge Areas – UAV MTOW 25kg or less operated within VLOS

Informational annex to Transport Canada TP 15263 related to SFOC operating conditions

12 March 2014

Draft

Information

This Annex is intended to be a companion to the *Recommended Knowledge Requirements for Pilots of Unmanned Air Vehicles (Less than 25kg,) Visual Line of Sight (Transport Canada TP 15263)*. It provides various definitions and operating practices that a UAV pilot would be expected to exercise as part of a compliant organization (per SFOC-SI 623-001 Issue #3).

These definitions and practices are considered to be essential knowledge for pilots acting on behalf of holders of SFOCs for VLOS operation of UAVS of less than 25kg.

Many of the operating practices found in this Annex will be imposed as **mandatory** conditions in the SFOC itself, as issued by Transport Canada. However, there is an expectation that a well-informed pilot will have been taught and will already understand the rationale behind them, *just as there is an expectation of a manned-aircraft pilot appreciating existing regulations that are in force*.

For clarity, **this Annex is not exhaustive**. The complete set of required knowledge areas is found in *Recommended Knowledge Requirements for Pilots of Unmanned Air Vehicles (Less than 25kg,) Visual Line of Sight (TP 15263)*. This Annex only addresses additional knowledge requirements that are not presently published in the Canadian Air Regulations (CARs).

For convenience, these are grouped per the section numbers of the Knowledge Requirements table, to preserve the relationship between new and existing material. Where applicable, references to existing CARs are provided for context.

This material is intended for use by training organizations for development of teaching material. It is subject to change as the regulatory environment evolves.

Interpretation

The following is terminology is necessary to understand this document and the UAV-VLOS Knowledge Requirements; it is also the terminology used in the Transport Canada SFOC application process.

command and control link (C2)

- means the data link between the UAV and the control station for the purposes of managing the flight.

control station

- means the facilities and/or equipment remote from the UAV from which the UAV is controlled and/or monitored.

crew member

- means a person assigned to duties essential to the operation of the UAV System during flight time.

handover

- means the act of passing pilot-in-command responsibilities from one control station or pilot to another.

lost link

- means the loss of command and control link contact with the UAV such that the pilot-in-command can no longer manage the aircraft's flight.

operator

- in respect of an aircraft, means the person that has possession of the aircraft or the UAV System, as owner, lessee or otherwise.

payload

- in the case of a UAV, means a system, an object or collection of objects on-board or otherwise connected to the UAV that performs, or is related to, a mission function but is not required for flight.

radio line-of-sight

- means the limit of direct reliable radio communication given the equipment being used and the prevailing conditions.

flight-termination system

- means a system that, upon initiation, terminates the flight of a UAV in a manner so as not to cause significant damage to property or severe injury to persons on the ground.

Note 1:

This system has the following characteristics:

- *An independent or automatic means to initiate;*
- *Results in a predictable ground footprint of the UAV or UAV debris;*
- *Interrupts the current trajectory of the UAV;*
- *Does not result in severe, or worse, injury to persons on ground;*

- *Does not result in significant damage to property;*
- *Includes a means to ensure the system is functional; and*
- *Has established and defined delay times, functional characteristics.*

Note 2:

Activation of the system may result in destruction or damage of the UAV itself.

sense and avoid

- means the capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action.

small UAV

- means a UAV with a maximum permissible take-off weight of 25 kg (55 pounds) or less.

small UAV System

- means a set of configurable elements consisting of a small UAV, 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.

visual line-of-sight (VLOS)

- means unaided (corrective lenses and/or sunglasses exempted) visual contact with aircraft sufficient to be able to maintain operational control of the aircraft, know its location, and be able to scan the airspace in which it is operating to decisively see and avoid other air traffic or objects.

visual observer

- means a crew member who is trained to assist the pilot-in-command in the safe conduct of the flight under visual line-of-sight.

The following existing definitions from the CARs are included here to lend context to the material which follows.

Pilot-in-command

- means in relation to an aircraft, the pilot having responsibility and authority for the operation and safety of the aircraft during flight time.

Note:

- *In this document, the term "pilot" refers to "pilot-in-command".*

Unmanned Air Vehicle (UAV)

- means a power-driven aircraft, other than a model aircraft, that is designed to fly without a human operator on board

Note:

- *Although terms such as "Unmanned Aircraft System (UAS)", "Remotely-Piloted Aircraft System (RPAS)", and others are commonly used, the term "Unmanned*

Air Vehicle (UAV)" is the present legal term in Canada and the one used in all Canadian legal documentation, including SFOC applications. This is the term that should be used in official documentation and communications with Transport Canada.

Related to Part IV - Personnel Licensing and Training

(Related to Standard 421): Best Practices for Personnel

(1) Age
A pilot must be eighteen years of age**.**

(2) Medical Fitness
The pilot must be deemed eligible for a Cat 4 Medical Declaration/Certificate. A current medical associated with a pilot's licence or permit will suffice.

(3) Knowledge Areas
An applicant must have:

(a) completed a course of pilot ground school instruction, based on the Transport Canada endorsed Knowledge Requirements, and including the following subjects:
   (i) relevant air law and procedures (e.g. general provisions, general operating and flight rules, air traffic control services and procedures, aviation occurrence reporting),
   (ii) flight instruments (e.g. altimetry, GPS, airspeed and heading indicators),
   (iii) navigation (e.g. aeronautical charts, pre-flight preparation),
   (iv) flight operations (e.g. wake turbulence causes, effects and avoidance; data and command links),
   (v) meteorology (e.g. required for line-of-sight operations),
   (vi) human factors (e.g. aviation physiology, the operating environment, aviation psychology),
   (vii) theory of flight (e.g. basic principles),
   (viii) aeronautical radiotelephony, and

obtained a passing grade on a written exam, administered by a training organization.

(4) Experience
The UAV pilot needs to have acquired on a small UAV System:

(a) practical training; and
(b) reached a satisfactory standard of experience to establish proficiency.

(5) Skill
The pilot must obtain a letter from the person responsible for the training, certifying that the pilot has successfully demonstrated the ability to perform both normal and emergency manoeuvres appropriate to the small UAV System used for the training program, and with a degree of competency appropriate for the operation of a Small UAV System - Restricted to VLOS.

(6) Credits The UAV pilot can be given credit for previous experience in accordance with the guidance below:

(a) Canadian Civil Licence
   A UAV pilot who holds a Private Pilot Licence or higher shall be considered to have met paragraph *3 Knowledge Areas* (above).

(b) Canadian Forces Pilots

Active and retired Canadian Forces personnel who have qualified to pilot aeroplane wings standard or who have successfully completed the Basic Flying Training course of approximately 120 hours shall be considered as having met paragraph *3 Knowledge Areas* (above).

Active and retired Canadian Forces pilots who hold current Canadian Forces qualifications on a small UAV (or equivalent), shall be considered as having met paragraphs 3, 4 and 5 (above).

Related to Part VI - General Operating and Flight Rules

601 - Airspace

(Related to CAR 601.08): Class C Airspace

(1) A pilot may only operate a UAV in Class C airspace if they are specifically approved to do so in the SFOC, and only if they receive a clearance from the appropriate air traffic control unit before entering the airspace.
(2) A pilot may operate a small UAV in Class C airspace, in VMC, within VLOS, but without radiocommunication equipment only if specifically approved in an SFOC. If so approved, the pilot must also receive authorization from the appropriate ATC unit prior to entering the airspace. In addition, the pilot must maintain contact with ATC by a means acceptable to ATC.
(3) As with manned aircraft, if ATC is unable to accommodate the aircraft then it cannot enter or operate in the airspace.

(Related to CAR 601.09): Class D Airspace

(1) A pilot may only operate a UAV in Class C airspace if they are specifically approved to do so in an SFOC, and only if they receive a clearance from the appropriate air traffic control unit before entering the airspace.
(2) A pilot may operate a small UAV in Class D airspace, in VMC, within VLOS, but without radiocommunication equipment, only if specifically approved in an SFOC. If so approved, the pilot must also receive authorization from the appropriate ATC unit prior to entering the airspace. In addition, the pilot must maintain contact with ATC by a means acceptable to ATC.
(3) As with manned aircraft, if ATC is unable to accommodate the aircraft then it cannot enter or operate in the airspace.

602 - Operating and Flight Rules

(Related to CAR 602.05): Compliance with Instructions

As with manned aircraft, every crew member engaged in the operation of a UAV must, during flight time, comply with the instructions of the pilot-in-command or of any person whom the pilot-in-command has delegated to act on his or her behalf.

(Related to CAR 602.08): Portable Electronic Devices

A UAV pilot must not allow the use of portable electronic devices near the control station if the device could impair the functioning of the systems or equipment.

(Related to CAR 602.13): Take-offs, Approaches and Landings within Built-up Areas of Cities and Towns

If an SFOC specifically authorizes it, a UAV pilot may perform take-offs, approaches and landings within a built-up area of a city or town. Otherwise, this is prohibited for all UAV operations.

(Related to CAR 602.15): Low Altitude Flight

The SFOC will specify the maximum altitude(s) for UAV operations, as well as the minimum horizontal separation from persons, obstacles, and inhabited buildings.

Note that this will over-rule the minimum altitudes and distances specified in CAR 602.14, which normally specifies minimum altitudes for manned aircraft.

(Related to 602.19): Right of Way - General

The pilot-in-command of a small UAV operated VLOS must give way to manned aircraft at all times. (This category of UAV may be undetectable to pilots of manned aircraft due to their size and shape, and in some cases, their mission requirements).

(Related to 602.40): Landing at or Take-off from an Aerodrome at Night

A pilot may conduct a landing or a take-off of a UAV at night at an aerodrome only if the SFOC approves it, and provided the flight is conducted without creating a hazard to persons or property on the ground. The SFOC will also specify the lighting requirements for the aerodrome and UAV.

(New to 602): UAV Visual Observers

Visual observers that are used to assist the pilot-in-command with sense and avoid during flight, must have

(a) reliable and timely communication between the pilot and observer, and
(b) standard operating procedures that are established, validated and followed.

(New to 602): UAV Lost Link

Before flight, the UAV pilot must assess the conditions under which further flight of the UAV cannot be safely achieved and the flight would need to be discontinued**.** This includes assessing the risk involved with lost link circumstances and establishing when auto-recovery manoeuvres or flight-termination shall be initiated. This is meant to establish, prior to flight, the trigger conditions for manual or auto-initiation of flight-termination.

(New to 602): Requirements for Small UAVs

Pilots operating a small UAV within VLOS must ensure that the following operational and emergency equipment is available to the appropriate crew member(s):

(a) a checklist or placards that enable the aircraft to be operated in accordance with the limitations specified in the aircraft flight manual, aircraft operating manual, pilot operating handbook or any equivalent document provided by the manufacturer;
(b) a hand-held fire extinguisher of a type suitable for extinguishing fires that are likely to occur, and
(c) a suitable portable light source if the aircraft is operated at night.

The SFOC may specify additional equipment that is required.

(Related to 602.96): Aerodrome Operations

A pilot may fly a small UAV VLOS in the vicinity of an aerodrome only if specifically approved to do so in the SFOC. If so approved, the pilot must keep the UAV out of the way of, and not mix it in with, manned aircraft operating in the traffic pattern.

605 - Aircraft Requirements

(Related to 605.09): Unserviceable and Removed Equipment - Aircraft with a Minimum Equipment List

If a Minimum Equipment List (MEL) exists for the UAV, a copy of the MEL should be immediately available to the pilot-in-command.

(Related to 605.30): De-icing or Anti-icing Equipment

A pilot may take off or fly a small UAV that lacks de-icing equipment into known icing conditions only if it is specifically approved to do so in the SFOC. If so approved, the flight must be planned and conducted such that persons or property on the ground and other airspace users are not endangered.

(Related to 605.38): ELT

In order to avoid unnecessary searches of downed UAV, they must not carry ELTs. However, UAV crashes should be reported in order to limit unnecessary responses if there is a possibility of the crash event or wreckage being confused with manned aircraft.

(new to 605): System Capability Requirements

The following are the fundamental, performance-based capabilities that are required for operating a UAV VLOS. They include (but are not limited to) means of:

(a) controlling the flight of the UAV;
(b) monitoring the UAV and system, as applicable;
(c) communication, as required by the Class of airspace;
(d) sense and avoid (of other aircraft, terrain, and remaining clear of cloud to the distance required);
(e) detecting hazardous environmental flight conditions;
(f) where the aircraft is to be handed over from one control station to another control station, the equipment required to execute the handover;
(g) mitigating the risk of loss of control of the UAV trajectory;
(h) aircraft lighting or illumination for night operations sufficient to maintain visual contact.

As examples, “controlling the flight of the UAV” could include equipment that would measure altitude, automatically hold altitude etc, or just be a remote control pilot flying manually. The capability for “sensing and avoiding” other aircraft is provided by the pilot and visual observers.

(new to 605): Radio Frequency Interference

UAV operators must always confirm prior to flight that radio frequency interference is not present nor is likely to be present for the duration of the flight.

(Related to 605.88): Inspection after Abnormal Occurrences

Despite the fact that the wording of CAR 605.88 assumes a manned aircraft, CAR 605.88 is also applicable to UAVs.

(Related to 605.92): Requirement to Keep Technical Records

Technical records must be kept for the UAV and the control station. Engines, propellers and other propulsive system components do not need their own records if they are permanently scrapped when they become unserviceable.

(Related to 605.95): Journey Log

A journey log should be kept for each UAV to record flight time and other particulars. It must be accessible to the pilot during the operation.

(Related to CAR 605.85 and Standard 625) : Elementary Work

For a UAV that is manufactured under Transport Canada's Small UAV Best Practices guidelines and is provided to the end user with a manufacturer's Declaration of Compliance, this list describes the types of maintenance work that can be provided by the pilot and crew. Repairs or modifications that are outside if this list may render the system non-compliant.

Any limitations to this list should be documented in the organization's Operations Manual, and the organization should keep a record of all personnel who are trained to do elementary work.

Elementary Work Task Listings
(1) fabric patches measuring not more than 15 cm (6 in) in any direction and not requiring rib stitching or the removal of control surfaces or structural parts;
(2) removal and replacement of tires, wheels, landing skids or skid shoes, not requiring separation of any hydraulic lines;
(3) removal and replacement of skis on fixed landing gear, not requiring separation of any hydraulic lines;
(4) repair of non-structural fairings, cover plates and cowlings;
(5) cleaning and replacement of spark plugs;
(6) checking of cylinder compression;
(7) cleaning or changing of fuel, oil, and air filters;
(8) draining and replenishing engine oil;
(9) checking the electrolyte level and specific gravity of lead acid batteries;
(10) adjustment of generator or alternator drive belt tension;
(11) replacement of deliberately frangile structures, batteries that can be swapped, propellers/fans, wings, tail surfaces or other such components designed for easy replacement ;
(12) removal and replacement of fuses, light bulbs and reflectors;
(13) removal and replacement of avionics components that are rack mounted or otherwise designed for rapid removal and replacement, where the work does not require testing other than an operational check;
(14) removal and replacement of aircraft batteries;
(15) opening and closing of non-structural access panels;
(16) removal and replacement of induction system anti-icing baffles, scoops and deflectors that are designed for rapid removal and replacement;
(17) removal, cleaning, replacement and adjustment of external components of chemical dispersal systems that are designed for rapid removal and replacement;
(18) checking and adjusting air pressure in helicopter floats, and aircraft tires having an operating pressure below 100 psi;
(19) repetitive visual inspections or operational checks (including inspections and tests required by airworthiness directives) not involving disassembly or the use of visual aids,

performed out of phase with the aircraft's scheduled check cycle at intervals of less than 100 hours air time, provided the tasks are also included in the most frequent scheduled maintenance check.

Similar to Part VII

(new) Application

The following apply to organizations that are compliant with Transport Canada's recommended Best Practices for VLOS operations of UAVs of less than 25kg. Note the distinction between "pilot" and "operator".

(new): Flight Duty Time Limitations and Rest Period

UAV Operators must establish and document maximum flight duty times and minimum rest periods and a system that monitors the flight duty time and time free from duty of each of its flight crew members. The details of that system will be included in the SFOC holder's Operations Manual.

(new): Operating Instructions

UAV Operators need to ensure that all operations personnel are properly instructed about their duties and about the relationship of their duties to the operation as a whole. The operations personnel should follow the procedures specified in the Operations Manual in the performance of their duties.

(new): Operational Control

UAV operation should take place under the control of the organization's operations manager.

(new): Operational Flight Plan

For every flight, an operational flight plan should be prepared in accordance with the procedures specified in its Operations Manual.

(new): Maintenance of Aircraft

A UAV must not be flown unless it has been maintained in accordance with the UAV Operating Manual or UAV Maintenance Manual, as applicable.

(new): Minimum Visibility - Uncontrolled Airspace

The SFOC will dictate the minimum visibility conditions for operation of a small UAV operated in VLOS. This may not be the same for different classes of airspace or for day vs. night operation.

In general, if a UAV is operated in VLOS within uncontrolled airspace at less than 1,000 feet AGL, visibility must be not less than three miles and the UAV must remain clear of cloud, unless otherwise authorized by the SFOC.

(new): Built up Area and Aerial Work Zone

For a UAV pilot to fly a UAV over a built up area at altitudes and distances less than those specified in Section 602.14 of the *Canadian Aviation Regulations*, or to conduct a take-off, approach or landing within the built-up area of a city or town, the UAV Operator needs to have a documented aerial work zone plan for each location. This is in addition to the requirement to have specific permission in the SFOC to fly over a built-up area.

(new): Designation of Pilot-in-command

There is always a designated pilot-in-command at all times during an UAV flight, regardless of the level of automation of the system.

(new): Crew Member Qualifications

All UAV crew members need to have fulfilled the requirements of the UAV operator's ground and flight training program.

(new): Training Program

(1) UAV operators must establish and maintain a ground and flight training program that is designed to ensure that each person who receives training acquires the competence to perform the person's assigned duties.
(2) The ground and flight training program should include
- *(a)* company indoctrination training;
- *(b)* upgrading training;
- *(c)* training in the specific work to be conducted; and
- *(d)* initial and recurrent training, including
  - (i) UAV type training,
  - (ii) procedures for passing piloting control from one control station or pilot to another (as applicable),
  - (iii) aircraft servicing and ground handling training,
  - (iv) emergency procedures training,
  - (v) training for personnel who are assigned to perform duties associated with the flight, and
  - (vi) any other training required to ensure a safe operation.

(3) The UAV Operator should

(a) include a detailed syllabus of its ground and flight training program in its Operations Manual; and
(b) ensure that adequate facilities and qualified personnel are provided for its ground and flight training program.

(new): Training and Qualification Records

(1) For each person who is required to receive training per the Training Program, the UAV Operator must, establish and maintain a record of
(a) the person's name and, where applicable, personnel permit number,
(b) if applicable, the person's medical category and the expiry date of that category;
(c) the dates on which the person, while in the UAV Operator's employ, successfully completed any training or competency checks; and
(d) information relating to any failure of the person, while in the UAV Operator's employ, to successfully complete any training or competency check required or to obtain any qualification required.
(2) A UAV Operator must retain the records referred to in paragraphs (1) (c) and (d) for at least three years.

(new): Distribution of Operations Manual

The UAV Operator should provide a copy of the appropriate parts of its operations manual, including any amendments, to each of its crew members and to its ground operations and maintenance personnel.

Every person who has been provided with a copy of the appropriate parts of an operations manual shall keep it up to date with the amendments provided and shall ensure that the appropriate parts are accessible when the person is performing assigned duties.

(new): Standard Operating Procedures

For each operation that is described in the Operations Manual, the UAV Operator needs to establish and maintain type-specific standard operating procedures (SOPs) as laid out in the *Small Unmanned Air Vehicle (UAV) Definitions and Best Practice.* These should be available at the control station.