Unmanned Systems
Systèmes Télécommandés
CANADA

Alternate Presentation of the Notice of Proposed Amendment (NPA) for Unmanned Air Vehicles

June 15, 2015

By: Kris Ellis
Director – Unmanned Systems Canada

PO/CP 81055, Ottawa, Ontario, Canada K1P 1B1
admin@unmannedsystems.ca / www.unmannedsystems.ca

Executive Summary

On May 28th 2015 Transport Canada released a Notice of Proposed Amendment (NPA) to establish comprehensive and accelerated rulemaking for unmanned aircraft not exceeding 25 kg that are operated within Visual Line of Sight (VLOS). The NPA spans 33 pages with much of the material being redundant across the three classes of UAV operation.

Objectives:

- This document attempts to present the NPA material with alternative formatting in order to better highlight the differences between the three proposed categories of UAV operations. It is hoped that this document will serve as a starting point for understanding the full scope of the NPA and therefore generate more informed feedback and comments.
- Additionally, this document has been prepared to highlight the areas where Transport Canada has specifically requested feedback and comments.

This document presents an objective and impartial re-presentation of the NPA material. Unmanned Systems Canada is undertaking a parallel effort to develop an opinion and comment document in order to initiate and focus discussion surrounding the proposed rules and the specific areas in which Transport Canada requests feedback.

Disclaimer

While every attempt has been made to ensure the accuracy of this document, it must be recognized that it has not been reviewed by Transport Canada, and as such may contain inaccuracies regarding the interpretation of the NPA. Prior to submitting formal comments to Transport Canada it is recommended that readers familiarize themselves with the full content of the official NPA, which is available here.

A Note on Terminology

There is a great variety of terminology associated with unmanned aircraft these days, with the popular press favouring the use of 'drone', ICAO and industry moving towards UAS and RPAS, and the existing Canadian regulations referring to UAV. The rationale for moving towards the UAS and RPAS is sound: it indicates that unmanned aircraft are in fact aircraft and not 'vehicles', and that a certain subset of these aircraft are remotely piloted (i.e. RPAS). Unmanned Air Vehicle is the term that is currently defined within the Canadian Aviation Regulations and this likely explains why it is UAV that is in use throughout the NPA. At the UAV roundtable chaired by the Hon. Lisa Raitt on May 28 2015 it was indicated that terminology is one of the areas where Transport Canada is seeking input, and this is further supported by the text in section 3 of the NPA where it is proposed to define UAS and use RPAS for the proposed set of rules. Unfortunately, when the NPA was drafted it did not make use of UAS or RPAS, and instead uses the term UAV throughout. In this alternate presentation of the NPA the terms UAS and RPAS have been

used in order to provide readers a sense of what the final rules may look like, and to increase familiarization with the proposed terminology. The table below provides the key to moving between the terminology of this report, and that contained within the NPA.

Table 1: Relationship between NPA terminology and that adopted for this document

NPA Term	Term used in this document	Acronym used in this document
Small UAV	Small Remotely Piloted Aircraft System	Small RPAS
Very Small UAV	Very Small Remotely Piloted Aircraft System	Very Small RPAS
Small UAV (Complex Operations)	Small Remotely Piloted Aircraft System (Complex Operations)	Small RPAS (*complex*)
Small UAV (Limited Operations)	Small Remotely Piloted Aircraft System (Limited Operations)	Small RPAS (*limited*)
Very Small UAV (Lower Threshold)	Low Threshold RPAS	LTRPAS

The terminology adopted for this document more closely resembles the terminology used by the Transport Canada UAV Program Design Working Group in their 2012 Phase 1 Final Report which serves as the basis for much of the material in the NPA and is the cited reason for which preliminary issue and consultation assessment for the NPA is not required.

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Acronyms

ATC	Air Traffic Control
CARAC	Canadian Aviation Regulation Advisory Council
CARs	Canadian Aviation Regulations
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
LTRPAS	Low Threshold Remotely Piloted Aircraft System
NPA	Notice of Proposed Amendment
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
SOP	Standard Operating Procedure
TC	Transport Canada
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UAV	Unmanned Air Vehicle
VLOS	Visual Line of Sight

Background

This section summarizes the six pages of background information contained in the NPA. The background information identifies TC's desire to balance safety to other airspace users and persons on the ground while encouraging innovation and growth within the unmanned aircraft sector

The background information identifies the existing regulatory approach for unmanned aircraft which is based upon a division based upon intent (i.e. recreational use falls under model-aircraft rules, and non-recreational falls under the existing Unmanned Air Vehicle rules requiring Special Flight Operation Certificates, or operations that fall under the exemptions). The exemptions to the SFOC requirement are expected to remain valid until December 2016.

A key area identified was the varying degrees of aviation expertise/knowledge associated with this growing sector including hobbyists. Of particular concern is the growing community of novice RPAS pilots who do not operate under the guidelines of a traditional model aircraft association (e.g. MAAC), who may not have the requisite knowledge to operate safely, or may mistakenly believe that model aircraft regulations apply to them. An increasing trend of unsafe/negligent RPAS use has been observed, with TC citing 50 investigations having launched since 2010.

The NPA also provides a short summary of international efforts for RPAS regulation ongoing as part of the International Civil Aviation Organization, ICAO, the United States Federal Aviation Administration (FAA), the European Aviation Safety Agency (EASA), Australia, and the United Kingdom's Civil Aviation Authority.

Overview of the Proposed Regulatory Approach

TC's NPA for Small RPAS operated in VLOS takes a risk based approach which focuses on two principal risks: (1) the risk of a RPAS being fatal to people and/or damaging property on the ground, and (2) the risk of a RPAS to an aircraft in-flight. The approach takes into account operational factors including size of the RPAS, its location, and its operational usage. Figure 1 presents the relationship between RPAS operational factors and these risks as presented to the UAV program Design Working group on May 27 2015 in advance of the NPA announcement.

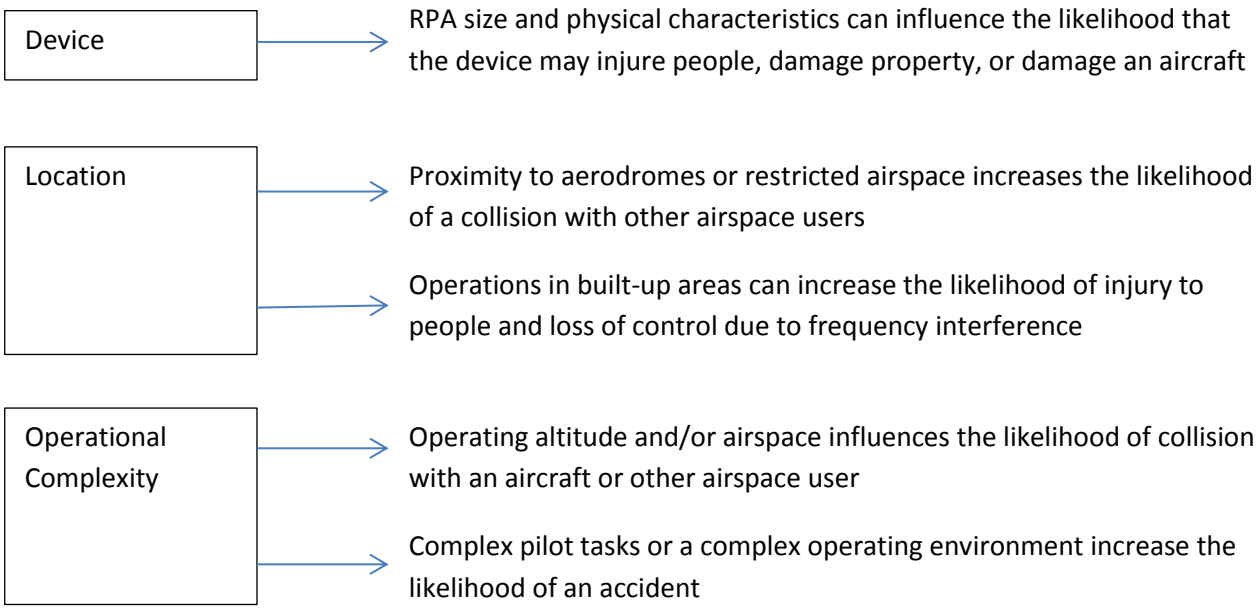

Figure 1: RPAS operational factors and risk relationship

The various RPAS operations can be visualized on a spectrum of risk that increases from left to right as illustrated in Figure 2. In the figure the operations identified by filled block are covered by the current NPA. All other operations not covered by the NPA, including large RPAS operations, Beyond VLOS operation, and operations non-compliant to the NPA may still be conducted under the SFOC process.

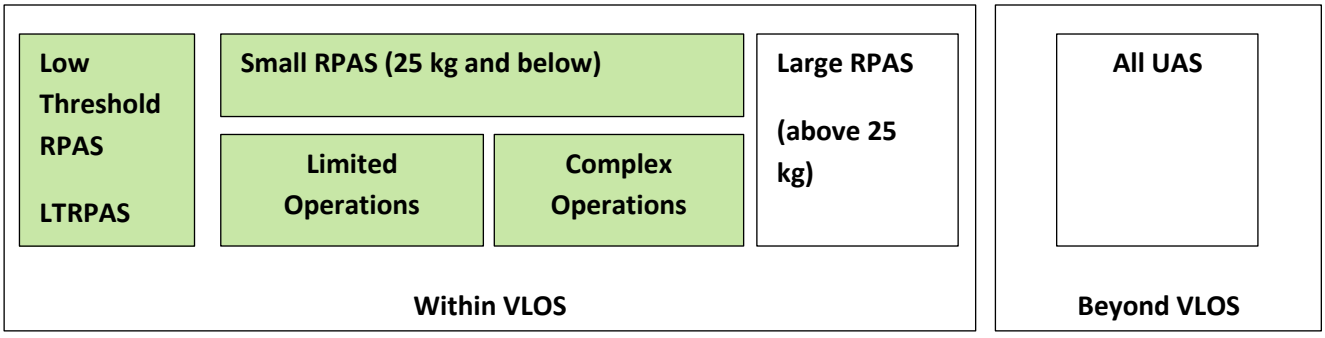

Figure 2: RPAS operation categories with increasing risk from left to right

It is worth mentioning at this point that the NPA gets rid of the 'intent' as the discriminator between model aircraft operations, and unmanned aircraft operations. Instead, all RPAS operations fall under the NPA, with the intent to develop a "carve-out" for traditional modelers operating under the guidelines of a recognized association such as MAAC.

Low Threshold RPAS (LTRPAS) represent the lowest risk category, and are unlikely to result in a fatality to persons on the ground owing to the characteristics of the RPA (e.g. mass, speed, frangibility, etc…). It

is anticipated that most recreational activities involving RPAS will involve this category, and that non-recreational operations will be simple, such as aerial photography.

Transport Canada invites comment on whether this category should be based on weight, or an alternative approach such as kinetic energy. The CARAC UAV Systems Program Design Working Group recommended rulemaking that would separately address a 'low energy' category, specifically a UAV that has been analyzed and/or demonstrated, for the case of an uncontrolled impact to not impart a peak energy of more than 12 J/cm^2 on a stationary person or object. The details of these criteria can be found the Applicability section of the Phase 1 report, and repeated in this document as Appendix A.

Small RPAS (Limited Operations) represent the next level of risk, and consist of larger aircraft than LTRPAS, up to 25 kg MTOW. Operational restrictions are placed on this category to limit their use to locations that are in rural areas away from populations, and away from aerodromes, and the system must conform to a design standard.

Small RPAS (Complex Operations) represent the highest level of risk associated with NPA. These aircraft have a MTOW of up to 25 kg, and can be operated near populated areas, people, and aerodromes. In order to mitigate the risks associated with these operations there is an elevated requirement for pilot training/licensing and compliance with a design standard. Table 2 presents a high level view of the requirements and privileges for each of these three classes of RPAS operations, and has been sourced directly from Annex A of the NPA, but with the class names changed to reflect the philosophy used in this report. This table provides the high level description of the limitations and requirements associated with each class of RPAS operation, and should serve as a starting point for becoming familiar with the overall content of the NPA. The specific details of these requirements and limitations are expanded upon in later sections of this report.

Organization of the Detailed Presentation of the NPA

In TC's official NPA the details are presented in their entirety for Small RPAS (complex operations), then for Small RPAS (limited operations), and finally for LTRPAS. For each category the following areas are addressed:

1. Operator Certificate requirements
2. Aircraft Marking and Registration
3. Personnel Licensing and Training
4. Airworthiness
5. General Operating and Flight Rules

This results in a significant amount of redundant information, and makes it difficult to understand the specific differences of each class of operation. The approach taken in this alternate presentation of the NPA content is to address each of the five areas identified above individually for all categories, starting with the LTRPAS, and then demonstrating how Small RPAS (limited) builds upon the requirements, and finally demonstrating the most rigorous requirements associated with the Small RPAS (complex) category.

Table 2: High level view of NPA regulatory requirements/privileges for each class of Small RPAS operations

	LTRPAS	Small RPAS (Limited)	Small RPAS (Complex)
Aircraft Requirements			
Identification	✓	-	-
Marking and Registration	-	✓	✓
Design Standard		✓	✓
Pilot Requirements			
Age Restrictions	-	✓	✓
Knowledge Test	✓ *(Basic)*	✓ *(Basic)*	✓ *(Advanced)*
Pilot Permit	-	-	✓
Respect for Privacy and Other Laws	✓	✓	✓
Permission to Fly			
At night	-	-	✓
In proximity to an aerodrome	-	-	✓
Within 9 km of a built-up area	✓	-	✓
Over people	-	-	✓

Liability Insurance	-	✓	✓
Operator Certificate *[1]	✓	✓	✓
Maximum Altitude (AGL)	**300 ft**	**300 ft**	**400 ft**

Operator Certificate Requirements

In manned aviation, an operator certificate is provided to any company or organization, to allow them to "operate" aircraft for commercial purposes. This process ensures that the "operator" has sufficient resources, procedures and structure to operate the aircraft in a safe manner.

The NPA presents the same text for all three categories of RPAS operation (i.e. LTRPAS, Small RPAS (limited) and Small RPAS (complex)). The NPA indicates that it will be possible to operate RPAS without the requirement for an Operator Certificate, but that larger operations may require "some additional regulations"[2] in order to ensure that there is an adequate management structure in place to ensure safe operation. The NPA explicitly calls for feedback regarding the appropriate criteria for requiring a registered description of operations. The following criteria was proposed for comment:

- Number of employees (e.g. more than 3)
- Companies who hire persons in commercial enterprises
- Companies with a large scope of operation (e.g. multi-region, across Canada, or large numbers and/or types of aircraft, or
- A combination of the above

The NPA is more specific about the requirements for the content of the "registered description of operations" (note: this is the author's wording, not TC's), and would require these RPAS operators to have:

- An adequate management organization
- A method of control and supervision of flight operations
- Pilot training programs
- Security procedures
- A maintenance control system
- A company operations manual
- Standard operating procedures

[1] As per the NPA "Operator Certificates" are not required for any RPAS operations, but operators with a large span of control, and complex operations (e.g. many employees, bases of operations, large and/or diverse fleets) may require additional documentation requirements regarding management structure, supervision, SOP's, maintenance, training, etc…

[2] In other words, something that meets the intent of an Operator Certificate, but isn't called an Operator Certificate as such. For purposes of this document it is termed a "registered description of operations"

The proposal would include rules for describing RPAS operator responsibilities (note, that operator in this context does not mean pilot, it refers to the organization) within the following areas:

- Flight Operations
- Documentation
- Flight Time and Flight Duty Time Limitations
- Emergency Equipment
- Maintenance Requirements
- Training Programs
- Operations Manual

The general content of the above areas was not indicated in the NPA, but it is reasonable to envision that they will be similar to those associated with an Aerial Work Operator Certificate as per Part VII Subpart 2 of the CARs.

Aircraft Marking

LTRPAS

Registration, and therefore marking the RPAS with easily readable "call letters" is not required, but there is a requirement to have permanent marking in/on the RPA for identification of the owner and contact information.

Small RPAS (limited) and Small RPAS (complex)

Small RPAS for both limited and complex operations are to be marked and registered. Given the diversity of size and configuration of these RPA's, marking specifications (e.g. size of lettering) will be flexible so that the size of the marks will be as large as practical, consistent with the size and configuration of the RPA.

Persons wanting to register a small RPAS for limited or complex operations must meet the qualifications to be a registered owner of a Canadian aircraft as outlined in section 202.15 of the Canadian Aviation Regulations.

Note: The Certificate of Registration would not be carried on-board the aircraft, rather the documentation would be accessible by the pilot-in-command during flight operations.

A unique series of 4 letter registration marks, starting with a specific letter is proposed as it will address a variety of unique reporting requirements and provide an easy manner to differentiate between manned and unmanned aircraft to support Air Traffic Control (ATC) concerns and practices.

It is not required for this category of RPAS to have an aircraft identification plate (i.e. fireproof, engraved plate).

Personnel Licensing and Training

This section presents the NPA requirements with respect to personnel licensing and training, starting with pilots, followed by flight training aircraft, maintenance engineers and maintenance requirements.

For all categories of RPAS operations TC considers RPAS pilots to be pilots as defined by the *Aeronautics Act* and the Canadian Aviation Regulations. RPAS pilots in-turn have responsibilities, including ensuring that they obtain proper training and experience in order to safely operate their aircraft within Canadian Airspace. For all categories of RPAS operations operators of launch systems and arresting hooks, visual observers, payload operators and mission planners will not need licensing certification.

Pilot Permit – LTRPAS

For this lower threshold category, Transport Canada proposes:

- to **not require** pilots to obtain a pilot permit or medical certificate.
- **to not set a minimum age requirement** for pilots operating LTRPAS, provided they are operating with adult supervision. A minimum age of 16 years is proposed to allow operations without adult supervision. However, these pilots would be required to demonstrate aeronautical knowledge in specific subject areas, such as airspace classification and structure.

Note: *This could, for example, be an on-line self-study program and test that is fashioned after existing models used by government agencies that require a demonstration of knowledge as a prerequisite to conducting specific activities.*

During discussions following the UAV Roundtable where the NPA was announced it was envisioned that this self-study program test could be something comparable to a pleasure craft boat license and exam.

The proposed knowledge areas for the study material and exam are:

- air law and procedures relevant to the permit (e.g. general provisions, general operating and flight rules, air traffic control services and procedures, aviation occurrence reporting);
- airspace (e.g. structure, classification; reporting requirements);
- flight instruments (e.g. altimetry, GPS, airspeed and heading indicators);
- navigation (e.g. aeronautical charts, pre-flight preparation);
- flight operations (e.g. wake turbulence causes, effects and avoidance; data and command links);
- meteorology (e.g. required for visual line-of-sight operations);

Pilot Permit – Small RPAS (limited)

For operations in the Small RPAS (limited) category TC proposes the same pilot permit and medical requirements as LTRPAS (i.e. none required), and the same age limits. Similarly, a self-study program and exam is proposed as a means to ensure RPAS pilots in the limited category have appropriate aeronautical knowledge. The proposed knowledge subject areas include:

- All areas identified in LTRPAS above, plus
- Human factors (e.g. aviation physiology, the operating environment, aviation psychology), and
- Theory of flight (e.g. basic principles)

For the Small RPAS (limited) category TC also proposes as an alternate to the subject areas above, TP15263E "*Recommended Knowledge Requirements for Pilots of Small Unmanned Air Vehicle Systems, Restricted to Visual Line-of-Sight*" , and seeks comments on the proposed areas of knowledge.

Pilot Permit – Small RPAS (complex)

The pilot permit requirements for operations in the Small RPAS (complex) category are substantially different (i.e. a permit is required). For these operations TC proposes:

- to require RPAS pilots to be properly trained and licensed to assure safe integration within Canadian airspace and hold a pilot permit.
- to issue a pilot permit, versus a pilot license, as the privileges of the permit would only apply to flight within Canadian domestic airspace.

The following criteria are proposed for obtaining a pilot permit:

- **Age** –A minimum age requirement of 14 while under adult supervision and 16 without adult supervision. Transport Canada is seeking comments on whether this proposal is considered appropriate for this type of RPAS operation.
- **Medical Fitness** - A Category 4 Medical Certificate would be required, based on a Self-declaration process. It would be valid for 60 months. This is consistent with other Canadian pilot permits.
- **Knowledge** - Pilots would be required to complete a course of instruction in specific aviation knowledge areas and pass a Transport Canada written examination that would be developed specifically for this category of RPAS. Training could be provided by a flight training school, a UAS training provider, a third party or be self administered.
- **Experience** - Pilots would need to acquire practical training on the category of RPAS, including RPAS system-specific training. This training may be provided to the pilot by the manufacturer, operator or by a third party, providing the person providing such training held a RPAS pilot permit.
- **Skill** - Pilots would be required to demonstrate competency in the ability to perform normal and emergency procedures appropriate to the particular type of RPAS. Skill tests/proficiency checks would be conducted by qualified RPAS operators, manufacturers or third parties.
- **Currency** – RPAS pilots would be required to maintain currency and proficiency.

- **Privileges** – meeting these criteria and the issuance of a permit, would allow a person to be a pilot-in-command of a RPA 25kgs or less, operated within visual line-of-sight within Canadian domestic airspace.

The proposed knowledge areas for this category of operations is identical to those for the Small RPAS (limited) category, with the additional requirement that candidate testing would follow the examination rules in section 400.02 of the *Canadian Aviation Regulations*.

Persons applying for a pilot permit would need to meet the proof of age and citizenship requirements as outlined in section 421.06 of the *Personnel Licensing and Training Standards Respecting Flight Crew Permits, Licences and Ratings.*

Transport Canada also proposes that:

- credits for some of the permit provisions would be provided for other holders of permits and licences, including active and retired Canadian Armed Forces pilots. Additionally, documented experience gained through operations with Small RPAS (limited) or LTRPAS could be recognized towards the requirements for the pilot permit.

Flight Training (all categories of RPAS <25 kg within VLOS)

It is proposed that Transport Canada not certify flight training units or schools that provide theoretical or flight training to RPAS operators and their crews. This would include schools for any RPAS position to include pilots, visual observers and maintenance personnel.

Aircraft Maintenance Engineers (all categories of RPAS <25 kg within VLOS)

It is proposed that Aircraft Maintenance Engineer licensing would not be required for this category of RPAS operating within VLOS. The skill set of an Aircraft Maintenance Engineer is not suited for aircraft of this size.

Airworthiness

This section describes the airworthiness requirements and maintenance requirements for the three categories of RPAS <25 kg within VLOS.

Design Standard: LTRPAS

TC proposes that LTRPAS are not required to meet a design standard.

Design Standard: Small RPAS (limited)

It is proposed that system manufacturers in the Small RPAS (limited operations) category be required to declare that the RPAS system meets a design standard for this RPAS category. The content of this Standard represents a balance between prescriptive requirements and statements of best design practice. The guiding principle of such a standard would be that the probability of a hazardous failure

condition (i.e. one that may result in no more than a single fatality) must not be greater than extremely remote.

The Transport Canada UAV System Program Design Working Group developed a design standard for RPAS, 25kgs or less, operated within visual line-of-sight. For small UAVs (limited operations), it is proposed that the design standard would detail requirements for the following areas:

- Flight Performance
- Structure
- Design and Construction
- Propulsion System
- Systems and Equipment
    - General Function and Installation
    - Flight and Navigation Information
    - High Intensity Radiated Fields Protection
    - Equipment, Systems and Installations
- Navigation Systems
- Sense and Avoid Systems
- UAV Control
- Launch and Recovery Systems
- Payloads
- Manuals and Documentation

Transport Canada invites comments, particularly from RPAS manufacturers, whether compliance with this standard would be achievable and commensurate with the risk posed to people and property on the ground and other airspace users for operations under this proposed rule. Transport Canada is willing to consider that there may be other validated consensus standards from recognized Standards' groups that may be acceptable, so welcomes feedback that identifies any such standards.

While Transport Canada is proposing a design standard for this category of RPAS, Transport Canada **would not**:

- require type certificates or production approvals; or
- issue a flight authority (i.e. Certificate of Airworthiness).

Please note: *The intent of a design standard is to provide an increased level of assurance in the safety of the UAV system. If such a design standard is not published as part of the proposed rulemaking efforts, Transport Canada would need a more restrictive regulatory regime to mitigate the increased risk of operating UAVs, that have not been built to any safety standard, near or over persons and near other aviation activities.*

Unmanned Systems Canada is attempting to gain clarity from TC regarding the design standard proposed for the NPA. In the meantime it is reasonable to assume it will mirror the content from the design standard associated with a "Compliant Small UAV System Design" as per the current staff instructions (623-001), and repeated in this document as Appendix B.

Design Standard: Small RPAS (complex)

The design standard requirement for Small RPAS (complex) category operations is identical to that of Small RPAS (limited) operations. It should be noted that the category is different, and the design standard itself has yet officially to be made publically available so there is the possibility of different standards depending on category.

Aircraft Maintenance Requirements – LTRPAS

Transport Canada proposes that LTRPAS:

- will **not be required** to meet any design standard or have any specific maintenance requirements.
- will be required to follow any maintenance instructions provided by the manufacturer.
- will be required to conduct a pre-flight check to ensure that the aircraft is in a fit and safe state for flight before take-off.

Aircraft Maintenance Requirements – Small RPAS (limited)

Transport Canada is proposing that small RPAS (limited operations) be maintained by the owner/operator of the RPAS. General maintenance of these systems would be performed by a person possessing the relevant experience and training on the maintenance of the specific RPAS and authorized by the owner/operator. This approach would be consistent with the risk associated with this category of aircraft.

Aircraft Maintenance Requirements – Small RPAS (complex)

The maintenance requirements for the Small RPAS (complex) category are identical to the Small RPAS (limited) category.

General Operating and Flight Rules

This section is presented in reverse order from the others, as the proposed rules are most permissive for the small RPAS (complex) category, and more restrictive for the small RPAS (limited) and LTRPAS. The proposed rules for the small RPAS (complex) category are used as a building block for the other two categories, and for this reason they are presented first.

Small RPAS (complex)

Transport Canada proposes to impose specific operating limitations to reduce or minimize potential encounters between manned and unmanned aircraft and to protect people and property on the ground. Such limitations would reflect the level of risk associated with a Small RPAS (complex operations).

For Small RPAs (complex operations), it is proposed that general **operating rules** covering the following areas would be incorporated;

- always operate within visual line-of-sight through unaided visual contact with the RPA.
- always give way to manned aircraft.
- never operate in a reckless or negligent manner.
- operate in visual meteorological conditions.
- never operate:
    - within Class A and Class B airspace,
    - within Class F Restricted airspace without required permission,
    - within, or in the vicinity of, a forest fire area,
    - at an air show, or
    - at an aerodrome.
- advance coordination with the air traffic control.
- never operate when suffering from fatigue or under the influence of alcohol or drugs.
- only one RPA operated in flight by a single pilot.
- operate in accordance with the published RPAS operating limitations.
- do not allow the use of a portable electronic device at the control station.
- never carry any explosive, corrosive or bio-hazard payloads on a RPA or create a hazard by dropping an object from the RPA.
- ensure visual observers have reliable communication with the pilot and can perform observation duties for only one (1) RPA.
- do not allow visual observers to function from a moving surface vehicle.
- ensure that the RPAS is in an airworthy condition before flight.
- there must be a means of: controlling and monitoring the RPA, navigating, avoiding other aircraft, terrain and obstacles, lighting the aircraft for night operations, remaining clear of clouds.
- require liability insurance.
- always follow a physical and command and control link security plan.
- the need for the RPAS to be properly equipped for the area of operation and the type of operation (e.g. radios, transponders, etc)
- get permission from the owner(s) of the property on which the RPA intends to take-off from and/or land on.
- assess the lost link risk before the flight.
- never operate in areas of high electromagnetic interference.
- never take off with snow or ice on the aircraft.
- be familiar with the available information required for the intended flight.
- comply with Air Traffic Control instructions.
- remain clear of the take-off, approach and landing routes and the pattern of traffic formed by manned aircraft operating at the aerodrome.
- meet specific communications requirements as detailed in the *Canadian Aviation Regulations*.
- notify Air Traffic Control in the case of a RPA fly-away.
- comply with minimum lateral distance requirements from person, animals, buildings, vehicles, etc.

- comply with maximum altitude requirements – not above 400 feet above ground level.
- comply with accident/incident reporting requirements.

NOTE: The table presented in Annex A of the NPA, and repeated in this document as Table 2 indicates that Small RPAS (complex) operations may take place over people, but I note that there is no specific wording in the Small RPAS (limited) and LTRPAS operating rules to prohibit this. This is likely an oversight.

Small RPAS (limited)

For RPAS falling under the proposed Small RPAS (limited operations) category, in addition to some of the rules proposed in the Small RPAS (complex operations) section, Transport Canada proposes to incorporate operational restrictions addressing the following areas:

- operate only during the day.
- comply with a maximum airspeed limit of 87knots.
- never operate in Class C, D, E or F airspace.
- comply with a specified minimum distance from aerodromes*.
- comply with the minimum distance of 5nm (9 km) from built-up areas (cities, towns or villages).
- comply with maximum altitude requirements – not above 300 feet above ground level.

*Transport Canada is considering two (2) options with regard to the minimum distance from aerodromes that small UAVs (limited operations) should be permitted to operate.

Approach 1 would mirror the current exemptions that were provided for lower-risk UAV operations and established a minimum distance of 5nm (9 km) from any aerodrome.

Approach 2 is based on the principal of prohibiting the operation of Small RPAS (limited operations) within controlled airspace, including control zones. To accommodate the largest control zones in Canada, this proposal would be to restrict operations within 11 nm (20 km) of any aerodrome.

Transport Canada is seeking comment on the above approaches.

LTRPAS

Transport Canada proposes to impose specific operating limitations to reduce or minimize potential encounters between manned and unmanned aircraft and to protect people and property on the ground. Such limitations would reflect the level of risk associated with a LTRPAS.

For RPAS falling under the proposed LTRPAS category, in addition to some of the rules proposed in the Small UAV (complex operations) category, Transport Canada proposes to incorporate operational restrictions addressing the following areas:

- operate only during the day.
- never operate in Class C, D, E or F airspace.

- comply with the minimum distance from aerodromes of 5nm (9 km).
- comply with maximum altitude requirements – not above 300 feet above ground level

Currently, in accordance with section 606.02 of the *Canadian Aviation Regulations,* all aircraft owners are required to subscribe for public liability insurance coverage. Transport Canada is proposing that there be no public liability insurance requirement for the *lower threshold* category of LTRPAS

Special Flight Operations Certificate

Since the proposed rule does not abolish the Special Flight Operations Certificate (SFOC) process, the existing requirement for an SFOC for UAS operations will be retained. The SFOC will be available to UAS operators for all other types of UAS operations that are not captured by the proposed rule (e.g. testing and development flights in restricted airspace test sites, UAS larger than 25kgs, beyond visual line-of-sight operations, etc). There may also be individual cases where a UAS operator meets the proposed rule in every respect, but because the operation is so specialized, they would need operational approval through an SFOC. Examples of such operations could include participating in an air show, operating at aerodromes, etc

Foreign Operations

As RPA's are considered aircraft, this proposal would maintain consistency with current rules pertaining to aircraft registration eligibility by limiting operation to Canadian citizens/corporations, except through an SFOC. This could affect foreign UAS operators operating small RPAS. However, it is also proposed that this restriction would not apply to UAS within the LTRPAS (*lower threshold)* category, allowing a foreign UAS operator to operate a LTRPAS in Canada. In light of the global context in which there is a growing potential for UASs in a variety of applications, Transport Canada will need to consider trade-related implications of UAS operations.

Conclusion

This document has attempted to present the NPA material with alternative formatting in order to better highlight the differences between the three classes of UAV. It is hoped that this document will serve as a starting point for understanding the full scope of the NPA and will help generate appropriate comments and feedback for Transport Canada through the CARAC process. Comments on the NPA content itself should be addressed to Transport Canada at carrac@tc.gc.ca (Note that it is carrac and not CARAC). It is recommended that those who wish to comment familiarize themselves with the full content of the NPA which is available here.

Appendix A – Definition of "Low Energy" RPAS

This Appendix repeats the relevant sections from the UAV Systems Program Design Working Group - Phase 1 Final Report - March 2012 in which the proposed criteria for the definition of a "Low Energy" RPAS is established.

Application

1.6 The Subgroups were tasked with considering the need to make a recommendation to establish a minimum weight or size limit for applying regulations. In other words, they were tasked with identifying whether there was some sort of lower threshold, under which the RPA did not need to be regulated, or could be regulated to a very low extent. As a result, the Working Group is recommending that there is a class of RPAS that, due to their nature, do not present a significant risk of harm to persons on the ground.

1.7 This class of RPA is defined by the maximum kinetic energy they possess and the maximum energy per unit area that they can impose on a human being. These RPA were defined as "Low Energy RPA". This conclusion was based on a variety of information sources such as range safety guides and design guidelines for non-lethal weapons. It is also noted that such aircraft, by their very design, have relatively short range and endurance. This, coupled with their low mass, makes them extremely unlikely to pose a threat to manned aviation. Therefore, the Working Group is recommending that section 101.01 of the CARs be amended such that low energy RPAS are added to the list of aircraft to which the Regulations do not apply unless otherwise indicated (i.e. model aircraft, rockets, hovercraft or wing-in-ground-effect machines).

1.8 A low energy RPA is an RPA that has been analyzed and/or demonstrated, for the case of an uncontrolled impact, to not impart a peak energy of more than $12J/cm^2$ on a stationary person or object in the most unfavourable of circumstances. Such analysis/demonstration is the sole element of airworthiness documentation required to comply with CARS 5xx.01.

Note: *$12J/cm^2$ is still subject to final validation.*

1.9 It is a low energy RPA that, by virtue of a number of characteristics, such as:

(a) low mass;
(b) low maximum speed;
(c) frangible or energy-absorbing deformable structure;
(d) small footprint;
(e) "soft" flight termination recovery;
(f) no hard massive components;
(g) protection against fire; and
- the use of fire-resistant materials, or
- any combination of the above,

is unlikely to result in severe injury to persons or significant damage to property.

Note: *A repeatable method to evaluate these aircraft to ensure they meet these criteria will be required to be adopted (see below).*

As an example of what 12J/cm^2 means, see the following:

1 Joule = 1kg m^2/s^2
1 knot = 0.514 m/s
Therefore:
12J/cm^2 = 0.5 kg travelling at less than 10 knots with 1 cm^2 frontal area, capable of imparting all of its kinetic energy instantaneously to a person.
For reference, here are some example values of kinetic energy/unit area:

Item	Typical Maximum Energy (J)	Typical Max. Energy/Unit Area (J/cm2)	Lethal?
Football	80	-	NO
Soccer ball	270	0.7	NO
Tennis ball	110	3.1	NO
Baseball	140	3.9	NO
Golf Ball	120	8.4	NO – but getting close!
RPA examples			
Maverick	440	440/4 **= 110J/cm**2**	YES
CyberQuad MAXI	133	133/42 **=3.17J/cm**2**	NO
Aeryon Scout	208 (total) 150 after “arms” break off	150/103 **=1.45J/cm**2**	NO

The level of energy that can cause harm when imparted on a human is cited in a variety of references, both regarding RPAS and non-lethal weapons. The values in RPAS specific documents range from 33.9J to 53[3]J. Equally, the harmful level of energy per unit area is cited anywhere from 6 J/cm^2, which can cause an eye injury in the most critical geometry collision, to 12.8J/cm^2.

1.10 A new regulation is being introduced in Part VI, Subpart 2 that states that a low energy RPA shall not be flown into cloud, in a manner that is likely to be hazardous to aviation safety and in a manner to endanger or be likely to endanger the life or property of any person. This proposed regulation is consistent with section 602.45 of the *CARs* – Model Aircraft, Kites and Model Rockets.

[3] RCC. *Standard 321-02, Common risk criteria for national test ranges: Inert debris*. Range Safety Group Risk Committee, Range Commanders Council, US Army White Sands Missile Range, NM, USA, June, 2002 - which defines 42J = < 5% risk of fatal injury

Appendix – B – Design Standard for a 'Compliant' Small UAV System

This section contains the information listed in Transport Canada's staff instruction 623-001 regarding the design requirements associated with a 'Compliant' small UAV system.

1. General - The following sections set out:
    a. The airworthiness criteria for a small UAV system that includes a UAV with a maximum take-off weight (MTOW) of 25 kg or less; and
    b. The requirements for inspections, equipment and instruments, and operating information necessary for this UAV system to be considered Compliant.

Flight Performance

. The aircraft shall be safely controllable and manoeuvrable during all flight phases including, where applicable:
    1. taxi;
    2. take-off/ launch
    3. climb;
    4. level flight;
    5. descent;
    6. go-around;
    7. land/recovery; and
    8. at all permissible aircraft speeds and in all permissible aircraft configurations.
    a. It shall be possible to make a smooth transition from one flight condition to another (including turns and slips) without danger of exceeding the limit load factor, under any probable operating condition.

b. If the UAV can aerodynamically depart from controlled flight:
    1. the probability of such a departure from which recovery is not possible using a prescribed technique shall be extremely remote, or
    2. there shall be a means of initiating flight termination in the event of such a departure
    c. The UAV pilot shall be provided sufficient and timely flight and systems information to adequately operate the UAV system.
    Note:
    This may include, if they are required by the pilot to maintain control, fuel or other energy source, angle of attack, angle of sideslip, speeds, g-loads, etc.

d. (e) A centre of gravity envelope, where the aircraft remains safely controllable, shall be established. The aircraft centre of gravity, including all modifications, consumables, configurations and payloads, shall remain within this envelope during flight.

e. (f) A performance envelope in terms of speeds, climb rate, and any other operating parameters, for all permissible aircraft weights and configurations, shall be established to determine the operating limitations of the UAV.
    Note:
    May include: best glide speed, Vmca, Vmcg, Vd, Vcruise, Vs, Vr, etc.

UAV Structure

. The UAV shall be designed to have sufficient strength for all expected operating conditions, including those with propulsion system failures and involving environmental factors such as gusts.
    a. Representative limit load cases shall be demonstrated to prove compliance with a 1.5 safety factor.
    b. The UAV structure shall not exhibit unintended binding, chafing or permanent deformation due to any expected flight and ground loads (including take-off/launch and landing/recovery).

Design and Construction

. The suitability of each part, component, and assembly, having an important bearing on safety and operations, shall be established.
    a. Materials and Workmanship - The suitability and durability of materials used for parts, the failure of which could adversely affect safety, shall:
        1. be established by experience or tests;
        2. meet accepted specifications that ensure their having the strength and other properties assumed in the design data;
        3. take into account the effects of environmental conditions, such as moisture (i.e. rain), temperature and humidity, expected in service; and
        4. have a high standard of workmanship.
        b. Fabrication Methods - The methods of fabrication used shall produce consistent results. If a fabrication process (such as gluing, spot welding, or heat-treating) requires close control to reach this objective, the process shall be performed under a documented process specification.
    c. Fasteners - Fasteners with suitable locking mechanisms shall be employed, where the failure of which, would prevent continued controlled flight.
    d. Protection of Structure - Each part of the structure shall be suitably protected against deterioration or loss of strength in service due to any cause, including:
        1. weathering;
        2. corrosion; and
        3. abrasion.
        e. If the UAV operation requires application of full propulsive power while the aircraft remains stationary, then a suitable means shall be provided to restrain the aircraft.
    f. Systems that present the potential for fire on the UAV shall be designed to minimize this risk.
    g. UAV designs should avoid sharp edges and incorporate energy absorbing materials

Propulsion System

. If a single failure within the propulsion system could result in the loss of control of the UAV trajectory:
        1. the probability of such a failure under all expected operating conditions shall be extremely remote, or
        2. there shall be a means of initiating flight termination in the event of such a failure.
        a. The installation of the propulsion system shall ensure safe operation throughout the aircraft flight envelope.

b. Any propellers or rotors shall have sufficient strength to ensure safe operation throughout the flight envelope.
c. Each fuel system shall be constructed and arranged to ensure fuel flow at a rate and pressure established for proper engine and auxiliary power unit functioning under all likely operating conditions.
d. Each fuel tank and its associated plumbing and related components shall be able to withstand, without failure, the vibration, inertia, fluid, and structural loads that it may be subjected to in operation.
e. Each electrical source for propulsion shall be constructed and arranged to ensure energy delivery at the required voltage and current levels under all likely operating conditions.
f. Each electrical source for propulsion and its associated wiring and related components shall be able to withstand, without failure, the vibration, inertia, temperature and structural loads that it may be subjected to in operation.
g. The UAV design shall incorporate provision for adequate cooling of propulsion system components.

Systems and Equipment

. General Function and Installation

1. Each item of installed equipment in a UAV shall:
    1. be of a kind and design appropriate to its intended function;
    2. be labelled as to its identification, function, or operating limitations, or any applicable combination of these factors, if appropriate;
    3. be installed according to limitations specified for that equipment; and
    4. function properly when installed.
    a. Flight and Navigation Information

1. The UAV system shall provide the pilot a means to determine, in a timely manner, the following parameters:
    1. UAV present position;
    2. UAV altitude;
    3. UAV heading;
    4. UAV fuel or other indication of remaining flight time;
    5. UAV operating status; and
    6. any parameters shall be provided at the resolution and accuracy levels required to comply with Air Navigation System requirements as mandated operational requirements
2. This information shall be provided in a clear fashion, under all operational conditions.

    Note:

    Some of this information may be provided through visual observation of the UAV.

b. High-Intensity Radiated Fields (HIRF) Protection

1. If the operation of the UAV system includes flight in areas where HIRF are probable, the UAV system electrical and electronic systems that perform functions whose failure would prevent the continued safe flight and recovery of the UAV shall be designed to mitigate this risk

c. Equipment, Systems, and Installations

1. Each item of equipment, each system, and each installation:
    1. when performing its intended function, shall not adversely affect the response, operation, or accuracy of any equipment essential to safe operation; and
    2. shall be designed to minimise hazards to the safe operation of the UAV system in the event of a probable malfunction or failure.
2. If a single failure of a UAV system could result in the loss of control of the UAV trajectory:
    1. the probability of such a failure under all expected operating conditions shall be extremely remote, or
    2. there shall be a means of initiating flight termination in the event of such a failure, or
    3. there shall be an alternate means of regaining control.

d. Navigation Systems

1. A UAV system shall have a means to determine the position and altitude of the aircraft in flight sufficiently accurate for the operation and associated airspace.
2. ***Note:***
   A pilot and/or observer may meet this requirement.

e. Sense and Avoid Systems

1. All UAV Systems shall have a means to sense and avoid collisions with other aircraft.
2. ***Note:***
   The pilot, or the pilot assisted by visual observers may satisfy the sense and avoid requirement.

f. UAV Control

1. For command, control and communication links required during the operation of the UAV system, the probability of a failure that results in loss of timely aircraft trajectory control shall be extremely remote, or the failure shall result in the activation of a flight termination system.
   Note:
   The performance of pre-programmed manoeuvres to regain link and/or return to base are not generally considered to constitute a "loss of timely aircraft trajectory control".
2. The pilot-in-command must be able to assess the risk involved with the particular lost link circumstance and establish when auto-recovery manoeuvres or flight termination shall be initiated.
3. There shall be a means to assure that prior to taxi and take-off or launch, the UAV systems and subsystems are operating correctly.
4. The probability of loss of control of aircraft trajectory caused by control station handovers shall be extremely remote in all expected operating conditions or this condition shall result in the activation of a flight termination system.
5. The control station and associated link to the UAV shall be designed such that the probability of the UAV receiving an incorrect command is, extremely remote.

Note:

The above includes security provisions against malicious hacking.

6. Warning information shall be provided to alert crew member(s) to unsafe system operating conditions and to enable them to take appropriate corrective action.
7. Systems, controls, and associated monitoring and warning means shall be designed to minimise crew member errors that could create additional hazards.
8. The control station shall provide appropriate control station and data link status information to the pilot- in-command (PIC).
9. The control station and associated UAV shall be tested and demonstrated in an integrated manner to be functional.
10. The control station permissible operating conditions shall be specified and verified.
11. Control station swap-out provision - In the case of a UAV where the UAV may be operated by a variety of permissible control stations, the above criteria (g (i) – (x)) shall be met by each combination which are to be specified in the Type Definition.
12. Data and control links swap-out provision - In the case of a UAV where the UAV may be operated by a variety of permissible data and control links, the above criteria (g (i) – (x)) shall be met by each combination which are to be specified in the Type Definition.
13. In cases where the control station relies on an external source of power, a means to retain control of the UAV in the event of power failure shall be present.

g. Launch and Recovery Systems

1. Operation of the launch and recovery system shall not pose a safety hazard.
2. The performance envelope for a safe take-off/launch and landing/recovery of the UAV shall be specified, including, if appropriate, but not limited to:
    1. clear areas required for take-off/launch and landing/recovery;
    2. meteorological conditions;
    3. wind components;
    4. density altitude;
    5. launch/recovery equipment settings;
    6. permissible aircraft configurations/loadings; and
    7. required system checks.
3. The conditions under which the operation of the launch system results in consistent transition into safe flight in all permissible operating conditions shall be defined.
4. The conditions under which the operation of the recovery system results in a predictable outcome in all permissible operating conditions shall be defined.
5. If a failure of launch or recovery systems can result in loss of control of the UAV trajectory:
    1. the probability of such a failure under all expected operating conditions shall be extremely remote;

2. a flight termination system shall be initiated; or
3. there shall be safe alternatives available to conclude the UAV operation.

h. Payloads

1. Payloads shall not create a hazard to the safe operation of the UAV system or to persons and property on the ground.
2. The limitations for payloads on the UAV shall be defined and a list of permissible payloads shall be provided.
3. A permissible payload shall meet the following standards:
    1. Maximum power load of payloads plus maximum power loads of all other systems onboard shall be within the power allowance of the aircraft power system;
    2. Payloads shall be designed and tested to avoid the inadvertent transmission of any electromagnetic interference (EMI) that affects the control of the UAV trajectory; and
    3. Payloads, associated fairings and their attachment to the aircraft shall be designed and tested to withstand maximum expected loads during flight, including take-off/launch and landing/recovery loads, or be placarded to impose flight restrictions to limit the aircraft to acceptable flight operations.
4. Active Payloads

    Note:

    Active payloads are defined as payloads that intentionally and actively release any Radio Frequency (RF), acoustic or material emissions as part of their normal function.

    1. Active payloads shall not present a hazard to ground crew or shall have a means of being rendered safe on the ground.
    2. Active payloads shall have a visible means of indicating that they are rendered safe on the ground.
    3. Active payloads shall have a safe means of testing their function(s) while on the ground.
    4. Active payloads shall have a secure and reliable means to manage its operation in flight, even in lost link and flight termination scenarios, if such operation presents a hazard.
5. Explosive Payloads (notwithstanding other regulations for these payloads)
    1. Explosive payloads shall have a means of being jettisoned during an emergency.
    2. There shall be a means to ensure that jettisoning of explosive payloads is conducted over designated safe areas only.
    3. Explosive payloads shall remain inert so long as the ground safeing equipment is in place.
6. Moving Payloads
    1. Moving payloads shall not present a hazard to ground crew or shall have a visible means of being rendered safe on the ground.

2. Moving payloads shall have a safe means of testing their function(s) while on the ground.
3. Payloads with moving parts shall be designed and tested to show that all possible movement does not adversely affect aircraft performance.

7. Payloads with Rotating Components
    1. Payloads with rotating components shall be designed and tested to ensure that either maximum rotation does not affect safe UAV trajectory in the air or that maximum rotation cannot be maintained for any duration of time that poses a risk to control of the aircraft trajectory.

       Note:

       As an example: gyroscopic effect critically hindering turn response.
8. External Payloads
    1. External payloads or payload components shall not render unsafe any flight critical systems on the UAV.
    2. External payloads or payload components shall not render unsafe the operation of the take-off/launch, landing/recovery, flight termination or safety features of the UAV.
9. Payloads used for "Flight Decisions"
    1. Payloads integral to the control of the UAV shall conform to the airworthiness standards for the flight control system.
10. In the case of a UAV system where the UAV may be operated with a variety of permissible payloads, the above criteria ((i) – (ix)) shall be met by each combination which are to be specified in the Type Definition.

Manuals and Documentation

. Flight Manual - The UAV system shall have a flight manual that includes operating limitations, standard operating procedures, emergency procedures, assembly instructions and UAV performance data.

a. Maintenance Manual - The UAV shall have a maintenance manual (which may be part of the flight manual) that defines actions that shall be taken to keep the UAV system in conformity with its Type Definition.

b. The following is the basic structure of a small UAV system flight manual. This outline is not exhaustive.

c. ***Notes:***

   Mandatory (safety critical) items and sections are identified by bolded and underlined text.

   The flight manual and maintenance manual may be separate documents or combined in a single document.

    1. **General**
        1. Description of the UAV
        2. Engine, propeller, rotor
        3. Three-view drawing
        4. Flight Controls, control deflections
        5. Ancillary controls

6. Displays
    1. Flight-related (Altitude, airspeed, magnetic heading, position, attitude)
    2. Control settings
    3. Switches and caution/warning lights

ii. **Limitations**

1. Weight
    1. Maximum weight
    2. Centre of gravity limits
2. Speed (or others that are appropriate for the UAV)
    1. Maximum speed (VDive)
    2. Manoeuvring speed
    3. Best gliding speed (max L/D)
3. Manoeuvring load factor (or equivalent)
4. Prohibited manoeuvres
5. Weather conditions (e.g. icing conditions)
6. Safety footprint for operational phases such as take-off/launch and landing/recovery

iii. Powerplant – propeller

1. Maximum power
2. Maximum engine/motor speed – propellers
3. Fuel system, indicators; battery state indicators

iv. **Emergency procedures**

1. Engine failure
2. Fire
3. Gliding
4. Landing/recovery
    1. Conventional horizontal run
    2. Parachute
    3. Net
    4. Other
5. Other emergencies:
    1. Loss of navigation aids
    2. Loss of command link
    3. Control jam
    4. Structural failure
    5. Etc.
6. Flight termination

v. **Normal Procedures**

1. Pre-flight inspection
2. Synchronization or other initialization procedures
3. Start up, taxi
4. Take-off/launch/launch
    1. Conventional horizontal run;
    2. Hand launch;

3. Catapult;
4. Winch;
5. Other

5. Cruise
6. Landing/recovery
    1. Conventional horizontal run
    2. Parachute
    3. Net
    4. Other
7. Post flight/shutdown landing and shutting down powerplant

vi. **Performance**

1. Take-off/launch
2. Wind limitations
3. Landing/recovery

vii. Mission equipment

1. List of equipment
    1. Identify flight critical equipment
    2. Identify equipment that may direct the trajectory

viii. **Assembly and adjustment**

1. Assembly and disassembly instructions
2. Rigging

d. The following is the basic structure of a small UAV system maintenance manual. This outline is not exhaustive:

0. Wings or envelope;
1. Structure:
    1. Doors and hatches;
    2. Fasteners; and
    3. Non-metallic components, including fabric or other covering
2. Engine(s) and propeller(s);
3. Command and control systems;
4. Environmental/type of use considerations;
5. Simple periodic maintenance activities based either on the number of flying hours or on calendar periods of use (whichever is reached first);
6. Major maintenance activities necessitating thorough checks which could require partial disassembly;
7. Acceptance inspection following the first TBD hours of use of a new system;
   Note:
   The manufacturer shall establish the appropriate period after which an acceptance inspection is due.
8. Necessary inspections following removal from storage;
9. A table containing the checks and deadlines that allows the owner to add his/her signature and the date the check is carried out. Any problems encountered, solutions applied and replaced parts should be noted;
10. Specify any instruments, special tools, jigs, fixtures or tooling used to help assess acceptable tolerance levels. The manual specifies life-limited parts;

11. Information, drawings or cut-away diagrams necessary to show how to assemble the various parts which can normally be disassembled. These criteria may also be taken into account by the propeller manufacturer;
12. Repair procedures;
13. Inspection procedures after abnormal occurrences;
14. Maintenance release procedures; and
15. Miscellaneous.