

Guidebook for Integrating a Micro Unmanned Aerial System (UAS) into Police and Emergency Operations

Jerome Engele
Saskatoon Police Services

Marc Sharpe
Ontario Provincial Police

Scientific Authority
John Evans
DRDC Centre for Security Science

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Defence R&D Canada – CSS

Contract Report
DRDC CSS CR 2012-012
October 2012

Principal Authors

Jerome Engele - Marc Sharpe – John Evans

Saskatoon Police Services - Ontario Provincial Police - DRDC

Approved by

Original signed by Steve Palmer

Steve Palmer

DRDC Centre for Security Science

Approved for release by

Original signed by Dr. Mark Williamson

Dr. Mark Williamson

DRDC Centre for Security Science- DRP Chair

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Abstract

The aim of this Guidebook is to present the facts to consider prior to establishing an Unmanned Aerial System (UAS) Unit within emergency responder operations. This Guidebook was produced through a collaborative effort between Canadian and American law enforcement agencies currently using UAS. While every effort was made to cover as many key areas as possible, this reference should not be considered authoritative or comprehensive. Instead it is intended to provoke thought and discussion on the many important issues that need to be addressed including legal, regulatory, jurisdictional and environmental.

The responder organizations currently using UAS are reporting increased responder safety, enhanced photographic evidence of crime scenes, faster evidence collection, an improved efficiency in clearing serious traffic collision scenes and significant cost savings as compared to manned aircraft use. Many more uses will be commonplace in the coming years including Tactical Support, Search and Rescue and Incident Command at Major Incidents.

Résumé

Le présent guide vise à présenter les faits à prendre en considération avant la mise sur pied d'une unité de systèmes aériens sans pilote à bord (UAS) au sein d'un service d'intervention d'urgence. Ce guide est le fruit de la collaboration entre des services policiers canadiens et américains qui utilisent déjà des UAS dans leurs opérations. Bien que tous les efforts aient été faits pour couvrir le plus grand nombre possible de points essentiels, il ne faudrait pas croire que ce guide fasse autorité ou qu'il soit complet. Il a plutôt pour but de stimuler la pensée et la discussion sur les nombreuses questions importantes que chaque service devra se poser, compte tenu des préoccupations légales, réglementaires, juridictionnelles et environnementales qui lui sont propres.

Les services d'intervention qui utilisent actuellement des UAS font état d'une meilleure sécurité des intervenants, d'une amélioration des preuves photographiques obtenues sur les scènes de crime, d'une collecte plus rapide des preuves, d'une meilleure efficacité dans le dégagement des scènes d'importantes collisions routières et de fortes économies par rapport à l'utilisation d'aéronefs avec pilote à bord. De nombreux autres usages vont devenir chose courante dans les prochaines années, qu'il s'agisse d'appui tactique, de recherche et sauvetage et de commandement sur place en cas de graves incidents.

Executive summary

Guidebook for Integrating a Micro Unmanned Aerial System (UAS) into Police and Emergency Operations:

DRDC CSS CR 2012-012; Defence R&D Canada – CSS; October 2012.

A UAS is an unmanned remote-controlled flying craft that uses aerodynamic forces to provide lift. Current UAS models come in two basic configurations; fixed wing or rotary wing: In general, fixed wing UAS fly faster and can cover larger distances than rotary wing UAS, which are better at manoeuvring in confined spaces and excel at providing up-close photos or videos. Micro-UAS weigh approximately two kilograms, have wing-spans of only a few feet, are electric or fuel powered, and have flight times ranging from 10-30 minutes. Micro-UAS can carry a payload which usually includes on-board cameras (still, high definition video or infra-red); and can also carry other sensors (environmental, explosive vapour, carbon monoxide, etc) and objects that do not hinder its flight. While this document is focused on Micro UAS, the majority of its contents also refer to larger UAS. The term Micro UAS will be used only when the content is specific to Micro UAS.

The rapid evolution of the UAS (Unmanned Aerial System) industry is compelling emergency responder organizations to consider if these systems are appropriate for integration into their operations. Several responder agencies across Canada and the United States are, in fact, already using UAS as an investigational aid for aerial photography at crime scenes, collision scenes, environmental/HAZMAT incidents, crime prevention through environmental design and other similar purposes.

Establishing an UAS Unit is not as simple as just “buy-and-fly”, rather it must be done carefully and with forethought. The purpose of this Guidebook is to help identify key areas to consider and address as part of the process to make sound decisions about procuring and operating UAS. While the collaborative effort of the agencies and individuals involved in developing this Guidebook have tried to cover as many key areas as possible, this Guidebook should not be considered authoritative or comprehensive. Instead it is intended to provoke thought and discussion on the many important issues that each agency will need to address based on individual legal, regulatory, jurisdictional and environmental concerns.

Using UAS to Enhance Police Investigations

The North American police agencies currently using UAS are reporting increased responder safety enhanced photographic evidence of crime scenes, faster evidence collection, an improved efficiency in clearing serious traffic collision scenes and significant cost savings when compared to manned aircraft use. These agencies have also used UAS to provide reconnaissance at a drug compound prior to a raid, patrol a border for drug smugglers, find a missing child lost in a marsh on a cold night and locate a child's body under the ice of a river. Many more uses will be commonplace in the coming years including Tactical Support, Search and Rescue and Incident Command at Major Incidents.

The use of UAS for surveillance is very sensitive. It is a trip-wire for public backlash and media sensationalism of a ‘Big Brother’ invasion of privacy. A few early trial programs have already suffered a quick death because of this. If not handled with great care, thoughtful planning and stringent controls, incidents could occur which will jeopardize the UAS program of not only the involved agency, but programs nationwide. UAS have a useful abilities in this area, but agencies should avoid this application unless they are prepared to put significant forethought into the policy of use and ensure they have a well planned public and media communication strategy to pre-empt any misunderstanding, media sensationalism or backlash from the public.

Key Points

The procurement of a UAS is not actually the first step in setting up a UAS unit. Numerous points need to be carefully considered and among them are the following:

- It is important to clear up the misconception that Micro-UAS are interchangeable with manned aircraft and responder agencies require only one type of aircraft. Micro-UAS are small, quiet, inexpensive to operate, and can fly very close to ground level but have very limited flight time and payload capability. Manned aircraft can quickly cover larger distances, but they are noisier, costly to operate and must fly at higher altitudes. The fact that manned aircraft can carry personnel onboard also provides benefits as they can make on the spot-decisions and take immediate action. Rather than being substitutable, micro UAS and manned aircraft are really complementary equipment since they perform different functions. It will be essential to develop a employment strategy with operational criteria under which the most appropriate decision can be made to deploy the right vehicle at the right time.
- Micro UAS are not the same class of aircraft as the military Predators, but it is important to note that this is frequently the image the public has when they hear the words unmanned aircraft. Micro UAS are intended for very low level, close-up zoom, and short-duration photography. Small enough to fit in a suitcase, micro UAS are very quiet, safe, easy to fly and can manoeuvre below the height of nearby buildings and are generally used to fly from ten to a few hundred feet above ground and within a range of a few hundred meters.
- It is imperative that agencies use UAS appropriately as their misuse can create controversy. Furthermore, poor judgment by one agency can negatively affect the perception of UAS use in the greater police community. Public acceptance is a key goal in the early stages of adoption of this technology. Err on the side of caution.
- Agencies must address their Operation Protocols to resolve issues such as appropriate use, levels of authority and responsibility, reporting and logging procedures, maintenance, etc.
- UAS require a Special Flight Operations Certificate from Transport Canada and a Certificate of Authority in the United States. In Canada UAS civil operations are confined to 'within line of site' operations ie the operator MUST maintain visual contact with the vehicle at all times. The standards and procedures for Beyond Line of Site Operations (BLOS) are under development.
- UAS pilots require training in both the operation of the system and air traffic regulations to include radio operator training to secure a radio operator certificate. The operator also requires training on theory of flight, weather, aerodynamics and airspace (Canada and US) and air navigation.
- Agencies must have special liability coverage.
- Micro UAS are often best placed with a support service such as Forensics or Collision Investigation as they are accustomed to photographic evidence and do not have competing functions during an emergency or Tactical Operation.
- UAS have limited roles for intelligence-gathering surveillance functions due to their range and short flight time. Surveillance (even using the word) is an especially sensitive 'tripwire' for public backlash. UAS should NOT be used for surveillance unless the agency has conducted a comprehensive examination of the potential for a public backlash or media sensationalizing of the UAS and taken all steps to ensure such a risk is mitigated and does not jeopardize both their UAS program and that of the greater police community.
- Micro UAS are very useful for situational awareness in short-duration tactical situations providing stealthy real-time video, either from circling above, hovering at a particular vantage point or from landing (perching) the micro UAS on a suitable position such as a rooftop. By perching a micro UAS, power is used only by the camera allowing it to run for many hours.

- UAS have the potential to perform a multitude of applications and could carry other sensors such as listening devices or chemical monitors.
- Agencies need to prepare a media strategy and ensure their governing bodies, the legal community and the media/public fully understand UAS use in responder operations prior to becoming operational.
- UAS use will rapidly become commonplace in emergency services. Even if immediate adoption is not a consideration, agencies should be aware of UAS and address this issue during their strategic planning and operational exercises.
- UAS are not limited to Emergency Services. Media, commercial enterprises, and the criminal element including terrorists are also able to make use of this technology and responder agencies must consider how to manage these applications as well.

Sommaire

Guide d'intégration d'un système aérien sans pilote à bord (UAS) dans des opérations de police et de secours:

DRDC CSS CR 2012-012 RDDC R&D pour la défense Canada – CSS; octobre 2012

Un UAS et un aéronef sans pilote à bord commandé à distance qui se sert de forces aérodynamiques pour générer de la portance. Les modèles actuels d'UAS peuvent adopter l'une ou l'autre des deux configurations suivantes : à voilure fixe ou à voilure tournante. Les appareils à voilure fixe volent plus vite et peuvent couvrir de plus grandes distances que les appareils à voilure tournante, lesquels sont toutefois meilleurs dans les manœuvres à l'intérieur d'espaces exigus, en plus d'exceller dans la prise rapprochée de photos et de vidéos. Les micro-UAS pèsent environ deux kilogrammes, ont une envergure de seulement quelques pieds, sont alimentés par des moteurs à combustion ou électriques et possèdent une autonomie de vol comprise entre 10 et 30 minutes. Les micro-UAS peuvent emporter une charge utile, comme des appareils-photos ou des caméras (vidéo haute définition ou infrarouge), des capteurs (environnementaux, de vapeurs explosives, de monoxyde de carbone, etc.) et des objets qui ne nuisent pas au vol.

La rapide évolution de l'industrie des UAS (systèmes aériens sans pilote à bord) ne peut faire autrement que d'amener les services d'intervention d'urgence à se demander s'il serait judicieux de leur part d'intégrer de tels systèmes dans leurs opérations. Dans les faits, plusieurs services d'intervention au Canada et aux États-Unis utilisent déjà des UAS comme outil d'aide aux enquêtes qui prennent des photographies aériennes sur des scènes de crime, sur des lieux d'accident, lors d'incidents environnementaux/HAZMAT, pour prévenir des crimes par l'aménagement du milieu et autres buts similaires.

Mettre sur pied une unité UAS ne se fait pas « en deux temps, trois mouvements », il s'agit plutôt d'un processus qui doit être mené avec soin et prévoyance. Le présent guide vise à vous aider à identifier les points essentiels à prendre en considération et à traiter afin que vous puissiez prendre des décisions éclairées en matière d'achat et d'utilisation d'UAS. Bien que, grâce aux efforts conjoints des services et des personnes ayant participé à la préparation du présent guide, il y a eu tentative de couvrir le plus grand nombre possible de points essentiels, il ne faudrait pas croire que ce guide fasse autorité ou qu'il soit complet. Il a plutôt pour but de stimuler la pensée et la discussion sur les nombreuses questions importantes que chaque service devra se poser, compte tenu des préoccupations légales, réglementaires, juridictionnelles et environnementales qui lui sont propres.

L'utilisation d'UAS pour améliorer les enquêtes policières

Les services policiers nord-américains qui utilisent actuellement des UAS font état d'une meilleure sécurité des intervenants, d'une amélioration des preuves photographiques obtenues sur les scènes de crime, d'une collecte plus rapide des preuves, d'une meilleure efficacité dans le dégagement des scènes d'importantes collisions routières et de fortes économies par rapport à l'utilisation d'aéronefs avec pilote à bord. Ces services ont également utilisé des UAS pour faire de la reconnaissance d'un laboratoire clandestin de drogue avant de procéder à une descente, pour patrouiller une frontière à la recherche de trafiquants de drogue, pour trouver un enfant porté disparu dans un marais par une nuit froide et pour localiser le corps d'un enfant sous la glace d'une rivière. De nombreux autres usages vont devenir chose courante dans les prochaines années, qu'il s'agisse d'appui tactique, de recherche et sauvetage et de commandement sur place en cas de graves incidents.

Les UAS ne doivent pas servir à la surveillance discrète de personnes ou de véhicules, sauf dans des circonstances exceptionnelles où il y a un risque immédiat à la vie ou à la sécurité qui pourrait être atténué par l'utilisation d'un UAS.

Points essentiels

- L'achat d'un UAS ne constitue pas, loin s'en faut, la première étape de la mise sur pied d'une unité UAS. De nombreux points doivent d'abord être soigneusement analysés; en voici quelques-uns :
- Il importe en premier lieu de corriger cette idée reçue voulant que micro-UAS et aéronefs avec pilote à bord soient interchangeables et que les services intéressés n'aient besoin que d'un seul de ces deux types d'aéronef. Petits, silencieux et peu coûteux à utiliser, les UAS peuvent voler au niveau du sol, mais ils ont un temps de vol limité. Quant aux aéronefs avec pilote à bord, ils peuvent rapidement couvrir de plus grandes distances, mais ils sont bruyants, ils sont coûteux à utiliser et ils doivent voler à des altitudes plus élevées. Le fait que les aéronefs avec pilote à bord puissent transporter du personnel à bord est également un avantage, car ces personnes peuvent alors prendre des décisions sur place. Plutôt que d'être substituables, les UAS et les aéronefs avec pilote à bord sont complémentaires, puisqu'ils ne remplissent pas les mêmes fonctions.
- Les micro-UAS ne sont pas des aéronefs identiques aux Predator militaires, puisque ces derniers peuvent servir d'armes de combat. Les micro-UAS sont destinés à effectuer des missions de courte durée à très basse altitude permettant de prendre des photos de très près. Suffisamment petits pour tenir dans une valise, les micro-UAS sont très silencieux, sûrs et faciles à utiliser, et ils peuvent manœuvrer plus bas que le sommet des immeubles environnants; en général, on les utilise de dix à quelques centaines de pieds au-dessus du sol et à une distance de quelques centaines de mètres.
- Il est impératif que les services se servent d'UAS de façon judicieuse, car tout abus pourrait créer la controverse. Qui plus est, le mauvais jugement dont pourrait faire preuve un service risque d'avoir une incidence négative sur la perception de l'utilisation des UAS dans les opérations policières.
- Les UAS doivent posséder un certificat d'opérations aériennes spécialisées délivré par Transports Canada et un certificat d'autorisation aux États-Unis.
- Les pilotes d'UAS doivent suivre une formation en utilisation du système ainsi qu'en réglementation de la circulation aérienne.
- Il se pourrait que les services aient besoin d'une assurance responsabilité spéciale.
- Les services doivent prévoir des protocoles d'utilisation permettant de régler des questions comme l'utilisation appropriée, les niveaux d'autorité et de responsabilité, les procédures de compte rendu et de consignation, la maintenance, etc.

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Acknowledgements

The project team acknowledges the following for their technical contributions:

Cst. Andy Olesen - EDU - Halton Police Service

Sgt. Dave Banks - FIS - Halton Police Service –

Cst. Marc Sharpe - OPP Kenora

Cst. Richard Cunningham - OPP Thunder Bay

Daniel DeVreker - OPP Orillia

Insp Tom Mansfield - Regina Police Service

Insp Marlo Pritchard - (Retired) - Regina Police Service

Cst. Cory Lindskog - Regina Police Service

S/Sgt Galvin Brower - RCMP E Div

Insp Yves Desjardins – RCMP Ottawa

Sgt Dave Jewers - RCMP Surrey BC

Insp Doug Wheler - RCMP E Div

Insp. Jerome Engele - Saskatoon Police Service

Sgt. Cameron McBride - Saskatoon Police Service

Sgt. Devon Racicot - Saskatoon Police Service

Agent Claude Bisson - Sûreté du Québec

Benjamin Miller - Mesa County Sheriff's Office - Grand Junction Colorado

John Evans - Canadian Police Research Centre

Patty Xenos - Canadian Police Research Centre

1 Section One: Introduction

Purpose of Guidebook

This guidebook is intended as a resource for emergency responder agencies considering establishing an Unmanned Aerial System (UAS) program. It is also meant to assist with creating acceptable policy consistent with regulations that exist for the use of this emerging technology. The focus of this is on micro UAS, however much of the content will also be applicable to large UAS.

The guidebook is divided into six sections to assist with ease of use. The annexes contain sample documents and forms required for UAS implementation and usage. A list of references is included for those wishing more detailed information.

Philosophy

The safe and lawful use of Unmanned Aerial Systems (UAS) can help protect emergency responders from harmful situations, enhance operational effectiveness and provide evidence that would have otherwise been challenging to obtain.

State of Industry and Technology

There are numerous UAS available today and models run the spectrum with respect to size and capabilities; some larger systems are capable of flying around the world while other ultra small systems can fit in the palm of your hand and can only fly for a few minutes. UAS found their initial market in military operations. With their successful maturity there, the industry is now focused on expanding into the civilian market. Payloads can range from small sensors to cameras to weapons. Operated using remotely controlled systems, some UAS can only fly within visual line of sight while other can be remotely piloted beyond line of sight. Still others are completely autonomous systems, pre-programmed to fly a course or pattern without pilot intervention. Operations can be executed by a single operator or may require multiple operators. The cost of this technology ranges from hundreds to millions of dollars.

UAS versus Manned

A common misconception is that UAS are only used in situations where the conditions are dangerous, repetitive and/or monotonous. This is sometimes true and since the UAS has primarily been used in a military context they emerged to perform the Dull, Dangerous and Dirty missions. As these systems have evolved the use of UAS promise to provide benefits in many civil and commercial applications. The UAS has proven its value to the Responder, and if used appropriately, they can be used in an investigation to obtain more efficient and cost effective outcomes. For instance the use of UAS to capture aerial photographs can produce images in a more cost effective and more efficient manner and at a much closer range. Conversely, for situations where higher altitudes and longer flight duration times are required, a manned system would be more cost effective. In cases requiring extended surveillance or the ability to refocus on another task, a manned system would probably be more effective.

Micro UAS can fill a niche for low-level, close proximity work that cannot be performed by manned systems. In most cases, the UAS is an enhancement to an agency's resources and although it may provide some of the services that a manned system can perform, the UAS cannot replace the manned system at this time since its function has some limitations. Smaller agencies whose budgets cannot sustain a full sized aircraft could benefit from a smaller UAS as it can provide a cost effective and affordable solution to enhance their capabilities.

Justification

Achievable

Current technology is readily available for use and existing regulations allow for use within Canadian civilian airspace.

Legitimate and Meaningful

UAS have been integrated into responder operations worldwide and they are being deployed in a variety of applications. Canadian law enforcement agencies are already operating UAS and have demonstrated that UAS enhance their agencies' investigative capabilities as well as their response to emergency situations.

Public Acceptance

An effective media strategy will raise the public's awareness as to the intended lawful and safe use of UAS and will help the public accept their use in responder operations.

Return on Investment

Measuring the ROI of the UAS is a difficult task since many of the primary benefits provided by the UAS are intangible and not quantifiable. For example, how do you calculate the value of the improvements the UAS makes to the evidentiary package that is forwarded to the courts? Similarly, how can you quantify the positive impact the UAS makes on the jury's ability to better understand viva voce (live voice) evidence when combined with the UAS' crime scene imagery? The fact that the UAS also increases responder safety is another valuable factor that cannot be calculated. A tactical unit could obtain stealth close-in live video of a yard they are about to enter. It is easy to calculate ROI when it comes to the savings in jet fuel as compared to the manned aircraft, but for the most part, it is impossible to estimate the value of the crucial evidence or intelligence provided by the UAS.

One practice that would contribute to maximizing the cost effectiveness of the UAS would be to use it in every application where it is thought to provide benefits. Restricting the UAS' use to just one or two scenarios would limit the ROI and would also reduce the pilots' opportunity to maintain their skill level.

2 Section Two: Concept of Operations

CBRNE – Hazmat

In the event of a CBRNE incident, emergency site managers would make it a priority to protect the responders by reducing the risk of exposing them to harmful substances. Obtaining an overview of the immediate and surrounding areas of the CBRN incident would be invaluable as an assessment could be made even before the responders don their HAZMAT gear. It is also much faster than ground robots and not hampered by ground obstacles. UAS could also capture photographs and/or video that could indicate possible contamination paths and environmental issues that cannot be immediately seen from the ground. In addition, photographs can provide the ability to get close up views of placards and an assessment of leakage or damage. Using UAS to gather intelligence at these scenes would safeguard the lives of the emergency responders by reducing the risk of exposure to harmful CBRN materials.

The UAS is also helpful at a CBRNE event because it can also carry objects to a person that is in a warm zone when another responder wearing proper protective equipment is not available.

Fire departments are currently using UAS to carry sensors that would detect carbon monoxide, hydrogen sulphide, explosive vapours, etc.

Collision Investigation

The UAS can acquire overviews and specific details of accident areas by capturing images detailing skid marks and paths that may not be apparent on the ground. They are also able to obtain photographs from unique perspectives and angles that are unavailable to a ground-based photographer. During initial trials of micro UAS, collision investigators have stated they were able to notice evidence on the aerial photographs that was not apparent at ground level.

Photographs combined with special analysis (photogrammetry) software, can assist in reducing the amount of time spent on scene as they are capable of producing 3D measurements from the UAS' aerial photographs. For example, photographs of a roadway can be imported into the photogrammetry software which is able to measure lane widths, lengths of skid marks, etc. Investigators are also able to create points for objects in the photos and take measurements on any of the points in this "point cloud". This point cloud data can then be exported to a CAD program to render a scale diagram of the scene and all evidence within, for presentation in court.

The ability to photograph the scene from alternate and elevated viewpoints capturing and relating all relevant perspectives can result in shorter resolution time for cases. In the near future, collision analysis will be able to replace total-station surveying with UAS photogrammetry.

Disaster – Major Event Situational Awareness

One of the biggest challenges at major event sites is managing the scene with limited resources. UAS can quickly provide valuable information and live images helping the incident commander to allocate resources efficiently and effectively. The images can provide insight as to the scope of the event, critical situations, and entry and egress routes, all of which are essential for situational awareness at such events.

Forensic Photography

UAS can be used to acquire overviews of and specific details about incident areas and even capture the scene state and fragile evidence such as footprints and tire tracks, prior to the investigators entering the scene. Photographs can detail objects of evidentiary value and also show evidence that may not be apparent at ground level. In addition, correlations to the victim, routes, residences, movements etc. may be revealed. Photographs combined with special analysis software, such as photogrammetry software can assist in reducing the amount of time spent at scenes by rendering 3D images of the crime scene. The

ability to capture crime scene images from low level aerial perspectives can greatly assist all parties in understanding the crime scene and the relationship between objects which can result in shorter resolution time for cases.

General Patrol and Traffic Monitoring

Micro UAS have limited application in this area at present due to their limited range and flight time and also restrictions on flying them over civilians, but as larger UAS become adopted they will be able to provide valuable intelligence in situations involving

- suspicious persons
- breaking and entering
- crowd dynamics at public events
- traffic congestion
- critical site or infrastructure surveillance (?)
- route surveillance when transporting VIP or other sensitive individuals (?)

Crime Prevention through Environmental Design

Photographs captured by the UAS could be used in the analysis of crime trends and correlations to crime. While images captured at ground level and pin mapping can indicate a great deal of information, aerial photography can reveal paths and correlations which otherwise may not be visible.

Grow-Op Detection

UAS could be used to help reveal evidence of grow ops as they would provide aerial photographs indicating the types of plants and other objects of evidentiary value normally associated with grow ops. This ability would be helpful in areas where the grow ops are hidden within a compound, densely wooded area, or in remote locations with limited access.

If the laws permit it, the UAS could also be used to carry infrared (FLIR) technology to assist in detecting grow-ops.

Perimeter Security

UAS can be used to assist with perimeter security of large areas, particularly in areas of rough terrain.

Search and Rescue

UAS can play a vital role in assisting at search and rescue scenes, especially in areas where trees, brush or tall grass limit visibility and areas that are difficult for searchers to move through such as rough terrain, waterways, swamp or on dangerously thin ice. UAS can also carry infrared cameras to help locate both live and recently deceased victims in these inaccessible areas. UAS are also being used to carry FLIR (Forward Looking Infrared Radar) systems to help them “see in the dark”, allowing for quicker rescues at night.

Tactical troop/crowd control

Emergency Response Tactical Teams could use the micro UAS to gain a vantage point of an area that is unsafe to deploy human resources. During an incident, the micro UAS could perch on a rooftop,

effectively being used as a remote video camera for the operation. The micro UAS could also provide footage of the “hot” backside of a building at a scene with an barricaded active-shooter or views of a compound or window that would otherwise be inaccessible.

Surveillance

Micro UAS have limited flight time and range and this greatly limits their abilities in this function. Despite this, micro UAS can be a very stealthy and cost effective means of obtaining intelligence in compounds, remote areas, or places that are difficult to access otherwise. Their duration can be greatly extended if it is possible to ‘perch’ the micro UAS on a vantage point such as a roof as the batteries will run the camera alone for many hours or days

It should be noted, however, that the surveillance of individuals has the potential for negative public backlash and this has resulted in the loss of the UAS program for other departments. Maintaining public confidence might entail a public commitment to not use the UAS for surveillance. The use of UAS for surveillance requires careful forethought. Decisions regarding this use must be reflected in policy and procedures and stringently adhered to.

Tactical Situational Awareness

UAS can help alleviate the guess work and possible misinterpretation that sometimes emanate from reconnaissance reports. Aerial photographs or video can provide real time images of subjects, locations of interest, entry and egress routes, and potential hazards. This information can be invaluable in the effective deployment of personnel and responder safety. The UAS may also provide extended real time observation of subjects or locations, especially in cases where approach or location may be difficult or hazardous to access.

3 Section Three: Operations

Important Steps

- Identify the need for the UAS.
- Identify and understand the regulations and the compliance required to use the UAS.
- Research the available systems that would be suitable for the intended use.
- Identify the training requirements and the cost of training as it will be one of the most substantial costs after the UAS itself. Travel may be required for training and therefore the training costs should be identified early as they will impact the cost analysis.
- Identify the costs related to developing a program
- Identify potential interested candidates who have the skill set to become operators and who would contribute to your program's success.
- Understand that like any other tool, a UAS has limitations which are directly related to the systems capabilities and the operator's skills.
- Develop the organization's policy or Standard Operating Procedures..
- Consider and budget for the ongoing training and maintenance costs

Safety

Despite the fact that many UAS are very small and lightweight, there is the potential for injury or property damage since they are driven by rotors or propellers. The rotor's speed and force have the capacity to cause serious injuries ranging from minor cuts to amputation. Additionally, since the UAS is airborne, a loss of power/control could result in serious injury to persons below should it fall or could have catastrophic results if it were to contact a manned aircraft. It is therefore critical to take precautions that would help ensure the safety of the UAS operators, the emergency responders working the scene, civilians and any aircraft flying in close proximity.

Police operations requiring the use of UAS normally cordon off the area to restrict access to unauthorized persons; this step is critical to ensuring ground safety. This will likely be a key requirement in obtaining an SFOC.

In order to respect and protect the affected airspace, UAS operators may be required to communicate with nearby airport control towers or any aircraft in the area to avoid collisions as per the situation or requirements specified in their SFOC.

Fail Safe

Many UAS are available with a feature that permits the safe landing of the UAS in an emergency such as a loss of communication with the controller or motor issues. This feature, sometimes referred to as a "lost-link-auto-land", is recommended for all UAS to ensure the safety of the unit and those on the ground.

Limiting Factors

Flight time

One of the most important factors to consider when selecting a UAS or planning a flight operation, is the available flight time. The length of time a UAS can remain aloft will affect the distance that can be covered or the amount of time a target can be observed before the UAS must return to be refuelled or have its battery changed.

Current UAS power options are limited to rechargeable batteries or fuel-fed engines. Whether a fuel or battery system is selected, the operational time aloft can be dramatically impacted by: weather (wind and temperature); heavier payloads (cameras or sensors); the excessive manoeuvring required to avoid obstacles or to complete a complex flight path; and the need to maintain an adequate power reserve in the event of unforeseen events.

In Canada, most police agencies utilize smaller micro UAS because of cost and logistical benefits. The two leading UAS currently used by police in Canada utilize a rechargeable battery system that provides a maximum flight time of about 20 minutes. Actual operational time however is generally around 13-15 minutes due to the above-mentioned variables and operational safety margins.

Larger UAS can provide substantial increases in flight time but often at a significant increase in costs and support system requirements.

Weather

Inclement weather affects both manned and UAS but the aircraft's size and capabilities play a key role in whether or not it can navigate the foul conditions. Many UAS are capable of operating in a very wide range of extreme temperatures but the temperature may affect the operators, especially if they use controllers requiring dexterous finger control. Rain and snow are factors affecting visibility and depending on the restrictions specified in the Special Flight Operations Certificate (SFOC), operational use will be cut back according to the limitations set by Transport Canada. Furthermore, a wet camera lens will not capture good quality images. Wind speeds have a significant effect on smaller UAS and the aircraft's weight and capabilities will determine its limitations; some micro-UAS can only fly in very calm winds while others can operate satisfactorily in winds as high as 40 knots.

Additionally, some UAS utilize various means of stabilization, such as barometric, gyroscopic and GPS sensors which are directly tied to the UAS' computers allowing an automatic position lock. The burden on the pilot may be reduced and some of the effect of wind can be mitigated through the use of these features.

Also, there are numerous aspects of micro-meteorology that should be considered by the pilot. For example, vortices and wind-shear encountered while operating around large buildings. A working knowledge of micro-meteorology can be obtained through courses at many local flying schools.

Terrain

All aircraft have individual requirements for take-off, landing and range of operation; these requirements will dictate the terrain in which it the UAS can operate. Water, fields, mountains, forest and city are all examples of different terrain types. Generally a fixed wing UAS requires an open, obstacle-free area to safely execute take off and landing.

Many SFOCs require the operator to maintain a watch for manned aircraft. The UAS operator should take care to ensure that while his/her UAS is in sight, the terrain (for example, the forest) does not obscure the view of the surrounding skyline which would prevent a proper watch. The effect of terrain on weather must also be considered as funnelling and other local weather phenomenon are directly influenced by the terrain.

Conflicting Air Traffic

Conflict with other air traffic is largely dependant on the altitudes at which UAS are expected to operate and the proximity to aerodromes. Many UAS operate at within visual line of sight and very low levels, usually below 400 feet AGL, making the potential for conflict with other air traffic very low.

Regulations and Liabilities

Special Flight Operations Certificate (SFOC)

In Canada, Transport Canada regulates the use of non- military airspace and mandates that all operations of UAS, with the exception of recreational use, require an SFOC. “Section 602.41 of the Canadian Airspace Regulations (CARs) states, “no person shall operate an unmanned air system in flight except in accordance with a Special Flight Operation Certificate (SFOC).” *

*See Transport Canada website for further explanation

<http://www.tc.gc.ca/eng/civilaviation/standards/general-recavi-brochures-UAS-2270.htm>

In the United States, the U.S. Federal Aviation Authority has similar requirements for Certificates of Authority (COA). Other countries will have similar regulations through their aviation authority.

Insurance

Before an SFOC is issued, Transport Canada stipulates that all operators must have Liability Insurance covering the UAS and any injuries, losses, damages or otherwise that could reasonably be caused through operation of the UAS.

Safety Planning

To ensure the safe operation of a UAS, the following operational aspects of flight must be addressed and should be captured in your agency’s policies and/or SOPs;

1. Authority to Operate
 - a. Is clearance required from Air Traffic Control Tower or is notification to an airport facility required?
2. Environmental Conditions
 - a. Do the conditions meet the visibility requirement set forth in the SFOC?
 - b. Are the wind conditions within the capability of the aircraft and of the operator?
 - c. Would any of the following hazards or obstructions interfere with the safe operation of the UAS: buildings, trees, utility lines, light standards, and/or communications towers?
3. Personnel

- a. Are adequate personnel in place to support the area of operation?
- b. Are all personnel involved with the operation/incident aware of the use of the UAS and adequately informed of the operational parameters of the UAS and their role in the operation?
- c. Are spotters and camera operators adequately trained? Are they informed of the use and operation of the system and the plan of intended use?
- d. Is the operator authorized to use the system and competent to perform the operation? Has he/she had adequate rest or are they under the influence of any drug that may affect their operational ability?
- e. Do all personnel have adequate communication available?
- f. Do all personnel have proper safety equipment?
- g. Are all incident personnel clear as to who is in command/ control of the UAS operation?

Other Legal Limits

Does the intended use fall within the authority of the agency with regard to municipal, provincial or federal acts?

Is a search warrant required?

Public Relations

Public Perception

The general public has been made aware of UAS through media reports but people tend to associate them with military applications since the coverage has been about UAS-use for spying and air-strikes in war zones or stories about drones. The public may also be familiar with the use of the Predator aircraft used in border surveillance which has raised concerns about privacy issues and noise levels.

Once the public is made aware of the UAS' intended use as well as the restrictions and legal requirements, they will be more open to the integration UAS into emergency responders' operations. Initially, the UAS will be a novelty, but eventually it will be seen as a tool that enhances emergency responders' ability to work more efficiently and effectively.

Media Strategy

Taking a proactive approach with the media will help prevent some of the possible misconceptions of UAS use by emergency responders and will reduce sensationalistic or inflammatory media articles. Messages that clearly state the fact that UAS would serve as a valuable reconnaissance tool at traffic accidents, large crowd gatherings, CBRNE events, and other emergency situations would help the public understand the agency's intended use of the aircraft would contribute to their acceptance of the system. Stressing in the media broadcasts that the UAS would NOT be used for surveillance of persons or vehicles will contribute to gaining public trust. Some agencies have already implemented successful media strategies through their departments' strategic communications sections and the details of these may be available to your department to help reduce the work in setting this up.

While it may not be necessary to obtain approval from the municipal or local government, it would be beneficial to advise officials as to your intentions ahead of time. This alert would provide them with the opportunity to gain a better understanding of the system's ability to enhance operations and support your agency when they are responding to media inquiries.

Initial Deployment

It is essential to have the required authority or clearance to operate the UAS. Failing to do so would have negative consequences and could possibly terminate the program or affect the future development of similar programs in other agencies.

Prior to purchasing the UAS, ensure that your administration supports your program as well as the necessary training and arrange for the SFOC approval prior to commencing training. Since training skills are perishable, waiting for a long period between the training and the operation of the UAS would be detrimental to the operation. Also, having the SFOC prior to obtaining the UAS ensure that no one will be tempted to “just try it out” before the SFOC is granted.

Advising your agency’s governing authorities about the UAS would help them prepare their responses to the media or the public’s inquiries ahead of time.

Protocols

Authority

Consider the following issues with respect to mission authority:

1. Ensure compliance with your SFOC with regards to respecting the jurisdictional area, visibility and hours of operations, etc.
2. Is additional clearance required from an airport control tower? Has the aerodrome been notified of your operations?
3. Do the operations fall within your agency’s jurisdiction and policy/ procedure protocols?
4. Are any search warrants required to fulfill requirements of the Criminal Code or any other Federal, Provincial, or Municipal Acts or regulations?

Mission Limiting Factors

Consider the following mission limiting factors prior to launching the UAS:

1. Are environmental conditions including wind, and visibility within the operation capabilities of the aircraft and the operator?
2. Are there any possible manmade or natural obstructions in the area of operations that would jeopardize the UAS?
3. Is the intended flight range within the capabilities of the UAS system and the operator?
4. What are the requirements for flight endurance? Is the fuel supply / battery charge adequate? Are additional batteries readily available?

On-Scene Operating Protocols

The following on-scene protocols need to be observed:

1. Are the SFOC and SFOC Application on-hand during the operation?
2. Are sufficient personnel in place to control and restrict access in the area of operation?
3. Has a briefing been held between the investigator(s), UAS pilot, payload operator and/ or other personnel to determine the goals of the operation?
4. Is everyone clear as to their role and duties?
5. Has a method of clear communication between all parties been established?
6. Have the pilot and payload operator developed a flight plan to capture the required data and make the most effective use of the UAS?
7. Are all aspects of the “emergency plan” as detailed in the SFOC in effect during the operation?
8. All personnel, regardless of rank, must understand that the UAS pilot is in control of the aircraft and is the final authority for its safe operation including the decision to begin or terminate a flight.

Reporting Requirements

Incident reports need to be completed as per the agency’s Standard Operating Procedures. These reports should include the following details of the operation;

- date and time,
- nature of the operation,
- roles of operational personnel,
- outline of goals and accomplishments,
- equipment used
- number of pictures/readings taken
- availability/ access of photographs/readings

Transport Canada requires that flight logs be completed and retained for at least one year for their inspection, as specified in the SFOC.

Misadventure Protocols (SFOC deviation)

In the event of a mishap resulting in damage to the UAS, other property or any person or livestock, the event must be reported to Transport Canada within 24 hours. (example - Annex C)

Record Keeping

Tracking the UAS’ cost effectiveness

It may be important to track the operational costs of the UAS program in order to analyze its cost effectiveness. This information is critical if your agency would like to make cost comparisons to operations involving the use of another aircraft or operating without the UAS entirely.

The baseline data should include;

- total number of incidents where the UAS is used
- resources expended in support of UAS operations at scenes
- resources saved due to use of UAS
- total number of similar incidents where UAS could have been used but was not deployed

Logbook

Keeping a logbook is the best method to accurately record performance and usage. Additionally, the logbook will be an invaluable tool in troubleshooting operational and performance issues of the aircraft and operator. Transport Canada requires that a flight logbook is maintained, as is outlined in your SFOC.

A log book may include, but should not be limited to, the following entries;

- Logbook number
- Flight log number
- Location
- Date
- Start time of operation
- End time of operation
- Start of flight time
- End of flight Time
- Total flight time
- Accumulated flight time
- Altitude
- Purpose of flight
- Type of Aircraft
- Pilot
- Co-pilot/camera operator
- Spotter/observer
- Other support personnel
- Wind conditions
- Temperature
- Payload type
- Pictures taken (with the associated file number)
- Performance issues
- Incidents associated to abnormal performance or deviation from regulatory requirements

Many aircraft systems also have flight data log recorders which detail all aspects of the performance of the aircraft and input of the operator.

Transport Canada may specify what is required as minimal entries for the purpose of a logbook.

Mission Reports

In addition to a logbook entry, some agencies may require a Mission Report. Much of the information recorded in a logbook will be useful in completing a Mission Report which will provide further detail as to the circumstances under which the UAS was used as related to the incident. It may also outline flight paths, descriptions of photographs, operational issues that may have occurred with respect to support or interaction with other operational aspects of the investigation. Consideration will have to be given on how this additional information will be captured and worked into the existing reporting and information workflow of your agency.

Maintenance Records

Accurate maintenance records are helpful in determining the performance of the aircraft and for troubleshooting. They ensure preventative maintenance is done and allow for better preparedness between operations. Nothing is worse than having an immediate need for equipment only to find it is not operationally ready.

4 Section Four: Personnel

Functional Location of Personnel

To reduce travel costs, UAS Operators would ideally be situated closest to the locations where the system would be utilized most frequently.

Selection

The ideal UAS operator candidate would possess the following qualities:

- a mature and responsible attitude towards safe, reliable operation
- an interest in the UAS program
- the aptitude to operate the system
- above-average hand-eye coordination
- a pre-existing aptitude for operating model aircraft
- adequate eyesight to maintain orientation of the UAS in flight
- the demonstrated initiative to learn to safely operate the UAS as well as advance skill levels in the future
- accepts responsibility
- accessibility for operations
- good depth perception

UAS Pilot

Subject to operational availability requirements, the number of pilots should be kept to a minimum. While it may appear advantageous to have as many persons as possible trained to operate the UAS, experience has shown that minimizing the number of operators is the best practice to minimize “mysterious” damages and ensure accountability.

Adequate controls over the UAS must be maintained by the pilot(s) to ensure that untrained individuals do not have access to the UAS.

UAS pilots must have the necessary skills to safely operate the aircraft and understand all aspects related to its operation. The UAS pilot must recognize the aircraft’s limitations and must also be aware of his/her own limitations for safe operations. The UAS pilot needs to communicate effectively with investigators and should be briefed on all aspects related to the scene in order to develop a well-coordinated flight plan for the most efficient use and success of the flight operation.

The UAS pilot ultimately makes the decision to proceed with or terminate an operation.

Payload Operator

The payload operator must:

- understand the UAS' flight capabilities
- have a basic knowledge of the aircraft's manoeuvrability.
- be able to communicate effectively with the UAS pilot to achieve the best results.
- be present at the pre-flight briefing so as to be aware of objectives of the operation allowing for proper coordination of efforts with the UAS pilot.
- must be competent and knowledgeable about the use of the payload and the handling of evidence it collects.

Safety Officer

The Safety Officer must:

- understand the UAS' flight capabilities
- have a basic knowledge of the aircraft's manoeuvrability.
- ensure safe operations at the site
- coordinate and monitor operational resources.
- have clear communications with all personnel involved with the operation so that appropriate adjustments can be made to any modifications in the operational plan.
- be able to recognize any unsafe conditions and advise the pilot to terminate the operation if necessary.

Training

Platform Operation

Candidates may have little or no previous manned or unmanned flight experience and would require flight training either directly from the manufacturer or through an instructor certified by the manufacturer. The appropriate training will help prevent unnecessary incidents or damage and would demonstrate due diligence in liability cases.

If a skilled UAS pilot is already on-hand to conduct the training, many UAS have "trainer modes" that allows the gradual introduction of greater channels/controls to the beginner pilot. At no time should a first-time or beginner pilot be given all flight controls until they have demonstrated the ability and competency at each control individually.

Ground School

UAS operators need adequate training on all aspects of flight regulations, airspace restrictions, safety and theory including;

- the dynamics or theory of flight
- capabilities and limitations
- conditions affecting flight
- maintenance, repair and troubleshooting
- potential hazards
- designation and use of airspace
- emergency procedures
- flight planning

- record keeping
- weather patterns
- regulatory issues
- legal issues

Practice

The best way to increase your UAS flying proficiency is to operate the system on a regular basis. Increased practice will help develop hand-eye coordination and muscle memory.

The complexities of the UAS vary significantly; some systems are challenging to set-up but once this step is complete, the UAS virtually fly themselves while others are simple in operation, but require constant input. Regardless of the system's complexity, regular practice is required to sharpen your skills. The degree of difficulty involved with flying a UAS can be misleading; some UAS appear to be easy to fly until inexperienced operators suddenly discover they are disorientated because the UAS is at a great distance or they have to make adjustments to avert hazards and they enter the wrong data. In real life scenarios, most environmental conditions and hazards are unique to that particular situation. Practice exercises should mimic these situations in order to increase competency in general operations; this will lead to making better decisions in challenging environments. The more complex UAS will require more practice time. Even after the desired level of proficiency has been achieved, flying at least 30 minutes a month will help pilots maintain their skill levels.

Court Presentation

Strategy of Evidence Presentation (credible overview)

Although digital photography is not new to the courts, many people are not familiar with UAS or their ability to take aerial photographs. Prior to surprising the courts in a sitting proceeding, it may be a good idea to make them aware of the technology by informally inviting them to a demonstration. Raising the courts' awareness may contribute to their acceptance of the technology. If test photographs were taken on the ground prior to the flight, they should be included, in the interest of full disclosure.

As it is true that that a picture paints a thousand words, good photographs can convey a great deal of information and perspective, eliminating the need to "imagine" the scene depicted in line drawings.

When providing photographic evidence to the courts, it is important to focus on the photographs rather than distracting the courts as to how these photos were obtained. The UAS simply serves as a platform for the camera and is really no different than using a tripod or standing on a ladder to take a photo. It is not necessary to mention that the photos were taken from the UAS but if questions should arise, explaining that the UAS serves as one of many possible platforms would clearly explain its function and should eliminate any uncertainty.

5 Section Five: System Selection

Fixed Wing or Rotary Wing

Some of the factors which may influence the platform selection will be directly related to the environment and the intended use of the UAS. Budget may also play a key role in selecting the appropriate platform.

Fixed Wing Aircraft

Fixed wing aircraft require continuous forward movement to maintain lift. Once they are airborne, fixed wing aircraft require less energy and perform well in situations demanding longer endurance and the coverage of larger areas.

For safe operation, fixed wing aircraft need to be flown at altitudes above all obstructions such as buildings, trees, light standards and utility lines. This requirement will restrict use at lower altitudes.

Fixed wing aircraft require a great deal of open space along the horizontal and vertical planes to achieve both take off and landing. The amount of space required will vary according to the aircraft's design as well as the launching and landing protocols.

Some fixed wing aircraft takeoff and land similar to traditional aircraft and will require a runway. Certain models can take off using a bungee/catapult launch system while others can be hand launched. Some fixed wing aircraft also have the ability to land almost vertically using a stall manoeuvre. Their space requirement is determined by their ability to manoeuvre and their required airspeed to stay aloft.

Fixed wing aircraft can provide good still photographs and video, however their ability to maintain constant visual reference on a subject depends on the sophistication of the camera and piloting system used. Since the aircraft is continually in motion, it can be difficult for the camera operator to frame the photo or achieve the desired perspective. Additionally, the motion of the camera can induce blurring if the shutter speed is not fast enough or the zooming is too great.

Fixed wing aircraft are ideal for use in search and rescue operations since they can rapidly cover large areas in grid patterns.

Rotary Wing

Rotary wing UAS, often referred to as either Vertical Take Off and Landing (VTOL) aircraft or helicopters, achieve flight by creating downward thrust. The need for a constant downward thrust means rotary wing UAS are not as energy efficient as fixed wing and generally will have shorter flight times. They will also cover less distance than comparably powered fixed wing UAS.

Rotary wing UAS can achieve movement in any direction on the horizontal plane by redirecting some of their downward thrust. The aircraft's ability to ascend or descend is controlled by an increase or reduction of the thrust, making rotary wing UAS highly manoeuvrable as it has the ability to move in any horizontal or vertical direction, move at various speeds, or remain stationary in a hover. This precise manoeuvrability combined with the ability for vertical take-off and landing makes the rotary wing UAS ideal for urban areas with congestion or obstructions.

Rotary wing UAS are capable of providing a 360 degree point of view from a single point using their ability to hover and rotate. Maintaining constant visual reference on a subject is easier as this type of UAS can rotate, move slow or maintain a stationary position. Its manoeuvrability also allows it to be utilized at lower altitudes, move between and among obstructions, and obtain low altitudes in areas that a fixed wing could not.

Due to their tremendous manoeuvrability, rotary wing UAS are ideal for crime scene and accident investigations where it is important to position and hold the UAS stationary to zoom in to obtain well framed and clear images. Their ability to manoeuvre close in and even land (perch) with their camera or sensor on a specific vantage point such as a roof is ideal for use in tactical support.

Size, Range and Endurance

UAS technology range in size and payload capabilities. Wingspans can range from 20 meters to 30 cm while payloads can range from 10,000 Kg to 200 grams. Endurance ranges from 36 hours to less than 10 minutes. Some UAS are capable of circumventing the world while others cannot make it past visual sight.

Larger UAS for beyond line of sight operations require sophisticated remote operations, guidance, and collision avoidance systems as well as highly trained staff. The cost and complexity of these is beyond all but the largest of agencies at this time, but this can be expected to change as this technology develops. (Affordable options may exist for their use through service contracting.)

For the purpose of this guidebook, most systems for current consideration in police and emergency operations would likely fall in a weight class of under 3 Kg and have an endurance of less than an hour, commonly referred to as micro UAS. While the systems may be capable of operating beyond visual sight, currently most SFOCs restrict operations within visual range.

Power Systems

UAS are either electric or liquid-fuel operated. With advancements in brushless motors and battery technology, both types of systems are equally capable of propelling the aircraft. Liquid-fuel systems often have greater flight times but are very noisy as compared to the virtually silent electric systems. There are potential drawbacks/dangers to both power systems: the fire hazards associated with the electric system's lithium polymer (LiPo) batteries during charging and the flammability of liquid fuel for those systems that require fuel.

Liquid fuels may offer longer flight times however the trade-offs include safety of storage and costs that are directly proportionate to flight times. The type of fuel and its inherent volatility (and specific storage requirements) must be considered.

Using non-consumables for fuel, such as rechargeable batteries may increase the initial expenditure, but in the long run operating costs are not proportionate to flight time as the batteries can be recharged for negligible cost. Batteries vary in cost based on their capacity (usually measured in milliamp-hours on small to midsize UAS). Longer capacity batteries will obviously be more costly (and heavier thereby impacting "lift" and flight time) and similarly, batteries comprised of better materials will also be more expensive.

The number of batteries purchased must be considered. To effectively determine the number of batteries required, consider the following: the duration of flight time achieved from a single battery; battery recharge time; and the battery's ability to endure the charging time (versus having enough batteries and chargers to fly continuously). For example, a UAS that can fly for 15 minutes on a single battery that takes 30 minutes to charge will require a minimum of 3 batteries and 2 chargers to avoid downtime. With most small to midsize UAS, the flight times will be shorter and charging times take longer than this example, therefore the number of batteries will increase.

The cost and usable life of the battery is also a consideration as some less expensive battery technologies may require frequent replacement while some more costly models may offer a longer life without power/capacity loss late in their life.

Some batteries may also have inherent safety considerations such as the Lithium Polymer (LiPo) batteries that are now prevalent in most small UAS. LiPo batteries offer tremendous performance however they may ignite during recharging, particularly if charged improperly. These batteries will require special provisions (such as fireproof charging containers) and monitoring in a secure area to ensure that a safety hazard is not created. LiPo batteries also require sophisticated chargers that a user must correctly operate, setting such things as charge rate, number of battery cells and amperage. The cost of these chargers increases with their features and complexity, however the more automated the charger is, the less likely that human error may occur thereby minimizing potential damage and safety concerns.

Control Systems

All control systems use some sort of a radio signal that must fall within Industry Canada regulations.

The control systems range in complexity from hobby store off-the-shelf remote control systems to custom made processors. The control of the aircraft may range from being completely manually operated remotely to semi-autonomous and full autonomous flight.

Consideration must be given to the possibility that signal interference may occur, either intentionally or inadvertently by other transmitters. These signals can also be affected by the presence of high-voltage power lines and so a radio license may be required.

Some departments have concerns about the vulnerability of video signals being sent by some UAS. If the scene being photographed is sufficiently sensitive, consideration should be given to the ease with which it can be intercepted and to using encryption technologies.

Payload

Payload capacity is unique to each specific aircraft. Most UAS are currently designed to carry camera payloads that vary in weight from approximately 100 grams to 2 kg. UAS payloads could include micro video cameras, low light video cameras, digital still cameras, high definition camera and infra red cameras. Consideration and development of other sensor payloads is also possible.

Maintenance

The complexity of the aircraft design, material make up, number of moving parts and the environment in which the aircraft is operated and stored will largely determine the amount of maintenance that will be required. In addition, the amount of operational abuse will play a factor multiplying maintenance and repair costs several fold. Traditionally fixed wing aircraft have fewer moving parts than classic helicopters, but with the advent of brushless motors and multiple blade design of some helicopter that is no longer the case.

Operational Costs

Operational costs will vary with the complexity and design of the system. Consider the following:

- Initial cost of equipment
- Batteries vs. liquid fuel*
- SD card for cameras
- Minor spare parts for replacement due to regular maintenance.
- Allowance for repair and replacement in the event of repairs required which may not fall under warranty
- Training costs; courses or time allocated for practice
- Personnel costs per incident; the number of personnel required to operate and support operations at a scene over and above personnel who would normally be there

- Insurance costs: is additional insurance required above normal liability insurance that the agency carries.

Other operating considerations include the quality and expected life-span of major components such as airframes and motors (which can often be very expensive to replace) as well as minor components such as O-rings that secure detachable rotors. The latter may be relatively inexpensive; however a maintenance schedule may call for the replacement of numerous parts many times a year. To gauge these costs, it is wise to check the manufacturer's recommended preventive maintenance schedule to determine what is required and how often.

It should be noted that a clear understanding of what exactly is covered by any manufacturer's warranty and for how long is important. For example, a motor that burns out for seemingly no reason may cost hundreds of dollars to repair and may be due to a myriad of possible causes, will likely not be covered.

Buy, Lease, Evergreen or Contract?

Options to buy, lease or enter into an evergreen lease agreement will vary with the equipment supplier. Normally most companies are willing to negotiate pricing and other conditions especially where purchases of multiple units may be involved.

Buy - to purchase outright, warranty and service normally set for a defined period.

Lease – to pay a fee for use of property/ equipment, ownership is retained by the supplier, normally for a set period, with penalties for early termination by lessor, other conditions such as maintenance, service and warranty are negotiated.

Evergreen Lease – a self-renewing lease agreement, conditions for acquisition / transfer of ownership may be included or negotiated. Any other conditions may also be negotiated.

Contract – the platform and pilot are provided under contract by a third party while the police provide the payload operator. The payload operator handles all the evidence related to the operation, thereby relieving the civilian pilot of court attendance or security issues.

6 Section Six: The Way Forward

Near-term applications

UAS have proven to be safe and cost effective while providing invaluable data in a variety of operations. As long as UAS are used within all regulatory boundaries, public perception will likely shift to viewing it more as a valuable resource rather than an unwelcome invasion.

While current uses are focused on post event examination, there will be a steady shift into the use of UAS for in-progress events as users become more accustomed to them and the technology and performance of UAS increase.

Future Impacts

Acceptance of the use of UAS by agencies, the courts and ultimately the public can lead to a more effective and efficient emergency responder service. UAS can also contribute to increased safety for emergency responders.

The rapid increase in use of UAS by many sectors of the population is certain. This will include the general public (hobbyist), industry, media and criminal elements. Over the next decade, UAS will create abundant new opportunities and challenges for police.

As the public and regulators become more accustomed to the UAS and their safety and on-board intelligence becomes more proven their use will grow at an exponential rate. The use of both larger and smaller micro-UAS will grow rapidly.

UAS research and development of self-navigating and collision avoidance UAS is moving at an incredible pace. Small UAS have now been designed that are so agile and aware that they can fly around a small room and when a hoop is tossed in their flight path, they can not only avoid the collision but can fly through the hoop.

Another major development is “swarming” technology where multiple UAS will communicate with each other not only to avoid collisions, but to cooperatively undertake tasks in teamwork.

Use of UAS to Commit Criminal Acts

There is no doubt that the criminal element could use UAS to commit crimes. It is very unlikely that the criminals will be seeking permission to fly UAS and they will no doubt find many creative ways of using them. Criminals may use it for their own security or counter-surveillance purposes or to deliver payloads such as money or drugs. There have already been cases of drugs being flown across the U.S. – Mexican border using UAS. An extreme example would see the use of UAS in terrorist activities like a poor-man’s cruise missile.

Use of UAS by the Media and Public

Current regulations state Transport Canada must authorize the use of UAS for commercial purposes. The media and the public are not exempt from this regulation and they would have to follow the same procedures as any other commercial operation. Firstly, they will need to demonstrate to Transport Canada that they can safely operate the UAS and that they have the necessary resources to ensure safety at the scene. The general public must also abide by the same rules when operating for commercial purposes.

The regulations do not, however, cover the use of UAS for hobbyist or recreational use. Identifying who is responsible for a particular UAS in the air is difficult and there is no easy way of knowing if the UAS is being used for commercial purposes. Unless the UAS is displaying some kind of marking, the simplest way

to determine if it is being used for commercial purposes is to identify the operator and ask questions. If they admit to flying the aircraft commercially, they must present a copy of the SFOC.

Annex A Sample SFOC Certificate Application

Transport Canada **Special Flight Operations Certificate Application**

Date of Application May 30, 2011

A. Applicant

Name: Saskatoon Police Service

Address: 130 4th Avenue North
Saskatoon, Saskatchewan
S7K 3R7

Telephone: [REDACTED]

Fax: [REDACTED]

B. Operations Manager

Name: Jerome Engele, Inspector

Address: 130 4th Avenue North
Saskatoon, Saskatchewan
S7K 3R7

Telephone: [REDACTED] Cell: [REDACTED] Fax: [REDACTED]

C. Method of Contact During Operation

Cellular phone and radio contact with those listed in Section I as Ground Supervisors

D. Type & Purpose of Operation

The type and purpose of operations by Saskatoon Police Service will include;

Obtaining photographs and video pertinent to the operations of the Saskatoon Police Service (specifically accident or crime scene photographs and or video for reconstruction purposes) in the limits of the City of Saskatoon in an urban location and within 5 miles of an airport, and a 25 kilometer radius of the city of Saskatoon.

Training of members of the Saskatoon Police Service, in an urban environment in the City of Saskatoon and within 5 miles of the Saskatoon Airport, in flight operations.

Demonstrations – of Draganflyer X6 capabilities to media or law enforcement agencies in an urban environment and within 5 miles of an airport within Saskatoon.

E. Dates of Operation & Time of Operation

For operations required for immediate response open and ongoing, daylight hours and night hours in areas that has adequate illumination to operate safely and avoid hazards.

For operations for training or demonstration purposes; open and ongoing with 3 working days notice to Transport Canada via email SFO Inbox

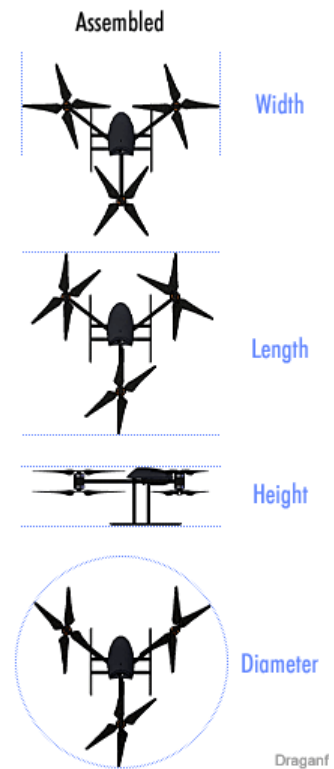
F. Description of Aircraft (include pertinent flight data)

Draganflyer X6 Helicopter Technical Specifications **Helicopter Size**

- **Dimensions**
 - o Width: 91cm (36in)
 - o Length: 85cm (33in)
 - o Top Diameter: 99cm (39in)
 - o Height: 25.4cm (10in)

RF Communications

- **2.4GHz Data Link**
 - o Link Type: Helicopter to Ground & Ground to Helicopter (Two-Way)
 - o Helicopter Antenna: Wired Whip Antenna
 - o Controller Antenna: Omni-Directional
 - o Transmission Power (North America): 100mW (+20dBm)
 - o Transmission Power (International): 10mW (+10dBm)
 - o RF Data Rate: 250kbps
 - o Receiver sensitivity: -100dBm
 - o Transmission Technique: DSSS (Direct Sequence Spread Spectrum)
 - o Frequency band: 2.4000 - 2.4835 GHz
 - o Certifications: CE, FCC, IC, ETSI
 - o Data Link Channel Selection: Automatic (12 Channels)
- **5.8GHz Video Link**
 - o Link Type: Helicopter to Ground (One-Way)
 - o Transmitter Antenna: Omni-Directional
 - o Receiver Antennas: Omni-Directional & Flat Patch
 - o Transmission Power: 12dBm
 - o Transmitter Power Consumption: 500mW
 - o NTSC and PAL Compatible
 - o 7 Selectable Channels: 5740MHz, 5760MHz, 5780MHz, 5800MHz, 5820MHz, 5840MHz, 5860MHz



11 Onboard Sensors

- 3 Solid State MEMS (Micro-Electro-Mechanical Systems) Gyros
- 3 Solid State MEMS (Micro-Electro-Mechanical Systems) Accelerometers

- 3 Magnetometers (Magnetoresistive Sensors)
- 1 Barometric Pressure Sensor
- 1 GPS Receiver
 - GPS Battery Backup: 75mAh Lithium Polymer

GPS

- GPS Used For: Position Hold, Location & Velocity Data
- Maximum Satellites Tracked Simultaneously: 16
- Position Update Rate: 4 Hz
- GPS Antenna: Ceramic Patch
- Battery Backup: Lithium Polymer

Black Box Data Recorder

- Flight Data Recording: On-Board
- Stored To: Removable 1Gb MicroSD Memory Card
- Data Recorded: Onboard Sensor Flight Data (Link quality, Orientation, Altitude, Speed, Direction)

Weight & Payload

- Helicopter Weight: 1,000g (35oz)
- Payload Capability: 500g (18oz)
- Maximum Gross Take-Off Weight: 1,500g (53oz)

Flight Characteristics:

- Climb Rate: 7m/s (23ft/s)
- Descent Rate: 4m/s (13ft/s)
- Turn Rate: 90°/second
- Cruise Speed: 10km/h (6mph)
- Maximum Speed: 50km/h (30mph)
- Minimum Speed: 0km/h (0mph)
- Launch Type: VTOL (Vertical Take Off and Landing)
- Maximum Altitude ASL: 2,438m (8,000ft)
- Maximum Flight Time: around 20 minutes without payload)

Rotor Blades

- Three Counter-Rotating Pairs (Six Rotors Total)
- Rotor Blade Material: Molded Carbon Fiber
- Upper Rotor Diameter: 40cm (16in)
- Lower Rotor Diameter: 38cm (15in)
- Upper Rotor Weight: 12g (0.42oz)
- Lower Rotor Weight: 11g (0.38oz)

Electric Motors

- Brushless Motors: 6
- Configuration: Direct Drive (One Motor per Rotor)

- Safety Features: Stall Protection
- Ball Bearing: 2 per Motor
- Rotor Mounting Points: Integrated
- Nominal Current Draw Per Motor: 1.04 Amps
- Nominal Power / Motor: 15.4 Watts
- Nominal Total Helicopter Motor Power: 92.4 Watts
- Peak Total Helicopter Motor Power: 450 Watts
- Motor Speed at Hover: 2000 RPM
- Voltage: 14.8V nominal
- Weight: 38g (1.34oz)

Camera Attachments

- 10MP (Mega-Pixel) Digital Still Camera with Remote Controlled Tilt, Zoom & Shutter
- 1080p HD (High Definition) Video Camera with Remote Controlled Tilt
- Thermal FLIR (Forward Looking Infra-Red) Camera with Remote Controlled Tilt
- Low Light (0.001lux) Dusk/Dawn Black & White Video Camera with Remote Controlled Tilt

Position Navigation Lights

- Type: 1 Watt LED Variable Brightness Emitters
- Luminous Flux at Full Brightness: 40lm
- Purpose: Helicopter Orientation Confirmation
- Visible Condition Range: Full Darkness to Direct Sunlight
- Standard Aircraft Colors
 - o Red: Left
 - o Green: Right
 - o White: Tail/Rear

Rechargeable Helicopter Battery

- Cell Chemistry: Lithium Polymer
- Voltage: 14.8V nominal
- Capacity: 2600mAh
- Cell Configuration 4s2p (4-series 2-parallel)
- Connectors: Integrated Balance and Power
- Recharge Time: 30 minutes (after typical flight)
- Length: 7.5cm (2.9in)
- Width: 6.7cm (2.6in)
- Height: 2.7cm (1.0in)
- Weight: 228g (8.0oz)

Landing Gear

- Installed Height: 18cm (7in)
- Stance Width: 30cm (12in)
- Skid Length: 30cm (12in)

- Landing Gear Material: Molded Carbon Fiber

Materials

- Carbon Fiber
- Glass Filled Injected Nylon
- Aluminum & Stainless Steel Fasteners
- RoHS Compliant

Operating Requirements

- Operating Temperature: -10° to 40°C (14° to 104°F)
- Relative Humidity: 0% to 90% Noncondensing
- Maximum Wind speed: 30km/h (18mph)
-

Draganflyer X6 Handheld Computerized Controller Transmitter

- Width: 22cm (8.7in)
- Height: 12cm (4.7in)
- Depth: 8cm (3.1in)
- Weight: 790g (28.0oz)
- Communication to aircraft 2.4GHz
- Video link 5.8GHz

G. Security Plan

For the area(s) of operation and security plan for the area(s) to be overflowed to ensure no hazard is created to persons or property on the surface.

Saskatoon Police Service personnel with at least one other person trained as a spotter will be present at all flights to identify possible hazards to persons or property on the surface and notify the operator of such hazards so they can adjust the flight operation to eliminate the hazard or cease the operation if necessary. Police personnel from the appropriate agency will provide personnel to secure areas of operation.

H. Emergency Contingency Plan

We will have known coordinates of all our locations. If an emergency occurs, Saskatoon Police Service Officers are always present. We will always have available the local air authority contact numbers with us at every location.

I. Ground Supervisor (if different from the Operations Manager)

Name: At least one of the below listed designated Saskatoon Police Service Personnel Trained in the operation of the X6 Helicopter. Both members listed have successfully completed Draganflyer X6 Training as provided by Canadian Centre for Unmanned Vehicle Systems and Draganfly Innovations Inc.

Sgt. [REDACTED] # [REDACTED] cell: [REDACTED]
Forensic Identification / Explosives Unit
Saskatoon Police Service

Resume of activities pertaining to the theory and use of the Draganflyer X6 helicopter:

April & May, 2005

-approximately 20 hours of simulated flight training using the Draganfly Innovations four rotor flight program

July, 2005 to August, 2006

-approximately 50 hours of flight practice using the Draganfly Innovations four rotor helicopter

April, 2009

-30 hours of pre-course, self-directed study including air law, meteorology, radio operations and theory of flight. Texts include the NAV Canada Weather Services Guide, CCUVS Training Manual, Draganflyer X6 User's Manual and "From the Ground Up", Millennium Edition.

April 2, 2009

-2 hour orientation and demonstration of the Draganflyer X6 helicopter

April 20-24, 2009

-Civil and Commercial Unmanned Air Systems Safety Course 0901. (See syllabus)
This course includes both theory and practical flight training for the Draganflyer X6 helicopter. I also received my restricted operator certificate for aeronautical radio operations. During the course, approximately 10 hours of hands on flight training were achieved under the direct supervision of Draganflyer Innovations instructors.

Constable [REDACTED] # [REDACTED]
Collision Reconstructionist – Saskatoon Police Service Traffic Unit
Office phone number: [REDACTED] cell: [REDACTED]

Resume of activities as it relates to the use of the Draganfly Innovations DraganFlyer X6:

April 2, 2009

Introduction to the DraganFlyer X6

- Attended a two hour demonstration & orientation on the DraganFlyer X6

April 10 - 20, 2009

Self-study & practical experience:

- Thirty (30) hours of pre-course, self-study materials including meteorology, theory of flight, radio communications and air law.
- Approximately 20 hours of hands on practical flight experience with indoor radio controlled helicopter provided prior to the training course.

April 20 – 24, 2009

Civil and Commercial Unmanned Air Systems Safety Course 0901 – See attached syllabus:

- Theory of flight / Modified ground school provided by flight instructors.

- Practical flight training supervised by Draganfly Innovations instructors - Approximately 10 hours of hands on.
- Obtained my Industry Canada Restricted Radio Operator's certificate with Aeronautical qualifications (ROC-A).

Reference Materials used:

- From the Ground Up – Millennium Edition
- DraganFly X6 User Manual
- Canadian Centre for Unmanned Vehicle Systems Pre – Course study Package

Address: 130 4th Avenue North
Saskatoon, Sask.
S7K 3R6

Flight Site phone as listed with names above or as changed by notification

J. Detailed Plan

All operations within 5 miles of an airport will be preceded by notification to the appropriate airport Authority /Flight Control Tower of specific location of operation and the estimated maximum height of operation and the expected time length of the operation. At the end of the operation the appropriate airport Authority /Flight Control Tower will be advised of the clearance of the operation.

We will execute each flight no higher than 175' AGL and the pilot will always be within 600' radius of the helicopter during operations. Care will be taken to ensure the operation does not pose a hazard to any person, or property including livestock. See item (iii) below

(i) Altitude & Routes of Approach & Departure

We will execute each flight outdoors no higher than 175' AGL and the pilot will always be within a 600' radius of the helicopter during operations.

(ii) Location & height above ground of obstacles in the approach and departure path

Outdoors potential obstacles might be trees and utility lines. We intend to take off, land in areas which will be free of obstacles. We will not be flying over spectators. The helicopter poses no risk to persons in occupied buildings.

Or

In the case of use of an indoor facility care will be taken to ensure no obstacle is in danger of damage and no flights will take place over spectators.

(iii) Exact boundaries of the area where the operation will be carried out

Photography and videography:

- Conducted at locations in Saskatoon and secured by Saskatoon Police Service personnel or by law enforcement agencies anywhere in Saskatchewan not over spectators.

Training of Law Enforcement Personnel

- Conducted indoors at any facility in which provides for an unobstructed space of at least 25 ft (W) x 35 ft (L) x 8ft (H).
- Conducted outdoors, at open area locations or designated training facilities, not over spectators. Training participants will wear safety glasses.

Demonstrations:

- Conducted indoors at any facility in Saskatoon which provides for an unobstructed space of at least 8 ft x 8 ft x 8 ft and where spectators can be separated from the flight area by at least 30 ft or where the flight area can be separated from spectators by a suitable netting or enclosure.
- Conducted at secured area locations anywhere in Saskatoon not over spectators, spectators will be separated from flight area by a minimum of 30 ft.
- Designated Saskatoon Police Service members will always retain master control of the Draganflyer X6 helicopter.

(iv) Altitudes and routes to be used while carrying out operation

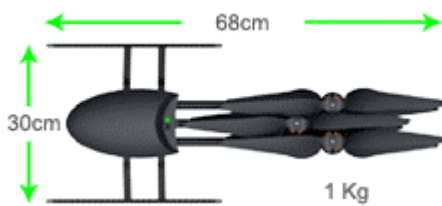
Max altitude 175 ft, routes and manoeuvres limited to a 600 foot radius from pilot.

(v) Other Information pertinent to safe conduct of Operation

Engineered for Safety

The Draganflyer X6 helicopter is designed with safe operation in mind. The size, rotor layout, data link, flight recorder, software configurations, navigation lights, and real time telemetry all have safety features incorporated.

Small Size & Low Weight



The Draganflyer X6 helicopter is smaller and lighter than conventional helicopters with comparable performance. In the event of a collision there is less kinetic energy in the helicopter, which decreases the damage done to both the helicopter and the object that it collides with.

On-Board Stabilization Software

On-board software continuously stabilizes the flight of the Draganflyer X6 helicopter. This allows the pilot to direct the helicopter rather than manually keeping it stable. The Draganflyer X6 helicopter also keeps itself within pre-programmed angular flight limits to ensure it remains stable.

High Brightness Navigation Lights



High power LED navigation lights using standard aircraft marker colors make the Draganflyer X6 helicopter easily seen in the air. This assists other craft in collision avoidance. The navigation lights also make determining the orientation of the Draganflyer X6 easier when it is far away, or in direct sunlight.



Rotor/Motor Damage Tolerance

With dual motors on each of the three arms, if an in-flight collision causes one of the rotors to break or one of the motors to stop working, the Draganflyer X6 helicopter will still be able to fly using the remaining five motors. This amazing ability to fly with a non-functioning motor or rotor is not found in any other helicopter.

Low Battery Indicator

The Draganflyer X6 helicopter battery and handheld controller battery level are monitored in real-time and displayed on the controller screen. An audible warning sounds and a visual alert pops up when the battery becomes dangerously low. If the helicopter continues to be flown, an auto landing will occur before the battery completely discharges.

Auto-Descent Failsafe

If for any reason the radio link is lost, the Draganflyer X6 helicopter will auto-descend and land automatically.

Maximum Operating Ceiling

The Draganflyer X6 helicopter can be programmed to restrict flight below a configurable maximum altitude.

Flight Recorder / Black Box

The onboard Flight Recorder saves flight data information to an on-board removable MicroSD memory card. This flight data can be used for post flight analysis or to analyze the cause of abnormal performance. Flight data can also be recorded to the MicroSD memory card in the handheld controller as a backup in case the Draganflyer X6 helicopter is lost. Recorded GPS coordinates can then be used for helicopter retrieval.

Transmission Frequencies

Data and control information for the helicopter are sent at 2.4GHz with automatic channel selection to eliminate frequency conflicts. This ensures a reliable and secure connection. Streaming video is sent at 5.8GHz, eliminating the possibility of interference with the data transmission.

Operating Altitude

Most operations for law enforcement use will require maximum altitudes of approximately 175 ft AGL. This poses no threat to any full size aircraft as they are operating at a much higher altitude.

Occupied Buildings

Where at all possible, flights over occupied buildings will be avoided. In the event that it is necessary to fly over an occupied structure, due to the light weight of the Draganflyer X6 and its light weight material make up, it poses no threat to persons in occupied buildings in that in the event of a crash into such a building it would cause little (paint scratch) to no damage. Since it is an electric aircraft there is no fuel to leak, ignite and cause fire.

General Public and Flight Operational Areas

Access to operational areas will be monitored and restricted by law enforcement personnel to prevent access by unauthorized persons into the area. Where the operation of the helicopter poses a physical threat to individuals or property the operation will be safely terminated or the situation causing the threat will be rectified.

Law Enforcement Personnel

All operations will only commence and proceed at the request of the appropriate law enforcement agency when sufficient personnel are present to safely undertake the operation.

Flight Operations

Flight operations for obtaining evidentiary photographs/video or tactical use will be under the direct control of experienced Saskatoon Police Service members trained in the operation and use of the Draganflyer X6 Helicopter. Saskatoon Police Service personnel will be utilized to operate the camera systems and will control all aspects related to evidentiary continuity of any crime scene.

No flight operations will occur under the authority of this SFOC unless; Saskatoon Police Service members trained in the operation and use of the Draganflyer X6 helicopter are present in a supervisory capacity.

Transport Canada - Airdromes & Navigation

Upon speaking with [REDACTED], Nav Canada, Saskatoon Control Tower, April [REDACTED] at 1400 hrs, regarding the proposal as stated in this SFOC, he stated that it would seem reasonable. He provided a phone number of 306 [REDACTED] for the Saskatoon Police Service to contact the Saskatoon Control Tower to advise of any time, location and height we will be flying the Draganflyer X6 helicopter. We will also contact them at the same number to advise of completion of the flight.

 **Transport Canada** **Transports Canada**
Civil Aviation (RAWR)
Prairie and Northern Region
344 Edmonton Street
Winnipeg, MB
R3C 0P6

May 30, 2011

5812-11-1211
RDIMS: 6752980

Saskatoon Police Service
130 4th Avenue North
Saskatoon, SK
S7K 3R7

Dear Inspector Engele,

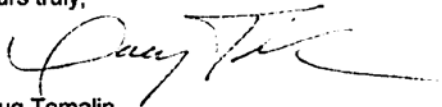
Pursuant to section 603.67 of the *Canadian Aviation Regulations*, this constitutes your **Special Flight Operations Certificate (SFOC)** for the operation of the **Draganflyer X6 Unmanned Air Vehicle (UAV)**, as described in your SFOC application and request dated **May 30, 2011** for photography and videography, flight training of members of the Saskatoon Police Service and demonstrations to media and law enforcement agencies of your **Draganflyer X6**. Issued under the authority of the Minister pursuant to the *Aeronautics Act*, this document certifies that the Certificate holder is adequately equipped and able to conduct a safe operation, subject to the observance and performance by the Certificate holder of the conditions set out in this Certificate, or any part thereof:

1. This Certificate:
 - a) is issued to the **Saskatoon Police Service**
 - b) may be suspended or cancelled at any time by the Minister for cause, including failure on the part of the Certificate holder, its servants or agents to comply with the provisions of the *Aeronautics Act* and the *Canadian Aviation Regulations* (CARs);
 - c) is not transferable and is valid **June 7, 2011** until **June 30, 2012** unless it is suspended or cancelled;
2. Except where otherwise referred to in this Certificate, the Certificate holder shall comply with the applicable provisions of the *Aeronautics Act* and the *Canadian Aviation Regulations* (CARs).
3. This Certificate is issued for the operation of the **Draganflyer X6** UAV without a transponder, aircraft markings, aircraft registration or a flight authority.
4. The Certificate holder shall maintain an adequate management organization that is capable of exercising supervision and operational control over persons participating in the UAV operations.
5. The management organization, the facilities, the normal operations plan, the emergency operating procedures, the operating limitations, the flying areas to be used, the Security and Emergency contingency plans for the **Draganflyer X6** UAV, shall be in accordance with data provided in your SFOC application, dated **May 30, 2011** or as otherwise agreed upon between the Saskatoon Police Service and Transport Canada.
6. The Certificate holder shall conduct the operation of the **Draganflyer X6** UAV in a safe manner.

7. The Certificate holder shall not require any person to operate the controls of the **Draganflyer X6** if either the person or the Certificate holder has any reason to believe that the person is suffering or is likely to suffer from fatigue so that they are unfit to perform their duties.
8. The Certificate holder shall not require any person to operate the controls of the **Draganflyer X6** within 8 hours after consuming an alcoholic beverage or while under the influence of alcohol or while using any drug that impairs the persons faculties to the extent that the safety of the operation is endangered in any way.
9. Only one (1) **Draganflyer X6** UAV shall be operated in-flight by an operator at any one time.
10. All **Draganflyer X6** UAV operations shall be limited to a maximum altitude of 175 ft. above ground level (AGL).
11. The **Draganflyer X6** UAV shall give way to manned aircraft.
12. The **Draganflyer X6** UAV shall be operated by personnel who are fully trained in all aspects of its flight planning, operation and recovery.
13. Throughout the flight operation, the Certificate holder shall ensure that the **Draganflyer X6** UAV is flown over areas that would permit a safe landing on the surface without hazard to persons or property in the event of any emergency requiring immediate descent.
14. The **Draganflyer X6** UAV may be operated at night to a maximum altitude of 100 AGL in areas that have adequate illumination to operate safely and avoid hazards.
15. For any **Draganflyer X6** UAV operated under the authority of this SFOC, **Saskatoon Police Service** shall have subscribed for liability insurance covering risks of public liability in the amount described in subsection 606.02(8) of the *Canadian Aviation Regulations*.
16. The **Draganflyer X6** UAV shall only be operated when visibility in the area of operation is not less than 1 mile and the **Draganflyer X6** UAV must remain clear of cloud during flight operations.
17. The **Draganflyer X6** shall be operated within visual line of sight of the operator.
18. The Certificate holder is responsible for ensuring that property owners, over which flights of a **Draganflyer X6** UAV will take place, have been advised of the proposed operation and have no objections or that the flight is conducted as authorized by the City of Saskatoon.
19. The Certificate holder shall locate an observer, in the area. This observer must advise the **Draganflyer X6** UAV operator if it appears that the UAV is violating any conditions of this SFOC.
20. The Certificate holder shall, prior to flight within the Saskatoon John G. Diefenbaker International Airport airspace contact Nav Canada, Saskatoon Control Tower at (306) 665-4240 and obtain a clearance to operate.
21. The Certificate holder shall ensure that the **Draganflyer X6** UAV is operated at a distance of not less than 100 feet away from members of the public or inhabited structures such as buildings and vehicles without the owners consent.
22. The **Draganflyer X6** UAV may be operated for demonstrations or training conducted at any facility which provides for an unobstructed space of at least 8 ft x 8ft x 8ft and where all persons can be separated from the flight area by at least 30 ft and are wearing safety glasses, or where the flight area is separated from all persons by a suitable netting or enclosure.

23. Flight over spectators is prohibited.
24. The Certificate holder is responsible for ensuring that all flights utilizing the **Draganflyer X6** UAV will be directed by the Saskatoon Police Service and authorized by the City of Saskatoon.
25. Certificate holder shall report to Transport Canada, General Aviation on the first working day following any of the following occurrences, with details of any of the occurrences:
- a) The **Draganflyer X6** UAV fly's outside of planned bounds of operation; or
 - b) Any person being injured as a result of the operation; or
 - c) Any unintended contact between the **Draganflyer X6** UAV and person(s), livestock, vehicle(s) or structure(s).
26. The Certificate holder shall not operate the **Draganflyer X6** UAV following any of the occurrences listed in condition 25 (a) (b) or (c), until Transport Canada, General Aviation, approves its further operation in writing.
27. All persons involved with these operations (flight crew, ground station crew, and spotters) shall be familiar with the contents of this **SFOC**, and the contents of the application dated **May 30, 2011**.
28. A copy of this **SFOC** and a copy of the application dated **May 30, 2011**, shall be on site any time the **Draganflyer X6** UAV is in operation.
29. The Certificate holder shall:
- a) Document their flight planning and procedures for each location and flight.
 - b) Document a post flight report on performance and any deviations from the plan.
 - c) Documentation shall be kept and made available for inspection for 1 calendar year.
 - d) The Saskatoon police Service will submit Quarterly reports to to Transport Canada (See appendix #1 for content and format).

Yours truly,



Doug Tomalin
Acting Superintendent Safety Oversight - Certification
General Aviation
Prairie and Northern Region
For the Minister of Transport

Canada

APPENDIX A

Company, Quarterly reports to Transport Canada,
Due after the last day of March, June, September, & December.

Date of Flight	Operator / Observer	Flight time (0.1, 0.2, 0.3 hrs)	Location, Address <u>or</u> Co-ordinates	Verification of Weather, Visibility Ceilings Winds	Altitude Flown & General Observations, Comments

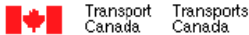
Add pages as necessary

Submitted by: _____
Scan and E-Mail to: PNRspecialflightops@tc.gc.ca

Canada

Annex B Sample Logbook

Annex C Sample Incident Report



AVIATION INCIDENT REPORT

AS OF: July 26, 2010 13:35 am
Local Date Local Time

To: Civil Aviation Contingency Operations (24 Hrs)
Fax: 613-993-7768 Tel: 613-992-6853

From: Marc Sharpe – OPP UAV Operation Manager Tel: 807-466-7461 Fax: 807-468-5849

OCCURRENCE:

- a. Type: Non-Fatal- UAV (3 lb rotary craft – Airframe damage only)
b. Location: Fort Hope First Nations Territory
c. Date: July 26, 2010
d. Local Time: 11:38 am

AIRCRAFT/VEHICLES:

- | | <u>Number One</u> | <u>Number Two</u> |
|--------------------|----------------------------------|-------------------|
| a. Identification: | <u>S/N 0X779AD9314620963</u> | <u>N/A</u> |
| b. Type/Model: | <u>Draganfly X-6</u> | <u>N/A</u> |
| c. Registration: | <u>N/A</u> | <u>N/A</u> |
| d. Owner/Operator: | <u>Ontario Provincial Police</u> | <u>N/A</u> |

ROUTE:

- a. Departure point: Fort Hope First Nations Territory - Ontario
b. Enroute stops: N/A
c. Destination: Fort Hope First Nations Territory - Ontario

PERSONS INVOLVED:

- | | <u>Number One</u> | | | <u>Number Two</u> | | |
|-------------|-------------------|------------|----------------------|-------------------|------------|--------------|
| | <u>Crew</u> | <u>Pax</u> | <u>Other</u> | <u>Crew</u> | <u>Pax</u> | <u>Other</u> |
| a. Total: | <u>NIL</u> | <u>---</u> | <u>3 ground crew</u> | <u>---</u> | <u>---</u> | <u>---</u> |
| b. Killed: | <u>NIL</u> | <u>---</u> | <u>---</u> | <u>---</u> | <u>---</u> | <u>---</u> |
| c. Injured: | <u>NIL</u> | <u>---</u> | <u>---</u> | <u>---</u> | <u>---</u> | <u>---</u> |

SUMMARY DESCRIPTION (including operational impact):

On the 26th of July 2010 at approximately 1138 hrs, noted OPP UAV sustained extensive damage as a result of an equipment failure during an operational flight.

UAV System:

- **Draganflyer X-6**
 - i. Length:.....85cm
 - ii. Width:.....91cm
 - iii. Height:.....25.4cm
 - iv. Rotor diameters:
 - 1. Upper.....40cm
 - 2. Lower.....38cm
 - v. Airframe weight:.....1000 g
 - vi. Max Payload :.....500 g
 - vii. Max gross take-off weight:.....1500g





UAV Flight Operation: (SFOC 5812-15-11-2009-1)

Aerial photography of a Sudden Death Crime Scene, located in the community of Fort Hope First Nations. Operations were being conducted within a police secured area at community soccer field when incident occurred.

Pilot / Operator:

II/Cst **Richard D CUNNINGHAM**
Ontario Provincial Police - Thunder Bay
Forensic Identification Unit
619 James St, South
Thunder Bay, Ontario
P7E 6V4
Ph # (807) 474-3123 Cell # (807) 629-7088

Environmental Conditions:

- Winds: from the southwest at 10-15 km/h
- Elevation at time of incident: 50 – 100 ft AGL
- Few clouds and light winds

Synopsis of Events:

At approximately 1130 hrs an operational flight was initiated, commencing aerial imaging at higher altitudes to a maximum of 350 feet AGL. Upon completion of upper level imaging, descent was initiated to flight level of approximately 50 to 100 feet where a hover was established for low level imaging.

After establishing a hover, the upper / rear rotor blade separated from the corresponding motor resulting in a loss of vertical stability. The resulting loss of vertical control caused an uncontrolled decent rate and extensive damage to the X6 when it came in contact with the ground.

Impact was in a field with no property damage beyond the aircraft itself. The closest person to the impact was approximately 500 feet.

Cause of Accident:

- Failure of the rubber "O" type rings (2) that hold rotor to motor hub assembly.

Corrective Action:

- All OPP UAV operations have been suspended pending Transport Canada incident review.
- Although the O-rings fasteners are inspected prior to each flight, the O-rings on this machine have logged in excess of 15hrs with a cumulative effect from material fatigue and/or an undetected flaw likely contributing to the failure.
- Although the O-ring / rotor blade mounting method has proven effective over extended periods on multiple airframes, additional data indicates that the O-rings will fail over time due to tension and environmental factors alone if not changed on a regular basis.
- **The OPP currently have four X-6 systems in operation. The remaining X-6 systems shall:**
 1. Have all O-ring rotor retainers replaced immediately to establish a known starting reference date.
 2. In the absence of obvious damage during pre-flight inspections, replacement of O-ring retainers shall occur on a quarterly basis (every 3 months) regardless of flight time with an appropriate entry within the operator's log. This procedure will become a mandatory maintenance procedure for all Draganfly Systems in operation with the OPP that use this rotor attachment mechanism.



3. The manufacturer shall been notified of the incident and findings in relation to the O-ring retainers.

Footnotes:

- I have reviewed the incident details with I/C Cunningham resulting in the corrective action recommendations.
- It should be noted that the established safety and operational procedures as detailed in the applicable SFOC and corresponding application were sufficient and effective, resulting in no injury or property damage outside of the aircraft itself.
- As a result of these noted procedures, system size/weight and VTOL configuration, the risk to the public and operators was/is negligible.
- It should further be noted that the same X-6 system operating for the purposes of "hobby or pleasure", is considered a "model aircraft" and incidents of this nature would not require report or notification of any type.

M.W. (Marc) Sharpe #6762
Identification Constable
Ontario Provincial Police
Kenora Forensic Identification Unit
Explosive Disposal Unit
222 Water Street
Kenora, Ontario
P9N 1S4
Ph: 807-468-3357 Ex.4872
Cell: 807-466-7461
Fax: 807-468-5849

Annex D Sample Maintenance Log

(Reprinted with the Permission of Draganfly innovations Inc.)

Draganflyer Maintenance Checklist

Every Flying Session

- ☐ Inspect folding mechanism and all joints for damages or wear
- ☐ Inspect motors for rough motion
- ☐ Inspect all rotor and camera mount o-rings for damage or wear
- ☐ Check to ensure the hand held controller is recording a log file.
- ☐ Clean all components with a soft cloth or compressed air

Every 3 Months

- ☐ Replace all rotor blade mounting o-rings
- ☐ Replace all camera mount quick release o-ring
- ☐ Check mounting bolts on rotor blades mounts
- ☐ Perform motor test and check for rough movement
- ☐ Cycle flight batteries
- ☐ Inspect canopy mounting latch and rear slot

Every Year or 300 flight hours

Refer to your Draganflyer operators manual for additional required services. Contact Draganfly Innovations Inc's Customer Service department to assist you with these maintenance needs.

Draganflyer Maintenance Log Book

Draganflyer model: _____

Revision: _____

Serial Number: _____

To help keep track of when your Draganflyer requires service please use this Service log book to track maintenance and repairs that have been conducted on your helicopter. Should you need to send your helicopter to Draganfly Innovations for servicing please ensure to include this Service Log and your flight log book with the Draganflyer system

[illegible]

Annex E Resources

Transport Canada Regional Offices

Transport Canada, Civil Aviation Pacific Region	Transport Canada, Civil Aviation Atlantic Region
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620-800 Burrard Street
Vancouver BC V6Z 2J8
Tel.: (604) 666-5575
Fax: (604) 666-4839

Street Address:
Heritage Court, 6th Floor,
95 Foundry Street
Moncton NB E1C 5H7

Mailing Address:
95 Foundry Street, P.O. Box 42
Moncton NB E1C 8K6

Tel.: (506) 851-7131
Fax: (506) 851-2563

Transport Canada, Civil Aviation Prairie and Northern Region	Transport Canada, Civil Aviation Ontario Region
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Street Address: 344 Edmonton Street, 1st Floor, Winnipeg MB R3B 2L4	300-4900 Yonge Street Toronto ON M2N 6A5
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Mailing Address: P.O. Box 8550 Winnipeg, MB R3C 0P6	Tel.: (416) 952-0215 Fax: (416) 952-0196
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Tel.: (204) 983-4341
Fax: (204) 984-2069

Transport Canada, Civil Aviation
Quebec Region

Regional Office
700 Leigh Capréol, 2nd Fl.
Dorval PQ H4Y 1G7

Tel.: (514) 633-3580
Fax: (514) 633-3585

Aeronautical Radiotelephone Operators License

[http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/ric21.pdf/\\$FILE/ric21.pdf](http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/ric21.pdf/$FILE/ric21.pdf)

Agencies currently using UAS – contacts

- Halton Regional Police

Andy Olesen
E-mail: andy.olesen@haltonpolice.ca

- Ontario Provincial Police

Marc Sharpe
E-mail: marc.sharpe@ontario.ca

- Prince Albert Police Service

Shawn Stubbs
E-mail: sstubbs@papolice.ca

- Regina Police Service

Tom Mansfield
E-mail: tmansfield@police.regina.sk.ca

- Royal Canadian Mounted Police 'F' Division

Dave Domoney
E-mail: dave.domoney@rcmp-grc.gc.ca

- Royal Canadian Mounted Police 'E' Division (LMD- Greater Vancouver)

Dave Jewers
E-mail: dave.jewers@rcmp-grc.gc.ca

- Saskatoon Police Service

Jerome Engele
E-mail: Jerome.engele@police.saskatoon.sk.ca

DOCUMENT CONTROL DATA		
(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)		
1. ORIGINATOR (The name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.) Saskatoon Police Services	2. SECURITY CLASSIFICATION (Overall security classification of the document including special warning terms if applicable.) UNCLASSIFIED NON-CONTROLLED GOODS DMC A Review ECL June 2010	
3. TITLE (The complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title.) Guidebook for Integrating an Unmanned Aerial System (UAS) into Police and Emergency Operations.		
4. AUTHORS (last name, followed by initials – ranks, titles, etc. not to be used) Engele, Jerome; Sharpe, Mark		
5. DATE OF PUBLICATION (Month and year of publication of document.) October 2012	6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.) 66	6b. NO. OF REFS (Total cited in document.)
7. DESCRIPTIVE NOTES (The category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.) Contract Report		
8. SPONSORING ACTIVITY (The name of the department project office or laboratory sponsoring the research and development – include address.) Centre for Security Science Defence R&D Canada 222 Nepean St. 11th Floor Ottawa, ON Canada K1A 0K2		
9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.) CPRC 2008-017	9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)	
10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.)	10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.) DRDC CSS CR 2012-012	
11. DOCUMENT AVAILABILITY (Any limitations on further dissemination of the document, other than those imposed by security classification.) Unlimited		
12. DOCUMENT ANNOUNCEMENT (Any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in (11) is possible, a wider announcement audience may be selected.) Unlimited		

13. ABSTRACT (A brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual.)

The aim of this Guidebook is to present the facts to consider prior to establishing an Unmanned Aerial System (UAS) Unit within emergency responder operations. This Guidebook was produced through a collaborative effort between Canadian and American law enforcement agencies currently using UAS. While every effort was made to cover as many key areas as possible, this reference should not be considered authoritative or comprehensive. Instead it is intended to provoke thought and discussion on the many important issues that need to be addressed including legal, regulatory, jurisdictional and environmental.

The responder organizations currently using UAS are reporting increased responder safety, enhanced photographic evidence of crime scenes, faster evidence collection, an improved efficiency in clearing serious traffic collision scenes and significant cost savings as compared to manned aircraft use. Many more uses will be commonplace in the coming years including Tactical Support, Search and Rescue and Incident Command at Major Incidents.

Le présent guide vise à présenter les faits à prendre en considération avant la mise sur pied d'une unité de systèmes aériens sans pilote à bord (UAS) au sein d'un service d'intervention d'urgence. Ce guide est le fruit de la collaboration entre des services policiers canadiens et américains qui utilisent déjà des UAS dans leurs opérations. Bien que tous les efforts aient été faits pour couvrir le plus grand nombre possible de points essentiels, il ne faudrait pas croire que ce guide fasse autorité ou qu'il soit complet. Il a plutôt pour but de stimuler la pensée et la discussion sur les nombreuses questions importantes que chaque service devra se poser, compte tenu des préoccupations légales, réglementaires, juridictionnelles et environnementales qui lui sont propres.

Les services d'intervention qui utilisent actuellement des UAS font état d'une meilleure sécurité des intervenants, d'une amélioration des preuves photographiques obtenues sur les scènes de crime, d'une collecte plus rapide des preuves, d'une meilleure efficacité dans le dégagement des scènes d'importantes collisions routières et de fortes économies par rapport à l'utilisation d'aéronefs avec pilote à bord. De nombreux autres usages vont devenir chose courante dans les prochaines années, qu'il s'agisse d'appui tactique, de recherche et sauvetage et de commandement sur place en cas de graves incidents.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

Unmanned Aerial Vehicle; Tri-Services; Surveillance; Emergency Operations