CARLETON UNIVERSITY
UNMANNED AERIAL VEHICLE

GeoSurv II

System Requirements Document

Revision E

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Prepared by:

Thomas James, Carleton University

Integration

Concurred by:

Ben Allison, Carleton University

Integration

Approved by:

Prof. Paul Straznicky, Carleton University

Project Manager

David Waigh, Sander Geophysics Ltd.

Aviation Manager

Revision History

Version	Date	Description
A	5-Nov-04	Initial Release
B	1-Feb-05	This document has been modified significantly from its initial release. Changes include addition of sections, restructuring of section 3.1, renumbering of many requirements, deletion of many requirements, addition of many new requirements as well as the addition of new sections. References to requirements in Version A may no longer be valid.
C	4-Mar-05	• The requirement numbering system has been slightly modified; a dash line has been added in place of a dot (e.g. 3.1.3.7 is now 3.1.3-7) • New Requirements: 3.2-12 • Modified Requirements: 3.1.1-2 , 3.1.1-6 , 3.1.1-8 , 3.1.2.1-6 , 3.1.3-7 , 3.1.3-13 , 3.2-7 , 3.6-3 , 3.6-7 • Deleted Requirements: 3.1.1.6.1 , 3.1.3.3.1 , 3.2-3 , 3.1.2.1-4 • Moved (renumbered) Requirements: 3.1.2.9-1 became 3.1.2-12 3.1.2.4-1 became 3.1.2-13 3.1.2.4-2 became 3.1.2-14 3.1.3.1-1 became 3.1.3-14 3.1.3.10-1 became 3.1.3-15 Note: Many requirements have had unnecessary tolerances removed.
D	6-Feb-06	SRC-01 included SRC-02 included SRC-03 included SRC-05 included SRC-07 included Cert. Status column added for section 3
E	31-Mar-08	SCR-10 included SCR-11 included SCR-12 included

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Purpose and Scope

The purpose of this document is to state the objectives and design requirements for the design of the GeoSurv II Unmanned Aerial Vehicle (UAV) system. This document is the governing documentation of the requirements of the customer, Sander Geophysics Ltd.

1.2 Document Control

The approved GeoSurv II Systems Requirements Document is controlled by the Integration group of the 2004-2005 Fourth Year Engineering Design Project - UAV Team. Approval of the document is by Prof. Paul Straznicky, UAV Project Manager and Sander Geophysics Ltd.

1.3 Acronyms, Abbreviations, and Definitions

1.3.1 Acronyms

AGL	above ground level
AME	aircraft maintenance engineer
ASL	above sea level
ATB	avionics test bed
BLOS	beyond line of sight
DGPS	differential global positioning system
FAA	Federal Aviation Administration
FOM	Figure of Merit
GCS	ground control station
GDAS	geophysical data acquisition system
GGS	geophysical ground station
KEAS	Knots equivalent airspeed
Lkm	line-kilometres

OTH	over the horizon
SGL	Sander Geophysics Ltd.
SRD	system requirements document
TBD	to be determined
TBO	time between overhaul
TC	Transport Canada
UAV	Uninhabited aerial vehicle

1.3.2 Abbreviations

ANL	analysis
DEMO	demonstration
INSP	inspection
ref	reference
Survey	geophysical survey
TST	test
Verif.	Verification
Cert.	Certification

1.3.3 Definitions

Crew	Group of persons performing survey at field location.
Geophysical data acquisition system	A distinct payload system responsible for measurement and acquisition of geophysical data.
Geophysical ground station	Ground based geophysical system for obtaining differential GPS corrections and diurnal magnetic field variations. Both of these are used for post mission data processing of the data acquired in flight.
Ground control station	Collection of ground based systems (both vehicle and

	mission oriented) used to control or monitor the UAV.
The Customer	Sander Geophysics Ltd. (SGL)
Line-kilometre	Unit of measure for survey sizing. The amount of data collected over a kilometre length of the survey. Sander Geophysics Ltd. charges clients for data on a line-kilometre basis.
Magnetic Noise	Undesired magnetic fields
Operator	Person operating and/or supervising the UAV from the ground control station.
Transit Distance	Distance between the launch/recovery site and the survey area.

1.4 References

1.4.1 Document Precedence

This system requirements document (SRD) is consistent with, and responsive to, the following documents. If the SRD conflicts with any of these documents, the SRD document takes precedence:

Document Number	Document Title	Version or Date

1.4.2 Document Inclusion

The following documents form a part of the SRD to the extent specified herein:

Document Number	Document Title	Version or Date
01	UAV Specification: Magnetic Noise	13-Sept-04
02	Magnetic Compensation Maneuvers	18-Feb-05

2 GENERAL DESCRIPTION

2.1 Functions and Purpose

The Carleton University UAV student team is designing a UAV system for geophysical surveillance. This design must meet the requirements and objectives of the customer, Sander Geophysics Ltd (SGL). This project is intended to last four years, beginning with the conceptual design stage and ending with a system capable of meeting the requirements. The UAV has been named GeoSurv II. The UAV system includes the aerial vehicle, launch system, payload, recovery system and the ground control station (GCS).

Typical geophysical surveillance field projects today include a crew of one or two geophysicists, a pilot, a co-pilot as well as an aircraft maintenance engineer (AME). Such projects require an aircraft capable of carrying two pilots plus a payload of several hundred pounds. The costs associated with these activities are the driving factor for pursuing a more economic means of performing surveys, particularly of smaller areas. The primary objective of the GeoSurv II system is to offer primarily an economic advantage over traditional manned aircraft surveying, and secondarily, a performance advantage. In order to accomplish this, it is required that the system be operated by a field crew of two people.

The UAV is to be used primarily for magnetic total field and gradiometer surveying and must therefore have an exceptionally low magnetic signature. Hence, the aircraft must not create fixed or time-varying magnetic fields.

The system shall be designed to operate in various geographical areas, which may include remote and underdeveloped areas. Considerations will be made for aircraft launch and recovery systems that accommodate the need to perform take-off and recovery in areas such as bush clearings, without access to a conventional landing strip. The recovery of the aircraft is to be performed at the same location as take-off. It is desirable that the system, including UAV, GCS, launching/recovery system and accessories, be transportable by a conventional road vehicle such as a pickup truck or cargo van. Similarly, the system shall fit within the cargo compartment(s) of a conventional transport aircraft, as survey projects may be located globally.

The system must be capable of operating year round anywhere in the world. It is expected that operations would be suspended in temperatures of -45 degrees Celsius and below.

The system should be robust and relatively inexpensive to facilitate field repairs or replacement if necessary following damage.

Survey projects will require capturing various levels of data resolution. As a result surveys may be performed at varying flight speeds. In general, the greatest flight speed permitted by the data capturing capability of the sensors/system is desirable. Variations in flight speed are undesirable but tolerable. The aircraft shall have a survey speed range of 60 to 100 KEAS. The 60 and 100 KEAS are two design points.

To achieve better operational efficiency and reduce 'down time', the UAV should have as large an endurance as possible. A minimum endurance of 2 hours is required at 100 knots and 4 hours at 60 knots. However, an endurance of 8 hours would be considered highly advantageous.

The UAV is expected to have a terrain following capability with terrain gradients of at least 10% followed at constant height above the ground. Surveys performed over terrain gradients greater than the UAV's capability are to be flown following a planned smooth surface (draped surface) which is generated prior to flight.

The avionics, communication and data management aspects of this system form a major part of the design considerations. The aircraft shall have an autopilot system allowing flight profiles to be preprogrammed and then flown while under minimum supervision of an operator at the ground control station (GCS). The aircraft shall have the ability to transmit and receive information with the GCS at regular and changeable intervals. Such information shall include position, 'general health' (such as fuel level) and data sample.

A collision detection and avoidance system shall be in place and shall operate automatically, without the need for operator intervention. This is a necessary safety consideration as it is not always possible to predict discrete obstacles. The system should allow for known obstacles, such as towers and power lines, to be preprogrammed into the flight profile.

Prior to any survey flying it is generally necessary to perform a series of compensation manoeuvres to ensure that the sensor(s) is(are) oriented correctly and that the overall system figure of merit (FOM) is acceptable. The data acquired during these compensation flights must be downloaded and analyzed prior to sending the aircraft out on a survey data acquisition mission. Compensation flying is performed at an altitude of approximately 8000 feet above ground. Therefore the UAV shall be able to attain this altitude.

The overall objective of the GeoSurv II UAV design project is to produce a high quality design of a UAV system that satisfies the requirements and objectives of SGL while providing valuable experience for the UAV student team.

2.1.1 Operations Concept (ConOps)

This section describes a typical survey mission.

Once at the survey area, or a suitable location within the vicinity, the two system operators assemble and prepare the aircraft and launch systems for the mission. Adequate fuel is added to the aircraft fuel tank. A prepared mission profile is transferred to the aircraft flight control system. A pre-flight check is performed including checks of the engine, structural and avionics systems, and geophysical equipment. The aircraft is then installed on the launch system.

When ready, the operators start the engine and allow time for it to reach operating temperature. The launch command is given and the aircraft is accelerated beyond its stall speed into flight. The aircraft can now begin the mission profile which may include transit to the survey area. Much of the flight will be over the horizon (OTH) and beyond line of sight (BLOS).

Communications between the operators and the UAV is done via the ground control station (GCS).

Through the course of the mission the on-board geophysical data system records all necessary data which includes differential global positioning system (DGPS) information as well as aircraft yaw, pitch and roll. Periodically, the aircraft transmits to the GCS its position, velocity, fuel status and other data on system health. Similarly, short bursts of data in binary format are transmitted and handled by processing software on the ground to provide magnetometer health assessments.

Once the mission profile is completed or a refuelling is needed, the aircraft returns to the launch site. The operators then execute the necessary procedures for recovery of the aircraft.

The mission data are retrieved and the aircraft is then prepared for another flight cycle or disassembled and stowed for transportation.

2.1.2 (Section removed)

2.2 (Section removed)

2.3 General Constraints

Requirement	Rationale	Cert. Status	Verif.	Status
2.3-1 The UAV system shall be cost competitive with existing manned survey services.	System must ultimately be more economic and more capable than existing survey services to justify investment.		ANL	TBD
2.3-2 The UAV system shall not pose hazards to the operators or general population.	The safety of all persons is the highest priority. See sections 3.13 and 3.14 for specific safety and certification requirements		ANL	TBD
2.3-2 Minor UAV service should be able to be performed by operator(s) on site.	This avoids the cost of transporting the UAV for minor services. This may include 'routine' engine replacement.		DEMO	TBD

3 SPECIFIC REQUIREMENTS

3.1 Functional Requirements

3.1.1 General Functional Requirements

Requirement	Rationale	Cert. Status	Verif.	Status
3.1.1-1 All field operations of UAV system shall require a crew of not more than 2 persons	Maintain low cost of field man-hours.		DEMO	TBD
3.1.1-2 The launch and recovery of the UAV shall be achievable within a flat area clear of obstructions meeting one of the following definitions: • A square measuring not more than 100 feet (30 metres) on each side; • A circle measuring not more than 115 feet (35 metres) diametre; • A rectangle measuring not more than 328 feet (100 metres) by 33 feet (10 metres) provided UAV can be safely launched and recovered from such an area without the long dimension needing to be aligned with the prevailing wind direction for winds meeting the requirements of section 3.6-4	Surveys are often performed in underdeveloped areas. There may be no airstrip within the vicinity of the survey area		DEMO	TBD

3.1.1-3 Uncompensatable magnetic fields (noise) generated by the UAV shall not exceed 0.1 nT +/- 0.05 nT for fixed sources. (reference section 1.4.2 – 01)	The magnetometers are passive devices that measure the strength of the local field in which they are located in . This includes the local effect of any noise generated by the aircraft. Therefore, noise will compromise measured data.		TST	TBD
3.1.1-4 Uncompensatable magnetic fields (noise) generated by the UAV shall not exceed 0.01 nT +/- 0.005 nT for time-varying sources, in a 0 to 5 Hz bandwidth. (ref section 1.4.2 – 01)	As above (3.1.1.3)		TST	TBD
3.1.1-5 The UAV shall operate on one of the following fuels: Jet A; JP-4 , unleaded gasoline, diesel.	The fuel must be readily available. Heavy fuel is preferred.		INSP	TBD
3.1.1-6 The UAV shall incorporate a means to minimize and dissipate static charge accumulation.	Significant static charge may otherwise accumulate and discharge at random thereby causing interfering electro-magnetic fields.		DEMO	TBD
3.1.1-7 The UAV shall provide necessary electrical power for avionics.	The UAV must provide for all necessary electrical power needs and should allow for future upgrading.		INSP	TBD
3.1.1-8 In addition to design flight loads as specified in the applicable design standard, the UAV shall be capable of safely sustaining design launch loads.			TST	TBD
3.1.1-9 The UAV structure shall consist of only	Metal materials within this area may create			

composite materials within 30 cm of the magnetometer sensors. Use of metals within this area shall be minimized and shall in any case be limited to non-magnetic hardware components	uncompensatable magnetic fields (noise) regardless of their ferrous content.			
3.1.1-10 Provisions for landing gear on the UAV shall be made. As well, the UAV shall be able to withstand all loads associated with the landing gear.	In testing the UAV, it may be necessary to have the UAV take-off and land using a ground strip, rather than with the winch launching and parachute landing systems. This requires that provisions be made to attach landing gear to the UAV.			

3.1.2 Flight Avionics

Requirement	Rationale	Cert. Status	Verif.	Status
3.1.2-1 (deleted)				
3.1.2-2 (deleted)				
3.1.2-3 The UAV shall carry on board a flight computer to process the sensor output data.	Data shall be processed by computer during flight to facilitate decision-making.		INSP	TBD
3.1.2-4 The UAV shall record air vehicle sensor data.	Data shall be recorded during flight to avoid the need to transmit all data.		INSP	TBD
3.1.2-5 The UAV shall transmit GPS coordinates (vehicle position) to the GCS every 1 minute.			DEMO	TBD
3.1.2-6 The UAV should incorporate an icing detection system.	This will allow for the triggering of a 'return to base' flight plan, as flight in icing conditions is not		DEMO	TBD

	required nor desirable.			
3.1.2-7 The UAV should monitor fuel consumption vs. line-kilometres flown (on the basis of complete lines)			DEMO	TBD
3.1.2-8 The auto-pilot system shall trigger a 'return to base' sequence when the fuel level is depleted such that at least 15 minutes of fuel remains at recovery.	This is to avoid running out of fuel during a mission. This acts as a safety in case communications with the UAV are lost. 15 Minutes of fuel is reserved for contingencies.		DEMO	TBD
3.1.2-9 DGPS corrections for flight avionics shall be done on the UAV, not through updates from the ground station.	Sensor readings need to be accurately data stamped.		TST	TBD
3.1.2-10 Flight avionics shall transmit the following data at predetermined intervals to payload avionics: pitch, roll, azimuth, track.	Payload computer can incorporate the necessary data with the derived sensor reading.		TST	TBD
3.1.2-11 The UAV shall accept mission amendments from the GCS.	Must be able to modify and /or abort a mission at any time, therefore giving the operator better control of system at all times.		DEMO	TBD
3.1.2-12 Flights with DGPS corrections for flight avionics shall be restricted to Canada.	Need only to be concerned with Canadian DGPS. Project scope is currently limited to flight within Canada.		DEMO	TBD
3.1.2-13 The UAV shall record vehicle attitude including pitch, roll and heading, at 10 Hz.			DEMO	TBD

3.1.2-14 The UAV shall record laser altimeter output (altitude) at 10 Hz.			DEMO	TBD

3.1.2.1 Guidance & Navigation

Requirement	Rationale		Verif.	Status
3.1.2.1-1 The navigation and guidance system shall incorporate an obstacle detection system.	The UAV must be able to detect unforeseen discrete obstacles within the flight path in order to avoid collision.		TST	TBD
3.1.2.1-2 The navigation and guidance system shall incorporate an obstacle avoidance system.	The UAV must be able to avoid unforeseen obstacles within the flight path in order to avoid collision		TST	TBD
3.1.2.1-3 The UAV shall carry 1 radar altimeter.	Accurate height above ground is required for geophysics. A radar altimeter may also be desirable as part of navigation/guidance system and for supplementary geophysical data.		INSP	TBD
3.1.2.1-4 (deleted)				
3.1.2.1-5 The UAV shall maintain a constant height above terrain as predetermined for each mission by the customer.			TST	TBD
3.1.2.1-6 Measurement of height above ground should be accurate to 2 feet (0.6 metres) (one sigma)			DEMO	TBD
3.1.2.1-7 Aircraft navigation system shall utilise GPS supplemented by barometric altimetry and the	GPS is an accurate worldwide navigation system; barometric altimetry provides redundant vertical data;		INSP	TBD

obstacle detection/avoidance system.	additional altimetry required for flight guidance.			
3.1.2.1-8 Aircraft guidance system shall be GPS supplemented by laser or radar altimetry and the obstacle detection/avoidance system.	GPS is an accurate worldwide navigation system; barometric altimetry provides redundant vertical data; additional altimetry required for flight guidance.		INSP	TBD
3.1.2.1-9 The UAV shall return to the flight plan upon avoiding an obstacle.	Keep in phase with the flight plan		DEMO	TBD

3.1.2.2 Communications

Requirement	Rationale	Cert. Status	Verif.	Status
3.1.2.2-1 The UAV shall use satellite communication (SATCOM) as the primary beyond line of sight system.	System currently used.		DEMO	TBD
3.1.2.2-2 The UAV shall transmit mission health parameters to the GCS.			DEMO	TBD

3.1.3 Payload Avionics

Requirement	Rationale	Cert. Status	Verif.	Status
3.1.3-1 The UAV shall carry on board a mission computer to process the magnetometer sensor output data.	Data shall be processed by computer during flight to facilitate decision-making.		INSP	TBD

3.1.3-2 The UAV shall carry on board a recorder to record sensor data.	Data shall be recorded by computer during flight to avoid the need to transmit all measured data.		INSP	TBD
3.1.3-3 An onboard colour camera shall be used for optical surveillance.	Photographs may need to be taken of areas where unusual sensor readings occur.		INSP	TBD
3.1.3-4 If 2 magnetometers are carried, these shall be mounted in horizontal gradiometer configuration.	Magnetic gradient perpendicular to the direction of flight is the most useful one to measure. Along track gradient can be determined with a single sensor and vertical gradient is often related to the others.		INSP	TBD
3.1.3-5 The UAV shall carry 1 or 2 G822A magnetometer sensors	SGL requirement.		INSP	TBD
3.1.3-6 The UAV shall carry 1 Billingsley TFM 100 vector magnetometer sensor	SGL requirement.		INSP	TBD
3.1.3-7 All materials within 1 foot (30 centimetres) of magnetometer(s) shall be non-conductive, with the exception of small non-magnetic fasteners.	This reduces eddy currents within the vicinity of the sensor(s)		DEMO	TBD
3.1.3-8 (deleted)				
3.1.3-9 The UAV shall record the output of each magnetometer sensor at frequency of 160 Hz			DEMO	TBD
3.1.3-10 DGPS corrections for payload avionics shall be done on the UAV, not through updates from the ground station.	Sensor readings need to be accurately data stamped.		TST	TBD

3.1.3-11 Payload avionics shall utilize its own GPS decoder board to supply its position data.	This is due to the need to record more than just decoded latitude, longitude and altitude information.		INSP	TBD
3.1.3-12 Payload needs to record timestamp from each satellite in view at 10hz.	This needs to be done for post processing.		TST	TBD
3.1.3-13 The UAV shall carry 1 laser rangefinder for altimetry.	Accurate height above ground is required for geophysics. A laser altimeter may also be desirable as part of navigation/guidance system and for supplementary geophysical data.		INSP	TBD
3.1.3-14 The UAV should use a CompactPCI architecture for the on board mission computer.	CompactPCI is easier to expand and more rugged. Currently used by SGL.		INSP	TBD
3.1.3-15 Flights with DGPS corrections for payload avionics shall be restricted to Canada.	Need only to be concerned with Canadian DGPS. Project scope is currently limited to flight within Canada.		DEMO	TBD

3.1.4 Ground Control Station (GCS)

Requirement	Rationale	Cert. Status	Verif.	Status
3.1.4-1 GCS shall receive and record the corrections for post-processing of the magnetometer data.			TST	TBD
3.1.4-2 The GCS shall have the capability to amend the mission during flight.	Must be able modify and /or abort a mission at any time, therefore giving the operator better control of		DEMO	TBD

	system at all times.			

3.2 Performance Requirements

Requirement	Rationale	Cert. Status	Verif.	Status
3.2-1 The aircraft shall be able to maintain a flight speed of 60 KEAS (30 m/s) to 100 KEAS (51.4 m/s) without the use of high lift devices.	This represents expected target surveying speeds. 100 knots is a desirable speed for efficient surveying of large areas.		DEMO	TBD
3.2-2 The stall speed without the use of high lift devices shall be no greater than seventy-five percent of the minimum survey speed.	Slow speed is desirable for high resolution surveys.		DEMO	TBD
3.2-3 The stall speed shall also be no greater than seventy-five percent of the lower of the minimum launch speed of the minimum recovery speed. High lift devices may be deployed as appropriate for the limiting condition (launch or recovery) to achieve the required stall speed.			DEMO	TBD
3.2-4 The UAV shall be capable of following terrain of at least 10% gradients, both climb and descent.	Gradient necessary for terrain following and collision avoidance		DEMO	TBD
3.2-5 The UAV shall be able to maintain climb and descent gradients of 10% at 30^{o}C (86^{o}F) and	This affects data quality in draped profile missions.		DEMO	TBD

8000 feet (2438 m) AGL.				
3.2-6 The UAV shall be able to maintain a minimum flight altitude of 33 feet AGL (10 metres).	Low altitude flight allows passive magnetometer sensors to be located closer to source being measured (i.e. submersed in stronger magnetic fields)		DEMO	TBD
3.2-7 The UAV shall be capable of performing survey operations at a maximum altitude of 8000 feet (2440 metres) ASL.	This is the maximum altitude necessary for magnetometer correction procedures. Some surveys may be conducted at this altitude. (ref section 1.4.2 – 02)		DEMO	TBD
3.2-8 The UAV shall be capable of a rate of climb of 400 ft of vertical rise per minute (122 metres per minute) at 30^{o}C (86^{o}F) and sea level conditions.	A desirable time frame to attain a suitable magnetometer correction altitude.		DEMO	TBD
3.2-9 The UAV shall have a minimum flight endurance of 4 hours at 60 knots and 2 hours at 100 knots. A flight endurance of 8 hours at 60 knots is the design point.	The higher endurance the better for increased operational efficiency		DEMO	TBD
3.2-10 The UAV should be capable of maintaining a constant flight speed +/- 3 knots (+/- 1.5 m/s).	Variations of speed along track are undesirable but tolerable in straight and level flight.		TST	TBD
3.2-11 The UAV should have a lateral deviation of not more than 33 feet (10 metres) for 1 sigma.			TST	TBD
3.2-12 Following cold soak of the air vehicle all systems must be brought to their minimum operating temperature before the start of the mission.			TST	TBD

3.3 External Interface Requirements

Requirement	Rationale	Cert. Status	Verif.	Status

3.4 Operational Availability Requirements

Requirement	Rationale	Cert. Status	Verif.	Status
3.4-1 The system shall be operable up to 16 hours per day, 6 days per week, 48 weeks per year.	Economical use of system.		DEMO	TBD
3.4-2 The maximum acceptable transit distance is 25 nmi (46.3 km).	This limits the distance between the UAV and operators during a mission.		INSP	TBD
3.4-3 The UAV assembly and disassembly process, including all mechanical preparations for flight as well as stowage of the UAV for transportation but not including programming of flight profile, should require not more than 2 hours combined time.	This is considering a crew of 2 persons. The less time and effort the better as this allows for more line-kilometres flown per day.		DEMO	TBD
3.4-4 The pre-flight and post-flight checks should require a time of not more than 15 minutes each.	This is considering a crew of 2 persons.		DEMO	TBD

3.4-5 The scheduled engine time between overhaul (TBO) should be at least 500 hours.	This may depend on engine cost and ease of engine replacement.		DEMO	TBD

3.5 (section removed)

3.6 Environmental Requirements

Requirement	Rationale	Cert. Status	Verif.	Status
3.6-1 The UAV should operate within a temperature range of -49 to 104 ^{o}F(-45 to 40 ^{o}C)	This represents the range in which the crew can operate.		DEMO	TBD
3.6-2 The UAV shall operate in rain of up to 0.12 inches/hr (3 mm/hr)	Moderate rain should not inhibit a mission.		DEMO	TBD
3.6-3 The UAV shall operate in snowfall of up to 0.5 inch/hr (13 mm/hr).	Moderate snowfall should not inhibit a mission.		DEMO	TBD
3.6-4 The UAV shall fly in crosswind of up to 0.6 V_{stall}.	Desirable not to be limited by crosswinds up to this size		DEMO	TBD
3.6-5 (deleted)				
3.6-6 The UAV system shall use a ground based lightning detection system.			DEMO	TBD
3.6-7 The UAV shall include positive airflow cooling of avionics.	Ram air cooling is preferred as rotating devices (such as fans) may create undesirable magnetic fields.		TST	TBD

3.7 Acceptance Testing Requirements

Requirement	Rationale	Cert. Status	Verif.	Status
3.7-1 The UAV system shall comply with UAV systems acceptance criteria as stated in the UAV Specification: Magnetic Noise – 13-Sept-04 (ref section 1.4.2 - 01)	Compliance to these specifications is essential to capturing valuable data.		DEMO	TBD

3.8 Security Requirements

Requirement	Rationale	Cert. Status	Verif.	Status

3.9 Transportability Requirements

Requirement	Rationale	Cert. Status	Verif.	Status
3.9-1 The entire UAV operational system shall be able to fit within a pickup truck bed 96 inches long by 50 inches wide by 36 inches high (2.4m long x	Must be easily transportable to/from operating area in a conventional road vehicle. This is the typical box size of a full size pickup truck.		DEMO	TBD

1.2m wide x 0.9m high)				
3.9-2 The complete UAV operational system shall be able to fit within an Air Canada cargo container of 7.16 feet long by 10.25 feet wide by 5.25 feet high (2.182m long x 3.124m wide x 1.600m high).	Allows for economic means of transportation by a conventional transport aircraft.		DEMO	TBD

3.10 Quality Requirements

Requirement	Rationale	Cert. Status	Verif.	Status

3.11 Reliability Requirements

Requirement	Rationale	Cert. Status	Verif.	Status
3.11-1 The UAV mission abort rate should be not more than 1 mission in 50.	This applies to missions aborts as a result of UAV related system failures (i.e. autopilot, engine, GCS, launch/recovery system). Missions not flown due to time required for routine aircraft maintenance or magnetic diurnal activity out-of-spec are not included.		DEMO	TBD

3.12 Maintainability Requirements

Requirement	Rationale	Cert. Status	Verif.	Status

3.13 Safety Requirements

Requirement	Rationale	Cert. Status	Verif.	Status
3-13-1 As part of the normal landing procedure, the propeller shall not incur any damage that requires significant propeller maintenance or propeller replacement			DEMO	TBD
3-13-2 As part of the emergency landing procedure, the propeller shall not damage the aircraft			DEMO	TBD

3.14 Certification Requirements

Requirement	Rationale	Cert. Status	Verif.	Status
3.14-1 The UAV should comply with the	-Design quality/safety		DEMO	TBD

GeoSurv II Standards Document (DR28-01)	-Ensure compliance with proposed international UAV regulations			
3.14-2 The UAV should comply with Canadian Aviation Regulation, Part V, 523-VLA (Very Light Aircraft) in instances where sufficient guidance is not provided by the GeoSurv II Standards Document (DR28-01)	-Design quality/safety -Ensure compliance with proposed international UAV regulations		DEMO	TBD

3.15 Training Requirements

Requirement	Rationale	Cert. Status	Verif.	Status
3.15-1 The training of system operators should require not more than 5 days, covering GCS operation, launch/recovery, field maintenance, servicing and diagnostics.	This is an acceptable time frame to allow for operator training.		DEMO	TBD
3.15-2 The training of existing Licensed Aircraft Maintenance Engineer (AME) should require not more than 10 days.	This is typical of what training an AME receives for a new aircraft Type at present.		DEMO	TBD