FLIGHT SAFETY FOUNDATION

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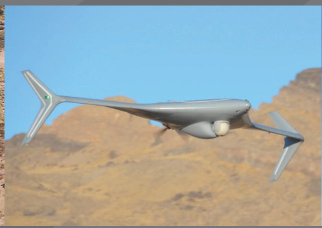
Basic Aviation Risk Standard

Remotely Piloted Aircraft Systems Implementation Guidelines


Version 4, October 2022

Benefactor BARS Member Organizations

BHP · Rio Tinto

BARS Member Organizations

AngloAmerican · Ok Tedi Mining · Worley (energy | chemicals | resources) · OZ Minerals · Vale

South32 · Newcrest Mining Limited · Glencore · SSR Mining · Freeport-McMoRan Copper & Gold · MMG

AngloGold Ashanti · Newmont · Downer (Relationships creating success) · Baffinland · wood.

Woodside Energy · sodexo (Quality of Life Services) · Tenke Fungurume Mining · IAGSA · QBE

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"Awareness and understanding of risk, whatever the task, is everybody's responsibility. Within aviation activities, it is vital that all personnel understand the critical control management of major risks involved within the task. It is only by mitigating those risks, that we can achieve safer operations."

Hassan Shahidi, President and CEO, Flight Safety Foundation

BARS Remotely Piloted Aircraft Systems IMPLEMENTATION GUIDELINES

Contents

Glossary of Terms and Abbreviations

Term	Definition
Above Ground Level (AGL)	The height above ground at any point over the Earth.
Above Mean Sea Level (AMSL)	The height above a datum based on the average sea level around the Earth.
Accountability	The obligation or willingness to accept responsibility for the execution or performance of an assigned function, duty, task or action; implies being answerable (i.e. accountable) to a higher authority for ensuring such responsibility is executed or performed. May also be a performance requirement (e.g. Single-engine Accountability).
ADM	Aeronautical Decision Making
ADS-B	Automatic Dependent Surveillance – Broadcast Note: there are different forms of ADS B such as ADS-B In, ADS-B Out.
Aerial Work	A commercial aircraft operation by aeroplanes or helicopters where they are used for specialized services and does not carry passengers.
AFM	Aircraft Flight Manual.
Air Operator Certificate (AOC)	A certificate issued by a responsible regulatory authority to permit the aircraft operator to conduct certain commercial air service activities. See Remote Operating Certificate for RPAS.
Airborne Collision Avoidance System (ACAS)	Also known as TCAS A system utilizing interrogations of, and replies from, airborne radar beacon transponders and provides information to the pilot: • TCAS I will provide traffic advisories to the pilot; and • TCAS II will provide traffic advisories and resolution advisories in the vertical plane to the pilot.
Aircraft Movement Area	That part of an aerodrome to be used for the takeoff, landing and taxiing of aircraft, consisting of the runways, taxiways and the apron(s).
Aircraft Operator	Refers to an aircraft operating company used to provide aviation services.
AMO	Approved Maintenance Organization.
Automatic Flight Control System (AFCS)	The AFCS is a system that integrates the flight director with the Autopilot systems.

Term	Definition
ATC	Air Traffic Control
Automatic Weather Observation System (AWOS)	An AWOS is a set of systems designed to autonomously collect meteorological information and transmit this information on a local frequency and/or transmit this data to another location for collection and collation.
Autopilot (AP)	A system designed to allow the aircraft to be flown without the continuous intervention of the pilot.
Basic Aviation Risk Standard (BARS)	The Program managed by the Flight Safety Foundation on behalf of subscriber BARS Member Organizations.
BMO	BARS Member Organization.
BVLOS	Beyond Visual Line Of Sight. When neither the RPA pilot nor observer cannot maintain direct unaided visual contact with the RPA.
BPO	BARS Program Office.
Bridging Document	A document agreed to between the contracting company and the aircraft operator listing key personnel and contact details of both parties.
CAA	Civil Aviation Authority (see NAA).
C2	Command and Control. The data link between the RPA and RP station (GCS) for the purposes of managing the flight.
C3	Command, Control and Communications.
Cargo	Revenue and non-revenue movement of goods or property not including accompanied baggage or mail. Company material (COMAT) is considered to be cargo.
CBT	Competency Based Training.
Center of Gravity (CofG)	An imaginary point where the total weight of the aircraft appears to be concentrated. The center of gravity changes according to fuel, passenger and cargo load within various locations of the aircraft.
Certified Safe Working Load	The manufacturer's recommended maximum weight load for a line, rope, crane or any other lifting device or component of a lifting device. The SWL is determined by dividing the minimum breaking strength (MBS) of a component by a safety factor assigned to that type and use of equipment.
Clearway	An area beyond the takeoff area clear of fixed obstacles.

Term	Definition
CMT	Critical Maintenance Task.
Cold Weather Environment	Operations on the ground in freezing conditions where surface snow, ice, standing water or slush may be ingested by the engines or freeze on engines, nacelles, airframe or engine sensor probes.
Commercial Pilot Licence (CPL)	A licence issued by the responsible regulatory authority of a country to permit the pilot to undertake flying activities for hire or reward.
Company	Refers to the individual company using the BARS to support their aviation operations.
Competent Aviation Specialist	A company designated aviation advisor or Flight Safety Foundation BARS accredited auditor.
CONOPS	Concept of Operations.
Control	Within the context of risk management: one or more activities within a system designed to reduce the likelihood or impact of a threat or error.
Controlled Flight Into Terrain/Water (CFIT/W)	An accident where an airworthy aircraft is flown into the ground or water.
Crew Resource Management (CRM)	A training course undertaken by flight crew, often involving cabin crew, focusing on crew coordination, human factors and leadership training.
Dangerous Goods (DG)	Articles or substances which are capable of posing a risk to health, safety, property or the environment and which are shown in the list of dangerous goods in the Technical Instructions, or which are classified according to those instructions.
DAA	Detect and Avoid. The capability to see, sense or detect conflicting traffic or other hazards and take appropriate action.
DGM	Dangerous Goods Manual.
Defence	Within the context of risk management: one or more activities within a system designed to mitigate the consequences of a threat or error.
Deferred Defects	Operation of the aircraft with specified unserviceable systems or equipment under certain flight conditions or operating limitations for a defined period.
DROPS Calculator	A tool for the determination of the potential consequences in terms of kinetic energy for a dropped object. (Height vs Mass).

Term	Definition
Duty Time	A period which starts when a flight crew member or cabin crew member is required by an operator to report for or commence a duty and ends when the person is free from all duties.
EMC	Electromagnetic Compatibility.
EMI	Electromagnetic Interference. Natural or human interference to C2 link including solar flares, volcanic ash or ionospheric activity).
EC	Electronic Conspicuity. Ability of the RPA to be detected or 'seen' electronically by others (ATC, other aircraft or RPA). Also referred to as 'Detectability'.
Emergency Response Plan (ERP)	A documented plan for systematic activities following an accident outlining the actions and responsible persons.
EVLOS	Extended Visual Line of Sight.
External Loads	A load that is carried or extends outside the RPA by cable or sling line from an external hook. Normally related to helicopters carrying loads on flexible sling equipment from an external hook arrangement.
Fatigue Management Program	A data driven means of continuously monitoring and managing fatigue-related safety risks, based on scientific principles and knowledge as well as operational experience, that aims to ensure relevant personnel are performing at adequate levels of alertness.
FAA	Federal Aviation Authority (USA)
Flight Crew	A licensed crew member charged with duties essential to the operation of an aircraft during a flight duty period.
Flight Data Monitoring (FDM)	Also known as FOQA. A means of capturing and analyzing data obtained during a flight, or series of flights, to aid in the identification of undesirable operational trends.
Flight Time	The total time from the moment the airplane first moves for the purpose of taking off until the moment it finally comes to rest at the end of a flight. For a helicopter this is from the moment the rotor blades start turning until the moment the helicopter comes to rest at the end of the flight and the rotor blades are stopped.
FOD	Foreign Object Debris/Damage.

Term	Definition
GA	General Aviation
GCS	Ground Control Station.
Geophysical Operations	Aerial survey operations using either fixed wing or rotary wing aircraft with fixed or towed array sensor equipment.
Global Positioning System (GPS)	A space-based satellite navigation system providing time and location information on or near the Earth.
Go-Around	A missed or baulked approach whereby the approach to land is discontinued and the aircraft climbs to a safe height in order to re-attempt the approach and landing.
Helicopter Landing Site (HLS)	An area of land or water, or an area on a structure on land, intended for use wholly or partly for the arrival or departure of helicopters.
Helideck	A heliport located on a floating or fixed offshore structure.
Helideck Landing Officer (HLO)	A suitably trained and competent person appointed to be in control of helideck operations on the installation.
HOTO	Hand Over Take Over. Transferring control and responsibility of the aircraft from one pilot to another in the course of the flight.
Human Factors	Principles which apply to aeronautical design, certification, training, operations and maintenance which seek safe interface between the human and other system components by proper consideration to human performance.
Hydrocarbon Fuel	Includes solid, liquid and gaseous fuels.
Instrument Flight Rules (IFR)	A set of regulations under which a pilot operates an aircraft in weather conditions unfavorable to flight by reference to terrain or water. En route navigation aids are used in lieu of visual references.
Instrument Meteorological Conditions (IMC)	A set of weather conditions that require an aircraft to be flown solely by reference to the aircraft instruments navigated by reference to electronic navigation aids.
International Air Transport Association (IATA)	An international association representing the interests of commercial air carriers.
International Civil Aviation Organization (ICAO)	An international body that is a part of the United Nations which establishes Standards and Recommended Practices (SARPS). These SARPS are the basis of the aviation regulations adopted by Member States.
Ingress Protection (IP rating)	A standard associated with the level of protection offered by an electrical enclosure against solids or liquids.

Term	Definition
Last Light	The end of civil twilight. See night flying definition.
LiDAR	Light Detection and Ranging.
Lifting Devices	The line, swivel, shackles, D-rings, straps, nets, baskets, welded lifting lugs, bags and anything used to secure or support an external load.
Line Check	A regular check flight where the pilot demonstrates knowledge and experience in normal line operations.
Long Line	External Load operations utilizing a cable greater than 50ft (15.2m).
Lowest Safe Altitude (LSALT)	An altitude that is at least 1,000 feet above the highest terrain or obstacle within a defined area or region.
LOS	Line of Sight. Direct unaided visual contact with the remotely piloted aircraft.
Minimum Equipment List (MEL)	A list which provides for the operation of aircraft (subject to specified conditions, with particular equipment inoperative) prepared by an operator in compliance with, or more restrictive than, the Master MEL established for the aircraft type.
NAA	National Aviation Authority (see CAAA).
Night Flying	Flight operations during the hours between the end of evening civil twilight and the beginning of morning civil twilight or such other period between sunset and sunrise, as may be prescribed by the responsible regulatory authority.
OEM	Original Equipment Manufacturer.
Official Sunset	The time that the surface of the sun disappears below the horizon.
Offshore	Flight operations to/from or in the vicinity of a floating rig, platform or vessel.
Operations Manual (OM)	A manual containing procedures, instructions and guidance for use by operational personnel in the execution of their duties.
ORA	Operational Risk Assessment.
Personal Protective Equipment (PPE)	Equipment worn or carried by the person to provide protection from natural or man-made environmental or other factors.
Pilot-in-Command (PIC)	The pilot designated by the aircraft operator as being in command and charged with the safe conduct of the flight.

Term	Definition
POH	Pilot Operating Handbook.
Proficiency Check	A regular check flight where the pilot demonstrates competence in normal, non-normal and emergency procedures.
Quality Assurance	A set of activities that are carried out to set standards to monitor and improve performance so that the service or product provided will satisfy stated or implied needs.
Responsible Regulatory Authority	The authority of a country designated to manage and oversee compliance and safety of civil aviation See NAA or CAA.
Risk Assessment	A systematic and documented process of identifying risks and mitigating actions associated with a particular activity.
ROC	Remote Operating Certificate or RPAS Operator Certificate. A certificate authorizing an operator to carry out specified RPAS operations.
RP	Remote Pilot.
RPA	Remotely Piloted Aircraft. An unmanned aircraft which is piloted from a remote pilot station.
RPAS	Remote Piloted Aircraft System. A remotely piloted aircraft, its associated remote pilot station(s), the required command and control links and any other components as specified in the type design.
RPS	Remote Pilot Station. The component of the remotely piloted aircraft system containing the equipment used to pilot the RPA. Also known as Ground Control Station (GCS).
RTH	Return to Home
Safety Management System (SMS)	A systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures.
Search and Rescue (SAR)	The search for and provision of aid to people who are in distress or imminent danger.
Shackles	A ring or device used to connect the load (line) to the hook (helicopter).
Short Line	External Load operations utilizing a cable less than 50ft (15.2m) and shorter than the distance from the hook to tail rotor.

Term	Definition
SIMOPS	Simultaneous Operations. Use of multiple RPAS assets or combined RPAS and conventional aviation assets in the same location or potential close proximity.
SLAM	Simultaneous Localisation and Mapping.
SOC	Standard Operating Conditions. Specific operating criteria and conditions for the non-complex operation of RPAS.
SOP	Standard Operating Procedure.
SPA	Single Point of Accountability. The nominated manager within a contracting company who hold authority and accountability for the contracted aviation operations (equal term NRMA - nominated responsible manager-aviation).
Special VFR Procedures	Meteorological conditions that are less than those required for basic VFR flight in controlled airspace and in which some aircraft are permitted flight under visual flight rules.
Standard	Standard means the Basic Aviation Risk Standard as issued by the Flight Safety Foundation.
Sterile Cockpit	The restriction of flight crew member activity to that which is operationally essential during busy phases of flight.
Strobe Lights	One or more flashing lights in aviation red or aviation white fitted to the aircraft as part of the aircraft navigation light system.
Supplementary Type Certificate (STC)	A certificate issue approving the modification to an aircraft.
Terrain Awareness Warning System (TAWS)	A system designed to warn a flight crew when their flight path may take them into proximity with terrain. Air traffic control systems may be equipped with TAWS to warn the controller when an aircraft's flightpath may take it into proximity with terrain.
Traffic Collision Avoidance System (TCAS)	Also known as ACAS. A system utilizing interrogations of, and replies from, airborne radar beacon transponders and provides information to the pilot: • TCAS I will provide traffic advisories to the pilot; and • TCAS II will provide traffic advisories and resolution advisories in the vertical plane to the pilot.

Term	Definition
Threat	Source of risk that must be managed to maintain the margin of safety.
Threat and Error Management (TEM)	A training program designed to educate students on aviation related threats and errors and associated risk mitigation strategies.
Technical Standards Order (TSO)	A minimum prescribed standard for the performance and manufacture of parts and materials used in aircraft.
UAS	Uncrewed Aerial System
Ultra High Frequency (UHF)	A radio band used for two-way communications. Limited to line-of-sight communications.
UPS	Uninterupted Power Supply.
Variations	Any variation to this Standard is at the discretion of each company. It is recommended that each variation be assessed to demonstrate that the risks associated with the variation are tolerable and justify safe continuation of operations.
Very High Frequency (VHF)	A radio band used for two-way communications. Limited to line-of-sight communications.
Visual Flight Rules (VFR)	A set of regulations under which a pilot operates an aircraft in weather conditions favorable to flight by reference to terrain or water.
Visual Meteorological Conditions (VMC)	A set of conditions where a minimum visual range, distance from cloud and height above ground can be maintained.
V_{NE}	Never exceed speed.
V_S	Stall speed or minimum steady flight speed for which the aircraft is still controllable.

Note: Commonality with ICAO definitions have been used as much as possible.

Introduction

Purpose

This Standard provides companies with a minimum control framework for risk-based management of Remotely Piloted Aircraft Systems (RPAS) operations.

All national and international regulations pertaining to RPAS operations must be followed. This Standard is designed to supplement those requirements.

Document Structure

The Standard is presented in a risk-based format to emphasize the relationship between threats to safe RPAS operations, associated controls and applicable recovery/mitigation measures. This document provides further details on threats and controls applicable to RPAS operations and addresses the role specific requirements applicable to certain additional RPAS activities, such as external load, BVLOS, underground/confined spaces operations and Offshore installation/Maritime situations.

The bow tie presentation of all threats and controls is illustrated in Figure 1.

The format is intended to assist all personnel associated with RPAS operations in the management of all associated risks to their activity. Importantly, the design encourages further risk assessment as the level of complexity of the activity increases. The appendices attached to this standard outline additional controls and risk assessment considerations for the increasing levels of complexity.

The text of the control or defence may contain the term 'appropriate' as a descriptor of a particular element of the requirement. The supporting Implementation Guidelines will provide additional context to the use of 'appropriate'.

These guidelines use the same risk-based format and same sections and control numbering as the BARS for RPAS Standard for ease of cross-referencing. The information provided for every BARS for RPAS Control is presented in this document in the following format:

Basic Aviation Risk Standard (BARS) Control Title

Safety Goal - Each BARS control and defence has been provided with a Safety Goal to assist users of the Implementation Guidelines to identify the purpose of the control or defence and a pathway towards creating a performance indicator to measure the effectiveness of the organization in achieving a desired level of safety performance.

Details the control as written in the BAR for RPAS Standard.

Information to provide further context and background to the control, threat or defence that is being addressed by the subsection.

Example evidence is provided for guidance, it is not prescriptive nor limiting.
It relates the expected manner in which the issue could be addressed by the aircraft operator (through drafting of procedures, etc.)
It is provided in order to assist the BARS Auditor and RPAS operator in assessing whether or not the control or defence requirements have been adequately addressed or implemented.

References presented as a 'quotation' are intended to highlight those aspects of particular relevance to contracting companies ('company').

Change bars have been utilized to indicate material changes to the content or intent of the Implementation Guidelines.

BARS Accredited Audit

A BARS audit using registered audit companies and accredited auditors provides an audit of the operations and technical management systems of an aviation operator. It is a deep-dive audit with the objective of clearly articulating and verifying what procedures, processes and systems the operator has in place.

Company Specific Operational Review

An Operational Review is company specific, and entirely at the discretion of the company using in-house or contracted specialists and is not always required. The Operational Review does not repeat the management systems portion of the BARS audit, but is a risk-based assessment of the relevant threats to a particular RPAS activity. The Operational Review is conducted as a field-based activity to ensure that standards and practices reviewed during the BARS audit are also embedded into actual operations supporting the contracting company.

Governance Model

The purpose of introducing a governance model is to ensure the introduction of a new risk, such as RPA activities into an existing company's operation, is managed with the same rigour as other material risks from the outset.

A suggested format for governance of RPAS supporting company or emergency service use is presented in Appendix 1. This model is intended to be fit-for-purpose, and in a format that can be adapted to any organization's structure and operating model. Additional examples as to how different organizations manage their governance surrounding RPAS usage can be obtained from the Flight Safety Foundation BARS Program Office (BPO).

As part of the governance process, certain RPAS activities based on their level of complexity will require the organization's internal approval of RPAS operators. Audits will be done to a protocol derived from the BARS RPAS Question Master List, the BARS RPAS standard and other referenced industry accepted RPAS standards.

Variations

Any variation to this Standard is at the discretion of each organization. It is recommended that each variation be assessed to demonstrate that the risks associated with the variation are tolerable and justify safe continuation of operations.

The BARS Variance Process is described in the BARS Implementation Guidelines.

Standard Operating Conditions

- Operation of one RPA per Remote Pilot at any one time;
- Maintaining Visual Line of Sight (VLOS) during day operations and below 400 feet Above Ground Level (AGL);
- Not to be operated closer than 30 meters to personnel who are not associated with the flight;
- Not to be flown over populous areas and/or personnel in the area of operation; and
- Not to be flown within 3 nautical miles (nm) of any aerodrome*, and to remain outside all active prohibited and restricted areas.

**for Resource Sector activities at uncontrolled aerodromes/HLS, permission must be obtained from the aerodrome/HLS operator.*

Figure 1: BARS Bow Tie Risk Model – Schematic of Remotely Piloted Aircraft

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Systems Management Controls and Recovery Measures.

- Power/Fuel Status Indicators
- Storage, Transport and Management of RPAS Fuel
- Fuel Quality Controls

- Minimum Demonstrated Experience
- Alerting
- RPA Suitable for Operating Environment

- HF Ergonomics Assessment
- Additional/Modified Payloads

- Weather Detection and Monitoring
- Post-Flight Analysis
- Night Operations
- Ground Crew
- Handover

- Loss of Signal
- RF Spectrum Analysis

- Launch Window/Template
- Lighting/Visibility
- NOTAM
- Wildlife

RPAS Accident

Recovery Measures:

Engine Failure

Emergency Equipment

Emergency Response Plan

Insurance

Incorporation of Research and Development Outcomes

Public Relations

Investigation Procedures

Additional Operational Risk Assessment Considerations

Underground and/or Confined Space RPAS Operations

Beyond Visual Line of Sight (BVLOS)/IFR/ Controlled Airspace RPAS Operations

Offshore Installation/ Maritime RPAS Operations

RPAS External Load Operations

BARS BASIC AVIATION RISK STANDARD
FLIGHT SAFETY FOUNDATION
Version 4, October 2022

Table 1: Additional Operational Risk Assessment Considerations

Activity	Considerations		
Underground and/or Confined Space RPAS Operations	**Remote Pilot (RP) Human Factors** • RP Fatigue • RP Training	**Loss of Situational Awareness** • Illumination • Navigation Source • Dust Suppressant • Tethering • Preflight Reconnaissance • Underground Turbulence • Loss of Signal	
Beyond Visual Line of Sight (BVLOS)/IFR/ Controlled Airspace RPAS Operations	**Inadequate Identification/ Communication Capability** • Mode C Transponder • Continuous Radio Contact	**Inadequately Equipped Ground Control Station (GCS)** • Redundant RPA Control System • Primary and Secondary Antennae Systems • Back-up Power System • Added Situational Awareness • Radio Communication System • Mandatory Abort Procedure	
Offshore Installation/ Maritime RPAS Operations	**Offshore Intrinsic Safe Operations Compromised** • Intrinsically Safe Design for Offshore Use • Operational Risk Assessment	**Communications** • Helicopter Deconfliction • Helideck Landing Officer (HLO) • Inadvertent Water Landing	
RPAS External Load Operations	**Fuel/Battery Exhaustion** • Fuel Reserve	**Failure of Lifting Equipment** • Lifting Equipment • Servicing Schedule • Visual Inspections • Shackles	**Inadvertent Load Release** • Manual and Electrical Release Mechanism • Guarded Release Switch • Load Construction

Refer to applicable Appendices 6 to 9 for a more detailed explanation of the Additional Operational Risk Assessment Considerations for each activity.

Intrinsic Safe Operations Compromised

- Intrinsically Safe Design
- Multi Rotor System
- Brushless Motors
- Battery Change
- Static Discharge Systems

Remote Piloted Aircraft not suitably Equipped for Underground use

- Obstacle Avoidance Sensors
- Caged Unit

Incorrect use of Airspace

- Approved Airspace
- Instrument Flight Rules (IFR) Flight Plan
- Alternate Landing Areas
- BVLOS Safety Case

Dangerous Goods

- Carriage of the RPA Offshore
- Storage and Charging Offshore

In-flight Loss of Control

- Pilot Experience
- Standard Operating Procedures
- Load Referencing Cameras
- Load Weight
- No Flying Over Occupied Areas

Line Fouling In Transit

- Considerations During Slinging Operations to Reduce Risk of Line Fouling

Ground Loss of Control

- Ground Briefing
- Ground Control
- Ground Personnel

1.0: All Threats: Common Controls

These controls apply to all threats in the RPAS Standard

Threats to aviation must be managed to provide the necessary assurance for continued safe operations at all times.

A risk-based standard allows the identification of critical controls that are intended to prevent an incident from occurring. Those controls are outlined in the RPAS BAR Standard.

Some controls are specific to a single threat. However, there are a number of controls required to be effective against all threats encountered in contracted RPAS aviation operations. These common controls are discussed further in this section.

1.1: Remote Pilot Qualifications, Experience and Recency

Ensuring pilot is competent to fulfill their duties by having appropriate training, qualifications and experience.

All Remote Pilots (RP) must meet the qualification requirements listed in Appendix 2.

Each RP must also be assessed for operational capability by an established Check and Training protocol that is clearly documented. Where available, appropriate simulation facilities that have been validated as being acceptable by either the responsible regulatory authority or company representative may be used for both training and currency purposes.

Poor or inadequate initial, recurrent training and proficiency checking of Remote Pilots is a key contributor to regulation breaches and degraded safety outcomes. Pilot recency between training and checking events aid in ensuring that the Remote Pilot's operational standards do not diminish between training and checking events.

Having a standardized Check and Training system, including appropriate training and qualified check pilots, ensures that all Remote Pilots maintain a consistently higher standard and reduces the potential for competency or decision making induced incidents.

The RPAS Operator's Check and Training protocols must be documented, fit for purpose, and adhered to.

The RPAS Operator must ensure that all Remote Pilots are appropriately licenced, undergo regular proficiency assessment, and have the required recency and experience for the intended RPA type, weight and operational specifics (e.g. external load, night, etc.). Variances to recency skills may be considered when simulator training can be demonstrated as an effective alternative and endorsed by the responsible regulatory authority.

Courtesy: Aviassist

The RPAS Operator must maintain records of Remote Pilot's qualifications, complete with copies of flight crew licences and summaries of experience and RPA category ratings. A documented control mechanism must be enforced to ensure that Remote Pilot are qualified, recent, and experienced to meet the task requirements when assigned to flights.

The RPAS Operator must have a records management system for recording and monitoring all relevant Remote Pilot recency, training and qualification parameters.

Where simulation facilities are used, evidence of the simulation facilities validation by the responsible regulator or a Competent Aviation Specialist must be retained.

Training records should confirm the Remote Pilot has been deemed proficient in accordance with the RPAS Operator's Check and Training protocol.

Where simulation facilities have been used for training or currency, records indicate the simulation facility has been validated by the responsible regulator or a Competent Aviation Specialist.

1.2: Regulatory Approval

Ensuring RPAS operations have local regulatory authority approval.

RPAS operations must be conducted in accordance with the local regulatory framework and, where applicable, within the provisions of the operating certificate issued by the National Aviation Authority (NAA).

There is no uniform licencing system from RPA, and each NAA has its local regulatory framework. The RPAS Operator must ensure compliance with all relevant licencing requirements of the local NAA, including licencing of the RPAS Operator and operating crew.

The RPAS Operator must have an operational document suite that adheres with the local regulatory framework. The operational document suite must include clearly defined roles and responsibilities for the following positions, or their equivalent:

- Head of Flight Operations; and
- Head of Check and Training.

Where applicable, the responsible regulatory authority should provide the RPAS Operator with a copy of any document approving the operator under the National Aviation Authority.

Records should confirm the presence of an operational documentation suite that covers the types of flight and categories of aircraft used by the RPAS Operator.

Where required, records indicate the operating certificate of the RPAS Operator is valid. All key positions have a person appointed and, where applicable, approved/accepted by the responsible regulatory authority.

1.3: Airworthiness Approval

Ensuring the RPA achieves acceptable standards of airworthiness.

All RPA must be issued with a current certificate of airworthiness if required by the NAA. Regardless of size and type, all RPA should have a system of airworthiness control in place that considers whether the RPA can meet minimum safety performance standards.

Ensuring an RPA meets a minimum standard of airworthiness is vital to detecting defects in design and manufacturing and that any defects do not result in an undesirable safety outcome.

Certification of RPAS and their component parts by the manufacturer and relevant aviation regulators ensures that the highest safety standards are achieved, from their initial design to subsequent retirement from service.

Many NAA do not have a system for airworthiness certification for RPA. In the absence of an airworthiness system, the burden shifts to the RPAS Operator to ensure that the RPA operated meets an alternative acceptable airworthiness standard.

The RPAS Operator must have a documented system of airworthiness control. The documented system must clearly define roles and responsibilities for the following positions or their equivalent:

- Head of Airworthiness and Maintenance Control.

Where applicable, the responsible regulatory authority should provide the RPAS Operator with a copy of any document stating the RPA meets the appropriate regulatory airworthiness standard.

Records should confirm that the RPAS Operator's system of airworthiness control meets the airworthiness standard of the National Aviation Authority or the OEM.

1.4: Safety Management System

Ensuring Safety Management Systems are effective at gathering and analysing safety information, managing risk, providing assurance and ensuring continuous improvement.

All RPAS operations must be supported by an integrated Safety Management System that includes use of Operational Risk Assessments (ORAs) for all tasks and activities and an incident reporting system that provides analysis and improvement opportunities.

A safety management system is a systematic approach to managing safety, including organizational structures, accountabilities, policies and procedures. An SMS is scalable so that it can be tailored to the size and complexity of the organization.

The universally accepted framework for SMS is detailed in the ICAO Doc 9859 SMM and includes four main components and twelve elements, representing the minimum requirements for an SMS.

Safety Policy and Objectives:

- Management and Commitment;
- Safety accountability and responsibilities;

- Appointment of key safety personnel;
- Coordination of emergency response planning; and
- SMS documentation.

Safety Risk Management:

- Hazard identification; and
- Safety risk assessment and mitigation.

Safety Assurance:

- Safety performance monitoring and measurement;
- The management of change; and
- Continuous improvement of the SMS.

Safety Promotion:

- Training and education; and
- Safety communication.

The NAA may include additional requirements above the minimum 12 recommended by ICAO.

evidence

The RPAS Operator's Safety Management System must be documented, fit for purpose, and include the necessary organizational structures, accountabilities, policies and procedures that will facilitate a systematic process for identifying hazards and minimization of risk.

Records must confirm that these RPAS Operator's Safety Management System requirements are complied with and that continuous improvement is being tracked and monitored.

1.5: Remote Pilot Approved and Operational Risk Assessment (ORA)

Ensuring all risks associated with aircraft operations are analyzed, minimized and accepted.

RPAS Operators must conduct a risk assessment, including the identification and implementation of mitigation controls, before commencing any operation. A guide to areas to be included in a basic ORA is presented in Appendix 3. In addition to providing an overview of the task risk assessment, the document further serves to formalise remote pilot approval for the task.

Preflight planning through an Operational Risk Assessment (ORA) is a valuable tool in threat and error management. Knowing the risks of operations and applying mitigation before flight significantly reduces adverse safety outcomes. Understanding the likelihood and type of possible abnormal operations that may be encountered during an operation allows the RPAS Operator to plan for the appropriate response to the abnormal operations and limit the escalation of the abnormal state.

The analysis method will depend on the particular application, the availability of reliable data, and the decision-making needs of the activity. Details on risk analysis techniques can be found in ISO31010:2009 Risk management – Risk assessment techniques. As appropriate, these techniques may involve the qualitative or quantitative assessment of risk.

Operational Risk Assessments must identify and address hazards associated with each flight phase, the specific location and operating environment and be reviewed and accepted by a competent aviation specialist.

For complex operations or where required by the NAA the JARUS SORA risk framework supplements the RPAS Operators ORA.

An RPAS Operator's safety management system must have an ORA, which, at minimum, includes the items in Appendix 3. An RPAS Operator's safety management system must include a primary Risk Register and a method to validate ORAs by appropriate personnel within the organization.

Records should confirm ORA's have been used to record, assess and manage all identified risks, including the mitigation actions taken for each risk. Records should confirm that ORA's are conducted and validated before all tasks and activities and where operational risks have changed.

1.6: Drug and Alcohol Program

Ensuring all safety critical personnel are fit-for-work at all times.

The RPAS Operator must have a Drug and Alcohol Policy which meets all requirements of the NAA. Where no such regulatory requirements exist the operator must, at a minimum, meet the requirements of the contracting company.

Certain drugs and alcohol impair performance and judgement. Impaired performance and poor judgment will negatively impact safety; this includes activities and decisions undertaken by personnel in managerial and operational roles beyond the RP. An RPAS Operator wide, standardized, Drug and Alcohol (D&A) Policy reduces the chances of a D&A related safety incident and provides the RPAS Operator with a system for promoting a positive D&A culture.

The NAA may publish requirements for a D&A Policy, which are considered the starting point or minimum standard for an RPAS Operator's internal D&A Policy.

The RPAS Operator's Drug and Alcohol Policy and the associated drug and alcohol management plan (where required by the responsible regulatory authority) must be published in the Operations Manual or other applicable manual.

An organization's actions must be underpinned by clearly documented procedures, easily accessible and understood by all relevant employees. The policy and plan must cover all persons involved in safety-sensitive operational activities.

Records should confirm that applicable requirements of the drug and alcohol monitoring program are routinely applied for persons involved in safety-sensitive aviation activities.

Courtesy: Northrop Grumman

1.7: Fatigue Management

Ensuring flight crew are not impacted by fatigue.

The RPAS Operator must have a Fatigue Management Plan in place that considers the workload for the Remote Pilot (RP) in addition to other members of the RPAS operations team. The Fatigue Management Plan must be endorsed by the contracting company and where necessary meets or exceeds the requirements of the NAA.

RP fatigue will result in a hazard that predictably degrades various types of human performance and can contribute to accidents and incidents. A Fatigue Management Plan is a key defence against fatigue-related incidents and accidents. A Fatigue Management Plan refers to how operators and operational personnel address the safety implications of fatigue. A basis derived from the ICAO safety-related Standards and Recommended Practices support two distinct approaches for fatigue management:

1. The operator complies with prescriptive duty time limits defined by the regulator and manages fatigue hazards using the SMS processes that are in place for managing other types of hazards; or
2. The operator develops and implements a Fatigue Risk Management System that the regulator approves.

Both approaches should take into account:

- The need for adequate sleep (not just resting while awake) to restore and maintain all aspects of waking function (including alertness, physical and mental performance, and mood);
- Daily rhythms in the ability to perform mental and physical work, and in sleep propensity (the ability to fall asleep and stay asleep) that are driven by the circadian clock in the brain;
- The contribution of workload to fatigue and physical and mental performance degradation; and
- The operational context and the safety risk that a fatigue-impaired remote pilot represents in that context.

Because fatigue is affected by all waking activities (not only work demands), a Fatigue Management Plan will generally present fatigue management as a shared responsibility between regulators, operators and team members. Time Zone changes are to be taken into account when developing a Fatigue Management plan.

The NAA may publish requirements for a Fatigue Policy, which is considered the starting point or minimum standard for an RPAS Operator's internal Fatigue Policy.

evidence

Details of the RPAS Operator's fatigue management program must be published in the Operations Manual and comply, where applicable, with the National Aviation Authority's Fatigue Management Regulations and fatigue policies of the company.

The RPAS Operator should include details in their Operations Manual of the system to record and track an individual Remote Pilot schedule and rest periods. While manual, paper-based systems are acceptable, computer programs that comprehensively track the varying limits and predict likely fatigue occurrences are readily available and are preferable.

Flight and duty time records must confirm compliance with all requirements of the fatigue management program. The maintained flight and duty time records should be consistent with information provided in other documents such as aircraft flight records.

1.8: Approval Framework

Ensuring application of a governance framework and the use of operators capable of meeting the requirements of this standard.

The RPA Operator (internal to the company or externally contracted) must be able to meet all requirements for commercial operations as dictated by the National Aviation Authority (NAA) in the jurisdiction of operations and under the following circumstances:

- ***Any RPA activities conducted under non-Standard Operating Conditions; and***
- ***All medium and large RPA activities.***

Regulatory approval provides a framework for safe operations. Where the NAA requires the operator to have a ROC, the requirements to hold the ROC and any operational requirements concerning the ROC is to be taken as a minimum requirement.

Some activities undertaken by an RPAS Operator may require approval from the NAA beyond the ROC. The RPAS Operator must consider the application of the ROC to the task and activity.

Refer to Appendix 1 Generic RPAS Governance model in the RPAS Standard.

Where operating very small or small RPA under non-standard operating conditions, the RPAS Operator must demonstrate a valid Remote Operating Certificate (ROC) issued by the local regulatory authority.

Records should indicate the Remote Operator Certificate is valid for the CONOPS and RPA types operated by the RPAS Operator.

Where the NAA requires further authorisation for particular CONOPS, the RPAS Operator records should include the required approval, permission or exemption as required by the NAA. Records should further demonstrate compliance with the requirements of the authorisation.

1.9: Equipment Standard

Ensuring aircraft are fitted with the required minimum level of equipment suitable for the intended operations.

RPAS must be designed to minimize the potential for a failure of any component that will prevent continued safe flight and/or recovery of the vehicle. Where parachutes integral to the operation are available for the category of RPA used, consideration for their use should be reviewed.

Include a minimum IP rating for the required RPAS operation in the ORA to consider the risk associated with the ingress of solid objects or liquids into the RPAS system and components.

Passive or Active redundancy systems are commonly incorporated to eliminate a single point of system failure where there is a reasonable probability that a component may fail. Some platforms avoid the necessity for redundancy by incorporating components that have been designed and manufactured to provide a reasonable guarantee of performance for a particular lifespan. Parachutes may be utilized as a last line of defence to mitigate high potential energy scenarios; however, area containment may prove impractical. Case by case analysis during the ORA must determine parachute practicality and the necessity for redundancy systems.

Dust and water ingress can pose a significant risk of component RPA failure. Most off the shelf RPA are not IP rated. The RPAS Operator must consider the environment in which the RPA is to be operated and the suitability of the platform chosen. RPA without demonstrated ingress protection should not be utilized in environments where dust and water ingress is likely. The RPAS Operator may choose to limit the operation of an RPA to specific environmental conditions to minimize the potential for component failure.

evidence

The RPAS Operator must document the limitations of each RPA type operated.

The RPAS Operator must document the suitability of the RPA for the particular operation against aircraft limitations through the ORA. The ORA must consider the environmental conditions and operational area of the flight with respect to component failures.

Records should indicate an ORA considering component failures has been completed for each operation.

1.10: Operations Manual

Ensuring clearly defined operating procedures are in place.

Each RPAS Operator must have a published Operations Manual that meets the requirements of the NAA and includes detail on how training, operations and maintenance are conducted.

Standardization of policies and procedures provides greater opportunities for risk evaluation and mitigation. A published Operations Manual is a key tool in disseminating standardisation information. The process of documenting practices and procedures often exposes weaknesses and facilitates early intervention in deficient systems.

The NAA may prescribe minimum content requirements for the RPAS Operator's Operations Manual, however for operations under contract or for the purpose of meeting international industry standards the RPAS Operator may need to include additional content in the Operations Manual to meet the desired safety outcomes.

The Operations Manual may be a single volume or be composed of a suite of volumes. Depending on the size and complexity of an operation, an operator may combine volumes or create additional Standard Operating Procedures (SOPs). The emphasis here should be on the useability of the manual by the operator's personnel in different parts of the operation.

evidence

The RPAS Operator must have a published Operations Manual that meets the requirements of the NAA.

The RPAS Operator's Operations Manual must contain at minimum procedures on how training, operations, and maintenance are conducted and who is responsible for these items in the organization.

The RPAS Operator must have a document control system to manage scheduled reviews and updates to the Operations Manual.

Records should confirm the current version of the Operations Manual is present, in use and subject to continuous improvement.

1.11: Human Factors

Ensuring RPAS Operator considers the Human Factors element in the operations.

Each RPAS Operator must have a system to consider the Human Factors element of design, operations and maintenance. Considerations include:

- ***Task priorities, including dealing with client requests;***
- ***Communications between pilot and observer (as required);***
- ***The employment of Sterile Cockpit procedures;***
- ***Threat and Error Management;***
- ***Crew Resource Management;***
- ***Ergonomics of control systems and their design; and***
- ***Spatial Disorientation as it pertains to RPAS orientation issues.***

Human factors continues to be a focus in the set of contributing factors of aviation accidents and incidents. Principles that apply to aeronautical design, certification, training, operations and maintenance, which seek a safe interface between the human and other system components by properly considering human performance, are essential. Inadequate ergonomics will result in poor performance, misidentification, and incorrect selection of GCS controls.

The RPAS Operator must have protocols to reduce the possibility of human error induced reduction on safety outcomes. The system must consider the human element in all safety-critical functions and result in the implementation of human error reduction strategies.

Training is a key component in the reduction of human error. The RPAS Operator must have a training program covering operational personnel that includes CRM and TEM. Remote Pilot's should be trained and supported to adhere to operational standards and mitigate client pressure, especially rejection of illegal or nonstandard operations at the client's request.

For a remote pilot, the natural field of view, auditory, proprioceptive and olfactory sensations are absent, making it more difficult for the operator to maintain functional situational awareness, especially identifying and self-correcting evident errors. This is especially pronounced during beyond visual line of site operations, where the remote pilot must rely on alternative sources of information. Unlike conventional piloted aviation, a remote pilot is likely to suffer from perceptual illusions and distortions related to depth perception and on-board cameras. The separation from obstacles and notable misleading depth cues during takeoff and landing may lead to a loss of situational awareness.

"Sterile cockpit" must be incorporated for critical stages of flight, such as takeoff and landing. The "sterile cockpit" concept prohibits extraneous conversations not applicable to the operational safety of the flight ensuring a Remote Pilot is focussed on the task at hand. Utilising "sterile cockpit" procedures avoids unnecessary distraction that might compromise the safety of the flight.

evidence

The RPAS Operator must have a documented procedure to reduce the possibility of human error. The procedure must incorporate Human factors training for personnel involved in the operation of the RPA.

The RPAS Operator's training records must show operational personnel have been training in Human Factors and decision making.

2.0: Fuel/Energy Source

A remotely piloted aircraft conducts a forced landing or ditching as a result of fuel mismanagement resulting in an accident

2.1: Battery Management and Identification

Ensuring RPAS batteries are identified and controlled.

All RPAS batteries must be identified by model and serial number and must be controlled and managed under a documented procedure.

Battery failure is the most common cause of RPAS loss of controlled flight. Proper management of RPAS batteries reduces the likelihood of an inflight battery failure and consequential loss of control of the RPA. Operators should gather and interpret data on battery cycles and endurance to reduce the possibility of premature battery failure. Battery management procedures should include serviceability, testing and maintenance. Monitor the battery temperature at start up, particularly at low temperatures as this can be a factor for poor battery performance.

evidence

The RPAS Operator must have a documented battery control procedure to determine the battery model, serial number and Total Time in Service. Total Time in Service information must include battery cycle details, including charge status before and after the flight, including flight times. The battery control procedure must include a system of maintenance for the aircraft and controller batteries that addresses serviceability and testing.

Records should confirm that each battery used by the RPAS Operator is being managed under the documented procedure.

2.2: Battery Charging

Ensuring eliminate the risk of fire associated with battery handling.

All RPAS batteries must be charged in accordance with manufacturer's recommendations and be protected from an overcharging event.

Improper charging of batteries may result in thermal runaway and other battery-related issues. Rapid charging of a battery will reduce the life of the battery and may lead to inflight failures. RPAS batteries generally undergo cell balancing during the charge cycle; failure to balance cells during charging can lead to an overcharging event and battery fire. Cell imbalance reduces the life and endurance of most battery types and may result in inflight failure.

evidence

The RPAS Operator must have a documented procedure for battery charging which considers battery overcharging. The RPAS Operator must have a record of battery charge cycles for each RPA battery.

Records should confirm that charge cycles are being recorded in accordance with the documented procedure.

2.3: Battery Overheat and Fire Protection

Ensuring eliminate the risk of fire associated with battery handling.

All batteries must be equipped with an appropriate mechanism to reduce or eliminate the risk of overheating and fire.

Lack of battery protection systems and supporting manuals increases the probability of battery fire. The selection of an RPA type should include consideration of the appropriateness of the RPA's battery protection mechanism.

The RPAS Operator must have a procedure for consideration of battery protection mechanisms when acquiring new equipment. The RPAS Operator must be able to provide documented evidence that the RPA batteries in service have appropriate mechanisms to reduce or eliminate the risk of overheating and fire.

Records should confirm that each battery used by the RPAS Operator is being managed under the battery control procedure.

2.4: Power/Fuel Status Indicators

Ensuring limiting the risk of control system or propulsion failure due to loss of power.

Battery powered RPA must be equipped with power supply status indicators that provide adequate notification to the operator of the power state and warnings when a low power level is approaching.

Hydrocarbon powered RPA must be equipped with a fuel quantity indication system that provides adequate notification to the operator of the fuel state and warnings when a low fuel level is approaching.

The GCS must also provide the Remote Pilot with an indication of power status and warnings when a low power level is approaching. Consideration should be given to the inclusion of an Uninterrupted Power Supply for the GCS when long duration flights are planned.

The low power indications or low fuel warnings must provide the Remote Pilot with sufficient notification to safely recover the RPA.

Flights shall be planned/managed to ensure the RPA has sufficient battery/fuel available to enable a safe return to the home location taking into account weather conditions - specifically wind direction and strength.

Energy mismanagement leading to power exhaustion is a direct cause of RPA loss. Assurance for safe flight depends on many factors, including guaranteed reliable power being produced when required.

Basic management principles required by an RPAS Operator must include the following:

- Appropriateness of the RPAS to the mission in relation to RPA endurance;
- Knowing exactly how much fuel/battery capacity is available at the commencement of a flight;
- Knowing the fuel/battery capacity required to satisfy the flight planned operation plus reserves;

- Knowing how much fuel/battery capacity is being consumed, considering all variables such as power settings, cruise levels and effect of wind and course deviations from reasonably foreseen circumstances; and
- Remote pilot knowledge of the aircraft fuel/power supply system and adhering to procedures.

Environmental factors, including wind and temperature, significantly impact the energy consumption of RPAS. It is essential for the safety of operations that the Remote Pilot is continually provided with an indication of the present energy state of the relevant RPAS components and is notified of a low energy state. The notification system for a low energy state should provide adequate reserves for a safe landing, considering environmental factors that may reduce endurance.

Special consideration must be made to any re-tasking during flight and the additional risk to energy management caused by the unanticipated extension of the flight.

evidence

RPA and GCS used by the RPAS Operator must have a means of determining the remaining energy state prior to and during flight. The energy state system must incorporate a low energy warning system able to give adequate warning to the Remote Pilot to allow the Remote Pilot to recover the RPA.

The RPAS Operator must have a procedure to ensure adequate energy is available prior to takeoff, considering the endurance requirements of the flight. The RPAS Operator must have a procedure in place to manage low energy states, including consideration of environmental factors.

RPA records must show actual energy consumption during flight to facilitate accurate energy planning. Flight records should demonstrate adequate energy planning for the particular flight. Remote Pilot training records must show training on RPA power management.

Courtesy: BHP

2.5: Storage, Transport and Management of RPAS Fuel

Ensuring the safe transport of dangerous goods associated with RPAS operations.

RPAS power supplies must be stored, transported and managed in accordance with governing environmental and Dangerous Goods requirements.

Batteries and hydrocarbon fuel must be stored in fireproof stores as required by OHS requirements - bunding to be included for liquids in the event of leakage.

Dangerous goods are solids, liquids and gases that are:

- Explosive substances;
- Goods which, by reason of their nature, are liable to endanger the safety of personnel and those involved in transporting the goods; and
- Goods that regulations declare to be dangerous goods.

RPA energy systems are Dangerous Goods. Improper storage and handling of liquid fuel and batteries increase the potential for fire and explosion.

Transportation of Dangerous Goods is regulated to reduce the potential for harm. Individuals involved in the preparation, transportation, handling and storage need to be aware of the risks involved and have a detailed understanding of the regulations. This level of awareness can only be achieved through the completion of initial and recurrent dangerous goods training programs for all personnel that may be involved in the transportation of Dangerous Goods.

The Contracting company or specific site may have additional requirements relating to the movement of Dangerous Goods and fuel.

The RPAS Operator must have a Dangerous Goods protocols (or an equivalent document) to provide all personnel with the necessary instructions and information to safely perform the task of handling and carrying dangerous goods.

The Dangerous Goods documentation must be appropriate to the type and quantity of Dangerous Goods handled.

Personnel training records must show completion of initial and recurrent dangerous goods training. Inspection of dangerous goods in storage and transport must demonstrate compliance with the RPAS Operator's Dangerous Goods manual.

2.6: Fuel Quality Controls

Ensuring the safety and quality of RPAS fuel supplies.

If the RPAS is not powered by battery, then hydrocarbon supplies must be managed in accordance with standard aviation fuel management procedures that address storage, testing and filtration.

RPAS hydrocarbon fuels can hold water, contaminating the fuel supplied to the

engine(s). The RPAS Operator should document the process by which fuel delivery and storage systems, including portable systems that are to be used for storage and fueling, are assessed and suitable for use. Water can be present in the fuel in several states, including dissolved, in suspension and free. There are a number of fuel testing regimes available, it is the RPAS Operator's responsibility to document acceptable methods to confirm that the fuel is free of water contamination.

Stored fuel must be checked for contaminants prior to RPA fueling in addition to sampling the fuel on-board the RPA prior to flight. Fuel contaminants typically settle to the bottom of the tank over time. Fuel samples must be taken from the sump drain or lowest point of the tank and adequate time allowed to permit the contaminants to settle to the bottom of the tank.

Aircraft operators who make use of drummed fuel in the course of their operations must have a procedure in place addressing the management and use of drummed fuel stock. The following performance requirements must be addressed:

Storage:

- Drums must be stored:
  - horizontally with access bungs at 3 and 9 o'clock; or
  - vertically with drum top cover in place to prevent the accumulation of water on the drum lid; and
- Drums must have minimal contact with the ground (using wooden slats or equivalent) and be stored under cover.

Quality:

- Fuel must be consumed within its Aviation Release Note certification date;
- The access bungs must be tight and the seals unbroken prior to use;
- The fuel must be sampled and include a positive test for the presence of water using water detecting capsules or paste;
- The refuel pump must be equipped with a Go/No-Go filter;
- Before fueling the aircraft, a small amount of fuel must be pumped into a container to remove any contaminants from the hose and nozzle; and
- All drum pumps, spears, and hoses must be sealed when not in use to protect from ingress of dust and contaminents. Seals must be non-porous and secure.

To provide optimum opportunity for any contaminants to settle, drums must be brought to the vertical three hours prior to testing. Where this is not practical (e.g. SAR, Emergency Response, etc.) all performance requirements of this control must be followed.

The RPAS Operator's documentation must include the requirements and procedures for fueling of aircraft and performing fuel testing as part of the preflight procedures.

The RPAS Operator's documentation should include procedures, such as initial and routine audits, that ensure fuel delivery systems and their associated operating procedures meet required standards.

The RPAS Operator's audit program that applies to fuel supplies would typically be one component of the Safety and Quality Management System. Associated records such as audit schedules, checklists, reports, and non-conformance/corrective action closeout reports must confirm that fuel delivery systems used for fueling the operator's aircraft, and their associated operating procedures, meet the required standards.

3.0: Platform

The remotely piloted aircraft exceeds its design limitations resulting in an accident

3.1: Size and Weight (Performance)

Ensuring RPA capability and performance in different operational ambient conditions.

The RPAS Operator must ensure that the RPA is capable of operating in the ambient conditions. Considerations include altitude, temperature, wind, visibility, cloud, the size of obstacles surrounding the area designated for takeoff/landing and the surface integrity such as dust, sand or swamp.

When selecting an RPA for a mission, the operator must evaluate the prevailing environmental conditions and select a platform appropriate for the conditions and the mission requirements. Considerations must include the performance of the aircraft in configurations in which it is likely to be flown.

Adverse environmental conditions significantly reduce the safety of RPA operations. Failure to adhere to IP ratings can result in dust and moisture affecting sensitive electronic componentry. Depending on the type of operation, Visual Line of Sight may be obscured and significantly reduced due to external environmental factors and must be considered.

In rare circumstances, whiteout and brownout may obscure visual cues and disorientate on-board relative distance sensors. Landing surfaces suitability must be taken into consideration and devoid of hazards.

The RPAS Operator must document a method for determining the ambient conditions of the day.

The RPAS Operator must document the limitations of each RPA type operated and the suitability of the RPA.

Engine Maintenance

3.2: Release to Service Under System of Maintenance

Assuring the ongoing airworthiness of the RPA in day-to-day operations.

Documented procedures must be in place that detail how the RPAS is declared serviceable for each intended operation.

Once the aircraft has entered into service, it is subject to operational wear and which may cause performance degradations or lead to structural or mechanical failure.

Prior to the commencement of flight, the RPAS must be inspected to confirm serviceability. The inspection will follow a standardized approach to minimize the potential of failure to identify defects. The preflight check must include a review of the relevant Technical Log to ensure compliance with maintenance requirements and the absence of unidentified defects.

evidence

The RPAS Operator must have a documented procedure to determine RPA serviceability before flight. The documented procedure must include a standardized preflight inspection and a method to identify the status of previous defects.

Records must indicate all defects have been cleared prior to flight, and a preflight inspection of the RPA has been conducted.

3.3: Maintenance/Inspection Regime

Ensuring all RPA repair and maintenance are conducted accurately.

The RPAS Operator must have a documented System of Inspections and Maintenance in place for the RPAS that follows regulatory requirements, manufacturer's recommendations and sound engineering and maintenance principles.

A system of defect recording, and rectification must be established.

RPAS performance must be recorded, and trend monitored to act as 'lead indicators' of future maintenance issues.

For battery powered systems, trend monitoring of battery performance must occur as part of this process.

Any maintenance activity must only be undertaken by appropriately trained and competent persons authorized under the Operations Manual.

Improper RPA repairs and maintenance procedures will negatively impact the reliability and safety of the aircraft. All RPA must have a system of inspections and maintenance that details the aircraft's maintenance intervals and activities. Where the RPA manufacturer does not provide a system of inspections and maintenance, the RPAS Operator will need to develop a system that will reasonably ensure the safe continued operation of the RPA. Where the NAA publishes requirements for an RPA's inspection and maintenance system, the RPAS Operator's adopted system will need to comply with the NAA requirements.

The operator should have a system to record all maintenance requirements and maintenance carried out on an RPA. The maintenance records should include a system for defects reporting that is available to the Remote Pilot prior to commencement of an operation and a system for defect rectification.

The RPAS Operator should have a system for training and certification of the maintenance personnel, including approved remote pilot maintenance activities. The training and certification system should include recurrent training requirements. Where an external provider carries out maintenance, the RPAS Operator must have a process for entering into a service agreement for all contracted maintenance, including requirements for initial and recurrent checking of the capability and competence of the external provider.

Operators should have a system to gather and interpret data on aircraft performance, battery cycles and endurance to reduce the likelihood of a premature battery failure and provide 'lead indicators' of future maintenance requirements.

evidence

The RPAS Operator must have a documented system of maintenance that meets regulatory requirements, manufacturer recommendations and sound engineering and maintenance principles.

The RPAS Operator's system of maintenance must document:

- A method for the recording of RPA defects and their rectification prior to release to service;
- A procedure for the retention of flight records, including flight time, fuel/oil or battery usage as applicable to the RPA type; and
- A method of ensuring maintenance, whether conducted internally or externally, is conducted by appropriately trained and competent persons.

Flight records should indicate technical logs and fuel/oil records are retained for a minimum of three months.

Maintenance records must show scheduled and unscheduled maintenance is conducted in accordance with the RPAS Operators system of maintenance.

3.4: Modifications

Ensuring any modifications to the RPA maintain the original airworthiness and safety margins.

Establish a system to manage modifications to the RPA. Such a system will consider the original certification or approval basis for the RPA, the extent of modifications, the impact of those modifications on the original design criteria and any requirement for ground or flight testing prior to operational use.

The RPAS Operator should have a documented procedure to manage RPA and RPA controlling software modification or include a prohibition in its operational documentation from operating modified RPA.

All aircraft modifications must be carried out in accordance with all applicable airworthiness requirements of the NAA. Modification considerations must encompass integration with existing systems, components and variance in-flight controller algorithm performance.

Where a modification can impact the flight characteristics of the RPA, testing should be undertaken prior to tasking.

Modification outside of manufacturer recommendations should be avoided unless the RPAS Operator can demonstrate that a pre-modification assessment of performance degradation and system interference was completed and validated with appropriate post-modification testing.

evidence

The RPAS Operator must have a documented system to manage RPA modifications, including a method to communicate changes in RPA performance.

Regulatory approvals.

RPAS Operator records must show the extent of any modifications, the impact on the original design criteria, and any post-modification testing results.

Courtesy: Carbonix

3.5: Minimum Demonstrated Experience

Ensuring pilots have minimum RPA type experience and qualifications.

Remote Pilots must have a minimum of type experience with the specific RPA model before employing the system in operations (Appendix 2 RPA Pilots Qualification and Experience). A documented Competency Based Training system may be used as an alternative if agreed to by company.

Poor or inadequate Remote Pilot experience, training and qualifications can rapidly lead to loss of situational awareness, regulation breaches and degraded safety outcomes. The RPAS Operator should implement minimum experience requirements that are appropriate for the complexity of the RPA and the operating profile(s).

The RPAS Operator could choose to implement a Competency Based Training (CBT) system in lieu of Remote Pilot minimum experience requirements. Where the RPAS Operator is utilising a CBT system, the system should be reviewed and endorsed by a Competent Aviation Specialist and meet the minimum requirements prescribed by the NAA (if applicable).

The RPAS Operator must document minimum qualification and experience requirements for Remote Pilots in the Operations Manual.

Records indicate Remote Pilots meet the minimum qualification and experience requirements of the NAA, Operator and Appendix 2 of the standard.

3.6: Alerting

Ensuring timely alerting and location identification to provide awareness of system status.

The RPAS must be equipped with an alerting system that provides awareness of system status. The alerting system should address:

- ***Communications link status.***
- ***Control status (e.g. normal/alternate/emergency);***
- ***Power state; and***
- ***RPA tracking and position.***

Inadequate RPA system awareness can result in poor situational awareness and potential hazardous outcomes. Alerting systems that include visual and aural alerting provide the optimal awareness for the Remote Pilot for abnormal and emergency operational circumstances. The alerting system should consider the severity of the abnormal situation and provide an appropriate alert to the RP.

Prior to the commencement of operations by any RPA type, the RPAS Operator should evaluate the alerting system of the RPA in consideration of the tasks and activities to be undertaken by the RPA.

The RPAS Operator's documented procedures must incorporate a procedure to determine RPA suitability, including RPA alerting system requirements. Where RPA alerting systems can be configured, the RPAS Operator must have documented procedures to ensure alerting systems are activated prior to operations.

RPAS Operator records show the RPA has been deemed suitable and configured correctly with respect to RPA alerting systems prior to operations.

3.7: RPA Suitable for Operating Environment

Ensuring the suitable selection of RPA vehicle.

The RPA must only be operated in environments it was designed for. In offshore locations or for operations above hazardous sites consideration should be given to RPA's that have redundant propulsion and power.

Certain operational environments will dictate the use of RPA with higher redundancy states, increased emergency response systems (e.g. parachute systems) or lower kinetic energy (weight and speed). The RPAS Operator should have a process to evaluate the operating environment, including weather, hazards, risk to property and risk to persons, both in the air and on the ground, when selecting RPA, and ensure that the chosen RPA is appropriate for the particular operation.

The RPAS Operator should document RPA limitations and determine RPA suitability in hazardous locations.

The ORA considers flight over hazardous sites with respect to power or propulsion failures.

Records should indicate an ORA has been completed for each operation, including RPA suitability where the operational area has been determined as hazardous.

Courtesy: Skydio

4.0: Payload

The remotely piloted aircraft payload interferes with the operating aircraft resulting in an accident

4.1: Independence from Flight Controls

Avoiding inadvertent mis-operation of equipment of controls.

Payloads that require operator control from the Ground Control Station (GCS) must be designed such that the payload controls and flight control are independent of each other.

Misidentification and incorrect selection of GCS controls when attempting to manipulate payload has resulted in significant RPA incidents. Where the RPAS Operator undertakes external load operations, the RPAS Operator should have a process to evaluate the GCS to ensure that the external load controls are separated from the flight control and are unlikely to result in erroneous input.

evidence

The RPAS Operator's documented procedures should demonstrate RPA suitability, including a Human Machine Interface assessment to identify risks associated with control confusion.

RPAS Operator records show the completion of a Human Machine Interface Assessment for each RPA type operated and a record stating the RPA and GCS has been deemed suitable.

Courtesy: Newcrest

4.2: Human Factors Ergonomics Assessment

Ensuring Human Factors ergonomics assessment is conducted for payload controls.

RPAS and Payload controls must undergo a Human Factors ergonomic assessment to identify and mitigate risks associated with control confusion.

A poorly designed Human Machine Interface may result in poor performance, misidentification, and incorrect selection of GCS controls. The RPAS Operator should have a process to evaluate the Human Machine Interface prior to commencement of operations of a particular RPA type to ensure that the controls are not likely to confuse, cause unreasonable fatigue, or contribute to remote crew error that could adversely affect the safety of the operation. The evaluation should consider the type of operations and the operational environment where the RPA is to be operated.

Procedures to determine RPA suitability, including a Human Machine Interface assessment to identify risks associated with control confusion.

4.3: Additional/Modified Payloads

Assuring the maintenance of the airworthiness of the RPA with different payloads.

Establish a system to manage payloads attached to the RPA. The system should consider the original certification or approval basis for the RPA and payload, the impact of the payload on the original RPA design criteria, changes to RPA performance and any requirement for ground or flight testing prior to operational use.

The RPAS control and flight characteristics can be compromised by disruption of the manufacturers intended weight, center of gravity and possible interference with existing systems. Programmed algorithms may falter when operating outside of the original certification and designed intention, which may lead to logic ambiguity or failure.

The RPAS Operator should have a documented procedure to manage the suitability and operation of RPA payloads. All payload changes should be in accordance with the applicable airworthiness requirements of the NAA. Payload considerations must encompass integration with existing systems, components and variance in-flight controller algorithm performance.

Where a payload change has the potential to impact the flight characteristics of the RPA, testing should be undertaken prior to tasking. Payload changes outside the manufacturer’s recommendations should be avoided unless the RPAS Operator can demonstrate that an assessment of possible performance degradation and system interference was completed and validated with appropriate post-modification testing.

evidence

The RPAS Operator must have a documented system to manage RPA payload modifications, including a method to communicate changes in RPA performance.

Where applicable, the responsible regulatory authority should provide the RPAS Operator with a copy of any document stating the RPA meets the appropriate regulatory airworthiness standard.

RPAS Operator records must show the extent of any modifications, the impact on the original design criteria, and any post-modification testing results.

Courtesy: Carbonix

5.0: Operations

The remotely piloted aircraft is operated in such a way that it results in an accident

5.1: Approvals

Deconflicting RPAS operations from community and environment.

The RPAS Operator must have a system in place to apply for and receive the applicable approvals for the intended operating site. Interaction with other activities and the impact of RPAS operations must be fully considered (e.g. blasting activities or manned aviation operations).

NAA and site approvals are intended to increase safety outcomes by ensuring physical or tactical separation between the RPA and other airspace users and hazards. The RPAS Operator should have a procedure to ensure required approvals are obtained from all relevant stakeholders prior to the commencement of operations. The procedure should include an assessment of all hazards in the area of operations and the impact of the RPA operations on other airspace users. Where approval is granted, the RPAS Operator shall ensure that all conditions of the relevant approval are met.

Annex A provides a model framework for the purpose of managing the risks associated with separation of RPAS and conventional aircraft over company work sites or infrastructure.

The RPAS Operator must also consider additional community and environmental impacts such as privacy, noise impacts, airspace users on adjacent sites, commercial sensitivities and areas of cultural significance.

evidence

The RPAS Operator must have documented procedures detailing when site and NAA approvals are required and the procedure for obtaining such approvals.

RPAS Operator records must indicate the presence of NAA or site approvals when required.

5.2: Radio

Ensuring radio and communication systems are approved and used appropriately.

The RPAS Operator must possess the appropriate radio communications licences for the RPAS and all payload communication systems, equipment and procedures applicable to the airspace environment intended for use. The RPA must be equipped with the appropriate avionics equipment to meet the airspace operating requirements (e.g. radio, transponder, detect and avoid technology, radio frequency licences etc).

It is also suggested that the RPAS team has an additional backup Air Band radio to assure continued operations if the primary radio should fail. During mining operations, conflicts can be experienced with other frequencies in use. Mining/ Operations Command and Control frequencies compatibility as well as any additional frequency spectrum approvals should be considered prior to operations commencing.

Radio frequency spectrums are controlled to manage equitable access and avoid congestion. The RPAS Operator should assess the radio frequency for communications between crew, with other ground or maritime agencies, and the RPAS C2 link. A frequency that will ensure adequate bandwidth, range, and freedom from congestion should be selected.

Many frequency bands and power outputs utilized by RPAS operators for voice and C2, including transmission on aeronautical radio frequencies, will require crew licencing from the local authority. Where the RPAS Operator is not utilising a frequency band and output power that meets the local authority's class licencing system, an apparatus licence is generally required to operate the equipment on the particular frequency.

The operator should coordinate with the company or site manager in relation to company frequencies utilized to ensure avoidance of any conflict with RPAS C2 link.

evidence

The RPAS Operator's documented procedures must incorporate a procedure to determine RPA and supporting communication equipment suitability, including radio communications and avionics equipment compliance with the NAA and local communication authority requirements. Documentation must detail procedures for communications and avionics equipment use as well as crew training.

Where applicable, the responsible regulatory authority should provide the RPAS Operator with a copy of any document stating the Remote Pilot and associated crew meet the appropriate regulatory instruments or approvals.

The RPAS Operator must document the suitability of the RPA and communication equipment for the operation through the ORA. The ORA must consider interference and contingencies should the primary communication method fail or become unusable.

RPAS Operator records must show the communication and avionics equipment used for an operation meet all regulatory requirements, and the Remote Pilot and associated crew have been adequately trained to use the communication and avionics systems.

Courtesy: "Little Ripper Life Saving"

5.3: Flight Management (Inclusion of ORA Elements)

Ensuring the risks and associated controls and defences are considered for each intended operation of the RPA.

The RPAS Operator must have a documented procedure that addresses the conduct of each flight. This document should describe the conduct of the flight and include information such as the operating area, airspace considerations, takeoff and landing sites, waypoints, broadcast requirements, power/ fuel reserves, etc. and must consider both planned and unplanned circumstances such as powerplant failure, loss of link/communications/GPS signal, conflict with intruder aircraft or birds, etc. The Flight Safety Foundation generic RPAS Flight Checklist is presented in Appendix 4 and can be adapted to all models of RPA used.

Pre-operational planning and risk assessments are essential elements in identifying and mitigating operational risks. The RPAS Operator should have a well-developed operational risk assessment (ORA) process as part of their SMS. The ORA should be used in the planning stage of each flight and include a review of applicable NOTAM, weather, loading, crewing requirements, fuel usage, RPA failsafes, and RPA performance.

Where the ORA identifies unmitigated risks, the RPAS Operator should implement applicable risk mitigation controls prior to commencement of operations.

Written checklists reduce human error and should be adopted by the RPAS Operator for all crew member's tasks that are critical to the safety of RPA operations.

evidence

The RPAS Operators documented procedures must incorporate the responsibilities of the Remote Pilot for flight operations. Documented procedures must detail how an operational area is assessed as suitable and detail how a flight is to be undertaken, including written checklists, ORAs and procedures in the event of unplanned circumstances.

RPAS Operator records should confirm that the documented policies, processes and procedures associated with flight activities are complied with.

5.4: Weight and Balance

Ensuring the RPA remains within the designed performance limits.

The RPAS Operator must have a documented procedure to calculate the Weight and Balance of the RPA.

The RPAS Operator should have a load management system for all RPA with interchangeable payload or energy systems that ensure the aircraft are operated within manufacturer load limitations. The Remote Pilot should confirm that the aircraft weight and balance configuration is appropriate for the flight operations prior to takeoff. Where the position or weight of payload is capable of change during flight, the weight and balance assessment needs to consider all possible combinations of weight and position likely to be encountered.

The RPAS Operator must have a documented load management procedure to ensure weight and balance is within the designed performance limit of the RPA.

Records retained by the RPAS Operator must confirm the RPA was operated within the designed performance limits of the RPA.

5.5: Weather Limits

Ensuring environmental operating criteria minimum limitations are in place.

The RPAS Operator must publish minimum operating criteria for both the RPA and the control console that define limits for the following items:

- ***Cloud;***
- ***Visibility;***
- ***Wind;***
- ***Turbulence;***
- ***Icing; and***
- ***Temperature Limits.***

Each RPAS Operator should establish weather minimums, which will meet or exceed the minimums prescribed by the OEM and the NAA for the particular flight profile. The RPAS Operator's documented practices and procedures should detail the minimum weather requirements for all relevant components of the RPAS. Where the minimum weather requirements are less restrictive than manufacturer recommendations, the RPAS Operator should have evidence to support the safe operation of the RPA in the published conditions. Evidence should consider any relevant NAA requirements and possible negative safety outcomes resulting from operations in the published conditions.

Low cloud, sun position, precipitation, dust and smoke substantially reduce the visibility of the RP, consequently reducing the Visual Line of Sight distance to the RPA and the ability for other airspace users to see the RPA.

Flight in winds above RPA limitations can result in the RPA not being able to maintain position and in severe cases unable to penetrate into the prevailing wind. Winds aloft may be significantly different to wind on the ground and an assessment should be made of both the wind at ground level and the winds aloft. Consideration should be made to the actions in the event of unanticipated wind.

Where significant changes in the wind speed or direction exist (wind shear), significant turbulence is likely to be encountered. Both the maximum wind, cross-wind and wind gust limits must be observed.

Careful consideration should be made to flight in visible moisture and areas of high humidity. Airframe icing can occur at temperatures above zero degrees, airframe ice accretion reduces both lift and thrust, and increases the RPAs weight and drag. Fuel-driven RPA with carburettor systems can experience carburettor icing at any temperature reducing power available. Icing on antenna and other communication equipment can reduce effective communication range or lead to link loss with the RPA.

The RPAS Operator must publish minimum operating criteria for each RPA and GCS used, considering NAA regulations, manufacturer limitations, and safety factors.

RPAS Operator records must indicate documented minimum operating criteria is being adhered to.

5.6: Weather Detection and Monitoring

Ensuring weather conditions assessment and verification are conducted for RPA operation.

The RPAS Operator must have procedures in place to verify that weather conditions are suitable for the intended (forecasts) and ongoing (observations) operation of the RPA. The impact and assessment of wind conditions at all operating levels is of critical importance and deserves specific consideration. When weather conditions deteriorate to minimum limits the operator must define procedures for immediate recovery of the RPA.

Weather is a key consideration in the planning and execution of all flight operations. Failure to apprehend hazardous weather conditions is likely to result in an undesired aircraft state or RPA loss.

Is it essential that the RPAS Operator have a procedure for preflight and in-flight assessment of weather relevant for the flight area and duration. Consideration of the potential for a change of weather whilst airborne, particularly at the landing area, is necessary to ensure the RPA can be recovered at the completion of flight. Training in meteorological assessment and access to appropriate forecast and report information is key to operating in an environment where adverse weather may be encountered.

Every weather assessment made by the remote pilot must be protected from external pressures intended on influencing their decision to commence or continue a flight (this includes the client).

Courtesy: Aviassist

The RPAS Operator must document a method of assessing the anticipated weather conditions and the ambient conditions before and during flight.

The RPAS Operator must have a procedure for responding to deteriorating weather, including a requirement for the safe recovery of the RPA prior to the weather limitations of the RPA being reached.

Records must indicate that RPA types are only used where they have been deemed as suitable in accordance with documented procedures.

5.7: Post-Flight Analysis

Providing a system of learning and feedback for RPA operation.

RPAS operations must include the requirement for post-flight analysis of both operator and platform performance. Development of a standardized post-flight debriefing template will greatly assist in the conduct of the debrief.

The RPAS Operator must have a procedure to facilitate post-flight reviews. A post-flight review of flight performance will quickly and clearly identify whether the intended parameters are being complied with. Specifically, RPA performance with desired aircraft state should be examined. The Performance Monitoring is a similar philosophy to the Flight Data Monitoring programs, and it should be seen as a safety improvement opportunity, not a reason to criticize a pilot or their flying skills.

The RPAS Operator's Operations Manual must include the requirement for post-flight analysis of both operator and platform. The RPAS Operator must have a system for the continuous improvement of flight operations.

The RPAS Operator's records must show where flights did not achieve the desired outcome and where learnings have been made in the post-flight analysis, evidence of continuous improvement exists.

Courtesy: AVCRM

5.8: Night Operations

Ensuring safe and approved night operations and identification of all operating hazards.

Night operations must only be undertaken when specific responsible regulatory authority permission or exemptions have been granted and the operator has night operations procedures in their Operations Manuals. RPAS pilot must be night rated and have the required competence and experience for night operations in accordance with Appendix 2.

Prior to night operations, the RPAS Operator must visit the site and complete the ORA in conditions of daylight sufficient to identify all operating hazards.

Night-flying has always been, and continues to be, more dangerous than flying during the day. The limited visual reference available at night introduces additional hazards (or threats) for Remote Pilots. The additional hazards need to be known and understood to adopt countermeasures to manage the threats. The RPAS Operator must ensure that the night operations are compliant with the NAA's requirements for RPA operations at night, including obtaining approval from the NAA.

The RPAS Operator should have a procedure to ensure remote pilots are competent in night flight, including requirements for training and checking.

The ORA for night flight operations should consider the additional risks associated with night operations and apply appropriate additional risk mitigation such as position lighting, failsafes and minimum GNSS requirements. The ORA should include a site visit by day to ensure sufficient identification of hazards.

evidence

The RPAS Operator must have documented procedures for night operations which include

- Requirement for NAA approval as applicable;
- ORA; and
- Minimum Remote Pilot qualifications and experience.

The RPAS Operator's records must indicate that the necessary regulatory approvals have been obtained and site inspection that informs the ORAs have been completed in daylight conditions. Personnel records must demonstrate Remote Pilots meet the minimum qualification and experience requirements of the NAA, company and Appendix 2 of the standard.

5.9: Ground Crew

Ensuring ground crew are fully inducted and trained for safe operations and appropriately separated from the operating RPA.

All ground crew used in support of RPAS activities must be fully safety inducted, be appropriately trained on the equipment in use and wear clothing appropriate to the task. Unless physically separated, ground crew must maintain 15m from the RPA during launch and retrieval. Where an RPA design does not allow this separation, danger zones of rotating and dynamic components must be clearly marked to enable safe body positioning at all times.

The RPAS Operator must ensure that support crew are appropriately training and assessed as competent for the required role. Where the role requires formal qualification (e.g. radio operator licence), the RPAS Operator must have a procedure to ensure the crew member is suitably qualified. If a support crew member's role exposes the crew member to environmental or operational hazards, the RPAS Operator must ensure the crew member is wearing appropriate PPE to mitigate the hazard.

The RPAS Operator must have procedures to ensure that ground crew maintain safe separation from the RPA during operations."

evidence

The RPAS Operator must document relevant support crew roles, required qualifications, PPE, relevant training and separation safety requirements prior to operations.

Records should confirm support crew roles assigned to flights have the minimum required qualifications, PPE and training for the role.

5.10: Handover

Ensuring continuity in multi-pilot operations.

Where control of an RPA is to be handed over to a new pilot or an alternate GCS, the RPAS Operator must have procedures and checklists in place to confirm that the disposition of the RPA is understood by both parties and that all GCS settings are appropriate for control changeover.

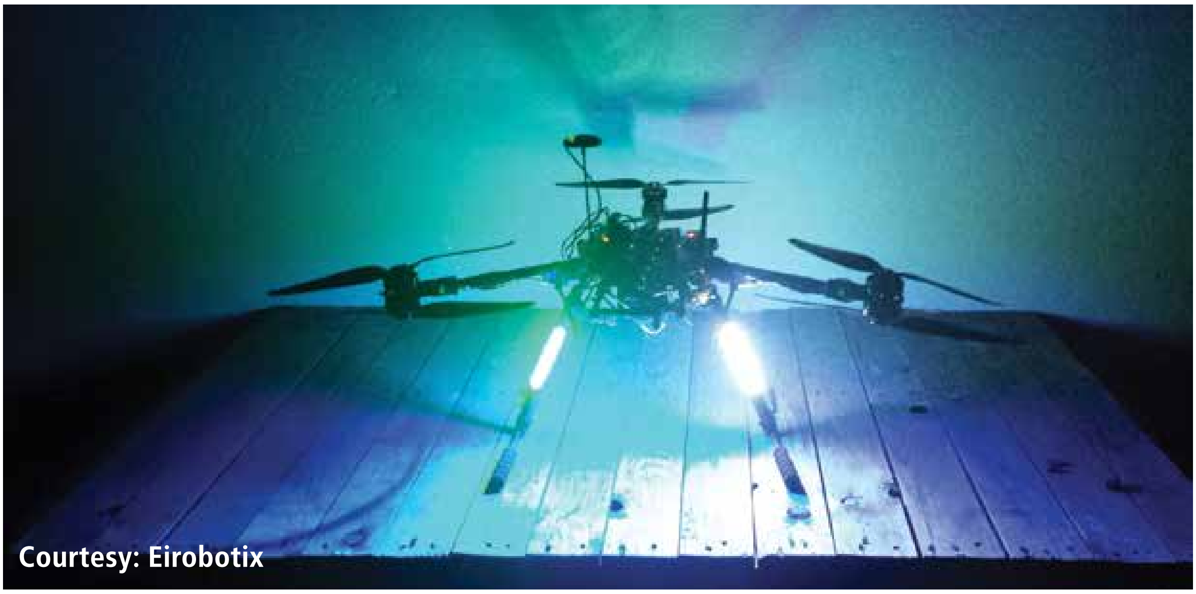
It is essential for the safety of RPAS operations that there is only one PIC at any one time and that all crew are aware of the identity of the PIC. Where the RPAS Operator conducts multi-crew operations, it must have a procedure for the safe handover-takeover (HOTO) of operational RPAS.

HOTO of operational RPAS must be conducted in a 'clean' aircraft state, i.e. there is no emergency or abnormal situation developing, and the conflicts are either solved or a plan for their resolution has been made. Prior to taking over control, the receiving remote pilot must have the necessary visual information to enact safe operation and understand the current mode and configuration of the RPA. Clear communication, "taking over", "I have control", "you have control" are examples of effective airmanship. SOP's and checklists must be used to formalize the process to prevent ambiguity, and a comprehensive preflight briefing to be conducted with all personnel involved in the flying operation. Where crew involved in handover are not co-located, the RPAS Operator's procedures must consider any additional requirements required to ensure the safety of operations.

evidence

The RPAS Operator must have a documented hand-over/take-over procedure appropriate to the RPA being operated.

The RPAS Operator records must show documented procedures, and associated checklists are being followed.



Courtesy: Eirobotix

6.0: Loss of Link

The RPAS loses its Command, Control, Communication or GPS Link resulting in loss of control of the RPA, causing an accident

6.1: Return to Home (Hardware and Procedures)

Ensuring a planned safe outcome for loss-of-link or emergency RPA situation.

All RPAS must have a redundant control mechanism and supporting procedures that allow for a 'Return to Home' or 'Autoland' procedure when commanded by the operator, or when defined conditions (e.g. loss of link) are encountered. The establishment of flight termination criteria should form part of the pre-flight risk assessment process and should take into account hazards such as terrain, airspace and Regulatory requirements for this semi-autonomous flight regime.

System failure or telemetry interference may result in loss of control and the RPA becoming a hazard to another aircraft, person or property. The RPAS Operator's Safety Management System and SOPs checklist must detail the requirement for assessing and managing operational risks as an integral part of the planning and execution of any operation.

All RPA must have a safe flight termination system that will command a safe landing of the RPA upon loss of link or remote pilot manual activation. Routing of the RPA upon activation of a failsafe action must be a consideration in preflight planning. The failsafe action must be configured prior to flight in accordance with the ORA to reduce the risk of collision with terrain and objects, including airspace users, upon activation. Remote Pilot training must include the programming and activation of safe flight termination systems.

evidence

The RPAS Operators documented procedures must incorporate a procedure to determine RPA suitability which includes RPA failsafes. Where RPA failsafes can be configured, the RPAS Operator must have documented procedures to ensure correct configuration.

The RPAS Operator must have documented procedures and associated training relating to manual and automated activation of failsafes and their subsequent flightpaths.

Criteria resulting in-flight termination must be assessed in the preflight ORA.

RPAS Operator records show the RPA has been deemed suitable and configured correctly with respect to RPA failsafes prior to operations. Retained ORAs must show consideration to flight termination criteria.

6.2: Loss of Signal

Ensuring a planned safe outcome for loss-of-link or emergency RPA situation.

All RPAS must have supporting procedures addressing actions in the event of a loss of link between the RPA and the GCS.

While modern link loss failsafe systems are generally reliable and, if properly configured, capable of returning the RPA to the ground in a manner that is safe to the RPA, a loss of link and uncontrollable automation poses significant risks to other airspace users and persons in the operating area. The operating environment will dictate what additional emergency actions are required upon a loss of link. Where there is a potential for interference with other airspace users, other airspace users must be advised of the hazard immediately. Personnel on the ground may need to be alerted of the RPA tracking and landing areas cleared. In some circumstances, activation of the site or RPAS Operator's ERP will be necessary.

evidence

The RPAS Operator must have documented procedures addressing actions in the event of a loss of link between the RPA and GCS.

RPAS Operator must demonstrate where a loss of link event has occurred the relevant procedures were followed.

6.3: RF Spectrum Analysis

Reducing the risk of C3 interference.

As part of the pre-flight risk assessment process, the RPAS Operator should where practicable conduct an RF spectrum analysis to ensure that Electromagnetic Interference/ Electromagnetic Compatibility (EMI/EMC) is assessed as suitable for the intended operation.

Include in this review any frequencies relating the communication spectrum of the various payloads carried.

Electromagnetic compatibility (EMC) is designed to limit the unintentional generation, propagation and reception of electromagnetic energy, which may cause unwanted effects such as electromagnetic interference (EMI). EMI may consist of narrowband and broadband interference resulting in a link loss. Beyond interference issues, microwaves can cause short circuits of electronic components and loss of control.

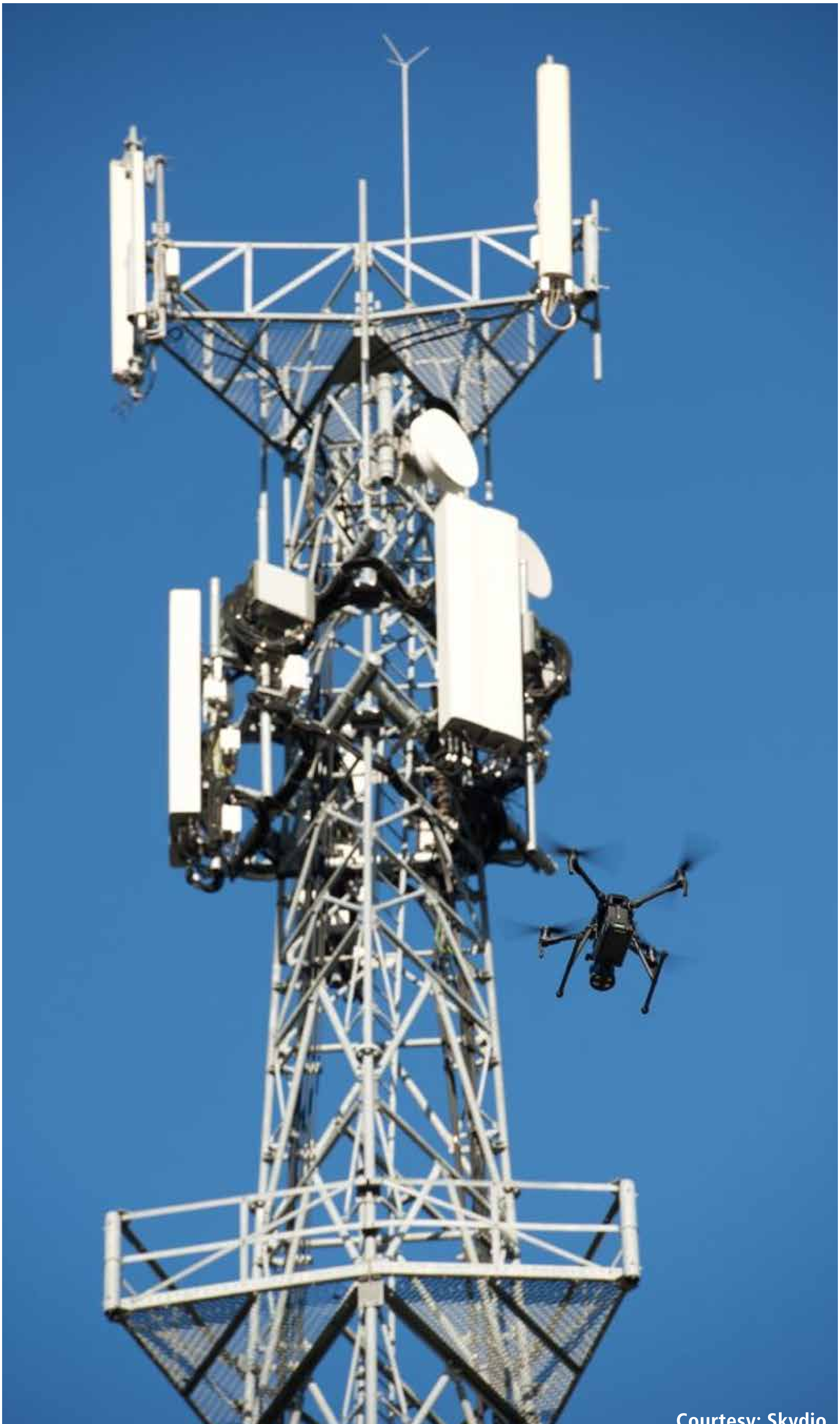
High powered microwave LOS links and RF communications systems are common on client sites. A review of the RF spectrum in the operating area will reduce the likelihood of the aircraft and payload experiencing link loss and control abnormality during flight.

The company must provide information to the RPAS Operator on potential EMI sources on the site that may interfere with or be influenced by the operation of RPAS.

evidence

The RPAS Operator's preflight ORA must include an item considering Electromagnetic interference of frequencies used by the RPA and relevant payload. Where practicable and appropriate, the ORA must include an RF spectrum analysis.

The RPAS Operators retained ORA records indicate electromagnetic interference consideration and RF spectrum analysis where applicable.


Courtesy: Skydio

7.0: Collision

The RPA collides with fixed or moving obstacles causing an accident

7.1: Detect and Avoid

Ensuring RPA equipped with detect and avoid systems.

Where available for the RPAS type, detect and avoid systems should be incorporated in the design where a risk assessment validates their employment as a risk mitigating strategy.

For BVLOS activities, the detect and avoid system must meet the prescribed performance levels as determined by the Safety Case.

The relatively small size of RPA reduces the ability for other airspace users to visually detect and avoid. Implementation of detect and avoid (DAA) and electronic conspicuity (EC) devices, such as ADS-B in/out, TCAS and Flight Alarm, reduce the likelihood of mid-air collision. The relevant NAA may require DAA and EC for certain operations. Regardless, where DAA and EC are available for the RPA type and the ORA identifies that the utilisation of DAA and EC is necessary for the safety of RPA operations, the RPAS Operator must ensure the equipment is utilized. Operations where the Safety Case determine that DAA and EC are necessary must not be conducted without the technology unless a suitable alternative control is implemented.

evidence

The RPAS Operator must have a documented policy regarding the use of detect and avoid technology.

Use of detect and avoid technology must be included in the preflight ORA as a risk mitigation strategy appropriate to the flight task.

RPAS Operator records show detect and avoid technology is utilized when required by the ORA, NAA or BVLOS safety case.

Courtesy: Freeport

7.2: ATC/Airspace

Deconflicting the RPAS activity with other aviation activities to ensure adequate separation.

All RPAS activities must utilise separation standards outlined in Appendix 5. The RPAS Operator must have an assessment process that considers the boundaries of the airspace intended for use for both normal and degraded/emergency operations. Absolute clarity must be achieved during pre-mission planning about what other manned and unmanned activity could potentially occur within the same airspace block. Details of the flight should be registered with ATC if operations in shared airspace are to be conducted and conflict with other aviation activities is possible.

RPAS operations pose safety risks to other airspace users and to the people and property over which they fly. These risks must be kept at an acceptable level through safety mitigations and liaising with local regulatory bodies, ATC and stakeholders. The ORA for all operations should clearly detail the boundaries of the operational area, including any buffers and the procedures for escape from the volume. A review of other airspace users is to be carried out at the planning stage. Any necessary mitigators, including stakeholder mitigation and flight plan or NOTAM lodgement where applicable, must be completed prior to flight.

evidence

The RPAS Operator must have documented procedures to assess the airspace volume to be utilized during normal and emergency operations. Where operations are in non-segregated airspace and conflict with other aviation activities is possible, the RPAS Operator must have a documented procedure to advise ATC or the relevant agency where appropriate to the flight details.

The RPAS Operators preflight ORA must detail the airspace volume, including applied buffers and consider piloted aircraft activities that may occur in the airspace volume during normal and emergency procedures.

The RPAS Operator ORA records show airspace consideration for normal and emergency operations. Where applicable, ATC notification has been used as a risk mitigator when in non-segregated airspace.

7.3: Integration of Multiple RPAS Assets – Simultaneous Operations (SIMOPS)

Ensuring SIMOPS are conducted fully integrated or separated to avoid collision.

Where multiple RPAS assets will be operating simultaneously in the same area, the RPAS Operator must ensure that validated SIMOPS procedures are in place to ensure operations are either fully integrated or fully separated.

Multiple RPAS assets within the same area of operation significantly increase the collision risk, amplified by depth perception limitations associated with RPA operations and human judgment. A Simultaneous Operations procedure reduces the chance of mid-air collision.

Limited bandwidth is available on any frequency allocation. There is an increased likelihood of interference with the C3 links where a significant number of RPA are operated in the same area which needs to be managed as part of the SIMOPS procedures.

Where the operational volume contains RPA operated by different RPAS Operators, the SIMOPS must involve all participants. When developing the SIMOPS, the RPAS Operator must consider aviation traffic from adjacent sites. Where a conflict may arise from adjacent site aviation activities, the adjacent site participants must be included in the SIMOPS. Refer to Annex A for a model SIMOPS framework.

Where multiple RPAS Operators are on site, the company should develop guidance on the SIMOPS requirements and have a notification procedure to ensure all RPAS Operators are aware of the simultaneous operations.

evidence

The RPAS Operator must have documented and validated procedures to avoid collision where multiple RPA are to be operated simultaneously (SIMOPS) in the same area. The documented procedures must include a method of defining if the operation is fully integrated or fully separated.

The RPAS Operator ORA records show that where multiple RPA are utilized, the documented SIMOPS procedures have been applied.

7.4: Launch Window/Template

Ensuring launch site is hazard and FOD free for takeoff and landing.

The areas used for takeoff and landing must be fully assessed against prescribed criteria to ensure that separation from hazards and obstacles can be adequately achieved. Segregation from personnel not directly associated with the operation of the RPAS must be a prime consideration.

The takeoff and landing area presents an increased risk profile for persons and property in the vicinity. The RPAS Operator must ensure that personnel not directly associated with the operation of the RPA are not located in the vicinity of the takeoff or landing area unless the additional risk posed by the RPA has been mitigated.

Foreign object debris (FOD) in the vicinity of the takeoff and landing area poses a significant risk to the RPA and operating crew. Failure to manage suitable operational areas increases the risk of incidents and accidents. FOD includes a wide range of materials, including loose hardware, pavement fragments, operational supplies, building materials, rocks, sand and even wildlife.

evidence

The RPAS Operator must have prescribed criteria that describes what constitutes a safe takeoff and landing area.

The RPAS Operator must have a documented procedure to assess the operational takeoff and landing area against the prescribed criteria.

The RPAS Operator's records must show that takeoff and landing areas have been adequately assessed.

7.5: Lighting/Visibility

Ensuring RPA is visible in the operating area during visual line of sight operations.

RPA should be painted/marked/lit such that it is easily visible during the scope of visual line of sight operations to both the operator and other personnel in the operating area.

RPA should be painted or patterned for maximum visibility for the operating environment. This may involve the use of high gloss, high visibility paint and contrasting colors and, where practicable, suitable collision avoidance lighting, such as strobe and navigation lights. If a tether line is used in above ground operations ensure this is marked/lit to ensure it is visible to other traffic.

7.6: Notam

Deconflicting the RPAS activity with other aviation activities.

The RPAS Operator must have a documented procedure for the application to release a NOTAM addressing the scope of intended operations.

NOTAMs mitigate the risk of mid-air collision by informing other airspace users of the RPA operations and increasing the other airspace user's vigilance in situational awareness. The NAA may require a NOTAM to be published for certain operational profiles. The RPAS Operator must ensure that a NOTAM is published as required by the NAA, or otherwise when the RPA poses an increased collision risk (if the NAA permits the issue of a NOTAM).

evidence

The RPAS Operator must have a documented procedure for the application of NOTAMS for the scope of the intended operations.

Documented evidence must be available to demonstrate that the assessment and management of NOTAM services are being conducted before commencing any new operations or making changes within existing activities as a result.

7.7: Wildlife

Ensuring ORA identifies and mitigates wildlife hazards.

Wildlife hazards, particularly that of predatory birds, must be considered as part of the ORA.

Wildlife hazards are a known and proven risk to RPA operations and need to be effectively managed. Operator's who do not manage their wildlife risk expose their operation to the increased likelihood of an incident or accident occurring. Operating in open fields and natural environments exposes the Remote Pilot to an increased risk from ground-based wildlife hazards such as snakes, spiders and wild animals.

The ORA must consider wildlife risks and implement appropriate mitigation strategies for the identified wildlife. Operational procedures must be established to respond to a wildlife encounter. In those cases where the wildlife problem is deemed high risk, specialist wildlife and bird control advice is recommended.

evidence

The RPAS Operator ORA must address and mitigate the risk of wildlife hazards.

19.0: Vehicle Accident

Mitigating defences in the event of a vehicle accident or loss

19.1: Engine Failure

Assessment of the risks associated with powerplant failure.

RPAS Operators must have procedures available addressing the management of one or more powerplant failures on the RPA. The preflight risk assessment should consider the engine/motor failure risk and include consideration of quarantining the operational area below the intended operation and/or a system with redundant propulsion/power. Quadrotor systems typically do not have redundant propulsion.

Where such controls are not possible to implement, the DROPS calculator should be utilized to consider the residual risk.

Most RPA are not certified and the likelihood of a powerplant failure is unknown. Where the RPA does not have redundant powerplants, a failure generally results in a falling object risk. Some RPA do not have powerplant redundancy, despite having multiple powerplants. This is common in quadcopters, where a failure of one powerplant is akin to a failure of all powerplants. Understanding how an RPA will respond to a powerplant failure is a key component in risk assessment and mitigation.

Even small RPA pose significant hazards to persons and objects in the event they become a falling object. The RPAS Operator must consider the probability of a powerplant failure resulting in a falling object and the risk posed by the falling object. Certain risk profiles will dictate quarantining an area below the RPA to reduce the consequence should a powerplant failure occur. The DROPS calculator is a useful tool for determining the harm level likely from an RPA falling from the sky.

evidence

The RPAS Operator’s must have documented procedures addressing the management of one or more powerplant failures on the RPA. The ORA must address and mitigate the risk of powerplant failures.

Courtesy: Freespace Operations

19.2: Emergency Equipment

Ensuring emergency equipment are provided and available.

Emergency equipment such as, but not limited to, fire extinguishers, first-aid kits, portable eye-wash units, overheating battery containers and fire-proof gloves must be provided at the operating site.

These containers, gloves, and bags must be readily available during equipment transport, especially if transported aboard aircraft.

RPA contain several highly combustible and toxic materials, particularly within the propulsion system. Liquid fuel systems have the potential for leak or rupture and may be ignited. Battery systems may contain chemicals that are sensitive to heat and susceptible to spontaneous combustion. The potential for ignition of all energy sources increases significantly in an uncontrolled impact.

The operator must have the correct fire suppression and containment devices for the particular combustible material, including any necessary personal protective equipment to ensure the safety of incident responders.

An impact of an RPA with a person, particularly a high-velocity component such as a propeller, is highly likely to cause significant injury and may result in a fatality. Indirect impact injury from a component separating from an RPA or from an object impacted by an RPA becoming a projectile is also a significant risk. It is essential for the safety of all persons in the vicinity of the operations that appropriate first-aid equipment is carried. The appropriateness of the first-aid equipment depends on the RPA type and operating environment.

evidence

The RPAS Operator's documented procedures must require minimum emergency equipment proportionate to the RPA type operated. The RPAS Operator should document a defined location where emergency equipment is retained. Where regulatory requirements do not define the contents of a first-aid kit, a complete description of the required contents should be included.

The RPAS Operator must have documented procedures to ensure emergency equipment remains intact, serviceable and within the expiry dates.

19.3: Emergency Response Plan (ERP)

Ensuring adequate and appropriate emergency response procedures are in place and up to date.

All RPAS operations must be conducted with an Emergency Response Plan in place that addresses the actions required in the event of an incident/accident. The ERP must specifically address management of the risks associated with a loss of Command/Control/Communications and the alerting requirements to ATC and manned aircraft that might be in the area. The ERP should also consider hazardous materials used on the RPA and actions to be taken to control the risk of third-party damage in the event of an accident or loss of platform. The ERP should also address required communication channels are in place for each specific activity - all hazards mentioned in the ERP must be addressed in the primary hazard and risk register.

Evidence shows that very few organizations are prepared when aviation accidents and significant incidents occur. RPA are more likely to have accidents/significant incidents than conventionally piloted aircraft due to the close proximity of operations to persons and obstacles and the general lack of redundancy and design reliability. Even small RPA present significant hazards and initiation of timely and appropriate action is critical.

People who have been involved in the immediate response to an aircraft accident will readily agree that events can be confusing and chaotic during the initial stages of emergency response. How an organization performs in the aftermath of an accident or other emergency can depend on how well it handles the immediate response during that time immediately following a major safety event.

A successful response to an emergency begins with effective planning. An ERP detailing what actions need to occur after an accident and who is responsible for completing each action needs to be developed considering both the RPAS Operator and the company. The ERP provides the basis for adopting a systematic approach to managing an organization's affairs and operations following a significant event. Regular practice and review of an ERP ensure that the response to an emergency is appropriate and efficient.

The RPAS Operator must document and make available an ERP to provide instructions and guidance on the duties and obligations of personnel following an accident or incident.

The ERP should be appropriate to the size, nature and complexity of the operations being undertaken. An effective ERP adequately details and provides for:

- The duties and responsibilities of key personnel in an emergency ;
- Contact details for all relevant organizations and individuals;
- Effective communication between the RPAS Operator and the company;
- Loss of command/control/communication procedures;
- Alerting requirements to ATC and/or piloted aircraft in the area;
- Hazardous materials used on the RPA;
- Actions to control the risk of third-party damage in the event of an accident or incident;
- A process for periodically checking and updating emergency contact lists; and
- Conducting periodic, scheduled emergency response drills, exercises or tests.

RPAS Operator records confirm the Emergency Response plan has been tested and emergency contact lists are current. All hazards mentioned in the ERP are listed on the primary hazard and risk register.

19.4: Insurance

Ensuring business continuity for the RPAS Operator.

It is the responsibility of the contracting company to determine the level of insurance required in accordance with company risk management standards.

Such insurance must not be cancelled or changed materially during the course of the contract without at least 30 days written notice to the company.

The company must be named as additional insured under the contract.

Significant financial loss can arise from even seemingly minor RPA incidents. Even with no direct property or person impact, consequential loss resulting from site shutdown and delay can quickly generate losses in the millions. The scope and limit of an RPAS Operator's insurance policy are driven by assessing the risks related to the activity, including any third party direct and consequential losses.

The RPAS Operator must ensure that the policy provides coverage for the company and that policy details are available to the company. Changes to the insurance policy during a contract term have the capacity to adversely impact the company in the event of an incident and must be communicated to the company so that it may consider appropriateness of the operator continuing to provide services.

The company may determine particular insurance requirements for operations which requirements must be clearly communicated to the operator.

evidence

The RPAS Operator must have a documented procedure that provides a detailed risk assessment prior to operation commencement to determine a suitable level of insurance.

The RPAS Operator must have statements of third-party liability insurance covering the period of the contract of not less than US $5 million or such higher value as deemed appropriate by the risk assessment.

19.5: Incorporation of Research and Development Outcomes

Ensuring continuous improvement in safety performance.

Where technical standards and innovations improve RPAS, the contracting company should consider upgrading contracted RPAS to a later developmental standard for improved operational and safety performance. Examples include the inclusion of collision risk mitigation technologies, improved crashworthiness and better command, control and communication systems.

RPAS technology evolves at a rate much faster than seen in conventionally piloted aviation. The technology improvements generally bring significant enhancement in the safety and efficiency of RPA operations. Upgrading RPAS to the latest technological standards ensures improved operational and safety performance.

19.6: Public Relations

Reducing reputational damage risks associated with RPAS operations.

The RPAS Operator and contracting company should develop and implement a Public Relations strategy where public interest in operations is likely to be generated.

RPA provide opportunities for improved work methods, creating cost, efficiency and safety benefits. While these benefits are well recognized amongst the fraternity of RPAS Operators, the carriage of recording devices and operations in close proximity to people/aircraft can create privacy, noise and safety concerns.

Early and purposeful public relations management is key to avoiding negative responses from the community and other stakeholders.

A successful stakeholder relations strategy will cover, as a minimum:

- Safety of operations;
- Noise;
- Privacy; and
- Equitable access to airspace.

The RPAS Operator must have a documented public relations strategy.

19.7: Investigation Procedures

Ensuring accurate causal factors and accident mitigations are identified and learnt.

Each RPAS Operator must have a defined investigation procedure that focuses on identification of root causes and the prevention of recurrence. Investigation procedures should be based on ICAO Annex 13 principles. Procedures should be developed for preservation and security of data recorded during the subject flight to assist with the investigation process.

Safety occurrence investigation is a key component of a successful safety management system. ICAO Annex 13 — Aircraft Accident and Incident Investigation contains the international Standards and Recommended Practices for aircraft accident and incident Investigation.

The sole objective of investigating an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability. Instead, an investigation is carried out to provide the operator with the necessary information to implement risk mitigation strategies that will prevent further occurrences.

An effective safety investigation relies on:

- A positive reporting culture;
- Access to quality information of the occurrence, including flight data;
- Suitably trained investigators; and
- A commitment to no fault reporting.

The requirement for a safety occurrence investigation will be driven by the severity of the incident and the possibility for recurrence. The RPAS Operator must have a defined policy to appropriately trigger a safety occurrence investigation. Where a safety occurrence investigation is undertaken in relation to activities at a company site, the RPAS Operator should provide feedback to the company regarding the investigation and close-out of significant incidents and whether any findings could be incorporated in risk mitigation strategies.

The procedure must include the preservation and security of the data recorded for the subject flight.

evidence

The RPAS Operator must have a documented accident/incident investigation procedure based on the principles of ICAO Appendix 13.

RPAS Operator records must include a narrative on the root cause, contributing factors of all accidents/incidents, including improvements to prevent future recurrence.

Courtesy: Altitude Imaging

Appendices

Appendix 1: Generic RPAS Governance Model

<table>
<tr><th>Category</th><th>Weight</th><th>Operating Conditions</th><th>Governance Model</th></tr>
<tr><td>Micro</td><td>≤250 g</td><td colspan="2">May be risk-assessed by company as not requiring governance. Otherwise treat as ‘Very Small’ category.</td></tr>
<tr><td>Very Small</td><td>>250g - 2 kg</td><td rowspan="2">1. Standard Operating Conditions</td><td rowspan="2">Approvals maintained at local site/asset/business unit.
All Remote Pilots have RPL or permit that meets local regulatory requirements.
Adopt all applicable controls contained within FSF RPAS Standard.</td></tr>
<tr><td>Small</td><td>>2 kg - 25 kg</td></tr>
<tr><td>Micro</td><td>≤250 g</td><td rowspan="3">1. Non-standard Operating Conditions
2. BVLOS/EVLOS</td><td rowspan="5">Audited against a defined protocol to facilitate company approval process.
RPA Operator (company internal or external) meets all requirements for commercial operation as dictated by the NAA in the jurisdiction of operations).
Adopt all applicable controls contained within FSF RPAS Standard, including all applicable ORA appendices.</td></tr>
<tr><td>Very Small</td><td>>250g - 2 kg</td></tr>
<tr><td>Small</td><td>>2 kg - 25 kg</td></tr>
<tr><td>Medium</td><td>>25 kg - 150 kg</td><td rowspan="2">1. Standard Operating Conditions
2. Non-standard Operating Conditions
3. BVLOS/EVLOS</td></tr>
<tr><td>Large</td><td>>150 kg</td></tr>
</table>

Weight Categories of RPA

Micro An RPA with a gross weight of 250g or less

Very small An RPA with a gross weight of more than 250g but less than 2kg.

Small An RPA with a gross weight of at least 2kg but less than 25kg.

Medium An RPA with a gross weight of at least 25kg but not more than 150kg.

Large An RPA with a gross weight of 150kg or more.

Appendix 2: Remote Pilot Qualifications, Experience and Recency

Operating Conditions	RPA Weight	Qualifications	Experience (Hours)		Recency	Simulator
			Total	Type/Model		
1. Standard Operating Conditions	<25kg	RPL	5	–	Three missions in previous 90 days or Successful completion of a check flight with a company approved RP on the RPA type being operated.	If dictated by Risk Assessment
	>25kg		10	5		
1. Non-standard Operating Conditions 2. EVLOS < 1500m	<25kg	RPL	10	5		
	>25kg		20	5		
1. EVLOS > 1500m 2. BVLOS	<25kg	RPL and Instrument Rating (theory)	20	10		
	25kg – 150kg		25	10		
	>150kg		50	20		Annual

Appendix 3: Remote Pilot Approval and RPAS Operational Risk Assessment (ORA)

The Operational Risk Assessment must be a documented process that records all hazards and threats associated with RPAS operations. The outcome of the ORA will be to identify clear mitigating controls used to manage the risk associated with this activity. These mitigating controls should be summarized and briefed to all participants prior to the commencement of operations. This document also serves to provide a formalized process for the task approval of the Remote Pilot/s.

Table 2: Example of Remote Pilot Approval and RPAS Operational Risk Assessment (ORA) – Dependent on the answer 'Yes' or 'No,' the ORA requires identification of mitigating Controls or Defences followed by discussion and agreement with management or the contracting company's representative prior to flight.

The Remote Pilot requesting approval to operate acknowledges that this form provides approval to operate the listed RPAs in the specified location in accordance with the Operational Risk Assessment. All RPAS used must be approved under the relevant form. The Remote Pilot acknowledges that additional site authorisation may be required.

Approval Information			
Date		Company	
Remote Pilot		Certificate/Licence Identification Number (if applicable)	
Operating Location			
Proposed Task Description			
RPA Make and Model (list all)			
Type Approval Requested	Aeroplane ☐	Multirotor ☐	Powered Lift ☐

Documentation to be Provided	
Copy of Regulatory issued Remote Pilot License (RePL) where applicable	☐
Annotated map of task area (for areas within 5NM of an aerodrome)	☐

Appendix 3: Remote Pilot Approval and RPAS Operational Risk Assessment (ORA) cont.

Table 2 below is a desktop assessment of the proposed activity and shall be reviewed prior to each new operation. Additional mitigations must be completed and implemented by the owner prior to conducting RPA operations.

Control	Query			Additional Mitigations	Owner
Planning	• Is the operation being conducted in accordance with the Standard Operating Conditions? • Operation of **one RPA per Remote Pilot** at any one time • **Maintain Visual Line of Sight (VLOS)** during day operations and **below 400 feet** Above Ground Level (AGL) • Not to be operated closer than **30 meters** to personnel who are not associated with the flight • Not to be flown over **populous areas** and/or personnel in the area of operation	Y	N	If no, the operations should not take place until the Standard Operating Conditions are satisfied or the activity is to be undertaken under a valid ReOC/ROC or Where no regulatory certificate to operate is applicable, in accordance with company's approval process and all controls outlined in the FSF RPAS Contracted RPAS Operators must ensure company approval is in place prior to undertaking such operations	
Aerodromes	Is the operation being conducted within: • **3 nautical mile**s (nm) of **an aerodrome**, or within active prohibited and restricted areas • **Approach and departure** paths as well as movement area of all aerodromes	Y	N	If yes, operations must have current company agreement in place with the aerodrome operator. Refer below for these controls. If yes, FSF RPAS simultaneous operations	
Remote Pilot	Do you understand the requirements for site authorisation at the requested sites?	Y	N	If no, consult the site training department to complete the required steps.	
	Have you maintained three flights in 90 days, and is the recency relevant to the type, weight and category being operated?	Y	N	If no, successful completion of a check flight with a company approved RP on the RPA type being operated	
Airspace	Do you understand the airspace and the expected crewed aircraft traffic in the area that RPA operations are being conducted?	Y	N	If no, complete an airspace assessment to confirm that the intended operation can be undertaken without penetrating unapproved airspace	
	Does the operation require NOTAMs to be issued?	Y	N	If yes, confirm that the applicable NOTAMs have been released or reviewed	
	Are aviation radio broadcasts required?	Y	N	If yes, confirm you hold the required license and conduct the required radio broadcasts. Assess the need for a backup radio	
RPA Operations	Do you understand the weather limits for all aspects of the operation?	Y	N	If no, provide training to understand weather limitations	
	Do you have access to weather conditions for the operating area on the day of the flight?	Y	N	If no, determine method to obtain current weather conditions on the day of flight/s	
	Will the RPA be hand launched or retrieved?	Y	N	Hand launched RPA require a Risk Assessment approved by the company's representative	
	Do you understand the lost link procedures of each listed RPA?	Y	N	If no, postpone the flight until you understand these procedures	
	Have you assessed the appropriate emergency equipment and whether it will be on hand?	Y	N	If no, postpone the flight until the required equipment is on hand	

Control	Query			Additional Mitigations	Owner
RPA Operations (cont.)	Are multiple crews involved in the operation?	Y	N	If yes, ensure task priorities, pilot handover, critical flight phases and communication methods between crew is clearly documented and understood by all. Ground crew must be adequately trained on the relevant equipment being used	
	Are crewed aircraft operations regularly being conducted in the RPA operating airspace?	Y	N	If yes, NOTAM information should be checked daily prior to each flight	
	Does the RPA use hydrocarbons as a power source?	Y	N	If yes, a procedure must be in place to contact emergency services in the event of a fire or spill	
	Has this RPA model been used at this location previously?	Y	N	If no, perform an RF spectrum analysis with the technology team prior to operating	
	Have wildlife hazards been considered, particularly that of predatory birds?	Y	N	If no, postpone the flight until these hazards are assessed.	
	Have engine/motor failure risks included consideration of quarantining the operational area below the operation?	Y	N	If no, postpone the flight until this item is assessed or a vehicle is employed with a redundant propulsion/power system.	
Specialised Activities	Do you intend to conduct any of the following? • Beyond Visual Line of Sight (BVLOS) Operations • Carrying external, tethered or suspended loads? • Underground or confined space tasks? • Operations in offshore or marine areas (excluding port berths)	Y	N	If yes, refer to FSF RPAS document with specific reference to ORA appendices and all company specific controls that must be implemented	

Task Notes: (Company Representative, Single Point of Accountability/Nominated Manager to complete)

As a remote pilot conducting work for <Company>, I acknowledge that all RPA work will be conducted as per company's requirements, all regulatory requirements pertaining to the National Aviation Authority and any site-based risk assessments or procedures.

This form expires <five> years from the below date, or when the assumptions of the above Operational Risk Assessment are no longer valid.

Approvals

Role	Name	Signed	Date
Remote Pilot			
Company Representative			

Company Representative, Single Point of Accountability/Nominated Manager use only	
Remote Pilot RePL (where applicable) valid for requested RPAs	☐
RPA make/model in company approved list	☐
Remote Pilot details entered into company register	☐

Appendix 4: Flight Safety Foundation Generic RPAS Flight Checklist

Pre-Start Briefing

1. Provide overview of Task
2. Specify tasking for crew
3. Articulate identified hazards
4. Outline how issues to be communicated
5. Nominate landing area and alternate
6. State safe zone location for bystanders
7. Describe actions following incident
8. Reiterate sterile cockpit procedure
9. Review all mission specific requirements

RPA Operating Limits

Wind - *"Insert"*	**Min Battery** - *"Insert"*
Rain - Nil	**Temperature** - *"Insert"*
Cell Voltage - *"Insert"*	**Error Codes** - Nil

Normal Procedures

1. Flight Approval and Recency	
A - Approval	Issued and current
I - Inspections	RPA airworthy/serviceable
R - Recency	30/90 days or checked to line

2. Setup Location	
F - Flight Area Hazards	Clear of hazards
L - Launch/Retrieval Area	Clear of hazards, secured
A - Alt Landing Areas	Identified
W - Weather	Checked and within limits
S - Site Specific Requirements	Checked and satisfied

3. Before Start	
F - Fuselage	Inspected, nil damage
A - Arms	Unfolded, locked
M - Motors, Propellers	Spin freely, secured
B - Batteries	Secured, sufficient
R - Remote Control	ON, assisted mode
A - All Personnel	Clear of propellers

4. After Start	
C - Compass	Green
B - Battery Voltage Deviation	*"Insert"*
A - App Status	'Ready to Fly'
D - Downward Vision Sensor	OFF (If operating close to objects)

5. Remote Pilot	
F - Fitness	IM Safe
Ilness, **M**edication, **S**tress, **A**lcohol, **F**atigue, **E**motion	

6. Before Takeoff	
B - Briefing	Completed
P - Pilot, Crew	Safety location/physical barrier
O - Observers	**>30m**

7. After Takeoff	
C - Control Check	Completed

8. In-flight	
H - Hazards	Avoid people and wildlife
O - Operating Limits	Check within limits
M - Monitor Battery	Commence RTH at 30%
E - Errors	Confirm nil errors

9. Before Landing	
P - Pilot, Crew	Safety location/physical barrier
O - Observers	**>30m**

10. After Landing/Post-flight	
D - Duration of Flight	Record
R - RPA	Inspect
D - Damage	Report
R - Relevant Information	Record

Abnormal Procedures

1. Motor Fail to Start	
Propellers	Stand clear
Remote Control	Cycle flight mode
Remote Control	Manual start
Power Switch	OFF/ON
2. Wildlife Interaction	
Remote Control	Avoid
Return to Home	If required
3. Motor Failure during Flight	
Remote Control	Attempt to steer away
Landing Area	Confirm safe
4. Personnel In-flight Area	
Remote Control	Pause
Personnel	Monitor
5. Aircraft in Vicinity	
Remote Control	Descend
Remote Control	Return to home
6. Loss of Control during Flight	
Remote Control	Cycle flight mode
Remote Control	Return to home
If control not gained	
Landing Area	Confirm safe
Motors	Shutdown

Post-Event Emergency Actions

1. **Remote Pilot -** Provide safety instructions to all personnel
2. **Motor -** Shutdown
3. **Injuries -** Assess, treat and call Emergency
4. **Battery -** Observe for minimum 15 minutes then as required
5. **Photos -** As required
6. **Flight Logs -** Retrieve and secure
7. **Report -** Notify responsible persons

Courtesy Newcrest

Appendix 5: Model of Separation Standards

The purpose of this section is to provide a model of a framework for the controls to ensure the separation between RPAS operations and known/unknown aviation traffic associated with a defined work site, mine site, offshore platform or company owned land/infrastructure.

Introduction

The onshore resource sector and other sectors operate Remotely Piloted Aircraft (RPA) in airspace that co-exists with other aeroplanes, helicopters and RPAS traffic.

Collision between drones and aircraft can have a catastrophic outcome and the risk must be managed.

For a consistent approach within industry, it is essential to standardize the control framework required to manage this risk, and ensure all stakeholders are conversant with the requirements.

Key stakeholders include:

- Aerodrome/Helideck operators;
- Aircraft operators;
- Flight crew;
- RPA operators; and
- Adjoining lease/airspace users.

Threat Scenarios

‘Fixed’ Aircraft Position Threat Scenarios

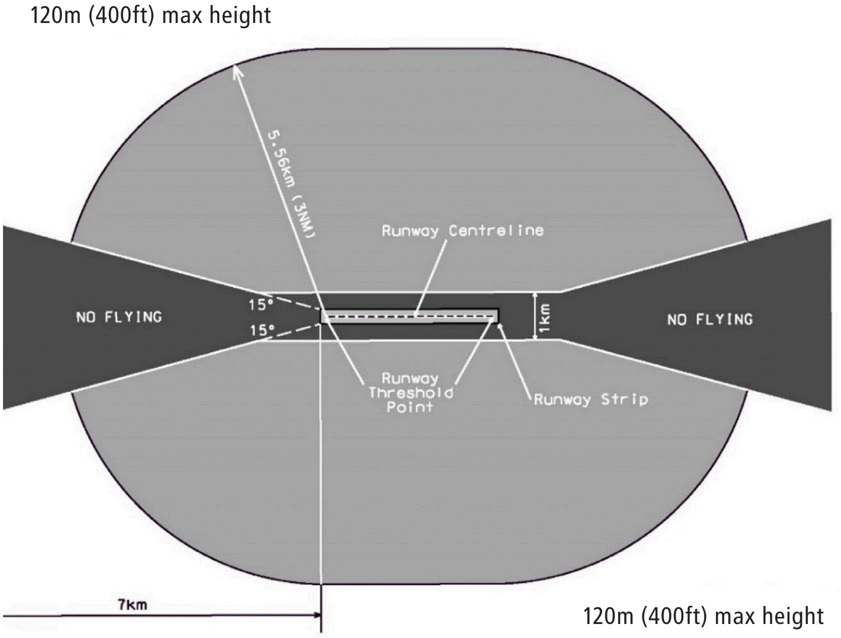
Associated with fixed positions on the ground used for takeoff and landing, such as aerodromes, landing strips, offshore platforms, windfarms and helicopter landing sites (HLS).

Threat scenarios are:

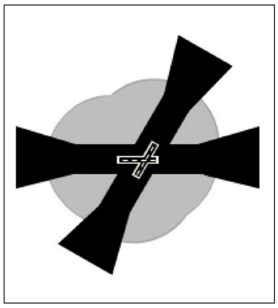
1. RPA Operation within 3nm of an aerodrome/HLS;
2. RPA operation within approach and departure paths of an aerodrome/HLS;
3. Non Standard Operating Condition (SOC) within 3nm of an aerodrome/HLS; and
4. Enclosed/confined operations within 3nm of an aerodrome/HLS.

Figure 1: Fixed Threat scenario example

Approach/Departure Paths - 15 degrees splays out 7 km



Intersecting Runways



'Mobile' Aircraft Position Threat Scenarios

Associated with aircraft movement such as low-level airborne geophysical operations and aerial seeding/spraying operating over a mine site/production area. Mobile threats can further include offshore oil spill response, fire response etc.

Threat scenarios are:

1. RPA operation in vicinity of other aircraft (unplanned);
2. Conducting non-Standard Operating Conditions (SOC) beyond 3nm from aerodrome/HLS; and
3. RPA operation in the vicinity of other aircraft (planned/coordinated).

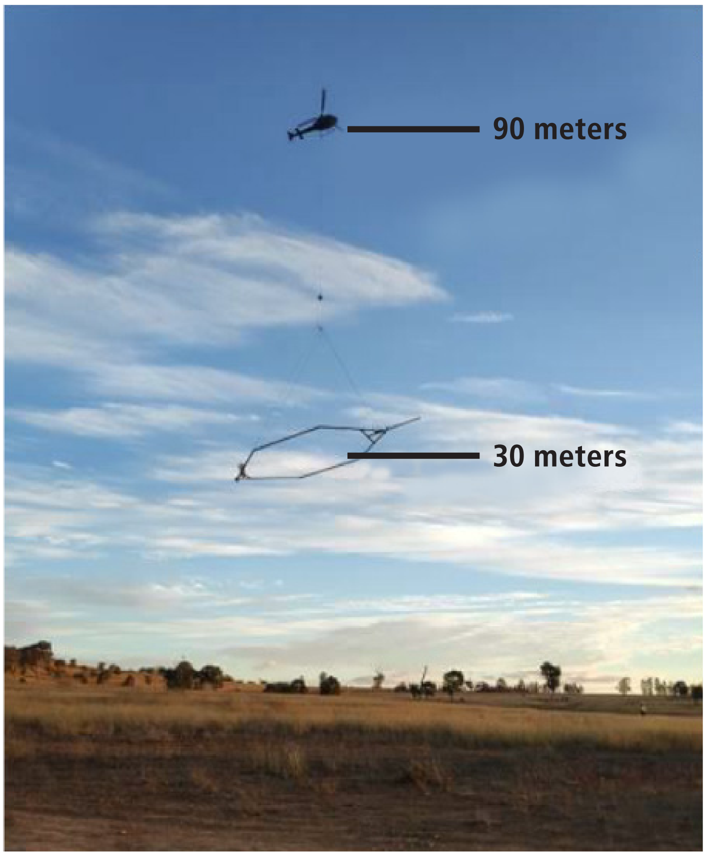


Figure 2: Mobile Threat scenario example

Appendix 5: Model of Separation Standards (cont.)

Summary of Controls – Fixed Position Threat Scenarios

	Controls							Comments
M - Mandatory R - Recommended Scenario	Flight approval by RPAS SPA (or delegate)	Airspace Assessment	Stakeholder Engagement	Radio Procedures	ADS-B In	Trained Observer	Contact Aerodrome	
1. RPA operation within 3nm of an aerodrome (but outside runway approach/ departure/path)	**R / M***	**M**	**M**	**M** - Monitor **R** - Broadcast **M*** - Broadcast	**R / M***	**R**	**R**	**M*** Mandatory when **less than 10 minutes** prior to scheduled arrival/departure
2. RPA operation within approach/ departure path of a runway or Helicopter Landing Site (HLS)	**M**	**M**	**M**	**M** - Monitor **R** - Broadcast	**R**	**R**	**R**	**Operations must be planned outside 30 minutes of scheduled arrival or departure**. RPA may remain airborne until **10 minutes prior** by utilizing the recommended controls to establish the known arrival or departure time
3. Non standard operation conditions (SOC) within 3nm	**M**	**M**	**M**	**M** - Monitor **R** - Broadcast	**R / M***	**R**	**R / M***	**All operations must be planned outside 30 minutes of scheduled arrival or departure**. **M*** Mandatory for EVLOS/BVLOS
4. Enclosed/confined operations within 3nm	**M**					**R**		All operations must consider an assessment of the structure to determine entry and exit points

Fixed Position Threat Scenario 1: RPA operations within 3nm of aerodrome

Controls

Compliance	Controls	Comments
Mandatory	Radio monitoring	CTAF and area frequencies
	Airspace assessment on expected traffic patterns and known altitudes	Review requirement to issue NOTAMS
	Prior stakeholder engagement with aerodrome operator and (known) aircraft operators	Establish frequency of communications/updates (minimum annually)
	RPA operations outside approach and departure paths	
Recommended	Radio broadcasts	Mandatory for operation within 10 minutes of scheduled arrival/departure
	ADS-B In device used throughout the operation	Mandatory for operation within 10 minutes of scheduled arrival/departure
	Flight approved by single point of accountability (or delegate)	Mandatory for operation within 10 minutes of scheduled arrival/departure
	Contact aerodrome for flight approval	
	Trained observer in contact with Remote Pilot	

Fixed Position Threat Scenario 2: RPA operations within approach/departure path

Controls

Compliance	Controls	Comments
Mandatory	Radio broadcasts	
	Airspace assessment on expected traffic patterns and known altitudes	Review requirement to issue NOTAMS
	Prior stakeholder engagement with aerodrome operator and (known) aircraft operators	Establish frequency of communications/updates (minimum annually)
	No operations planned within 30 minutes of scheduled arrival/departures	
	Flight approved by single point of accountability (or delegate)	
Recommended	Trained observer in contact with Remote Pilot	RPA may remain airborne until **10 minutes prior** by utilizing the recommended controls to establish the known arrival or departure time
	ADS-B In device used throughout the operation	RPA may remain airborne until **10 minutes prior** by utilizing the recommended controls to establish the known arrival or departure time
	Contact aerodrome for flight approval	RPA may remain airborne until **10 minutes prior** by utilizing the recommended controls to establish the known arrival or departure time

Fixed Position Threat Scenario 3: Non-standard operating conditions within 3nm of aerodrome

Controls

Compliance	Controls	Comments
Mandatory	Radio broadcasts	
	Airspace assessment on expected traffic patterns and known altitudes	Review requirement to issue NOTAMS
	Stakeholder engagement with AD operator and known crewed aircraft operators	Establish frequency of communications/updates (minimum annually)
	Flight must not be planned within 30 minutes of scheduled arrival/departures	
	Flight approved by single point of accountability (or delegate)	
Recommended	Trained observer in contact with Remote Pilot	
	ADS-B In device used throughout the operation	Mandatory for EVLOS/BVLOS
	Contact aerodrome for flight approval	Mandatory for EVLOS/BVLOS

Fixed Position Threat Scenario 4: Enclosed/confined operations within 3nm of aerodrome

Controls

Compliance	Controls	Comments
Mandatory	Flight approved by single point of accountability (or delegate)	
	Assessment of structure to determine entry and exit points	
Recommended	Trained observer in contact with Remote Pilot	

Appendix 5: Model of Separation Standards (cont.)

Summary of Controls – Mobile Position Threat Scenarios

Controls									Comments
M - Mandatory R - Recommended Scenario	Flight approval by RPAS SPA (ordelegate)	Airspace Assessment	Stakeholder Engagement	Radio Procedures	ADS-B In	Trained Observer	Initiate radio contact within 10nm horizontal 1,500 feet vertical	Abort flight within 10nm horizontal 500 feet vertical	
1. RPAS in the vicinity of other overflying aircraft (unplanned)		**M**	**M**	**R** - Monitor	**R**		**M**	**M**	All operations should consider the likelihood of other airspace users
2. Non-SOC operations (beyond 3nm from AD)	**M**	**M**	**M**	**M** - Monitor **R / M*** - Broadcast	**R / M***	**R**	**M**	**M**	**M*** Mandatory for EVLOS/ BVLOS
3. RPAS in the vicinity of other aircraft (planned interaction)	**R**	**M**	**M**	**R** - Broadcast	**R**				Detailed separation and stakeholder engagement requirements discussed further in Mobile Scenario 3

Mobile Position Threat Scenario 1: RPA in vicinity of other aircraft (unplanned)

Controls

Compliance	Controls	Comments
Mandatory	Abort flight - when aircraft is tracking towards RPA and compromises 10nm and 1,500 feet vertical separation	
	Abort flight - 10nm and 500 feet vertical separation	Land immediately
	Airspace assessment on expected traffic patterns and known altitudes	
	Stakeholder engagement with (known) aircraft operators	
Recommended	ADS-B In device used throughout the operation	
	Radio monitoring	CTAF and area frequencies

Mobile Position Threat Scenario 2: Non-SOC operations > 3nm from aerodrome

Controls

Compliance	Controls	Comments
Mandatory	Radio monitoring	
	Airspace assessment on expected traffic patterns and known altitudes	
	Stakeholder engagement with (known) aircraft operators	
	Radio contact - 10nm and 1,500 feet separation Abort flight - 10nm and 500 feet vertical separation	Land immediately
	Flight Approved by single point of accountability (or delegate)	
Recommended	Trained observer in contact with Remote Pilot	
	ADS-B In device used throughout the operation	Mandatory for EVLOS/BVLOS
	Radio broadcasts	Mandatory for EVLOS/BVLOS

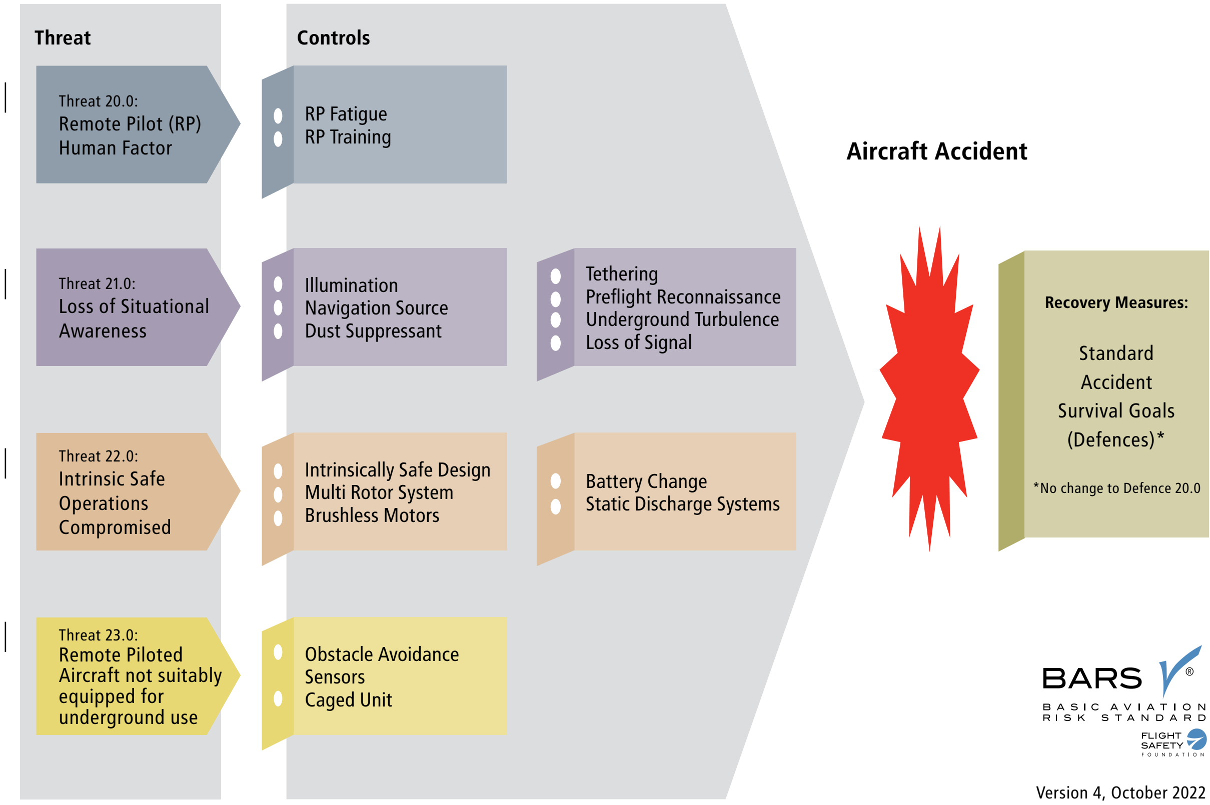
Mobile Position Threat Scenario 3: RPA in vicinity of other aircraft (planned)

Controls

Compliance	Controls	Comments
Mandatory	3nm and 500 feet vertical separation	To be applied around planned project area
	Pre-activity alert two weeks prior to operation	
	Positive acknowledgement of planned interaction by all Remote Pilots	To be implemented via nominated software
	Daily liaison between aircraft operator and RPAS single point of accountability	
	Daily communication/distribution of aircraft operations updates	
Recommended	Radio broadcasts	
	ADS-B In device used throughout the operation	
	Flight approved by single point of accountability (or delegate)	

Appendix 6: Underground and/or Confined Space RPAS Operations

Figure 2: BARS Bow Tie Risk Model – Schematic of RPAS Management Controls and Recovery Measures for Underground or Confined Space Operations



BARS BASIC AVIATION RISK STANDARD
FLIGHT SAFETY FOUNDATION

Version 4, October 2022

20.0: Remote Pilot (RP) Human Factor

The Remote Pilot makes an error of judgement and loses control of the RPA

20.1: RP Fatigue

Ensuring remote pilot fatigue is minimized by appropriate management and pre-start risk assessment.

A fatigue management plan must be in place prior to the start of the activity and which takes into account the additional demands that operating an RPA underground places on the Remote Pilot.

Underground and confined space operations require high concentration levels due to the presence of obstacles and precise tracking requirements. Maintaining a high level of concentration results in significant fatigue, which must be managed appropriately to avoid human error. A Fatigue Management Plan covering flight, duty and rest time is an essential tool in managing Remote Pilot fatigue.

evidence

Details of the RPAS Operator's fatigue management plan must be published in the Operations Manual and, where applicable, comply with the NAA's fatigue management regulations.

The RPAS Operator must include details in the Operations Manual of the system to record and track an individual Remote Pilot schedule and rest periods. While manual, paper-based systems are acceptable, computer programs that comprehensively track the varying limits and predict likely fatigue occurrences are readily available and are preferable.

Flight and duty time records must confirm compliance with all requirements of the fatigue management plan. The flight and duty time records that are maintained must be consistent with information provided in other documents such as aircraft flight records.

Courtesy: BHP

20.2: RP Training

Ensuring remote pilots are competent to operate RPA without GPS signal in an underground environment.

The Remote Pilot must undergo specific training associated with absence of GPS signal in an underground environment (such as operating in manual-mode) before commencing first operation.

Operating in GPS denied environments reduces the automation available to the Remote Pilot, requiring a higher degree of manual piloting skills. Task-specific training for complex operating environments is integral to ensure Remote Pilots have the skill and experience to operate the RPA safely prior to assignment.

evidence

The RPAS Operator must detail in the Operations Manual specific training for underground and confined spaces.

RPAS Operator training records must confirm specific training has been completed for GPS denied environments prior to underground/confined space operations.

Courtesy: Emesent

21.0: Loss of Situational Awareness

The Operator loses situational awareness and the RPA loses control and crashes

21.1: Illumination

Ensuring adequate illumination in the absence of natural light.

Consideration in applying additional illumination on the RPA and/or in the surrounding environment must form part of the pre-start Operational Risk Assessment.

The best visual acuity occurs in daylight conditions. In the absence of natural light, supplemental lighting must be considered, particularly for critical stages of flight such as takeoff and landing.

The safest way to avoid collisions and other threats is to provide adequate illumination of the RPA. The human eye and visual SLAM do not perform well in low light. Careful consideration should be made not to re-expose the Remote Pilot to bright light during flight as this will temporarily destroy night vision.

evidence

The RPAS Operator's ORA must address and mitigate the risk of inadequate illumination.

The RPAS Operator ORA records show that strategies have been put in place to mitigate the risk of inadequate illumination.

21.2: Navigation Source

Ensuring accurate RPA navigation in the absence of external navigation signals.

Consideration in applying a Light Detection and Ranging (LiDAR) mapping capability as a navigation source on-board the RPA must form part of the pre-start Operational Risk Assessment.

Most RPA utilize Global Navigation Satellite System (GNSS) for position hold and in-flight navigation and rely on the Remote Pilot to avoid obstacles. Operating RPA in GNSS denied areas, such as underground or confined spaces, increases the complexity of the flight.

Simultaneous localisation and mapping (SLAM) and similar technology allow RPA to map unknown environments for RPA navigation. Visual SLAM systems use images from cameras that become limited in areas of low light. LiDAR SLAM systems are more precise and not affected by low light conditions.

RPA utilising SLAM and similar technology can avoid obstacles without intervention from the Remote Pilot and must be used in the absence of external navigation signals.

evidence

The RPAS Operator's ORA must address and mitigate the risk of an absence of external navigation signals.

21.3: Dust Suppressant

Ensuring the maintenance of visual reference in contaminated environmental conditions.

Use of water or any alternative (mobile platform) as a suppressant in areas of high dust (such as launch and recovery sites) must be considered as part of the pre-start Operational Risk Assessment to minimize loss of visual reference.

RPA create significant downdrafts, which cause dust particles, particularly in confined spaces, to become airborne. Once airborne, dust particles can significantly reduce visibility to the point of obscuring the visual line of site with the RPA. A dust suppression system is essential when operating in an environment with a potential for significant aeration of dust particles.

evidence

The RPAS Operator’s ORA must address and mitigate the risk of contaminated environmental conditions.

21.4: Tethering

Provision of a RPA retrieval mechanism in hazardous environments.

Use of an approved tether mechanism attached to the RPA when being used underground should be considered to assist recovery of the unit anytime a return-to-launch site is unsuccessful.

RPA operations underground often involve flight in hazardous areas where it is impossible to access the RPA if a return to launch is unsuccessful. A tethered RPA uses a permanent physical link to the RPA to assist in RPA retrieval where a return to launch is unsuccessful.


Courtesy: Emesent

The use of an approved tether mechanism must be considered in the ORA where flight is conducted in a hazardous environment.

evidence

The RPAS Operator's ORA must address and mitigate the risk of RPA retrieval in hazardous environments.

21.5: Preflight Reconnaissance

Ensuring the maintenance of situational awareness in a unique operating environment.

Conduct of a preflight reconnaissance of the layout to be surveyed/inspected will assist in the overall situational awareness of the RP and should be conducted as part of the Operational Risk Assessment.

Situational awareness is key to a positive safety outcome and a critical skill for Remote Pilots. Building situational awareness involves planning and preparing a mental model of the operating environment. To prepare a good mental model of the operating environment, data must be available. A preflight reconnaissance of the operational area provides essential data needed to gain and maintain situational awareness for the flight.

Loss of situational awareness is a leading cause of aviation accidents and must be considered as part of the ORA.

evidence

The RPAS Operator's ORA must address and mitigate the risk of situational awareness loss in an underground/confined space.

21.6: Underground Turbulence

Ensuring awareness of environmental hazards in a unique operating environment.

During the Operational Risk Assessment the identification of any potential underground turbulence (such as ventilation systems) must be noted and documented for Remote Pilot awareness.

Wind shear adversely affects the performance of RPA, particularly in GNSS denied environments such as underground and confined spaces. Wind shear occurs where the environmental airflow changes velocity and/or direction. Wind shear in underground/enclosed spaces can be from various sources, including ventilation shafts and openings to an otherwise enclosed area.

The Remote Pilot must be made aware of environmental hazard sources prior to commencement of operations to facilitate a successful outcome.

The Operator should ensure there is close cooperation with the company or client at the planning stage in relation to the operating environment.

The RPAS Operator's ORA must address and mitigate the risk of underground turbulence in an underground/confined space.

21.7: Loss of Signal

Ensuring the maintenance of C3 in a unique operating environment.

The addition of repeaters or any signal boost capability must be considered prior to start if loss or reduction of signal between the Remote Pilot and the RPA is possible.

Physical barriers common in underground and confined spaces can interfere or block command, control and communication links between the Remote Pilot and the RPA. Operating without an adequate C3 link reduces the safety of the operation, particularly when attempting to recover from an undesired aircraft state.

Repeaters or range extenders can ensure the C3 link is maintained when the RPA operates in a confined space.

The RPAS Operator's ORA must address and mitigate the risk of link loss in an underground/confined space.

Courtesy: Flyability

22.0: Intrinsic Safe Operations Compromised

The intrinsic safe operation of the RPAS is compromised and a materially unwanted event results

22.1: Intrinsically Safe Design

Elimination of the RPA as a potential ignition source in a potential flammable environment.

Where required by law or a potential or suspected flammable atmosphere may exist any RPA used in an underground environment must adopt an intrinsically safe design approach to ensure an ignition source from a spark or hot surface will not be a threat.

In the absence of an intrinsically safe design, all risks associated with operating an RPA which is not certified intrinsically safe must be considered in the ORA and mitigated via alternative means.

Static discharge, electrical sparking, and hot components are potential ignition sources and need to be properly managed when operating in a potentially flammable environment such as an underground mine. The preferred method to avoid ignition when operating in a potentially flammable environment is to utilize RPA classified as intrinsically safe.

Where intrinsically safe RPA are not utilized, the RPAS Operator must consider the risk of inadvertent ignition and implement alternate strategies to mitigate the risk.

evidence

The RPAS Operators documented procedures should determine RPA suitability where a potentially flammable atmosphere may exist. Unless required by law, where an intrinsically safe design is not utilized, the RPAS Operator's ORA must address and mitigate the risk of the RPA being an ignition source.

22.2: Multi Rotor System

Ensuring RPA manoeuvrability in confined space by utilizing a multi-rotor system.

A multi-rotor system RPA should be considered when operating in confined spaces and/or an underground environment to provide the required redundancy and manoeuvrability.

Operating RPA underground and in other confined spaces increases the likelihood of inadvertent impact of the RPA with an object. Multirotor RPA provides the best manoeuvrability and may incorporate redundancy depending on design, making them the preferred platform in obstacle-rich environments.

evidence

The RPAS Operators documented procedures should determine RPA suitability for operations in a confined space with consideration of manoeuvrability.

22.3: Brushless Motors

Elimination of the RPA as a potential ignition source in a potential flammable environment.

Only brushless motors are to be used in an underground environment to avoid any risk of ignition source from the powerplant.

Internal combustion and other liquid fluid powerplant types may have extremely hot surfaces, particularly in the exhaust segment. Brushed electric motors have some sparking during operation, which increases significantly as the brushes wear down. If used in a flammable atmosphere, the hot surfaces of liquid fuel powerplants and the sparking of brushed electric motors may become a source of ignition.

evidence

The RPAS Operators documented procedures should determine RPA suitability for potentially flammable environments where brushless motors must be utilized with consideration of motor and powerplant type.

22.4: Battery Change

Elimination of the RPAS as a potential ignition source in a potential flammable environment.

All battery changes must be performed at the surface (or in pre-approved and sealed 'safe' rooms underground) to avoid any threat of inadvertent ignition source compromising continued intrinsically safe operations.

A battery may arc as the terminals are engaged and disengaged with the RPA. If used in a flammable atmosphere, the terminal sparking may become a source of ignition. To avoid the threat of inadvertent ignition from a terminal arc, batteries should be changed outside of a potentially flammable environment.

The Operator should ensure there is close cooperation with the company or client at the planning stage in relation to the operating environment.

evidence

The RPAS Operator must have documented procedures to ensure all battery changes are performed at the surface or in pre-approved 'safe' rooms underground. The RPAS Operators ORA must address and mitigate the risk of battery changes becoming a potential ignition source.

22.5: Static Discharge Systems

Elimination of the RPA as a potential ignition source in a potential flammable environment.

RPAs that have any form of static discharge system must not be used in an underground environment.

Static discharge may become a source of ignition in a flammable atmosphere. To avoid the threat of inadvertent ignition from static discharge, RPA with a static discharge system must not be used in a potentially flammable environment.

The Operator should ensure there is close cooperation with the company or client at the planning stage in relation to the operating environment.

evidence

The RPAS Operator's procedures and ORA must address and prevent the use of an RPA with a static discharge system being utilized in a potentially flammable environment.

23.0: Remote Piloted Aircraft not suitably Equipped for Underground use

The RPA is not suitably equipped and an accident results

23.1: Obstacle Avoidance Sensors

Provision of suitable equipment to avoid terrain or obstacle contact.

Obstacle avoidance sensors in all six-axes is highly desirable to avoid inadvertently flying the RPA into terrain. A range of on-board obstacle avoidance systems include Light Detection and Ranging (LiDAR) mapping, stereo vision, monocular vision, ultrasonic and infrared sensors.

Operating continuously close to obstacles in a GPS denied environment increases the likelihood of Controlled Flight Into Terrain (CFIT). Obstacle avoidance sensors can lower the likelihood of CFIT by providing distance information and limitations from obstacles.

The accuracy and limitations of the obstacle avoidance system varies with the technology installed on the RPA. The RPAS Operators ORA should consider the environmental limitations of obstacle avoidance technology.

evidence

The RPAS Operators documented procedures should determine RPA suitability for underground operations, including obstacle avoidance sensor requirements.

Courtesy: Skydio

23.2: Caged Unit

Provision of suitable equipment to mitigate terrain or obstacle contact.

Consideration in the provision of an approved and serviceable cage (or external frame system) surrounding the RPA should occur during the Operational Risk Assessment to aid in the prevention of injury and/or accident in the event if inadvertent contact with obstacles.

Operating continuously close to obstacles in a GPS denied environment increases the likelihood of Controlled Flight Into Terrain (CFIT). The use of an approved and serviceable caged RPA can lower the consequence of CFIT by protecting the RPA from critical damage.

For RPA designed to operate with a cage, the RPAS Operators preflight checks should ensure the unit is serviceable before flight. Before installing cages onto other RPA, the manufacturer should be consulted.

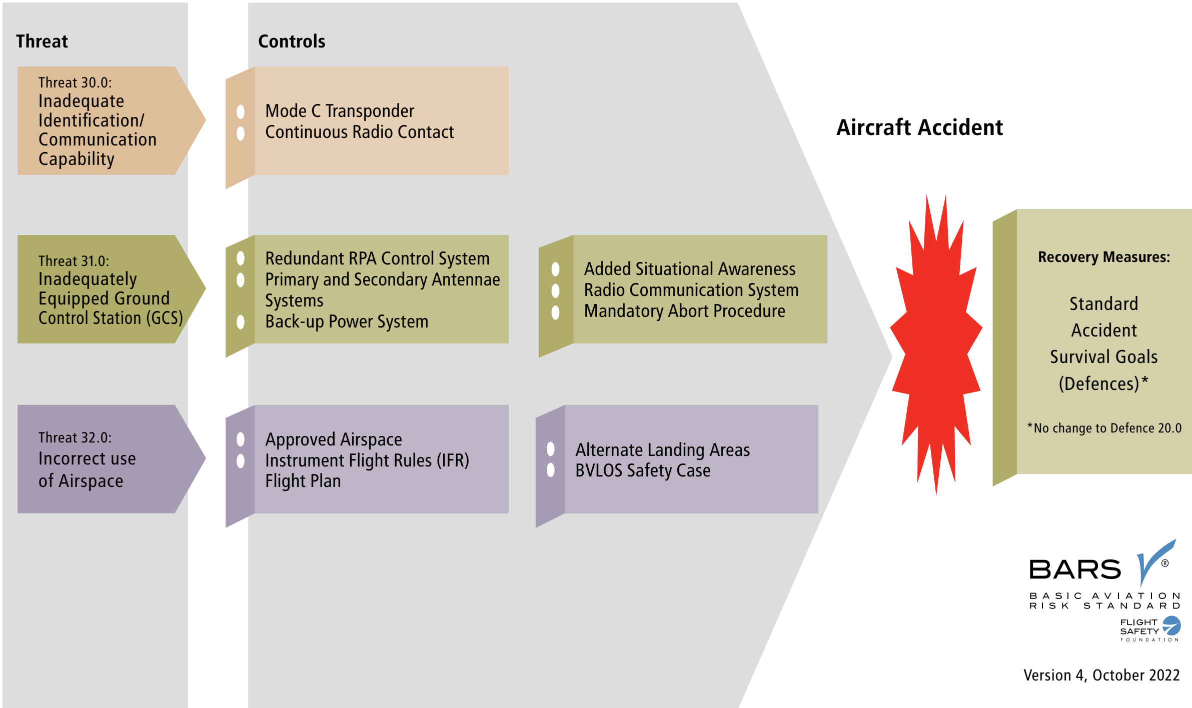
evidence

The RPAS Operators documented procedures should determine RPA suitability for underground operations, considering a caged unit.

Courtesy: Flyability

Appendix 7: Beyond Visual Line of Sight (BVLOS)/IFR/ Controlled Airspace RPAS Operations

Figure 3: BARS Bow Tie Risk Model – Schematic of Additional RPAS Management Controls and Recovery Measures during BVLOS, IFR or Controlled Airspace Operations



30.0: Inadequate Identification/Communication Capability

RPA identification and/or communication systems are inadequate for the task resulting in a materially unwanted event

30.1: Mode C Transponder

Ensuring awareness and separation of other aviation assets during RPAS operations.

A serviceable Mode C transponder (ADS-B Mode S preferred) must be provided on the RPA.

Transponders allow for electronic surveillance of RPA position and altitude information. Mode C transponders provide a reply with identifying code and altitude information when interrogated by ATC or another aircraft. ADS-B Mode S transponders automatically broadcast its identity, precise location, velocity, and other information.

The ability for ATC and other airspace users to identify and separate from the RPA significantly reduces the risk of collision and should be installed where RPA are operating Beyond Visual Line of Sight, under Instrument Flight Rules or in Controlled Airspace.

evidence

The RPAS Operators' documented procedures must incorporate a procedure to determine RPA suitability for BVLOS/IFR and CTA operations, including transponder requirements.

The RPAS Operator's RPA inspection or equipment fit records indicate transponders are fitted and serviceable for BVLOS/IFR and CTA operations.

Courtesy: Northrop Grumman

30.2: Continuous Radio Contact

Ensuring awareness and separation of other aviation assets during RPAS operations.

During operations, the Remote Pilot must maintain continuous radio contact with all other airspace users during the entire flight.

Radio is the primary method of communication between airspace users. Additionally, radio provides awareness of traffic where ADS-B is not used by other airspace users in the operational area or is not available at the GCS.

Radio coverage must be available for the entire area of operation being conducted Beyond Visual Line of Sight to ensure awareness and separation of other aviation assets. To maintain radio coverage, a combination of ground and airborne radio equipment should be considered.

evidence

The RPAS Operators documented procedures must incorporate a procedure to determine RPA suitability for operations BVLOS where continuous communication relies on on-board RPA equipment. The RPAS Operator's ORA must address continuous radio contact during BVLOS operations.

The RPAS Operator's records must show RP's operating BVLOS/IFR or in CTA have the relevant radio qualifications.

31.0: Inadequately Equipped Ground Control Station (GCS)

The provision of an inadequately equipped GCS results in loss of RPA and a materially unwanted event

31.1: Redundant RPA Control System

Ensuring back-up system in place to control the RPA in case of unwanted events.

The GCS must have a back-up system to control the RPA to provide the required level of redundancy.

Continuous availability of the command and control (C2) link ensures a greater level of protection from ground and air risks. A back-up GCS provides redundancy in case of failure or errors in the primary GCS.

evidence

The RPAS Operators' documented procedures must incorporate a procedure to determine RPA suitability for BVLOS/IFR and CTA operations, including backup GCS requirements.

31.2: Primary and Secondary Antennae Systems

Ensuring GCS provide appropriate level of redundancy by utilizing primary and secondary antennae system.

The GCS must have both a primary and secondary antennae system to provide the required level of redundancy.

Duplicate antenna systems provide link redundancy. Where the links are operating on different frequency bands, protection from external interference is provided. Having antenna systems separated, physically or by polarisation, reduces the potential for the RPA to be flown into the antenna null zone.

evidence

The RPAS Operators documented procedures must incorporate a procedure to determine RPA suitability for operations BVLOS/IFR and CTA, including primary and secondary antennae system requirements.

31.3: Back-up Power System

Ensuring recovery of RPA utilizing back-up power supply in case of primary power source failure.

An Uninterrupted Power Supply (UPS) battery back-up (or equivalent alternative) must be provided in the event of primary power source failure. The UPS must power all mission-critical systems for the duration required to recover the RPA in a worse-case scenario (ie the furthest point from recovery).

Failure of power supply to the GCS will result in a loss of link and an inability for the Remote Pilot to control the RPA. The majority of GCS platforms incorporate lithium battery power supplies with no redundancy between battery cells. Depending on the operational environment, mains power may be intermittent or unreliable as the sole source of GCS power.

The secondary power source requirements will vary with the risk profile of the operation. In some situations, the risk profile will dictate an automatic source switching system to ensure no perceivable interruption upon failure of the primary power source.

evidence

The RPAS Operators' documented procedures must incorporate a procedure to determine RPA suitability for BVLOS/IFR and CTA operations, including backup power requirements.

31.4: Added Situational Awareness

Provision of redundant situational awareness systems during BVLOS operations.

An additional means of providing situational awareness over and above radio communications, such as a web-based data capability that shows the RPA and any surrounding traffic, must be provided to the Remote Pilot and supporting personnel.

Conventionally piloted aircraft operating IFR or in CTA are generally equipped with electronic conspicuity such as ADS-B out. Situational awareness is greatly improved by using technology that can provide position and track information of air traffic in the operational area, particularly where the location of traffic is displayed in relation to the RPA.

evidence

The RPAS Operators documented procedures must incorporate a procedure to determine RPA suitability for operations BVLOS/IFR and CTA, including redundant situational awareness system requirements.

31.5: Radio Communication System

Ensuring availability of constant communication system.

A primary and backup radio communication system must both be serviceable to provide the required redundancy level.

Aeronautical radio continues to be the primary means of separation between aircraft. The RPAS Operator must have a serviceable aeronautical radio system for the duration of operations. Two aeronautical radio systems better guarantee the availability of radio communications.

evidence

The RPAS Operators documented procedures must incorporate a procedure to determine RPA suitability for operations BVLOS/IFR and CTA, which includes a primary and backup communication system.

31.6: Mandatory Abort Procedure

Ensuring mandatory abort is performed where degradation of the GCS or RPA is identified.

A mandatory abort procedure must be in place for anytime a degradation of the GCS or RPA is identified (as outlined in all aforementioned controls).

Incorporating conditions into procedures that require a mandatory abort of the mission assists RP's and crew in performing quick defined actions in the event of a degraded GCS or RPA state. The roles of all crew members involved in the recovery actions needs to provide clear responsibilities in the event of a degraded state.

Determining pre-planned actions in the event of a degraded state provide the best opportunity to recover the RPA or where necessary terminate the flight in a safe location. Where a particular degraded state is likely to adversely affect the safety of the flight rapidly formulating a recovery checklist that can be performed by memory and assessing RPs and crew on the memory items increases the likelihood of recovery of safe flight termination.

RP's should include memory items and define the responsibilities of other crew in the preflight brief.

Further procedures determining the conditions that require an in-flight shutdown should be considered. The NAA may require the use of an in-flight shutdown mechanism in certain situations.

evidence

The RPAS Operators documented procedures must incorporate actions in the event of a degraded GCS or RPA state.

32.0: Incorrect use of Airspace

The incorrect use of airspace results in traffic conflict and mid-air accident with manned aircraft

32.1: Approved Airspace

Ensuring operational airspace are safe and approved for the operation.

When possible, the airspace for use should be designated as a Danger or Restricted area or at the very least activated by NOTAM.

RPAS are generally very difficult to see, and traditional see and avoid separation techniques may be ineffective, particularly when operating outside of the Remote Pilot's VLOS. Operating within a Restricted area provides a guarantee of separation from other airspace users. Operating in a danger area or an area covered by a NOTAM alerts other airspaces users of a need to remain vigilant for RPA traffic and will reduce the change of encounter.

evidence

The RPAS Operator must have a documented procedure to ensure operational airspace is contained within a restricted area, danger area or an area activated by NOTAM.

The RPAS Operators records must show operational airspace is activated for the period of the flight.

32.2: Instrument Flight Rules (IFR) Flight Plan

Ensuring separation of known traffic.

An IFR flight plan (or equivalent level of flight notification) must be submitted for all flights.

An IFR flight plan provides operational information to air traffic control enabling notification to other airspace users of the RPA operations and inflight procedural separation. Understanding the role of air traffic control and the separation services provided in the local airspace is essential to avoid complacency and derive the full benefit of the services.

evidence

The RPAS Operator must have a documented process for submitting an IFR flight plan (or equivalent) prior to flight BVLOS.

32.3: Alternate Landing Areas

Ensuring alternate landing areas are identified and approved.

Alternate landing areas must be identified throughout the airspace coverage for the intended mission and appropriate approvals for use obtained.

Operations over uncontrolled ground areas increase the likelihood of the primary landing area becoming unavailable during operations. Larger operations, particularly operations BVLOS, increase the potential for the primary landing area to be unreachable in the event of an emergency. Having an alternate landing area located strategically throughout the operational area ensures that there is always an accessible landing area within the vicinity of the RPA during operations.

evidence

An RPAS Operator conducting BVLOS operations must identify and note in the ORA the location of alternate landing areas.

32.4: BVLOS Safety Case

Ensuring BVLOS operations have all relevant risks identified and addressed.

For any BVLOS activity, a Safety Case to the satisfaction of the NAA, as well as the client company, will need to be developed and approved prior to any operation. If operating in a region where the NAA does not have BVLOS regulatory requirements the current global regulatory guideline is the JARUS SORA process.

Important to also note that, depending on the region, other regulatory approvals such as radio spectrum authorization as well as military/security approvals may be required.

Operating BVLOS significantly increases the risk profile of an operation. See and avoid techniques are the primary means of aircraft and other obstacle separation when operating in VMC; these techniques are generally unavailable when operating BVLOS. The additional risks inherent in BVLOS operations must be thoroughly assessed and mitigated prior to operations. Operational risks will vary depending on the RPA to be operated, the ground area to be overflown, the airspace in which the RPA is operated and any adjacent areas. In some cases, the risk profile will dictate the adoption of additional or alternative technology to meet the required safety outcome.

The safety case must be made available to the company or competent aviation specialist for review prior to commencement of operations.

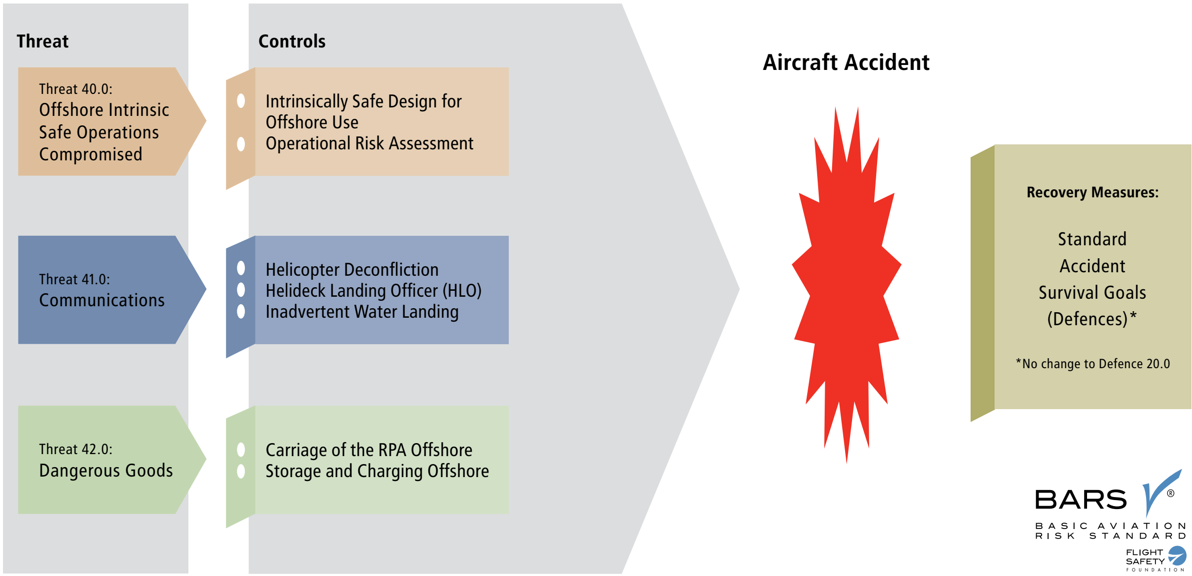
evidence

The RPAS Operator must have a documented procedure to prepare a safety case to the satisfaction of the NAA and the company prior to BVLOS operations.

The RPAS Operator's records must show BVLOS safety case approval for each operation conducted BVLOS. Where additional requirements arise during the safety case process, these records must be also be maintained with the BVLOS Safety Case.

Appendix 8: Offshore Installation/Maritime RPAS Operations

Figure 4: BARS Bow Tie Risk Model – Schematic of Additional RPAS Management Controls and Recovery Measures during Operations in a Maritime or Offshore Installation Environment



Version 4, October 2022

40.0: Offshore Intrinsic Safe Operations Compromised

The intrinsic safe operation of the RPAS in the offshore environment is compromised and a materially unwanted event results

40.1: Intrinsically Safe Design for Offshore Use

Elimination of the RPA as a potential ignition source in a potential flammable environment.

Where required by law or a potential or suspected flammable atmosphere may exist any RPA used in an offshore environment must adopt an intrinsically safe design approach to ensure an ignition source from a spark or hot surface will not be a threat.

In the absence of an intrinsically safe design, all risks associated with operating an RPA which is not certified intrinsically safe must be considered in the ORA and mitigated via alternative means.

Static discharge, electrical sparking and hot components are potential ignition sources and need to be properly managed when operating in a potentially flammable environment. The preferred method to avoid ignition when operating in a potentially flammable environment is to utilize RPA certified as intrinsically safe.

Where intrinsically safe RPA are not utilized, the RPAS Operator must consider the risk of inadvertent ignition and implement alternate strategies to mitigate the risk.

The Operator should ensure there is close cooperation with the company or client at the planning stage in relation to the operating environment.

evidence

The RPAS Operators documented procedures must incorporate a procedure to determine RPA suitability where a potentially flammable atmosphere may exist. Unless required by law, where an intrinsically safe design is not utilized, the RPAS Operator's ORA must address and mitigate the risk of the RPA being an ignition source.

40.2: Operational Risk Assessment

Ensuring ORA identifies and addresses operational hazards and risks.

The location of flare stacks, exhaust vents, areas of known turbulence from the superstructure and projected crane operations must be identified and noted during the Operational Risk Assessment. The derived flight plan route for operations must take this analysis into consideration.

Operating in and around offshore structures present unique hazards. Operations are generally conducted closer to obstacles where sight of the RPA may be obstructed. The superstructure and equipment in the vicinity of the RPA may interfere with navigation and obstacle avoidance sensors. Turbulence and thermal effects due to wind moving through and around the structure, exhaust vents and flare stacks are common and may cause controllability issues.

It is essential that the RPAS Operator, through the ORA, considers the specific hazards and implements appropriate risk mitigation strategies.

The Operator should ensure there is close cooperation with the company or client at the planning stage in relation to the operating environment.

evidence

An RPAS Operator conducting offshore operations must identify and note in the ORA the location of flare stacks, exhaust vents, areas of known turbulence and projected crane operations.

Courtesy: Skydio

41.0: Communications

Effective communications are not maintained and the RPA conflicts with a helicopter, vessel or the installation

41.1: Helicopter Deconfliction

Ensuring deconfliction between RPAS and known helicopter operations.

The daily schedule of all helicopter movements to the offshore installation/vessel must be known and discussed during the Operational Risk Assessment to ensure time based deconfliction between the RPA and helicopter can be maintained.

One of the simplest methods of traffic deconfliction is time-based. When developing the schedule for aircraft movements, known aviation operations must be taken into consideration to ensure adequate separation between piloted and remotely piloted aviation assets.

The Operator should ensure there is close cooperation with the company or installation manager at the planning stage in relation to the operating environment.

evidence

An RPAS Operator conducting offshore operations must identify and note in the ORA the daily schedule of helicopter movements.

41.2: Helideck Landing Officer (HLO)

Ensuring deconfliction between RPAS and known helicopter operations

The HLO (or other suitably nominated representative) must be assigned as the nominated person responsible for escorting the RP during all operations. Furthermore, the nominated person must maintain constant radio watch with the installation and any aviation traffic.

The HLO is critical to the safe aviation activities on and around the structure and assumes overall coordinating authority. RPA operations which may impact on other aviation activities must be coordinated with the HLO. While the Remote Pilot has ultimate responsibility for the safety of operations while operating in an offshore environment, the Remote Pilot must follow all reasonable instructions given by the HLO.

evidence

The RPAS Operator must have documented procedures for offshore operations, which include the role and responsibilities of the Helideck Landing Officer. A preflight briefing incorporating the role of the Helideck Landing Officer must be included.

Observation of flight operations where possible can confirm compliance with the RPAS Operator's published procedures and limitations.

41.3: Inadvertent Water Landing

Provision of RPA location and recovery measures for off vessel landing.

The nominated person retains responsibility for noting the RPAs location in the event of an unintended water landing. In order to assure data integrity and minimize damage to the RPA in the event of an inadvertent water landing, consideration must be given to waterproofing data capturing units, sensors, motors, batteries and processors. Additional recovery measures that can be considered must include approved RPA modifications using flotation devices and self-deployed water dye-pack to mark the impact area. Where the RPA and proposed activity can be done using tethering techniques, this method of operation must also be used to avoid loss of unit. Include relevant IP rating for example IP 77.

An inadvertent water landing of an RPA may result in negative environmental outcomes, loss of data and loss of equipment. The longer the RPA is in the water, the more pronounced the impact. Successful recovery of the RPA relies on early identification of the impact site and rapid deployment of recovery services.

The choice to recover, ability to recover, and the speed in which recovery needs to be carried out, will be dictated by assessing the risks associated with an inadvertent water landing. Most off the shelf RPA will quickly sink upon impact with water, and recovery would be unviable. The risk assessment will consider the necessity of floatation devices, ingress protection, and location identification to prevent the loss of critical data. Certain operational profiles will dictate the use of a teether to ensure the RPA does not enter the water. Any additional risks resulting from the use of a tether must be mitigated.

evidence

The RPAS Operator must have documented procedures to determine RPA suitability for offshore operations, considering the locating and recovery of the RPA in the event of an unintended water landing.

Courtesy: Rio Tinto

42.0: Dangerous Goods

The RPA and its power source is not transported or stored in accordance with requirements and catches fire resulting in a material unwanted event

42.1: Carriage of the RPA Offshore

Ensuring the safe transport of dangerous goods.

The aircraft operator must be consulted regarding the carriage of the RPA and associated batteries to ensure compliance with the IATA Carriage of Dangerous Goods Manual is maintained.

The IATA Carriage of Dangerous Goods Manual is widely considered as the appropriate standard for the requirements for the carriage of dangerous goods. The majority of aircraft operators follow the IATA DGM and NAAs incorporate the DGM into local regulations.

RPAS contain items that are dangerous goods under the IATA DGM and may have restrictions. The most common restricted item is the rechargeable batteries systems used to power RPA. Many RPA utilize batteries that have an energy rating that exceeds the maximum permissible under the IATA DGM for carriage on passenger aircraft.

Transportation of the RPA, batteries, GCS, spares and equipment will need to be coordinated with the contracting company or installation manager along with the contracted aviation or maritime transport provider.

evidence

The RPAS Operator must have documented procedures for the transport of Dangerous Goods, which identifies and informs the transport provider of any Dangerous Goods carried and ensures compliance with the Dangerous Goods requirements.

42.2: Storage and Charging Offshore

Ensuring appropriate storage and charging area is available and batteries are identified.

The offshore installation/vessel must be consulted prior to embarkation to ensure the RPA and associated batteries are appropriately tested and tagged and a suitable environment established for storage and charging on the offshore installation/vessel prior to arrival.

RPA energy systems are Dangerous Goods. Improper storage, handling and charging of batteries increase the potential for fire and explosion. The risks posed by fire and explosion are more pronounced in offshore and maritime environments. The potential for battery-related emergencies is reduced by assessing the serviceability of batteries prior to embarkation and ensuring proper facilities are available to contain a battery fire or explosion occurring while the batteries are in storage or undergoing charging.

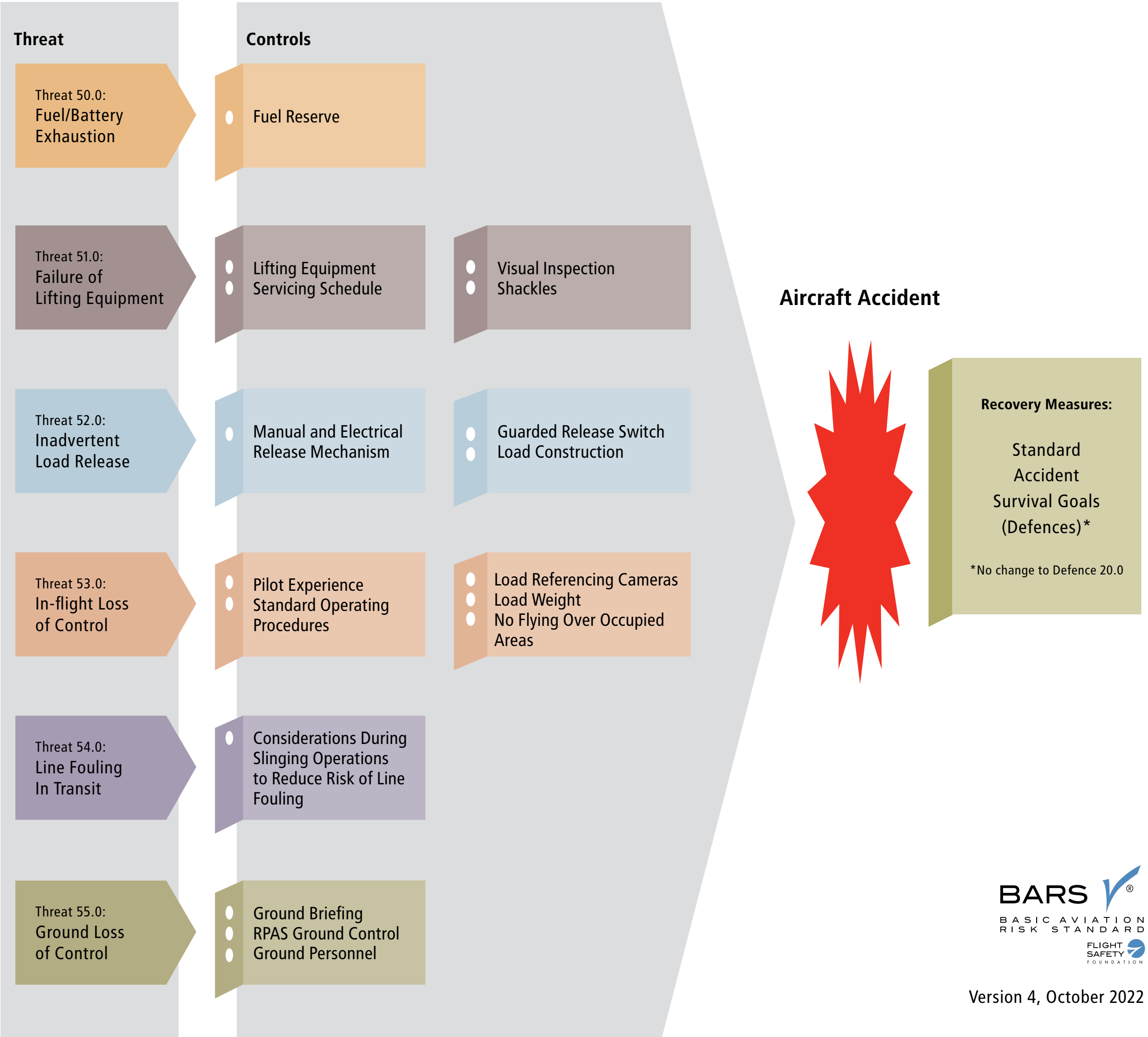
evidence

The RPAS Operator must have documented procedures for offshore operations, including consultation with the offshore installation/vessel to determine a suitable location for the storage and charging of batteries.

The RPAS Operators ORA must address and mitigate the risk of battery changes becoming a potential ignition source.

Appendix 9: RPAS External Load Operations

Figure 5: BARS Bow Tie Risk Model – Schematic of Additional RPAS Controls and Recovery Measures for External Load Operations.



50.0: Fuel/Battery Exhaustion

The RPAS operates on minimum fuel load to maximize lifting capability, runs out of fuel/battery life and suffers an engine failure resulting in an accident

50.1: Fuel Reserve

Ensuring sufficient fuel is carried/battery life, including required reserves.

Maintain a minimum fuel reserve 10 minutes/battery life of 30% at all times.

Unless more reserve fuel is required to be carried following the completion of an ORA or by the national aviation authority, RPA operations engaged in external load operations must ensure that a minimum "fixed" reserve of fuel is carried to allow for 10 minutes of flight and not less than 30% battery where applicable.

The carriage of this energy reserve is intended to provide for unplanned maneuvering in the vicinity of the landing site. This reserve fuel would normally be retained upon final landing.

evidence

The RPAS Operator must have a documented procedure to ensure an adequate fixed energy reserve of 10 minutes and 30% battery life during external load operations.

The RPAS Operator's records must show RPA are landed with the fixed reserve intact.

51.0: Failure of Lifting Equipment

The lifting equipment fails and drops the load resulting in an accident on the ground

51.1: Lifting Equipment

Ensuring certification of lifting equipment and compliance with the equipment manufacturer's servicing requirements.

The RPAS Operator must ensure the serviceability and certified safe working load of lifting equipment is adequate for the task and appropriate to the material used for the line.

The lifting equipment can fail and drop the load resulting in an accident on the ground and/or entanglement of RPA surfaces or propulsion systems.

Certified, in-date and serviceable external load equipment is a critical control in any external load activity. External load equipment includes everything from the belly hook of the aircraft downwards. This incorporates the line, swivels, shackles, D-rings, straps, nets, baskets, welded lifting lugs, bags and anything used to secure or support a load. A disciplined and rigorous assurance process using the following controls will assist in preventing the failure of lifting equipment:

- Certified to manufacturer's requirements by appropriately qualified personnel, and within the certification period (in-date);
- Periodic scheduled servicing by appropriately qualified personnel in accordance with the RPAS Operator's maintenance schedule;
- Each item is stamped and/or "tagged", showing its certified load rating and its compliance with certification dates and servicing cycles;
- Assessed as serviceable by maintenance personnel after each use before return to store;
- Maintained in the RPAS Operator's maintenance system in accordance with the requirements of aircraft parts;
- Assessed as serviceable before use by ground/flight crew;
- Securing shackle pins (e.g. lock-wire) to prevent accidental load release; and
- Returning the equipment to the RPAS Operator immediately after use and ensuring that it is not used for any other purpose.

evidence

The RPAS Operator must have documented procedures for external load operations that include a requirement to ensure certification of lifting equipment and compliance with the manufacturer's servicing requirements.

The RPAs Operator's inspection records must show serviceability of lifting equipment.

51.2: Servicing Schedule

Ensuring early detection of impending failure of load lifting equipment.

Lifting equipment must conform to a servicing schedule that provides all necessary documentation associated with inspections, certification and serviceability. Copies of this servicing schedule must be made available to the RPAS Operator's representatives in the field.

Failure to maintain an adequate servicing schedule may result in undiagnosed faults, leading to equipment failure.

Servicing schedule to incorporate from the belly hook of the aircraft downwards; the line, swivels, shackles, D-rings, straps, nets, baskets, welded lifting lugs, bags and anything used to secure or support a load. A disciplined and rigorous assurance process using the following controls will assist in preventing the failure of lifting equipment.

evidence

The RPAS Operator must have documented procedures for external load operations that include a requirement to conform with a servicing schedule.

The RPAs Operator's maintenance and inspection records must demonstrate lifting equipment conforms with manufacturer servicing schedules.

51.3: Visual Inspections

Ensuring servicing routines are supplemented with visual inspections prior to each use.

All lifting equipment (cables, lines, straps, baskets, swivels, clevises, etc.) must be inspected by qualified personnel daily prior to the flight. Any signs of wear, fraying, corrosion, kinks or deterioration must result in the equipment being discontinued from use.

A visual examination of an interior or exterior component, installation, or assembly to detect obvious damage, failure, or irregularity to prevent inflight separation and hazardous outcomes.

Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses, etc., may be necessary to identify lifting equipment faults.

Each item identified damaged or faulty to be "tagged", clearly stating unserviceable and the fault documented.

evidence

The RPAS Operator must have documented procedures for external load operations that include a requirement for a daily inspection of lifting equipment prior to use.

51.4: Shackles

Ensuring that shackles are compliant and compatible with other load lifting equipment.

The shackles used to connect the cable to the RPA must conform to specific Flight Manual supplements (where available) or as described in the operator's Operations Manual, regarding the diameter of the shackle rings and their use with respective hook types on the RPA.

If information is not readily available a risk assessment must be conducted prior to operations being conducted.

From attained results an engineering assessment and solution is to be formulated and implemented.

Note must be taken that all modifications to the vehicle platform or systems must be done with approval from the OEM and/or NAA.

Incorrectly sized shackles significantly amplify the risk of underslung loads being inadvertently released or unable to be released. The most common cause of this is due to the hook "keeper" being fouled by the incorrectly sized shackle.

Shackles provide a method of attaching load lines to the aircraft and the load line to the load itself. The shackle, ring or device used to connect the load to the hook must be compatible with the hook.

If there is no Flight Manual supplement available, a pre-start operational risk analysis should be conducted to confirm the correct shackle size is being used.

The RPAS Operator must have documented procedures for external load operations that require shackle rings used in external load operations to meet the design specification of the equipment fitted to the RPA and as detailed in the applicable AFM supplement.

Where AFM supplements are unavailable or inconclusive, the shackles used for external load operations must be included in the ORA.

52.0: Inadvertent Load Release

The load is inadvertently released in-flight, falls to the ground and causes an accident

52.1: Manual and Electrical Release Mechanism

Ensuring that RPAS have appropriate mechanisms for release of loads in normal and emergency situations.

The RPAS must have a serviceable remote release mechanism and an external manual release at the hook.

The lack of a pilot in the aircraft and associated physical perception of shifting load and stability issues may increase the time it takes for an abnormal situation to be identified. Remote and manual release mechanisms are important safety features to ensure that load-related abnormal situations can be addressed prior to the aircraft reaching an uncontrollable state. Serviceability testing of release mechanisms prior to flight is essential to ensure that they are available if and when they are needed.

The RPAS Operator must have documented procedures for external load operations that require all lifting equipment to be subject to a daily serviceability inspection by qualified personnel prior to use. Such procedures must contain requirements for the daily inspection of manual and electrical hook releases to ensure the serviceability and correct operation of this equipment.

52.2: Guarded Release Switch

Removing the potential of inadvertent load release.

When available for the RPAS controller, all electronic release switches must be guarded or incorporate a safety device (dual switching or similar) to prevent inadvertent activation.

Two-stage activation systems better protect critical aviation systems. The two-stage process comes in many forms, and can involve the use of 'gates' or lift-and-throw type switches. The primary design philosophy is to protect against inadvertent selection by introducing the requirement for the flight crew to go through two separate and distinct processes before a system can be activated.

To protect against inadvertent activation of the external load release switches, guards should be fitted to all electrical release switches where possible.

Whenever non-standard conditions across the operator's equipment exists, appropriate differences training on the equipment type must be developed.

The RPAS Operator must have documented procedures for external load operations, including guarded release switches where they are available for the RPA type.

52.3: Load Construction

Ensuring that all loads are rigged by appropriately trained and qualified personnel.

The RPAS Operator must ensure that all loads are rigged by appropriately trained personnel.

The integrity of an external load can be affected by many factors, including the load's rigging, shape, size, length and distribution. External loads are subject to a wide variety of forces in-flight, and the aerodynamic effects on loads cannot be anticipated. Qualified personnel must always be used during the load preparation phase as they will be best able to anticipate the load construction and restraint requirements.

While the Pilot-in-Command of an RPA performing an external load operation has final responsibility for accepting any load to be carried, only personnel who have been appropriately trained and qualified must be authorized to perform rigging of the load. Personnel such as qualified Loadmasters or RPA operator's specialists must be trained and where necessary, qualified using recognized industry training programs that utilize manufacturer standards and rigging procedures.

RPA operators' documentation, or third party riggers' documentation, must include guidance for the rigging of loads carried by various means. This includes loads carried on pallets within nets, long loads requiring the use of pipe hooks, use of unequal lines for slender lengthy loads liable to swing, loads containing flammable liquids or other hazardous materials, and loads likely to have aerodynamic characteristics.

evidence

The RPA operator's Operation Manual must detail the roles and responsibilities of personnel assigned to construction and rigging of loads that must be carried in RPA external load operations. It must also include the details of the training that must be provided to personnel appointed to these positions and the process by which their ongoing competencies are assured.

The RPA operator must have a documented rigging manual detailing correct rigging procedures for various load types.

The RPAS Operator's training records must show riggers have been appropriately trained.

53.0: In-flight Loss of Control

Poor manipulative control in-flight results in a loss of control and an aircraft accident

53.1: Pilot Experience

Ensuring flight crew are adequately trained and have sufficient experience to conduct RPAS external load operations.

Flight crew must be adequately trained and have sufficient experience to conduct RPAS external load operations, commensurate with the risk involved for the specific lifting operation.

Pilots engaged in external load activities must comply with the following requirements:

- ***Use only licenced RPAS Operators who have been approved for use by company established process and where necessary, a Competent Aviation Specialist; and***
- ***If available, the successful completion of an operator's external load training program, the process to be based on the complexity of the task being performed.***

External load operations hold a higher level of risk than internal load operations. To meet the desired safety outcomes, Remote Pilots need higher minimum experience, together with specific training and proficiency assessment. The crew requirements will be driven by the risk profile of the particular operation, including the operating environment, aircraft and load to be carried.

evidence

The RPA operator must document in the Operations Manual, minimum qualification and experiences requirements for Remote Pilot's engaged in external load operations that reflect both the minimum standard and that may be required by the responsible regulatory authority.

Details of the RPA operator's training and checking program for external load training must be published in the Operations Manual and follow established criteria. The program must cover requirements and procedures for initial training and approval along with the processes for conducting periodic recurrent training and checking.

The RPAS Operator's training records must show RPs have been suitably trained for external load operations.

RP files and rostering records must confirm that crew assignments are appropriate to meet the task requirements.

53.2: Standard Operating Procedures

Ensuring safe, efficient and standardized external load lifting operations.

The RPAS Operator must have Standard Operating Procedures outlining all requirements of personnel engaged in the external load activity. The procedures must be relevant to the local environment and terrain being operated in.

Standard Operating Procedures are a key component in Threat and Error Management. The increased risk inherent in external load operations necessitate well-considered and implemented SOPs.

To be effective, external load SOPs must be relevant to the local environment. This includes the type of load to be carried, the proximity of obstacles and atmospheric conditions that may impact the operations.

Implementation of SOPs required training and proficiency checking to ensure consistent adoption by crew, and to validate the effectiveness of the procedures. It is essential that SOPs be reviewed regularly and modified any time the procedures no longer meet the desired safety outcomes.

evidence

The RPAS Operator must have documented procedures for external load operations outlining the requirements of all personnel involved in the operation. These must include equipment checks, load preparation and ground operations, flying techniques, crew responsibilities, communication and emergency procedures.

Observation of flight operations, where possible, can confirm compliance with the RPAS Operator's published procedures and limitations.

53.3: Load Referencing Cameras

Ensuring enhanced situational awareness of the external load at all times.

Where available for the RPAS type, a camera shall be fitted which allows the pilot a view below the aircraft of the hook and load being carried. Preferably this shall be a separate camera operated independently of the camera used for flight.

The provision of external cameras enables the RPA pilot to gain the necessary assurance that the hook area and line attachment remain correctly configured and operating normally during flight. The use of a dedicated load camera provides the remote pilot with a better view of the load and separates the tasks of flight and load management, improving crew performance in an abnormal situation.

evidence

The RPAS Operator must have documented procedures for external load operations, including using external load cameras where they are available for the RPA type.

Observation of flight operations where possible, can confirm compliance with the RPAS Operator's published procedures and limitations.

53.4: Load Weight

Ensuring accurate load weights are known and within RPAS limits.

Note must be taken during the planning of sample collection operations to assure the additional weight of the collected sample is accounted for and will not exceed the maximum lift capacity of the specific platform.

Knowledge of the weight of external loads is essential for the safe conduct of each operation. The weight of external loads must be made available to the Pilot-in-Command before each flight. Care must be taken to ensure that the weight of straps, slings, hooks, swivels, etc., is included in the total weight to be lifted. Where an accurate load weight is not available, such as in sampling operations, the Remote Pilot must consider the possible performance variations for all weights between the minimum and maximum possible payload to be carried. The safety of operations dictates that flight planning on variable load operations is based on the worst-case scenario.

evidence

The RPAS Operator must have documented procedures for external load operations, including providing the maximum external payload for each RPA and ensuring accurate load weights have been provided to the pilot before each lift.

Where standard loads are carried, the documented procedures must specify the circumstances under which standard load information may be used to ensure standard load weights are only used when accurately known.

Courtesy: Freespace

53.5: No Flying Over Occupied Areas

Removing unnecessary exposure to risk for personnel by overflight.

No flight overhead of personnel and occupied vehicles and structures.

External load operations increase the risk of an object being carried, or the aircraft itself, becoming a falling object hazard to persons in the vicinity of the operations. Depending on the size and weight of the falling object, persons within structures may also be at risk. The risk from a falling object is not contained to impact; a falling object near a person that causes distraction may also result in a negative safety outcome, such as distracting the driver of a motor vehicle.

Absent appropriate mitigators to ensure the safety of persons, including those within vehicles and structures, RPA flightpaths must be planned so not there is no overflight of personnel, occupied vehicles and structures.

evidence

The RPAS Operator must have documented procedures for external load operations, including assurance that flights with external loads are not flown overhead personnel, occupied vehicles or structures.

The RPAS Operators ORA must identify no-fly zones whilst undertaking external load operations, addressing areas where personnel and occupied vehicles and structures exist.

54.0: Line Fouling in Transit

The load becomes detached from the line or the line is flown empty which, when above a certain speed, causes it to stream up and into the rotor systems resulting in an accident

54.1: Considerations During Slinging Operations to Reduce Risk of Line Fouling

Ensuring RPAS cannot become entangled by fouled lines.

- ***Transit with a line and no load attached is not permitted;***
- ***The line must be suitably weighted if it is to be flown without a load attached;***
- ***Implement preflight checks which are designed to ensure flight crew involved in repetitive loads are aware of when the line is attached;***
- ***All safe transit speeds, the maximum angle of bank, the maximum allowable rate of descent and general handling associated with stable load operations must be briefed and understood by all flight crew prior to the commencement of operations;***
- ***All applicable never exceed speeds must be briefed and understood by all flight crew prior to the commencement of operations; and***
- ***Where these speeds are not published by an OEM a flight trial program to establish never exceed speeds must be implemented and the results incorporated into the SOP's.***

Long lines are inherently unstable when flown above certain speeds. Unweighted lines will always drop vertically down from the hook when the RPA is hovering and will begin to trail behind the RPA as speed increases. The angle at which they trail is proportional to the forward airspeed of the RPA, as to is the instability of the line.

The aerodynamics of an unweighted line is unpredictable, and there have been many accidents caused when the long line has streamed to a position where contact with the aircraft has occurred.

The most common risk mitigation strategy to prevent line streaming into the tail rotor is to add a minimum weight to the line to alter the mass and aerodynamic characteristics.

The maximum airspeed achievable with varied external cargo shapes is limited by controllability. When carrying external cargo, care should be taken as handling characteristics may be affected due to the cargo load's size, weight, and shape.

Some loads have a natural tendency to "fly", such as flat packs that can act as a wing. In these cases, the pilot must reduce the maximum forward airspeed as required. Maximum operational airspeed with external loads depends on the load configuration and sling length. It is the RPAS Operator's responsibility to establish the maximum operational speed for each specific configuration.

The RPAS Operator must have documented procedures for external load operations. These procedures must include:

- A restriction on flying with unladen lines;
- Publish a minimum mass that is required to be attached to the line without a load attached;
- Preflight checks ensure the Remote Pilot is aware of when a line is attached;
- Preflight briefing ensures the Remote Pilot understands safe transit speeds, maximum bank angles, maximum allowable rate of descent and handling of stable loads; and
- Preflight briefing ensures the Remote Pilot and any ground crew understands applicable never exceed speeds.

Observation of flight operations where possible, can confirm compliance with the RPAS Operator's published procedures and limitations.

Courtesy: Rio Tinto

55.0: Ground Loss of Control

A departure from normal operations on the ground results in loss of control of the load and RPAS resulting in an RPAS accident

55.1: Ground Briefing

Ensuring all personnel involved in the external load lifting operations are comprehensively briefed.

The pilot must ensure all personnel involved in the external load activity are briefed prior to the commencement of operations. This brief must include all emergency scenarios that could involve the ground crew.

The Remote Pilot must ensure a full and comprehensive preflight briefing is conducted with all personnel involved in an external load operation. An integral component of the briefing is an assessment of identifiable risks that may be unique to that specific operation.

The briefing should:

- Cover all aircraft emergency scenarios and actions required by pilots and ground personnel;
- Include the assigned Loadmaster (if used), hook-up person and marshaller (if required) and identification of same vests;
- Identify antennae, skid gear and other fuselage parts that can cause injury to personnel or damage to the RPA;
- Discuss load sequencing with the Loadmaster, pilot and crew on size, shape and weight with respect to the fuel burn and turn-around time;
- Reiterate how sling gear can get tangled on skids or other obstacles;
- Discuss potential static discharge and how to avoid it;
- Review wind direction and flightpaths;
- Discuss the importance of areas being clear of debris and loose materials that can blow away, be sucked into rotors or cause injury to personnel;
- Confirm hand signals procedures;
- Confirm radio terminology to be used;
- Emphasize that no crew member should turn their back on the line or the load during all approach, hook-up and departure operations;
- Emphasize that all crew members should maintain eye contact with the line and/or load at all times during the final approach, maneuvering, and departure phases of the operation;
- Make it clear that ground personnel not essential to the hook-up operation must stay in recognized safe areas when the RPA is operating;
- Make it clear that the load must be securely attached, and all ground members must be clear before the signal is given for the pilot to depart; and
- Make it clear that all ground members must wear appropriate PPE.

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The RPAS Operator must have documented procedures for external load operations, including a requirement that the Remote Pilot must conduct a briefing with all personnel involved in the operations prior to commencing external load operations. This briefing must include all known aircraft emergency scenarios that could involve ground crew and encourage discussion of identifiable risks associated with the planned operations.

Observation of flight operations where possible, can confirm compliance with the RPAS Operator's published procedures and limitations.

55.2: RPAS Ground Control

Ensuring safety of all personnel in the vicinity of RPAS conducting external load lifting operations.

Where practical the RPAS must be shut down prior to connection or disconnection of external loads. Where shutdown is not possible a pilot must remain at the controls whilst on the ground at all times. The pilot must remain focussed on control of the aircraft and may not assist with any ground activities such as load attachment or removal.

Ground personnel close to an operating RPA have a higher risk of being struck by the rotors. RPA pilots must minimize the risks to ground personnel during rotors turning operations by always remaining in positive control of the RPA. The pilot must only be engaged in essential flight duties to devote all their attention to the RPA to identify external hazards and monitor activities around the aircraft.

The RPAS Operator must have documented procedures for external load operations, including a requirement for the Remote Pilot to remain at the controls anytime the RPA is under power.

Observation of flight operations where possible, can confirm compliance with the RPAS Operator's published procedures and limitations.

55.3: Ground Personnel

Ensuring ground personnel have appropriate Personal Protective Equipment (PPE).

Ground personnel must wear appropriate PPE including hard hats with chin straps, impact resistant goggles, gloves and where the RPA cannot land to attach/ remove a load (or removal cannot be completed remotely) a means of positively communicating with the flight crew.

Access to and movements within a lifting or dropping site should be strictly controlled and non-essential personnel must not be allowed to work in, or cross, the operating area when external load operations occur. All ground personnel who are required to perform functions supporting the external load operation must be provided with PPE to ensure that the risk of sustaining personal injuries during the operation is minimized.

Where operations must be conducted in dusty conditions or if the load is likely to give rise to significant or harmful dust, ground personnel must be provided with suitable respiratory protection.

The RPAS Operator must have documented procedures for external load operations, including the PPE requirements that apply to ground personnel. Observation of flight operations where possible, can confirm compliance with the RPAS Operator's published procedures and limitations.

Courtesy: Emesent

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