

Basic Aviation Risk Standard Remotely Piloted Aircraft Systems





Courtesy: Worley

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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. 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.

Each BARS control and defence has been provided with a **Safety Goal** to assist users of the BAR Standard 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.

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

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.

A diagram showing the Basic Aviation Risk Standard Variance Process is presented in Figure 2 on page 9.

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 Systems Management



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Controls and Recovery Measures.



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

RPAS Operations in the Vicinity of Electrical Infrastructure



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Table 1: Additional Operational Risk Assessment Considerations

<p>Underground and/or Confined Space RPAS Operations</p>	<p>Remote Pilot (RP) Human Factors</p> <ul style="list-style-type: none"> ● RP Fatigue ● RP Training 	<p>Loss of Situational Awareness</p> <ul style="list-style-type: none"> ● Illumination ● Navigation Source ● Dust Suppressant ● Tethering ● Preflight Reconnaissance ● Underground Turbulence ● Loss of Signal 	
<p>Beyond Visual Line of Sight (BVLOS)/IFR/ Controlled Airspace RPAS Operations</p>	<p>Inadequate Identification/ Communication Capability</p> <ul style="list-style-type: none"> ● Traffic Awareness ● Continuous Radio Contact 	<p>Inadequately Equipped Ground Control Station (GCS)</p> <ul style="list-style-type: none"> ● Redundant RPA Control System ● Primary and Secondary Antennae Systems ● Back-up Power System ● Added Situational Awareness ● Radio Communication System ● Mandatory Abort Procedure 	
<p>Offshore Installation/ Maritime RPAS Operations</p>	<p>Offshore Intrinsic Safe Operations Compromised</p> <ul style="list-style-type: none"> ● Intrinsically Safe Design for Offshore Use ● Operational Risk Assessment 	<p>Communications</p> <ul style="list-style-type: none"> ● Helicopter Deconfliction ● Helideck Landing Officer (HLO) ● Inadvertent Water Landing 	
<p>RPAS External Load Operations</p>	<p>Fuel/Battery Exhaustion</p> <ul style="list-style-type: none"> ● Fuel Reserve 	<p>Failure of Lifting Equipment</p> <ul style="list-style-type: none"> ● Lifting and Stringing Equipment ● Servicing Schedule ● Visual Inspections ● Shackles 	<p>Inadvertent Load Release</p> <ul style="list-style-type: none"> ● Manual and Electrical Release Mechanism ● Guarded Release Switch ● Load Construction ● Human Factors Assessment
<p>RPAS Operations in the Vicinity of Electrical Infrastructure</p>	<p>Loss of Control – In-flight (LOC-I)</p> <ul style="list-style-type: none"> ● Performance and Control Margins ● Minimum Safety Distance (EMI) ● Propeller Guards 	<p>Collision into Infrastructure/Asset Strikes</p> <ul style="list-style-type: none"> ● Flightpath Planning ● RTL/RTH ● Payload ● Stability and Navigation Accuracy ● Landing Sensors ● Day VMC Operations ● Separation distances ● Pilot Experience and Recency ● Position of Sun 	

Refer to applicable Appendices 6 to 10 for a more detailed explanation of the Additional Operational Risk Assessment Considerations for each activity.

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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

Crew Communication Breakdown

- Dedicated Radio Channel
- Terminology

Inadequate Communication

- Asset Owner Approval

Weather

- Adverse Weather Policy
- Thunderstorm Avoidance

Loss of Control - In-flight (LOC-I) - Stringing

- Ground/Flight Reconnaissance
- Visual aids

Equipment Failure - Stringing

- Swivel
- Weak Link
- Puller Tensioner Fouling

All Threats 1.0: Common Controls

These controls apply to all threats in the RPAS Standard

Common Control 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.

Common Control 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).

Common Control 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 documented method of initial airworthiness and a system of airworthiness control in place that considers whether the RPA can meet minimum safety performance standards.

Common Control 1.4: Safety Management System

Ensuring Safety Management Systems are effective at gathering and analyzing 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.

Risk Culture

All organizations must demonstrate an active commitment to managing risk. They must actively encourage and promote a positive safety culture within their organization through development of risk awareness training for flight crew. They must regularly evaluate their culture using risk culture surveys or analysis of other indicators.

Common Control 1.5: Remote Pilot Approval 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 formalize remote pilot approval for the task.

Common Control 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.

Common Control 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.

Common Control 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.

Common Control 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. The use of parachutes must be considered where exposure to personnel is high. For other operations, where parachutes integral to the operation are available for the category of RPA used, consideration for their use must 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.

Common Control 1.10: Operations Manual

Ensuring clearly defined operating procedures are in place.

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

Common Control 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.

Common Control 1.12: Safety Intelligence

Ensuring a collaborative approach to sharing safety information to directly benefit the entire industry and all stakeholders.

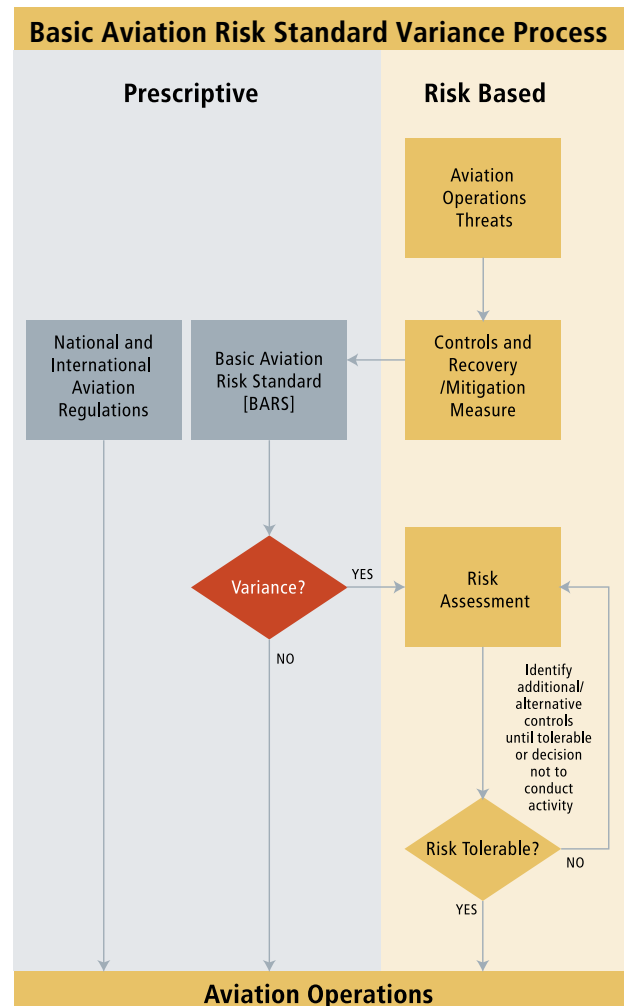
Organizations must share safety occurrences using locally applicable mandatory and voluntary internal/external safety reporting schemes.

The contracted RPAS operator must promptly advise the contracting company of any incident, accident or non-standard occurrence related to the service provided to the company that has, or potentially could have, disrupted operations or jeopardized safety, and include any corrective or preventative actions being taken.

Organizations must examine available external occurrence and accident reports and safety promotion material and identify relevant lessons and necessary internal actions.

For long-term contracts, organizations must provide a report of all flights, personnel training and incidents at least annually to the contracting company.

Figure 2: Variance Process.



Threat 2.0: Fuel/Energy Source

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

Threat

Threat 2.0:
Fuel/Energy Source

Controls

- Fuel/Energy Source Management and Identification
- Energy Source Charging and Generation
- Overheat and Fire Protection
- Fuel/Energy Status Indicators

- Storage, Transport and Management of RPAS Energy Sources
- Fuel/Energy Quality Controls

Control 2.1: Fuel/Energy Source Management and Identification

Ensuring RPAS energy sources are identified and controlled.

All RPAS energy sources (batteries, hydrocarbon fuel, solar panels, etc.) must be identified, controlled and managed under a documented procedure. RPAS batteries must be identified by model and serial number.

when a low energy 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 energy indications or warnings must provide the RP with sufficient notification to safely recover the RPA.

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

Control 2.2: Energy Source Charging and Generation

Ensuring energy sources are charged in a manner that will prevent a fire.

All RPAS energy sources must be charged or managed in accordance with the manufacturer's recommendations and be protected from overcharging or overloading events.

Energy-harvesting systems (e.g., solar panels), must be integrated and managed to avoid overloading.

Control 2.5: Storage, Transport and Management of RPAS Energy Sources

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

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

Batteries, gaseous 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. Compressed gaseous fuels to be stored as per manufacturers requirements.

Control 2.3: Overheat and Fire Protection

Ensuring energy sources are handled in a manner that will prevent a fire.

All energy sources must be equipped with appropriate mechanisms to reduce or eliminate the risk of overheating and fire.

For RPAS batteries, where the battery type does not provide this mechanism, a fireproof container must be used.

Control 2.6: Fuel/Energy Quality Controls

Ensuring the safety and quality of RPAS energy supplies.

Regular maintenance and testing must be conducted to verify the integrity, efficiency, and safety of the energy supply systems.

RPAS batteries must be inspected prior to flight to ensure individual cell voltage deviation is within manufacturers recommendations.

Hydrocarbon supplies must be managed in accordance with standard aviation fuel management procedures that address storage, testing and filtration.

Compressed gaseous fuel must be managed in accordance with accepted industrial management that address storage, testing and filtration.

Control 2.4: Fuel/Energy Status Indicators

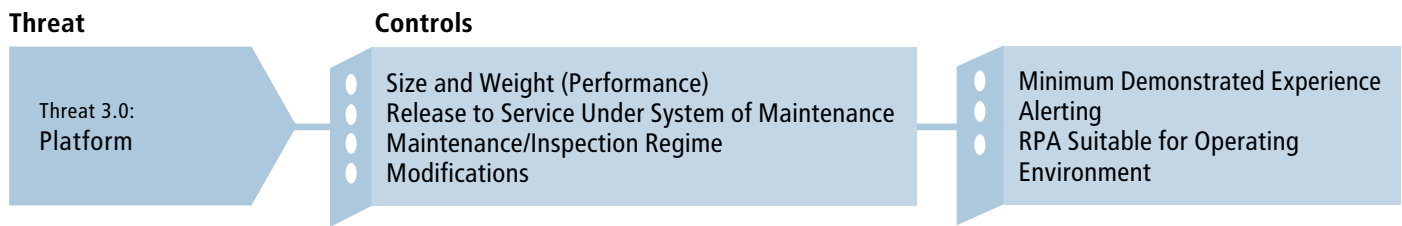
Ensuring flight crew situational awareness with regard to available fuel/energy reserves.

All RPA must be equipped with an energy supply indication system that provide adequate notification to the operator of the energy state and warnings when a low energy level is approaching.

The Ground Control Station (GCS) must also provide the Remote Pilot with an indication of energy status and warnings

Threat 3.0: Platform

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



Control 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.

Control 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.

Control 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. This requirement must include all powered and captive tethers in use by the RPAS operator. 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.

Control 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.

Control 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 the company.

Control 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.

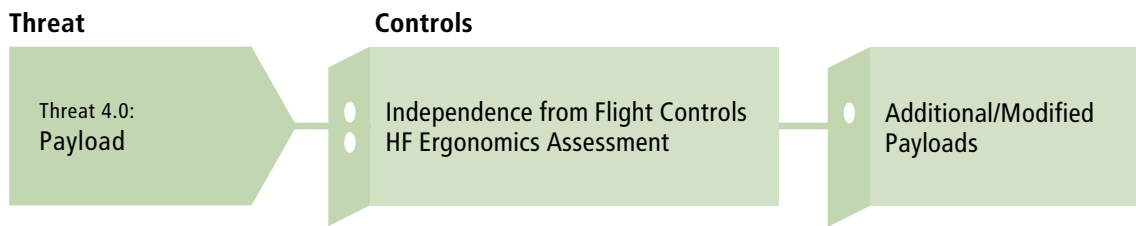
Control 3.7: RPA Suitable for Operating Environment

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.

Threat 4.0: Payload

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



Control 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.

Control 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.

Control 4.3: Additional/Modified Payloads

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

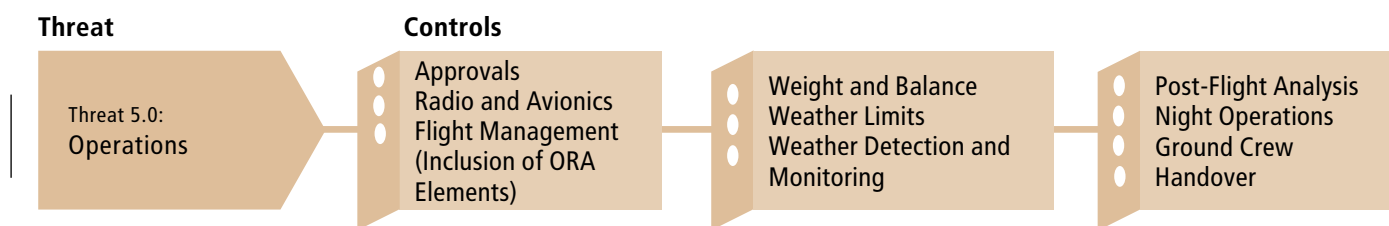
Establish a system to manage payloads attached to the RPA. The system should consider the original certification or approval basis for the RPA and payload, the impact of the payload on the original RPA design criteria, changes to RPA performance and any requirement for ground or flight testing prior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



Courtesy: Newcrest

Threat 5.0: Operations

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



Control 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 crewed aviation operations).

Control 5.2: Radio and Avionics

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).

The RPAS team must consider the use of 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 must be considered prior to operations commencing.

Control 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.

Control 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.

Control 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;
- Wind; and
- Visibility;
- Temperature Limits.

Turbulence and Icing limits must be defined where identified in the preflight risk assessment.

Control 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.

Control 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.

Threat 5.0: Operations (cont.)

Control 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.

Control 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 have isolation procedures to control inadvertent RPA startup.

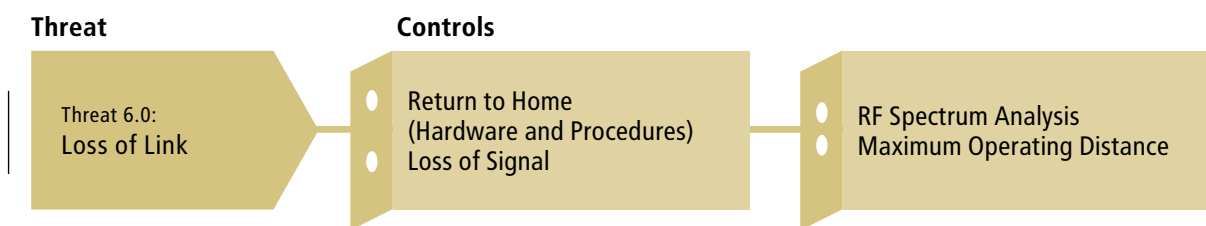
Control 5.10: Handover

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.

Threat 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



Control 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 preflight risk assessment process and should take into account hazards such as terrain, airspace and Regulatory requirements for this semi-autonomous flight regime.

Control 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.

Control 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 to the communication spectrum of the various payloads carried.

Control 6.4: Maximum Operating Distance

Reducing the risk of C3 loss.

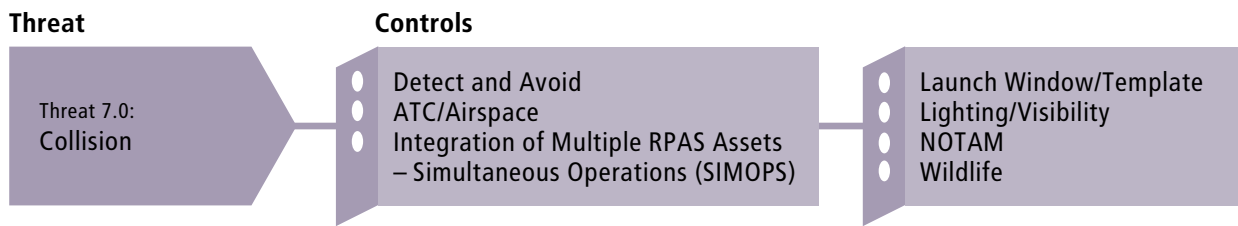
The maximum operating distance between the RPA and C3 link source must be no more than 80% of the manufacturer's recommendation.



Courtesy: BHP

Threat 7.0: Collision

The RPA collides with fixed or moving obstacles causing an accident



Control 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.

Control 7.2: ATC/Airspace

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

All RPAS activities must utilize 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 crewed and uncrewed 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.

A flyaway plan should be made in advance of the operation and should include at least:

- Frequency or frequencies to announce on;
- Appropriate ATC phone number to call; and
- Location relative to a nav aid or airport.

Control 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.

Control 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.

Control 7.5: Lighting/Visibility

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

RPA, and tethers in use, 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.

Control 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.

Control 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.

Defences 19.0: Vehicle Accident

Mitigating defences in the event of a vehicle accident or loss

Defence 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.

Defence 19.2: Emergency Equipment

Ensuring emergency equipment are provided and available.

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

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

Defence 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 crewed 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.

Defence 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.

Defence 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.

Defence 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.

Defence 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 and collected using a documented template. Procedures should be developed for preservation and security of data recorded during the subject flight to assist with the investigation process.



Courtesy: Northrop Grumman

Appendices

Glossary of Terms and Abbreviations

AGL Above Ground Level

Airspace Assessment - At minimum review aviation charts for designated instrument approaches and controlled airspace, obtain locations of all aircraft landing areas, obtain copies of regular public transport and known charter schedules and engage to understand local aerial work routines.

ATC Air Traffic Control

BVLOS Beyond Visual Line of Sight

CFIT Controlled Flight into Terrain

Company - Individual entity or organization using RPA activities.

EMC Electro Magnetic Compatibility

EMI Electro Magnetic Interference

EVLOS Extended Visual Line of Sight

External Load - Any additional weight attached to the RPA by a physical line extending towards the ground, that is suspended, pulled, or towed from below the RPA but is not intended to limit movement.

Flight Cycle - One takeoff, transition from hover or climb to altitude and one landing.

FOD Foreign Object Damage

FPV First Person View

GCS Ground Control Station

GPS Global Positioning System

HLO Helideck Landing Officer

HLS Helicopter Landing Site

Hydrocarbon Fuel - Includes solid, liquid and gaseous fuels.

ICAO International Civil Aviation Organization

IFR Instrument Flight Rules

IMC Instrument Meteorological Conditions

Intrinsic Safe Operations - is a protection technique for safe operation of electrical equipment in hazardous areas limiting the energy, electrical and thermal, available for ignition. Areas with dangerous concentrations of flammable gases or dust are found in applications such as petrochemical refineries and mines.

Internal Load - Any additional weight, that is directly attached or contained within the RPA frame that is not required for the operational control of the RPA but is required as for the purpose of the RPA's intended mission.

IP Ingress Protection

IR Infra Red

LiDAR Light Detection and Ranging

LiPo Lithium Polymer

Mission - The planning, evaluation and execution of activities designed to accomplish a defined objective, which may include tasks such as data collection, delivery, surveillance, or any other operational goal. A mission may include multiple flights over multiple days at a single geographic location or contiguous locations.

NAA National Aviation Authority

NM Nautical Mile

NOTAM Notice to Air Missions

Operator - Operating entity providing RPAS services. Can be internal or external to company.

OHS Occupational Health and Safety

ORA Operational Risk Assessment

PIC Pilot-in-Command

PPE Personal Protective Equipment

ReOC RPA Operator's Certificate

RF Radio Frequency

RPL Remote Pilot Licence

RP Remote Pilot

RPAS Remotely Piloted Aircraft System

RPA Remotely Piloted Aircraft

RPS Remote Pilot Station

RTH Return to Home

RTK Real-time Kinematic Positioning

RTL Return to Land

SIMOPS Simultaneous Operations

Tether - A physical line extending from the ground to the RPA, for the purposes of limiting movement and capturing the RPA or providing platform resources (e.g power or water).

VFR Visual Flight Rules

VLOS - Visual Line of Sight with the RPA such that the pilot can continually see, orient and navigate the aircraft to meet separation and collision avoidance responsibilities.

VMC Visual Meteorological Conditions

C3 Command, Communication and Control

Generic RPAS Governance Model

Category	Weight	Operating Conditions	Governance Model
Micro	≤250 g	May be risk-assessed by company as not requiring governance. Otherwise treat as 'Very Small' category.	
Very Small	>250g - 2 kg	1. Standard Operating Conditions	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.
Small	>2 kg - 25 kg		
Micro	≤250 g	1. Non-standard Operating Conditions 2. BVLOS/EVLOS	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.
Very Small	>250g - 2 kg		
Small	>2 kg - 25 kg		
Medium	>25 kg - 150 kg	1. Standard Operating Conditions 2. Non-standard Operating Conditions 3. BVLOS/EVLOS	
Large	>150 kg		

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.

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 flight cycles in previous 90 days or Successful completion of a check flight with an operator approved RP on the RPA type being operated.	If dictated by Risk Assessment
	>25kg		10	5		
1. Non-standard operating conditions	<25kg	RPL	10	5		
2. EVLOS < 1500m	>25kg		20	5		
1. EVLOS > 1500m 2. BVLOS	<25kg	RPL and Instrument Rating (theory exam) or NAA equivalent	20	10		
	25kg – 150kg		25	10		
	>150kg		50	20		
1. BVLOS in controlled airspace*	<25kg	RPL and Instrument Rating (theory exam)	20	10		If dictated by Risk Assessment
	>25kg		25	10		

* Not including underground or confined space operations.



Courtesy: Northrop Grumman

Remote Pilot Training

M - Mandatory R - Recommended Training Element	Operating Scenario			Recency
	SOC	Non-SOC	BVLOS	
Airband Radio Procedures	R	R	M	Annual
Ground Risk Mitigation Procedures	M	M	M	Annual
Air Risk Mitigation Procedures	M	M	M	Annual
Minimum Equipment Requirement	M	M	M	Annual
Loss of Link Procedures	M	M	M	Annual
Airspace Incursion Procedures	M	M	M	Annual

Training elements should include desktop and practical flight tests.



Courtesy: Rio Tinto

Check + Training Personnel

Qualifications	Comments	Recency
License	Endorsed for the applicable RPA category, weight and model	Annual
Instrument Rating	Recommended	Annual
Experience	Comments	
Total Hours	20 hours on company operations	Annual
Training Elements	Comments	
Airspace	Knowledge of reading airspace charts, radio frequencies and airspace classes	Annual
Aerodromes	Knowledge of aerodrome departure, approach and missed approach procedures	Annual
Company Equipment	Knowledge of the limitations for company equipment	Annual
NOTAM	Able to read NOTAM and weather information	Annual

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.

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 <input type="checkbox"/>	Multicopter <input type="checkbox"/>	Powered Lift <input type="checkbox"/>

Documentation to be Provided	
Copy of Regulatory issued Remote Pilot License (RePL) where applicable	<input type="checkbox"/>
Annotated map of task area (for areas within 5NM of an aerodrome)	<input type="checkbox"/>

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 control owner prior to conducting RPA operations.

Control	Query			Additional Mitigations	Owner
Planning	<ul style="list-style-type: none"> 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) Day operations 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	<p>If no, the operations should not take place until the Standard Operating Conditions are satisfied or the activity is to be undertaken with the required NAA approval or Where no regulatory certificate to operate is applicable, in accordance with company's approval process and all controls outlined in the FSF RPAS.</p> <p>Each hazard should be identified and risks mitigated according to the operators Risk assessment process and BARS Controls</p> <p>Contracted RPAS Operators must ensure company approval is in place prior to undertaking such operations</p>	
Aerodromes	<p>Is the operation being conducted within:</p> <ul style="list-style-type: none"> 3 nautical miles (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	<p>If yes, operations must have current company agreement in place with the aerodrome operator. Where the aerodrome is nonresponsive, the attempt to notify must be recorded. Refer to FSF RPAS Appendix 5 simultaneous operations.</p>	
Remote Pilot	Do you understand the requirements for site authorization at the requested sites?	Y	N	If no, consult the site training department to complete the required steps.	
	Have you maintained three flights cycles 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 an operator approved RP on the RPA type being operated	
	Are you aware of the danger points on the operating RPA and how to effectively isolate the equipment?	Y	N	If no, review operating equipment for danger areas and develop isolation procedures for equipment	
Ground Risk	Has the requirement for no-fly zones been reviewed and established?	Y	N	If no, review areas that are to be designated no-fly and update procedures	
	Are people likely to be in the area?	Y	N	If Yes, consider the use of observers, parachutes or FPV cameras. Operations over buildings or people require a detailed risk assessment	
Infrastructure	Have battery charging and storage locations been reviewed to control the risk of fire?	Y	N	If no, seek consultation	
	Do you understand the airspace and the expected crewed aircraft traffic in the area where RPA operations are being conducted?	Y	N	<p>If no, complete an airspace assessment to confirm that the intended operation can be undertaken without penetrating unapproved airspace</p> <p>Refer FSF RPAS Appendix 5 simultaneous operations</p>	
	Does the operation require NOTAMs to be issued?	Y	N	If yes, confirm that the applicable NOTAMs have been released or reviewed	

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

Control	Query	Y	N	Additional Mitigations	Owner
Air Risk	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	
	Is the operation conducted within Controlled airspace, Danger, prohibited or restricted areas	Y	N	If yes, confirm whether area is activated and relevant area owner approval received prior to flight	
	Has a simultaneous RPAS operations procedure been developed compliant to FSF BARS?	Y	N	If no, assess relevant stakeholders and develop SIMOPS plan as per BARS 7.3	
	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	
RPA Operations	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	
	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	
	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 RPA is employed with a redundant propulsion/power system.	
Considering the operating environment and scope of operations, is a minimum IP rating applicable? If so, identify the minimum IP rating requirement	Y	N			
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	<input type="checkbox"/>
RPA make/model in Company approved list	<input type="checkbox"/>
Remote Pilot details entered into company register	<input type="checkbox"/>

Flight Safety Foundation Generic RPAS Flight Checklist

Pre-Start Briefing

- | | | |
|----------------------------------|--|--|
| 1. Provide overview of Task | 4. Outline how issues to be communicated | 7. Describe actions following incident |
| 2. Specify tasking for crew | 5. Nominate landing area and alternate | 8. Reiterate sterile cockpit procedure |
| 3. Articulate identified hazards | 6. State safe zone location for bystanders | 9. Review all flight 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		5. Flight Crew	
A - Approval	Issued and current	F - Fitness	IM Safe
I - Inspections	RPA airworthy/serviceable	Illness, Medication, Stress, Alcohol, Fatigue, Emotion	
R - Recency	30/90 days or checked to line	6. Before Takeoff	
2. Setup Location		B - Briefing	Completed
F - Flight Area Hazards	Clear of hazards	P - Pilot, Crew	Safety location/physical barrier
L - Launch/Retrieval Area	Clear of hazards, secured	O - Observers	>30m
A - Alt Landing Areas	Identified	7. After Takeoff	
W - Weather	Checked and within limits	C - Control Check	Completed
S - Site Specific Requirements	Checked and satisfied	8. In-flight	
3. Before Start		H - Hazards	Avoid people and wildlife
F - Fuselage	Inspected, nil damage	O - Operating Limits	Check within limits
A - Arms	Unfolded, locked	M - Monitor Battery	Commence RTH at 30%
M - Motors, Propellers	Spin freely, secured	E - Errors	Confirm nil errors
B - Batteries	Secured, sufficient	9. Before Landing	
R - Remote Control	ON, assisted mode	P - Pilot, Crew	Safety location/physical barrier
A - All Personnel	Clear of propellers	O - Observers	>30m
4. After Start		10. After Landing/Post-flight	
C - Compass	Within Limits	D - Duration of Flight	Record
B - Battery Voltage Deviation	"Insert"	R - RPA	Inspect
A - App Status	'Ready to Fly'	D - Damage	Report
D - Downward Vision Sensor	OFF (If operating close to objects)	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

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).

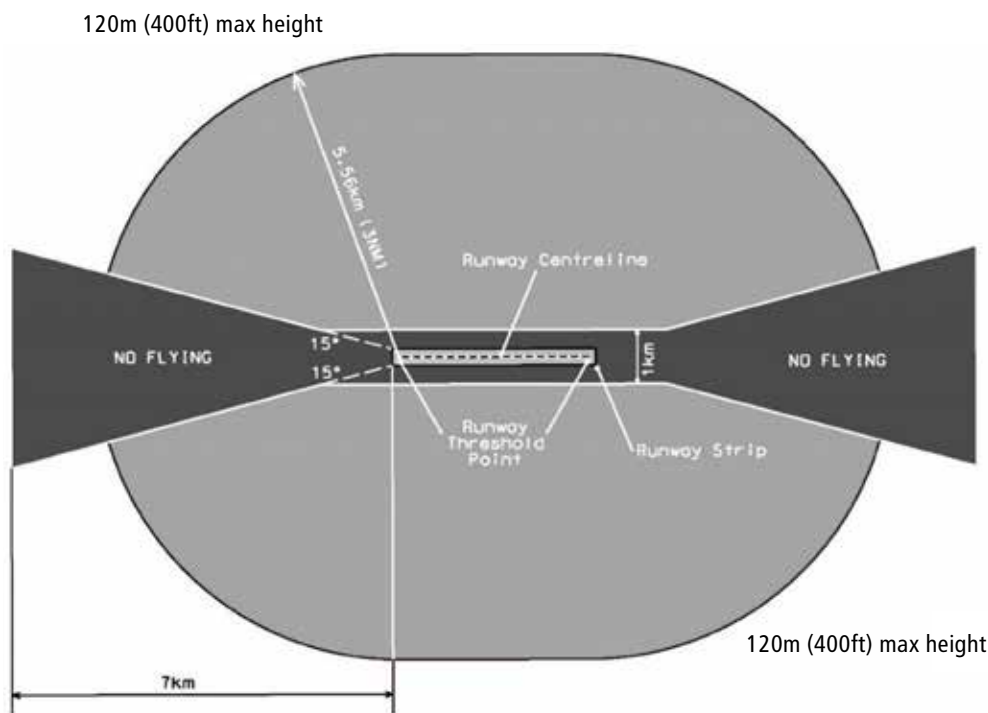
Threat scenarios are:

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

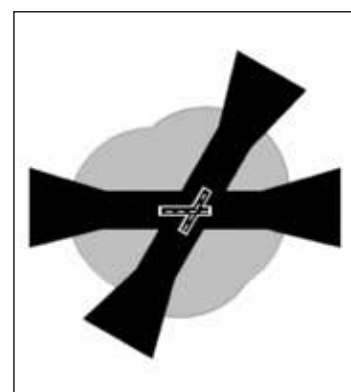


Figure 1: Fixed Threat scenario example

Approach/Departure Paths - 15 degrees splay 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 (Non-SOC) beyond 3nm from aerodrome/HLS; and
3. RPA operation in the vicinity of other aircraft (planned/coordinated).

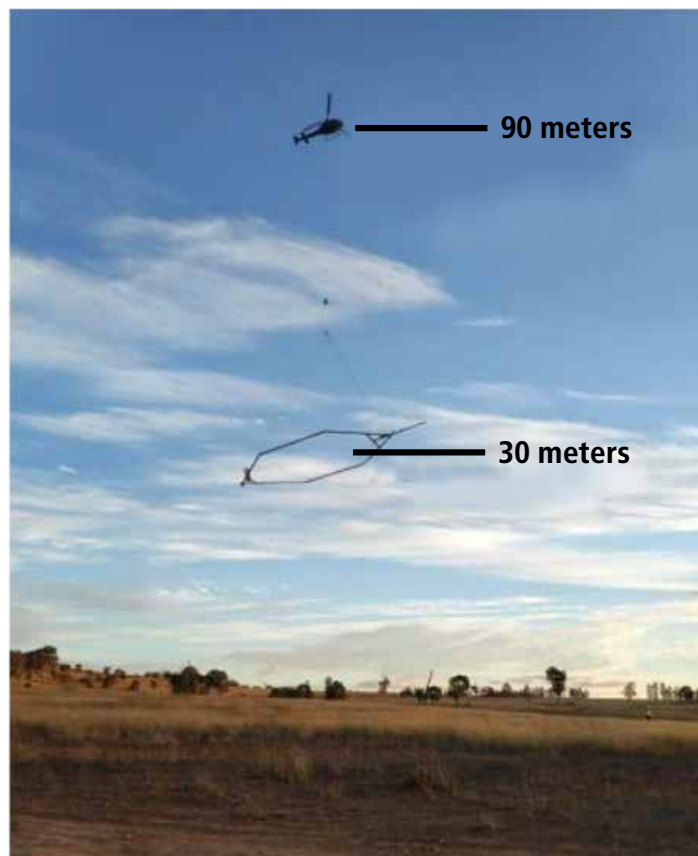


Figure 2: Mobile Threat scenario example

Model of Separation Standards (cont.)

Summary of Controls – Fixed Position Threat Scenarios

M - Mandatory R - Recommended Scenario	Controls							Comments
	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 or where no scheduled is provided
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

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 (where permitted by NAA) 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	Where permitted by NAA
	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	Where permitted by NAA
	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

Model of Separation Standards (cont.)

Summary of Controls – Mobile Position Threat Scenarios

M - Mandatory R - Recommended	Controls								Comments
	Flight approval by RPAS SPA (or delegate)	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	
Scenario									
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	
Recommended	Stakeholder engagement with (known) aircraft operators	
	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

* Not applicable to operations within populous areas or within 30m of people

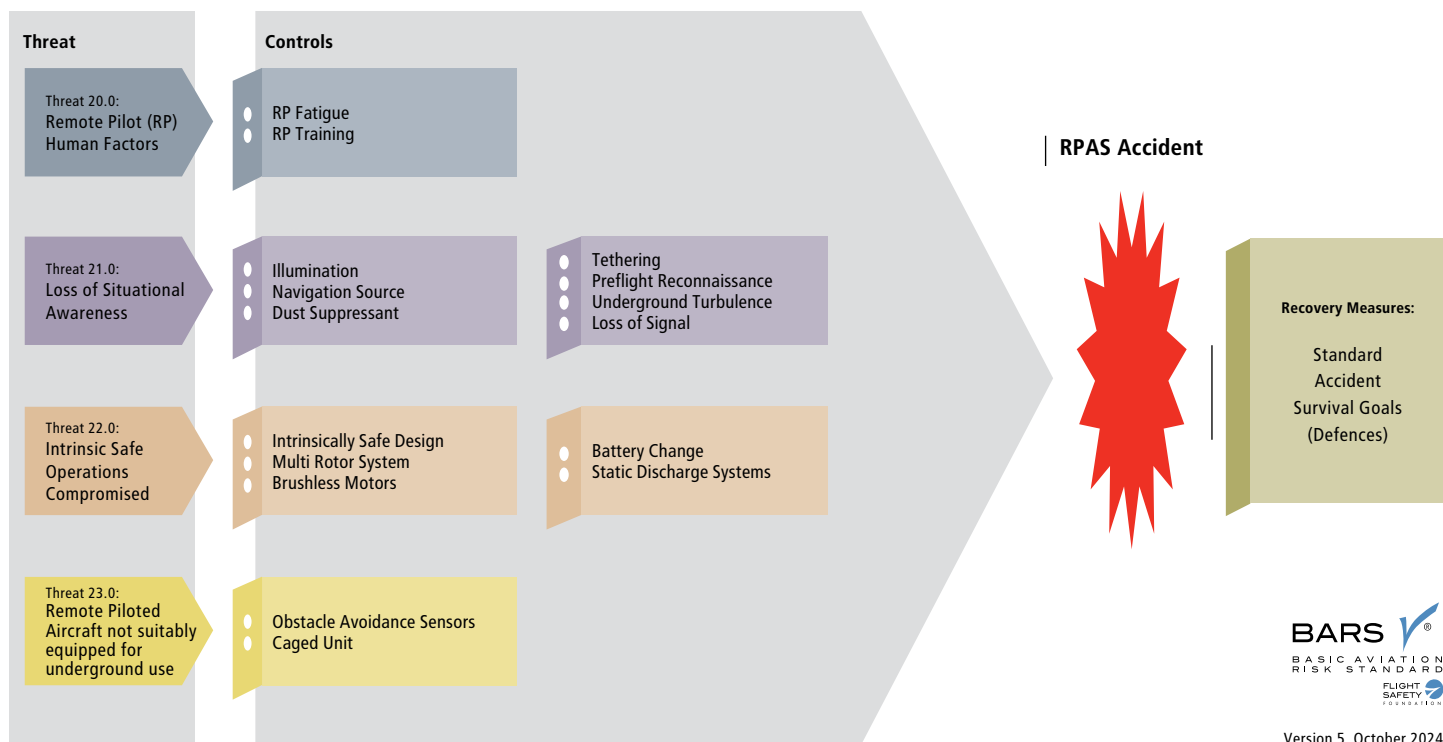
Mobile Position Threat Scenario 3: RPA in vicinity of other aircraft (planned)

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)	

Underground and/or Confined Space RPAS Operations

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



Threat 20.0: Remote Pilot (RP) Human Factors

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

Threat

Threat 20.0:
Remote Pilot (RP)
Human Factors

Controls

RP Fatigue
RP Training

Control 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.

Control 20.2: RP Training

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

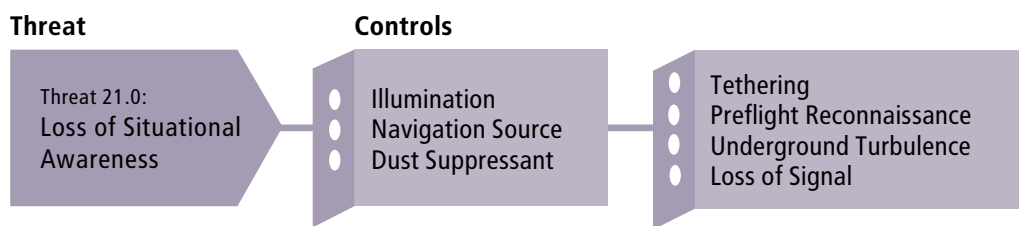
The Remote Pilot must undergo specific training associated with absence of GPS signal in an underground environment (such as operating in manual-mode) before commencing first operation.



Courtesy: Rio Tinto

Threat 21.0: Loss of Situational Awareness

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



Control 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.

Control 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.

Control 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.

Control 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.

Control 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 must be conducted as part of the Operational Risk Assessment. A review of the surrounding material and surface conditions must be considered to identify areas where downdraft from the RPA may dislodge material.

Control 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 RP awareness.

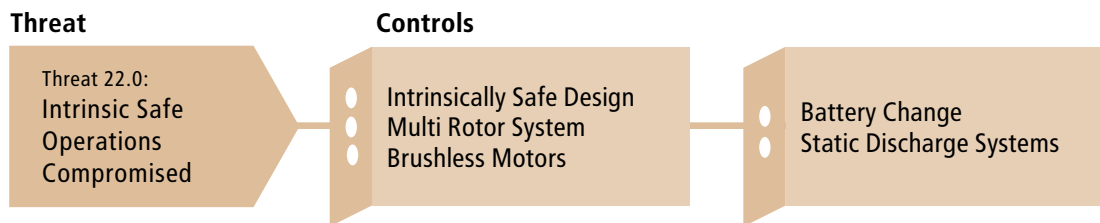
Control 21.7: Loss of Signal

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 RP and the RPA is possible.

Threat 22.0: Intrinsic Safe Operations Compromised

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



Control 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.

Control 22.2: Multi Rotor System

Ensuring RPA maneuverability 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 maneuverability.

Control 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.

Control 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.

Control 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.



Courtesy: BHP

Threat 23.0: Remote Piloted Aircraft not suitably Equipped for Underground use

The RPA is not suitably equipped and an accident results

Threat

Threat 23.0:
Remote Piloted
Aircraft not suitably
Equipped for
Underground use

Controls

- Obstacle Avoidance Sensors
- Caged Unit

Control 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.

Control 23.2: Caged Unit

Provision of suitable equipment to mitigate terrain or obstacle contact.

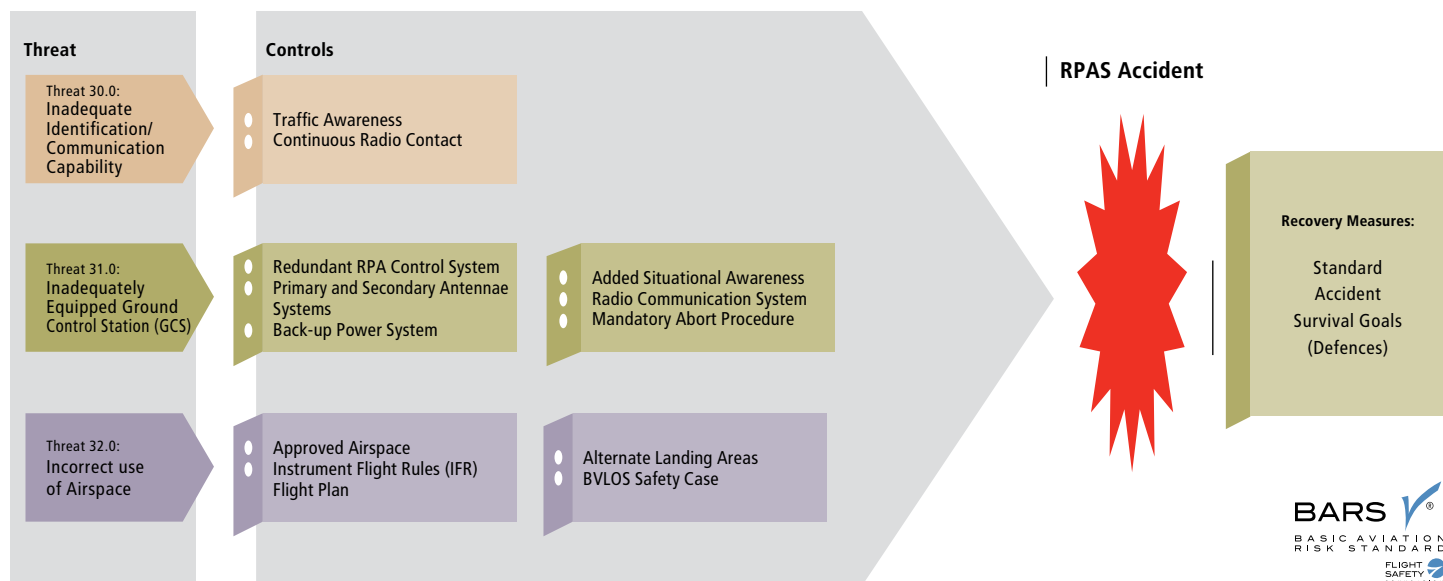
Consideration in the provision of an approved and serviceable cage (or external frame system) surrounding the RPA should occur during the Operational Risk Assessment to aid in the prevention of injury and/or accident in the event if inadvertent contact with obstacles.



Courtesy: Altitude Imaging

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



Version 5, October 2024

Threat 30.0: Inadequate Identification/Communication Capability

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

Threat

Threat 30.0:
Inadequate
Identification/
Communication
Capability

Controls

- Traffic Awareness
- Continuous Radio Contact

Control 30.1: Traffic Awareness

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

Mode C Transponder

A serviceable Mode C transponder (ADS-B Mode S preferred) must be provided on the RPA if considered necessary during the pre-start risk assessment.

Control 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.



Courtesy: Northrop Grumman

Threat 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

Threat

Threat 31.0:
Inadequately
Equipped Ground
Control Station (GCS)

Controls

- Redundant RPA Control System
- Primary and Secondary Antennae Systems
- Back-up Power System

- Added Situational Awareness
- Radio Communication System
- Mandatory Abort Procedure

Control 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.

Control 31.2: Primary and Secondary Antennae Systems

Ensuring GCS provide an 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.

Control 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).

Control 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 must be provided to the RP and supporting personnel. The use of locally acquired information, such as ADS-B in, ground-based radar or vision systems are preferred in place of web-based data. Where possible, traffic information integrated into the primary flight display is recommended.

Where information is sourced from a remotely located device, a secondary means of communication or situational awareness must be established.

Control 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.

Where the GCS and RPA are not co-located, the RPAS operator must implement secure and reliable communication links between the RP and the RPA, including backup systems to handle potential communication failures. A documented procedure which specifies coordination and communication protocols between the remote operations center and operational sites must also be in place.

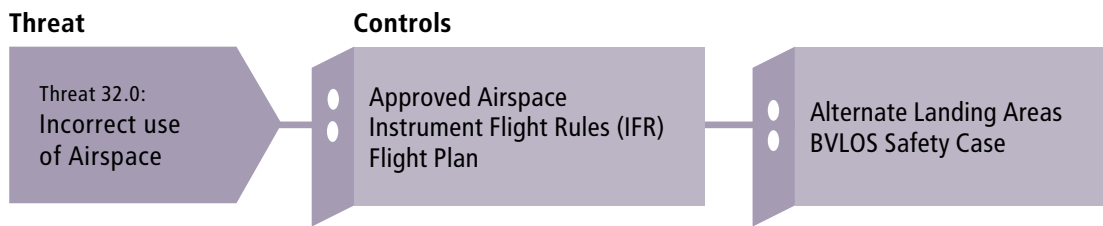
Control 31.6: Mandatory Abort Procedure

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).

Threat 32.0: Incorrect use of Airspace

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



Control 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.

Control 32.2: Instrument Flight Rules (IFR) Flight Plan

Ensuring separation of known traffic.

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

Control 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.

Control 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, must 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.

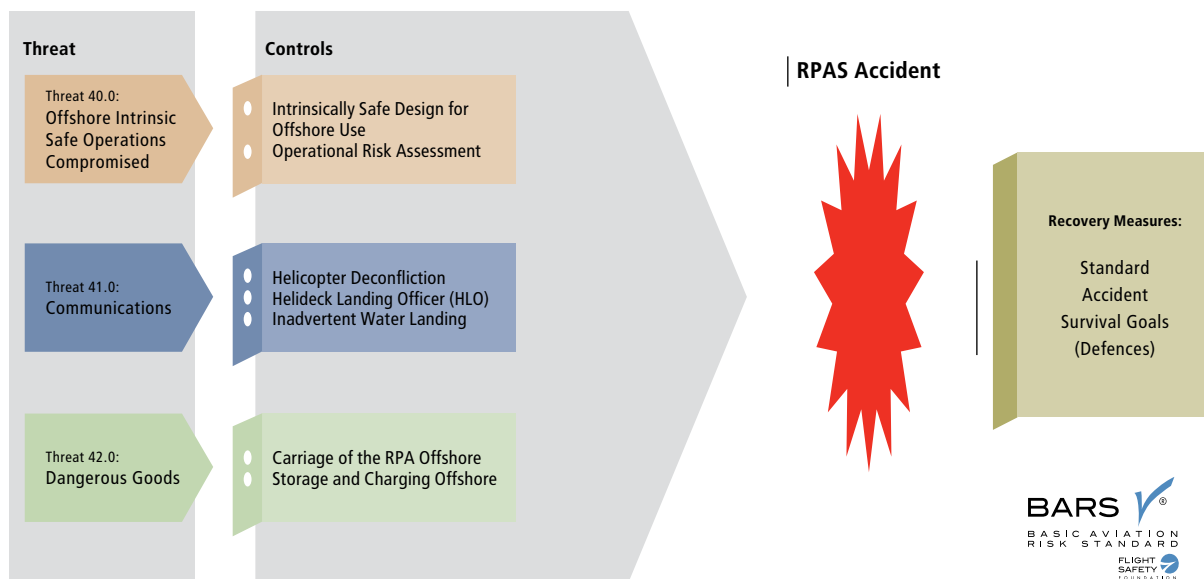
Other regulatory approvals such as radio spectrum authorization as well as military/security approvals may be required.



Courtesy Northrop Grumman

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 5, October 2024

Threat 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

Threat

Threat 40.0:
Offshore Intrinsic
Safe Operations
Compromised

Controls

- Intrinsically Safe Design for Offshore Use
- Operational Risk Assessment

Control 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.

Control 40.2: Operational Risk Assessment

Ensuring ORA identifies and addresses operational hazards and risks.

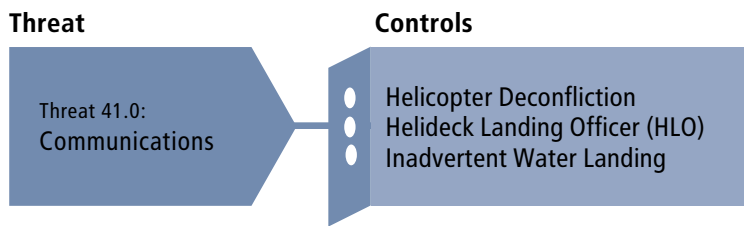
The location of flare stacks, exhaust vents, areas of known turbulence from the superstructure and projected crane operations must be identified and noted during the Operational Risk Assessment. The derived flight plan route for operations must take this analysis into consideration.



Courtesy: "Little Ripper Life Saving"

Threat 41.0: Communications

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



Control 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.

Control 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. The nominated person must maintain constant radio watch with the installation and any aviation traffic.

Control 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.

Threat 42.0: Dangerous Goods

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

Threat

Threat 42.0:
Dangerous Goods

Controls

- Carriage of the RPA Offshore
- Storage and Charging Offshore

Control 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.

Control 42.2: Storage and Charging Offshore

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

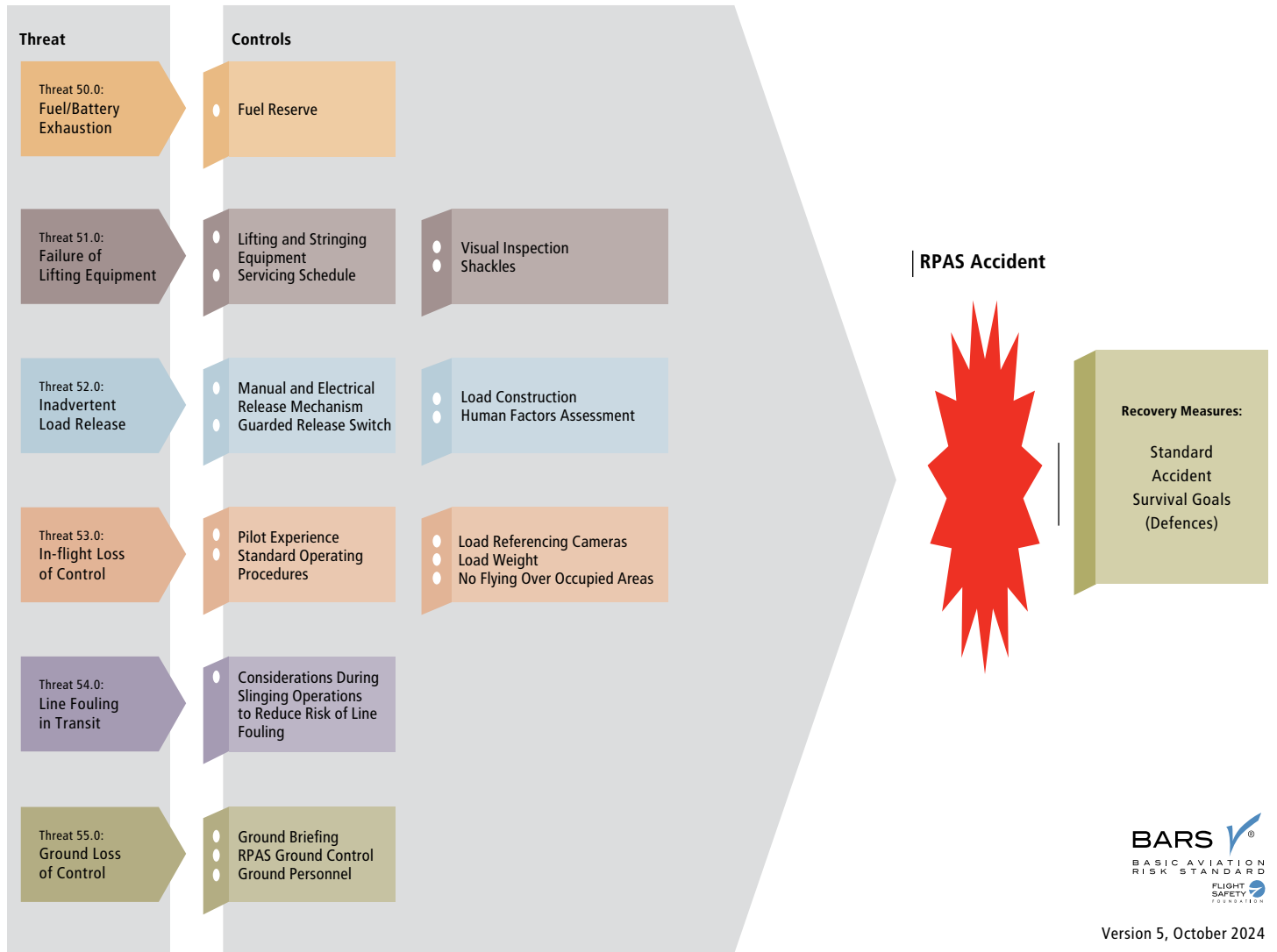
The offshore installation/vessel must be consulted prior to embarkation to ensure the RPA and associated batteries are appropriately tested and tagged and a suitable environment established for storage and charging on the offshore installation/vessel prior to arrival.



Courtesy: Freeport

RPAS External Load Operations

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



Threat 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

Threat

Threat 50.0:
Fuel/Battery
Exhaustion

Controls

Fuel Reserve

Control 50.1: Fuel Reserve

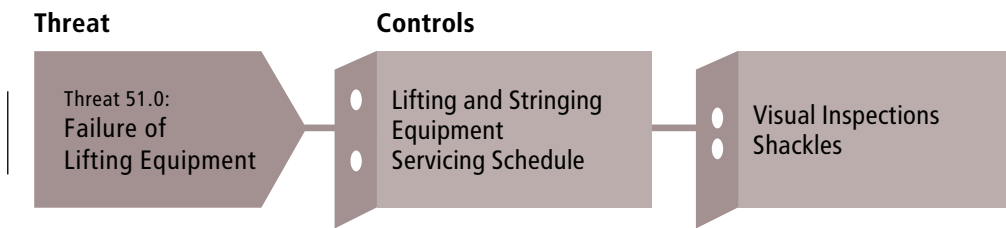
Ensuring sufficient fuel is carried/battery life, including required reserves.

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



Threat 51.0: Failure of Lifting Equipment

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



Control 51.1: Lifting and Stringing Equipment

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

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

Control 51.2: Servicing Schedule

Ensuring early detection of impending failure of load lifting and stringing equipment.

Lifting and stringing 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.

Control 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.

Where equipped, hooks with remote release must be inspected for serviceability.

Control 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.

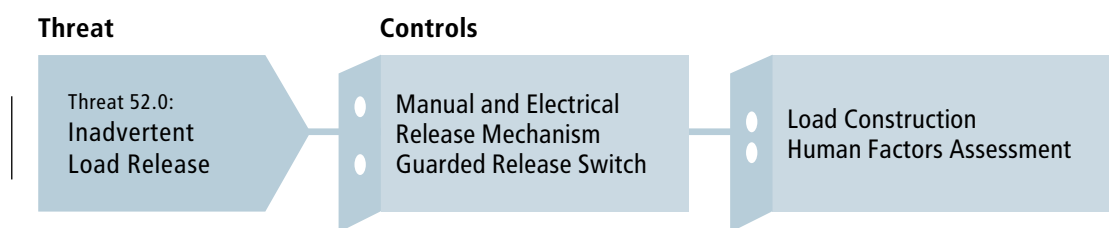
If information is not readily available a risk assessment must be conducted prior to operations being conducted.

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.

Threat 52.0: Inadvertent Load Release

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



Control 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 could include an external manual release at the hook.

Line release capability is essential in the event of an emergency situation arising. Releasing the load permits the RPA to return to its unladen state, thereby allowing the remote pilot to maneuver the RPA more effectively in the event of an emergency.

For Stringing operations, automated line release must be configured in the event of a loss of link.

Control 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.

Control 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.

Control 52.4: Human Factors Assessment

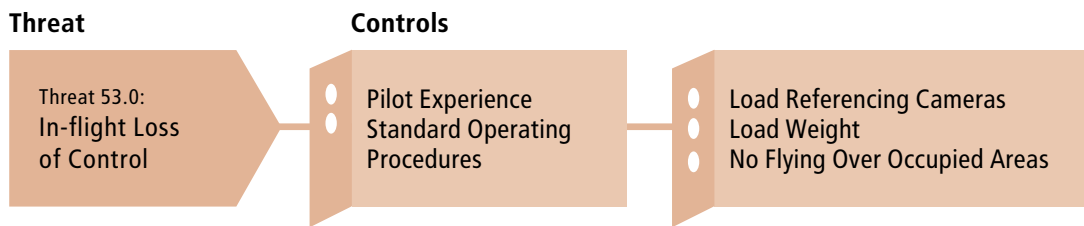
Ensuring that control interfaces do not introduce operator confusion.

Ergonomics and the control interface must be assessed with consideration of the following:

- Clear labeling of the payload release switch/button;
- Whether a different device can inadvertently release the payload; and
- Determination if the payload hook is in the open or closed position by the remote pilot at the remote controller station.

Threat 53.0: In-flight Loss of Control

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



Control 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.

Control 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.

Where applicable for the RPA in operation, procedures must include disabling of collision avoidance sensors where false identification could result in loss of RPA stability.

Control 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.

Control 53.4: Load Weight

Ensuring accurate load weights are known and within RPAS limits.

All loads must have accurate weights provided to the pilot before each lift. 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.

Where accurate weighing facilities are not available, the pilot may reference a list of pre-approved loads and RPA configurations.

Control 53.5: No Flying Over Occupied Areas

Removing unnecessary exposure to risk for personnel by overflight.

Flights over occupied vehicles and structures must only be conducted after a detailed risk assessment, and action plans implemented.

No flights shall be conducted overhead of personnel.

Threat 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

Threat

Threat 54.0:
Line Fouling
in Transit

Controls

Considerations During Slings Operations
to Reduce Risk of Line Fouling

Control 54.1: Considerations During Slings and Stringing Operations to Reduce Risk of Line Fouling

Ensuring RPAS cannot become entangled by fouled lines.

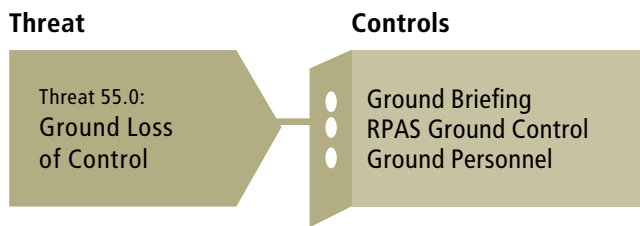
- Transit with a line and no load attached is not permitted;
- The line must be suitably weighted if it is to be flown without a load attached;
- Implement preflight checks which are designed to ensure flight crew involved in repetitive loads are aware of when the line is attached;
- All safe transit 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.



Courtesy: Worley

Threat 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



Control 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.

Control 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 focused on control of the aircraft and may not assist with any ground activities such as load attachment or removal.

Where the RPA cannot land to attach/remove a load (or removal cannot be completed remotely) establish a system of positive communication between the flight crew and ground crew.

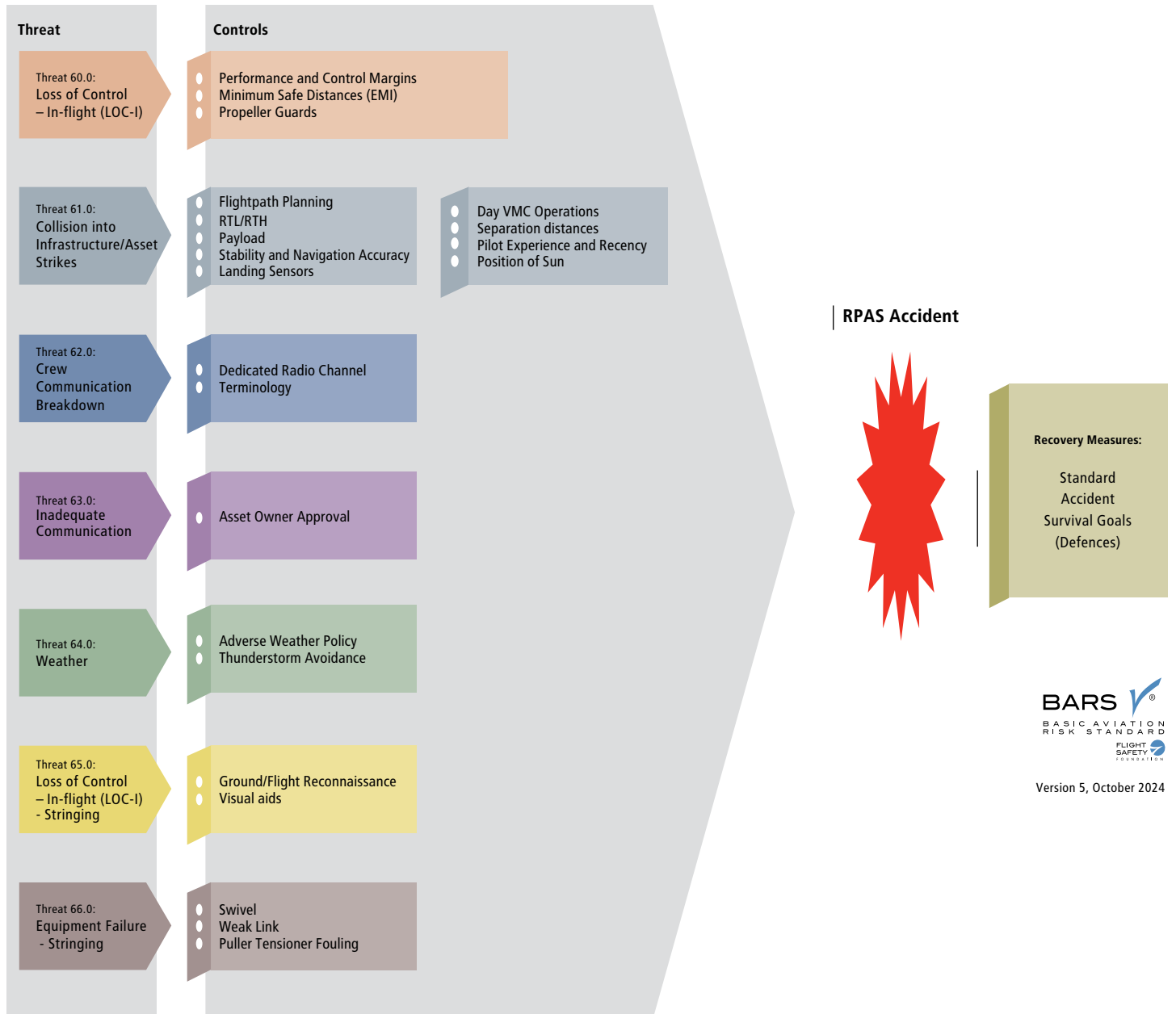
Control 55.3: Ground Personnel

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

Ground personnel should wear appropriate PPE including hard hats with chin straps, impact resistant goggles and gloves.

RPAS Operations in the Vicinity of Electrical Infrastructure

Figure 6: BARS Bow Tie Risk Model – Schematic of Additional RPAS Controls and Recovery Measures for Operations in the Vicinity of Electrical Infrastructure.



Threat 60.0: Loss of Control – In-flight (LOC-I)

Crew actions inadvertently place the RPA outside the normal flight envelope or the intended flight path and lead to an unrecoverable flight

Threat

Threat 60.0:
Loss of Control
– In-flight (LOC-I)

Controls

- Performance and Control Margins
- Minimum Safety Distances (EMI)
- Propeller Guards

Control 60.1: Performance and Control Margins

Operation of the RPA in a manner that maximizes performance and control margin.

The operator's procedures must ensure that center of gravity limits are respected throughout the flight and that suitable control margins are applied to RPA manufacturer limits.

A review of the RC gain and exponential settings must be conducted to limit the speed of maneuvers.

Control 60.3: Propeller Guards

Ensuring stability in the event of a wire strike.

Where available for the RPAS type, propeller guards must be fitted.

Control 60.2: Minimum Safe Distances (EMI)

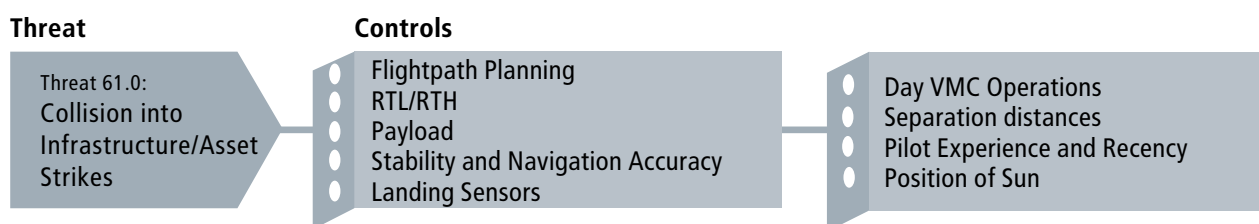
Ensuring RPA are not operated in an environment where flight stability is compromised.

Preflight risk assessments must define a Minimum Safety Distance taking into account the effects of Electro Magnetic Interference (EMI).



Threat 61.0: Collision into Infrastructure/Asset Strikes

An airworthy RPA under the control of crew is flown into the ground, obstacle or water resulting in an accident



Control 61.1: Flightpath Planning

Ensuring the planned flight path is thoroughly planned to identify potential hazards.

In consultation with client requirements and ground crews, pilots engaged in electrical operations must carefully plan the route to be flown, taking into consideration ground wires, stay wires as well as identifying potential hazards.

Planning must also include documenting and briefing proper clearances from energized conductors.

Control 61.2: RTL/RTH

Ensuring automatic failsafe are configured correctly.

Return to Land (Return to Home) must be configured to avoid inadvertent collision with electrical infrastructure in the event of activation.

Control 61.3: Payload

Ensuring RPA are operated at the maximum distance possible from infrastructure.

Consideration should be given to the use of zoom cameras or side mounted LiDAR to avoid operating in close proximity to the infrastructure.

Control 61.4: Stability and Navigation Accuracy

Ensuring the RPA remains stable at all times.

RPA must be fitted with GPS for all operations. The minimum number of acceptable satellites during normal operations must be at least one more than the manufacturer recommendation.

When operating within a live Aerial Restricted Zone (ARZ) a supplementary positioning system must be used (RTK positioning GPS, vision stability).

Control 61.5: Landing Sensors

Ensuring safety sensors do not interfere with normal operations.

RPA fitted with landing detection or protection sensors must be disabled during flight to remove the risk of activation during flight.

Control 61.6: Day VMC Operations

Ensuring effective and safe separation from terrain and obstacles.

To minimize risk of collision/obstacle strikes, contracted activities at lower altitudes must be conducted in day VMC conditions with appropriate weather limitations established.

Control 61.7: Separation Distances

Ensuring safe separation between RPA and infrastructure during all phases of operation.

Minimum Separation Distance (MSD)

The Minimum Safe Distance is 5m.

Aerial Restricted Zone (ARZ)

All areas within the MSD are known as the Aerial Restricted Zone (ARZ). Operation within the ARZ is only permissible for RPA operations engaged in precision external loads, platform operations, powerline stringing and powerline cleaning. When any part of the RPA enters ARZ the remote pilot must ensure the RPA maneuvering speed is adequate to provide separation from the structure and conductors.

Given potential variability due to wind gusts, aircraft stability, and other uncertainties, flights within the ARZ must be done only under controlled conditions that are well understood by the RPAS operator.

Overflight

Overflight must be performed at heights greater than 12m.

Figure 7: Separation Distances Transmission Lines – RPAS

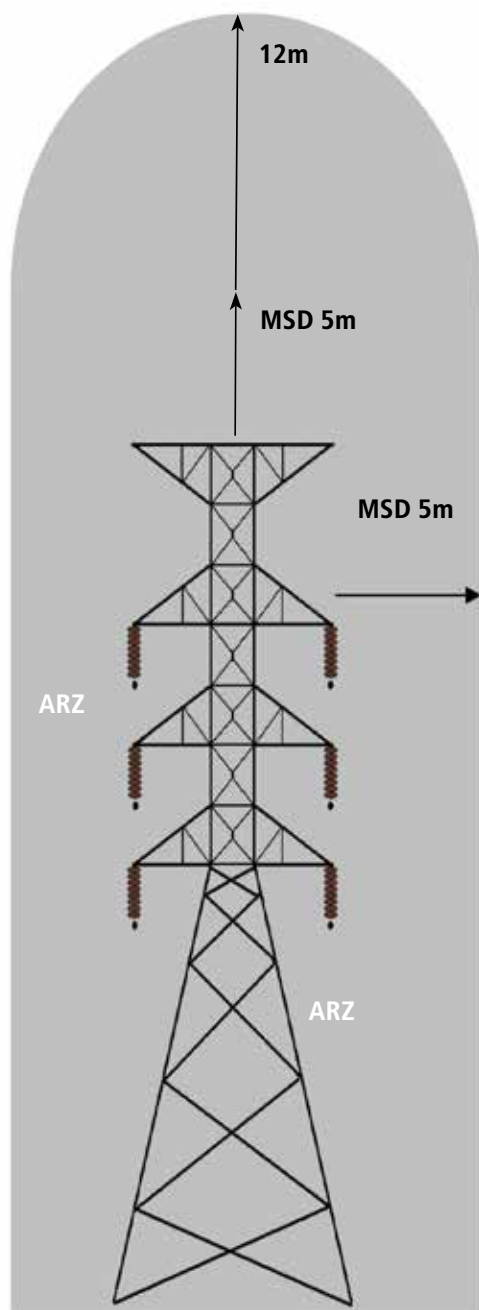


Diagram showing applicable distances for RPAS operating around transmission tower type structures. The ARZ is the area within 5m.

Control 61.8: Pilot Experience and Recency

Ensuring flight crew are adequately trained and have sufficient experience to conduct RPA operations in the vicinity of electrical infrastructure.

Crews operating any RPA in any role must be fully prepared for the task. Due to the often sporadic nature of Utility and Energy sector flight operations, crew recency in any particular task must be carefully considered and managed.

Pilots engaged in operations in the vicinity of electrical infrastructure activities must comply with the following requirements:

- Successful completion of operator’s electrical infrastructure operations training program;
- At least 20 hours of electrical infrastructure operations, relevant to the RPA in use; and
- An annual proficiency check with designated check and training personnel.

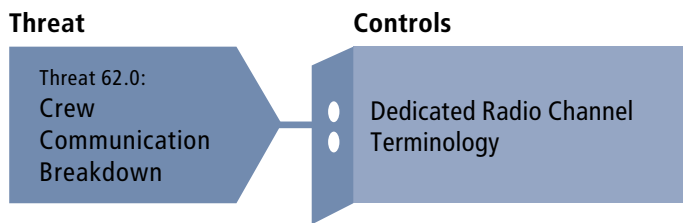
Control 61.9: Position of Sun

Ensuring sun position and possibility of glare obscuring crew vision is considered prior to each flight.

The remote pilot must be located to ensure the position of the sun during operations does not interfere with visibility or introduce glare. Where necessary, consideration should be given to adjusting the time of the day for the patrol or inspection.

Threat 62.0: Crew Communication Breakdown

A breakdown in effective communication occurs between crew members, leading to an accident due to the ineffective response to a safety-related threat



Control 62.1: Dedicated Radio Channel

Maintain open communications on a dedicated radio channel.

Communications with ground crew personnel must be maintained on a dedicated channel using clear, standardized communications throughout the activity.

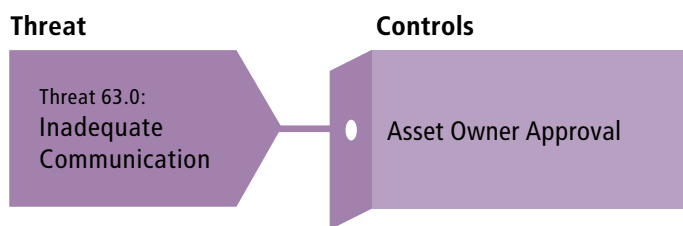
Control 62.2: Terminology

Ensuring consistent terminology is used by an operating crew and ground support crew to avoid accidents through misunderstanding.

All operational and ground crew members must use standard terminology related to the routine and detailed patrol/inspection flights.

Threat 63.0: Inadequate Communication

An event escalates due to inadequate communication with asset owner



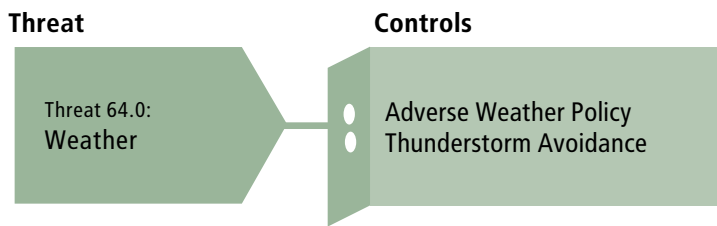
Control 63.1: Asset Owner Approval

Ensuring the Asset Owner is aware and approves of all line work.

Prior to work commencing, the Asset Owner pre-start approval must include a review and documented acceptance of the work being undertaken. Contact details must be provided for on the Emergency Response Plan.

Threat 64.0: Weather

Adverse weather conditions cause an accident



Control 64.1: Adverse Weather Policy

Establishing weather limitations consistent with the capabilities of the RPAS are applied to each flight.

An Adverse Weather Policy must be developed by the company in conjunction with the operator when weather conditions exist that are suitable for flying, but not suitable for the contracted activity or only suitable with risk mitigations.

The Adverse Weather Policy must outline clearly under what conditions the contracted activity should be restricted or temporarily halted.

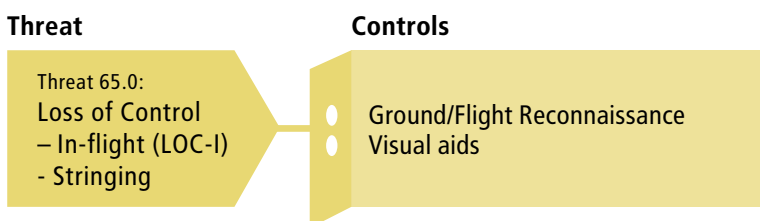
Control 64.2: Thunderstorm Avoidance

Ensuring safe operations in the vicinity of thunderstorms.

Operators must outline thunderstorm avoidance techniques in the Operations Manual.

Threat 65.0: Loss of Control – In-flight (LOC-I) - Stringing

The RPA performance required exceeds the performance available resulting in loss of control of the RPA and subsequent collision with structures or terrain



Control 65.1: Ground/Flight Reconnaissance

Ensuring the risks associated with the upcoming pull are clearly understood by all personnel.

A reconnaissance flight must be undertaken by the pilot prior to the commencement of a stringing pull. This provides the pilot an opportunity to mentally rehearse the upcoming pull and identify any areas where challenges are likely to be encountered.

Control 65.2: Visual Aids

Ensuring load devices can be seen by RPA crew.

A visual aid must be installed onto the line to increase visibility for the Remote Pilot and ground crew.

Threat 66.0: Equipment Failure - Stringing

The RPA suffers an emergency as a result of failure of the stringing equipment

Threat

Threat 66.0:
Equipment Failure
- Stringing

Controls

- Swivel
- Weak Link
- Puller Tensioner Fouling

Control 66.1: Swivel

Ensuring that any twisting force in the cable is eliminated.

Fit all stringing lines with a swivel mechanism (insulated barrel swivel preferred) to prevent any twisting force being transferred from the cable to the RPA.

Control 66.3: Puller Tensioner Fouling

Ensuring safe and effective operation of the tensioning equipment.

Maintain the cable tensioning system and the braking site in a condition to minimize the opportunity for cable fouling.

Control 66.2: Weak Link

Ensuring that the RPA automatically disconnects from the load in the event of an overload scenario that would otherwise lead to a loss of control.

A weak link should be fitted as determined by risk assessment.



Courtesy: Rio Tinto

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