FLIGHT SAFETY FOUNDATION

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Basic Aviation Risk Standard

Remotely Piloted Aircraft Systems





Version 1, July 2016

Courtesy Northrop Grumman

Contents

Purpose

This Standard provides companies with minimum requirements for performing risk-based management of the remotely piloted aircraft systems operations that support their activities.

All national and international regulations pertaining to operations of remotely piloted aircraft systems 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 remotely piloted aircraft system operations, associated controls and applicable recovery/mitigation measures as presented in Figure 1.

The format is intended to assist all company personnel engaged in coordinating remotely piloted aircraft activities to manage and understand the associated risk to their operation.

All companies and operations of remotely piloted aircraft systems are encouraged to further risk assess all controls to the level of detail they consider necessary for their individual operations and confirm that the residual level of risk is acceptable.

Aircraft Operator Review

This Standard is designed to be used as a primary reference for the review and approval of remotely piloted aircraft system operators supporting companies who contract out these activities. Remotely piloted aircraft operators will be audited to the BARS Question Master List for remotely piloted aircraft system operations, with questions drawn from this Standard and other industry accepted standards for the operation of remotely piloted aircraft systems.

Variations

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

Key Definitions

Company

Refers to the individual entity using this Standard to support their aviation operations.

Companies have an option to use the Operation Risk Assessment (ORA) at Appendix 2 for Visual Line Of Sight (VLOS) for RPAS categorized as light (sub-2kg).

Operator

Refers to a company operating remotely piloted aircraft systems to provide services.

Competent Aviation Specialist

A company designated aviation advisor or Flight Safety Foundation BARS Accredited Auditor.

Additional definitions related to the use of this Standard are listed in Appendix 1.

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

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

BARS
BASIC AVIATION RISK STANDARD

All Threats 1.0: Common Controls

These controls apply to all threats in the RPAS Standard

Common Control 1.1: Pilot Qualifications, Recency and Experience

All RPAS operators must meet the qualification requirements listed in Appendix 1. Each RPAS pilot must also be assessed for operational capability by an established Check and Training protocol that is fully auditable and includes RPAS Crew Resource Management training. Where available, appropriate simulation facilities that have been validated by either the responsible regulatory authority or Competent Aviation Specialist may be used for both training and currency purposes.

Common Control 1.2: Regulatory Approval

RPAS operations must be conducted in accordance with the provisions of the operating certificate issued by the responsible regulatory authority.

Common Control 1.3: Airworthiness Approval

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

Common Control 1.4: Safety Management System

All RPAS operations must be supported by an integrated Safety Management System that spans the entire function.

Common Control 1.5: Operational Risk Assessment

RPAS operators must conduct a risk assessment, including the identification and implementation of mitigation controls, before commencing any operation.

Courtesy "Little Ripper Life Saving"

Common Control 1.6: Drug and Alcohol Program

The RPAS operator must have a Drug and Alcohol Policy which meets all requirements of the responsible regulatory authority. 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

The RPAS operator must have a Fatigue Management Plan in place that considers the workload for the RPAS pilot and other members of the RPAS operations team. The Fatigue Management Plan must be endorsed by the contracting company.

Common Control 1.8: Company Approval

Use only licenced RPAS operators who have been approved for use by company established process and where necessary, a Competent Aviation Specialist.

Common Control 1.9: Equipment Standard

RPAS should be designed to minimize the potential for a failure of any component that will prevent continued safe flight and/or recovery of the vehicle.

Common Control 1.10: Operations Manual

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

Common Control 1.11: Human Factors

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.

Threat 2.0: Fuel

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

Threat	Controls
Threat 2.0: Fuel	Battery Management and Identification Battery Charging Battery Overheat and Fire Protection Power/Fuel Status Indicators Storage, Transport and Management of RPAS Fuel Fuel Quality Controls

Control 2.1: Battery Management and Identification

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

Control 2.2: Battery Charging

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

Control 2.3: Battery Overheat and Fire Protection

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

Control 2.4: Power/Fuel Status Indicators

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

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

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

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

Control 2.5: Storage, Transport and Management of RPAS Fuel

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

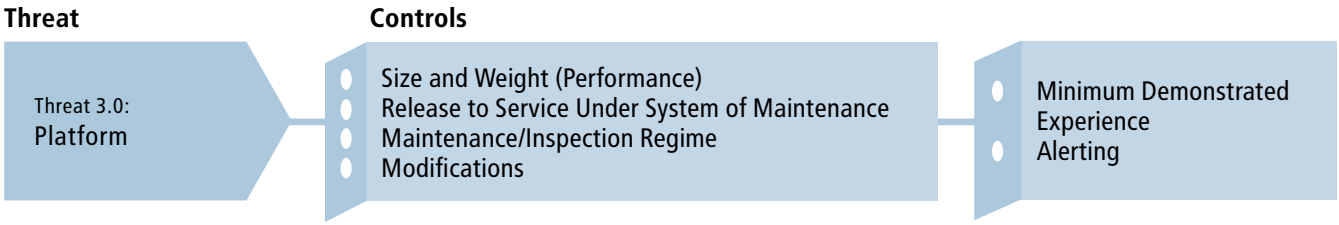
Control 2.6: Fuel Quality Controls

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

Courtesy BHP Billiton

Threat 3.0: Platform

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



Control 3.1: Size and Weight (Performance)

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

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

Control 3.3: Maintenance/Inspection Regime

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

A system of defect recording and rectification must be established.

RPAS performance should be recorded and trend monitored to act as 'lead indicators' of future maintenance issues. For battery powered systems, trend monitoring of battery performance is a key element of this process.

Control 3.4: Modifications

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

RPAS operators must have a minimum of 50 cycles of flight experience with the specific RPAS before employing the system in operations (refer Appendix 1).

Control 3.6: Alerting

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

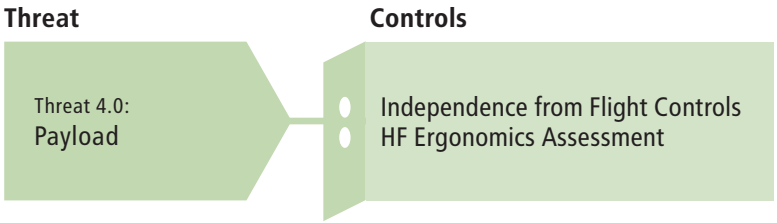
- Communications link status;
- Control status (e.g. normal/alternate/emergency);
- Power state; and
- RPA tracking and position.

Courtesy Northrop Grumman

Courtesy BHP Billiton

Threat 4.0: Payload

The remotely piloted aircraft's payload interferes with control of the RPAS resulting in an accident



Control 4.1: Independence from Flight Controls

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

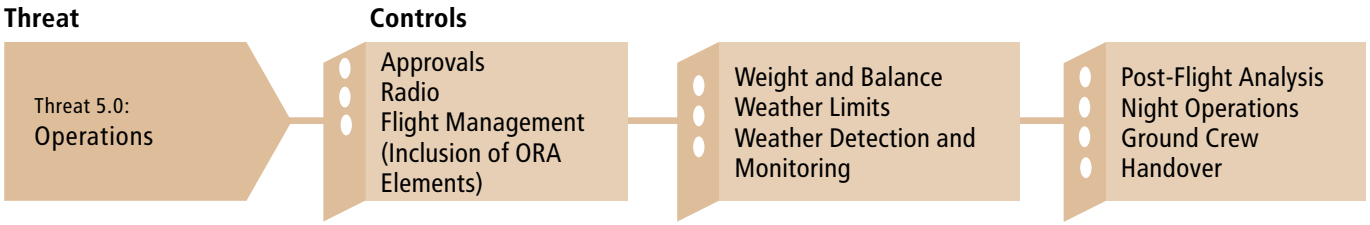
Control 4.2: HF Ergonomics Assessment

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

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

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 on those activities must be fully considered (e.g. blasting activities and RPAS communication links).

Control 5.2: Radio

The RPAS operator must possess the applicable radio communications licences, 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, etc).

Control 5.3: Flight Management (Inclusion of ORA Elements)

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 operator should consider the use of written checklists for the planning and operation of the RPAS task.

Control 5.4: Weight and Balance

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

Control 5.5: Weather Limits

The RPAS operator must publish minimum operating criteria that defines limits for the following items:

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

Control 5.6: Weather Detection and Monitoring

The RPAS operator must have procedures in place to verify that weather conditions are suitable (forecasts) for the intended and ongoing operation (observations) 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

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.

Control 5.8: Night Operations

Night operations must only be undertaken when specific responsible regulatory authority permission or exemptions have been granted. 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

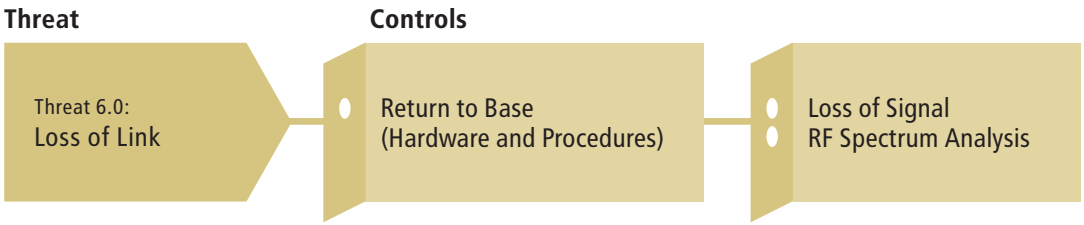
Any ground crew used during operations must be fully safety inducted, be appropriately trained on the equipment in use and wear clothing appropriate to the task.

Control 5.10: Handover

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 Base (Hardware and Procedures)

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

Control 6.2: Loss of Signal

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

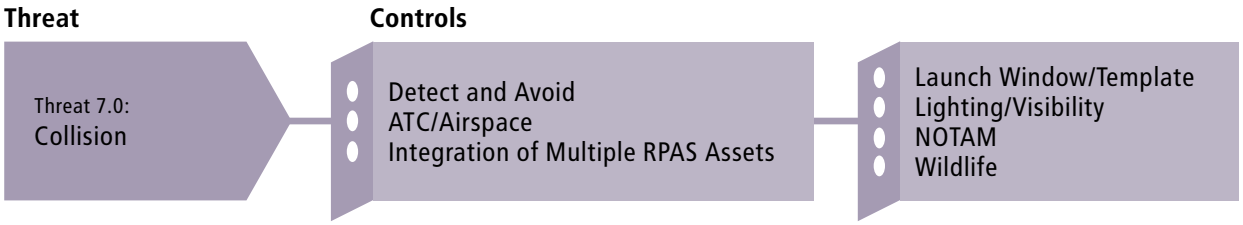
Control 6.3: RF Spectrum Analysis

As part of the pre-flight risk assessment process, the RPAS operator must conduct an RF spectrum analysis to ensure that EMI/EMC is assessed as suitable for the intended operation.

Courtesy BHP Billiton

Threat 7.0: Collision

The RPA collides with fixed or moving obstacles causing an accident



Control 7.1: Detect and Avoid

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 mitigation strategy.

Control 7.2: ATC/Airspace

The RPAS operator must have an assessment process that considers the status of the volume of airspace intended for use for both normal and degraded/emergency operations. Consideration must be given as to whether the airspace is segregated or non-segregated airspace and the threat posed by any other aviation (manned/unmanned/avian) activity. Details of the flight should be registered with ATC if operations in unsegregated airspace are to be conducted and conflict with other aviation activities is possible.

Control 7.3: Integration of Multiple RPAS Assets

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

Control 7.4: Launch Window/Template

The areas used for takeoff and landing must be fully assessed using a template (or similar) 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

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

Control 7.6: NOTAM

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

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

Courtesy Altitude Imaging

Courtesy Freeport

Defences 8.0

Defence 8.1: Engine Failure

RPAS operators must have procedures available addressing the management of one or more powerplant failures on the RPA.

Defence 8.2: Emergency Equipment

Emergency equipment such as fire extinguishers, first-aid kits, eye-wash, overheating battery containers, etc. should be provided at the operating site.

Defence 8.3: Emergency Response Plan

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. 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.

Defence 8.4: Insurance

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 8.5: Incorporation of Research and Development Outcomes

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 8.6: Public Relations

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 8.7: Investigation Procedures

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

Courtesy Northrop Grumman

Appendices

Courtesy Newcrest

Appendix 1:

RPAS Pilot

Licencing Requirements	Experience	Recent Experience
RPAS pilot certification, including the equivalent of an ICAO class 3 medical assessment. Where operations are to be conducted in airspace where broadcasts are recommended on air traffic control frequencies, the RPAS pilot must posses the equivalent of ICAO level 4 english proficiency.	100 hours or 100 flight cycles	Day Operations Three takeoffs and landings/launch and capture or transitions to/from hover in 90 days. Night Operations Three takeoffs and landings/launch and capture or transitions to/from hover at night in 90 days. Emergency Procedures Three landing/capture in a degraded control state in 90 days.

Definitions

D&A	Drugs and Alcohol
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
Flight Cycle	One takeoff, transition from hover or climb to altitude and one landing
GCS	Ground Control Station
Non-segregated Airspace	Airspace where a separation standard does not apply. In effect, uncontrolled airspace
RPA	Remotely Piloted Aircraft – an unmanned aircraft which is piloted from a remote pilot station
RPAS	Remotely Pilot Aircraft System – A remotely piloted aircraft, its associated remote pilot station(s), the required command and control links and any other components as specified in the type design
RTB	Return to Base
Segregated Airspace	Airspace where a separation standard applies. In effect, controlled airspace, including Restricted Areas

Appendix 2:

RPAS Operational Risk Assessment (ORA)

The Operational Risk Assessment should 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.

Table 1: Example of Operational Risk Assessment – any answer 'No' requires identification of mitigating Controls or Defences followed by discussion and agreement with management or contracting company's representative prior to flight.

Minimum Critical Controls (for non-contracting operations or sub-2kg)	RPAS Pilot	Properly licenced and operating under a valid approval framework?	Y	N
		Meets all Qualification, Recency and Experience requirements in this Standard?	Y	N
		Not affected by fatigue or D&A?	Y	N
	RPAS	Meets all equipment requirements of this Standard?	Y	N
		Damage inspection completed?	Y	N
		No outstanding maintenance due?	Y	N
		All elements of the RPA and RPAS Control System function correctly?	Y	N
		RPAS Release to Service completed?	Y	N
	Power Source	Batteries fully charged or fuel load sufficient for planned sortie?	Y	N
		Batteries or fuel stored and transported appropriately?	Y	N
		Methods of fuel and battery management, testing, sampling, connection/delivery understood?	Y	N
	Weather	Method of establishing daily weather conditions established?	Y	N
		Localized weather phenomenon discussed and impact on operations understood?	Y	N
		Weather limits briefed and understood by all?	Y	N
	Operations	Airspace assessment completed?	Y	N
		NOTAMs issued?	Y	N
		Radio serviceable and broadcasts complete?	Y	N
		RF spectrum analysis complete?	Y	N
		Launch and recovery areas suitable?	Y	N
		Lost link procedures understood?	Y	N
		RTB position established?	Y	N
		Emergency equipment on hand?	Y	N
		All Team members briefed?	Y	N

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BASIC AVIATION RISK STANDARD

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