# Environmental Guidelines for operation of Remotely Piloted Aircraft Systems (RPAS)[1] in Antarctica (v 1.1)[2].

## *Introduction*

Deployment of Remotely Piloted Aircraft Systems[2] (RPAS) can, in some circumstances, reduce or avoid environmental impacts that might otherwise occur. Their use may also be safer and require less logistical support than other means of deployment for the same purpose.

These Environmental Guidelines for operation of RPAS in Antarctica aim to assist implementation of Environmental Impact Assessment (EIA) requirements and aid decision-making for use of RPAS through provision of guidance based on current best available knowledge.

System failures and/or RPA loss in Antarctica may release waste into the environment. The short and long-term impacts of RPAS, including of noise and visual intrusion on Antarctic wildlife, are presently not well understood, and there remain uncertainties about the extent to which RPAS have the potential to cause environmental impacts. As such, there is a recommendation to proceed with a precautionary approach to use of RPAS in Antarctica at the same time as seeking to maximise the many potential scientific, logistic and other benefits of RPAS technology.

It is recognised that in some cases it may be desirable deliberately to operate close to fauna or flora to meet specific scientific or other objectives that have been assessed in the EIA or permitting process. Scientific understanding of the impacts of RPAS on Antarctic wildlife is currently not well developed, with limited knowledge of physiological or long-term demographic effects. Species vary widely in the extent to which they appear to be affected by RPAS operations, and this may also vary by many other factors such as breeding stage, local conditions, etc. Behavioural displays, or their lack, are not necessarily clear indicators of the level of disturbance occurring to wildlife. RPAS operations over or near wildlife should be sufficiently justified taking into account potential for disturbance through the EIA or permitting process.

Guidelines to address aspects of RPAS in Antarctica are available from the Council of Managers of National Antarctic Programs (COMNAP), and a number of competent authorities have also prepared practical manuals for RPAS use within national programmes. RPAS users are referred to these guidelines for essential additional information, particularly related to operational and safety aspects (see Appendix 1).

## *Pre-deployment Planning and Environmental Impact Assessment (EIA)*

### 1 Requirements of the Madrid Protocol and its Annexes

1.1 Any proposed activities undertaken in the Antarctic Treaty area shall be subject to the procedures set out in Annex I of the Madrid Protocol[3] for prior assessment of the impacts of those activities on the Antarctic environment.

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[1] A Remotely Piloted Aircraft System (RPAS) is defined by the International Civil Aviation Authority (ICAO) (2015) as "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". A Remotely Piloted Aircraft (RPA) is "An unmanned aircraft which is piloted from a remote pilot station". RPAS are one class of Unmanned Aerial System (UAS), and they are often referred to as Unmanned Aerial Vehicles (UAVs), Unmanned Aircraft Systems (UAS) or 'drones'. In these guidelines RPAS is used for all types of remotely piloted drone systems and RPA is used to refer specifically to the aircraft itself.

[2] These guidelines are intended primarily for application to RPAS of small to medium size (≤25 kg in weight). While many of the principles and guidelines also apply to use of large RPAS (>25 kg in weight), these operations may present additional potential risks in need of specific management procedures that should be addressed in project-specific EIAs.

[3] As required by Art. 8 of the Madrid Protocol.

1.2 Flying or landing an aircraft in a manner that disturbs concentrations of birds and seals is prohibited in Antarctica, except in accordance with a permit issued by an appropriate authority under Annex II to the Madrid Protocol[4].

1.3 Removal of wastes from Antarctica, including electrical batteries, fuels, plastics, etc. is required by Annex III[5], which should be considered in contingency plans for lost or damaged RPAS as part of the Environmental Impact Assessment (EIA).

1.4 A permit issued by an appropriate national authority is required to enter an Antarctic Specially Protected Area (ASPA)[6], and special requirements to operate RPAS may apply within an ASPA or an Antarctic Specially Managed Area (ASMA): any planned RPAS operation within ASPAs or ASMAs, including any overflight of these areas, must be in accordance with the respective ASPA or ASMA Management Plan.

## 2 General considerations

2.1 When planning RPAS use in Antarctica, the current approved versions of the documents listed in Appendix 1, which include, *inter alia*, recommendations, guidelines, Codes of Conduct and manuals prepared by the Antarctic Treaty Parties, SCAR and COMNAP and also recent published scientific papers such as those listed in Appendix 2 may be helpful additional considerations to these guidelines.

2.2 Consider the relative environmental advantages and disadvantages of RPAS and other alternatives, and consider the environmental characteristics of the RPAS and the values present at the proposed location(s) of operation, weighing up both the benefits and environmental impacts of RPAS use.

2.3 Undertake detailed pre-flight planning, including thoroughly assessing the particularities of the operational site in advance of deployment, to ensure an appropriate understanding of its topography, weather and any hazards that may impact upon an environmentally sound operation. Where possible, carry out simulated flights using software tools.

2.4 Map out flight plans, prepare contingency plans for incidents or malfunctions, including alternative landing sites and plans for RPA retrieval should there be a crash.

2.5 Assess the particularities and dynamics of the values that could be affected at the site, including the species of fauna and flora present, their numbers and/or extent, and where they are located to assess their concentrations, as part of the environmental impact assessment process and mission planning. Where appropriate, adjust flight plans, including the timing of the mission to avoid sensitive breeding periods (including for all species that may be present in addition to any study species), so that potential disturbance is minimised.

2.6 Identify any specially protected sites (eg, ASPAs, ASMAs, Historic Sites and Monuments (HSMs) and any special zones within these areas), or sites subject to Antarctic Treaty Visitor Site Guidelines, in the vicinity of planned RPAS operations and ensure any overflight restrictions specified in their management plans or site guidelines are followed.

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[4] As required by Art. 3 Annex II to the Protocol. This permit can only be granted under certain conditions.

[5] As required by Art. 2 Annex III to the Protocol.

[6] As required by Annex V to the Protocol.

2.7 Consider options and contingencies carefully in the EIA before planning to operate in and over potentially environmentally sensitive areas (*eg*, wildlife colony, or extensive vegetation cover that could be impacted by trampling), or where retrieval of a lost RPA would be difficult or impossible, while recognising that such areas may also be of particular interest for RPAS surveys.

2.8 If you plan to operate RPAS from boats or ships, be aware of elevated risks of collisions with flying birds that often follow ships.

2.9 Where multiple RPAS operations are anticipated to occur in the same area or repeatedly over time, consider in the EIA the potential for cumulative environmental impacts.

## 3 RPAS Characteristics

3.1 Carefully select the type of RPAS and sensors that will be most appropriate for fulfilling the objectives of planned air operations and where possible use Best Available Technology to minimise environmental impacts. Carry out test flights outside Antarctica to verify your choice (*eg*, testing sensor capabilities at different flight altitudes, and where practicable selecting sensors or lenses that allow greater separation distances from wildlife).

3.2 Consider selecting RPA models with the lowest practicable noise levels, and models with non-threatening shapes, sizes and/or colours, for example that do not closely resemble aerial predators likely to be present at the site of operation to minimise stress on prey species and/or attacks by territorial species.

3.3 Ensure the RPAS is well-maintained and operates reliably before deployment to reduce risk of failure and loss. The use of RPAS equipped with a Return To Home (RTH) feature is recommended. Ensure sufficient power or fuel to accomplish missions. For electric RPAS closely monitor battery capacity and performance, which varies with conditions. For combustion RPAS, check there are no fuel leaks, that fuel caps are secure, use best practice when handling fuel and refuelling and ensure that fuel spillage counter-measures are in place.

3.4 To reduce the risk of non-native species introductions, ensure that the RPAS and all associated equipment and carrying cases are clean and free of soil, vegetation, seeds, propagules or invertebrates prior to shipment to Antarctica. To reduce the risk of species transfer within Antarctica, carefully clean RPAS and associated equipment after use and prior to use at another site.

## 4 Operator Characteristics

4.1 RPAS pilots should be well-trained and experienced before undertaking operations on-site in Antarctica.

4.2 Before operating in Antarctica, RPAS test flights should be undertaken in a variety of conditions by the pilot that will be operating in Antarctica with the specific type, model and payload of RPAS that will be deployed.

4.3 RPAS operations should comprise a pilot and, as appropriate, at least one observer. Pilots should have good knowledge of the environmental requirements as listed in Section 1, and all aspects of the planned site of operations before deployment to the field, including site sensitivities and potential hazards.

## *On-site and In-flight Operations*

### 5 General considerations

5.1 Pilots and any designated observers should operate within Visual Line Of Sight (VLOS) with the RPA at all times, unless the operation is approved by a competent authority to operate "Beyond Visual Line Of Sight (BVLOS)".

5.2 Pilots and any designated observers should be vigilant during operations and maintain good communications with each other throughout operations, watching for wildlife moving into the area of operations.

5.3 Complete flight operations with number and duration of flights as practicable, while still achieving mission objectives.

### 6 Operations over or near wildlife

6.1 Select RPAS launch/landing site(s) carefully, considering topography and other factors (*eg*, prevailing wind direction) that may influence selection of the optimal distance from wildlife. Where practicable, consider locating RPAS launch/landing sites out of sight (bearing in mind any requirements to operate within VLOS) and downwind from concentrations of wildlife, and as far away from wildlife as possible.

6.2 Consider the noise level emitted by the RPA during launch and flight to inform decisions about the location of launch/landing site and flight altitude, taking into account the influence of wind conditions on noise at ground level.

6.3 Where practicable, consider attaining flight altitude while avoiding unnecessary overflight of wildlife.

6.4 Where practicable, consider operating RPAS at times of the day or year when the risk of disturbance to species present is minimised.

6.5 During VLOS operations, pilots and any designated observers should be aware of and monitor the proximity and behaviour of predators that could attack animals or their young within the area of RPAS operations, or attack the RPA to present significant risk of collision. Should proximity of predators be observed and if their behaviour is observed to exceed levels of disturbance deemed acceptable in approvals for the activity, RPAS operations should be modified or ceased.

6.6 To the extent practicable, consider avoiding unnecessary or sudden RPA manoeuvres over wildlife, or flying RPA directly at or from above wildlife, and if possible fly in a grid flight pattern while still achieving mission objectives.

6.7 Fly as high as practicable and not lower than necessary when operating near or over wildlife. Where operation of RPA near wildlife is necessary, exercise minimum wildlife disturbance flight practices, maintaining a precautionary distance from wildlife at all times during flight which ensures that no visible disturbance occurs. Wildlife reactions to RPA vary extensively, for example depending on the species, their breeding status, the flight altitude and whether flight approaches are either horizontal or vertical.

Where multiple species are present, follow the most precautionary approach and if wildlife disturbance is observed at any separation distance, a greater distance should be maintained.

6.8 Pilots and any designated observers should operate with special care near cliffs where birds may be nesting, and where practicable maintain the horizontal separation distance. During VLOS operations, pilots and any designated observers should watch for, and inform each other of, signs of wildlife disturbance. They should be mindful that outward behavioural displays may not be a good indicator of the actual level of stress being experienced by wildlife, which should also be taken into account in the EIA and planning phase. Should wildlife disturbance be observed to exceed levels deemed acceptable in approvals for the activity, pilots should adopt a precautionary approach by considering increasing RPA distances from animals if safe to do so, and considering ceasing operations if disturbance persists.

6.9 When BVLOS operations over or near wildlife concentrations are planned, consider the practicality of placing an observer nearby to note potential behavioural changes and inform the pilot.

**7 Operations over terrestrial & freshwater ecosystems**

7.1 Pilots and observers should take care to minimise disturbance to sensitive geological or geomorphological features (*eg*, geothermal environments, fragile surface features such as crusts or sedimentary deposits), soils, rivers, lakes and vegetation in the area of RPAS operations, and conduct their activities, including walking over the site, so as to avoid sensitive sites to the maximum extent practicable.

7.2 Should it be necessary to make an unplanned landing and/or retrieve an RPA from an unfamiliar area, the pilot and/or observer should be especially careful to minimise disturbance to site features that may be sensitive, such as wildlife, vegetation or soils.

**8 Human considerations**

8.1 To the extent practicable, avoid operating RPAS over Historic Sites or Monuments (HSMs) to minimise the risk of RPA loss at these sites. Should retrieval of a failed RPA within an HSM be necessary, notify the appropriate authority and receive advice before undertaking any action.

8.2 RPAS operators should be aware that many people value Antarctica for its remoteness, isolation and aesthetic and wilderness values. Respect the rights of others to experience and appreciate these values, and where practicable adjust flight operations (*eg*, timing, duration, distance) to avoid or minimise intrusion.

## *Post-flight Actions and Reporting*

**9 Actions**

9.1 In the event of an unplanned forced landing or crash, and mindful of the obligations for removal of waste from Antarctica in accordance with the Madrid Protocol (see Item 1.3), retrieve the RPA if:

- It is safe to do so;

- There is a risk that human life, wildlife or important environmental values are endangered, in which case notify the competent authority and as appropriate emergency procedures should be taken to neutralise the risk;
- The environmental impact of removal is not likely to be greater than that of leaving the RPA *in situ*;
- The RPA does not lie within an ASPA for which you do not have a Permit for entry, unless the RPA poses a significant threat to the values of the ASPA in which case notify the competent authority and as appropriate emergency procedures should be taken to neutralise the risk.

9.2 If a lost RPA cannot be retrieved, notify the competent authority, providing details of the last known position (GPS coordinates) and the potential for any environmental impacts.

## 10 Reporting and updating these Guidelines

10.1 Observe and record animal reactions before, during and after RPAS flights, preferably by a dedicated observer rather than the pilot who should be principally focused on RPA systems and control.

10.2 Post-activity reporting should be completed in accordance with the EIA and/or permitting associated with the activity. Consider including details of any environmental impacts and consider how such impacts may be avoided in the future. Where practicable, consider using a standard format to report this information (*eg*, see forms provided in the COMNAP RPAS Operator's Handbook), and consider making the information accessible in order to improve RPAS environmental best practices in the future.

10.3 RPAS operators are encouraged to carry out further research into the environmental impacts of RPAS to help minimise uncertainties, undertake regular reviews of the research, and publish observations in the literature to help refine and improve these Best Practice Environmental Guidelines for the operation of RPAS in Antarctica.

### ***Appendix 1: Selected technical documents relevant to environmental guidelines for Remotely Piloted Aircraft Systems (RPAS) in Antarctica***

Antarctic Treaty Parties, Resolution 2 (2004) Guidelines for the Operation of Aircraft Near Concentrations of Birds in Antarctica.

Antarctic Treaty Parties, Committee for Environmental Protection Non-Native Species Manual (Version 2017).

COMNAP (Council of Managers of National Antarctic Programs) 2017. Antarctic Remotely Piloted Aircraft Systems (RPAS) Operator's Handbook. Version 7, 27 November 2017.

IAATO (International Association of Antarctica Tour Operators) 2016. IAATO Policies on the use of Unmanned Aerial Vehicles (UAVs) in Antarctica: update for the 2016/17 season. Information Paper 120, XXXVIII ATCM held in Santiago, Chile, 23 May – 01 Jun 2016.

ICAO (International Civil Aviation Organisation) 2015. *Manual on Remotely Piloted Aircraft Systems (RPAS)* First Edition. International Civil Aviation Organization Document 10019. Montréal, Canada.

SCAR Code of Conduct for Terrestrial Scientific Field Research in Antarctica (2009).

SCAR Code of Conduct for Activity within Terrestrial Geothermal Environments in Antarctica (2016).

## Appendix 2: Selected peer reviewed scientific papers on the environmental impacts of Remotely Piloted Aircraft Systems (RPAS).

Acevedo-Whitehouse, K. Rocha-Gosselin, A. & Gendron, D. 2010. A novel non-invasive tool for disease surveillance of freeranging whales and its relevance to conservation programs. *Animal Conservation* 13: 217–225.

Borrelle, S.B. & Fletcher, A.T. 2017. Will drones reduce investigator disturbance to surface-nesting seabirds? *Marine Ornithology* 45: 89–94.

Christiansen F, Rojano-Doñate L, Madsen PT and Bejder L. 2016. Noise levels of multi-rotor Unmanned Aerial Vehicles with implications for potential underwater impacts on marine mammals. *Frontiers in Marine Science* **3**: 277. doi: 10.3389/fmars.2016.00277

Erbe, C., Parsons, M., Duncan, A., Osterrieder, S.K. & Allen, K. 2017. Aerial and underwater sound of unmanned aerial vehicles (UAV). *Journal of Unmanned Vehicle Systems* 5: 92–101. dx.doi.org/10.1139/juvs-2016-0018

Goebel M.E., Perryman W.L., Hinke J.T., Krause D.J., Hann N.A., Gardner S. & LeRoi D.J. 2015. A small unmanned aerial system for estimating abundance and size of Antarctic predators. *Polar Biology* **38**: 619-630 doi:10.1007/s00300-014-1625-4

Hodgson, J.C. & Koh, L.P. 2016. Best practice for minimising unmanned aerial vehicle disturbance to wildlife in biological field research. *Current Biology* **26**: R404-R405 doi:http://dx.doi.org/10.1016/j.cub.2016.04.001

Korczak-Abshire, M., Kidawa, A., Zmarz, A., Storvold, R., Karlsen, S.R., Rodzewicz, M., Chwedorzewska, K., & Znoj, A. 2016. Preliminary study on nesting Adélie penguins disturbance by unmanned aerial vehicles. *CCAMLR Science* **23**: 1-16.

McClelland, G.T.W., Bond, A.L., Sardana, A. & Glass, T. 2016. Rapid population estimate of a surface-nesting seabird on a remote island using a low-cost unmanned aerial vehicle. *Marine Ornithology* 44: 215–220.

McEvoy, J.F., Hall, G.P. & McDonald, P.G. 2016. Evaluation of unmanned aerial vehicle shape, flight path and camera type for waterfowl surveys: disturbance effects and species recognition. *PeerJ* 4: e1831. doi: 10.7717/peerj.1831

Moreland, E.E., Cameron, M.F., Angliss, R.P. & Boveng, P.L. 2015. Evaluation of a ship-based unoccupied aircraft system (UAS) for surveys of spotted and ribbon seals in the Bering Sea pack ice. *Journal of Unmanned Vehicle Systems* 3: 114–22. dx.doi.org/10.1139/juvs-2015-0012

Mulero-Pázmány, M., Jenni-Eiermann, S., Strebel, N., Sattler, T., Negro, J.J. & Tablado, Z. 2017. Unmanned aircraft systems as a new source of disturbance for wildlife: A systematic review. *PLoS ONE* 12 (6): e0178448. doi:10.1371/journal.pone.0178448

Mustafa, O., Esefeld, J., Grämer, H., Maercker, J., Rümmler, M-C., Senf, M., Pfeifer, C., & Peter, H-U. 2017. Monitoring penguin colonies in the Antarctic using remote sensing data. Umweltbundesamt, Dessau-Roßlau.

Pomeroy, P., O'Connor, L. & Davies, P. 2015. Assessing use of and reaction to unmanned aerial systems in gray and harbor seals during breeding and molt in the UK. *Journal of Unmanned Vehicle Systems* 3: 102–13. dx.doi.org/10.1139/juvs-2015-0013

Rümmler, M-C., Mustafa, O., Maercker, J., Peter, H-U. & Esefeld, J. 2016. Measuring the influence of unmanned aerial vehicles on Adélie penguins. *Polar Biology* **39** (7): 1329–34. doi:10.1007/s00300-015-1838-1.

Smith, C.E., Sykora-Bodie, S.T., Bloodworth, B., Pack, S.M., Spradlin, T.R. & LeBoeuf, N.R. 2016. Assessment of known impacts of unmanned aerial systems (UAS) on marine mammals: data gaps and recommendations for researchers in the United States. *Journal of Unmanned Vehicle Systems* 4: 1–14. dx.doi.org/10.1139/juvs-2015-0017.

Vas, E., Lescroël, A., Duriez, O., Boguszewski, G. & Grémillet, D. 2015 Approaching birds with drones: first experiments and ethical guidelines. *Biology Letters* 11: 20140754. dx.doi.org/10.1098/rsbl.2014.0754.

Weimerskirch, H., Prudor, A. & Schull, Q. 2017. Flights of drones over sub-Antarctic seabirds show species and status-specific behavioural and physiological responses. *Polar Biology* (online). DOI 10.1007/s00300-017-2187-z.