University National Oceanographic Laboratory System (UNOLS)

Uncrewed Aerial Systems (UAS) Operations from the U.S. Academic Research Fleet: Operator's Handbook

Photos courtesy of Luc Lenein, Chris Zappa and NSF/USAP

A publication from the UNOLS Scientific Committee for Oceanographic Aircraft Research

Document Release and Revision history

Version 1.0: UNOLS Council Endorsement and Release -March 28, 2019
Version 2.0: Changed the word Manned to Crewed and Unmanned to Uncrewed - July 8, 2021
Version 3.0: Changed XXXXX - 2025

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NOTES to discuss

- ADD B4UFLY

I agree with the switch from COA's to Part 107. That seems to be the direction things are going. However, we do still call in NOTAMs occasionally. For example, if we do a UAS flight in Newport, OR because it's nearby an airport. But maybe there's more efficient ways we could be doing this.

With regards to the flow chart and the description of saying "no recreational flights off a ARF vessel". Do we want to consider modifications to this? If you recall we had discussed the idea of allowing it at the Captains discretion as long as there is at least one crew member on watch who is part 107 certified.

COAs - are these appropriate for work on ships?

RE NOTAMS (from the Google)

A UAS NOTAM should be submitted when you are operating a drone under a Certificate of Authorization (COA) requiring it, typically 24 to 72 hours before your intended flight operation; this means you should file it well in advance of your drone flight to alert other airspace users about your planned activity.

Key points about UAS NOTAMs:

Not required for Part 107 operations:

If you are flying under the standard Part 107 rules for recreational drone operations, a NOTAM is generally not required.

Check your COA requirements:

If you have a COA, carefully review the conditions to see if it mandates filing a NOTAM for your specific drone operation.

Contact Flight Services:

To submit a NOTAM, you can contact Flight Services via phone at (877) 487-6867.

Provide necessary details:

When filing a NOTAM, be sure to include accurate information about your flight area, dates, times, altitude, and any other relevant details about your drone operation

Objectives

Operation of UAS, or drones, from or over ARVs may not take place without demonstrated compliance with national or international regulations (International Coalition for Sustainable Aviation, ICSA, Federal Aviation Administration, FAA) and specific approval of the ship's captain or designee, as a minimum. This policy also applies to the high seas, or the airspace above areas beyond the exclusive economic zones of the nations of the world.† This applies to crew, technicians and members of the science party, and refers to all operations, whether recreational, educational, or professional. The purpose of this document is to provide guidance to the research community and operator institutions.

UNOLS recognizes that UAS must be safely integrated into the airspace of the proposed experiment site. All UAS operation must also demonstrate compliance with ship operation requirements, and any other oversight entities (e.g. University Center of Excellence, Risk Management office) associated with the operator institution or with funding agencies (e.g. ONR environmental review). It also recognizes that UAS are built in a variety of shapes and sizes and serve diverse purposes, and therefore there is not a unique approach to operating UASs from research vessels.

This document represents the agreed information from discussions during recent UNOLS Scientific Committee for Oceanographic Aircraft Research (SCOAR) meetings and has been reviewed and approved by its Subcommittee on UAS Shipboard Operations.

This Handbook is divided into three parts:

- Chapter 1 includes introductory/general information.
- Chapter 2 contains requirements and recommendations for safe operations on academic research vessels.
- Chapter 3 contains appendices of various templates of common forms, such as communications plans and UAS pilot logs. These templates are provided as examples and can be modified to suit a specific UAS activity. Note that specific institutions will have different requirements.

Finally, this handbook should be viewed as a living document which, as UAS technology evolves, and as published research on the use of UAS from research vessels is made available, the recommendations and appendices are expected to evolve. Comments from any UNOLS institution, on any aspect of this Handbook, would be welcomed.

Acronyms, Abbreviations & Terminology

ADIZ -Air Defense Identification Zones
AGL -Above Ground Level
AMAP - Arctic Monitoring and Assessment Programme
ARF -Academic Research Fleet
BRLOS – Beyond Radio Line-of-Sight
BVLOS – Beyond Visual Line-of-Sight
COA – Certificate of Authorization, applies for both Public Agencies or Commercial UAS flights
CONMAP - Council of Managers of National Antarctic Programs
CW – Continuous Wave
DoD – Department of Defense
EIA - Environmental Impact Assessment
EM -Electromagnetic
EVLOS -Extended Line of Sight
FAA -Federal Aviation Administration
ICAO -International Civil Aviation Organization
ICSA - International Coalition for Sustainable Aviation
IR -Infrared
LASER - Light Amplification by Stimulated Emission of Radiation
NOTAM -Notice to Airmen
Part 107 - FAA Small UAS Regulations
PIC -Pilot in Command
RPA -Remotely Piloted Aircraft
RPC -Remote Pilot Certificate
SCOAR - Scientific Committee for Oceanographic Aircraft Research
UAS -Uncrewed Aircraft System(s)
UNOLS -University-National Oceanographic Laboratory System
UTC -Universal Time Coordinated
UV -Ultraviolet
VFR -Visual Flight Rules
VLOS -Visual Line of Sight

Chapter 1 -General Information

Introduction

Technological advances have led to increased UAS capability and deployability in recent years. Most categories of UAS are now available at low cost, are lightweight and easily transportable, making it very attractive to the research community, both for science and outreach purposes. Technological advances will continue and will make their uses a common occurrence on research vessels.

The principle objective of aviation regulatory guidelines is to achieve and maintain the highest possible level of safety. In the case of UAS, this means ensuring the safety of any other airspace user and of persons, environment, wildlife, infrastructure and equipment on the ground, including areas and equipment of scientific importance. Hazards and risks should be identified and assessed for each specific deployment as for any airborne object, advance notification and communications with other operators in any given region is essential to reduce risk of harm.

Size & Category

Remotely Piloted Aircraft Systems (RPAs) and UAS can vary in size to those that are small (micro-), very light to light (mini-) and can be hand-launched, to those that are large to very large (major). Some countries have in place their own UAS classification system by size or weight of the unfuelled RPA component of the system and some countries have not yet agreed upon a classification system. Countries which have developed their own category systems and definitions, use varying terminology and size/weight categories so that no two agreed systems are identical.

Below (Table 1) is an attempt to summarize the range of size generally used for research purposes (Fladeland et al. 2017, NCAR / EOL Workshop - Uncrewed Aircraft Systems for Atmospheric Research).

Weight (kg)	Normal Operating Altitude (ft)	Mission Radius (km)	Typical Endurance (hrs)
<2	<400	5	<1
2-24	<3,000	25	2-8
25-149	<5,000	50	4-12
150-600	<10,000	200-500	8-14
>600	<18,000	1000	>20
>600	>18,000	5000	>24

For the purposes of simplicity of this Handbook, UNOLS SCOAR considers that there are only 2 categories of RPAS. Those with a RPA that is:

- Small/Medium – Less than 25kgs
- Large – Greater than 25kgs.

Most RPAs, if not all, that have been deployed from research vessels in support of science currently fall within the small/medium category and are therefore the focus of the Handbook.

Large UASs (those >25kg) fall under very different regulations and have more restrictive operational requirements and restrictions. See the FAA website for more information.

Regulations

ADD SOMETHING ABOUT B4UFly

FAA Operation of Small Uncrewed Aircraft (Part 107)

Small drones less than 55 pounds, can be flown on the Academic Research Fleet by following the Part 107 guidelines. To fly under Part 107 rules, there are 3 main steps:

1) Understanding the Rules
2) Become an FAA Certified Drone Pilot
3) Register the Drone with the FF.

CFR 107, the Small Unmanned Aircraft Systems (sUAS) Rule, governs the commercial operation of drones in the United States. Below is a summary of the Key Requirements to CFR 107. Always refer to the official CFR 107 regulations for the most accurate and up-to-date information.

CFR 107 Key Requirements (as of 31Dec24):

- Pilot Certification:
    - In order to fly a drone under the FAA's Small UAS Rule (Part 107), users must obtain a Remote Pilot Certificate from the FAA. This certificate demonstrates that you understand the regulations, operating requirements, and procedures for safely flying drones. Remote pilots must hold a Remote Pilot Certificate with a Small UAS rating issued by the FAA to operate UASs off of the vessels of the US ARF. More information on obtaining a license can be found on the FAA website.
- Aircraft Registration:
    - All small drones used onboard the US ARF must be registered with the FAA. Aircraft can be registered through the FAA DroneZone application online. T
- Visual Line of Sight (VLOS):
    - Pilots must maintain direct, unaided visual observation of the drone at all times.
    - Exceptions exist for certain operations under specific conditions.
- Operating Limits:

Under Part 107 there are several operating limits:

    - Altitude: Maximum altitude of 400 feet above ground level (AGL).
    - Daytime Operations: Generally limited to daylight hours (civil twilight to civil twilight).
    - Flight Over People: Prohibited unless the individuals are directly involved in the operation and are protected from falling objects.
    - Flight Near Airports: Restrictions on flying near airports and other controlled airspace.
- Waivers:

A waiver is an official document issued by the FAA which approves certain operations of aircraft outside the limitations of Part 107. Waivers must be obtained to operate outside the Part 107 operating limits. Find out more about obtaining a waiver from the FAA website. Waivers can take up to 60 days to process so starting the process early is key.

- Airspace Restrictions:

Small UASs operated under Part 107 are prohibited from operating in certain airspace, such as within 5 miles of a military installation or within 30 miles of a controlled airport without prior authorization.

Recent updates to Part 107 allow for the operation of small unmanned aircraft over people, moving vehicles, and at night under certain conditions with restrictions. These updates also provide updated regulations on Night Operations and the Remote Pilot Knowledge Test. The details of these updates can be found on the FAA Website.

- Safety Requirements:
    - Pre-flight Inspections: Mandatory pre-flight inspections of the aircraft and equipment.
    - Weather Considerations: Operations must be conducted in weather conditions that allow for safe operation.
    - Hazard Avoidance: Pilots must actively avoid hazards such as other aircraft, towers, and power lines.
- "Rules of the Road"
- Part 107 also outlines several general rules of operations.
    - Always avoid manned aircraft.
    - Never operate in a careless or reckless manner.
    - Keep your drone within sight. If you use First Person View or similar technology, you must have a visual observer always keep your drone within unaided sight (for example, no binoculars).
    - You cannot be a pilot or visual observer for more than one drone operation at a time.
    - Do not fly a drone over people unless they are directly participating in the operation.
    - Do not operate your drone from a moving aircraft.
    - Do not operate your drone from a moving vehicle unless you are flying your drone over a sparsely populated area and it does not involve the transportation of property for compensation or hire.

UNOLS UAS Policy

In the summer of 2016, the UNOLS Council endorsed the following UAS policy:

With the recent publication of the FAA small UAS rule, a policy for U.S. academic ships has become necessary. Effective immediately, operation of Uncrewed Aircraft Systems (UAS), or drones, from or over U.S. academic ships may not take place without demonstrated compliance with national or international regulations (ICSA, FAA) and specific approval of the ship's captain or designee, as a minimum. This applies to crew, techs and members of the science party, and refers to all operations, whether

recreational, educational, or professional. Obtaining national approvals, such as FAA's Sec 333 exemption or Certificate of Authority or Waiver (COA), as well as pilot qualifications, are not a guarantee the operations will be approved by the ship's captain. Recreational or hobbyist freedom of use over land is not available at sea, so the importance of contacting the ship's operator ahead of time is critical.

Certificate of Authorization (COA)

I don't think we can use this! - see

https://www.faa.gov/media/12546#:~:text=A%20state%20uruversity%20with%20a,not%20related%20to%20development%20of

and

https://pilotinstitute.com/certificate-of-authorization/#:~:text=Public%20safety%20agencies%20often%20need,Pilot%20Institute%20offers%20for%20free.

American Drone Security Act 2023

The American Security Drone Act of 2023 is part of the National Defense Authorization Act of 2024. The Act prohibits federal procurement and operation of drones manufactured in "covered foreign entities". This includes drones manufactured by DJI, which are a very popular, inexpensive systems often used within the U.S. ARF. Drones from "covered entities" pose a security risk because their software allows data to be sent back to the manufacturer. Operators cannot control this data flow, as it is integrated into the drone's operating system. The Act's effective as of December 22, 2025 after which time only UASs from the Blue UAS Cleared List are able to be operated onboard the US ARF. More information on the Act can be found here.

Chapter 2 -Planning & Requirements

Planning and Preparation

The international civil aviation community is continuing to refine the regulation of UAS operations. Some countries have developed and have in place regulation, while in other countries there is little regulation of uncrewed operations.

Operation of all Uncrewed Aircraft Systems (UAS), or drones, from or over U.S. ARF vessels may not take place without demonstrated compliance with national or international regulations (ICSA, FAA) and specific approval of the ship's captain or designee, as a minimum. This applies to crew, techs and members of the science party, and refers to all operations. Obtaining national approvals, such a pilot qualification, are not a guarantee the operations will be approved by the ship's captain. Recreational or hobbyist freedom of use over land is not available at sea, so the importance of contacting the ship's operator ahead of time is critical.

Flowchart for decision-making

The flow chart below (Figure 1) may be used by science party and operator institution as a tool to assist them with safe UAS operations in a range of situations. It recommends appropriate steps to take in the pre-planning stages of the activity. The flow chart will be updated regularly as the FAA and UNOLS policies evolve. Note that FAA policies on UAS operation are constantly evolving; this chart is only meant to provide general guidelines for safe and legal operation and one should always refer to the most recent regulations of their governing airspace entity.

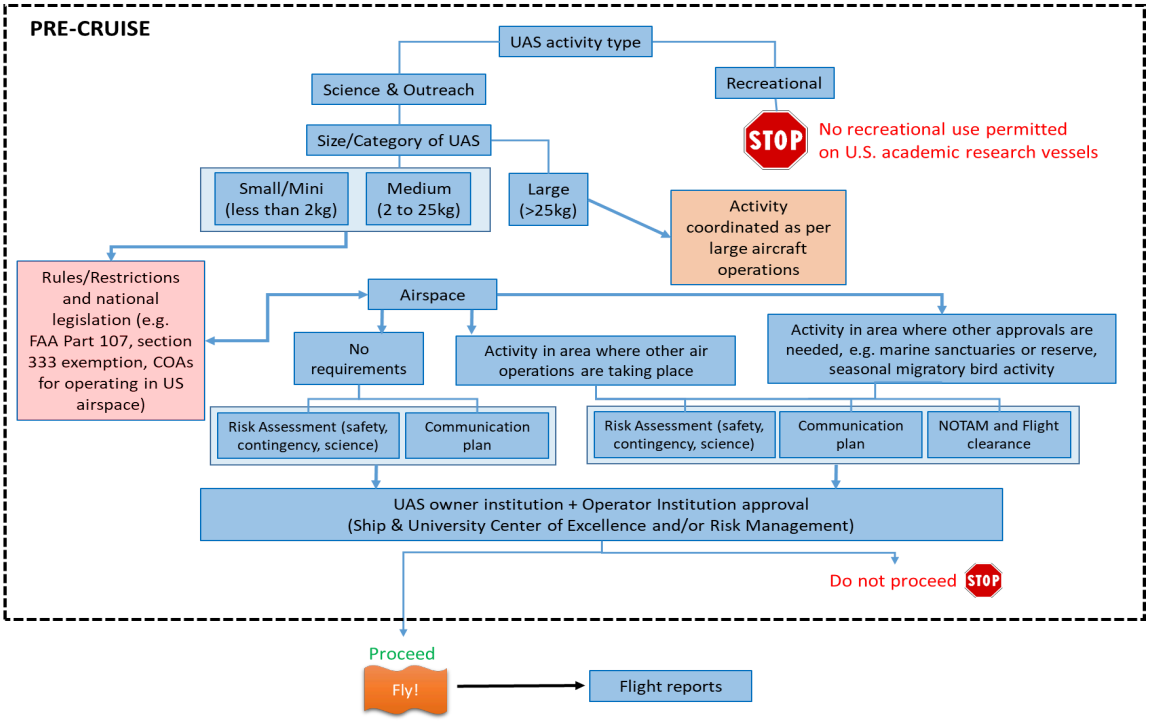

Figure 1. Flowchart for UAS Operation decision-making

Timeline

Figure 2 shows a typical expedition timeline, highlighting the critical steps needed to ensure a successful UAS deployment during a research cruise.

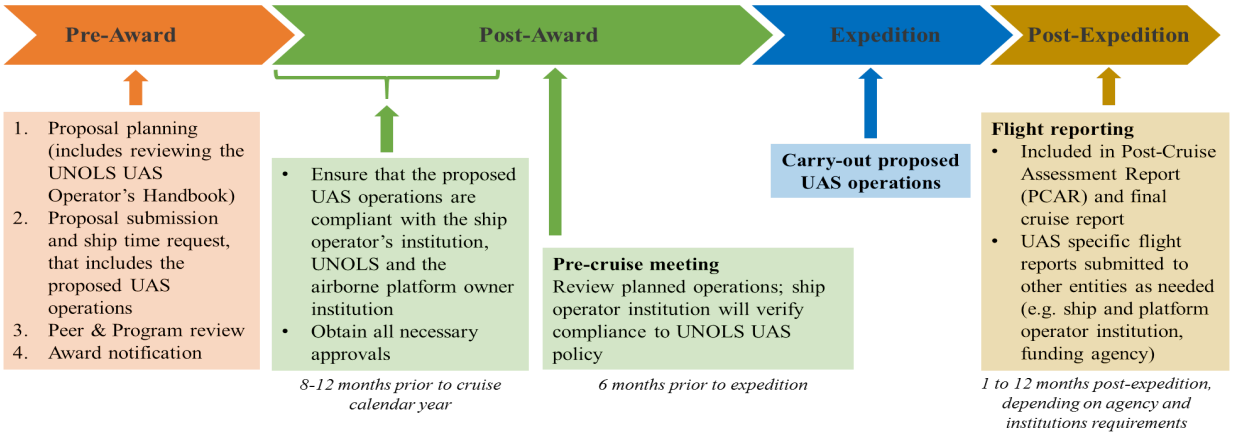

Figure 2. Expedition Planning Timeline.

Recommendations and Guidance

- All UAS deployments are to be conducted for support of science, including science support, ship logistics and operations, outreach/documentation of research, and for use in emergency and search and rescue situations. Recreational use is not permitted on U.S. academic research vessels.
- All proposed UAS operations conducted from an academic research vessel must be approved by the oversight entity of the ship (vessel operator) and UAS operator institution. A number of institutions now have a flight request system in place to check FAA compliance of the proposed effort. The research vessel must have an approved shipboard UAS operations policy tailored to the specific ship.
- All UAS operational plans must be covered in pre-cruise planning meetings with the research vessel crew.
- Liability insurance coverage must be compliant with the requirements imposed by the ship operator institution and the institution that owns the UAS or RPA.
- A reciprocal waiver agreement is required to address the potential liability of the ship operator if the UAS is damaged while in storage, transit, or while being handled by the ship's crew.
- Recognizing that there are many regions of the world where no crewed air operations take place and that there are areas that require detailed coordination with range operators (restricted and warning airspace along the coast of continental United States). In these areas, advanced communication of planned UAS operations, emplacement of UAS restrictions (height and radius around crewed air operations locations and facilities) or emplacement of technologies such as "geo-fences required.
- If operations are conducted in waters or airspace where no local regulations are in place, or in high seas, it is recommended to follow the general guidance of the Convention on International Civil Aviation Organization (ICAO). Note that it is the responsibility of the UAS operator to

determine that the proposed operation area is clear of any controlled airspace or Air Defense Identification Zones (ADIZ).

- Where practical, all major components of any UAS must carry identification marks, including any national registration and identification information, in order to identify the pilot and operator for record keeping or in the event of an accident, incident or near-miss. Any such marks, especially on medium and large RPA should be placed on the deployed aircraft in a manner that can be clearly visible during flight. Brightly colored RPAs might be appropriate for over the water use, for retrieval/recovery purposes.
- Ship operator institutions are to take a common approach to safety risk assessment based on a recognized and commonly accepted air operations framework so that RPA operations can be carried out in as safe a manner as crewed aircraft operations and not present a hazard to persons, property or the ocean environment that is any greater than that attributable to the operation of crewed aircraft performing the same or similar activity.
- Each RPA pilot must produce proof of appropriate training and certification, and the ship operator institution must ensure that each RPA pilot is appropriately trained in accordance with national regulations and in a manner that is consistent with, for example, the provisions of Annex 1 to the Convention on International Civil Aviation (ICAO) Personnel Licensing, and provides proof of proficiency of training or competency for the specific category and type of RPA to be flown. If the pilot is flying his/her own manufactured RPA, specific airworthiness certification must be required.
- Ensure that proposed UAS or RPA operations is in compliance with Department of Defense (DoD) requirements if the project or airborne platform is funded by DoD.
- Instrumentation Environmental Review - LASER and electromagnetic (EM) radiation instrumentation when utilized on UAS operated from seafaring vessels within marine environments and sanctuaries, needs to strictly follow industry and research community safety standards as would be followed in any normal operating procedure.

Shipboard Procedures

1. A pre-flight plan/check-list must be developed prior to the start of a field experiment using UASs. Plans must be reviewed with the Captain or designee prior to operations.
2. Risk assessment must be part of a pre-flight check-list to be completed prior to UAS flight operations. Identification of hazards and assessment of risk related to deployment of UAS from research vessels is a continuously applied process that is aimed at ensuring all risks are mitigated to a low or equivalent rating. It also incorporates provisions that allow those risks which cannot be mitigated to be addressed. There are many examples of “Consequence-Probability”, or “Cause-Consequence”, or “Hazard –Risk” matrices available (see Chapter 3: Resources).

Risk assessment must include

- Environmental considerations

  As with any activity undertaken from research vessels, at remote locations or not, an Environmental Impact Assessment (EIA) should be used to determine the level of environmental impact a proposed activity is expected to have. That EIA should include waste management and recovery procedures for the safe recovery of any RPA that has crashed.

- Safety of human life considerations

  In many instances, UAS use provides a safe alternative to crewed aircraft operations. In UAS operations, from the point of view of safety to human life, the most severe possible outcomes are those that result in injury or death to persons on the ground or persons in other aircraft.

3. Flight Logs? Flight Logs are recommended??
4. Communications Plans?
5. All UAS deployments conducted from research vessels must involve appropriate licenses, authorizations and notifications. In areas with crewed air operations, use of a communications plan and the NOTAM (or similar) system may be required. According to: A NOTAM is not required under Part 107 flights. They are only required if you have a Certificate of Authorization (COA) to fly under Part 91 as a public aircraft and part of the COA has a requirement to issue a NOTAM.
6. Prior to UAS launch, a safety brief must be held for all personnel involved with the operation.
7. All UAS operations conducted from research vessels must contain provisions for safe and appropriate retrieval of waste in the event the UAS suffers an accident as part of its operations.
8. In accordance with Part 107, any UAS accident, incident or near miss must be reported immediately via FAADroneZone. Accident reports may also be made by contacting the nearest FAA Flight Standards District Office (FSDO).

Post-Cruise Actions

1. All ship operator institutions must routinely share operational and certification information and any documentation developed, in support of the sharing of best practices and to facilitate the establishment of national accreditation and operational programs.
2. A flight record for each UAS flight should be submitted to the operator institution and UNOLS SCOAR, in accordance with Appendix 5.

Chapter 3 -Resources

There are many resources on operating an UASs in accordance with Part 107 as well as operational templates. Some include:

- FAA website on Drone Operations
- COMNAP RPAS Operator's Handbook (18 December 2023)

The CONMAP RPAs Operator Handbook includes many great templates

  - Risk Assessment and Management (Appendix 1)
  - Communications Plan (Appendix 2)
  - Reporting and Record Keeping (Appendices 4 & 5)

- Other Resources?