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| IALA Guideline |

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use of drones for aton management

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# Introduction

During the Competent Authority’s inspection of marine Aid(s) to Navigation (AtoN), such as lighthouses and underwater breakwaters, on-site inspectors face difficulties accessing the site directly, exposing them to danger and limiting their ability to thoroughly check the facility's condition. Drone inspections could be effective in areas of harsh weather.

AtoN authorities have introduced drones for safety inspections of high-rise structures like lighthouses, beacons, and hard-to-reach objects or hazards. Drone operations within this document pertain specifically to aerial devices. By utilizing drones for AtoN inspections, it becomes feasible to capture footage of high-rise marine facilities and analyze videos, which are typically challenging to visually inspect. This approach addresses problems such as marine traffic safety blind spots, stemming from difficulties in accessing and inspecting sites. Consequently, it facilitates efficient and effective AtoN maintenance work.

Drone equipped with cameras and Real-Time Kinematic (RTK) modules are capable of capturing high-quality images and recording accurate geo-data, providing more detailed and consistent information about the state of AtoN such as position, damage, and failure.

The use of drones may lead to safe operation of staffs and cost effective method of inspecting AtoN while supporting sustainability, climate change, and reduction in vessel use and emissions. Data analysis and documentation in conjunction with administration of the AtoN is streamlined by a uniform data set which enables a quicker identification of potential issues or anomalies of the inspected AtoN.

Drone could also be used to enhance the heritage aspect of lighthouses and other AtoN structures, aligning with United Nations’ Sustainable Development Goal 11.4 to enhance sustainability.

# Scope

Within this guideline, the term 'Drone' refers to any remotely controlled Unmanned Aerial Vehicle (UAV) operated for AtoN management and hazard identification. These operations will include, but are not limited to:

* AtoN Installation
* AtoN Improvement
* AtoN Inspection
* AtoN Calibration

## Designation of Roles

* Competent Authority: Maritime AtoN service provider
* Drone Operator: Nominated authority within the organisation to oversee drone operations, administrative affairs, and oversee maintenance of drones. Provides guidance and supervision of Drone Pilots, and checks the qualification of Drone Pilot, and manages drone footage.
* Drone Pilot: The person who prepares the operation plan, does pre-operation checks, conduct the operation of drones
* Drone Maintenance Technician: The person who undertakes routine maintenance of drones
* National Regulator: National authority

In some organisations, one person may hold multiple roles.

# X.Application Scenarios in AtoN Management

**X.1 Routine Visual AtoN Inspections**

The routine visual AtoN inspections conducted by UAVs include, but are not limited to, position verification, appearance evaluation, and light quality assessment.

**X.2 AtoN Malfunction Inspections**

Upon receiving the AtoN alarm, UAVs can be deployed to verify the fault, capture the on-site information of the malfunction.

**X.3 Support for AtoN Deployment**

UAVs can be effectively utilized for terrain survey and site selection, offering significant application advantages in remote islands, capes, or other areas that are challenging for human access.

**X.4 Other Application Scenarios**

By deploying suitable software and hardware equipment, UAVs can be effectively applied in other scenarios, including but not limited to, radio signal detection, remote control of AtoN equipment, lighthouse range assessment, and radar beacon signal monitoring.

**X.Cost Analysis**

The use of drones in the AtoN management may lead to additional expenditures. Therefore, the Responsible Authority should conduct a cost analysis before implementation.

**X.1 Infrastructure and Personnel Requirements**

UAV take-off and landing facilities;

Ground control stations and other facilities;

Qualifications and certifications of operators.

**X.2 Area Conditions**

Scope of operations;

Operational cycle

Existing available sites;

Local environment factors (airspace, wind and wave conditions, etc.).

**X.3 Input and Output**

Acquisition cost and durable years of new drones;

Cost of drone spare parts;

Insurance costs;

Maintenance and operational expenses;

Development and maintenance costs of the drone system;

Training expenses for drone operators;

The impact on reducing labor costs and labor intensity, as well as other expenses associated with vessel operations;

Other potential benefits.

# drone pilot

## Designation of Pilot

### Designation of Pilot

To ensure safety of operation, the Responsible Authority should designate the Drone Pilot.

### Certification

As per relevant national legislation

## TRAINING

The Responsible Authority should ensure that training is provided to enable Drone Pilots to achieve and maintain the necessary levels required for drone pilot certification, etc. for:

* Operation of Drone
* Safe and efficient planning of the intended operation
* Risk assessment for the specific drone activities
* Maintenance of Drone and equipment
* National legislation updates
* Processing, analysis, and storage of data acquired

It is important for the Drone pilot to be familiar with national legislation and guidance, examples are available in Section 9 References.

# PURCHASE AND REGISTRATION

The Responsible Authority should consider operational efficiency and suitability when purchasing drones. For example waterproof drones. Each drone purchase should be reported to the Responsible Authority and registered as per national legislation requirements. The Responsible Authority should also ensure that appropriate insurance is in place, as per national legislation or guidelines.

# Drone OPERATIONs Manual

An operations manual is a vital document for ensuring the safe, compliant, and efficient operation of an UAV.

It functions as a comprehensive management tool, systematically detailing all operational processes and regulatory requirements. The manual should provide clear and standardized procedures for routine operations, as well as contingency and emergency protocols, ensuring that all personnel understand their specific roles and responsibilities.

Furthermore, an operations manual is essential for demonstrating compliance with relevant national and international regulations. It serves as evidence of the organization's commitment to adhering to safety standards, legal requirements, and best practices. The following sections should be included in any organizations operations manual.

## General Information

This chapter should provide an overview of the drone operator’s commitment to regulatory compliance, safety, and responsible operations, outlining key policies on security, environmental impact, and organizational structure.

### Opening Statement

The operator should commit to adhere to all relevant national and regional (EU) regulations governing UAV operations. The focus is on ensuring safety, following operational procedures, and fostering a "Just Culture" where personnel can report safety concerns without fear of reprisal.

### Security and Privacy Statement

The operato should ensure the protection of personal data and operational information in compliance with GDPR and internal policies. Systems are in place to safeguard against unauthorized access, misuse, or loss of sensitive information.

### Environmental Statement

The operator should be dedicated to minimizing environmental impact through sustainable practices. Efforts include reducing noise, emissions, and energy consumption during operations to promote eco-friendly drone use

### Operational Organization

This section provides an overview of the organizational structure, detailing the roles and responsibilities of key personnel, including operators, pilots, and maintenance crew. An organizational chart may be included to visualize the hierarchy and responsibilities within the team.

## Document Control

This chapter should outline the procedures for managing the documentation related to UAV operations, ensuring that all revisions are tracked, distributed, and retained in accordance with regulatory requirements.

### Revision Management

There should be a clear process for updating the operations manual requiring all changes to be reviewed and approved by the competent authority before implementation. Any updates must be clearly communicated to all relevant personnel to ensure they are working with the most current version of the manual

### Document Distribution and Retention

Documents should be distributed either digitally or physically, ensuring all personnel have access to the latest information. Important records related to flights, personnel qualifications, safety procedures, and maintenance logs must be retained for a specified period, typically at least three years, to comply with national legislative and operational requirements.

## Personnel Requiremnets

This chapter should define the necessary qualifications, roles, and health standards for all personnel involved in UAV operations, ensuring that only trained and capable individuals participate in flight operations. Adherence to these requirements ensures operational safety and compliance with regulations.

### Qualification and Roles

**Qualifications and Roles**

* **Operators**: Operators must hold the appropriate certifications for mission planning, risk mitigation, and ensuring safe UAV operations. This includes knowledge of airspace regulations, flight planning tools, and safety protocols.
* **Pilots**: UASVpilots must possess relevant certifications, such as remote pilot licenses, and undergo training in accordance with national legislation. This includes theoretical knowledge and practical experience to ensure proficiency in UAV control and safety procedures.
* **Maintenance Personnel**: Technicians responsible for maintaining UAS systems must have the necessary technical qualifications and experience. They are responsible for ensuring that the aircraft is properly maintained and in optimal condition for safe operations.
* **Ground Crew**: Personnel assisting with UAV operations must be adequately trained in their roles, which may include launch and recovery operations, communication with pilots, and ensuring safety on the ground.

## Operational Procedures

This chapter should outline the core operational procedures required for UAV operations, focusing on comprehensive planning, inspections, and emergency protocols to ensure safe, compliant, and effective operation of the UAV.

### Operational Planning

Comprehensive planning involves using up-to-date resources such as maps, AtoN data, and weather reports to ensure safe and accurate UAS operations. The planning process includes verifying compliance with geographical zones, airspace restrictions, and coordinating with both air traffic control (ATC) and VTS centers, especially when operating near controlled airspace or within a VTS zone. This ensures that all required regulatory clearances are obtained and that operations adhere to safety protocols.

### Pre Flight and Post Flight Inspections

Procedures for conducting thorough pre-flight and post-flight inspections of the UAV are essential to ensure it is airworthy. Pilots must check all systems, including communications and safety equipment, before each flight. These inspections should be carried out using standardized checklists, with all findings and corrective actions documented for future reference.

### Emergency and Contingency Procedures

Emergency procedures must be in place for handling unexpected situations such as adverse weather conditions, equipment malfunctions, and airspace intrusions by unauthorized aircraft. This includes specific protocols for loss of communication links, system failures, and other operational issues. Pilots must be trained in these procedures and be prepared to act swiftly to mitigate risks to people, property, and the UAS itself.

## Operational limitations

This chapter should outline the general operational limitations for UAV operations based on the drone manufacturer's specifications. Adhering to these limits will ensure safe and compliant drone operations

### Environmental conditions

* Light Conditions: UAV operations are restricted to daylight hours or as specified by the manufacturer, ensuring proper visibility for safe operation.
* Wind and Weather: Operations should not exceed the maximum wind speed or occur in adverse weather conditions (rain, snow, hail) that could impact safety.
* Temperature Range: The UAV must operate within the temperature limits specified by the manufacturer to avoid equipment malfunctions.

### Technical Limitations

* Maximum Take-off Weight (MTOW): The UAV must not exceed the manufacturer-defined take-off mass to ensure flight stability.
* Flight Speed and Altitude: Operations are restricted by manufacturer-set maximum speed and altitude, typically limited to 120 meters AGL unless otherwise authorized.
* Flight Angles: The UAV should maintain safe pitch and roll angles as per the manufacturer’s guidelines to avoid destabilization.

### Flight Areas and Restrictions

* Controlled Areas: Flights must occur in secured areas where unauthorized personnel are excluded. Operators must ensure the area remains controlled throughout the operation.
* Geographical Zones: UAS must comply with no-fly zones and airspace restrictions unless proper clearances have been obtained

### Automated and Manual Control

* Automated Systems: Geofencing, Return-to-Home, and other automated flight systems must be configured to ensure the UAV stays within designated operational area. Manual control must always be an available fallback.

### Payload and Battery

* Payload Limits: The UAV should not exceed the payload weight recommended by the manufacturer to avoid impacting flight performance.
* Battery Management: Battery levels must be monitored to ensure sufficient power for the entire operation and a safe return.

### Manufacturer Compliance

* All operational limits and procedures must align with the UAV manufacturer's manual to ensure safe and compliant flight operations. Regular checks for software updates and changes in operational guidelines should be mandatory.

## Training and Competency

This chapter outlines the essential training and competency requirements for personnel involved in UAS operations, ensuring that all staff are adequately prepared and regularly assessed to maintain high safety standards.

### Training Requirements

All personnel must undergo mandatory training, covering topics such as UAV operation, emergency response, and compliance with national airspace regulations. Regular refresher courses are required to ensure up-to-date knowledge on airspace structure, weather assessment, flight planning, and the correct use of equipment.

### Crew Resource Management

CRM training focuses on enhancing communication and coordination between crew members. Effective CRM is essential for ensuring teamwork, reducing errors, and maintaining safety during UAV operations, especially in multi-crew or complex mission scenarios.

## Maintenance

This chapter should cover the essential maintenance practices for UAV operations, ensuring the aircraft is kept in optimal working condition through scheduled inspections, software updates, and battery management.Maintenance items include, but are not limited to, batteries, fuselage structure and power systems.

### Scheduled Maintenace

UAV maintenance must be performed in line with the manufacturer’s guidelines, including routine inspections to identify wear and tear or potential issues. Only qualified personnel should be permitted to carry out maintenance tasks, and all activities must be logged in the technical logbook to maintain a detailed maintenance record. This ensures that the UAV remains safe and compliant with operational standards

### Sofware updates

When software updates are released by the manufacturer, they must be applied in a controlled manner. After updates, test flights should be conducted to verify that all systems are functioning correctly, and the UAV remains safe to operate. Any issues discovered during the tests must be documented and addressed before returning the UAV to regular service.

### Propeller and Battery Maintenance

* Propeller Maintenance: The propellers should be regularly inspected for signs of damage, wear, or imbalance. Damaged propellers must be replaced immediately to avoid compromising flight performance and safety.
* Battery Maintenance: Battery health is critical for safe UAV operation. Batteries must be regularly inspected for signs of degradation, swelling, or reduced capacity. Proper charging and storage procedures should be followed to extend battery life, and operators must ensure that batteries are always charged to appropriate levels before each flight. Any damaged or underperforming batteries should be removed from service.

# management of data acquired

## Data Storage & Access

The Responsible Authority should consider how to maintain the acquired data in an appropriate manner to ensure easy future access. They may need to consider data privacy requirements and the volume of data storage required.

The Responsible Authority could provide data access in accordance with national legislation (e.g., EU Privacy Protection Law). Data could be delivered to internal or external stakeholders such as Port Authority, Environmental entities, etc.

## Data protection

The Competent Authority shall be responsible for the protection of data acquired through drone operations, including metadata such as time and location. The Competent Authority shall also give consideration to cybersecurity measures to ensure the consistency and integrity of the data.

# maintenance of drone equipment

## Oblication of Maintenance

The Responsible Authority should ensure that a suitable maintenance programme has been put in place, and suitable processes are being followed by the Drone Pilot.

## Periodic Inspection

Drones should be inspected periodically like the examples below:

* Daily inspection: Conducted before and after the first use on the day of operation.
* Monthly inspection: Conducted once a month according to the manufacturer's maintenance instructions.
* Frequent inspection: Performance inspection conducted during maintenance, repair, or parts replacement.
* Special inspection: Conducted by an external company with professional personnel and inspection equipment if self-maintenance is not possible.

In addition, the Drone Maintenance Technician should conduct a comprehensive semi-annual inspection, including assessing the storage conditions of the drones, ensuring the availability of spare parts, and evaluating the overall operational status.

## Failure/Damage/Loss

Any failure, damage, or loss of drones should be recorded and reported to the Responsible Authority, the National Regulator, and other relevant bodies as required.

Plans and procedures should be prepared in the event of drone failure to minimize potential damage and increase the chance of recovery.

## Disposal

In cases where a drone becomes unusable due to the lapse of its durable years, damage, loss, etc., the matters should be reported to the Responsible Authority as required.

Drone or unusable parts should be disposed of in ethical and sustainable manner.

# Definition

Unmanned Aerial Vehicle (UAV): It refers to an aircraft that operates without an onboard pilot, that is equipped with its own flight control system, and engages in non-manned flight activities, including remotely piloted aircraft, autonomous aircraft, model aircraft, etc.

Unmanned Surface Vehicle (USV): It refers to a small surface self-propelled carrier with surface ships as the support platform, that can be a long time autonomous long-range navigation unmanned intelligent equipment.

Unmanned Underwater Vehicle (UUV): It refers to the unmanned equipment which is controlled by wired or wireless means or navigates underwater by autonomous program, that can be used for ocean exploration, resource survey, equipment maintenance and other tasks.

Real-time kinematic (RTK): A satellite navigation technique used to enhance the precision of position data derived from satellite-based positioning systems(global navigation satellite systems, GNSS) such as GPS, BeiDou, GLONASS, Galileo and NavIC.

First Person View (FPV): Also known as remote-person view, or video piloting, a method used to control a [radio-controlled vehicle](https://en.wikipedia.org/wiki/Radio-controlled_vehicle) from the driver or pilot's viewpoint.

Drone operation: Controlling drones and analysing data acquired, inspecting and maintaining drones and equipment

# references

* IALA Standard 1020 Marine Aids to Navigation Design and Delivery
* IALA Recommendation R1018 Responsible Design, Operation and Maintenance on the provision of Marine AtoN
* The Drone and Model Aircraft Code in UK (register-drones.caa.co.uk/drone-code)
* Korea Ministry of Oceans and Fisheries Unmanned Aerial Vehicle Guildelines (www.mof.go.kr)
* Federal Aviation Administration (faa.gov/uas)
* Australian Civil Aviation Safety Authority (casa.gov.au/knowyourdrone/drone-rules)
* Danish Civil Aviation and railway authority (droneregler.dk/english)
* CLASS N K Guidelines for ROV/AUV (www.classnk.or.jp)
* EASA (www.easa.europa.eu/en/newsroom-and-events/news/easa-publishes-template-operations-manual-specific-category-uas-operation )