



# IALA GUIDELINE

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## DEVELOPING A MAINTENANCE STRATEGY FOR AIDS TO NAVIGATION

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# DOCUMENT REVISION

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Revisions to this IALA Document are to be noted in the table prior to the issue of a revised document.

Date	Details	Approval
December 2009	First edition. This document incorporates content from the previous guideline on Painting, with the addition of sections covering maintenance strategies, maintenance methods, and condition-based maintenance.	Council 46
July 2022	Edition 1.1 Editorial corrections.	
December 2024	Edition 2.0. The document has been entirely rewritten to offer comprehensive guidance on developing maintenance strategies and plans for AtoN. A new Annex A has been added, while all other annexes have been removed.	Transition Council 3



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## 1. INTRODUCTION

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Maintenance is required to ensure that Marine Aids to Navigation (AtoN) equipment and systems continue to perform at the levels required by mariners to safely navigate the world's waterways. AtoN providers should develop a maintenance management strategy.

## 2. PURPOSE

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Maintenance management should consist of a high-level maintenance strategy and maintenance plans. The purpose of this document is to support AtoN providers with the information required to develop a maintenance management strategy and maintenance plans.

The maintenance strategy sets out the organisational approach to AtoN maintenance including, aims, objectives, constraints. When developing a maintenance strategy for AtoN, it is crucial to balance performance, risk, and cost to ensure the long-term sustainability and efficiency of operations whilst meeting IALA availability targets.

The maintenance strategy should be aligned with the organizations objectives to ensure organizational policy and coherence across organizational functions is supported.

Different asset and equipment types across an AtoN network may require different maintenance strategies to be applied, an example of this can be found in Annex A.

Maintenance plans identify the activities to be undertaken, required resources, philosophy, skills, equipment and schedule at asset/site level to achieve the stated aims and objectives of the maintenance strategy. Maintenance plans are dynamic and should follow the principles of Plan, Do, Check, Act.

## 3. GUIDING PRINCIPLES FOR MAINTENANCE STRATEGY

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The following guiding principles may assist authorities in developing their maintenance plans. When developing plans an AtoN authority should consider the following principals.

### 3.1. OPTIMAL SERVICE LIFE

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The designed operating lifetime of an asset beyond which continued maintenance and logistic support become economically unjustifiable. Maintenance plans should be developed to ensure that the maintenance activities taking place on the asset are balanced to provide efficient and cost-effective management of the asset during its service life.

### 3.2. OPTIMAL ASSET PERFORMANCE

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The required performance of an asset should be defined by the AtoN provider. The understanding of the performance requirements for assets, systems and supporting structures will assist in identifying the scale and level of maintenance required at each site. The following provide examples of key performance parameters that should be considered:

- The category and availability objective for each AtoN as detailed in R0130 Categorisation And Availability Objectives For Short Range Aids To Navigation.
- An understanding of the risk factors associated with each asset site. Examples include environmental risks, hazardous materials, access constraints.
- Mean Time to Repair (MTTR) and Mean Time Between Failure (MTBF) both influence the frequency of maintenance for each asset site.



The balance of such parameters in the development of maintenance plans is the means by which optimal asset performance is achieved.

### **3.3. COST OPTIMISATION**

Maintenance plans should reduce operational costs where practicable whilst minimising the risk to the performance of the asset. For example, a programme of planned maintenance may extend the life of an asset and reduce the risk of costly unplanned maintenance to rectify a failure.

### **3.4. REGULATORY COMPLIANCE**

Maintenance plans should identify the maintenance activities required to ensure compliance with the relevant local, national and international regulations.

In order to comply with relevant legislation, authorities may need to consider the following in their maintenance plans:

Environmental considerations, e.g., operating in remote areas or sensitive marine parks, may require additional operating procedures to be implemented.

Safety considerations, e.g., operating from small craft or working at heights, may require additional training and safety procedures to be implemented.

Heritage AtoN and their supporting structures may require increased levels of maintenance and monitoring to be carried out.

AtoN with a higher IALA category or importance may require a more intensive maintenance regime to ensure that the required level of performance is achieved.

Relevant standards should be referenced in the design phase of new AtoN to ensure that new AtoN comply with the most recent standards.

### **3.5. MANAGEMENT OF OBSOLESCENCE**

Maintenance plans should identify when an asset is expected to reach the end of its operational life. The strategy should consider the options at this stage for example: replacement, upgrade, disposal, refurbishment etc.

### **3.6. RISK MANAGEMENT**

Risk management means identifying risks and taking action to eliminate those risks so far as is reasonably practicable, and if that is not possible, minimising the risks as low as is reasonably practicable.

Maintenance plans should seek to identify risks associated with operating and maintaining an asset and apply the appropriate level of risk management.

## **4. DEVELOPING MAINTENANCE PLANS**

AtoN service delivery should be considered an iterative process of requirements, design, and maintenance, with the overall goal of providing an AtoN to the mariner to satisfy the Guiding Principles above. Where these Guiding Principles cannot be achieved, it may be appropriate to revisit the original designs and user requirements.

### **4.1. DEFINE ASSET LISTS (UNDERSTANDING THE ATO N)**

Generally, each asset will be unique in some way. Before any type of maintenance plan can be formulated, AtoN service providers should ensure they have a thorough understanding of all assets, including their operational and maintenance requirements, that make up their network.

## 4.2. DETERMINE MAINTENANCE PHILOSOPHY TO BE ADOPTED

There are two broad maintenance philosophies: Preventative Maintenance and Reactive Maintenance. These philosophies are outlined below and could be wholly or partly considered in the development of maintenance plans.

### 4.2.1. PREVENTATIVE MAINTENANCE (PM)

#### 4.2.1.1. Planned Preventative Maintenance (PPM)

PPM is a proactive approach to maintenance and involves a process of routine inspection and servicing of assets to prevent failures and deterioration from occurring. PPM is performed at pre-determined fixed intervals (based on calendar time, operating hours, number of cycles, manufacturers recommendations, etc), and consists of regular refurbishment or replacement of an item or its components.

#### 4.2.1.2. Condition-Based Maintenance (CBM)

CBM is undertaking maintenance based on asset condition, rather than time or usage interval. Performing only the required maintenance at each visit, minimizing spare parts cost, reducing downtime and reducing time spent on maintenance is the objective of a condition-based maintenance approach. This will reduce both operational and maintenance costs for AtoN providers.

Visual inspections, physical measurements and detailed condition reporting, live monitoring of assets are useful tools for the implementation of effective CBM.

#### 4.2.1.3. Risk Based Maintenance (RBM)

RBM is a maintenance philosophy whereby maintenance is undertaken based upon a risk assessment methodology where a score is assigned based upon a combination of likelihood and severity of a performance of an asset being impacted.

Maintenance resources are assigned to assets when an asset risk score has exceeded a threshold score set during the development of the maintenance strategy.

### 4.2.2. REACTIVE MAINTENANCE (RM)

Unplanned failures or breakdowns can be expected throughout the life of an asset, therefore, reactive maintenance will form part of any maintenance strategy.

Reactive maintenance (RM) can be defined as the maintenance which is required to restore the functionality of an asset when it has failed or has deteriorated. When failures occur or an asset has deteriorated to the point where it is no longer functional, this often leads to reduced asset performance and therefore a reactive maintenance philosophy carries additional risk when compared to a preventative maintenance philosophy.

#### 4.2.2.1. Run to Failure

Run to failure is a reactive maintenance philosophy where maintenance is only performed when an asset has failed. Unlike other maintenance philosophies, run-to-failure maintenance is a deliberate and considered strategy that is designed to minimize total maintenance costs.

Whilst this approach will realise cost savings upfront, AtoN service providers must be aware of the risks to availability and infrastructure condition when utilising this philosophy and the potential for higher lifecycle costs due to the costs associated with unplanned deployments.

## 4.3. IMPLEMENTING MAINTENANCE PLANS

Operational factors will affect the undertaking of maintenance at each AtoN site. When planning and implementing maintenance, the following should be considered.



#### 4.3.1. EQUIPMENT TYPE

Unique assets should be identified as they could require a specialised approach to maintenance. A more standardised network will most likely be a less onerous maintenance requirement.

The same maintenance strategy and similar plans could be utilized for all assets of the same type across an AtoN network.

#### 4.3.2. DESIGN FOR OPERATIONAL LIFE CYCLE

It is crucial to account for long-term maintenance and logistics support early on in the design process. The goal should be to design a cost-effective asset that will meet functional requirements, reduce the need for maintenance, extend the time interval for required maintenance, enable maintenance upon the evidence of need (condition-based maintenance), facilitate maintenance activities, and reduce the “logistics footprint” required for maintenance and support.

To accomplish this, the focus of the design should ensure that the attributes of “reliability”, “maintainability” and “supportability” are key components of the design.

#### 4.3.3. ASSET AGE

As assets age, the maintenance requirements will most likely change as well. Older equipment may be more susceptible to failure. A maintenance plan may need a level of flexibility to enable an increase in maintenance over time.

Obsolete equipment should be identified as part of any maintenance plan. Where possible, replacement of obsolete equipment is recommended, but if this is not practicable the maintenance plan should contain mitigation measures to manage the risks posed by obsolescence.

#### 4.3.4. MINIMISE THE IMPACT ON THE ENVIRONMENT

Legislative obligations and community expectations require AtoN authorities to ensure that their activities do not have an adverse impact on the environment. Any maintenance plan should mitigate the impact on the environment. For example, operating in remote areas or sensitive marine parks, may require additional operating procedures to be implemented.

Information on this topic is available in IALA Guideline *G1036 Environmental Considerations in AtoN Engineering*.

#### 4.3.5. ENVIRONMENTAL CONDITIONS

Knowledge of environmental conditions at each AtoN site, such as seasonal weather and tidal conditions and potential climatic extremes should be considered when forming a maintenance plan.

Environmental conditions can affect the performance of an asset such as accelerated deterioration of an asset due to a high salinity environment.

#### 4.3.6. THEFT AND VANDALISM

AtoN service providers should consider the risk of theft and vandalism when developing maintenance plans.

#### 4.3.7. SUSTAINABILITY

AtoN service providers should consider incorporating sustainable practices into their maintenance plans in line with R1004 Sustainability in the Provision of Marine AtoN. When adopting sustainable practices care should be taken so the performance of assets is not adversely affected.

#### 4.3.8. SAFETY

Maintenance plans should consider measures to ensure the risks associated with undertaking maintenance activities are managed. Sites where the general public have access may require additional measures to be implemented.



#### 4.3.9. INFORMATION SECURITY

When developing maintenance plans AtoN service providers should consider information security best practice to mitigate data security threats and cyber threats.

#### 4.3.10. RESOURCES

AtoN service providers should consider the resources required when developing maintenance plans. Overall, as part of the development of maintenance plans for an AtoN network the following broad aspects should be considered.

- Competent, qualified personnel.
- Required number of personnel to deliver the maintenance plan.
- Funding.
- Plant and equipment.

In addition, the use of specialist third parties (sub-contractors), arrangements such as public-private partnerships or full maintenance lease agreements could be considered to ensure the maintenance plan is adequately resourced.

#### 4.3.11. HERITAGE & CULTURAL CONSIDERATIONS

Outside of legislative requirements, AtoN service providers may need to consider sensitivities relating to traditional owners or local communities who may hold a strong connection to the AtoN or local area and surrounds, particularly at heritage or culturally significant sites. These sensitivities may require additional consideration in the development of the maintenance plan.

### 4.4. REVIEW CYCLE

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When a maintenance plan is implemented a review process should be established to ensure the maintenance plan remains effective.

Detailed recording of maintenance activities, routine inspections, and the condition of AtoN equipment will allow authorities to monitor and analyse asset performance over time. Analysis of this data may lead to improvements being identified and implemented resulting in improved overall asset performance.

#### 4.4.1. MAINTENANCE RECORDS

Detailed maintenance records should validate the performance and effectiveness of the maintenance plan by:

- allowing analysis of the AtoN network to identify deficiencies in the maintenance plan;
- feed back into the maintenance system to make improvements to the delivery of the maintenance plan; and
- enable informed diagnostic work on the specific equipment and type.

Systems should be implemented that monitor and record maintenance activities to ensure that maintenance work is carried out such that it delivers repeatable high-quality outcomes.

Many authorities and external service providers currently have systems in place or are putting systems in place that comply with the requirements in Quality Management Systems such as ISO 9001. These management systems call for the necessary policy and procedures to be put in place to ensure that:

- Systems and processes are documented.
- Necessary training programs are in place.
- Changes are controlled and monitored.
- Equipment and material selection is controlled.





- Systems and processes are audited.
- Deficiencies can be identified, reported and corrected; and
- Improvements can be realized.

## 5. ACRONYMS

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AIS	Automatic Identification System
AtoN	Aid(s) to Navigation
CBM	Condition-Based Maintenance
CM	Corrective Maintenance
DGPS	Differential Global Positioning System
GRP	Glass-Reinforced Plastic
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IMO	International Maritime Organization
ISO	International Organization for Standardisation
LED	Light Emitting Diode
PLC	Public Limited Company
PM	Planned Maintenance
PPM	Planned Preventative Maintenance
SOLAS	International Convention for the Safety of Life at Sea
TH	Trinity House
UV	Ultraviolet

## ANNEX A ATON MAINTENANCE STRATEGY EXAMPLES

*Table 1 Floating AtoN Maintenance Strategy Example*

Asset/Equipment type	Maintenance philosophy	Interval	Notes/considerations
Polyethylene Buoy/hull with steel structure	Preventative	4 years – Inspection and cleaning 16 years - replacement	
Aluminum Mast/Tower	Preventative	4 years – Inspection, cleaning and coating repairs 8 years – Refurbishment and repainting	
Mooring system	Preventative	4 years – replacement of mooring chains and shackles	A Condition Based philosophy may be utilised where more frequent inspection intervals are utilised
Power supply	Preventative	4 years – replacement of batteries 8 years – replacement of other power supply equipment	
AtoN equipment	Preventative	8 years – replacement	High value equipment such as racons may be overhauled rather than replaced using a Condition Based Philosophy

Table 2 Fixed AtoN Maintenance Strategy Example

Asset/Equipment type	Maintenance philosophy	Interval	Notes/considerations
Structure	Preventative	1 or 2 years – Inspection, cleaning and general structure maintenance	Frequency of maintenance should consider local requirements and be adjusted as necessary
Protective coating system	Condition Based		Carry out protective coating maintenance as required at the scheduled maintenance interval for the AtoN site
	Preventative	15 years – Overcoat of protective coating systems	
Power supply – Batteries	Preventative	6 years – replacement	
Power supply – Other	Condition Based		
AtoN Equipment	Preventative	Replacement interval dependent on AtoN type	Some AtoN equipment such as racons and rotating lanterns may be refurbished at specified intervals or using a Condition Based philosophy
Grounds	Preventative	1 or 2 years – inspection, vegetation control and general repair/maintenance	
Fencing	Preventative	1 or 2 years – inspection and general repair/maintenance	
Helipad	Preventative	1 or 2 years – Inspection, cleaning and general structure maintenance	