IALA

IALA GUIDELINE

G1067-0
SELECTION OF POWER SYSTEMS FOR AtoN AND ASSOCIATED EQUIPMENT

Edition 3.1

December 2017

urn:mrn:iala:pub:g1067-0:ed3.1

10, rue des Gaudines – 78100 Saint Germain en Laye, France
Tél. +33 (0)1 34 51 70 01 – contact@iala-aism.org

www.iala-aism.org

International Association of Marine Aids to Navigation and Lighthouse Authorities
Association Internationale de Signalisation Maritime

DOCUMENT REVISION

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

Date	Details	Approval
May 2009	1st issue	Council 45
June 2011	Table 2: Availability of improved lithium battery information Improved table logic Periodic review.	Council 51
December 2017	All sections reviewed and updated following the realignment of the document to the new IALA documentation structure.	Council 65
July 2022	Edition 3.1 Editorial corrections.	

CONTENTS

List of Tables

List of Figures

1. INTRODUCTION

The purpose of this Guideline is to assist authorities in the selection and design of power systems for Marine Aids to Navigation (AtoN).

This Guideline contains a summary of power generation and energy storage options that are available for use with AtoN, together with their advantages and disadvantages.

Suggestions on life cycle management issues are also addressed in the document.

2. HOW TO USE THIS GUIDELINE

This document is an overarching Guideline and needs to be read in conjunction with the following documents:

- IALA Guideline *G1067-1 Total Electric Loads of AtoN*
- IALA Guideline *G1067-2 Power Sources*
- IALA Guideline *G1067-3 Electrical Energy Storage for AtoN*

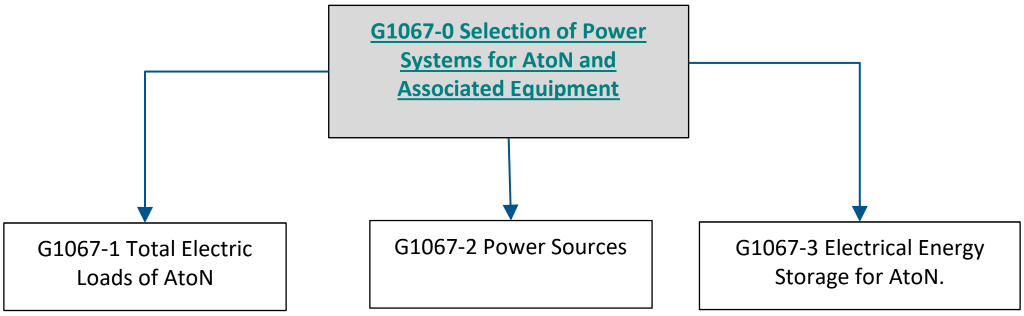

Figure 1 Overview of guideline structure

2.1. SCOPE

This Guideline is focused on engineering of power systems for AtoN but may equally be applied to ancillary services such as security systems, remote control, monitoring and domestic loads.

The following flowchart (figure 2) shows the steps needed to make the best use of this Guideline:

2.2. APPLICATION OF THE G1067 SERIES OF GUIDELINES

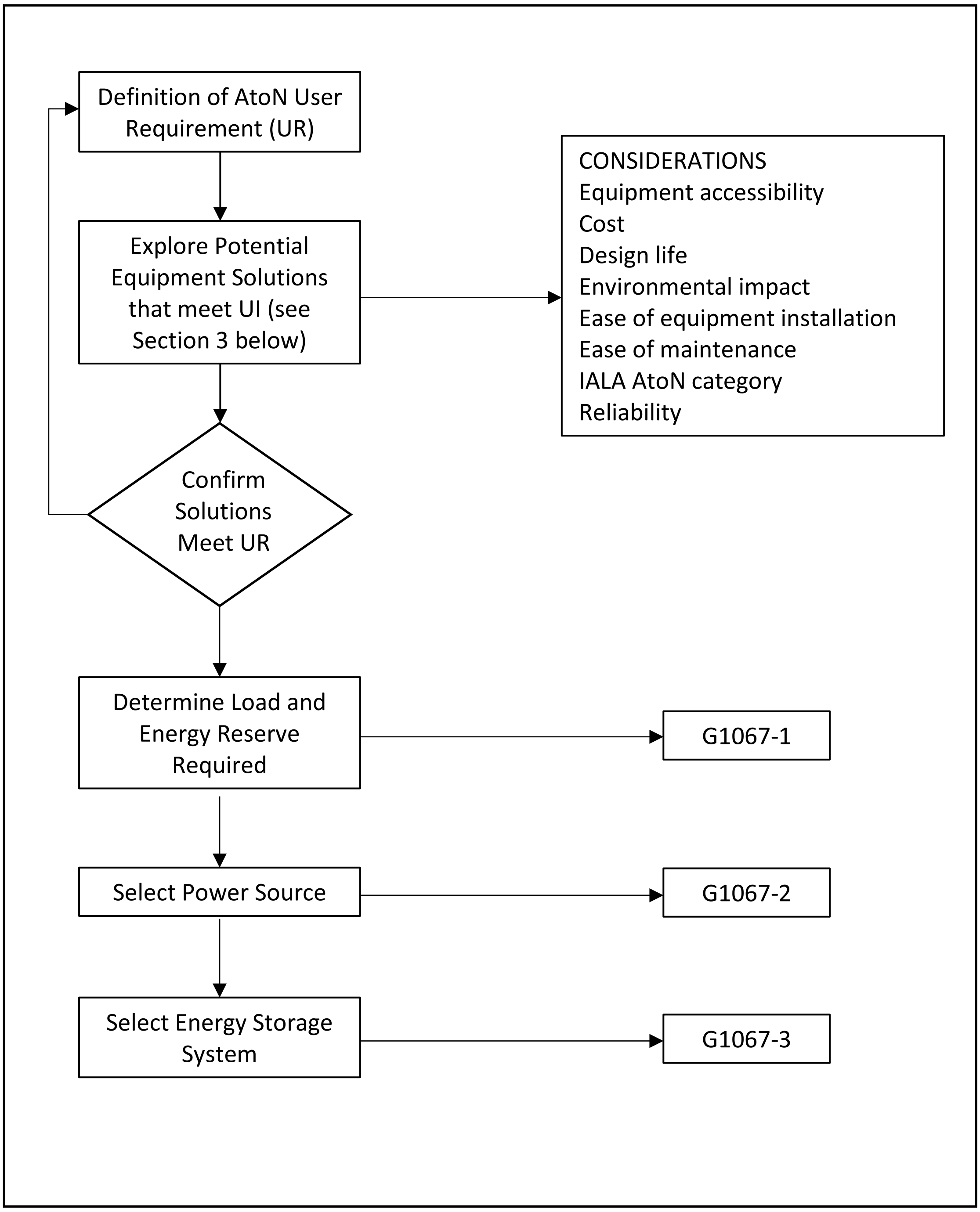

Figure 2 Flowchart for the Application of the G1067 series of guidelines

3. GENERAL

The power requirement for AtoN cannot be based on the light source in isolation because the power system provides for the total needs of the AtoN. This may include audible signals, lights, RACONs, AIS, remote control and monitoring facilities, security and domestic loads. Domestic loads can vary substantially - demand on manned stations will be at a constant high level, while the demand on unmanned stations would only occur during maintenance visits.

In addition to the development of new light sources, the automation of lighthouses and changing user requirements play a significant part in the relevance and size of power supplies.

However, developments in technology have made it possible to reduce the power consumption of AtoN without any detrimental effect on the service provided to mariners. In particular, battery systems, rather than diesel generators, can be used as back up for utility power or as a companion to renewable energy sources. Integrated power system lanterns may also meet the requirements, thus eliminating the need for external power generation and energy storage.

4. USER REQUIREMENTS

The user requirement also has an important part to play in power consumption. For every mile reduction in range for lights the required luminous intensity is roughly halved and hence power consumption reduced. The application of visual and audible AtoN is changing; ranges are being reduced considerably, resulting in far less power demand.

4.1. AUTOMATION

Automation will reduce the need for constant domestic loads but is very likely to require the use of control devices to ensure that navigation equipment operates when required. Typical examples are day/night sensing for the light sources, fog detectors for audible signals and load control for diesel generators.

4.1.1. DISADVANTAGES

The continual reduction of power consumption and thus the requirement for smaller power supplies has distinct advantages, but when this is applied to buildings that were previously occupied, there are building conditioning issues that should be recognized and addressed. The result could be damp conditions leading to the deterioration of the building itself as well as the AtoN equipment.

Where main power is available, heating or air conditioning can be provided without increasing the capacity of back-up power supplies. However, with renewable energy or hybrid operated systems there is likely to be no spare capacity for building conditioning as this would negate any savings made.

In these cases, alternatives need to be considered including:

- Improved ventilation
- Good building maintenance
- Ancillary powered heating/cooling either by high efficiency gas or diesel fired boilers, photovoltaic or wind generators
- High efficiency power, e.g., Stirling cycle engine, fuel cell, etc. to provide heating as well as electrical power

5. SELECTION OF POWER SYSTEMS AND ENERGY STORAGE

This section identifies those items that should be taken into consideration when selecting energy storage and associated power systems for AtoN locations. Table 1 provides general guidance on the most appropriate power systems for a number of locations, power requirements and environmental issues. However, it would be prudent to use the appropriate guideline to better determine the potential and define the optimal solution.

5.1. GUIDANCE ON POWER SOURCES

Where reliable and readily available power is supplied by others, this may be the cheapest energy source. When utility power is used, it is sufficient, to provide back-up facilities by means of energy storage only. The capacity of the device need only be sufficient to enable time for access to site and repair.

Where externally supplied power is difficult or impossible to install, solar energy, wind energy or other renewable source of energy should be considered as the next best option. In some situations, where a renewable energy source is not practicable, primary batteries can be used.

Diesel generators should only be considered for major loads.

Table 1 provides information on the practical choice of energy storage systems and guidance on the application of power sources for marine aids to navigation.

Table 1 Selection Guide of power systems for AtoN

Sources of Energy	Remote Site	No Easy Access	High Power > 300 Wh / day	Medium Power 300 – 100 Wh / day	Low Power < 100 Wh / day	Extreme Temperatures	Ventilation not possible	Buoy	Major Floating Aid	Life Expectancy (estimated years)
Utility power	+o	+	++	++	+	++	++	-	-	-
Diesel generator	+	o	+	o	-	o	o	-	-	20
Photovoltaic	++	++	-	+	++	++	-	++	++	20
Wind HAWG*	++	-	+	++	++	o	-	o	+	1 to 15
Wind VAWG**	++	-	+	++	++	++	-	+	+	10 to 20
Fuel Cell	+	o	+	++	++	o	o	-	+	5 to 10
Wave Actuated Generator	-	-	-	+	++	o	-	+	o	3 to 10
Hybrid	++	++	+	++	+	o	-	++	+	Not applied
++ + o	Recommended solution Good solution Not recommended			+o -	Recommended solution where utility power is available Not relevant					

* HAWG: Horizontal Axis Wind Generator

** VAWG: Vertical Axis Wind Generator

Table 2 Selection Guide of energy storage equipment for AtoN

Energy Storage	Remote Site	Maintenance Required	High Power > 300 Wh / day	Medium Power 300 - 100 Wh / day	Low Power < 100 Wh / day	Extreme Temperatures	Ventilation not possible	Buoy	Major Floating Aid	Comments
Secondary Cells										
Lead acid	+	Yes	+	+	+	-	o	o	+	
Sealed Gel lead acid	++	No	+	+	+	+	-	++	+	
AGM lead acid*	+	No	o	+	+	+	-	+	-	
Pocket NiCd	++	Yes***	+	+	+	+	o	o	+	***Charge level dependant
Sintered NiCd	+	No	+	+	+	+	o	o	+	
Sealed NiCd	++	No	+	+	+	+	-	++	+	
Ni-Metal Hydride	+	No	+	+	+	-	-	+	+	
Lithium (secondary)**	+	No	+	+	+	-	-	+	+	
Primary Cells										
Air depolarized	o	No	-	-	+	o	-	+	o	
Alkaline	o	No	-	-	+	o	++	+	o	
Zinc-Carbon	-	No	-	-	+	-	++	+	-	
Lithium (primary)	+	No	o	o	+	o	++	+	o	
++	*Recommended solution*				o	*Not recommended*				
+	*Good solution*				-	No comment				

* AGM: Absorbed Glass Mat

** Caution must be applied when specifying this battery type as the battery chemistry can vary widely thereby offering differing degrees of performance and safety requirements

5.2. REDUNDANCY, CAPACITY AND AUTONOMY

Whether redundancy is required in the delivery of a unique AtoN is an organizational decision, usually defined in terms of AtoN importance or category. Equipment demands can be captured and a risk-based analysis done to determine the best solution.

The autonomy of the power systems, being either a primary or secondary backup power, is determined based on a typical, site specific, engineering life cycle analyses, but needs to take into account the battery characteristic.

Tangible considerations known to impact the "sizing and selection" of energy production and storage equipment can include, but are not limited to:

- Power load profile (peaks)
- The availability of renewable energy source (e.g., sun, wind)
- Life cycle cost
- Regulatory environment
- Environmental risks impact

When trying to determine the "sizing and selection" of a solar system see Guideline *G1039 Designing Solar Power Systems for AtoN*.

6. LIFE CYCLE MANAGEMENT CONSIDERATIONS

The life cycle management covers from conception to disposal; this has an increasing impact on the design and selection of equipment, and has a direct link to the overall financial requirements.

6.1. INITIATION PHASE

6.1.1. CAPTURING THE MARINERS' REQUIREMENTS

The start of any AtoN project is that a requirement is identified by a maritime entity. This could range from a vague idea to a thoroughly considered approach. When developing the design criteria for the final solution, it is imperative to achieve full and concise design requirements from the initiating body.

6.1.2. CONSIDERATION OF DESIGN OPTION

Careful consideration should be given to the "through life costs" of any solution as a low capital cost solution could offer very high running costs and vice versa.

It is therefore important to consider the true overall cost of "Ownership" of the AtoN. This consideration should take into account such issues as maintenance periods, equipment replacement periods and environmental implications, both through life and at the end of life disposal; therefore, end of life recycling/disposal costs should be considered.

6.2. IMPLEMENTATION AND IN-SERVICE PHASES

During the in-service life of the AtoN equipment, it is important to monitor the performance of the equipment to ensure the protection of the environment. Appropriate measures should be taken to limit the impact of the maintenance activities on the environment.

Maintenance activities should be appropriate to protect the heritage status of the sites and be compliant with the current regulation, where applicable.

It is recommended that the maintenance requirements be evaluated during the conception phase in a manner to extend the maintenance interval wherever possible.

6.3. DISPOSAL PHASE

The disposal of any equipment has to be considered during the conception phase in order to minimize the impact on the environment.

Disposal of equipment containing hazardous materials is an increasingly important factor and the emphasis must be put on reworking/reusing components to extend life and then the re-cycling of equipment in preference to disposal. Disposal of non-reusable equipment or components should be limited to the minimum.

It is important to ensure that any disposal of AtoN equipment is done according to current regulations and limits the negative impact on the environment as much as possible.

Consideration should be given to passing on obsolete equipment to a museum if it might be of interest to future generations.

7. DEFINITIONS

The definitions of terms used in this Guideline can be found in the *International Dictionary of Marine Aids to Navigation* (IALA Dictionary) at http://www.iala-aism.org/wiki/dictionary and were checked as correct at the time of going to print. Where conflict arises, the IALA Dictionary should be considered as the authoritative source of definitions used in IALA documents.

8. ABBREVIATIONS

AIS	Automatic Identification System
Ah/day	Ampere hour(s) per day
AtoN	Marine Aids to Navigation
HAWG	Horizontal axis wind generator
Ni	Nickel
NiCd	Nickel Cadmium
RACON	Radar beacon
UR	User requirement
Wh/day	Watt hour(s) per day