Input paper: [[1]](#footnote-1) ENG18-3.2.1.4

Input paper for the following Committee(s): check as appropriate Purpose of paper:

**□** ARM **☑** ENG **□** PAP **☑** Input

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Agenda item [[2]](#footnote-2) the remote control and monitoring of marine AtoNs

Technical Domain / Task Number 2 ………6.1.2………………

Author(s) / Submitter(s) ……CHINA MSA………

Proposal on the Revision of Chapter 5 - Objectives of the Guideline G1008 on Remote Control and Monitoring of Marine Aids to Navigation

# Summary

The update on the guideline G1008 *on* *the Remote control and monitoring of marine aids to navigation* is included the Committee work programme for the period 2023-2027. The description of the availability in the revised draft guideline does not reflect the role of remote control and monitoring system (RCMS), making some IALA members to question whether RCMS can improve theavailability of AtoNs. Therefore, the application of RCMS is questioned. In this case, we start from the IALA availability formula, through the analysis of its influencing factors - mean time to repair (MTTR) and the number of failures, to prove that RCMS can improve the availability, hoping to fundamentally solve the problem of "why use RCMS ".

## Purpose of the document

This proposal proves that the application of RCMS can improve the availability by discussing the availability of IALA and related formulas. It is hoped that IALA will revise Chapter V - the objective of the draft Guide to clarify the impact of RCMS on the availability of AtoNs and further clarify the role of RCMS of AtoNs, thus dispelling the doubts of IALA members on the application of RCMS, and laying a solid foundation for IALA to promote RCMS.

## Related documents

1. *G1008-Ed2.1-Remote-Control-and-Monitoring-of-Marine-Aids-to-Navigation-June-2009*
2. *G1035-Ed2.1-Availability-and-Reliability-of-Aids-to-Navigation-Theory-and-Examples-December-2004*

# Background

With the development of communication technology, RCMS of marine aids to navigation technology has been widely used in Europe, America and East Asia, and the technical means are becoming mature. However, after the discussion of ENG13-17 meetings, the revision process of the draftguidline is still slow, and the relationship between RCMS and the availability has not been solved in Chapter V - Objectives. This makes some IALA members to question the application of RCMS that if RCMS can not improve the availability , it will not have outstanding application significance. In order to clarify this point, the draft guideline not only needs to discuss technical issues, but also needs to supplement the discussion of the relationship between the availability and the RCMS , so as to lay a foundation for the application and promotion of RCMS of AtoNs.

# Discussion

IALA has been committed to the study of improving the availability of the AtoNs. The issues, including whether RCMS can improve the availability and the role of the application of RCMS, need to be discussed in Chapter 5 - Objectives.

## Definition of Availability and related formulas

Availability is the probability that AtoN (a AtoN or system ) will perform its assigned function at any randomly selected time as defined by the competent authority. This means that the aids to navigation or the aids to navigation system shall perform the functions specified therein, and it is also a measure of the services provided by the navigator.

Here we begin with the Availability equation for a single AtoN to describe the role of RCMS:

(equation 1)

(equation 2) **Total time=(365×24×X① )hours**

① X-year

Total time is a quantity, Down time is a variable. From equation 1, it can be concluded that“the smaller the failure time, the higher the performance of the AtoNs.”.

(equation 3) ②

② Ti is a set of time for AtoN failure in a period of time.

For the convenience of research, we convert the failure time into:

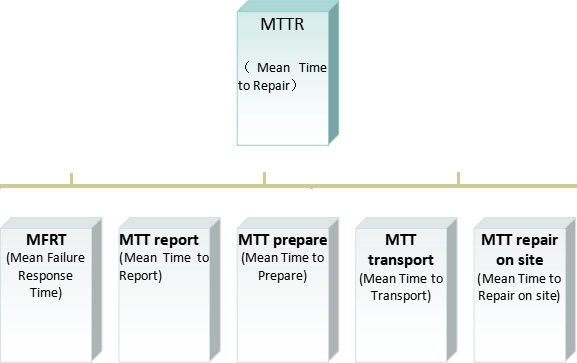
(equation 4 Down time=MTTR③×Number of failures

③ MTTR - Mean Time to Repair

As can be seen from equation 4, the Down time is proportional to the MTTR and the Number of failures of the AtoN, and can be reduced simply by reducing the MTTR and Number of failures. Let’s focus on MTTR and Number of failures, two variables that affect the down time.

## MTTR

MTTR is the time it takes for AtoN to return to normal operation after a failure. This is a measure of the administrative arrangements, resources and technical capabilities of the navigational AIDS authority for the maintenance of AtoN faults. In fact, it is also a measure of the performance of the maintenance team.



1. MTTR Decomposition diagram

(equation 5) MTTR=MFRT+MTT report+MTT prepare+MTT transport+MTT repair on site

The following is a comparative analysis of equation 5 between AtoNs with the RCMS and AtoNs without RCMS.

1. Process comparative analysis

|  |  |  |
| --- | --- | --- |
| **Parameter** | **AtoNs with RCMS** | **AtoNs without RCMS** |
| **MFRT** | Greatly shortened | Finding difficulty and instability |
| RCMS can find the fault of the AtoNs by monitoring the AtoNs parameters and transmit the fault data to the command center at a certain interval. (RCMS in China Sea area can monitor the position and the light characters of the AtoNs , and the launch interval is set at 1 hour, which means that the MFRT can be maintained to be less than 1 hour by RCMS. The fault identification of the AtoNs without RCMS can only rely on the traditional ship inspection, pilot station or feedback from past ships, which is inefficient and unstable, and greatly affects the MFRT, which may be 1 hour、24 hours or 48 hours. The fault identification is the biggest and most stable advantage of RCMS, and also the biggest factor affecting the MTTR. | |
| **MTT report** | No difference | No difference |
| Once the fault of the AtoNs is found, whether it is a manual report or a system report, there is no significant difference here. | |
| **MTT prepare** | Shrink | Enlarge |
| Due to the accurate data monitoring and control of RCMS, the causes of the AtoNs fault can be basically predicted, so the preparation work can be better done. However, due to the uncertainty of the pilot station or the past ships, the fault report of the traditional aids to navigation would be inaccurate, which would lead to the need for more complicated preparation, and lead to the increase of the mean preparation time. | |
| **MTT transport** | Shrink | Enlarge |
| When the AtoN is not drifting, the transportation time is not different whether the AtoN is equipped with RCMS or not. When the AtoN is drifting, the time of searching for the drifting AtoN should be considered into the transportation time. When the AtoNs are equipped with RCMS, the AtoNs can be found accurately and timely by the positioning system. When RCMS is not applied to the AtoN, it is difficult to intelligently search for the lost AtoN, which will greatly increase transport time.At the same time, as the lost AtoN cannot be located without RCM, it will further harm the passing ships and fishing grounds. | |
| **MTT repair on site** | No difference | No difference |
| The telemetry and remote control terminal adopts integrated design. RCMS are integrated with the lantern. When there is a failure with the lantern, the whole lantern replacement method is used for maintenance, which can not only greatly shorten the repair time on the site, but also reduce the difficulty of field repair. So the method of replacing the lantern as a whole will not affect the MTT repair on site. | |

**Conclusion 1: By comparing and analyzing MFRT, MTT report, MTT prepare, MTT transport, MTT repair on site, we can conclude that RCMS can greatly reduce MTTR.**

## Number of failures

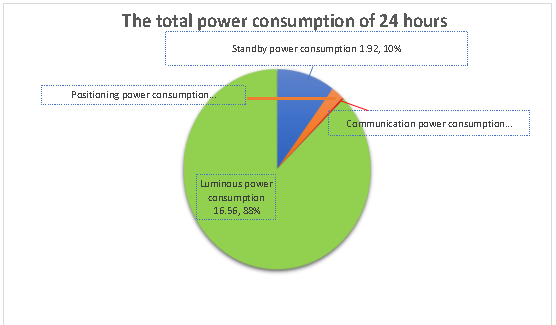
## 3.3.1 Analysis from the type of AtoNs failure

When considering the number of failures, we need to be clear about the concept of physical isolation to prevent the failure of RCMS causing the failure of the AtoNs. so, we do not consider RCMS failure here. As for how to improve the stability of RCMS and reduce the failure rate will be discussed in other technical sections.

We analyze the factors that influence the number of failures according to the types of AtoNs failures.The malfuntion of AtoNs can be divided into light extinction,strctural damage, AtoN displacement, and AtoN drift. The structural damage, displacement and drift of AtoNs are mainly caused by improper maintenance, extreme weather or ship collision, etc. The main cause of lights going out is the damage to the lanterns, but there is also the possibility that the battery power supply is insufficient. How much power is used for positioning and data transmission, and whether it will cause additional burden on the power supply to the AtoNs, causing the AtoNs lights to turn off? We’d like to analyze the power consumption of the AtoN integrated RCMS in northern China:

The power consumption of the lantern is the basis of calculating the battery capacity and the power configuration of the solar panel. In order to ensure sufficient energy, the flash rhythm of the lantern is based on fixed light, and the lighting duration at night is 14 hours in winter. Through the experiment summary and the actual application, the energy consumption of each system of the integrated lantern is quantified and the following data is got:

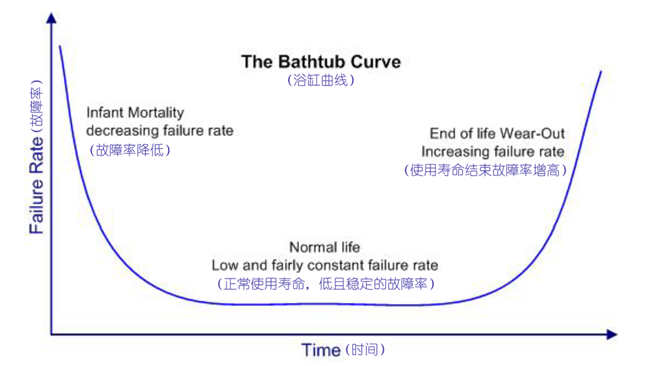
The total power consumption of 24 hours = Standby Power + positioning power + communication power + luminous power = 1.92 wh + 0.4224 wh + 0.048 wh + 16.56 wh = 18.9504 wh

1. Power consumption chart of AtoNs with the RCMS

It can be analyzed from figure 2 that only 2% of the power consumption is used for positioning and data transmission, which is very low. Therefore, it is concluded that the lantern will not be extinguished because of the power consumption of RCMS. As a result, the number of failures does not increase as a result of RCMS.

## 3.3.2 Analysis from the life cycle of the AtoNs

Here we introduce the Bath-tub Curve, and by comparing the AtoNs with RCMS and AtoNs without RCMS, discuss the influence of RCMS on the number of failures from the stages of early failure life (infant mortality) , normal life and end of life.



1. The Bathtub curve
2. Early failure period, stationary period and end-of-life comparative analysis

|  |  |  |
| --- | --- | --- |
| **The influence of life cycle on the number of failures** | **AtoNs with RCMS** | **AtoNs without RCMS** |
| **Early failure life**  **(infant mortality)** | No difference,but it’s challenging | No difference,but the challenge is small |
| As long as the manufacturers of the AtoNs with RCMS take full account of the impact of the marine environment when designing, and carry out adequate experiments and optimize the design under the relevant marine environment conditions, there is no difference between the failure rate of the AtoNs with RCMS and that of the AtoNs without RCMS. | |
| **Normal life** | No difference | No difference |
| During the normal life, the failure probability of the AtoNs is very low, but there will still be random failures. The random failures are independent of whether the AtoNs are equipped with RCMS, but the AtoN Management Authority department can use RCMS to count the random failure data (including the damaged parts and the damaged reasons) , so as to optimize the design or update the material. | |
| **The end of life** | Reduced number of failures | Increased number of failures |
| The increase of failure rate at the end of life is mainly due to material fatigue (natural aging and wear) , which is an irreversible process. The AtoN Management Authorities may monitor the life cycle of the AtoNs equipment through RCMS. The preventive maintenance before the units reach the end of their life cycle (replacement of components that may be worn out or aging before actual failure) to reduce the number of failures is an advantage of RCMS. | |

**Conclusion 2: According to the analysis of the categories of aids to navigation faults combined with the life cycle of aids to navigation , theoretically RCMS can reduce the number of failures caused by terminal wear. From the overall consideration, it is concluded that the application of RCMS will not increase the number of failures.**

## RCMS can improve the availability

**Conclusion 3: The equation 4 can be used to conclude that the Down time can be shortened because the MTTR can be greatly reduced and the Number of failures can be reduced.**

**Conclusion 4: The equation 1**  **shows that : the Availability can be improved because the system can shorten the Down time.**

After discussing that RCMS can improve the availability, we can see that RCMS have advantages in fault identification, fault diagnosis, fault statistics, the maintenance of AtoNs, and search for drifting AtoNs. Here, we have also attached the advantages and disadvantages of AtoNs with RCMS and without RCMS as an annex to assist in the revision of chapter V of *the draft Guideline.*

# References

1. *G1008-Ed2.1-Remote-Control-and-Monitoring-of-Marine-Aids-to-Navigation-June-2009*
2. *G1035-Ed2.1-Availability-and-Reliability-of-Aids-to-Navigation-Theory-and-Examples-December-2004*

# Action requested of the Committee

The Committee is requested to:

1. Further clarify the contribution of RCMS for AtoNs to the improvement of the availability.
2. Further clarify the advantages of the RCMS.
3. Collect relevant technical materials on ships' anti-collision with AtoNs.

1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-1)
2. Leave open if uncertain [↑](#footnote-ref-2)