# ANNEX The practicable use of AIS AtoN on buoys

# PHYSICAL APPLICATION

## Power requirement

The power requirement of an AIS AtoN station is dependent on a number of factors which are usually available for setting via the unit configuration method. These are:

VDL access method – FATDMA will give substantially lower power drain than RATDMA.

FATDMA slot selection – if Mode B is used, then the Channel A and Channel B slots should be close together in time, to minimize the period for which processes in the AIS AtoN unit are active.

Reporting interval – an extended reporting interval will, of course, reduce power drain, but the interval should satisfy the relevant guidance.

Configuration of the AIS AtoN unit - the AIS AtoN unit could be designed or configured to enter into a “sleep” mode when not active.

Repetition of the AIS AtoN messages by a local AIS shore station, during the reporting interval of the AIS AtoN station, may allow the reporting interval of the AIS AtoN unit to be extended. For example, the AIS AtoN may have a 10 minute reporting interval, but the local AIS shore station repeats the AIS AtoN message every frame, i.e., every minute. Consideration should be given to the coverage areas of the AIS AtoN unit and the base station to ensure that operational requirements are met. An advantage of repeating from an AIS shore station may be to increase the coverage area of the AIS AtoN Station.

The power consumption needs to be balanced to the generation facility as well as the power consumption other AtoN such as lights etc. to deliver the required autonomy. The power consumption at the agreed configuration should be measured, rather than rely on the manufacturer’s generic data.

## Antenna

### VHF Antenna

In the case of floating signals, installing VHF and GNSS antenna at the uppermost section of a superstructure is a disadvantage from the structural point of view, as it is vulnerable to damage if the buoy is struck by a passing ship or when the buoy is being recovered for maintenance.

### GNSS Antenna

When planning the installation of a GNSS antenna on a buoy, it is a priority that it be clear of any vertical obstruction at all times, considering also the angles of vertical divergence.

### Choice of location for antennae

The location of the antennae needs to be carefully considered to optimize radio performance and its vulnerability to damages from collisions or during maintenance activities. The proper choice of antennae (integrated or separate) and the mounting devices selected are all connected to provide optimal long-term performance.

The environmental conditions also affect the choice of equipment and the location of antennas.

### Transmission range

A typical transmission range is between 5 to 15 nautical miles though this will increase with antennas with a higher gain. In areas of very heavy traffic, the volume of AIS transmissions may overload the base station, which will reduce the range that the base station will be able to cover.

In a VHF bandwidth operation system, Transmission (Tx) and Reception (Rx) range reach is tightly linked to the height of the antenna. Therefore, location is of key importance, ensuring the highest position in the AtoN for safe installation and maintenance.

In certain regions as well as under specific environmental conditions, some meteorological phenomenon in the troposphere gives clouds different refractive indexes, forcing electromagnetic waves to bounce back to the ground and enhancing the VHF coverage. This particular phenomenon should not be relied on to provide enhanced coverage.

### Selection of VHF antenna

The Standing Wave Ratio (SWR) is the ratio between maximum and minimum voltage of the standing wave. It may also be related to reflected and incident power.

In the case of perfect matching, SWR is 1 and all the power delivered by the system is radiated by the antenna, requiring that all installations endeavour to obtain the lowest possible SWR within the bandwidth or the frequency range in which the antenna operates.

VHF antenna to be installed for AIS applications is required to be marine VHF-type. Generally, they have a central frequency is 156-157 MHz and a bandwidth of between 6 and 7 MHz, ensuring good performance between 152 and 160MHz, and optimum work (SWR=1) in their central frequency.

Given that the frequency channels used by AIS are 161,975 MHz and 162,025 MHz, it is critical to use an antenna with a broader bandwidth or tuned to a frequency closer to that defined for the work of AIS.

An antenna with a SWR lower than 1.5 is recommended.

## IP rating

Electronic equipment installed on a Navigation Buoy will be subject to severe environmental exposure.

In order to safeguard the integrity of the equipment, increase its lifespan and ensure its reliability, the installation must prevent the condensation cycle from starting. In order to achieve this, an IP (Ingress Protection) level of not less than IP56 should be specified.

### IP enclosure rating

The enclosures and their connections should, as a minimum, be rated to IP56, although this should be increased to suit local severe environment conditions. The unit should be protected from direct water spray.

Approved and tested assemblies ensure enclosures capable of withstanding challenging weather conditions, thereby preserving the equipment within.

In a harsh environment, the use of two enclosures (> IP56) may be considered to provide the required level of protection.

### Pressure balance

The pressure in the enclosure needs to be balanced with the outside in order to eliminate air flow between and thus eliminate condensation. This can be achieved with a propriety vapour barrier to the appropriate IP rating.

## Lightning protection.

In areas where Lightning strikes are considered to be a specific hazard, consideration should be given to protecting the AIS-AtoN unit from this by installing Surge Protection.

The implementation of a surge protection to guard the equipment against an atmospheric discharge is essential in any installation of electronic equipment afloat.

These atmospheric discharges affect the stability of the equipment for the operation in the GNSS signal acquisition and VHF transmission.

Lightning protection can take the form of diode-based surge protectors, varistors, gas discharge units and good grounding.

### Grounding

Good equipotential bonding between the superstructure, mounted equipment and the sea water will provide some protection against the raised electrical potential during a lightning storm. This will also prevent a static build up on the buoy.

## Impact on buoy performance

The installation of AIS-AtoN on buoys may impair the buoyancy and stability characteristics. The overall mass and centre of gravity of any additional items needs to be considered at the design stage.

Some split AIS-AtoN requires the GNSS receiver and VHF antenna to be placed at a high level. The connected cables pass through the buoy's lighting unit and may affect its performance. Therefore, all cable routes need to be considered at the design stage to minimize this situation. Some integrated AIS navigation beacon does not have the above problems.

## Integrated AIS-AtoN Units

AIS-AtoN can be supplied as an integrated unit with equipment such as lanterns, metrological or hydrological sensors. Monitoring data can include solar voltage, battery voltage, status of operating lamp or flasher, number of available lamps remaining (lamp changer), sun switch status, and flash code.

AIS-AtoN can be supplied complete with an integrated lantern, solar PV power supply with battery storage and all required controls and monitoring facilities.

## Redundancy

For remote AtoN sites, the user can consider having a system with two AIS-AtoN units. Transmissions alternate between the AIS-AtoN units at the configurable reporting interval. Should one AIS-AtoN unit fail, the other will continue to transmit at its configured reporting interval.

## application scenarios

In addition to providing navigation assistance services for general scenes such as marking obstacles, channel limits, faulty beacons and safe water limits, AIS-AtoN can also offer services for special scenes such as offshore wind farms, offshore oil pipelines, ocean pastures, undersea tunnels and complex waterways.

# COMMISSIONING & TESTING

## Configuration

AIS-AtoN units require programming for the following parameters as a minimum:

1. MMSI
2. Name and type of Navigation Aid
3. AIS type (Type1, 2 or 3)
4. Charted position
5. Guard ring (off-position alarm)
6. For type 1: Transmission interval, Slot allocation
7. AIS type (Real, Virtual or Synthetic)
8. Dimensions of the AtoN

Confirmation of all on site programmed information needs to be recorded with the Competent Authority.

## testing

### Tests pre deployment

* Power Consumption
* Output Power
* SWR
* Slot synchronization (if possible)
* Functional test
* Off-stations alarms
* Configuration

Prior to deployment, the AIS-AtoN should be set-up for transmission at an approved location and its performance monitored remotely. Testing of off-station alarm should also be part of the testing sequence by moving it beyond its guard ring.

When testing the AIS-AtoN that is not in its assigned position, agreement must be gained with the licensing authority to avoid confusion to local shipping. If two AIS-AtoN use the same MMSI this will cause confusion; consideration should be given to using a specific MMSI for test purposes only.

### Analysis of results

It is recommended to compare the results of the tests with the manufacturer’s specifications for compliance.

### Tests post deployment

* Functional test
* Transmitted position
* Configuration
* Range test

# MAINTENANCE & OPERATION

## Maintenance requirements

It must be noted that when the equipment has been integrated by the supplier there is a lower risk of failure to the internal connections, external antenna connection, balance of energy, etc. User-implemented AIS equipment runs a higher risk of failing.

The purpose of this section is to consider the probability of failures occurring due to human error, requiring that the process be standardized to minimize risk of failure.

### Technical Staff

One of the most common situations to be faced on board the buoy tender while conducting Maintenance and Repair tasks is that of repetitive work. It is essential to maintain attention to detail when maintaining and programming AIS-AtoN as this is the most common point of failure. Verification of the received signal post installation and repair is essential to confirm the correct operation of the unit.

Close attention to the watertight integrity of glands and connectors is also essential.

Technical staff are responsible for verifying:

* AIS-AtoN operation
* VHF and GNSS antenna cables
* Non-intrusive inspection of the condition of VHF antenna, of its flexibility and of the GNSS antenna if placed on the outside
* Condition of wiring and connectors, stiffness, cracks, moisture and oxidation
* SWR measurement (if possible)
* Power supply checking
* Fixing system
* Transmission range and coverage measurement.

### Configuration Software

The technician needs to be well acquainted with the configuration software. Good configuration management methodology should be in place to ensure accurate tracking of configuration of the AIS-AtoN and the embedded software version.

## Training

### Capabilities required

The technical staff associated with the maintenance and operation of AIS-AtoN should have specific training to enable them to work safely and competently on the AIS-AtoN. The skills required to maintain and programme AIS-AtoN units at sea are at a higher level than that required to maintain a basic lighted buoy. Since AIS-AtoN maintenance and implementation on navigational aids is not a routine task, their performance is to be assessed and monitored periodically.

When a vessel gives support to an AIS-AtoN, technical personnel on board do not usually have the best working conditions, therefore for operational reasons the AIS-AtoN equipment installation needs to be conducted by specially trained personnel or in workshops designed for such purposes.

### Training documentation

As with all training, manuals need to be plain, concise, reader-friendly and readily available to the maintainer.

## Spare transponders

It is necessary to have spare transponders to replace those that fail, which are damaged by passing ships, vandalized or out of service. The best way to maintain the service is to replace a malfunctioning transponder and to repair at the workshop.

The spare number of transponders required depends on the installed number. The rate of spares needs to be evaluated and adapted by each authority.

# SELECTION OF EQUIPMENT

When selecting a suitable AIS-AtoN system, the following points should be considered:

* Life cycle cost analysis
* Reliability
* Size of unit compared to available space
* Simplicity to configure and interrogate
* Upgrade easy to perform
* After-sales service and support
* Hardware and software capacity expansion
* Different hardware solutions adaptable to the equipment base
* Ease of installation
* External connection (Example: high-integrity external connections.)
* Low power consumption.