USCG/NOAA
Automatic Identification System (AIS) on Data Buoys and C-MAN Stations

System Requirements Specification

prepared for

U.S. Coast Guard
G-OC/MDA

by

National Oceanic and Atmospheric Administration
National Weather Service
National Data Buoy Center

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REVISION HISTORY

REV.	DESCRIPTION	DATE	APPROVED

ACRONYMS AND ABBREVIATIONS

AIS	Automatic Identification System
AtoN	Aid to Navigation
C-MAN	Coastal Marine Automated Network
DoD	Department of Defense
GPS	Global Positioning System
IALA	International Association of Lighthouse Authorities
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
ITU	International Telecommunications Union
ITU-R	International Telecommunications Union- Radiocommunications Bureau
MDA	Maritime Domain Awareness
MMSI	Maritime Mobile Service Identity
NDAC	NDBC Data Assembly Center
NDBC	National Data Buoy Center
NMEA	National Marine Electronics Association
PC	Personal Computer
RF	Radio Frequency
SIM	System Identity Module
VDL	VHF Data Link
VDM	VHF Data Link Message
VHF	Very High Frequency
VOS	Voluntary Observing Ship

1.0 SCOPE

1.1 Identification

This document describes the requirements for an Automatic Identification System (AIS) embedded on National Data Buoy Center (NDBC) buoys and select Coastal-Marine Automated Network (C-MAN) stations. This system shall: receive identification and other information from marine vessels; process and re-transmit these data to an NDBC Data Assembly Center (NDAC) distribute these data to the United States Coast Guard (USCG) National AIS Infrastructure via internet; receive meteorological data from vessels participating in the National Oceanographic and Atmospheric Administration (NOAA) Voluntary Observing Ship (VOS) program and re-transmit these data to the NDAC; and transmit meteorological, hydrological, and safety-related data and warnings to vessels. Figure 1 shows a diagram of the components that comprise this AIS system.

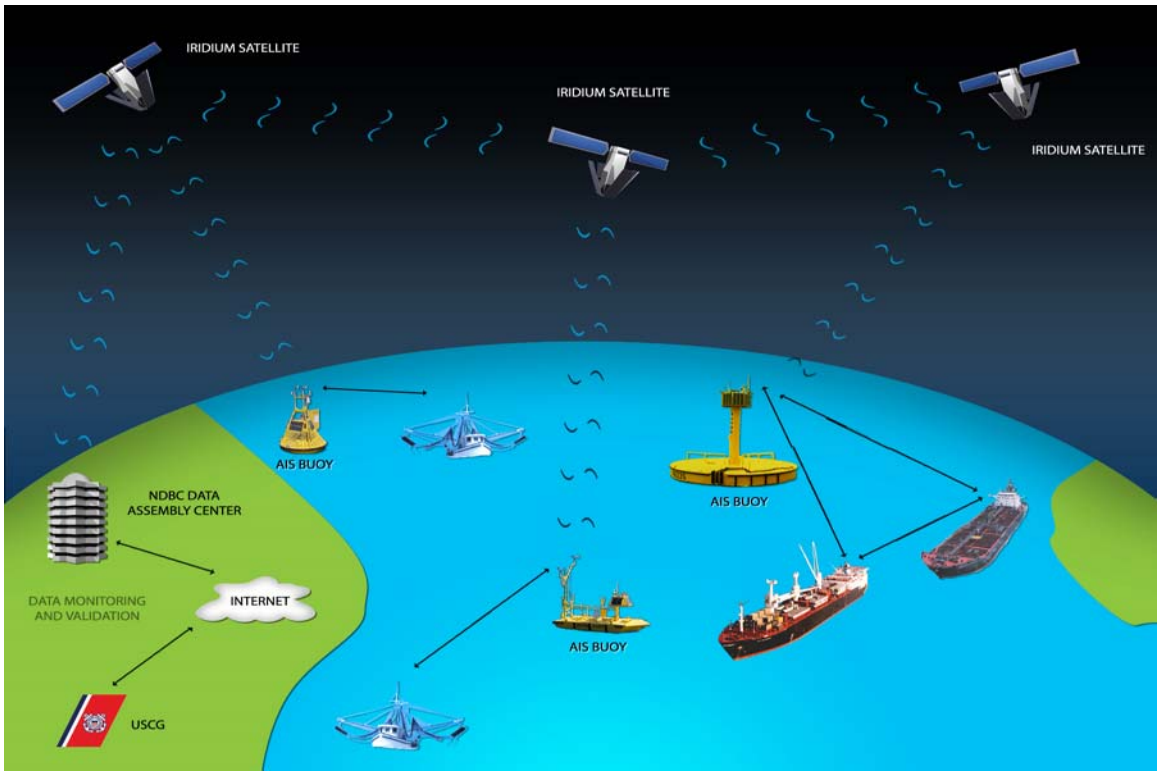

Figure 1. Maritime Domain Awareness AIS System

1.2 System Overview

NDBC operates a fleet of buoys and C-MAN stations located in the oceans surrounding the continental United States, Alaska south of the Bering Strait, and the Hawaiian Islands. These buoys and C-MAN stations shall be integrated into the USCG AIS network by installation of a low-

power AIS receiver or transceiver, AIS system controller, and IRIDIUM modem on each platform. These AIS components shall provide AIS data received from marine vessels (identification, position, and other voyage-related data) that are within radio range of these NDBC stations. The remote, AIS-enabled stations shall also receive environmental measurement data from vessels that are participating in the NOAA VOS program within radio range of NDBC stations. Both data types shall be received through the AIS Very High Frequency (VHF) Data Link (VDL) and retransmitted to the NDAC via IRIDIUM modem. Environmental measurement data from VOS vessels shall be transmitted using the trial message in Appendix 1, of the "Draft SN Circular on Guidance on the Application of AIS Binary Messages," Application 1, "Meteorological and Hydrological Data," (NAV 49/19, Annex 18, Appendix 2, pp. 4-5). The draft message unused bits shall be modified by NDBC to ensure that environmental measurements broadcast by VOS vessels are not generally available to AIS-enabled ships to prevent the distribution of environmental data that has not undergone quality assurance checks. In addition, the remote stations shall collect and process meteorological data using existing NDBC payloads and receive safety-related messages and warnings from the NDAC via IRIDIUM modem, and then re-format these data for transmission to ships within radio range through the AIS VDL.

The AIS system on each platform shall consist of: an AIS receiver or transceiver and VHF antenna; an AIS system controller unit, which shall control all AIS functions and process all AIS data on the remote station; and an IRIDIUM modem and antenna to transfer the AIS data to the NDAC. A system concept of operations diagram with an expanded block diagram of the AIS system to be installed on NDBC stations is shown in Figure 2. The NDBC Data Assembly Center shall consist of several IRIDIUM receiving stations (modems and antennas) and desktop PCs with internet communications to receive the AIS reports and relay them to the USCG, if IRIDIUM short burst mode proves infeasible, or the NDAC shall consist of an internet server socket to the Department of Defense (DoD) IRIDIUM gateway in Hawaii if short burst mode proves feasible.

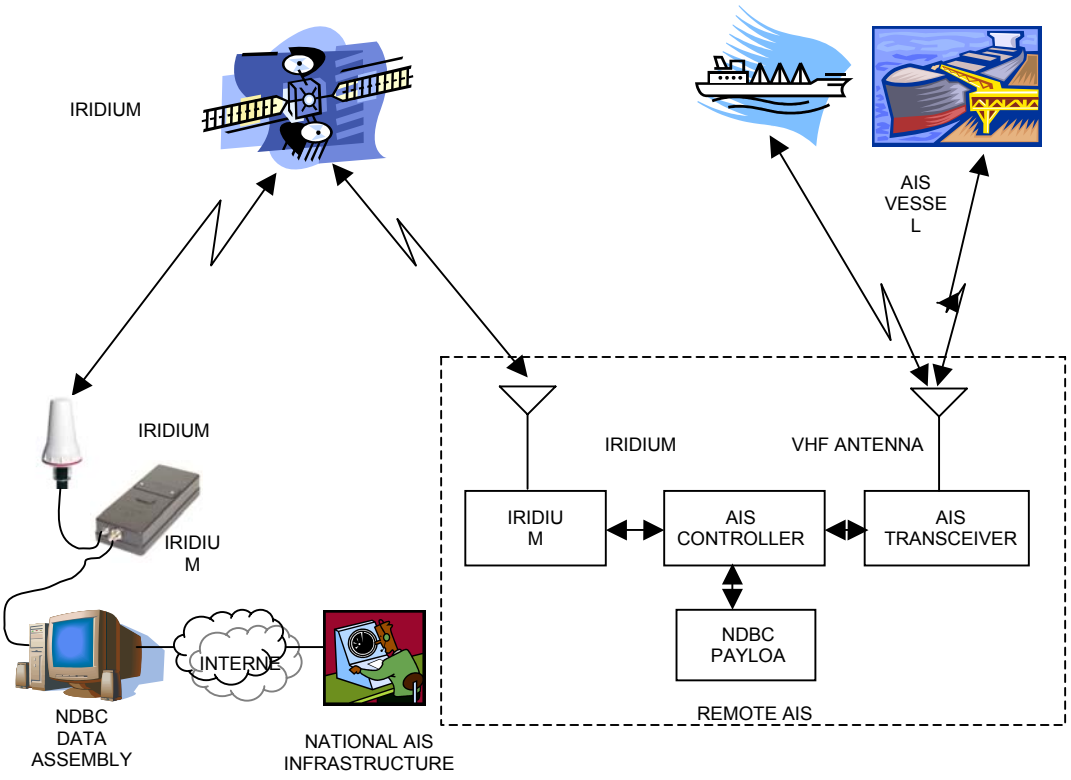

Figure 2. AIS System Block Diagram

2.0 REFERENCED DOCUMENTS

a) IEC-61993-2 Maritime navigation and radiocommunication equipment and systems - Automatic identification systems (AIS) - Part 2: Class A shipborne equipment of the universal automatic identification system (AIS) - Operational and performance requirements, methods of test and required test results.

b) IEC-61162-1 Maritime navigation and radiocommunication equipment and systems –Digital interfaces –Part 1: Single talker and multiple listeners

c) IMO SN Circ.227, GUIDELINES FOR THE INSTALLATION OF A SHIPBORNE AUTOMATIC IDENTIFICATION SYSTEM (AIS).

d) IMO Resolution MSC.74(69), Annex 3, Recommendation on Performance Standards for an Universal Shipborne Automatic Identification Systems (AIS)

e) ITU-R Recommendation M.1371-1, Technical Characteristics for a Universal Shipborne Automatic Identification System Using Time Division Multiple Access in the Maritime Mobile Band

f) IALA GUIDELINES ON THE UNIVERSAL AUTOMATIC IDENTIFICATION SYSTEM (AIS), Volume 1, Part II – Technical Issues, Edition 1.1, http://www.iala-aism.org/web/pages/publications/docpdf/ais/AISGDLti.PDF

g) INTERNATIONAL MARITIME ORGANIZATION, SUB-COMMITTEE ON SAFETY OF NAVIGATION, 49th session, ANNEX 18, DRAFT SN CIRCULAR ON GUIDANCE ON THE APPLICATION OF AIS BINARY MESSAGES, http://www.iadc.org/committees/offshore/Documents/NAV%2049%20report.pdf

h) Automatic Identification System: A General Discussion of Development, Application, and Implementation, M. J. Lewandowski, Potomac Management Group, and D. J. Pietraszewski, U. S. Coast Guard Research and Development Center, For USCG R&D Center Project 2410.5-Vessel Traffic Management Research. http://www.rdc.uscg.gov/iws/pubs/ais-paper.pdf

i) NDBC 1102, Electronic Equipment Environmental Stress Screening, 2/9/1989.

3.0 REQUIREMENTS

3.1 Functional Requirements

3.1.1 Platform AIS Equipment

3.1.1.1 The AIS design process shall consist of three phases. Phase 1 shall implement the receipt of AIS messages from ships with AIS transceivers, Phase 2 shall implement the receipt of VOS environmental data from NOAA VOS ships, and Phase 3 shall implement broadcast of AIS messages from NDBC platforms. For Phases 1 and 2, the platform's AIS equipment shall be a commercial-off-the-shelf Universal Automatic Identification System receiver. The AIS receiver shall receive AIS messages and VOS meteorological data using approved AIS messages as per ITU-R M.1371-1 on AIS VHF channels at 161.975 MHz and 162.025 MHz. For Phase 3, an IEC compliant AIS transceiver will replace the AIS receiver. The AIS transceiver shall transmit AIS messages on these same VHF channels at up to 12.5 Watts output power. Transmitted messages shall include meteorological data, safety-related messages, and warnings using AIS messages as described in ITU-R M.1371-1.

3.1.1.2 The AIS receiver and transceiver shall output approved VHF Data Link Message (VDM) sentences as described in IEC 61993-2 to the AIS system controller through an RS-232 serial port. The AIS transceiver shall accept approved IEC sentences through an RS-232 serial interface from the AIS system controller for messages broadcast on the VDL.

3.1.2 AIS Controller.

3.1.2.1 The AIS controller shall be a low power microcontroller unit that operates and controls all remote station AIS equipment.

3.1.2.2 The AIS controller shall provide power for all remote station AIS equipment.

3.1.2.3 The AIS controller shall be powered from the 12-16 volts DC buoy/C-MAN battery power system.

3.1.2.4 The AIS controller unit shall provide power management functions required to reduce overall power consumption to the designed level. This shall include turning on power to the AIS equipment and the IRIDIUM modem only as required, and operating the controller in a low power mode.

3.1.2.5 The AIS controller shall have an RS-232 serial interface to communicate with the AIS equipment and accept the AIS data from the equipment. The serial interface shall operate at 38.4 kbps. The AIS controller shall receive serial data at this rate continuously when on and store selected AIS data to a temporary memory buffer.

3.1.2.6 The AIS controller shall have an RS-232 serial interface to communicate with the IRIDIUM modem. This serial interface shall operate at 9600 bps.

3.1.2.7 The AIS controller shall have an RS-232 serial interface to communicate with the NDBC payload. This serial interface shall operate at 9600 bps.

3.1.2.8 The AIS controller shall have an RS-232 serial interface to communicate with a laptop or palm computer for test and configuration functions. This serial interface shall operate at 9600 bps.

3.1.2.9 The AIS controller shall provide power to the AIS equipment to permit operation on the VDL for a minimum of three minutes in every fifteen minute period, however this VDL operation time shall be programmable to a resolution of 1 second to allow other VDL on-times.

3.1.2.10 The AIS controller shall have sufficient memory to store the most recent message of each type received from each unique MMSI detected by the AIS equipment during the synoptic interval of operation.

3.1.2.11 The AIS controller shall process data received from, and going to, the AIS equipment.

3.1.2.11.1 The AIS controller shall create an IRIDIUM report every 15 minutes. This report shall contain the most recent of each message type (e.g. position, static and voyage-related, assigned position, etc.) from each unique vessel, as determined by MMSI, for the programmed VDL operation time during the past 15 minute period.

3.1.2.11.2 The AIS controller report message shall contain approved sentences, as described in IEC 61993-2, and instrumentation information to include platform identification, time of each received report, and report signal strength if available.

3.1.2.11.3 The AIS controller message buffer, containing the unique AIS sentences collected during the on-time of the AIS equipment during every 15 minute synoptic interval, shall be aligned with a real-time clock set to Universal Time, Coordinated (UTC) and shall contain a buffer for minute 0 to minute 15, minute 15 to minute 30, minute 30 to minute 45, and, minute 45 to minute 0. Each message buffer shall contain buoy GPS position in VDO format as received the AIS GPS receiver.

3.1.2.11.4 AIS sentences shall be stored in memory in the form as provided by the AIS equipment. Each received AIS sentence shall have a station identifier, a time tag, and signal strength, if available, appended to end of the sentence.

3.1.2.11.5 VOS environmental data received through AIS from VOS ships shall be forwarded to the USCG after undergoing quality control of the measurement data at NDBC.

3.1.2.11.6 The AIS controller shall verify the checksum for each received AIS sentence and those sentences with invalid checksums shall be ignored.

3.1.2.12 The AIS controller shall control and operate the IRIDIUM modem through the modem RS-232 serial interface and initiate an IRIDIUM transmission of data to the NDAC after each programmed acquisition interval. If no AIS data are collected during an acquisition interval, the controller shall send a zero length, Short Burst Data message through IRIDIUM to receive any pending commands.

3.1.2.12.1 The AIS controller shall manage power to the IRIDIUM modem as required to minimize power consumption.

3.1.2.12.2 The AIS controller shall perform all IRIDIUM modem configuration functions necessary to send the AIS data to the NDAC through the IRIDIUM modem.

3.1.2.12.3 The AIS controller shall respond to data requests from the NDAC through the IRIDIUM modem.

3.1.2.12.4 The AIS controller shall receive broadcast messages from the NDAC through the IRIDIUM modem.

3.1.3 Remote IRIDIUM Modem.

3.1.3.1 USCG G-OC/MDA shall supply an activated IRIDIUM System Identity Module (SIM) card with telecommunications service for each IRIDIUM modem on each buoy or C-MAN station with an installed AIS system, and additional activated SIM cards as required for the NDAC PCs. IRIDIUM telecommunications service charges for all IRIDIUM SIMs shall be the responsibility of the USCG G-OC/MDA.

3.1.3.2 The IRIDIUM modem shall be power-managed by the AIS system controller, and be active only when required to relay synoptic AIS data or a zero length message to the NDAC.

3.1.3.3 The IRIDIUM modem RS-232 serial interface shall operate at 9600 bps.

3.1.3.4 The IRIDIUM modem Radio Frequency (RF) data link shall operate at 2400 bps in the frequency range of 1616.0 to 1626.5 MHz.

3.1.4 NDBC Data Assembly Center (NDAC).

3.1.4.1 The NDAC shall consist of a single server with a direct TCP/IP internet socket connection over the public internet to the DoD IRIDIUM secure gateway in Hawaii if Short Burst Mode transmission is used, or an IRIDIUM modem, IRIDIUM antenna, and a desktop PC for each three remote stations should Short Burst Mode prove infeasible.

3.1.4.2 USGC G-OC/MDA shall supply all required activated IRIDIUM SIM cards for the NDAC. IRIDIUM telecommunications service charges shall be the responsibility of the USCG G-OC/MDA.

3.1.4.3 The NDAC PCs shall control shore-side IRIDIUM modems through the IRIDIUM modem RS-232 serial interface and receive the AIS data from the remote stations through the IRIDIUM modem RF data link.

3.1.4.4 Each remote AIS station shall call the Data Assembly Center at least once every 15 minutes with an AIS data report. With the completion of Phase 3 design, the NDAC shall transmit any safety-related messages, warning messages, or other broadcast messages to the remote AIS station during this call.

3.1.4.5 Each NDAC PC shall receive AIS data from an IRIDIUM modem through an RS-232 interface, verify sentence checksums, discard sentences with invalid checksums, store the data in disk files, and transfer valid sentences to the USCG National AIS Infrastructure .

3.1.4.6 Data transferred to the USCG National AIS Infrastructure shall be transferred via TCP/IP internet connection.

3.1.4.7 AIS messages transferred to the USCG National AIS Infrastructure shall be transferred in the approved AIS sentence formats for these message types in accordance with IEC 61993-2 and with the additional receiving station identification, signal strength (if available), and time fields.

3.1.5 USCG Network Interface.

3.1.5.1 The NDAC shall interface to the US Coast Guard National AIS Infrastructure at the US Coast Guard Research and Development Center (USCG R&DC) using a direct TCP/IP socket connection over the public internet

3.1.5.2 The NDAC server providing the TCP/IP connection to the National AIS Infrastructure shall employ Java Client software developed by the USCG R&DC to relay AIS data received at the NDAC from remote NDBC AIS stations to the USCG National AIS Infrastructure. USCG R&DC shall provide the AIS Java Client source code and executables to NDBC.

3.1.5.3 AIS data shall be transferred to USCG National AIS Infrastructure as the data is received at the NDAC from each remote AIS station. Communications and processing shall be implemented to minimize transmission latency from the NDAC to the USCG National AIS Infrastructure at USCG R&DC.

3.1.5.4 NDAC processing shall verify checksums of all AIS messages received from remote AIS stations on NDBC buoys and shall deliver only those AIS messages that pass checksum verification.

3.1.5.5 NDAC processing servers shall provide communications to receive AIS data messages directly from the DoD IRIDIUM gateway in Hawaii using a TCP/IP direct socket connection. Communications and processing required to interface with the DoD Gateway shall be implemented to minimize transmission latency to the NDAC.

3.1.5.6 The NDAC shall accept AIS sentences from the USCG National AIS Infrastructure at USCG R&DC for broadcast by, or command to, the remote AIS station on the addressed NDBC buoy. This capability shall apply the methods currently under development by IEC and IALA. Broadcast sentences accepted from the USCG National AIS Infrastructure for broadcast or command shall be screened by the NDAC to ensure the requested broadcasts or commands can be accommodated within remote buoy power system limitations. USCG R&DC shall be notified via internet if a broadcast or command request cannot be accommodated.

3.1.5.7 NDAC processing servers shall retain specific AIS messages that are designated for internal use and processing by NDBC. These messages include VOS environmental data messages and NOAA safety or warning broadcasts.

3.1.6 AIS VOS Function

3.1.6.1 The remote AIS system shall receive meteorological data from participating NOAA VOS ships using AIS Message 8. VOS data shall be transferred from the remote AIS stations to the NDAC with the USCG-bound data and separated from the USCG-bound data at the NDAC prior to transmission of vessel position and voyage-related data to USCG.

3.1.7 AIS Buoy Identification Function

With the completion of Phase 3, each remote AIS station shall transmit buoy position and identification data to vessels within radio range of the remote AIS station using Message ID 21 under the limited base station modes as developed by IEC Working Group 14

3.2 Performance Requirements

3.2.1 Data Integrity.

3.2.1.1 The standard AIS sentences have checksums attached. The NDAC shall perform checksum calculations and shall not transfer AIS data to the USCG R&DC that does not have a valid checksum. Receipt of data by the USCG National AIS Infrastructure shall be verified using standard TCP/IP internet protocols. Receipt of data at the NDAC from the DoD IRIDIUM gateway shall be verified using standard TCP/IP internet protocols.

3.2.2 Environmental

3.2.2.1 All remote AIS equipment shall have an operating temperature range of -15 to +50 degrees Celsius.

3.2.2.2 All remote AIS equipment shall have an operating relative humidity range up to 85% non-condensing except VHF, IRIDIUM, and GPS antennas

3.2.2.3 VHF, IRIDIUM, and GPS antennas shall have an operating relative humidity range of 100% condensing.

3.2.2.4 EMC, salt fog, and vibration of the AIS equipment shall meet IEC 60945 requirements.

3.2.3 Power Consumption

3.2.3.1 The AIS equipment, AIS system controller, and IRIDIUM modem on each AIS station shall have a total system power consumption of less than 4 Ampere-hours per day in order to meet NDBC station power capacity limitations.

3.3 AIS Documentation Requirements

3.3.1 Required System Documents

- System Requirements Specification
- Preliminary Design Review Report
- Critical Design Review Report
- System Design Document
- NDBC/USCG Network bi-directional interface specification
- System Test Plan and Procedure
- System Maintenance/Operations Manual

- Level A Engineering Design Drawings, Installation Drawings, and Test Procedures