Input paper: [[1]](#footnote-1) ENG16-3.1.2.13

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

**X** ARM **□** ENG **□** PAP **□**Input

**□** ENAV **□**VTS **X** Information

Agenda item[[2]](#footnote-2) 3.1.2

Technical Domain / Task Number2 …………………………………

Author(s) / Submitter(s) China Maritime Safety Administration

Tidal current chart drawing test by using multi-functional buoy in Shanghai port

# Summary

China Maritime Safety Administration (China MSA) actively builds a high-efficiency and high-precision comprehensive sensing system for the maritime environment. By deploying a large number of sensing devices with a certain density in important waters, key channels, turning points and other locations, upgrading the traditional buoys to multi-functional buoys, activate the potential functions of multi-functional buoy in scientific research, service, supervision, etc. Multi-functional buoys are deployed in Large-scale ports such as Shanghai Port, Ningbo Zhoushan Port, Guangzhou Port, and Tianjin Port; By deploying6 multi-functional buoys in Shanghai Port, China MSA collect tidal current data, transferred back using Beidou satellite system or AIS technology. Then complete the tidal current chart drawing test according to the time series algorithm. Compared with traditional methods, the tidal current charts drawn by the data collected from multi-functional buoys are more accurate and reliable, also with the advantages of better timeliness, and automatically generated.

## Purpose of the document

The purpose of the document isto introduce the test result of the application of multi-functional buoy that it can be submitted for review by the ENAV Committee.

## Related documents

## IALA Guideline 1066 "THE DESIGN OF FLOATING AID TO NAVIGATION MOORINGS"

# Background

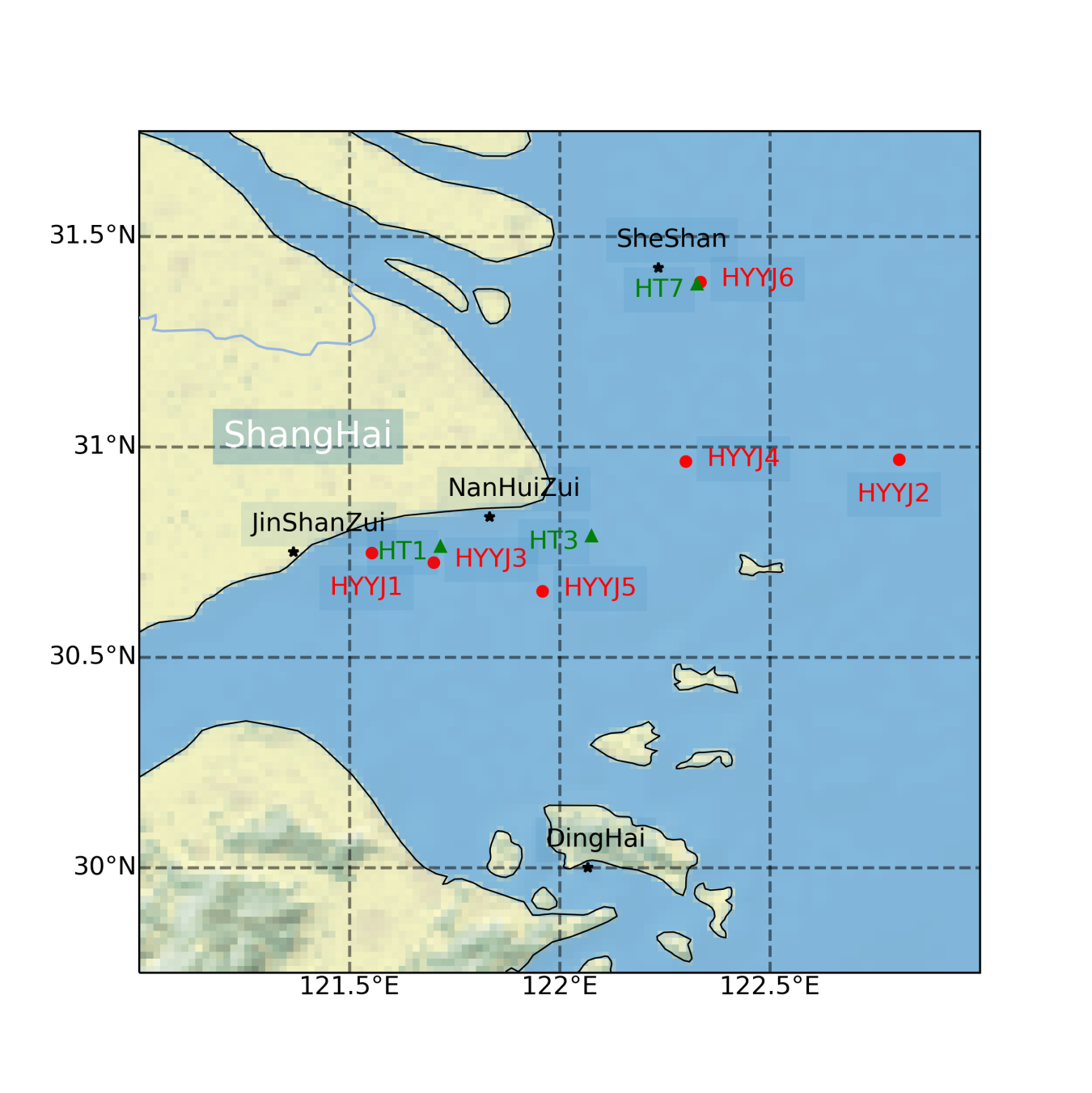
The multi-functional buoy is an intelligent AtoN composed of beacon light device, AIS intelligent terminal, meteorological collection terminal, hydrological collection terminal, CCTV, atmospheric environment monitoring terminal, intelligent information integration terminal, Beidou satellite communication terminal, lithium battery pack, solar panel, radar transponder and other equipment. With the acceleration of ships towards large-scale, rapid speed and intensified volume. The use of modern technological means to empower traditional AtoN play a more effective role of offshore navigation service. This should be the development direction of AtoN service. The Yangtze River Estuary and the Yangshan Deep Water Channel of Shanghai Port are artificially excavated. Changes of hydrological conditions in the channel are inevitable. Therefore, it is particularly important to fully understand the hydrological changes in the port area.

# Details

## The layout of buoys and the collection of tidal current data

China MSA deployed 6 multi-functional buoys from the north bank of Hangzhou Bay to the outer sea of Yangtze River Estuary (see Chart 1).The buoys weight 1.8 tons, diameter is 3 meters, each buoy is equipped with Aruba 5400 tidal current meter, surface observation depth is about 2 meters, the working frequency is 600kHz, the data accuracy can reach 0.3cm/s. The data is automatically recorded every half an hour.After removing abnormal data, the tidal current data collected from June 1 to December 1, 2021 was processed in the backstage data center.

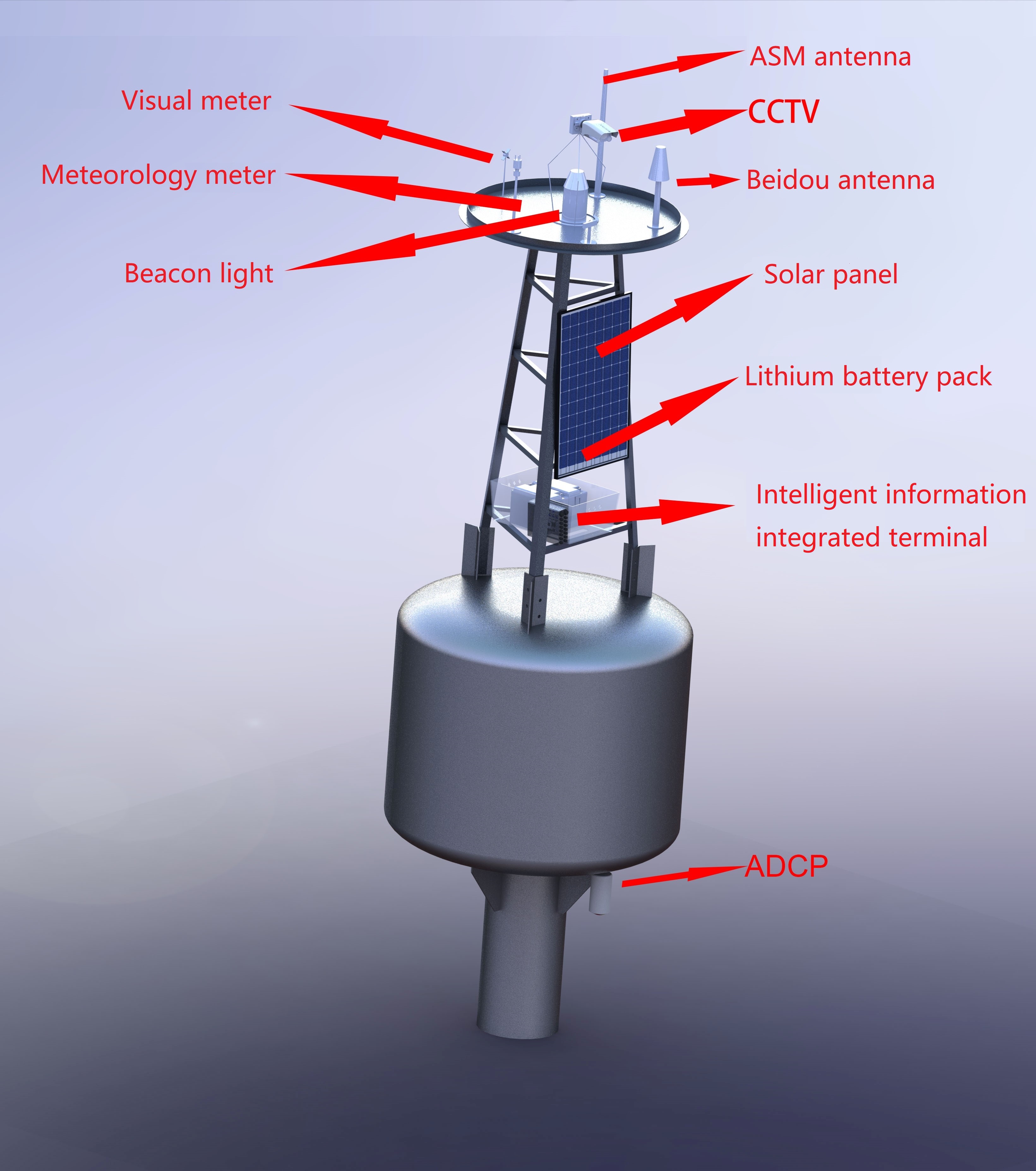
The hydrological condition information of some important locations is broadcasted to the ships around through No. 6, 8, 12and 14 AIS/ASM messages in real-time.



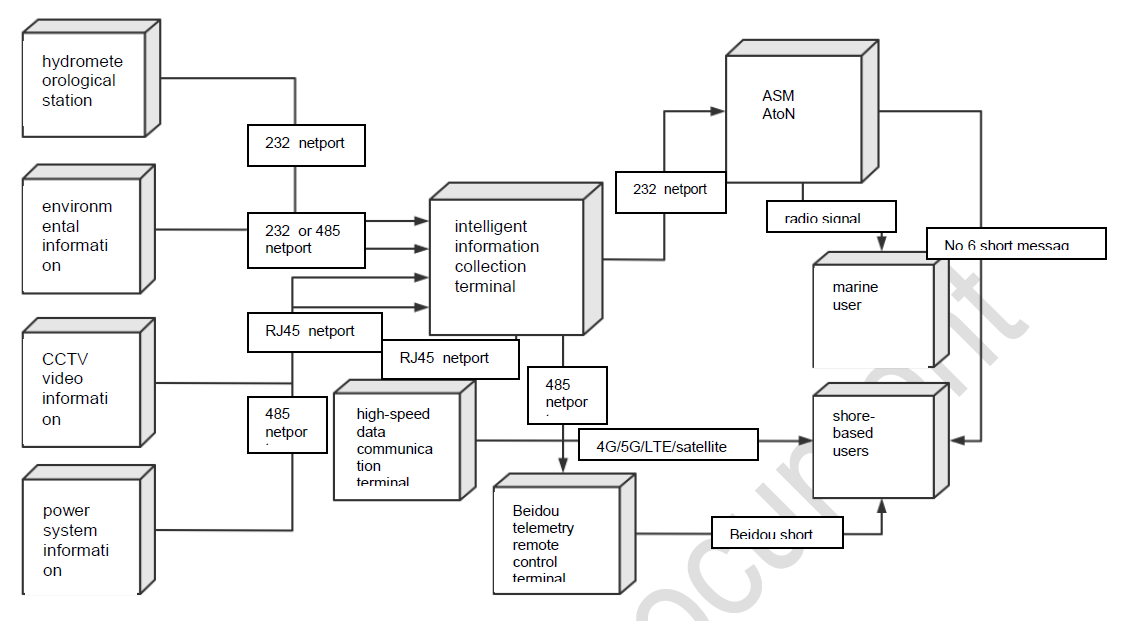
*Figure 1 The layout of multi-functional buoys*

## System structure

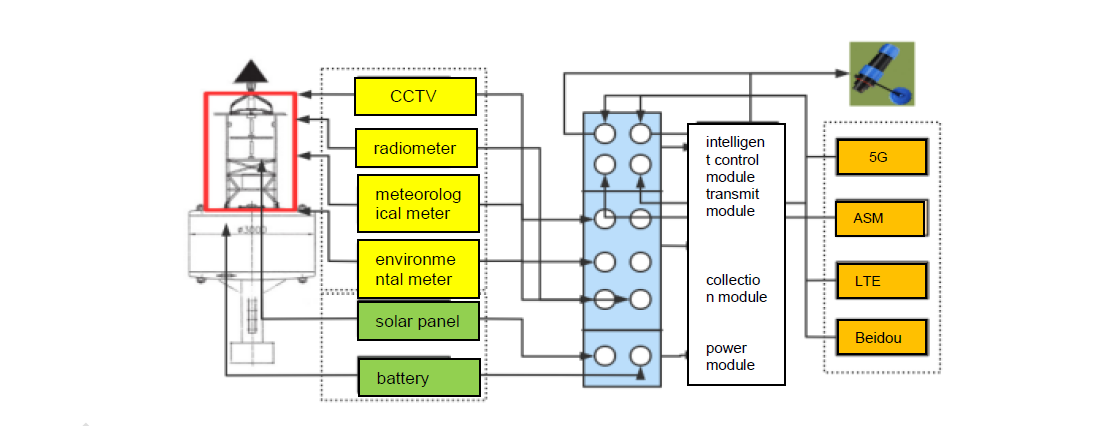
In order to provide more diversified AtoN services, multi-functional buoys expand other service functions beside the basis of visual navigation, so as to achieve the goal of deeper service for marine users and expansion of users. Multi-functional buoys are transformed from existing AtoNs, by upgrading energy and communication methods, adding a variety of sensors as needed, and connecting to intelligent information integration terminals; Data processing adopts the current mainstream bus data flow method, uses lithium-ion batteries as energy support subsystems, integrates and standardizes all sensor connectors, and performs local information packaging and processing through 5G edge computing architecture, then use AIS, Beidou and 5G data communication channels to transmit back to the data center, broadcast hydrological, meteorological and AtoN information use AIS/ASM at the same time, so that ships around can understand the detailed navigation information in the waters in real time.



*Figure 2 The installation of integrated devices*



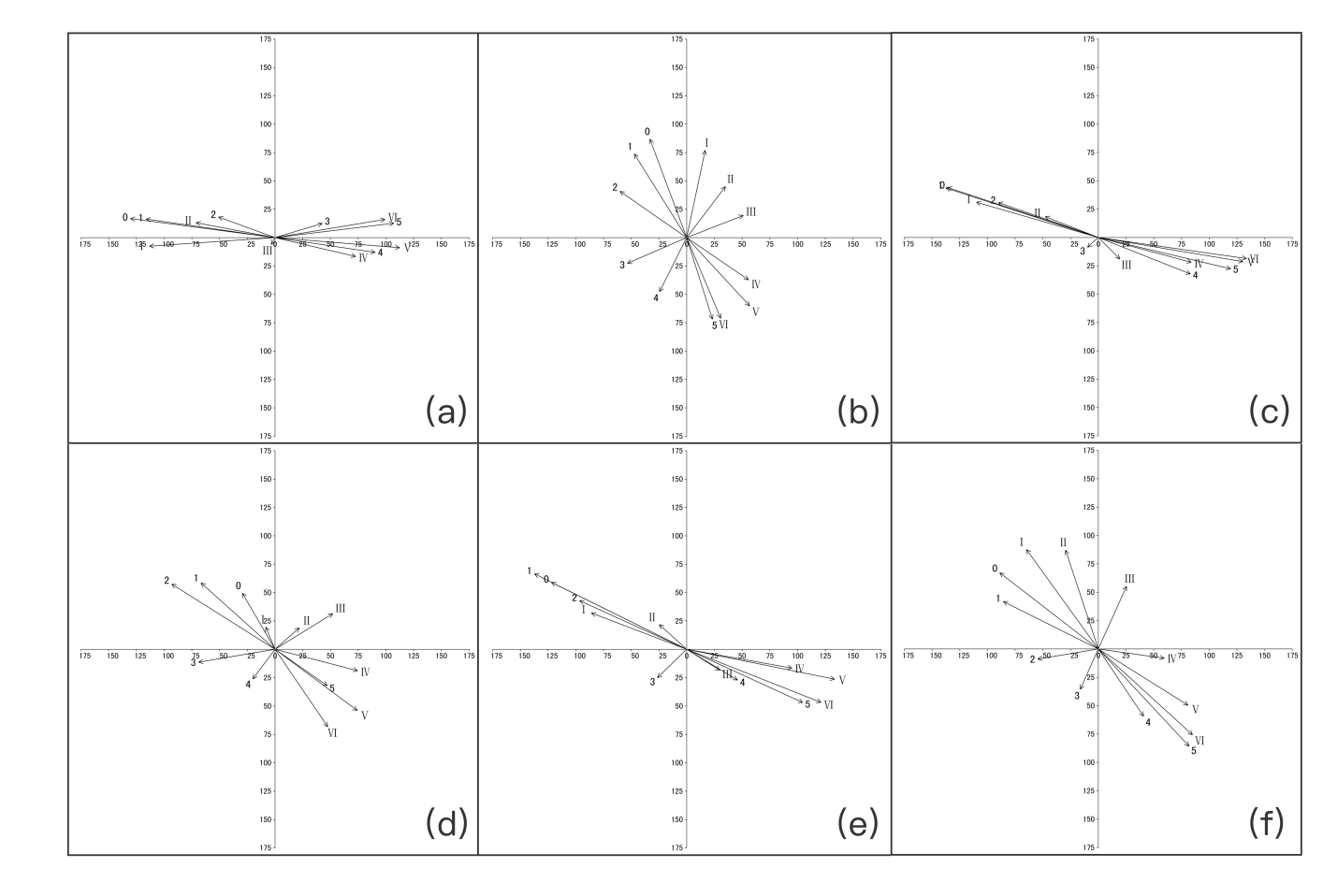
*Figure 3 Data processing flow chart of multi-functional buoy*



*Figure 4 Connection diagram of intelligent information collection terminal*

## Application of tide detection

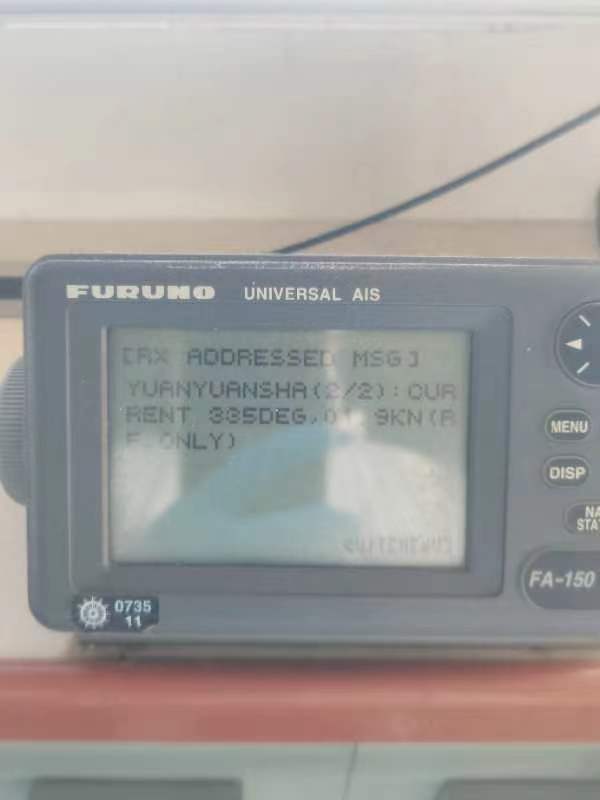
The hydrological information returned by the Beidou short message is stored in the data center, and the data is used for tide detection. Judging from the changing process of astronomical tides at each moment, it shows an obvious two-high and two-low process of "rising rapidly - rising and resting - falling rapidly - falling and resting". From the eigenvalue of flow velocity, the tidal flow velocity in the north coast of Hangzhou Bay is generally relatively large, and the maximum velocity appears in the Xiaoyangshan sea area of Hangzhou Bay, and it can reach 188.9 cm/s at V time after high tide in August; The flow velocity of astronomical tides in the waters outside the Yangtze River Estuary varies relatively slowly at each moment. The tidal changes around Shanghai are affected by factors such as Yangtze River runoff, continental shelf circulation and wind stress, and basically have obvious seasonal differences.



*Figure 5 Synthetic tidalcurrent chart in months of HYYJ1--6*

## The information reception and display on shipboard terminal

The hydrometeorological data is sent point-to-point or broadcast to the surrounding ships through the standard AIS message, received and displayed through the standard AIS shipboard terminal, providing a variety of AtoN service.



*Figure 6 The information reception and display in shipboard terminal*

# Test Result

**4.1** Multifunctional buoy could conduct long-term and continuous observation, monitor and collect tidal current data, with its independent energy system, it should not be limited by geographical location, facility size or energy supply.

**4.2** The drawn of tidal current chart will greatly reduce the errors caused by occasional extreme weather and monthly tide differences, which advantages in automatic generation and timeliness.

**4.3** By carrying other different sensors, the multi-functional buoy expands the efficiency of traditional AtoN, it’s user friendly, economical and easy to promote for application.

# References

IALA Recommendation A-126“the use of the Automatic Identification Systems (AIS) in Marine Aids to Navigation Services”.

# Action requested of the Committee

The Committee is invited to note the above information about the application of multi-functional buoy in Shanghai port.

1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-1)
2. Input papers should be assigned to a work task as listed in the Committee work plan which is available in input papers. Leave open if uncertain but consider how the paper is to be processed if not relevant to a work task [↑](#footnote-ref-2)