# ENVIRONMENTAL MONITORING

## Introduction

The aim of this section is to:

* identify functional and operational requirements for gathering, processing and display of environmental data in VTS;
* provide guidance on design and installation of such equipment.

Hydrological, meteorological, Oil Spill and any other environmental information, that the VTS Authority requires, should be integrated into VTS applications to provide the VTSO a real-time assessment of the environmental situation in the VTS area. Information collected from this equipment may be provided to ships to assist in assessment of the prevalent conditions.

The protection of the environment is an issue that has grown significantly in importance, both politically and socially, over recent years. The environmental impact of normal commercial activities is analysed such that risk reduction measures can be determined and implemented. Traditionally, VTS Authorities have collected environmental data simply to support their VTS activities. However, many VTS Authorities have their VTS areas in, or alongside, marine protected areas or maritime reserves where any damage to the environment should be avoided.

Therefore, the VTS should consider two aspects of environmental monitoring:

* navigation data collection;
* environmental protection.

Navigation Data Collection includes the traditional environment monitoring sensors, typically referred to as the hydrological / meteorological (hydro/meteo) systems. Typical meteorological variables are those provided by weather stations and include air temperature and humidity, wind velocity and direction, rainfall, air pressure and visibility. In certain locations, hydrological variables such as tidal level, and current direction and velocity may also be required. Hydrological data may be obtained through real sensors or available in predictive tables/databases from national authorities. Sensors, providing this data, usually are located at remote sites and communicate data to a VTS centre via a telecommunications or radio link. Alternatively, wave height, direction and surface current could be derived from the main VTS radar through software processing. The accuracy of such measurements from dedicated sensors and from analysis of radar-originated data should be evaluated as part of the VTS design process.

An Environmental Protection system could include implementing additional capability that provides early detection of any polluting incidents that may be caused by visiting vessels. This early detection of pollution could be achieved through the software processing of the VTS radar signals or by specialist sensors that are designed to detect oil, or other pollutants, in the water.

## Definitions and References

### Definitions

For general terms used throughout this section, please, refer to reference [2].

### References

There are many applicable IMO, IEC, WMO and other requirements. These include, but are not limited to:

1. WMO - Guide to Meteorological Instruments and methods of Observation.
2. WMO - International Meteorological Vocabulary.
3. IMO Resolution A.686(17) - Code on Alarms and Indicators (and MSC.39(63) Adoption of amendments to the Code on Alarms and Indicators).
4. IMO Resolution A.694(17) - General Requirements for Shipborne Radio Equipment forming Part of the Global Maritime Distress and Safety System (GMDSS) and for Electronic Navigational Aids.
5. IEC 529 - Degrees of protection provided by enclosures (Ingress Protection (IP) Code).
6. IEC 721-3-6 - Classification of environmental conditions.
7. IEC 60945 - Maritime Navigation and Radiocommunication Equipment and Systems.
8. IEC 61162 - Digital Interfaces for Navigation Equipment within a Ship.
9. IMO Resolution A.915(22) - Maritime Policy for the Future Global Navigation Satellite System (GNSS).

## Characteristics of Environmental Sensors in VTS

For hydrological/meteorological (hydro/meteo) systems within a VTS system, measurement sensors should be installed and located by the VTS Authority in consultation with hydrologist/meteorologist(s) and Local Authority standards. The sensor identification and location should be provided.

The measurements/sensors may include:

* wind speed / wind direction / wind gust;
* air temperature / relative humidity;
* precipitation;
* barometric pressure (atmospheric pressure);
* visibility;
* water temperature / Water level;
* height of tide;
* current speed (may be required at various depths);
* current direction (may be required at various depths);
* wave height / direction (also used to indicate wave height anomalies that might indicate oil spill);
* ice coverage / thickness;
* salinity.

The hydro/meteo data is transmitted to the VTS centre and presented to the VTSO in order to support decision making associated with the safe navigation of vessels and protection of the environment. In cases of severe weather conditions this information is particularly important.

## Operational Requirements

### Information Presentation

The results of the meteorological and hydrological measurements should be transmitted in WMO standard units and displayed in user-selectable format.

Refer to Section 10.4.2 for presentation requirements.

### Malfunctions and Indicators

As a minimum requirement, malfunctions, warnings, alarms and indicators should respond to the requirements of IMO Resolution A.686(17) [1]. Additional requirements may be required, depending on the individual type or purpose of the sensor.

In particular, where measurements from a number of sensors overlap or provide coverage for adjacent areas, the identification of potentially anomalous readings should be included within the functionality of the data processing to reduce the possibility of incorrect decisions and to highlight the need for maintenance or inspection of the sensors.

### Accuracy

Where a VTS Authority determines a need to establish their own monitoring stations, it should be noted that the individual VTS Authorities, in conjunction with hydrographical and meteorological experts, should determine the accuracy and availability requirements for each VTS Centre, as these will be based on individual circumstances. Table 19 gives an indication of typical measuring range and minimum accuracy requirements for various common environmental parameters.

**Note**: The availability requirement should be as prescribed by IMO A.915(22) [9].

1. Environmental Sensor Requirements

| Parameter | Measuring Range | Minimum Accuracy | Remarks |
| --- | --- | --- | --- |
| Height of Tide | 0 to 20 m (or greater) | ≤ 0.01 m |  |
| Rate of Tidal Stream/ Current | 0 to 10 m/s | ≤ 1% | Maximum value to reflect local conditions |
| Direction of Tidal Stream/Current | 0° to 360° | ≤ 5° |  |
| Wave Height | 0 to 20 m | ≤ 0.1 m, for ≤ 5 m  ≤ 10%, for > 5 m |  |
| Wave Direction | 0° to 360° | ≤ 20° |  |
| Wind Speed | 0 to 75 m/s | ± 0.5 m/s, for ≤ 10 m/s  ± 5%, for > 10 m/s |  |
| Wind Direction | 0° to 360° | ≤ 3° |  |
| Visibility | 10 to 20,000 m | ≤ 50 m, for ≤ 600 m  ≤ 10%, for 600 m – 1500 m  ≤ 20%, for > 1500 m |  |
| Air Temperature | -10° to +50° C | ≤ 0.3° C | The measuring range should be aligned to the applicable hot/cold climate category area |
| Air Humidity | 0 to 100% RH | ≤ 2% RH |  |
| Air Pressure | 920 to 1080 hPa | ≤ 0.3 hPa |  |
| Sea Surface Temperature | -2° to + 40° C | ≤ 0.5° C | The measuring range should be aligned to the applicable hot/cold climate category area |
| Ice Coverage | - | - | Typically, measured by satellite remote sensing |
| Ice Thickness | - | - | Typically, measured by satellite remote sensing |
| Oil Spill | - | - | Typically measured by satellite or radar remote sensing |
| Salinity | 0 to 70 PSS | ≤ 1% |  |

**Note**: For air temperature, air humidity, air pressure and salinity accuracy. The accuracy values may be sufficient for shipping activities but if the information is to be used for scientific purposes (e.g. oil spills, environmental responses etc.) these values may need to be more stringent.

The VTS system requirements should also specify the time periods over which the various data parameters should be updated and may be averaged, if required, as these factors will depend upon the local circumstances pertaining to the VTS system.

## Functional Requirements

This section describes the essential functions of the hydro/meteo system for inclusion and integration within the overall VTS system.

Environmental measurements are made by dedicated and/or multipurpose sensors positioned throughout the VTS area (and its approaches) such that an overall environmental picture can be determined, taking account of the possibility of anticipated variations arising from the particular geography of the VTS location.

Measurements are transmitted by the communication system to a VTS centre for analysis, system wide processing and subsequent display to the VTSO in user-selectable format. The measured data is to be presented both numerically and graphically (in chronological order).

The VTS Authority may also require such data to be stored for a predefined period (e.g. up to one year).

It is essential that a VTS Centre also has access to external local hydro/meteo information relevant to the VTS area(s). In addition, the VTS system can, if required by the VTS Authority, disseminate the available environmental data to the VTS users (shipping etc.) and to external allied services.

## Design, Installation and Maintenance Considerations

The environmental monitoring systems should be specified taking the considerations in Section 1 into account. This should also consider maintenance access, lightning protection and wind load on antennas. The build-up of ice in some climates should also be a consideration.

Key aspects, related to design and installation, include:

* suitability to meet range, accuracy and update rate requirements;
* location within the VTS area and its approaches;
* durability and resistance to environmental conditions;
* interference;
* power supply requirements / options;
* installation;
* maintenance;
* interfacing;
* back-up arrangements;
* safety precautions.

### Suitability to Meet Range, Accuracy and Update Rate Requirements

Individual sensors (multipurpose where appropriate) should be selected to provide the specified range, accuracy and update rate requirements.

### Location within the VTS Area and its Approaches

The network of environmental sensors should be part of a coherent sensor network designed to achieve the VTS system requiremnts (coverage, appropriate accuracy in areas of different assessed risk, redundancy etc.).

### Durability and Resistance to Environmental Conditions

Electronics installed externally should be in a suitable environmental enclosure. IEC requirements for environmental conditions should be applied as practicable.

### Interference

These sensors should comply with applicable international standards and regulations. IEC requirements (IEC 60945) (ref. [7]) refer.

### Power Supply Requirements / Options

Relevant IEC requirements should be applied. In remote locations, due to the low power consumption of hydro/meteo sensors, authorities should consider use of alternative power (e.g. solar panels or wind vanes), in lieu of generators, when commercial power is not available.

### Installation

Requirements concerning the installation of sensors, wiring and the arrangement of the equipment providing hydro/meteo information to the VTS centre should be determined in accordance with national and international standards where applicable. Operational requirements will determine where sensors are to be located and how many are required. Sites for sensors should be selected based upon optimising data relevant to the VTS. Other considerations include:

* availability of power;
* protection against vandalism;
* housing and co-location with existing VTS, AtoN, or other suitable infrastructure.

Relevant IEC requirements should be applied. For example:

* IEC 529 ‘Degrees of protection provided by enclosures (IP Code)’[5];
* IEC 721-3-6 ‘Classification of environmental conditions, Part 3: Classification of groups of environmental parameters and their severities; Ship environment’ [6];
* IEC 60945 ‘Maritime navigation and radio communication equipment and systems - General requirements, methods of testing and required test results’ [7];
* local national wiring standards / regulations.

The environmental requirements for operation and survivability of environmental sensors and associated equipment should be determined by the VTS Authority and referred to Section 1.5.3 - General design, configuration installation and maintenance consideration.

### Maintenance

Possible requirements, in addition to IMO Assembly Resolution A.694(17) [4] concerning maintenance, should be determined. Location considerations for sensors should include maintenance, repair, and accessibility requirements.

### Interfacing

The typical information to be interfaced for the hydro/meteo service are described under the Operational Requirements, see Section 4.4.

For the interfacing of hydro/meteo services to VTS equipment, several different standards are in use. Among those standards, IEC 61162, Digital Interfaces for Navigation Equipment within a Ship (part 1 and part 3) [8], has been applied for these applications. In addition, the WMO has developed an interface standard for hydro/meteo applications [1].

For the interface between a VTS and its users, hydro/meteo data should follow standardised data exchange formats, e.g., XML. (In addition, a time stamp and source should be provided.)

### Backup Arrangements

Depending on the individual type of the equipment, requirements concerning back-up and fall-back arrangements should be determined based on VTS requirements, availability and risk assessment.

### Safety Precautions

Depending on the individual type of the equipment, requirements in addition to IMO Resolution A.694(17) [4] should be determined based on local occupational health and safety requirements and regulations.