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Marine technology — Ocean observation systems — Design criteria of ocean hydro-meteorological observation systems reuse and interaction

Technologie maritime — Systèmes d'observation des océans — Critères de conception de la réutilisation et de l'interaction des systèmes d'observation hydrométéorologique des océans

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CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 13, *Marine technology*.

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Introduction

Ocean hydro-meteorological observation is an important means for human cognition and research on the ocean. It plays an important role in the study of ocean science, protection of the ocean environment, early warning of ocean disasters, and development of ocean resources. Observation activities are coordinated by ocean hydro-meteorological observation systems at observing sites. The observation system is responsible for receiving, storing, displaying, processing and analyzing ocean hydro-meteorological data, providing software support for accurate and efficient observation activities.

The lack of design standards for ocean hydro-meteorological observation systems leads to different system structures, poor interface versatility, and diverse data types, which seriously affects the reusability and interactivity of the system, and brings a series of comprehensive problems, mainly in the following aspects: the system function coverage is imperfect and cannot meet all observation requirements; the interconnection between systems is difficult, which hinders the analysis and application of large-scale ocean data; the system development efficiency is low, the upgrade cost is high, and the ocean observation cost increases.

This document provides an overall framework for ocean hydro-meteorological observation systems. It standardizes the functional composition of such systems, their structure type of the data, their data transmission format and protocol, and their input and output interfaces. As such, this document contributes to improving the development and operation efficiency of these systems, and to meeting diverse needs. It also improves the application analysis and integrated management capabilities of ocean big data.

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1 Scope

This document specifies the overall framework of ocean hydro-meteorological observation systems, including the system function composition, the data structure type and data transmission format and protocol, as well as the input and output interface. These systems support automatic measurement of e.g. buoy, submersible and shore station instruments, with output interfaces, and provide observations on e.g. water temperature, salinity, depth, current, ocean wave, temperature, pressure, humidity, wind, visibility and precipitation. They have the ability to receive, store, display, process, and analyze data. This document is intended for both developers of ocean observation systems and ocean observers.

2 Normative references

There are no normative references in this document.

3 Terms and definitions, and abbreviated terms

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 Terms and definitions

3.1.1
interface
function used to implement data reception or transmission

3.1.2
standardized interface
interface (3.1.1) for the uniform specification of names, functions, *parameters* (3.1.5) and return values

3.1.3
instrument
device with a sensory environmental characteristic parameter function for implementing ocean hydro-meteorological observation activities

3.1.4
precision
closeness of agreement between indications or measured quantity values obtained by replicate measurements on the same or similar objects under specified conditions

[SOURCE: ISO/IEC Guide 99:2007, 2.15, modified - Preferred term "measurement precision" deleted; Notes 1 to 4 to entry deleted.]

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3.1.5
parameter
ocean hydro-meteorological observation elements measured by an observation *instrument* (3.1.3)

3.1.6
ocean hydro-meteorological complex virtual instrument
ocean hydro-meteorological observation system software element consisting of standardized input and output *interfaces* (3.1.1) and function module

3.2 Abbreviated terms

CTD	conductivity, temperature and depth
URL	Uniform Resource Locator
XML	Extensible Markup Language
OHM-CVI	ocean hydro-meteorological observation complex virtual instrument
MQ	message queue
REST	representational state transfer
API	application programming interface

4 System architecture, workflow and types of interfaces

4.1 Architecture

4.1.1 General

The document combines the requirements of ocean hydro-meteorological observations, and adopts the ocean hydro-meteorological complex virtual instrument (OHM-CVI) as the system design reference model to standardize the overall structure. It specifies standardized data, input and output interfaces and a data exchange format. The input interface is responsible for receiving the collected data of the ocean observation instrument. The output interface provides MQ and REST data sharing modes for different data sharing scenarios to realize the interaction of ocean observation data. A function module is also specified, that includes data display, statistical analysis, and comprehensive query functions to meet the storage, display, processing and analysis requirements for ocean hydro-meteorological observation. The detailed description of the OHM-CVI components is given in 4.1.2 and 4.1.3.

Figure 1 shows the system architecture model, with the standardized interfaces marked in blue.

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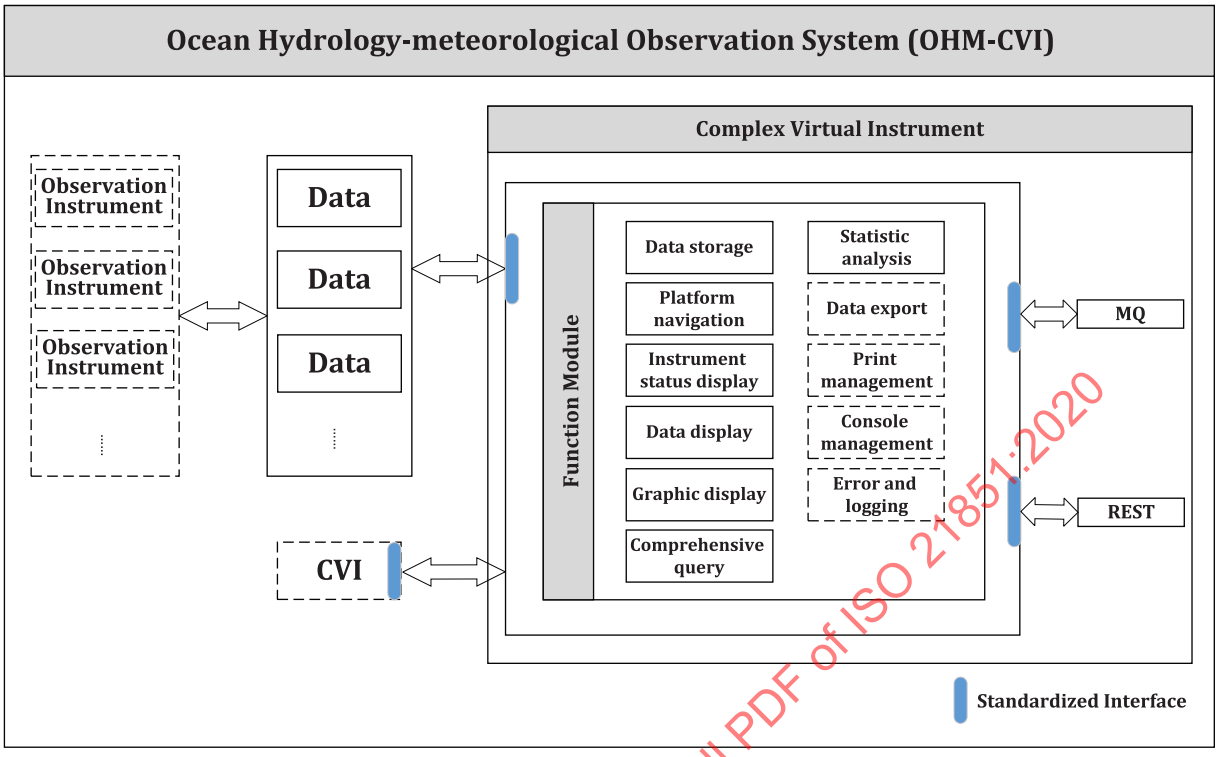

Figure 1 — System framework model

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Interaction between a upper application and a OHM-CVI, as well as between several OHM-CVIs, is implemented through a registration centre. The registration centre is responsible for the centralized management of OHM-CVI information, and provides the OHM-CVI registration interface and directory retrieval interface. The OHM-CVI completes registration through the registration interface. The upper application or OHM-CVI obtains the registered OHM-CVI list through the directory retrieval interface, and realizes the data interoperation through the standardized data output interface of OHM-CVI. The OHM-CVI registration and access process is shown in Figure 2. Detailed information is given in 4.1.4.

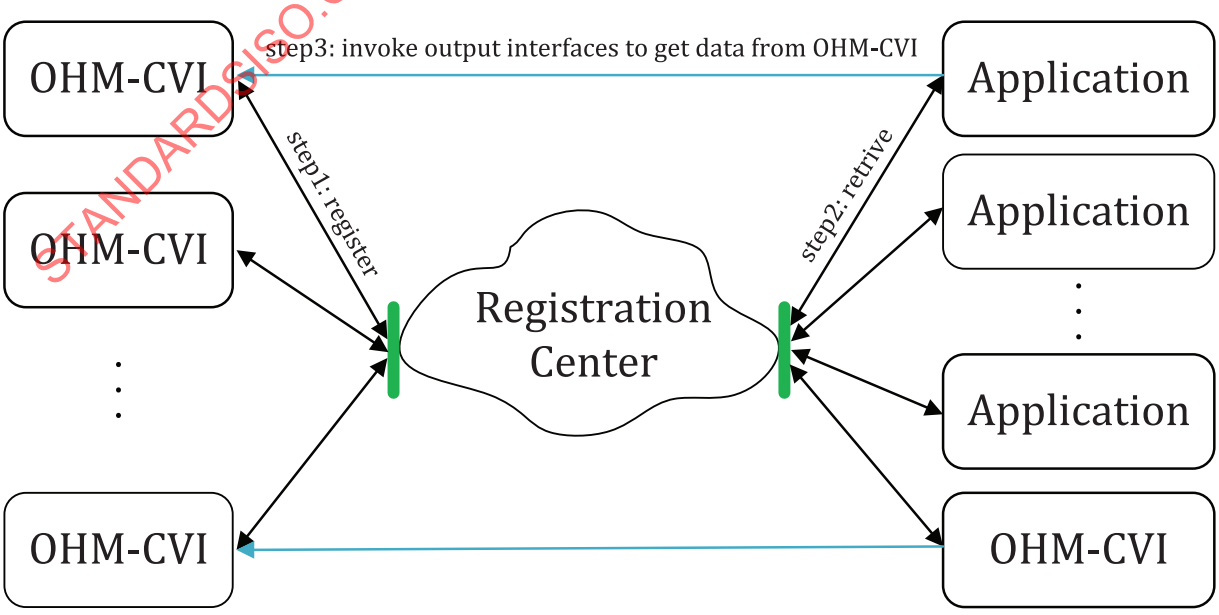

Figure 2 — OHM-CVI registration and access process

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4.1.2 Function module

The function module is a module that analyses and displays the source data acquired by OHM-CVI, and provides a standardized interface through MQ and REST. This document lists the data presentation forms commonly used by data display and calculation analysis modules based on observation parameters. Users can increase or decrease data presentation forms according to their requirements and observation parameters. This module shall have the following functions.

1. Data storage: to store the received hydro-meteorological parameter data (see 6.1).
2. Platform navigation: with a horizontal map as the background, to achieve navigation to each platform, (see 6.2).
3. Instrument status display: to show the operation status of each instrument in a visual way (see 6.3).
4. Data display: to display the various parameter data in real time in the form of a list (see 6.4).
5. Graphic display: for real-time display of the various parameter data in a suitable way (see 6.5).
6. Comprehensive query: to query the data under certain conditions, and to display the query results in an appropriate way (see 6.6).
7. Statistic analysis: for the mathematical analysis and display of hydro-meteorological parameter data (see 6.7).
8. Data export: to export data or charts (see 6.8).
9. Print management: to print data or charts (see 6.9).
10. Console management, page closure, minimization or maximization of the software and function module switching operations (see 6.10).
11. Error and logging, warning and logging of errors during software operation (see 6.11).

4.1.3 Standardized interface

The standardized interface standardizes data transformation format. It shall consist of the following.

1. Source data input interface: to transfer source data to OHM-CVI, in a specified format (see 7.2.1.1).
2. Instrument status input interface: to transfer instrument status to OHM-CVI, in a specified format (see 7.2.1.2).
3. Data output interface: for the OHM-CVI to provide standardized observation data interfaces (see 7.3.1).
4. Instrument status output interface: for the OHM-CVI to provide standardized instrument status interfaces (see 7.3.2).

4.1.4 Registration centre

4.1.4.1 General

The registration centre shall contain a registration interface and a query interface.

4.1.4.2 OHM-CVI registration interface

The OHM-CVI registration interface shall be as follows.

1. Name: registrationOHM-CVI.
2. Function: OHM-CVI register.

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3. Request parameters: The request parameters are shown in Figure 3, which include URL, UserName, Password, and OHM-CVI description information, where username and password are optional. More details of request parameters are shown in Table 1.

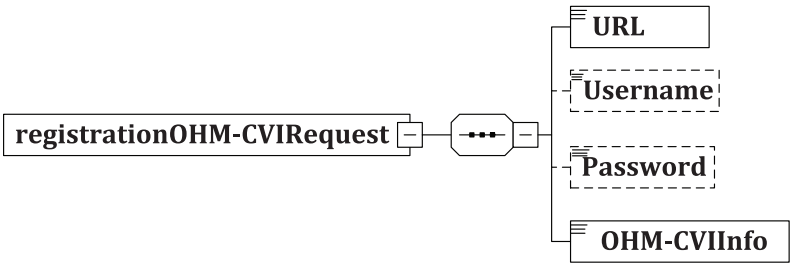

Figure 3 — registrationOHM-CVI request

Table 1 — registrationOHM-CVI request parameters

Name	Type	Description	Use
URL	xs:string	Address of the registration centre	Required
Username	xs:string	User name of registration request information	Optional
Password	xs:string	Password of registration request information	Optional
OHM-CVIInfo	OHM-CVIInfo	Registered OHM-CVI information (see 5.1)	Required

4. Response: Registration successful returns the registration code, and registration failed returns 0. Response result is shown in Figure 4 and details in Table 2.

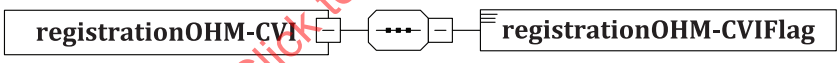

Figure 4 — registrationOHM-CVI response

Table 2 — registrationOHM-CVI response result

Name	Type	Description	Use
registrationOHM-CVIFlag	xs:string	Registration successful returns the registration code, and registration fails returns 0.	Required

5. Exception: Return an exception report message, as specified in Clause 8.

6. Example: The registration information is described in 5.1.

4.1.4.3 OHM-CVI query interface

The OHM-CVI query interface shall be as follows.

1. Name: getOHM-CVI.

2. Function: Query attributes, instrument and parameter information of OHM-CVI through the registration centre.

3. Request parameter: The request parameters are shown in Figure 5, which include URL, UserName, Password, and OHM-CVI name, where username and password are optional. More details of request parameters are shown in Table 3.

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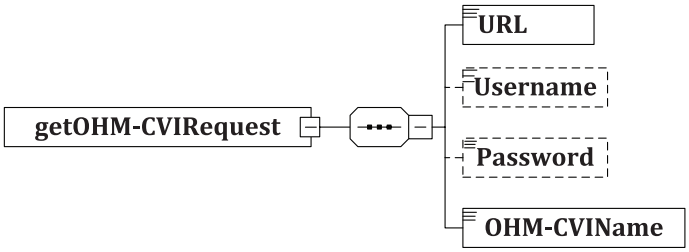

Figure 5 — getOHM-CVI request

Table 3 — getOHM-CVI request parameters

Name	Type	Description	Use
URL	xs:string	Address of the registration centre	Required
Username	xs:string	Login to the user name of the registration centre	Optional
Password	xs:string	Login to the password of the registration centre	Optional
OHM-CVIName	xs:string	OHM-CVI name	Required

4. Response: query successful returns OHM-CVI information, and query failed returns 0. Response result is shown in Figure 6 and details in Table 4.

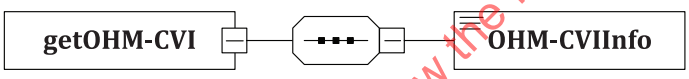

Figure 6 — getOHM-CVI response

Table 4 — getOHM-CVI response result

Name	Type	Description	Use
OHM-CVIInfo	OHM-CVIInfo	OHM-CVI specific description information is given in 5.1	Required

5. Exception: Return an exception report message, as specified in Clause 8.

6. Example: The OHM-CVI information is described in 5.1.

4.2 Workflow

The workflow shall be as follows.

1. Turn on the service and wait to receive data.

2. OHM-CVI obtains platform, instrument, and parameter attribute information.

3. OHM-CVI does the standardized conversion, storage, processing and display of the acquired source data.

4. Provide standardized data interfaces through MQ and REST.

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4.3 Type of interfaces — MQ and REST

4.3.1 MQ

Message queue (MQ) provides an asynchronous communications protocol, meaning that the sender and receiver of the message do not need to interact with the message queue at the same time. Messages placed onto the queue are stored until the recipient retrieves them. Message queues have implicit or explicit limits on the size of data that may be transmitted in a single message and the number of messages that may remain outstanding on the queue.

Using MQ, OHM-CVI sends data to MQ middleware. MQ middleware stores data and creates a message queue by the data arrival time. MQ middleware is responsible for monitoring and responding to user data requests.

4.3.2 REST

Representational state transfer (REST) is a design and development method for network applications, which can reduce the complexity of development, improve the scalability of the system, and facilitate the transfer of information between different software/programs in the network. The user sends a CTD data request to the OHM-CVI, which sends the CTD instrument monitoring data to the user as a string through the REST protocol.

5 Attribute description and observation elements

5.1 Attribute description

5.1.1 General

This subclause describes the OHM-CVI, instrument, and parameter attributes, including name, type, description, and use. The names of OHM-CVI, instrument and parameter shall have obvious indicative information, and the types should be numbered in the same order, such as "towed CTD1", "temperature at 5 meters underwater 1".

5.1.2 OHM-CVI description

OHM-CVI is the root node which includes attributes and instrument child node information. The relationship between OHM-CVI and instrument is one-to-many, that means one OHM-CVI may contain many instruments. OHM-CVI description is shown in Figure 7. An example of OHM-CVI description is given in Annex A.

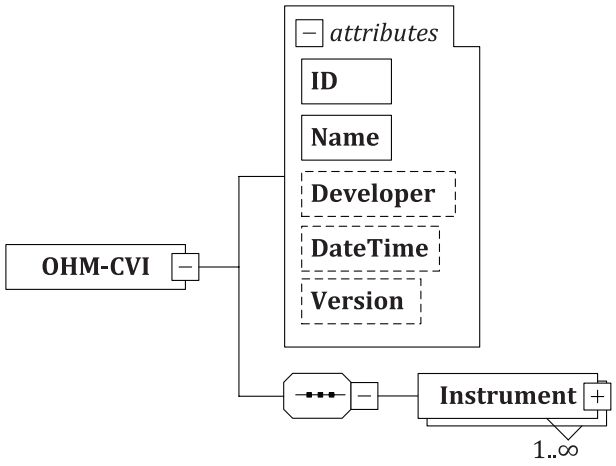

Figure 7 — Description of OHM-CVI

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OHM-CVI attributes and child node information are show in Table 5. The attribute of ID and Name are required, and the others are optional. Attributes of OHM-CVI can also be expanded on demand.

Table 5 — OHM-CVI attribute and child node information

Name	Type	Description	Use
ID	xs:integer	Global unique identifier of OHM-CVI	Required
Name	xs:string	Name of OHM-CVI	Required
Developer	xs:string	Developer of OHM-CVI	Optional
DateTime	xs:string	Creation date of OHM-CVI	Optional
Version	xs:string	Version of OHM-CVI	Optional
Instrument	Instrument	See 5.1.3	Required

5.1.3 Instrument description

Instrument is the child node of OHM-CVI which includes attributes and parameter child node information. The relationship between instrument and parameter is also one-to-many. Instrument description is shown in Figure 8.

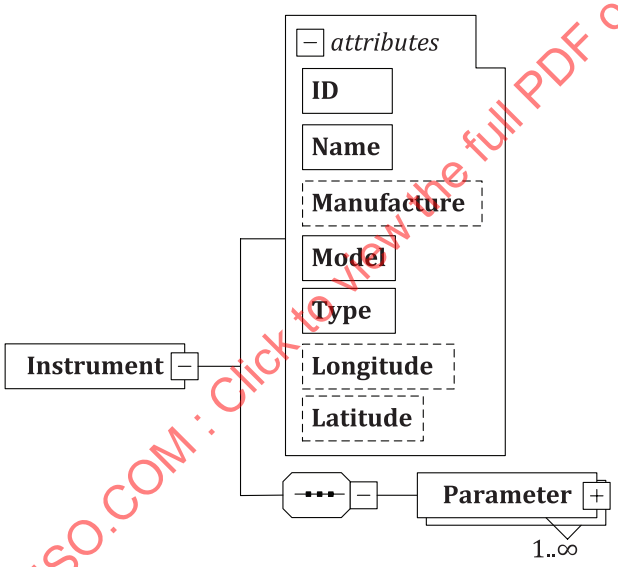

Figure 8 — Description of instrument

Instrument attributes and child node information are shown in Table 6. The attribute of ID, Name, Model and Type are required and the others are optional. Attributes of instrument can also be expanded on demand.

Table 6 — Instrument attribute and child node information

Name	Type	Description	Use
ID	xs:integer	Relative identifier of instrument	Required
Name	xs:string	Name of instrument	Required
Manufacture	xs:string	Manufacture of instrument	Optional
Model	xs:string	Model of instrument	Required
Type	xs:string	Type of instrument	Required
Longitude	xs:string	Longitude of instrument	Optional
Latitude	xs:string	Latitude of instrument	Optional
Parameter	Parameter	See 5.1.4	Required

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5.1.4 Parameter description

Parameter is the child node of instrument which includes attributes information. Parameter description is shown in Figure 9.

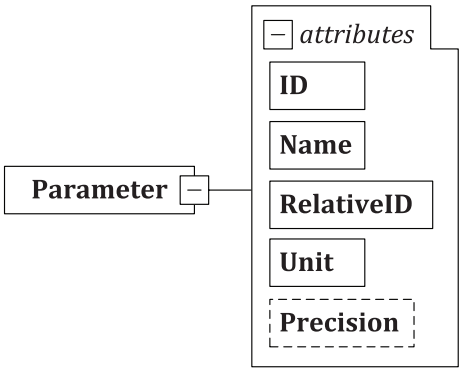

Figure 9 — Description of parameter

Parameter attributes are shown in Table 7. The attribute of Precision is optional and the others are required. Attributes of parameter can also be expanded on demand.

Table 7 — Parameter attribute information

Name	Type	Description	Use
ID	xs:integer	Relative identifier of parameter	Required
Name	xs:string	Name of parameter	Required
RelativeID	xs:integer	Parameter relative ID of instrument	Required
Unit	xs:string	Unit of parameter	Required
Precision	xs:string	Precision of parameter	Optional

5.2 Observation elements

5.2.1 General

The observation elements refer to those that can be obtained by automatic ocean hydro-meteorological observation instruments. The ocean hydro-meteorological observation elements are described in 5.2.2 and 5.2.3.

5.2.2 Hydrologic data

Ocean hydrology refers to the observation of various hydrological elements at a certain point or section in the ocean, and the analysis and arrangement of observation data, including basic observation elements such as water temperature, salinity, current speed, current flow direction, wave height, wave period, and wave direction, which can be reduced or expanded according to actual needs.

Basic ocean hydrological elements are shown in Table 8, including names, units, and remarks.

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Table 8 — Parameter attribute and observation method of marine hydrological data

Name	Unit	Remark
Water temperature	°C	Observation of physical properties of seawater
Salinity	‰	
Current speed	cm/s	Observation of current
Current flow direction	°	
Wave height	m	Observation of wave
Wave period	s	
Wave direction	°	

5.2.3 Meteorological data

Ocean meteorological research on moisture and heat exchange between ocean and atmosphere, and influence on weather and climate change. Ocean meteorological elements include wind speed, wind direction, air temperature, relative humidity, air pressure, visibility, precipitation, visibility, water level basic meteorological elements in the ocean, which can be shortened or extended according to actual needs.

Basic ocean meteorological elements are shown in Table 9, including names, units, and remarks.

Table 9 — Parameter attribute and observation method of marine meteorological data

Name	Unit	Remark
Wind speed	m/s	Observation of sea surface wind
Wind direction	°	
Air temperature	°C	Observation of sea surface physical properties
Relative humidity	%	
Air pressure	hPa	
Visibility	km	
Precipitation	mm	
Water level	m	Observation of water level

6 Function module

6.1 Data storage

The received hydro-meteorological parameter data shall be stored in a database to be applied in function modules (6.2 to 6.9). Besides, this module should provide unified data access APIs, for example, a data query API, to rest function modules to use data.

6.2 Platform navigation

With a horizontal map as the background, the platform navigation function is realized. Detailed functional specifications shall be as follows.

1. After selecting any OHM-CVI on the horizontal map, the OHM-CVI detailed parameter data can be displayed.

2. Global and local information display can be realized by shrinking and zooming.

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6.3 Instrument status display

It shall be possible to visually display the real-time status of the instrument, i.e. whether each instrument is functioning properly.

6.4 Data display

The data of hydrology-meteorological parameters, such as salinity, wave period, wave height, temperature, water level, current speed, flow direction, flow rate, wind speed, wind direction, humidity, air pressure and rainfall shall be displayed in real time in a list. Detailed functional specifications shall be as follows.

1. It can display one or more parameter data in real time.
2. The list can be sorted by ascending/descending order of parameter initials and ascending/descending order of parameter values.
3. It can display or hide one or more parameter data in the list, according to the parameter name.

6.5 Graphic display

The graphic display shall provide the corresponding hydro-meteorological data in real time, in the form of a line chart, a vertical profile (optional), a vertical section (optional) and a temperature-salinity characteristic diagram (optional).

1. Linear chart

   The data of temperature, wave period, wave height, water level, precipitation, barometric pressure, salinity, humidity and other parameters are displayed by linear chart. Detailed functional specifications shall be as follows.

   1) It can display one or more parameter data in real time.
   2) After selecting any point on the line chart, it can display the parameter name of the point and the corresponding detailed parameter data of the point, and the data annotation function is provided.
   3) It is possible to display global and local information by shrinking, zooming in and dragging, and one or more parameter data can be displayed or hidden according to the parameter name.

2. Vertical profile (optional)

   The change in temperature or salinity with depth or time is displayed by vertical profile, as well as the variation of wind speed or air pressure with height or time. Detailed function specifications should be as follows.

   1) The temperature or salinity parameter data can be displayed in real time.
   2) After selecting any point on the vertical profile, the parameter name of the point and the detailed parameter data corresponding to the point can be displayed and the data annotation function is provided.
   3) It is possible to display global and local information by shrinking, zooming in and dragging.

3. Vertical section (optional)

   The physical distribution of temperature or salinity varying with longitude, latitude or depth and the distribution of pressure isobars varying with longitude, latitude or height are shown in the form of vertical profiles. Detailed functional specifications should be as follows.

   1) It can display temperature, salinity or barometric parameter data in real time.

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2) After selecting any point on the vertical section, the parameter name of the point and the detailed parameter data corresponding to the point can be displayed and the data labelling function is provided.

3) It is possible to display global and local information by shrinking, zooming in and dragging, and to display or hide temperature or salinity parameter data according to the parameter name.

4. Temperature-salinity characteristic diagram (optional)

The relationship between temperature and salinity parameters is shown in the form of temperature-salinity charts. Detailed functional specifications should be as follows.

1) The temperature and salinity parameter data can be displayed in real time.

2) After selecting any point on the temperature-salinity characteristic diagram, it can display the parameter name of the point and the corresponding detailed parameter data of the point, and the data labelling function is provided.

3) It is possible to display global and local information by shrinking, zooming in and dragging.

6.6 Comprehensive query

The function module shall be able to query hydro-meteorological parameter data and to display the query results in the form of a list, linear chart, vertical profile (optional), vertical section (optional) and temperature-salinity characteristic diagram (optional). Lists, linear charts, vertical profiles, vertical sections, and temperature-salinity characteristic diagrams shall have the following functions in addition to the functions required for the data display and graphic display sections.

1. List

It can query and display the data with the specified time range as the query condition.

2. Linear chart

It can query and display the data under the query condition by specifying certain parameters or specifying the time range as the query condition.

3. Vertical profile (optional)

It can query and display the data under the query condition by the specified depth range, or the specified time range as the query condition.

4. Vertical section (optional)

It can query and display the data under the query condition by the specified depth range, the specified latitude and longitude range, or the specified time range as the query condition.

5. Temperature-salinity characteristic diagram (optional)

It can query and display the data under the query condition with the specified time range as the query condition.

6.7 Statistic analysis

The function module shall be able to conduct a mathematical analysis of salinity, wave period, wave height, wave direction, temperature, water level, current speed, flow direction, wind speed, wind direction, humidity, pressure, and precipitation, i.e. to calculate the average value, variance, standard deviation, period, and maximum and minimum, as well as daily cumulative, monthly cumulative or

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annual cumulative values of the above parameter data. Detailed functional specifications shall be as follows.

1. One or more parameters of any OHM-CVI can be selected, and the parameters are mathematically analyzed from the spatial category.

2. One or more parameters in any time period or curve segment can be selected, and the parameters are mathematically analyzed from the time category.

3. The function module can set the average, variance, standard deviation, period, maximum and minimum values, and daily cumulant, monthly cumulant or annual cumulant thresholds, and can provide an early warning when values greater than or less than the thresholds prompt.

The calculation analysis results shall be displayed in four forms: list, linear chart, histogram, and rose diagram. The list and linear chart shall meet the functional requirements of data display (6.4), graphic display (6.5), and comprehensive query (6.6). The detailed functional specifications of the histogram and rose diagram shall be as follows.

a. Histogram

   Display of the daily precipitation, monthly precipitation, and water flow statistics in the form of a histogram. The detailed functional specifications shall be as follows.

   1) After selecting any point on the histogram, the parameter name of the point and the detailed parameter data corresponding to the point can be displayed, and the data labelling function is provided.

   2) It is possible to display global and local information by shrinking, zooming in and dragging, and can display or hide one or more parameter data according to parameter names.

   3) It can query, calculate and display the data under the query condition by specifying certain parameters or specifying the time range as the query condition.

b. Rose diagram

   The statistical results of average wind speed, wind direction frequency, current speed and flow direction frequency are displayed in the form of a rose graph. The detailed functional specifications shall be as follows.

   1) After selecting any point on the rose diagram, the parameter name of the point and the detailed parameter data corresponding to the point can be displayed, and the data labelling function is provided.

   2) It is possible to display global and local information by shrinking, zooming in and dragging.

   3) It can query and calculate the wind direction, wind direction frequency, average wind speed parameter data or flow direction, flow direction frequency, average current speed parameter data under the query condition with the specified time range as the query condition. Rose diagrams are drew based on the query and calculation results.

6.8 Data export

It shall be possible to export all kinds of hydrological and meteorological parameter data, as well as various forms of data display results mentioned in the data display (6.4), graphic display (6.5), and statistic analysis (6.7). Detailed functional specifications shall be as follows.

1. For hydro-meteorological parameter data, data can be exported in the format of txt, xml, xlsx, csv, myd, and dbf.

2. For images, data can be exported in bmp, png, jpeg, jpg, tiff, eps, and bmp formats.

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6.9 Print management

It shall be possible to print all the hydro-meteorological parameter data, as well as the various forms of data display results mentioned in the data display (6.4), graphic display (6.5), and statistic analysis (6.7).

6.10 Console management

The function module shall provide the function of controlling the platform software page and function switching. The detailed functional specifications shall be as follows.

1. It can close, minimize, maximize the window, and can drag and drop the window and drag the edge of the window to zoom in or out.

2. It can switch between data management, platform navigation, instrument status display, data display, graphic display, comprehensive query, print management, data export, calculation and analysis and error warning and logging module.

6.11 Error and logging

The function module shall be able to issue warnings of operational errors during running of data storage (6.1), platform navigation (6.2), instrument status display (6.3), data display (6.4), graphic display (6.5), comprehensive query (6.6), statistic analysis (6.7), data export (6.8), print management (6.9), and console management (6.10). The cause of the error, the error time, the error module name and the error OHM-CVI ID shall be logged. The log file format should be log, err or txt.

7 Data interfaces

7.1 Transmitted data format

The input and output data differ only in the time continuity of the data transfer, so the same data format is used. The data format shall be as follows.

TransmissionData includes OHM-CVIID and Instrument. The specific structure is shown in Figure 10 and Table 10.

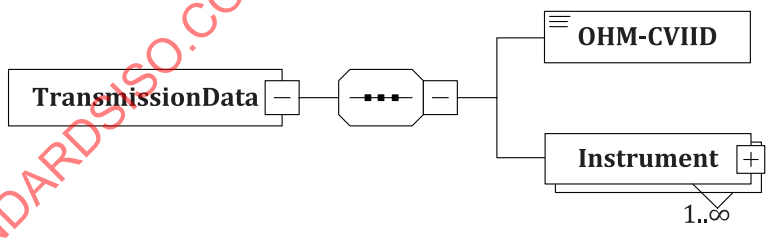

Figure 10 — TransmissionData structure

Table 10 — TransmissionData structure

Name	Type	Description	Use
OHM-CVIID	xs:integer	Global unique identifier of OHM-CVI	Required
Instrument	Instrument	Figure 11, Table 11	Required

Instrument includes InstrumentID, DateTime and Parameter. The specific structure is shown in Figure 11 and Table 11.

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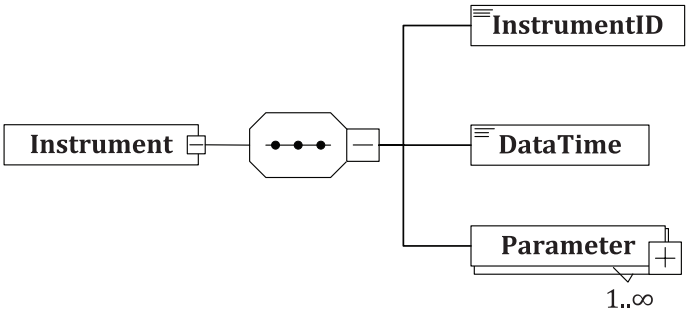

Figure 11 — Instrument structure

Table 11 — Instrument structure

Name	Type	Description	Use
InstrumentID	xs:integer	Relative identifier of instrument	Required
DateTime	xs:string	Observation time of instrument	Required
Parameter	Parameter	Figure 12, Table 12	Required

Parameter includes ParameterID and Value. The specific structure is shown in Figure 12 and Table 12.

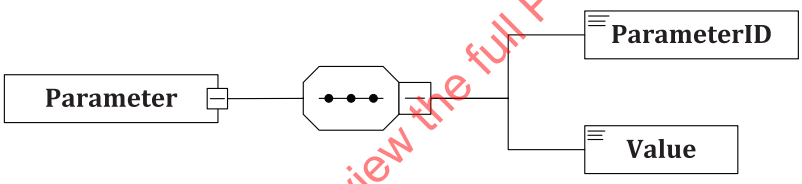

Figure 12 — Parameter structure

Table 12 — Parameter structure

Name	Type	Description	Use
ParameterID	xs:integer	Relative identifier of parameter	Required
Value	xs:srting	Observed value of parameter	Required

The transmitted data includes observation data and instrument status. They have the same data structure. The difference is that the parameter value of the observation data is the observation value, and the instrument status parameter value is the instrument status.

7.2 Input interfaces

OHM-CVI shall obtain source data by MQ and REST communication. It shall define command format of data request and response, and interact with other OHM-CVI through calling external interface.

7.2.1 Data input interfaces

7.2.1.1 Source data input interface

The source data input interface shall be as follows.

1. Name: putSourceData.
2. Function: Getting source data.
3. Request parameters: OHM-CVIID, SourceData (see Figure 13 and Table 13).

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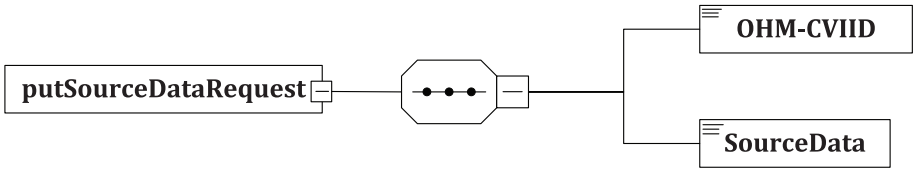

Figure 13 — putSourceData Request

Table 13 — putSourceData Request parameters

Name	Type	Description	Use
OHM-CVIID	xs:integer	Global unique identifier of OHM-CVI	Required
SourceData	TransmissionData	Observation data	Required

SourceData format is shown in 7.1.

4. Response: Data transmission status, 0 means the transmission failed, 1 means the transmission was successful (see Figure 14 and Table 14).

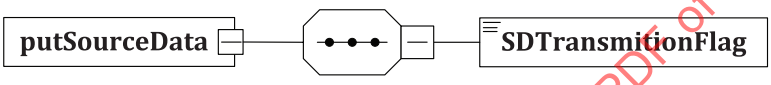

Figure 14 — putSourceData Response

Table 14 — putSourceData Response parameters

Name	Type	Description	Use
SDTransmitionFlag	xs:string	0:transmission failed 1:transmission succeeded	Required

5. Exception: When an exception occurs during the request, it shall return an exception information. The details of the exception are given in Clause 8.

6. Example: An example of request information is as follows.

```
MQ request file:
<?xml version="1.0" encoding="UTF-8"?>
<SourceData>
   <OHM-CVI ID="1">
      <Instrument ID="1" DateTime="2019-03-01 10:30:00 GMT+8">
         <Parameter ID="1" Value="10.3"></Parameter>
      </Instrument>
      <Instrument ID="2" DateTime="2019-03-01 10:30:00 GMT+8">
         <Parameter ID="1" Value="8.5"></Parameter>
         <Parameter ID="2" Value="5.0"></Parameter>
      </Instrument>
      <Instrument ID="2" DateTime="2019-03-01 11:30:00 GMT+8">
         <Parameter ID="1" Value="7.5"></Parameter>
         <Parameter ID="2" Value="10.0"></Parameter>
      </Instrument>
   </OHM-CVI>
</SourceData>
REST request file:
{"SourceData":{"CVI":{"ID":"1","Instrument":[{"ID":"1","DateTime":"2019-03-01 10:30:00
GMT+8",
"Parameter":{"ID":"1","Value":"10.3"}},{"ID":"2","DateTime":"2019-03-01 10:30:00 GMT+8",
"Parameter":[{"ID":"1","Value":"8.5"},{"ID":"2","Value":"5.0"}]},{"ID":"2","DateT
ime":"2019-03-01 11:30:00 GMT+8","Parameter":[{"ID":"1","Value":"7.5"},{"ID":"2","Va
lue":"10.0"}]}]}}}
```

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7.2.1.2 Instrument status input interface

The instrument status input interface shall be as follows.

1. Name: putSourceStatus.
2. Function: Getting source status.
3. Request parameters: OHM-CVIID, SourceStatus (see Figure 15 and Table 15).

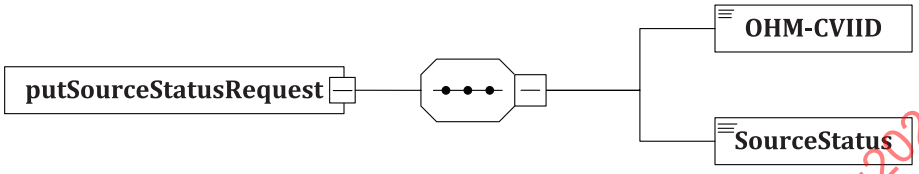

Figure 15 — putSourceData request

Table 15 — putSourceData request parameters

Name	Type	Description	Use
OHM-CVIID	xs:integer	Global unique identifier of OHM-CVI	Required
SourceStatus	TransmissionData	Instrument status	Required

SourceStatus format is shown in 7.1;

4. Response: Data transmission status, 0 means the transmission failed, 1 means the transmission was successful (see Figure 16 and Table 16).

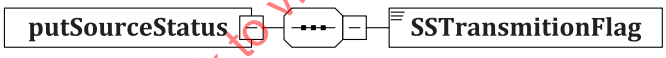

Figure 16 — putSourceData response

Table 16 — putSourceData response parameters

Name	Type	Description	Use
SSTransmitionFlag	xs:string	0:transmission failed 1:transmission succeeded	Required

5. Exception: When an exception occurs during the request, it shall return an exception information. The details of the exception are given in Clause 8.
6. Example: An example of request information is as follows.

```
MQ request file:
<?xml version="1.0" encoding="UTF-8"?>
<SourceStatus>
   <OHM-CVI ID="1">
      <Instrument ID="1" DateTime="2019-03-01 10:30:00 GMT+8">
         <Parameter ID="1" Status="1"></Parameter>
      </Instrument>
      <Instrument ID="2" DateTime="2019-03-01 10:30:00 GMT+8">
         <Parameter ID="1" Status="1"></Parameter>
         <Parameter ID="2" Status="1"></Parameter>
      </Instrument>
      <Instrument ID="2" DateTime="2019-03-01 11:30:00 GMT+8">
         <Parameter ID="1" Status="1"></Parameter>
         <Parameter ID="2" Status="1"></Parameter>
      </Instrument>
   </OHM-CVI>
```

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```
</SourceStatus>
REST request file:
{"SourceStatus":{"CVI":{"ID":"1","Instrument":[{"ID":"1","DateTime":"2019-03-01 10:30:00
GMT+8",
"Parameter":{"ID":"1","Status":"1"}},{"ID":"2","DateTime":"2019-03-01 10:30:00 GMT+8",
"Parameter":[{"ID":"1","Status":"1"},{"ID":"2","Status":"1"}]},{"ID":"2","DateT
ime":"2019-03-01 11:30:00 GMT+8","Parameter":[{"ID":"1","Status":"1"},{"ID":"2","Sta
tus":"1"}]}]}}}
```


7.2.2 OHM-CVI interaction

OHM-CVI shall be able to directly call other OHM-CVI external interconnection service interfaces to realize interoperability between OHM-CVI. It shall be possible to use OHM-CVI output as input of other OHM-CVI, so as to become one of the data sources of OHM-CVI.

7.3 Output interfaces

7.3.1 General

This subclause specifies two types of data output interfaces, including request and response file format specifications and interface descriptions. The output interfaces use MQ and REST communication protocols to address different timeliness requirements: using REST for real-time data transmission and using MQ for custom data.

7.3.2 Observation data output interface

The observation data output interface shall be as follows. See Figure 17 and Table 17.

1. Name: getObservationData.
2. Function: Provide standardized observation data.
3. Request parameters: OHM-CVIID, StartTime, EndTime. The EndTime is optional. If the request parameter has no EndTime, it means that the query data is up to the current system time.
4. Response: ObservationData.

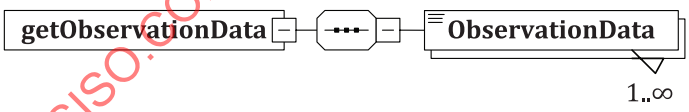

Figure 17 — getObservationData response

Table 17 — getObservationData response parameters

Name	Type	Description
ObservationData	TransmissionData	Standardized observation data

ObservationData format is given in 7.1.

5. Exception: When an exception occurs during the request, it will return an exception information. The details of the exception are given in Clause 8.
6. Example: An example of response file is as follows.

```
MQ response file:
<?xml version="1.0" encoding="UTF-8"?>
<ObservationData>
   <OHM-CVI ID="1">
      <Instrument ID="1" DateTime="2019-03-01 10:30:00 GMT+8">
         <Parameter ID="1" Value="10.3"></Parameter>
```

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```
      </Instrument>
      <Instrument ID="2" DateTime="2019-03-01 10:30:00 GMT+8">
         <Parameter ID="1" Value="8.5"></Parameter>
         <Parameter ID="2" Value="5.0"></Parameter>
      </Instrument>
      <Instrument ID="2" DateTime="2019-03-01 11:30:00 GMT+8">
         <Parameter ID="1" Value="7.5"></Parameter>
         <Parameter ID="2" Value="10.0"></Parameter>
      </Instrument>
      <Instrument ID="1" DateTime="2019-03-02 10:30:00 GMT+8">
         <Parameter ID="1" Value="10.8"></Parameter>
      </Instrument>
      <Instrument ID="2" DateTime="2019-03-02 10:30:00 GMT+8">
         <Parameter ID="1" Value="8.9"></Parameter>
         <Parameter ID="2" Value="5.5"></Parameter>
      </Instrument>
      <Instrument ID="2" DateTime="2019-03-02 11:30:00 GMT+8">
         <Parameter ID="1" Value="7.3"></Parameter>
         <Parameter ID="2" Value="10.5"></Parameter>
      </Instrument>
   </OHM-CVI>
</ObservationData>

RESTresponse file:
{"ObservationData":{"OHM-CVI":{"ID":"1","Instrument":[{"ID":"1","DateTime":"2019-03-01
10:30:00 GMT+8","Parameter":{"ID":"1","Value":"10.3"}},{"ID":"2","DateTime":"2019-03-01
10:30:00 GMT+8",
"Parameter":[{"ID":"1","Value":"8.5"},{"ID":"2","Value":"5.0"}]},{"ID":"2","DateT
ime":"2019-03-01 11:30:00 GMT+8","Parameter":[{"ID":"1","Value":"7.5"},{"ID":"2","Value":
"10.0"}]},{"ID":"1",
"DateTime":"2019-03-02 10:30:00 GMT+8","Parameter":{"ID":"1","Value": "10.8"}},{"ID":"2",
"DateTime":"2019-03-02 10:30:00 GMT+8","Parameter":[{"ID":"1","Value":
"8.9"},{"ID":"2","Value":
"5.5"}]},{"ID":"2","DateTime":"2019-03-02 11:30:00 GMT+8","Parameter":[{"ID":"1",
"Value":"7.3"},
{"ID":"2","Value":"10.5"}]}]}}}
```

7.3.3 Instrument status output interface

The instrument status output interface shall be as follows. See Figure 18 and Table 18.

1. Name: getInstrumentStatus.
2. Function: Provide standardized instrument status data.
3. Request parameters: OHM-CVIID, StartTime, EndTime. The EndTime is optional. If the request parameter has no EndTime, it means that the query data is up to the current system time.

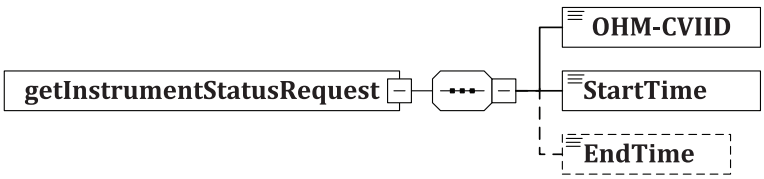

Figure 18 — getInstrumentStatus request

Table 18 — getInstrumentStatus request parameters

Name	Type	Description	Use
OHM-CVIID	xs:integer	Global unique identifier of OHM-CVI	Required
StartTime	xs:string	Start time	Required
EndTime	xs:string	End time	Optional

4. Response: InstrumentStatus (see Figure 19 and Table 19).

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