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Hydrometry — Hydrometric data transmission systems — Specification of system requirements

Hydrométrie — Systèmes de transmission des données hydrométriques — Spécification des exigences des systèmes

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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Introduction

Hydrometric data transmission systems provide data for the day-to-day management of water resources and for warning and forecasting of floods, droughts and conditions affecting water quality and public health. The systems transmit data measured at remote telemetry stations to a receiving center for further processing.

This Technical Specification defines and standardizes the required specifications of hydrometric data transmission systems. It does not describe the specifications of the equipment and units constituting hydrometric data transmission systems, but does describe the functional performance that the hydrometric data transmission systems should provide.

Hydrometry — Hydrometric data transmission systems — Specification of system requirements

1 Scope

This Technical Specification specifies the technical requirements that should be considered in designing and operating hydrometric data transmission systems and the necessary functions of those systems.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 772:1996, *Hydrometric determinations — Vocabulary and symbols*

ISO 1000:1992, *SI units and recommendations for the use of their multiples and of certain other units*

ISO/IEC 2382-1:1993, *Information technology — Vocabulary — Part 1: Fundamental terms*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 772 and ISO/IEC 2382-1 apply.

4 Basic requirements

4.1 General

This clause specifies the general requirements for designing a hydrometric data transmission system (HDTS).

An HDTS shall be designed to meet the basic requirements, defined hereinafter, taking into consideration functionality, geographical structures, time structures, installation conditions, reliability, safety, maintainability and economy. The final system specifications should be determined through the process of repetitive discussions among technological specialists in hydrological and telecommunications fields.

The conceptual configuration of an HDTS is shown in Annex A.

4.2 Objectives of use

An HDTS shall be designed with a full understanding of the necessity and importance of hydrometric services for appropriate water management in river basins in which this system is to be used.

4.3 Functional requirements

The functional requirements for an HDTS are classified into the following.

a) **Mandatory requirements**: the minimum requirements that an HDTS designer shall comply with in designing the system. The mandatory requirements include legal requirements, for example for the site where the system will be installed, and applicable specifications of various standards.

b) **Optional requirements**: the functions and methods of implementing them that an HDTS designer can select. The optional requirements include the requirements, such as the data collection sequence and selection of communications link as specified in Clause 5.

An HDTS should be designed to fully achieve the mandatory functional requirements, and to meet the optional requirements in full consideration of the user's requirements and operational purposes of the system so as to demonstrate the required system functionality.

4.4 Geographical structures

The following geographical structures shall be determined as a fundamental element of HDTS:

a) location(s) of the remote telemetry station(s);

b) location(s) of the receiving center(s); and

c) location(s) of the relay station(s), if necessary.

A remote telemetry station is located at a selected hydrometric-observation point. Therefore, remote telemetry stations are distributed over a geographically wide area, including a river basin. Remote telemetry stations can not always be located at optimum hydrological sites, but may be relocated from the planned sites because of geographical problems and difficulties in data transmission.

A receiving center consists of equipment and receives data from remote telemetry stations for data processing and display; it is located at a site where data and/or information is needed. Therefore, the receiving center will usually be located within the facility of a user organization. In large river basins, receiving centers may be distributed at user organizations near a hydrometric-observation point.

According to the necessity of the communication medium, a relay station shall be provided in the system.

These geographical structures should be considered not only at the time of designing but also for the future plans.

4.5 Time structures

Usually, an HDTS is used on a real-time basis. An HDTS has two time domains: the first domain is the time used in the natural world; the other is the time series in system operation.

The basic property of time in system operation is the time when the hydrometric observation is made at a gauging point; the gauging intervals and the delay times are required in data presentation.

Usually, sensors at remote telemetry stations continuously measure hydrological phenomena, but the data monitored at the receiving center are sampled in a time series. Therefore, these time characteristics and their allowable error range should be determined for the purposes of operation. Details are shown in Annex E.

4.6 Installation conditions

The environmental conditions of the remote telemetry stations may be more severe than those of telecommunication equipment installed indoors. Therefore, the following conditions should be considered:

a) temperature range and rate of change;

b) relative humidity range with no condensation;

c) wind velocity;

d) seismic resistance;

e) damage due to sea wind, dust, and/or toxic gases;

f) available power supply conditions (including impact of surge currents due to lightning);

g) equipment damage and access during flooding.

The environmental conditions of the telecommunications and information equipment to be installed at a receiving center should also be considered for items a), b), d) and f) above. Details are shown in Annex C.

4.7 Considerations for designing

4.7.1 Reliability

An HDTS is basically designed for continuous operation for its original purpose of use, particularly in the case of heavy rains and floods. Designers shall consider the reliability of equipment and the entire system. For the important functions of the system, alternative means or a redundancy of the system should be provided.

For example, duplicate communication lines can be installed to connect important remote telemetry stations in a gauging area to a receiving center. A hot-standby system can also be used for the equipment having important functions. The hydrological data measured by important remote telemetry stations can be input to site recorder and the storage term(s) and period should meet the user's requirements.

4.7.2 Safety

An HDTS shall be designed as a safe (fail-safe) system that can always secure safe system operation in the case of a malfunction of equipment, faulty operation by a user, or a system failure due to any external factor. The fail-safe should prevent such problems from spreading over the entire system.

If the malfunction or failure in part of the system or faulty operation by a user is non-critical, the principal functions of the system should continuously operate because of the importance of hydrometric observation.

4.7.3 Data permanence

The permanence of hydrometric data should be assured, since these are stored and used for water resources management over a long period.

The permanence of the data shall be assured even if peripheral unit(s) are replaced. In addition, interface specifications shall be defined for the data transmission system, format and transfer timing between the sensors to be installed in the pre-stage of an HDTS and the information processing system to be installed in the post-stage of an HDTS. Data received at the receiving center should be saved on reliable media.

4.7.4 Maintainability

The HDTS equipment shall be designed to have a composition that is easy to maintain and repair.

The HDTS equipment should be designed so that it is easy to check and replace parts, and so that inspections and adjustments can be conducted (easily or) conveniently.

Software shall be designed with future maintainability taken into consideration, i.e. for future modifications and/or future improvements. Documentation shall be provided in order to easily carry out necessary procedures for the cases when modifications are required.

4.7.5 Operability

Each piece of the equipment shall be designed to allow for simple operation and to avoid erroneous operation, such as authority limits and wrong operation refuse. An HDTS should be designed to enable the receiving center to supervise the operational status of the entire system, identify problems and control necessary operations.

4.7.6 Economy

An HDTS should be designed to have a good cost performance in terms of required functions and reliability. The economy of the system should be evaluated considering the entire life cycle cost including the initial cost and operational cost. An HDTS should allow future updating or expansion.

5 Functional requirements of system

5.1 General

The functional block diagram of an HDTS is shown in Annex B. The hydrometric data measured at remote telemetry stations are encoded into a format adequate for transmission at the remote telemetry stations. Communications are made between the remote telemetry stations and the receiving center according to a prescribed collection sequence, transmitting the encoded data from the remote telemetry stations to the receiving center. The receiving center decodes the received data and performs data verification and processing to disseminate it to users as hydrometric information. An information processing system may be provided in the stage following this system.

5.2 Remote telemetry stations

5.2.1 General

The principal function of a remote telemetry station is to measure hydrometric data using sensors. This is a process for collecting data to be input to the system and for monitoring hydrological phenomena that change with time.

5.2.2 Locations

The locations of remote telemetry stations shall be determined in considering the distances from the receiving center and the topography of the sites of the stations. The possibility of using the sites, the availability of existing communication lines and radio links, the radio propagation conditions (if radio links are chosen), the lead-in conditions from power sources and the access roads should also be considered as important factors for determining the locations. The items that should be investigated in selecting the sites of remote telemetry stations from the viewpoint of data transmissions are shown in Annex C.

5.2.3 Data measurements

The measuring conditions for data to be acquired shall be specified based on operational purposes.

The items to be specified are

a) data type and number of measuring points,

b) range of measurement, effective digits and measuring accuracy and resolution,

c) timing of measurement,

d) input interface (typical interfaces are shown in Annex D),

e) threshold values for detecting alarms, and

f) other necessary items.

Specifications of sensors and converters are outside the scope of this Technical Specification. However, the SI Units (International System of Units) specified in ISO 1000 shall be used for measurement.

5.2.4 Data processing

In general, the results of data measurements should be transmitted as momentary data without being processed. However, such input data may be processed for conversion into a form that can be transmitted at the interfaces with the sensors. For some data and under certain measuring conditions, it may be effective to calculate the moving average; maximum and minimum values of the data measured at successive time points at remote telemetry stations and transmit the calculated results. Judgement, marking and deletion of abnormal data should be considered.

In recording and displaying the data measured at remote telemetry stations, the following items should be considered and decided:

a) storage of multiple data for batch transmission;

b) protection against data loss due to system troubles;

c) securing the convenience for system maintenance.

5.3 Telemetry system

5.3.1 General

The telemetry system is the core of this HDTS, and its principal function is to transmit the data measured by sensors at remote telemetry stations to the data processing system at the receiving center.

5.3.2 Amount and intervals of data transmission

The total amount of data and intervals of data transmission shall be provided for each data transmission link. The necessary capacity (speed) of a communication line is determined by adding the allowable transmission delay time to these parameters and also depends on the selected data communication channel.

5.3.3 Data collection sequence

The data collection sequence that is the fundamental function of the telemetry system shall be determined. There are various data collection and transmission sequences, such as continuous data transmission with time, data transmission in certain intervals, and data transmission when the data reaches certain threshold values.

The method in which the receiving center polls the remote telemetry stations one after another and receives the data measured at each polling time may cause time differences in measurement as restricted by the polling order. On the other hand, the method in which remote telemetry stations measure data at regular times, temporarily record the data and transmit the data to the receiving center asynchronously with the measurements can minimize the delay time in measurements.

The typical methods are shown in Annex E.

5.3.4 Communication lines

There are various types of communication links and communication methods such as wired lines, radio links, public telecommunication lines, mobile telephone network and satellite communication links. The type of communication link and communication method shall be decided by taking into consideration the communication environment and conditions of use including the amount of information to be transmitted, transmission speed, reliability of transmission, operating environment, feasibility and economy, and allowable delay time.

The communication lines available for data transmission and their technical outlines are shown in Annex F. Communication lines should be decided through comprehensive evaluation of the following items:

a) types and functions of communication lines that are provided by the telecommunication company in the area where HDTS is to be installed;

b) possibility (including technical and legal restrictions) of constructing dedicated communication lines for the telemetry system other than those provided by telecommunication company;

c) required transmission speed calculated from the amount of data that the telemetry system transmits (amount of data transmissions), sampling intervals and allowable delay time;

d) required reliability and economy of communication lines. Reliability should be considered in event of disasters and floods, and economy should be considered for the initial cost and life cycle cost.

Usually, exclusive radio communication links are used. In such cases, the frequencies and output powers are provided by international standards and national laws. Radio communications are usually available over distances of several tens of kilometres. Relay stations may be needed for longer distances and/or steep terrain. Since the quality of radio communication depends on the peripheral conditions, propagation tests should be made after designing the communication links. A general process of designing simplex radio links is shown in Annex G.

5.3.5 Network architecture

Networks for interconnecting remote telemetry stations and receiving centers may be configured as various architectures depending on the locations of the remote telemetry stations and the receiving centers, the types of communication lines to be used, presence of relay stations, etc. Appropriate network architecture shall be determined with a full understanding of the advantages and disadvantages of various architectures, such as economy, reliability and adaptability. Some network architectures for the telemetry system are shown in Annex H. Data repeating methods at a relay station are shown in Annex I.

5.4 Receiving center

5.4.1 General

The principal functions of the receiving center are data collection through telemetry, data verification and processing, and dissemination of the results to users. The process of data processing and the subsequent process may be conducted by providing a separate information processing system. In such a case, the details are outside the scope of this Technical Specification.

5.4.2 Data verification

Data shall be verified to ensure the quality of collected data.

The data verification can be classified into two processes.

— The first is to detect errors in data transmission. This can be performed using parity bit, Cyclic Redundancy Check (CRC) error detection codes or other methods. These methods may be included in the communication control procedure.

— The other process is to examine the properties of hydrometric data, which can be performed using measured range of sensors, the upper and lower limits of data values, and limits of changing rate of measured data. Since most of the threshold values of these items vary depending on types of systems and/or application forms, the system should be designed to enable threshold values to be set as parameters that can be specified individually. These data verification processes may be handled in the data processing system.

The system will generate a report that identifies potentially spurious data.

5.4.3 Data processing

Data processing in the HDTS is the process that generates meaningful hydrological information from the data measured at remote telemetry stations.

Users generally make their decisions based on operational information instead of basic hydrometric data. Therefore, necessary conversion functions should be incorporated in the real-time environment if the system is not provided with an information processing system in the post-stage of the HDTS.

Parameters for processing, such as the stage-discharge relation, may be modified afterwards. Therefore, the real-time information that is necessary for decision-making and the information that is stored as hydrometric records for a long time should be separated within the HDTS.

5.4.4 Data storage

The HDTS shall have a function to store data and information in a memory media on the system.

The data storage in the HDTS should be intended for

— buffering measured data until it is transmitted to an information processing system after the HDTS,

— real-time generation of information by combining data at multiple time points, and

— temporary storage of real-time information necessary for decision-making.

Information that will be stored for a long time and used as standards should be stored as a database in an separate information-processing system from the HDTS.

5.4.5 Data display and printing

The system shall have the functions of displaying and printing out data and information in tables and graphs. For these functions, there are methods for displaying and printing data immediately after each timing of data collection, and methods for outputting a batch of data collected at multiple sampling times (such as daily) and for outputting information on a timing as requested by a user.