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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 committee responsible for this document is ISO/TC 113, *Hydrometry*, Subcommittee SC 5, *Instruments, equipment and data management.*

This first edition of ISO 24155 cancels and replaces ISO/TS 24155:2007.

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 centre for further processing.

This International Standard 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 International Standard specifies the technical requirements that should be considered in designing and operating hydrometric data transmission systems (HDTS) and also the necessary functions of those systems. The scope of HDTS is shown in Annex A.

2 Normative references

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

ISO 772, *Hydrometry — Vocabulary and symbols*

ISO 80000-1, *Quantities and units — Part 1: General*

ISO/IEC 2382, *Information technology — Vocabulary*

3 Terms and definitions

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

4 Basic requirements

4.1 General

This Clause specifies the general requirements for designing an 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 drainage basins, such as needed for early warning of high flood levels, or low flows in ecologically sensitive rivers, 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 communication links as specified in 5.3.4.

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 centre(s);

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 drainage basin. Remote telemetry stations cannot always be located at optimum hydrological sites, and may be relocated to alternate sites because of geographical problems and difficulties in data transmission.

A receiving centre consists of equipment that receives data from remote telemetry stations for data processing and display. It is located at a site where data and/or information are needed. Therefore, the receiving centre will usually be located within the facility of a user organization. In large drainage basins, receiving centres 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 that are required in data presentation.

Usually, sensors at remote telemetry stations continuously measure hydrological phenomena, but the data monitored at the receiving centre 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) lightning protection;

e) seismic resistance;

f) damage due to sea wind, dust, and/or corrosive gases;

g) available power supply conditions;

h) equipment damage and access during flooding.

The environmental conditions of the telecommunications and information processing system equipment to be installed at a receiving centre should also be considered for items a), b), d), e), and g) 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 links can be installed to connect important remote telemetry stations in a gauging area to a receiving centre. A hot-standby system can also be used for the equipment having important functions. The hydrological data measured by important remote telemetry stations also can be input to a 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 ensured, since these are stored and used for water resources management over a long period.

The permanence of data shall be ensured even if some component(s) of the system is replaced or changed. 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 centre should be saved on reliable storage 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.

The HDTS should also include the capability of performing line testing between receiving centre (Rc), via relay station (Rs), and remote telemetry station (Rts).

4.7.5 Operability

Each piece of the equipment shall be designed to allow for simple operation and to prevent unauthorized access, illegal operation, and unintentional shutoff of the power. An HDTS should be designed to enable the receiving centre to monitor 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 for 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 suitable for transmission at the remote telemetry stations. Communications are made between the remote telemetry stations and the receiving centre according to a prescribed collection sequence, transmitting the encoded data from the remote telemetry stations to the receiving centre. The receiving centre 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 features of communication link(s) to be introduced as well as hydrological points of view. The possibility of using the sites, the availability of existing communication links 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, data value, and units;

c) resolution and accuracy against full scale;

d) timing of measurement;

e) input interface (typical interfaces are shown in Annex D);

f) threshold values for detecting alarms; and

g) other necessary items.

Specifications of sensors and converters are outside the scope of this International Standard. However, the SI Units (International System of Units) specified in ISO 80000-1 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 or maximum and minimum values of the data measured at successive time points at remote telemetry stations and transmit the calculated results. Abnormal data should be marked or highlighted for further inspection.

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) provision of displaying raw data, etc. for easy maintenance on site.

The sampling interval of a data logger should be determined by the balance among the purpose of the logging data, the recordable time depending on the recording capacity and intervals of the logger, the intervals of log collecting and associated cost, and the risk of loss of data through natural causes or vandalism, etc.

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 centre.

5.3.2 Amount and intervals of data transmission

The total amount and intervals of data transmission shall be provided for each data transmission link. The necessary capacity (speed) of a communication link is determined by the total amount of data, interval of data transmission, and allowable transmission delay time. The necessary capacity 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.

If the receiving centre polls remote telemetry stations one after another and receives the data measurement at each polling time, the actual time of measurement for each station may be different from each other as per polling order. On the other hand, if remote telemetry stations measure data with their own time schedule, the delay time in measurements can be minimized.

The typical methods are shown in Annex E.

5.3.4 Communication links

There are various types of communication links and communication methods such as wired lines, radio links, public telecommunication lines, mobile telephone network, Internet 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 links available for data transmission and their technical outlines are shown in Annex F. Communication links should be decided through comprehensive evaluation of the following items:

a) types and functions of communication lines that are provided by 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 links. Reliability should be considered in event of disasters such as 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 rugged 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 centres may be configured as various architectures depending on the locations of the remote telemetry stations and the receiving centres, the types of communication links 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 centre

5.4.1 General

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

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. Both processes should be performed.

— 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 the rate of change 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 specified and set for individual parameters.

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

5.4.3 Data processing

Data processing in the HDTS are the procedures that generate meaningful hydrological information for users 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, such as accumulation of rainfall or conversion from a stage observation to a discharge, should be incorporated in the real-time environment if the system is not provided with an information processing system in the post-stage of 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 a 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 data collection and transmission cycle, and methods for outputting a batch of data collected at multiple sampling times (such as daily) and for outputting information for a specific time as requested by a user.

5.5 System monitoring

5.5.1 General

An HDTS shall be able to record its operational status, to provide a report of this record in order to check its operational status and to quickly notify users of problems, so that users can identify and remove the causes of problems, and quickly and appropriately restore the system.

5.5.2 Monitoring of operational status

The system should always be monitored to promptly detect any problems. Such events are usually transmitted through the HDTS.

The remote telemetry stations are to be installed geographically distributed and operated unmanned. Therefore, the operational status of the entire system including the remote telemetry stations should be monitored, and any problems should be detected remotely from the receiving centre.

