

Measurement of liquid flow in open channels —

**Part 8: Measuring instruments and
equipment —**

**Part 8F: Hydrometric data transmission
systems: general**

[ISO title: Hydrometric data transmission systems —
Part 1: General]

UDC 532.543:681.327.8

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Industrial-process Measurement and Control Standards Committee (PCL/-) to Technical Committee PCL/3, upon which the following bodies were represented:

- Department of the Environment for Northern Ireland
- Institute of Measurement and Control
- Institution of Civil Engineers
- Institution of Water Engineers and Scientists
- Scottish Development Department
- Water Authorities Association
- Welsh Office

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- Clyde River Purification Board
- GAMBICA (BEAMA Ltd.)
- Institute of Hydrology

This British Standard, having been prepared under the direction of the Industrial-process Measurement and Control Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 January 1986

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The following BSI references relate to the work on this standard:
Committee reference PCL/3
Draft for comment 82/24025 DC

ISBN 0 580 14906 4

Amendments issued since publication

Amd. No.	Date of issue	Comments

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National foreword

This Part of BS 3680 has been prepared under the direction of the Industrial-process Measurement and Control Standards Committee and is identical with ISO 6419-1:1984 “*Hydrometric data transmission systems — Part 1 General*”, published by the International Organization for Standardization (ISO).

Terminology and conventions. The text of the International Standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

Wherever the words “part of ISO 6419” appear, referring to this standard, they should be read as “British Standard”.

The comma has been used as a decimal marker. In British Standards it is current practice to use a full point on the baseline as the decimal marker.

Cross-references

International Standard	Corresponding British Standard
ISO 1000:1981	BS 5555:1981 <i>Specification for SI units and recommendations for the use of their multiples and of certain other units</i> (Technically equivalent)
ISO 646:1983	BS 4730:1985 <i>Specification for UK 7-bit coded character set</i> (Identical exercising national options)

The Technical Committee has reviewed the provisions of ISO 772:1978, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. A related British Standard to ISO 772 is BS 3680 “*Methods of measurement of liquid flow in open channels*”, Part 1:1983 *Glossary of terms*”.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Introduction

A system of hydrometric stations, data transmission and data handling constitutes a hydrometric data acquisition system, the density of which should relate to the scale of both existing and potential objectives.

Collection of hydrometric data may be governed by legal, present and anticipated scientific and operational needs.

If the network is sufficiently dense, generating large quantities of data, or if the time-interval of the necessary reaction to measurement is relatively short, then recourse to modern techniques of fast, concentrated data handling is necessary.

The advances already made and the continuing development in the technology of measurement, data transmission and data handling result in a wide variety of design and operation of data systems. However, with the increasing size and complexity of such systems and the special requirements of hydrometric data systems, it has become evident that standardization of some aspects of hydrometric telemetry would improve the design, specification and operation of systems, as well as delaying equipment obsolescence.

1 Scope and field of application

This part of ISO 6419 specifies the general functional requirements for hydrometric telemetry. It defines characteristics of the system required to transmit field data to a receiving station and the minimum processing for subsequent use.

2 References

ISO 646, *Information processing — ISO 7-bit coded character set for information interchange*.

ISO 772, *Liquid flow measurement in open channels — Vocabulary and symbols*.

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

3 Definitions

For the purposes of this part of ISO 6419, and in addition to those given in ISO 772, the following definitions shall apply.

3.1

bit

a binary digit; a digit (1 or 0) used to represent a number in binary notation

3.2

baud

a unit for measuring data flow on a communication path, equivalent to one bit per second

3.3

remote station; outstation

all facilities and equipment associated with the sensing and transmission of valid data from a hydrometric station

4 Units of measurement

The units of measurement used in this part of ISO 6419 are SI units in accordance with ISO 1000.

5 System description

5.1 General

The end-product of hydrometry is data, relating to measurements of relevant parameters.

The common objective in hydrometry is to acquire continuous data in which the acquisition rate will make it possible to understand the phenomena in general and predict its development in time.

It is convenient to examine the data acquisition system by means of each of the distinct stages through which the data shall pass before its ultimate use. Figure 1 illustrates this in block form.

5.2 Data system stages

Six distinct stages may be identified in any data acquisition system, however simple the system may be:

- a) primary measurement;
- b) encoding;
- c) transmission;
- d) decoding;
- e) validation;
- f) use.

The extent of a telemetry system encompasses stages b) to e), as indicated in Figure 1.

An interface exists between each of these stages and it is at these interfaces that the greatest opportunity for standardization exists, thus minimizing the adverse effect on the user of technological obsolescence.

5.2.1 Primary measurement

A primary measurement is made with the object of describing a physical process in a form which can be interpreted by human senses, or which enables this objective to be met.

In hydrometric instrumentation this is achieved by sensing energy changes, as reflected by changes in the natural parameter and converting such changes into a form suitable for subsequent processes. The device which performs this function is called a transducer.

The most common outputs are either mechanical or electrical.

5.2.2 Encoding

The measurements taken at the field site will be required at some other place and/or some other time.

This requirement can be met by coding a transducer output, thus making it more convenient for transmission and/or storage.

5.2.3 Transmission

The movement of the information from place of measurement to the place of use.

5.2.4 Decoding

The reversion of the coded information into physical units.

5.2.5 Validation

This is the process of confirming, using some specified means, that the data as received (immediately following the decoding process) are acceptable within the tolerance limits specified.

The validation of data shall be treated as an integral part of any acquisition system and validation is best carried out as soon as possible after reception.

5.2.6 Use

A large proportion of the use made of hydrometric data involves the analysis of time-series data.

The method chosen for storage of, and access to, the data shall recognize this and the fact that data archives tend to grow at an accelerating rate.

6 Principles of operation

6.1 General

In this clause it is necessary to keep in mind the sequential nature of the system, described in clause 5, and especially the concept of a definite interface between each stage.

6.2 Hydrometric telemetry

Hydrometric telemetry is the transmission of data from primary sensors to another location.

The mode of transmission influences many other system design considerations.

6.3 Means of transmission

6.3.1 General

The most readily available, and most widely used, energy form is electrical, and further considerations in this part of ISO 6419 are confined to this form.

Sufficient power shall be generated by the transmitter to guarantee the integrity of the received signal, allowing for energy losses along the transmission path.

In a terrestrial environment these losses can be considerable, whereas outside the Earth's atmosphere they become insignificant.

6.3.2 Transmission by line

6.3.2.1 Lines may be "dedicated" or shared with general purpose communications. In some networks, lines are dedicated to data transmission but shared between users.

6.3.2.2 Advantages:

- a) low probability of atmospheric interference;
- b) high value of mean-time-between-failure (MTBF);
- c) systematic energy loss is predictable;
- d) system commissioning is simplified.

6.3.2.3 Disadvantages:

- a) installation cost increases with distance;
- b) overhead lines are susceptible to failure due to high winds and ice or snow;
- c) underground lines can be damaged by numerous causes, including flooding, each movement and construction activity;
- d) failure may occur anywhere along the line;
- e) probability of interference increases with line length;
- f) natural temperature changes affect line impedance, particularly with overhead lines;
- g) increase in line impedance with length limits the choice of signal type;
- h) installation of temporary outstations is inhibited;
- j) traffic becomes high during critical hydrological events.

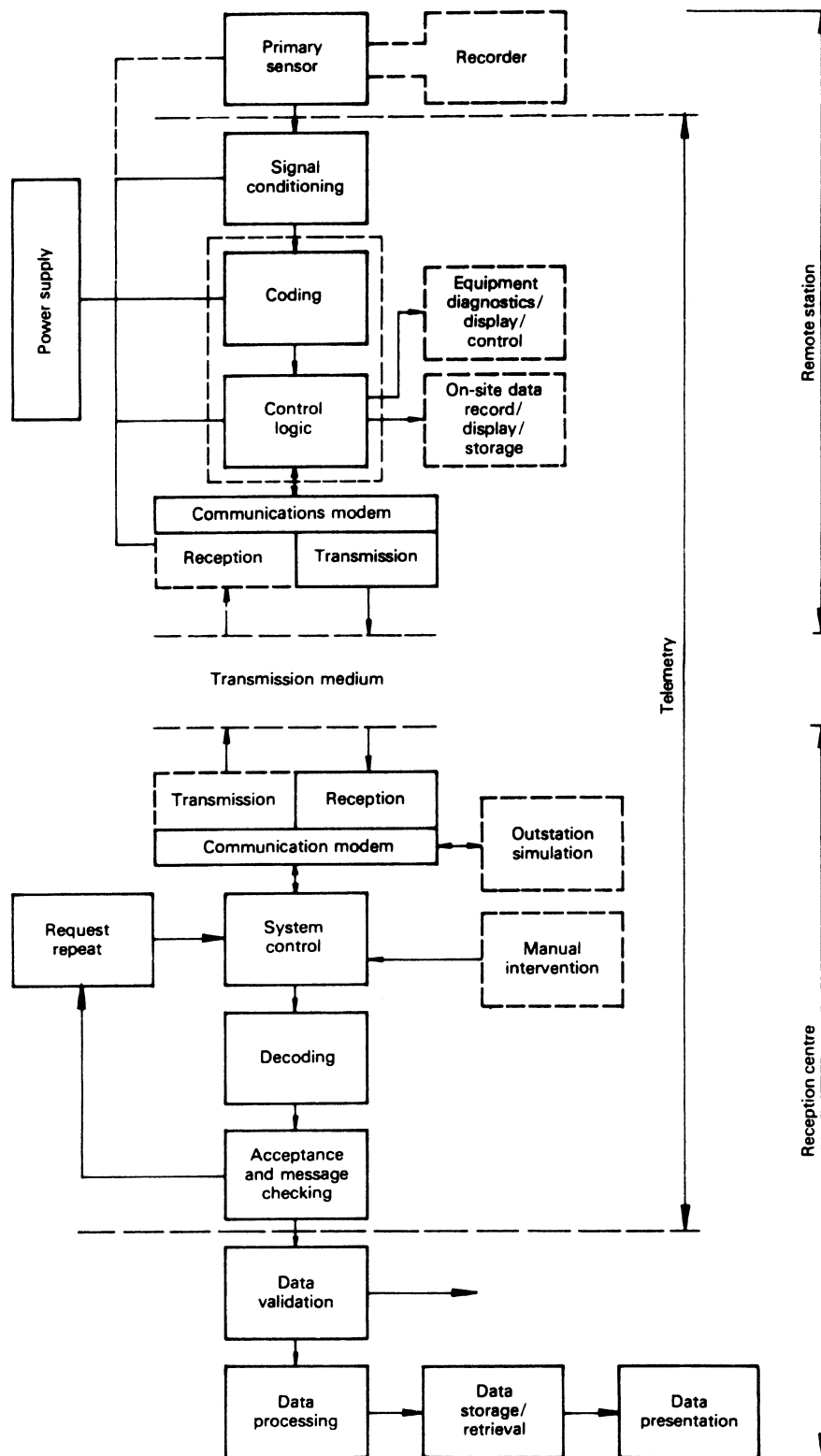
6.3.2.4 A dedicated line would have a high level of system integrity, but the installation and maintenance costs would also be dedicated to the user and could certainly be higher than for a shared line.

6.3.2.5 The use of other than dedicated lines will, almost certainly, involve compatibility with signal standards imposed by others.

6.3.2.6 If a comprehensive public network exists some of the disadvantages may be mitigated by the provision of alternative transmission paths.

6.3.3 Transmission by radio

6.3.3.1 Radio waves are specified by frequency (in hertz) and occupy the portion of the electromagnetic spectrum having frequencies less than visible light. For convenience, these frequencies are identified by band widths which are set out in Annex D.



NOTE Dashed blocks indicate optional extras to the basic system.

Figure 1 — Data acquisition system — Functional block diagram

6.3.3.2 Allocation of radio frequency (RF) bands, for whatever purpose, is agreed internationally under the auspices of the International Telecommunication Union (ITU) and in some parts of the world some bands are heavily loaded, which can influence overall system design. Any use of radio transmitters shall be licensed by the appropriate national body.

6.3.3.3 Both terrestrial and satellite radio systems are in use. Their relative merits, and their comparison with line transmission, are mainly:

6.3.3.3.1 *Terrestrial radio systems*

6.3.3.3.1.1 Advantages:

- a) installation cost is less dependent on distance than transmission by line;
- b) equipment failure is limited to discrete sites, facilitating fault diagnosis;
- c) once frequencies have been allocated there is a high degree of exclusiveness, equivalent to a dedicated line;
- d) there is more flexibility in the use of temporary out-stations.

6.3.3.3.1.2 Disadvantages:

- a) susceptible to atmospheric interference, although this tends to be of short duration;
- b) signal loss is less easily predicted;
- c) in abnormal atmospheric conditions there can be mutual interference between systems on similar frequencies;
- d) repeater stations may be required to overcome signal loss due to distance or topography.

6.3.3.3.2 *Satellite radio systems*

6.3.3.3.2.1 Advantages:

- a) repeater stations, other than the satellite itself, are not required;
- b) equipment failure is limited to discrete sites, facilitating fault diagnosis;
- c) stations are easy to relocate;
- d) one receiver site can provide continental coverage;
- e) antennae are less obtrusive than for terrestrial radio;
- f) site selection is less inhibited by topography.

6.3.3.3.2.2 Disadvantages:

Consequences of the failure of a satellite, or receiver site, are critical; alternative spacecraft and/or receiver equipment may not be readily available.

6.3.4 Conclusion

It can be seen that the advantages and disadvantages of line and radio tend to be complementary.

6.4 Signals

Signals in this context mean information represented in a form suitable for the operation of the system.

6.4.1 Signal representation (see Annex A)

6.4.1.1 *Analogue technique*

The principal advantage of an analogue signal is, that by a relatively simple transformation, a continuous signal can be received which reflects the continuity of the original parameter.

The analogy may be obtained electrically by means of one of the following:

- a) voltage modulation;
- b) current modulation;
- c) amplitude modulation (AM);
- d) frequency modulation (FM);
- e) phase modulation.

The term "modulation" is used here to mean the simple alteration of the signal to follow the variation of the measured parameter with time.

6.4.1.2 *Digital techniques*

Digital representation necessitates a fundamental departure from the basic continuity of the original measured parameter by the technique of sampling; parameter values between the discrete samples are available only by inference.

If the sampling rate is high, relative to the variation of the measured parameter, the continuity can be restored, if necessary, by integration to give an analogue output. The sampling rate should enable the hydrological process to be reproduced within a specified accuracy, but a compromise is usually necessary between time/space/cost.

Four examples of digital techniques which can be used in this way are:

- a) pulse duration modulation;
- b) pulse amplitude modulation;
- c) pulse code modulation;
- d) pulse position modulation.

6.4.1.3 *Summary of signal representation*

Two basic types of signal have been discussed: