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Hydrometric telemetry systems —

Part 2:
Specification of system requirements

Systèmes de télémétrie hydrométrique —

Partie 2: Spécification des caractéristiques des systèmes

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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.

International Standard ISO 6419-2 was prepared by Technical Committee ISO/TC 113, *Measurement of liquid flow in open channels*, Sub-Committee SC 5, *Flow measuring instruments and equipment*.

ISO 6419 consists of the following parts, under the general title *Hydrometric telemetry systems*:

— *Part 1: General*

— *Part 2: Specification of system requirements*

— *Part 3: Criteria for design and implementation*

Introduction

ISO 6419-1 specifies the general functional requirements for hydrometric telemetry and defines the characteristics of a system required to transmit field data to a receiving station, with minimal reference to data processing for subsequent use of the data.

The assembly of systems for hydrometry relies heavily on both hardware and software produced for other telemetry purposes which have larger markets. Therefore the desire to elaborate ISO 6419-1 to cover complete systems unique to hydrometry was resisted.

Nevertheless there are requirements in hydrometric data acquisition and data management which necessitate special considerations in system design and in this part of ISO 6419 these considerations are examined in the context of a total system specification.

As a matter of principle, the content of this part of ISO 6419 is independent of the state of development of the technology current at the time of implementation. It is recommended that this principle should also apply to system specifications except in the recognition of the opportunities which evolution of the technology will allow.

This part of ISO 6419 is intended to form a bridge between the user and the supplier to cover any limitations in the knowledge of the one of the requirements of the other. The objective is to give guidelines for the structure of both the user's specification and the supplier's response as an aid to clarity and to limit ambiguity.

It should be noted that compliance with an International Standard does not in itself confer immunity from legal obligations.

Hydrometric telemetry systems —

Part 2:
Specification of system requirements

1 Scope

This part of ISO 6419 outlines a method for specifying hydrometric telemetry systems and identifies factors which influence the design and operation of such systems. It covers the specification of system requirements and those for installing, commissioning, acceptance testing and documentation. Consideration of procurement procedures is not included.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 6419. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 6419 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 772:1988, *Liquid flow measurement in open channels — Vocabulary and symbols.*

ISO 2382-1:1984, *Data processing — Vocabulary — Part 01: Fundamental terms.*

ISO 6419-1:1984, *Hydrometric data transmission systems — Part 1: General.*

ISO 7498:1984, *Information processing systems — Open Systems Interconnection — Basic Reference Model.*

3 Definitions

For the purposes of this part of ISO 6419, the definitions given in ISO 772 and ISO 2382-1 and the following definitions apply.

3.1 system: A set of elements organized to perform a set of designated functions in order to satisfy specific objectives.

An element is a set of resources organized to perform some highly related subset of the desired system functions.

The resources that comprise an element can include people, equipment, materials, facilities, information and money.

3.2 data; raw data: The output resulting directly from the measurement of a basic variable.

3.3 information: The result of applying a process to data.

3.4 default mode: Condition automatically adopted by a system unless it is otherwise directed or to which it reverts when either it is unable to sustain the directed condition or the direction is unclear.

3.5 energy: Quantity characterizing the ability of a system to do work.

3.6 power: The time-rate of transferring or transforming energy or of doing work.

NOTE 1 In this and associated International Standards the term energy is used where only capacity is implied but where either rate or both rate and capacity are implied the term power is used.

3.7 hardware: Tangible equipment associated with the system.

3.8 software: Intangible element of a system which, when applied to the hardware, enables the system to perform in the designed manner.

3.9 real-time: Characteristic which defines the requirement to complete all the necessary procedures in time to influence a process while it is in progress.

4 Data and information

In ISO 6419-1 and this part of ISO 6419 a deliberate distinction is made, or implied, between the terms data (3.2) and information (3.3).

The output resulting from the measurement of a basic variable, i.e. data, is the "best truth" available. In the real-time environment of hydrometry and process control systems, this measurement cannot be repeated.

Data may be accepted (within the specific limits of uncertainty imposed by the sensor and the measurement facility), qualified (as a consequence of validation procedures) or rejected as unusable, but it cannot be modified without compromising its identity as data.

As an example, if a sensor is known to exhibit drift, for example as a result of temperature or time, any correction applied to the data converts it into information.

A further example is the case where the objective is the determination of discharge using the measurement of stage as the input; here, the statements of stage are data whereas those of discharge are information.

Unlike data, information may be modified, as would be the case if a stage/discharge relationship were revised.

For this reason it is recommended that data be treated as the principal record in a data acquisition system and that information be treated as a secondary record (see also 7.3).

5 Operational context

5.1 General

It is not necessary that the elements considered in this clause appear in the system specification under the headings identified. These elements are rather a set of considerations which will contribute to one or more of the elements of the structure of the specification defined in clause 8.

The definitive system specification will be the result of an iterative process both within the user organization and between the user and the supplier(s).

5.2 The operational purpose

As stated in the Introduction, one of the purposes of this part of ISO 6419 is to form a bridge between the user and the supplier. To achieve this objective it is prudent to assume that the supplier has no knowledge of the user's field of application.

The specification should therefore include an objective summary of the purpose for which the user organization exists, and a statement of why actions and activities are necessary, together with a definition of their relative significance since they will influence the data acquisition and information management of the proposed system.

5.3 The functional structure

The functional requirements should be defined under two categories as follows:

a) obligatory, for example a statutory requirement;

b) elective, where the user has a choice of whether or how to fulfil the function.

The user should appreciate that merely transferring existing operational philosophies into the specification of the proposed system can limit the full exploitation of the technology and techniques now available. Existing procedures should be analysed so that they may be restated objectively in order to take full advantage of the potential for a novel operating environment.

5.4 The geographical structure

The following elements of the existing system shall be defined:

a) the points of measurement;

b) the point(s) where data and/or information are required.

In both these cases, consideration should be given to probable or possible future requirements. Only the user can make judgements regarding these considerations but the system supplier would be expected to quantify their influence on the proposed system configuration. A characteristic of hydrometric telemetry, is the wide geographical dispersal of measurement points coupled with the fact that, generally, a small number of parameters are measured at each site.

There are opportunities inherent in establishing a telemetry remote station which may be exploited by including, or making provision for, additional facilities for relatively little extra cost. These might take the form of

a) additional equipment to increase reliability, such as multiple sensors, the duplication of transmission equipment or the provision of local data storage devices, and

b) the measurement of additional parameters which, on their own, would not have justified the resources employed.

When attending a remote station it may be advantageous or necessary, during maintenance, calibration or operation, to have access to data or information from other sites or stations in the system. If this is so, this requirement shall be included in the specification as it will influence the communications requirement. It is recommended that all such procedural requirements be specified separately.

Consideration should also be given to the possible need for the introduction of data and/or information into the system from other sources, e.g. the input of data from field reports or from other systems, or for the transmission of data and/or information to other systems.

5.5 The time structure

Hydrometric data transmission systems operate in a real-time environment which has two time domains. The time constants may range from minutes to days or even weeks and since no control can be exercised over these, it follows that the only controllable time variable relates to the time characteristics of the data acquisition system. This is one of the areas where the desirable characteristics of flexibility and expansibility should be explored.

Examination and explanation of the inherent dynamic changes within the natural system will assist in establishing the appropriate rate of routine polling (interrogation) and the required system response time.

In addition to specifying the minimum rate of polling, which may alternatively be expressed as the maximum period between transmissions, the required data recording rate shall be stated. The recording rate shall be a variable which can be selected by the user to suit the prevailing needs for data.

If a data recording facility is provided at the remote station then the rate of recording can be independent of the rate of polling, whereas without such a facility the maximum recording rate is limited to the rate of polling.

The initial selection of the polling rate should be based on the maximum acceptable interval between the requirements for data and/or information, whether these requirements refer to a complete data set, an individual measurement or a status indicator (see also 6.1 and clause 7).

The period for which data and/or information will be required to be accessible on-line shall also be stated, with an appropriate allowance for expansion (see 7.3.6).

5.6 The man-system interface

5.6.1 General

The man-system interface is the focal point of contact between the user and the system, and its primary purpose is to service the communications between an equipment environment and the human environment.

The routine operations of modern data transmission systems are designed to be largely automatic but, however well this is accomplished, the efficacy of the whole system will ultimately be judged on the effectiveness of this interface.

The initial judgement will be influenced by the range and capabilities of the facilities provided but the final judgement will rest on how easy these are to use.

There is normally a hierarchy of skills and responsibilities in any organization and these must be taken into account when specifying the required presentation of data and/or information.

The presentation needs to be considered under two headings at each level, namely

a) what needs to be known, and

b) how it is to be effectively presented.

In general, as information passes up the hierarchy there will usually be a reduction in the need for detail and an increase in the need for interpretative skill.

5.6.2 Access

In order to protect the system and the data from inadvertent or unauthorized corruption it is recommended that facilities be specified which allow control of access to the system in operation. These facilities may be incorporated in the hardware or the software (or both), where access is restricted, respectively, by a physical or a conceptual "lock and key".

It is recommended that at least three levels of access to the system be provided as follows.

a) Level 1: Inspection

A restricted facility is available to allow data and information to be viewed but without the authority to make any changes.

b) Level 2: Control

The facilities of level 1 are available together with the addition of a restricted access to facilities appropriate to the exercise of normal operation, such as the variation of recording rates and the modification of and/or validation limits.

c) Level 3: Development

The facilities of level 2 together with access to facilities to enable modifications to be made to the fundamental operation of any aspect of the system are available. This level of access should be severely restricted.

Authority for access should be matched to responsibilities. This may result in the need to allow only limited access at levels 2 and 3.

This concept of graded access can be applied throughout the system.

5.6.3 The organizational structure

The description of how management and control are, or are planned to be, exercised will have an influence on the design of the data and information management element of the system.

The design shall allow sufficient flexibility so that any changes in the organizational structure can be accommodated without major configuration changes (see also 6.3.1.1 to 6.3.1.3).

5.7 Risk analysis and assessment

The consequences of the malfunction of parts of the system, from whatever cause, should be explored. The user should make value judgements of these consequences in order to determine their significance and to compare the options for their limitation or avoidance.

The recommended principle to adopt for specification and design is that of "controlled degradation".

6 System definition

6.1 General

The degree of success in the achievement of the most appropriate system for the end user is governed largely by three factors as follows:

a) the achievement of a consensus within the user organization of the boundaries, objectives and characteristics of the proposed system;

b) the formulation by the user of well-considered statements of both tactical and strategic objectives; as a matter of principle these should avoid considerations of the potential system's technology or methodology except where these may be constrained or pre-empted by the user's operating environment (see 6.3.1.3);

c) the establishment of a firm mutual understanding between the user and the supplier(s) of their respective requirements, capabilities and limitations.

Care should be exercised to avoid over-specification, the principle being to minimize statements of specification.

Similarly, the selection of options should be deferred until actually required, the reason being that technology is advancing at such a speed that the basis of decisions based on viability may change between the statement of requirements and their implementation.

The key aspects which need to be explored and explained in order to translate the objectives into a specification for a data transmission system and to achieve the desired mutual understanding are discussed below.

6.2 System objectives

The system objectives are as follows:

a) to transmit data from a network of hydrometric stations to the point(s) of data use;

b) to recover data with sufficient certainty and in sufficient time that the management objectives relating to the natural system can be met;

c) to minimize the manual content of data management;

d) to maximize the use of equipment common to all remote stations;

e) to employ technology and good practice appropriate to both the natural and the management environment;

f) to minimize the effect on the initial system of changes resulting from the enhancement of objectives or advances in technology.

6.3 System characteristics

6.3.1 Individual characteristics

6.3.1.1 Flexibility

The opportunities for varying established methods and procedures are often identified, or become more obvious, only after a system becomes operational. Provision for flexibility not only avoids potential frustration but also allows for the provision

of varying degrees of continued operation during malfunction or failure of non-critical system components.

6.3.1.2 Expansibility

Hydrometric networks are occasionally completely designed but rarely completely installed in the first phase of development. It follows that unnecessary limitations in the system configuration should be avoided in the specification and not accepted in the design proposal.

6.3.1.3 Evolutionary robustness

A characteristic of modern electronic technology is the relatively short time interval between installation and obsolescence. This fact shall be taken into account in the design concept and the specification so that advantage can be taken of advances in technology when the need or opportunities arise.

The effects of obsolescence can be reduced by distributing the various processing tasks and integrating them by the use of a local area network (LAN). This enables the user to change elements, or to introduce additions, with minimal disturbance to the remainder of the system (see also 6.3.2).

6.3.1.4 Transportability/transferability

The greater proportion of the cost of modern systems is the intellectual investment in its software. The protection of this investment requires that changes in hardware during the lifetime of the system be anticipated in the specification.

6.3.2 Interrelationship of characteristics

The boundaries between these four system characteristics overlap such that each should not be considered in isolation. The integrity of the system will be enhanced and its useful life extended by their proper consideration in the design concept and in the specification.

The concept of modularity assists in the realization of these characteristics. A module may be considered as an identifiable, separable, element arrived at by a process of decomposition of the major elements of the system. This process can be applied throughout the conceptual design and need not be confined to equipment, although modularity in this area can be of particular advantage for system maintenance.

It should be noted that the ability to take subsequent advantage of these characteristics can be severely impeded by inadequate documentation.

6.4 Existing facilities

Existing facilities which may impinge on the proposed system are those in contact with the boundaries of the system, i.e. the measurement stations and the subsequent data usage and existing communications facilities.

The definition of the boundaries in effect defines the system (see clause 3) and it follows that the specification of outputs from the measurement facilities are a necessary part of the system specification.

The transfer of data from the system and the input of data from other sources into the system forms another interface. It is recommended that there be a data buffer between the real-time system and this external environment: whether the subsequent data processing facilities exist or are yet to be developed; in the latter case the buffer stage should form part of the specification as it is assumed that data which is transferred will need to be preserved until the subsequent facilities are provided.

The introduction of a buffer stage protects the system from changes outside its own environment and control.

7 Operational requirements

7.1 Remote stations

A description of the parameters to be measured and their application should be included together with an indication of the factors influencing the specified frequency of acquisition.

The recording of data at remote stations may be required for

a) the concentration of data for subsequent transmission in batch mode,

b) protection against loss of data resulting from system malfunction, and

c) inspection during visits to the station(s).

A recording facility may be within the boundary of the data transmission system or outside it (see 6419-1:1984, figure 1).

Each field station should be specified uniquely, with a list of the parameters to be included and, if relevant, allowed for.

Where existing sensors or transducers are to be incorporated their specification should be included. Particular reference should be made to the interface between the existing and proposed equipment. This should include a statement of where the interface is

intended to be and the specification of the output from the measurement element.

The need to detect anomalies, faults or failures in any element of the system may eventually govern the polling rate.

7.2 Communications

7.2.1 General

Communications are fundamental to telemetry systems and their adequacy has a direct effect on the performance of the system.

If some existing facilities are available they should be identified fully, giving their technical specification, location, present use and present loading. As a matter of principle a prescription of their use in the system being specified should be avoided unless there are sound reasons for their inclusion.

In general any consideration of their use should follow the principles specified in 5.3.

7.2.2 Need lines

A need line is an abstract concept identifying the need for a logical connection between a source of data, or information, and its destination point.

It should not be assumed that this necessarily implies that a direct transmission path will result; as long as communication is achieved which is operationally acceptable, the actual path taken is irrelevant to the user.

The source and destination points of all data and control links should be identified and listed, whether for hydrometric or system purposes.

7.2.3 Loading

It is necessary to determine the traffic on the need lines (7.2.2). This determination shall take into consideration both the number of parameters (including those related to measurements of the natural system and those related to the telemetry equipment) and their frequency of transmission.

In some cases data will flow in one direction only, in other cases only control signalling is needed in one direction and more intensive data traffic in the other. The communication system may be configured such that data flows in one direction only (simple), in two directions alternately (half-duplex) or in two directions simultaneously (full-duplex).

The length of that part of the message which represents the measurement data will depend on the range and resolution required of the data. The supplier will probably add loadings which result from the system's own requirements.

An overall estimation of the expected traffic, the average message length and the required response times shall be defined in the specification.

7.2.4 System interactions

Any constraints on the timing sequences of data acquisition or controls shall be defined. These constraints may be caused by the specification of equipment outside the scope of this part of ISO 6419 or by natural forces.

Other than those constraints which are in some way unavailable, the user may express preferences but should be aware that these, if they are too rigid, may influence the system design out of proportion to their real value (see also 5.5).

7.2.5 Communication configuration

The eventual configuration will result from the consideration and satisfaction of the statements and facts in the specification but will also be influenced by topography and compliance with local telecommunication restrictions.

In cases where public domain communications must be used, or where public data networks provide effective solutions or may even be compulsory, predefined interconnection protocols shall be used. Where a choice is available, it is recommended that the internationally accepted model for Open System Interconnection be employed (see ISO 7498).

Communication media and methods of data transmission are considered in ISO 6419-1.

7.3 Data and information management

7.3.1 General

For hydrometric telemetry systems, which are essentially constructed in a geographically distributed fashion, appropriate means for management and maintenance have to be provided. Systems management will be an important part of the total system design.

Examples of systems management requirements are programs for diagnostic tests, recovery mechanisms and system reconfiguration. Other examples are software and hardware to enable the gathering of statistics on performance, traffic and errors, and facilities to enable, disable, or select certain parts of functions within the system.

In clause 4 a distinction was made between data and information. Although data should be treated as the principal record, it is usually information which is used as the basis of decisions. When considering the needs for access to data and information, particularly in a real-time environment, the man-

agement, and thus the usage, of these two types of record should reflect this distinction.

It is a reasonable assumption that modern telemetry systems will include software-programmed processing units. These units are increasingly being distributed throughout data transmission systems.

The essential design characteristics are that the operation be in a real-time environment with multitasking facilites and that both the hardware and the software be modular.

If the user has every reason to believe that what he specifies is unlikely to change even if the network expands or if technology improves, the design and language of the software may, if he so decides, be left to the supplier. However, with regard to the characteristics described in 6.3, it is recommended that the software be specified to be written in a recognized real-time high-level language which can be demonstrated to be soundly supported.

7.3.2 Data acquisition

Two modes of data acquisition need to be considered, i.e.

a) automatic, and

b) on demand.

In the automatic mode, which can be taken to be the "normal" or "default" mode, the system would be expected to acquire the data at a rate at least equal to its specified minimum. The optional methods which can be used are specified in ISO 6419-1:1984, 6.5.

This rate could be one of the user-controlled variables but an increase in rate requires that sufficient system capacity be allowed for its accommodation (see ISO 6419-1:1984, 6.6).

In practice, other considerations may result in data being acquired at a rate in excess of the minimum specified by hydrometric considerations (see 7.1).

The rate at which acquired data is recorded is another user-controlled variable which need not be the same as the specified acquisition rate (see 5.5).

With some systems of communication it may be necessary for data to be acquired in batch mode, in which case there is a requirement for data storage at the field station and the local recording rate should at least equal the specified acquisition rate.

In such systems a facility for on-demand polling is not feasible.

It is recommended that the filtering out of "excess" data be accomplished under the more controllable environment of the reception site.

Where on-demand polling is possible, and required, it should be expected that an individual parameter could be addressed and even interrogated if necessary, although the supplier may choose to achieve this facility in a manner which is transparent to the end-user.

A design decision will be needed to establish the relative priority of on-demand requests, particularly if they might arise from a number of control terminals.

7.3.3 Data validation

7.3.3.1 System

The data acquisition system would be expected to check the validity of messages received in response to polling demands. At the basic level this would reject messages which failed fundamental checking procedures. Message acceptance at this level means only that the transmission criteria have been satisfied; it does not imply that the data within the message are acceptable for operational use.

Additional checks could include those for sensor range, upper and lower data limits and rate-of-change limits. It is recommended that these limits be user variables since initial values may of necessity be coarsely set and will be capable of refinement only after operational experience.

The response to these checks needs to be considered in the context of the operational abnormalities dealt with in 7.5.

7.3.3.2 User

The system validation process should be designed to accomplish as much automatic checking as possible, but the limiting factor is usually the lack of precision available to the user, particularly with new parameters or sites.

There may be more than one stage of user validation, depending on both the accumulated knowledge of the parameter and the time available before the data, or information derived from it, must be used.

7.3.4 Information

Information is a derivative of data and since many operational decisions are made on the basis of information rather than the raw data, some of the derivation process may need to be included in the real-time environment of the system.

Since the basis of conversion may be subject to subsequent alteration it is prudent to draw a distinction between information needed for real-time

decisions and that used as the basis of long-term archives (see 7.3.7).

7.3.5 Displays

The display element is the principal man-machine interface and as such is the point at which the end-user judges the efficacy of the system as a whole.

It follows that great care should be exercised in considering all aspects of this element. These considerations include the facilities provided, the ease with which the facilities may be exploited and developed, together with the ergonomics of the installation.

Displays are usually combined with interactive tools such as a keyboard, a graph-pen, a tracker-ball or the freely positioned version known as a "mouse". As a consequence, data has to be presented in such a way that interactions of this nature are possible. For interactive usage, menu or query-oriented representation techniques are of increasing importance.

Displays may be considered in two categories as follows.

a) Dynamic

Dynamic displays are taken to include all those displays which incorporate the display of real-time data and information, which by definition are subject to change.

b) Static

Static displays encompass all other types of display and include the facility for constructing new, or for modifying existing, display formats. In this mode there should be complete isolation from any possibility of interference with the operation of the real-time system.

7.3.6 On-line storage

7.3.6.1 General

This is taken to include both the data and information held in some form of memory accessible in real-time and the facility to produce printed (hard) copies derived from the real-time system.

7.3.6.2 Real-time data-base

It is recommended practice to limit the amount of data and information held in the real-time system to that which can influence real-time decisions.

It is further recommended that the ultimate destination of data transferred from the real-time system should not need to be known by the system. The subsequent use of data is deliberately outside the scope of this part of ISO 6419 but the advantage in this separation is that changes made beyond this point in the processing of data are prevented from forcing changes in the real-time system.

In 7.3.1 it was stated that both data and information are needed for most real-time management and they must, therefore, be immediately accessible. However, it is recommended that information derived for this purpose should not be transferred, since it should be expected that a more stringent control will be exercised over the derivation process for longer-term archive purposes.

7.3.6.3 Hard copy

Two categories of printed record should be considered, i.e. that produced automatically and that produced on demand. It is recommended that automatic output be severely limited to the logging of anomalies (see 7.5) and essential periodic summaries.

There should be the facility to obtain a hard copy of a current display and this necessitates the assurance that the display and printer formats are compatible, and preferably that they conform to a recognized standard.

7.3.7 Data transfer

7.3.7.1 Outputs from the system

Long-term archives are outside the scope of this part of ISO 6419, as are all other subsequent processes, but facility to transfer data from the real-time system is a normal requirement of hydrometric systems.

The frequency of data transfer should be considered but the facility should be flexible. The need for access by other users to data acquired by the real-time system will be the governing factor and may be subject to change.

7.3.7.2 Inputs to the system

If there is a requirement for data and/or information to be introduced to the system, such as data from stations not included in the present configuration, status information regarding equipment not monitored automatically or data from other systems such as weather forecasts, then the compatibility of these data must be assured.

7.4 Control

7.4.1 General

The degree of flexibility in the operation and development of the system and its overall manageability

will depend on the proper consideration and specification of all the control requirements.

Even if the system under consideration is purely for data acquisition, with no immediate requirement for the remote control of equipment such as sluices or pumps, there will still be the need to exercise control and, since one element of the system is the remote stations, some remote control may be necessary.

Control may be considered under three headings as follows:

a) data control;

b) data system control;

c) telemetry system control.

7.4.2 Data control

The data acquisition element may be designed to be automatic in normal operation but a facility for manual intervention should be examined. The ability to interrogate on-demand, whether of a parameter or a complete field station, is of particular benefit during commissioning, for maintenance, when station configurations are being changed and for calibration purposes.

Some communication configurations, especially satellite links, may preclude this facility or even exclude it completely.

Experience has shown that, whatever the initial specification of data presentation and information management, changes will be required which should be designed at the outset to be accomplished in a manner which is straightforward for the user and which protects the operational integrity of the system.

This flexibility in the data-acquisition design requires control.

7.4.3 Data system control

Data system control is taken to encompass all the facilities required to obtain reliable measurements.

Some sensors may only be capable of operating within defined ranges of their ambient environment, and the data and/or information from some sensors may only be relevant during certain seasons or while a particular phenomenon is present. Particularly for very remote stations, the ability to shut down elements of the station enables energy to be conserved and/or prevents invalid data being inadvertently misused.

7.4.4 Telemetry system control

The requirements of system reliability may result in the duplication of equipment for some elements of the system. Even though provision may be made for automatic change-over there will be reasons why this function may need to be over-ridden; this may occur during routine or corrective maintenance or for the management of duty-cycles.

7.5 Abnormalities

7.5.1 General

Operational abnormalities encompass all departures from what is considered to be the normal state of operation of the system.

The following are therefore included under this heading:

a) alerts;

b) alarms;

c) faults;

d) failures.

These abnormalities should be considered in terms of

a) the definition of what is abnormal, and

b) the necessary reaction to its occurrence

A further division of abnormalities should also be recognized, i.e. those arising from

a) the data, and

b) the system.

7.5.2 Alerts and alarms

The difference between an alert and an alarm is best explained in terms of the reaction required to an event. An alert requires to be indicated and, perhaps, noted whereas an alarm, when indicated, generally demands an action, or at least a positive reaction.

Alerts can be taken to include indications of the successful completion of a planned automatic or manual change in the system, such as a change-over in duplicated equipment based on duty-cycle or the alteration of limits.

Alarms are the result of unplanned changes or excursions of data outside specified limits.

7.5.3 Faults and failures

Faults may be transitory or persistent, and may cause corruption of data without necessarily otherwise upsetting the operation of the system. Their analysis can be an aid to the prevention of failure.

Faults, therefore, are one of the system's data sources which are of significance to individuals or groups, sometimes separate from the principal end-user, whose requirements must be included in the specification.

Failures indicate a degradation of the system's facilities which, depending on the robustness of the system design, may be critical or survivable.

7.5.4 Diagnostics

In conjunction with data and information management (7.3), careful consideration shall be given to facilities for gaining access to data (particularly from remote stations) since this assists in the diagnosis of faults and failures.

Diagnosis is assisted by the ability to gain access to data at the system level, i.e. the coded data as used by the system as opposed to the decoded data expected by the principal end-user.

7.6 Environment

7.6.1 Operational

Owing to the very large variation in ambient environmental conditions throughout the world it is considered to be potentially detrimental, and outside the scope of this part of ISO 6419, to define the range of ambient environmental conditions.

The user shall define the anticipated ambient conditions appropriate to the local environment. In some cases these will vary throughout the system and may be stated in the specification for each field station and data reception site. In the interests of system standardization and ease of maintenance, however, a uniform environmental specification may be preferred.

The more important criteria are as follows:

a) temperature range and the rate and range of temperature change;

b) relative humidity range, without condensation;

c) the probability and severity of lightning activity;

d) wind velocities and gusting conditions.

Examples of other criteria are

e) maximum precipitation intensity and duration,

f) maximum flood level, and

g) health and safety hazards.

These parameters should be stated in terms of their expected effects of the maintenance of full operational performance (see also 5.7).

In addition, factors which are potential sources of interference and/or damage should be identified. These include peculiarities of topography, geology and climate, the proximity of high-voltage transmission lines or radio/radar transmissions and potential hazards of damage, whether accidental or wilful.

7.6.2 Non-operational

The specification shall establish the boundaries of responsibility between the user and the supplier regarding the environmental conditions to be met, or provided for, when any equipment is in transit and temporary storage.

7.7 Power considerations

7.7.1 General

It should be made clear in the specification whether power sources are to be provided as part of the system or whether they already exist or are to be provided separately.

7.7.2 Remote stations

The user should state the performance expected of remote stations, in terms of both the duration between visits and the degree of protection against interruption.

7.7.3 Reception sites

The user should state the degree of protection expected against interruption at reception sites.

7.7.4 Auxiliary power

For both remote stations and reception sites, the user shall specify the minimum time for which any back-up power facilities are expected to provide continued operation.

Various techniques may be employed to extend the utility of back-up sources by reducing the power demand while the principal source is unavailable. If the communications system allows, it is recommended that this reduction is initiated under central control since a malfunction resulting from a locally generated degradation of remote-site facilities may entail local reactivation. Special precautions should be taken if sensors or transducers have been delib-

erately disabled as this may result in an inaccurate response until they have resettled in their operating environment.

7.8 Maintenance

The future policy and organization for system maintenance should be defined. It need not be assumed that a single policy must be applied to all elements of the system.

The facility to modify the elements as the system design develops will influence the definitive system and this influence must be borne in mind if a policy change is subsequently envisaged.

The specification should be formulated in such a way as to ensure that the requirements for the maintenance of all equipment supplied are incorporated in the resulting system. It should also describe the options for the holding and supply of spares, including the availability of alternative sources of supply.

7.9 Testing and acceptance

Before the user formally accepts the system the supplier is responsible for demonstrating that the requirements embodied in the agreed specifications have been satisfied.

The user should include in the specifications the criteria for testing and acceptance. It is usually the supplier's responsibility to organize and document the test procedures. The tests are conducted by the supplier in the user's presence.

Testing is usually accomplished in two stages, i.e. pre-delivery and post-installation testing.

The first stage is carried out on the supplier's premises and may involve some degree of simulation of actual conditions, for example of measurement output signals and of communications. The tests are carried out by the supplier and witnessed by the user.

The second stage will be on the user's sites and may progress from sub-system testing to full system acceptance. These tests may also be phased to include "setting-to-work", i.e. testing of the initial functioning, followed by an agreed period designed to demonstrate satisfactory performance in the operational environment, and the final acceptance, which signifies the formal change of ownership and the commencement of the agreed warranty period.

Agreed test procedures shall be specified in advance of manufacture for the acceptance of all appropriate sub-systems. These test procedures shall include not only tests of the functional behaviour of the sub-system but also test specifications for the interfaces and for the monitoring and testing of interconnected and collaborating sub-systems.

8 System specification

8.1 General

It was stated in 5.1 that the various considerations which will have an influence on the facilities and configuration of the definitive system need not be considered under the headings employed in 5.2 to 5.7. Nevertheless the consequences of these considerations should be incorporated in the specification.

It is recommended that the specification be prepared in two sections, the first being an operational requirements specification and the second being one of more functional specification(s), depending on the decision of the user as to the possible segmentation of the system into major elements.

The major functional elements are the remote station telemetry equipment, the communications facilities and the reception centre facilities. Although this part of ISO 6419 excludes the measurement facilities and subsequent data usage, the wider system will certainly encompass these.

8.2 Operational requirements specification

8.2.1 General

It is recommended that this section of the specification be prepared in such a way that it may be used as a first volume to accompany the separate functional specification(s). In this form it may also be used to elicit technical and budgetary proposals, and thus may also be a means of pre-qualifying potential suppliers.

It may be considered to comprise six subsections as follows.

8.2.2 Objectives

The statement of objectives not only indicates to the eventual supplier criteria for the judgement of satisfaction but also is a useful, documented, reminder for internal purposes.

8.2.3 Functional context

The functional context gives a general view of the "water system" which the system being specified must be designed and implemented to support.

It should be written with the objective of giving the supplier an insight into the user organization's operational activities and to highlight problems pertinent to control and management.

8.2.4 Concept and philosophy

The concept and philosophy subsection enables the user to express, in non-technical terms, the "idea" which is providing the impetus for the implementation. It is the opportunity to begin the process of particularizing the system to the user organization.

It should include statements not only of present needs but also of future intentions.

There is freedom in this subsection to indicate the general characteristics of the intended system, such as its flexibility, expansibility, robustness and ease of use.

Also appropriate to this subsection is an indication of policies regarding maintenance and development.

8.2.5 Operational procedures

The operational procedures subsection provides a description of data and information needs and of their management and use.

8.2.6 Facilities requirements

The facilities requirements subsection comprises a description of the facilities which are required in order to service the procedures.

These descriptions should not specify equipment but rather what the equipment must do. For example, it might be stated that all data shall be stored for immediate access for not less than 10 days and shall be protected against loss. It is for the supplier to propose the most appropriate solution.

8.2.7 Appendices

The appendices comprise

a) a schedule of the remote sites (which includes their location, the number and type of parameters to be acquired, and the minimum rate of acquisition) and of the reception sites, and

b) maps which illustrate both topology and topography.

8.3 Functional specification(s)

8.3.1 General

Even if the implementation is intended to be treated as a total system contract it is recommended that the major elements of the system be specified separately.

Any conditions particular to the user's organization, such as financial regulations, or additions to or variations from any applied standard conditions, should be defined.

8.3.2 Application of standards

Any international standards or national standards which apply to any parts of the specification, and if relevant any standards which apply to associated work, shall be specified.

8.3.3 Scope of the work

The scope of the work shall be specified as follows:

a) included items;

b) excluded work;

c) programme of work;

d) other relevant contracts or activities.

8.4 Field stations

8.4.1 General information

The elements which are common to all, or most, field stations shall be specified. These may include the requirements for equipment enclosures, standards of finish and labelling, and access for inspection, testing and maintenance.

8.4.2 Particulars

A definitive list of all field stations, giving in each case the minimum information outlined in 8.4.2.1 to 8.4.2.6, shall be applied.

8.4.2.1 Site description

The site description shall include

a) the location,

b) the access, and

c) the site plan.

8.4.2.2 Site environment

The description of the site environment shall include

a) operational environment,

b) energy considerations,

c) specification of any relevant existing equipment, and

d) location of sensing point(s) relative to telemetry equipment.