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Tendering Documents –

Part 1: General and annexes

Turbines hydrauliques, pompes d'accumulation et pompes-turbines –
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Partie 1:
Généralités et annexes

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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HYDRAULIC TURBINES, STORAGE PUMPS AND PUMP TURBINES – TENDERING DOCUMENTS –

Part 1: General and annexes

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.

3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.

4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but no immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

Technical reports of types 1 and 2 are subject to review within three years of publication to decide whether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

IEC 61366-1, which is a technical report of type 3, has been prepared by IEC technical committee 4: Hydraulic turbines.

The text of this technical report is based on the following documents:

Committee draft	Report on voting
4/110/CDV	4/122/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

Technical Report IEC 61366-1 is one of a series which deals with Tendering Documents for hydraulic turbines, storage pumps and pump-turbines. The series consists of seven parts:

Part 1: General and annexes (IEC 61366-1)

Part 2: Guidelines for technical specifications for Francis turbines (IEC 61366-2)

Part 3: Guidelines for technical specifications for Pelton turbines (IEC 61366-3)

Part 4: Guidelines for technical specifications for Kaplan and propeller turbines (IEC 61366-4)

Part 5: Guidelines for technical specifications for tubular turbines (IEC 61366-5)

Part 6: Guidelines for technical specifications for pump-turbines (IEC 61366-6)

Part 7: Guidelines for technical specifications for storage pumps (IEC 61366-7)

Parts 2 to 7 are "stand-alone" publications which when used with Part 1 contain guidelines for a specific machine type (i.e. Parts 1 and 4 represent the combined guide for Kaplan and propeller turbines). A summary of the proposed contents for a typical set of Tendering Documents is given in the following table 1 and annex A. Table 1 summarizes the arrangement of each part of this guide and serves as a reference for the various chapters and sections of the Tendering Documents (see 3.2 of this part.)

A bilingual edition of this technical report may be issued at a later date.

Table 1 – Summary of guide for the preparation of Tendering Documents for hydraulic turbines, storage pumps and pump-turbines

CONTENTS OF GUIDE IEC 61366-1 TO IEC 61366-7			SAMPLE TABLE OF CONTENTS OF TENDERING DOCUMENTS (TD) (Example for the Francis turbines; see 61366-1, annex A)	
Part	**Clause**	**Title**	**Chapter**	**Title**
1		General and annexes	1	Tendering requirements
1	–		2	Project information
1	1	Object and scope of this guide	3	General conditions
1	2	Reference documents and definitions	4	Special conditions
1	3	Arrangement of Tendering Documents	5	General requirements
1	4	Guidelines for tendering requirements	6	Technical specifications
1	5	Guidelines for project information	6.1	Technical requirements
1	6	Guidelines for general conditions, special conditions and general requirements	6.1.1	Scope of work
			6.1.2	Limits of the contract
1		Annexes	6.1.3	Supply by Employer
			6.1.4	Design conditions
	A	Sample table of contents of Tendering Documents for Francis turbines	6.1.5	Performance and other guarantees
	B	Comments on factors for evaluation of tenders	6.1.6	Mechanical design criteria
	C	Check list for tender form	6.1.7	Design documentation
	D	Examples of technical data sheets	6.1.8	Materials and construction
	E	Technical performance guarantees	6.1.9	Shop inspection and testing
	F	Example of cavitation pitting guarantees	6.2	Technical specifications for fixed/embedded components
	G	Check list for model test specifications	6.3	Technical specifications for stationary/removable components
	H	Sand erosion considerations	6.4	Technical specifications for guide vane regulating apparatus
			6.5	Technical specifications for rotating parts, bearings and seals
2 to 7		Technical specifications	6.6	Technical specifications for thrust bearings
			6.7	Technical specifications for miscellaneous components
2		Francis turbines	6.8	Technical specifications for auxiliary systems
3		Pelton turbines	6.9	Technical specifications for instrumentation
4		Kaplan and propeller turbines	6.10	Spare parts
5		Tubular turbines	6.11	Model tests
6		Pump-turbines	6.12	Installation and commissioning
7		Storage pumps	6.13	Field acceptance tests

HYDRAULIC TURBINES, STORAGE PUMPS AND PUMP TURBINES – TENDERING DOCUMENTS –

Part 1: General and annexes

0 Introduction

The application of hydraulic machines to a specific project is made from design criteria uniquely adapted to that particular site. Accordingly, the possibility of using identical machines from one site to another is usually remote because of many variations in basic design and operating conditions. For this reason, it is not feasible in a single publication of this type to develop standard documents which cover a wide range of site specific applications or to specify in detail the various machine types. However, the technical report will assist in preparation of Tendering Documents (TD) through the use of a common layout which takes advantage of uniformity and the time-saving features of word processing software. A uniform approach of the type proposed will make it easier for the Employer to prepare the Tendering Documents and for the Tenderer to prepare its proposal.

The report outlines the various chapters needed for a complete set of Tendering Documents, together with comments on the purpose of each and discussions as necessary. The guide is intended to assist in making certain that information is placed in the appropriate section; thereby avoiding possible conflict or duplication. This results in a greater degree of completeness in the documents and adds to their adaptability and ease of updating while minimizing misinterpretations.

The main objective for inviting competitive tenders for hydraulic machines is to purchase the most economical equipment which will meet the performance requirements of the specific site. The capital investment in machinery is a significant one; it can range from 20 % to 50 % of project costs. The value of machine performance becomes an important item of concern in the purchasing process. This guide contains some information on methods of evaluation and means of establishing performance criteria to assist in achieving optimum equipment selection.

In preparing Tendering Documents, cognisance should be taken of problems which may be encountered by unnecessarily restrictive specifications, particularly when applied to machines of small to moderate sizes within the range covered by the guide. Restrictive requirements may add significantly to the cost of the equipment without a proportional gain in its reliability or performance. It is important therefore that Tendering Documents properly define and describe, in an effective manner, the specific conditions of operation, size, number of units to be installed, and special features required, if any.

Tendering Documents which require an inordinate amount of information from Tenderers can also unnecessarily increase the costs for preparing and evaluating tenders. This may also unnecessarily restrict the successful Contractor's freedom to apply an optimal design and may deter the Tenderer from tendering at all. Information requested in the technical data sheets, therefore, should be limited to that which is really essential for evaluation and comparison of tenders by the Employer and engineer.

In conclusion, this guide should not be used to replace the engineering effort needed in the selection, design, manufacturing, installation, and testing of the machines and associated systems; nor does it contain complete detailed specifications and descriptions of conditions or components. It is assumed that qualified engineering personnel will be engaged on the project to undertake the necessary evaluation of site conditions and selection of equipment which will meet the performance, operation, reliability, and maintainability criteria established for the project.

1 Scope and object

This technical report, referred to herein as the "Guide", is intended to assist in the preparation of Tendering Documents and tendering proposals and in the evaluation of tenders for hydraulic machines.

The object of this technical report is to provide a general guide for preparation of Tendering Documents (TD) for the supply, installation and testing of hydraulic turbines, storage pumps, and pump-turbines herein referred to as hydraulic machines as defined in 2.2 of this publication. This technical report considers the case where both equipment supply and site installation are carried out by the same Contractor. In those cases where site installation is not included in the scope of work, the Tendering Documents should include supplementary provisions for site supervisory services to be provided by the equipment supply Contractor and for day-to-day interface with the site installation Contractor.

Hydraulic machines for small units with power less than 5 MW and with runner/impeller diameters less than 3 m are covered in IEC 61116. These limitations are not intended to be absolute and will depend on the type of machine and on other project characteristics.

2 Reference documents and definitions

2.1 Reference documents

2.1.1 Application of reference documents

The adoption of reference documents can greatly assist users of this guide by avoiding unnecessary duplication of standards and codes which have gained industry acceptance. There are a number of sources for reference documents such as IEC, ISO, regional or national standards, and other recognized standards. It is strongly recommended that users take advantage of such standard documents in preference to developing new versions for similar requirements. The Employer should be prepared to provide copies of non-international standards to the Tenderers and/or the Contractors upon request.

2.1.2 IEC publications

IEC publications (in their latest revision), as they apply, should be used and referenced in the preparation of Tendering Documents and the related technical specifications. The list of IEC publications relating to hydraulic machinery is as follows:

IEC 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60041:1992, *Field acceptance tests to determine the hydraulic performance of hydraulic turbines, storage pumps and pump-turbines*

IEC 60617 (all parts), *Graphical symbols for diagrams*

IEC 60193,— *Model acceptance tests to determine the hydraulic performance of hydraulic turbines, storage pumps and pump-turbines (to be published)*

IEC 60308:1970, *International code for testing of speed governing systems for hydraulic turbines*

IEC 60545:1976, *Guide for commissioning, operation and maintenance of hydraulic turbines*

IEC 60609:1978, *Cavitation pitting evaluation in hydraulic turbines, storage pumps, and pump-turbines*

IEC 60609-2:1997, *Cavitation pitting evaluation in hydraulic turbines, storage pumps and pump-turbines – Part 2: Evaluation in Pelton turbines*

IEC 60805:1985, *Guide for commissioning, operation and maintenance of storage pumps and of pump-turbines operating as pumps*

IEC 60994:1991, *Guide for field measurement of vibrations and pulsations in hydraulic machines (turbines, storage pumps and pump-turbines)*

IEC 61362,— *Guide to specification of hydroturbine control systems* [1)]

IEC 61116:1992, *Electromechanical equipment guide for small hydroelectric installations*

IEC 61364:1998, *Nomenclature of hydraulic machinery*

IEC 60034 (all parts), *Rotating electrical machines*

2.1.3 ISO standards

In addition to IEC publications, numerous internationally accepted recommendations have been prepared by ISO, some of which may apply to specific items. If a contradiction is found between IEC standards and ISO standards, the IEC standards shall govern.

2.1.4 National standards

Where no applicable international standards exist, regional and/or national standards should be used in preference to developing unique requirements. In this connection, where equivalence of national standards has been previously established by the Employer, this equivalence should be accepted for subsequent projects.

Where national standards are mandatory by law, such requirements shall be specified in the documents. The Employer should provide copies of mandatory standards to Tenderers and/or Contractors upon request or specify where such standards may be obtained.

2.2 Definitions

The following definitions apply to this guide:

Words for which definitions are given in IEC publications shall be used only with the meanings defined by IEC. No other definitions shall be used for such words.

2.2.1
Employer
party named in the Tendering Documents which will employ the Contractor and the legal successors in title to the Employer but not, except with the consent of the Contractor, any assignee of the Employer. Employer shall also mean purchaser and owner.

2.2.2
Contractor
party whose tender has been accepted by the Employer and includes the Contractor's personal representatives, successors, and permitted assignees. The Contractor shall also mean supplier.

NOTE – The terms Employer and Contractor are in agreement with relative use in FIDIC documents, see 6.1.

2.2.3
guide
this technical report for the preparation of Tendering Documents for hydraulic turbines, storage pumps and pump-turbines

2.2.4
hydraulic machinery
hydraulic impulse or reaction turbines, storage pumps, or pump-turbines

2.2.5
turbine
hydraulic turbine. Its meaning shall also include a pump-turbine operating as a turbine.

2.2.6
pump
pump and it shall also include a pump-turbine operating as a pump

2.2.7
Tendering Documents
complete documents including the tendering requirements, project information, general conditions, special conditions, general requirements, technical specifications and drawings prepared for the purpose of soliciting tenders for hydraulic machines

2.2.8
tendering requirements
instructions to Tenderers, tender proposal form, technical data sheets, and other contractual forms

2.2.9
Tenderer
as the context requires, any party or parties tendering on the various classes of work and services covered by the Tendering Documents

2.2.10
tender
proposal prepared by Tenderer and submitted to the Employer in response to Tendering Documents

2.2.11
contract documents
includes the Employer-Contractor agreement, the Tendering Documents, all addenda issued prior to execution of contract, and all modifications thereto, and any other items specifically stipulated as being included in the contract documents

2.2.12
contract
agreement entered into between the Employer and the Contractor for work to be done and/or material and equipment to be furnished in accordance with the Tendering Documents and the Contractor's tender proposal which will be either referred to in or attached to and form part of said agreement. Contract shall also mean all written information, specifications, and drawings which further detail, explain or modify by mutual agreement the work even though such written information, specifications, and Contractor's and Employer's drawings are issued after execution of said agreement.

2.2.13
work
material, labour, equipment, services, and all the various classes of work to be executed, whether temporary or permanent, under the contract. It also means the place of working where the context so indicates

2.2.14
licensor
owner of intellectual property such as patents, proprietary information, know-how who authorises another party, the licensee, to use said intellectual property

2.2.15
engineer
person, firm, or company appointed and designated by the Employer to act as the engineer for the purposes of the contract

2.2.16
engineer's representative
any engineer or assistant of the engineer appointed from time to time by the Employer or the engineer to perform the duties set forth in the Tendering Documents whose authority shall be notified in writing to the Contractor by the engineer

Terminology for different machine components shall be as defined in the IEC 61364.

2.3 Schematic representation of a hydraulic machine

The limits of a hydraulic machine are represented in figures 1 and 2 in which the terms "high-pressure reference section" and "low-pressure reference section", as well as "high-pressure side" and "low-pressure side" are identified.

The terms "high-pressure reference section" and "low-pressure reference section" define the high-pressure and low-pressure sides of the hydraulic machine irrespective of the flow direction. Therefore, the terms are independent of the mode (turbine or pump) of operation of the machine. The "high-pressure reference section" and "low-pressure reference section" of the machine are those to which hydraulic performance guarantees apply.

Refer to IEC 60041 for other technical terms, definitions, symbols and units.

2.4 Use of SI units

The International system of units (SI) applies to this guide. All terms used in the Tendering Documents should be given in SI units in order to comply with the IEC publications which relate to performance tests of hydraulic machines (either model or prototype).

In the SI system, mass (kg) is one of the base units. The energy per unit mass, known as "*specific hydraulic energy*", is used in this guide as a primary term instead of energy per local unit weight, known as "*head*".

The term "head" has the disadvantage that weight depends on acceleration due to gravity (g) which changes with both latitude and altitude. These changes can influence the absolute measurements of hydraulic performance of a machine and could lead to unnecessary confusion in the interpretation of the final test results. The term "head" differs from the term "specific hydraulic energy" only by the factor "g" which is the local value of acceleration due to gravity. Accordingly, the term "specific hydraulic energy" should be used when specifying performance guarantees and related requirements in the Tendering Documents. The term "head" may remain for some time because it has been in use for many decades. In this guide, the term "specific hydraulic energy" will be followed by the term "head" in parenthesis.

2.5 Specific hydraulic energy

The "specific hydraulic energy of the machine", with the symbol E, is the specific energy of water (J/kg) available between the high and low-pressure reference sections of the machine taking into account the influence of compressibility. For a more definitive definition for practical application, refer to 2.3.6 of IEC 60041.

$$E = \frac{(p_{abs} - p_{abs2})}{\bar{\rho}} + \frac{\left(v_1^2 - v_2^2\right)}{2} + (z_1 - z_2) \times \bar{g}$$

where

p_{abs} is the absolute pressure (Pa)

ρ is the density (kg/m^3)

v is the velocity (m/s)

z is the elevation of point in the system above reference datum (usually mean sea level)

g is the acceleration due to gravity (m/s^2)

$\bar{\rho}$ $0{,}5 \times (\rho_1 + \rho_2)$

$\bar{g}$ $0{,}5 \times (g_1 + g_2)$

The application of "specific hydraulic energy" to a particular project requires care in identifying losses:

E_g is the specific hydraulic energy of the plant which is defined as the specific hydraulic energy of water (J/kg) available between headwater level and tailwater level;

E_L are the specific hydraulic energy losses between any two sections (J/kg);

E is the specific hydraulic energy of the machine (J/kg).

Assume $E_L = E_{L3\text{-}1} + E_{L2\text{-}4}$ (refer to figure 1)

where

$E_{L3\text{-}1}$ is the specific hydraulic energy loss between headwater level (3) and high-pressure reference section (1);

$E_{L2\text{-}4}$ is the specific hydraulic energy loss between the low-pressure reference section (2) and tailwater level (4).

For a turbine: $E = E_g - E_L$ (J/kg)

For a pump: $E = E_g + E_L$ (J/kg)

Derived quantities (also used in previous IEC publications):

H (turbine head) [1] $= E/\bar{g}$ (m)

H_g (plant head) [1] $= E_g/\bar{g}$ (m)

H_L (head losses) [1] $= E_L/\bar{g}$ (m)

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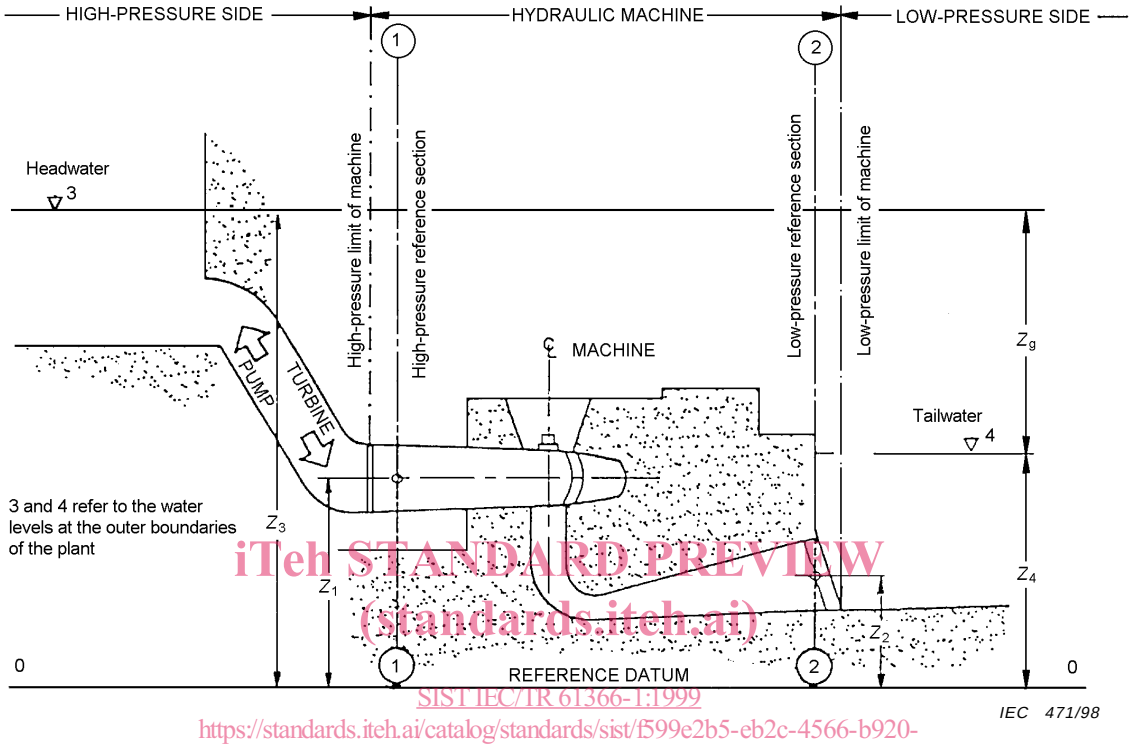
[1] Use of these terms in Tendering Documents should be avoided.

2.6 Specified conditions

This guide uses the term "specified" to describe or denote values of quantities such as power, specific hydraulic energy (head), speed, discharge, etc. which dictate the design conditions for the hydraulic machine. Terms starting with the prefix "rated" (such as rated power, rated specific hydraulic energy, and rated discharge) should no longer be used.



For symbols of this figure, refer to figure 6 of IEC 60041.

Figure 1 – Schematic representation of a hydroelectric plant

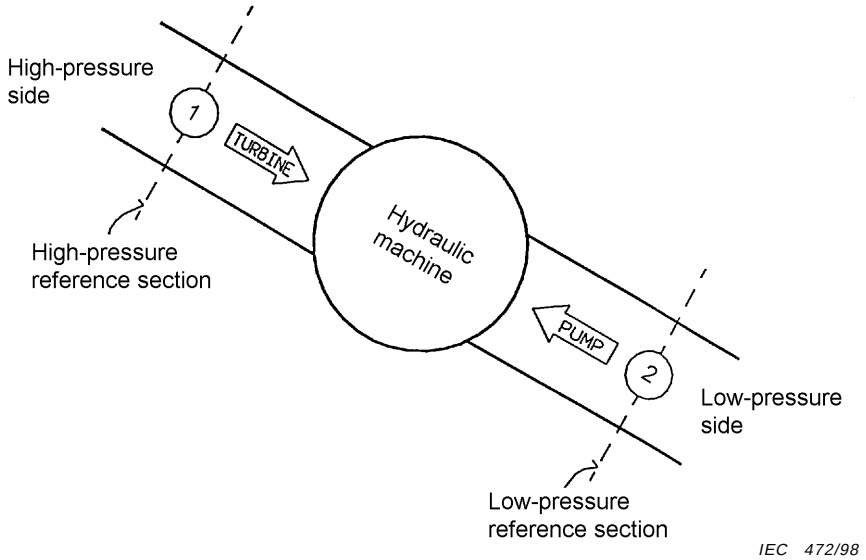


Figure 2 – Schematic representation of a hydraulic machine