TECHNICAL REPORT

IEC 61366-1

First edition
1998-03

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Hydraulic turbines, storage pumps and pump-turbines – Tendering Documents –

Part 1: General and annexes

Turbines hydrauliques, pompes d'accumulation et pompes-turbines –
Documents d'appel d'offres –

Partie 1:
Généralités et annexes

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Consolidated versions of some IEC publications including amendments are available. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

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IEC publications prepared by the same technical committee

The attention of readers is drawn to the end pages of this publication which list the IEC publications issued by the technical committee which has prepared the present publication.

* See web site address on title page.

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TECHNICAL REPORT – TYPE 3

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CONTENTS

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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.

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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.

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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		
Part	**Clause**	**Title**
1		General and annexes
1	–	
1	1	Object and scope of this guide
1	2	Reference documents and definitions
1	3	Arrangement of Tendering Documents
1	4	Guidelines for tendering requirements
1	5	Guidelines for project information
1	6	Guidelines for general conditions, special conditions and general requirements
1		Annexes
	A	Sample table of contents of Tendering Documents for Francis turbines
	B	Comments on factors for evaluation of tenders
	C	Check list for tender form
	D	Examples of technical data sheets
	E	Technical performance guarantees
	F	Example of cavitation pitting guarantees
	G	Check list for model test specifications
	H	Sand erosion considerations
2 to 7		Technical specifications
2		Francis turbines
3		Pelton turbines
4		Kaplan and propeller turbines
5		Tubular turbines
6		Pump-turbines
7		Storage pumps

SAMPLE TABLE OF CONTENTS OF TENDERING DOCUMENTS (TD) (Example for the Francis turbines; see 61366-1, annex A)	
Chapter	**Title**
1	Tendering requirements
2	Project information
3	General conditions
4	Special conditions
5	General requirements
6	Technical specifications
6.1	Technical requirements
6.1.1	Scope of work
6.1.2	Limits of the contract
6.1.3	Supply by Employer
6.1.4	Design conditions
6.1.5	Performance and other guarantees
6.1.6	Mechanical design criteria
6.1.7	Design documentation
6.1.8	Materials and construction
6.1.9	Shop inspection and testing
6.2	Technical specifications for fixed/embedded components
6.3	Technical specifications for stationary/removable components
6.4	Technical specifications for guide vane regulating apparatus
6.5	Technical specifications for rotating parts, bearings and seals
6.6	Technical specifications for thrust bearings
6.7	Technical specifications for miscellaneous components
6.8	Technical specifications for auxiliary systems
6.9	Technical specifications for instrumentation
6.10	Spare parts
6.11	Model tests
6.12	Installation and commissioning
6.13	Field acceptance tests

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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.

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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*

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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

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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.

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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.

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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.

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

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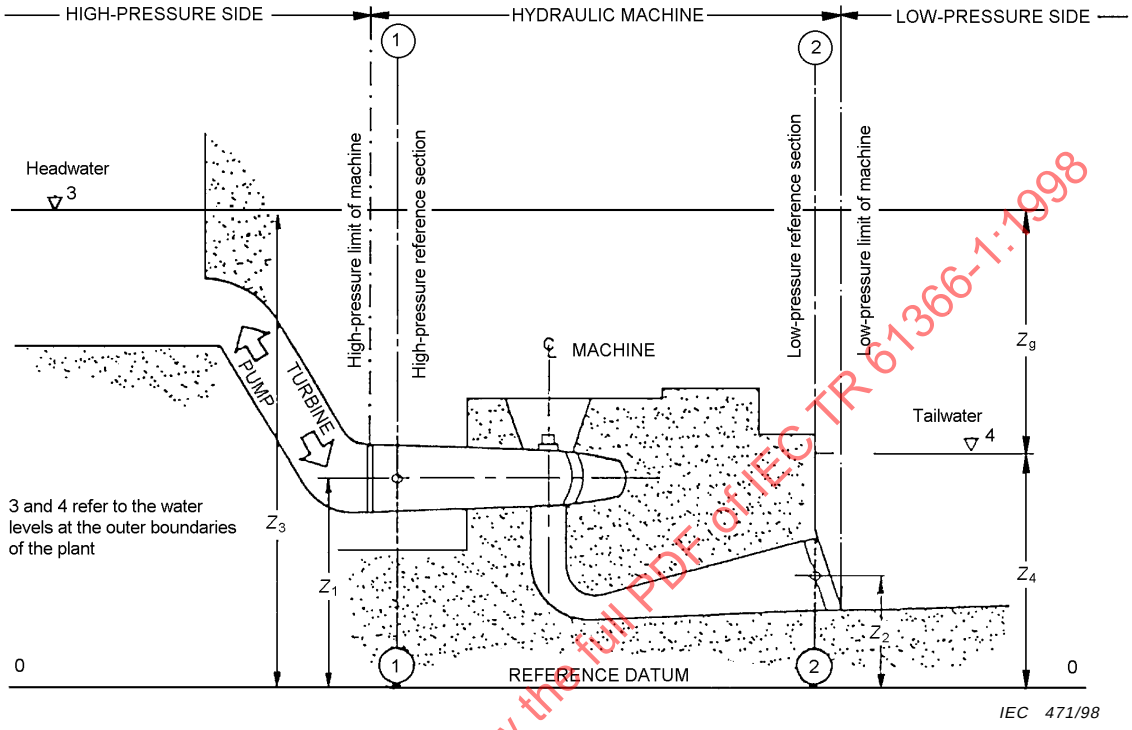
1) Use of these terms in Tendering Documents should be avoided.

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

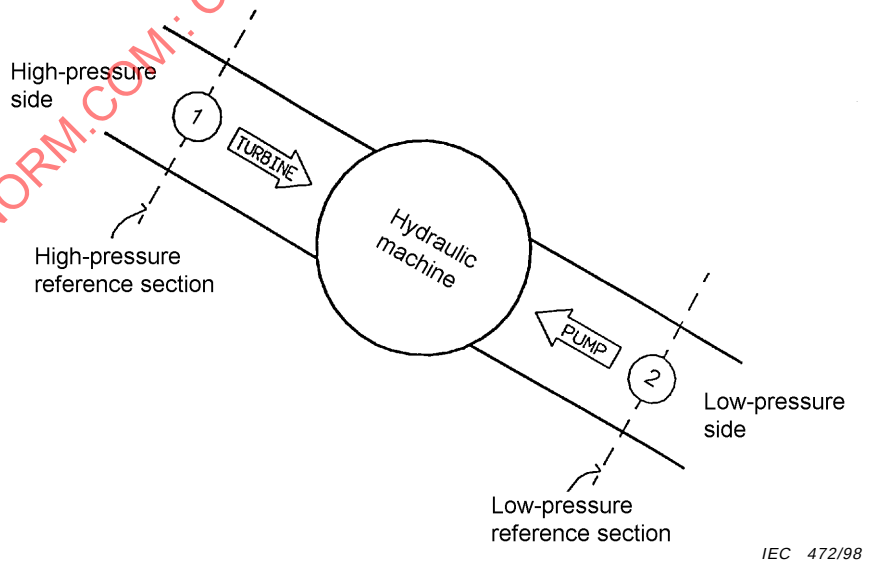


Figure 2 – Schematic representation of a hydraulic machine

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3 Arrangement of Tendering Documents (TD)

3.1 General

It is recommended that the Tendering Documents (TD) used for procurement of hydraulic machinery be prepared in a standard layout. This should reduce the time taken to prepare the documents, ensure that they are presented in an orderly and thorough manner, and avoid confusion in their subsequent interpretation.

3.2 Table of contents

The sample table of contents for Tendering Documents for Francis turbines (annex A) is based on the following arrangement of main chapters:

Chapter	*Title*
1	Tendering requirements (see clause 4)
2	Project information (see clause 5)
3	General conditions (see clause 6)
4	Special conditions (see clause 6)
5	General requirements (see clause 6)
6	Technical specifications for hydraulic machines (see Parts 2-7)
7 [1)]	Technical specifications for hydro-turbine control systems
8 [1)]	Technical specifications for oil pressure systems
9 [1)]	Technical specifications for high-pressure side [shut-off] valves or gates
10 [1)]	Technical specifications for relief valves
11 [1)]	Technical specifications for low-pressure side valves or gates
12 [1)]	Technical specifications for thrust bearings (when not part of hydraulic machine supply)

Tendering Documents (TD) for hydroelectric power equipment procurement, may at the option of the Employer, include related equipment other than hydraulic machinery such as generators or motors; motor-generators; excitation and/or starting systems; control, metering and relaying panels; bus duct equipment; switchgear; power transformers; etc.

The Tendering Documents (TD) should be arranged in chapters, sections, and subsections as follows:

1 Chapter

1.1 Section

1.1.1 Subsection

1.1.1.1 Use only as required

Chapters 2 (Project information), 3 (General conditions), and 5 (General requirements), may be common to all Tendering Documents for machine procurement on a given project. These chapters contain much information which applies specifically to the project, therefore they need to be carefully co-ordinated between the Employer and the engineer.

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Chapter 6 will vary according to the type of hydraulic machine for which the Tendering Documents are being prepared. Guidelines for the preparation of technical specifications for various types of hydraulic machines are provided in (parts 2 to 7 of this guide). There may be occasions, however, when it may be necessary because of the characteristics of the site to have the choice between two different types of machines remain open to Tenderers. This will permit Tenderers to prepare their tenders on the basis of their equipment designs which may offer performance and/or cost advantages for the particular site. In this event, chapter 6 (main tender) and chapter 6-1 (alternative) should be used for the main or alternate machine types, respectively, in which the contents and numbering systems would be similar for uniformity.

When the decision is made to include the full range of equipment and systems for a single unit or units in a combined set of Tendering Documents, additional chapters may be added to the technical specifications as illustrated above (i.e. chapters 7 to 12, inclusive). Guidelines for preparation of technical specifications for equipment and systems other than for hydraulic machines, however, are not given in this guide.

Technical specifications for machines and systems other than hydraulic machines should be prepared using the same or similar headings and numbering systems illustrated for TD chapter 6 in parts 2 to 7 for the various machine types. This will retain continuity throughout the Tendering Documents. In parts 2 to 7 of this technical report, subclause numbering corresponds to subsection numbering of chapters in the Tendering Documents (see annex A).

A detailed sample table of contents for the Tendering Documents prepared in this case for Francis turbines is provided in annex A. This guide follows the sequence of the various chapters and sections in annex A in accordance with the general scheme explained above. The table of contents may have to be modified to accommodate other types of hydraulic machines.

3.3 Main sections of the Tendering Documents

The chapters of the Tendering Documents are briefly described in this clause. Reference is made to other clauses in the guide where more information is given for the main chapters.

3.3.1 **Tendering requirements** (see clause 4)

3.3.1.1 **Instructions to Tenderers** (herein referred to as ITT)

The main purpose of the ITT is to list, explain, and bring to the attention of the Tenderers, those items which specifically apply to the preparation of tenders. The ITT should contain instructions to the Tenderers clarifying the Employer's request for tenders, closing date, submittal of information, options to be considered, and data concerning evaluation of tenders. The Employer should make certain that matters of importance for the administrative validity of the tender are listed in the ITT only and not in the technical specifications.

To avoid confusion, all requirements for preparation of the tenders should be stated only in the ITT and should not be hidden in other chapters of the Tendering Documents.

3.3.1.2 Tender forms

Tender forms are formal documents which are to be completed by the Tenderer. The tender forms include pricing information, formal signatures of the Tenderer, tendering bond (if used), and other related information such as license agreements. See annex C for check list of tender forms.

3.3.1.3 Technical data sheets

Blank data sheets should be prepared by the Employer to show technical information required from each Tenderer. This will ensure that technical and project related information describing the product proposed by Tenderer is in a common tabular format for convenient evaluation of the tenders. An example of technical data sheets is given in annex D.

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3.3.1.4 Tenderer's drawings

Drawings referred to in this section are those which are to be prepared by the Tenderer to illustrate details of the equipment and systems to assist in the Employer's evaluation of the tenders.

3.3.1.5 Other contract forms

These forms, to be completed by the successful Tenderer, include performance bond, form of Agreement, and other forms specified by the Employer.

3.3.2 **Project information** (see clause 5)

This section provides a description of the scope of work, project conditions, scheduling requirements, operating conditions, project drawings, and other project-related information. The location of this section near the beginning of the Tendering Documents serves as an important reference summary of the work.

3.3.3 **General conditions, special conditions, and general requirements** (see clause 6)

3.3.3.1 General conditions

The general conditions are contractual requirements normally established by the Employer to meet corporate or business needs.

3.3.3.2 Special conditions

Special conditions are used to amplify, qualify, or alter the general conditions for the specific Tendering Documents.

3.3.3.3 General requirements

The purpose of general requirements is to consolidate those requirements which are of a general technical nature. Adaptation of these requirements should be possible from one contract to another within the project.

3.3.4 Technical specifications

Technical specifications contain engineering and technical details from which the Tenderers will prepare their tender, and from which the Contractor will design, manufacture, install, and test the machine. The technical specifications, as proposed in this guide, will make it possible to have the Tendering Documents in a convenient form for the purchase of a complete generating/pumping unit or units. Technical specifications for specific machine types are contained in the following parts of the guide:

– Guidelines for technical specifications for Francis turbines (Part 2)
– Guidelines for technical specifications for Pelton turbines (Part 3)
– Guidelines for technical specifications for Kaplan and propeller turbines (Part 4)
– Guidelines for technical specifications for tubular turbines (Part 5)
– Guidelines for technical specifications for pump-turbines (Part 6)
– Guidelines for technical specifications for storage pumps (Part 7)

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4 Guidelines for tendering requirements (TD Chapter 1)

4.1 Instructions to Tenderers (ITT)

4.1.1 Object of tender (1.1.1 of annex A)

The object of tender should contain the following information:

– name of project;

– a one paragraph summary covering scope of work and key contract dates;

– name, address, telephone, telex and FAX numbers of the Employer's representative to be contacted by Tenderers during the tendering period; and

– process (and cost, if any) by which Tenderers may obtain additional copies of the Tendering Documents.

4.1.2 Submission and opening of tenders (1.1.2 of annex A)

This Subsection should include:

– time, date, and location (when, where, and how) tenders shall be submitted. If a “public opening of tender” is planned by the Employer, the time, date and nature of such opening should be defined together with the extent and details of tender information received from Tenderers which will be made available by the Employer to all Tenderers. It is recommended that a minimum tendering period of 12 weeks be provided for preparation of tenders with suitable extension of the tendering period, if addenda containing significant alterations to the Tendering Documents are issued. It is understood that the Employer will not open any tender before stated time and date;

– number of copies of tenders to be submitted;

– title and identification number used for the Employer's reference;

– name and address of the Employer's representative designated to receive the tenders;

– packaging procedure for tender submittal, including number of packages, their contents, signing requirements (each page or not) and appropriate sealing requirements, if any; and

– statement that submission of a tender shall be held in evidence that the Tenderer is aware of all conditions under which the Contractor will be obliged to execute the work.

4.1.3 Tendering documents (1.1.3 of annex A)

This Subsection should list the various chapters (with number of pages) which are included in the Tendering Documents.

– Tender requirements

– Project information

– General conditions

– Special conditions

– General requirements

– Technical specifications (including subsections)

– Drawings (by Employer)

4.1.4 Order of precedence for Tendering Documents (1.1.4 of annex A)

To avoid the possibility of discrepancies between the various chapters comprising the Tendering Documents, the order of precedence should be clearly stated in the instructions to Tenderers according to the Employer’s corporate rules and procedures in the preparation of this technical report, the following has been assumed:

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– special conditions shall take precedence over general conditions;
– technical specifications shall take precedence over general requirements;
– technical specifications shall take precedence over the Employer's drawings.

Similarly, the Employer may elect to specify order of precedence of data contained in the tenders submitted.

4.1.5 **Validity of tender** (1.1.5 of annex A)

The period of time the Employer wishes to have the tenders remain valid after the tender opening date should be clearly stated.

4.1.6 **Clarifications and addenda** (1.1.6 of annex A)

This subsection should include:

– instructions to Tenderers as to procedure to visit the site and for arrangements (if any) for pre-tendering meeting;
– process by which Tenderer may request clarification of
  a) any discrepancy or omission in the Tendering Documents as identified by the Tenderer,
  b) and certain conditions or requirements of the documents.

This may be done at pre-tendering conference and/or by letter.

– Process for issuing addenda on changes to the Tendering Documents.
– Multiple text alterations itemized in a letter can make the Tendering Documents unreadable. Whenever possible, reissue a complete revised page of the documents with revisions clearly identified in the right margin with revision number opposite the revision and the revision issue date on the bottom of the page.
– Statement that all communications shall be in writing; that addenda and question and answer series will be issued as required by the Employer to the Tenderers of record; and that the Employer will not be responsible for oral clarification or communications unless confirmed in writing by the Employer.
– Statement limiting time immediately prior to tender opening when questions will not be accepted (e.g. questions shall be received by the Employer not later than 21 calendar days prior to the tendering opening date).
– Statement by the Employer that clarifications and addenda will not be issued to the Tenderers after a certain time period in calendar days before tender opening date (e.g. 14 calendar days).
– Statement that any extension of the tender opening date will be made by appropriate electronic communication from the Employer not later than a certain period in calendar days before the previously established tender opening date (e.g. 14 calendar days).

4.1.7 **Modification to or withdrawal of tender** (1.1.7 of annex A)

This subsection should state that the Tenderer may modify its tender after submittal or may withdraw its tender at any time before the specified time on the tender opening date.

4.1.8 **Acceptance and rejection of tenders** (1.1.8 of annex A)

This subsection should contain:

– statement that the Employer reserves the right to postpone the project and to not award a contract in which case the tender bonds will be returned promptly to the Tenderers;

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– statement that the tender including tender form, technical data sheets, and all other information that the Employer considers mandatory for evaluating tenders shall be submitted complete in every respect and that failure to fulfil this requirement may result in rejection of the tender because of non-conformance. In this regard, it should be understood that requests for mandatory information should be kept to an absolute minimum and confined to only that needed for evaluation of tenders. Furthermore, the Employer is at liberty after tenders are received to request additional information from one or more Tenderers to aid in the evaluation process.

4.1.9 **Preparation of tender** (1.1.9 of annex A)

This subclause should outline conditions for preparation of the tender:

– statement that the Employer will not be responsible for any costs incurred by the Tenderer in preparation of its tender;

– statement of language and system of units for the contract;

– summary of technical information required with the tender with reference to technical data sheets and drawings;

– statement of the information required by the Employer with the tender or as part of the contract negotiations to illustrate the Tenderer's financial and manufacturing qualifications and experience. (This statement may not be necessary if such information has been provided during pre-qualification of Tenderers.)

4.1.10 **Signature of Tenderer** (1.1.10 of annex A)

This subsection should outline the conditions acceptable to the Employer for the Tenderers to sign the tender form (such as legal authorization).

4.1.11 **Tender prices** (1.1.11 of annex A)

This subsection should include:

– statement of requirements for prices whether firm or subject to price adjustments such as escalation and currency changes. Agreement between the Employer and the Tenderer should be reached on the use of formal published indices including the specific formula on which price adjustments will be calculated. The indices adopted for the contract should be those which are applicable to the country whose currency is specified. Indices should be stated and related to definitive terms (key-dates);

– statement of the currency or currencies to be used for the contract, including the definition of the rate of exchange on the day of payment;

– statement of additional applicable price requirements, such as taxes, customs duties, fees, etc.;

– financial conditions such as cash, export-credit, credit-insurance, etc;

– terms of payment (i.e. progress payments, lump sum payments, or key date payments) which should be referred to the contract schedule.

4.1.12 **Tender bond** (1.1.12 of annex A)

This subsection should outline requirements (if any) for submission by the Tenderer of a tender bond with its tender. If a tender bond is required, its fixed value and validity shall be specified by the Employer (fixed at about 3 % to 6 % of the Employer's estimated value of the contract).

4.1.13 **Design and performance** (1.1.13 of annex A)

This subsection should outline the following.

– The Employer's intention to purchase equipment which will result in the most economical overall project costs considering revenue, capital expenditures, and operation and maintenance expenses.

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– In addition to capital expenditures and performance, the importance of operation and maintenance should be clearly defined (section 2.5 of the Tendering Documents) and any specific requirements noted in the ITT.
– Project-specific requirements which could influence the Tenderer's response to the Tendering Documents; reference should be made to unusual items which need special attention, such as large variations in specific hydraulic energy (head), unusual transient conditions, severe water quality, complex intake or penstock conditions, significant number of cyclic load reversals, and similar items.

4.1.14 **Alternative tenders and deviations from Tendering Documents** (1.1.14 of annex A)

This subsection should contain the following.

– Statement outlining conditions under which alternatives or deviations from the Tendering Documents will be accepted for evaluation, stressing the value of performance, and reliability for such alternatives or deviations. The Tenderer's alternative or deviation proposal shall be accompanied with a full technical description with the advantages claimed.
– Brief description of those items designated as alternatives which the Employer intends to assess during tender evaluation.

4.1.15 **Evaluation of tenders** (1.1.15 of annex A)

The purpose of this subsection is to specify the salient features of the tender which the Employer intends to evaluate. It is important, therefore, to outline the evaluation process as clearly as possible to enable Tenderers to respond in an effective manner. Refer to annex B for comments on the evaluation process. The Employer should request information from the Tenderers which is needed to confirm that the guarantees by competing Tenderers are founded on comparable model and/or field test results.

There are two separate, but interrelated aspects of tender evaluation; one being concerned with information on how evaluation will be made by the Employer and the other with specified requirements for guarantees, performance, and other aspects relating to actual operation of the machines. To make an investment decision with the maximum degree of confidence, the Employer must ensure that the evaluation methods are clearly described in the Tendering Documents.

Examples of items which could be evaluated by the Employer are listed as follows:

– tender price, financing and payment schedule;
– technical evaluation for design, manufacture, operation, maintainability and reliability;
– manufacturing and installation schedule;
– civil construction costs;
– efficiency and energy productions;
– alternative offers;
– technical and manufacturing capabilities of Tenderer;
– quality assurance programme;
– Tenderer's license agreements.

4.1.16 **Letter of acceptance** (1.1.16 of annex A)

This subsection should outline the method and significance of the use of the letter of acceptance combined with a purchase order to notify the successful Tenderer that the Employer intends to award the contract. This letter should contain:

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– reference to Tendering Documents and tender;
– value and method of payment for work authorized by the letter of acceptance such as preliminary engineering, procurement of long delivery materials, and other restrictions, if any;
– items which require resolution before signing the contract and an indication of the time period in which resolution shall be made and the contract signed;
– short-term schedule requirements including delivery dates;
– designated person(s) responsible for handling the Employer's interests under the contract and procedures for handling correspondence and technical information submitted by the Contractor.

4.1.17 **Formal contract** (1.1.17 of annex A)

This subsection should contain the conditions under which a formal contract will be drawn up. It should include:

– list of documents comprising the formal contract together with a statement on the order of precedence;
– reference to the agreement form and other contract forms which may be included in the Tendering Documents;
– contract start date, including the conditions for commencement of contract, should be clearly established in the agreement form;
– time restrictions for completing the formal contract.

4.1.18 **Performance bond** (1.1.18 of annex A)

This subsection should state requirements for a performance bond in the event of a contract being awarded.

4.1.19 **Premium and liquidated damages** (1.1.19 of annex A)

This subsection should state the conditions (if any) in which premium and liquidated damage provisions shall apply, together with their value which could be limited to a specified percentage (10 % to 20 %) of the contract price.

4.2 **Tender form** (1.2 of annex A)

4.2.1 **General**

The tender form, section 1.2 of the Tendering Documents, will contain the price and non-technical information to be completed by the Tenderers. See annex C for tender form checklist.

Receipt of each addendum should be acknowledged by the Tenderers in the tender form.

4.2.2 **Documents constituting the tender** (1.2.2 of annex A)

Provision should be made for a complete list of documents, constituting the tender, to be supplemented by the Tenderer. This list should indicate the Tendering Documents required by the Employer and leave space for Tenderer's own tender proposal documents.

4.2.3 **Deviations from Tendering Documents** (1.2.3 of annex A)

A numbered list of deviations from the Tendering Documents shall be incorporated in the tender form. Reference to the appropriate section(s) of the Tendering Documents and a space to describe the nature of the deviation should also be provided.

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4.2.4 **Tender prices** (1.2.4 of annex A)

For tender prices, a convenient method is to use pay items numbers which are identical to the numbers used in subsections 2.1 and 6.1.1 of Tendering Documents (see sample table, annex A) to define the scope of work (as described in 5.1 of this Part and 3.1 of Part 2).

4.3 **Technical data sheets** (1.3 of annex A)

The technical data sheets should be prepared by the Employer to list and identify technical information to be provided by the Tenderers. The data sheets should be designed to provide a relatively consistent method of presentation of the information required by the Employer for evaluation of tenders. The technical data sheets form an important part of the tender and will become part of the contract. Technical information which is necessary for tender evaluation and contract record purposes should be specified by the Employer. Non-essential information should be avoided. Sample data sheets are provided in annex D.

Users of this guide should recognize the impact of overly detailed requests for data on the costs incurred by Tenderers in submitting such information for evaluation. It is strongly recommended that only data necessary for tender evaluation should be requested by the Employer. Furthermore, the Employer should indicate in the ITT under section 1.3 (TD), the type and extent of additional information which may be requested from selected Tenderers to assist in the evaluation prior to an award of the contract.

4.4 **Tenderer's drawings** (1.4 of annex A)

This section should describe the type and extent of drawings to be prepared by the Tenderer which the Employer requires for evaluation purposes and which are to be submitted by the Tenderer with its tender. Drawings should include general arrangements, cross-sections and plans, typical sketches of major components and sketches of assembling and dismantling procedures.

The number of drawings which accompany the tender should be limited to those providing essential information for evaluation.

4.5 **Other contract forms** (1.5 of annex A)

Section 1.5 (TD) should include other contract forms for such items as performance bond, form of agreement, and other forms required for the contract. These forms will probably be available from the Employer to suit its own business practices.

4.6 **Tenderer's reference list** (1.6 of annex A)

Tenderers should be instructed to provide a complete reference list of contracts previously undertaken for similar equipment with names, contacts, addresses, telephone of Employer and location, size and type of project involved in each case.

5 **Guidelines for project information** (chapter 2 of annex A)

5.1 **Scope of work** (2.1 of annex A)

The scope of work should be a complete list of all items of work and services which will be included in the contract. This list shall be clear and concise dividing the contract items in logical pay items as used in the tender form.

The scope of work should contain an opening paragraph which specifies the various elements for items of work. These elements include (where applicable) design, model testing, supply of materials and labour, fabrication, manufacture, quality assurance, quality control, shop assembly, shop testing, spare parts, transportation and delivery to site, site installation, commissioning, acceptance testing, warranty, training of staff, and other services specified or required for the items of work. The items of work identified by pay item numbers should be summarized using a short description of each item.

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This section should also specify those items of work associated with the contract but provided by the Employer. This could be accomplished by reference to the appropriate clauses in the technical specifications (see Part 2, 3.3).

As explained in clause 1, this guide has been prepared on the basis of a contract which includes both supply and site erection and installation. Tendering Documents in those cases where site erection and installation are not included in the scope of work should include supplementary provision of supervision services to be provided by the supply Contractor and for interface relationships with the erection Contractor.

5.2 **Project description** (2.2 of annex A)

This section should provide a summary of the project in which the following should be described:

– site characteristics: location, method of access, special construction features, description of hydraulic scheme (dams, reservoirs, channels, etc.);

– general technical summary: purpose of the plant and description of electrical system on which it will operate, description of the hydraulic circuit (intake, penstock, surge tank, inlet valve, and tailrace), and description of powerhouse;

– general description of the plant control and extent of automation;

– project drawings prepared by the Employer which show general arrangement of site, access, interrelationship of structures, electrical one line diagrams, and other information necessary to prepare the tender;

– other related technical data, such as temperature, water temperature, seismic conditions, water characteristics, etc.

5.3 **Project and contract schedules** (2.3 of annex A)

The overall project schedule with key dates should be provided so that the Contractor may become fully aware of the design and construction activities which may impact on the contract. Information should also include details concerning the phasing of installation of machines including electrical machines.

Contract schedules for design, manufacture, delivery, installation and testing of the hydraulic machines should be clearly specified in this section to identify schedule activities and key dates for submittal of design data and drawings, for manufacture and delivery, and for all site activities. Requirements for submittal of the Contractor's design, manufacture, delivery and installation schedules should be specified.

5.4 **Delivery point** (2.4 of annex A)

The purpose of this section is to outline the following:

– a concise description of the delivery point for the project to which all material deliveries shall be made;

– the persons, and organization to which deliveries shall be made should be identified; and

– reference should be made to TD section 5.8 of general requirements in which requirements for packaging, shipping, and transportation limits are specified.

5.5 **Operation and maintenance** (2.5 of annex A)

This section should describe the Employer's proposed operation and maintenance data for the project, particularly as they may influence the design of the machinery; for example:

– proposed mode of operation (base load, run-of-river, peaking, etc.);

– local or remote operation and manual or automatic control systems;

– reliability and availability;

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– maintainability, interchangeability, traceability, life cycle requirements, ease of access;
– installation and maintenance limitations such as use of powerhouse crane, or mobile crane;
– characteristics of auxiliary a.c. and d.c. power supply; and
– general safety requirements.

5.6 **Project facilities and information** (2.6 of annex A)

This section should specify the methods, procedures and responsibilities for handling the various temporary construction services required for site installation such as:

– unloading, storage, protection and transportation of Contractor's work at site;
– site access roads;
– powerhouse crane;
– electrical power;
– compressed air;
– potable and service water;
– sanitary facilities;
– first aid and medical facilities;
– fire protection;
– safety requirements;
– ventilation requirements;
– security and guard requirements;
– construction camp accommodation and facilities (if any);
– site office facilities for the Contractor (and the Employer);
– co-operation at site with other Contractors;
– construction permits (if required);
– construction insurance provisions;
– specific local regulations.

5.7 **Project organization** (2.7 of annex A)

This section should outline the proposed organization responsibilities for the project, such as:

– description of the overall project organization for administration, engineering design, and construction;
– procedures for handling contractual items involving changes in the contract price or contract conditions;
– procedures for handling correspondence and communications;
– methods for review and acceptance of the Contractor's and subcontractor's engineering design and drawing production;
– procedures for review and acceptance of the Contractor's and subcontractor's site installation programme and impact with other Contractors at site; and
– description of the conditions under which the Contractor's forces will be engaged at site, including the process of pre-qualification of the Contractor's supervisory staff by the Employer and the level of technical competence of the Contractor's installation crew.

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6 Guidelines for general conditions, special conditions and general requirements

6.1 Guidelines for general conditions

General conditions [1)] are contractual requirements established by the Employer to meet corporate or business needs. They contain definitions, as well as legal, and contractual items prepared for all of the Employer's projects. Accordingly, the general conditions may apply to a full range of contracts for the Employer's projects.

6.2 Guidelines for special conditions

Special conditions are used to amend, amplify, or alter the general conditions to suit the specific contract conditions for each contract. This applies more particularly when standard pre-printed general conditions are included in the Tendering Document. In the event of discrepancies, special conditions shall take precedence over general conditions.

6.3 Guidelines for general requirements

General requirements contain general and technical data which are supplemental to the technical specifications. General requirements are applicable to the full range of mechanical, electrical, hydraulic, civil, and structural work included in the Tendering Documents. Once established by the Employer, general requirements could remain unchanged and should be applicable to other equipment contracts. Site-specific requirements should be included in the technical specifications or in supplemental special requirements to the general requirements. In the event of discrepancies, technical specifications shall take precedence over general requirements.

The general requirements should include the following sections:

– general items;
– technical documents;
– project administration;
– materials and workmanship;
– quality assurance and quality control programmes;
– shop assembly and tests;
– surface preparation and protective coatings;
– packaging, transportation and delivery to site;
– model acceptance tests;
– site installation requirements;
– field acceptance tests.

The purpose of the general requirements is to specify the basic standard technical requirements applicable to the contract. These requirements could be considered as standard for a particular Employer as indicated above and would not vary between projects for that Employer. The general requirements, therefore, similar to general conditions, could become pre-printed standard sections for Tendering Documents issued by the Employer for its equipment contracts.

6.3.1 General items

The general items should contain statements concerning:

– intent of specifications;
– international and national standards;
– statement of language; and
– system of units (International System of Units, SI).

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6.3.2 Technical documents

This subclause should cover requirements for preparation and submittal of documents produced for the contract having respect for the Contractor's intellectual property, such as:

– Employer's drawings and data;
– Contractor's drawings: preparation requirements (e.g. format, size, title block, lettering, line width, drawing standards, etc.);
– Contractor's equipment performance data and guarantees (such as efficiency and discharge curves for the full operating range);
– Contractor's calculations;
– Contractor's specifications;
– Contractor's reports and photographs;
– Contractor's shop and installation schedules;
– Contractor's installation and test procedures;
– Contractor's operating and maintenance manuals; and
– final documentation.

6.3.3 Project administration

The following should be clearly specified:

– project administration general requirements;
– correspondence with the Employer and the engineer;
– design co-ordination progress reporting;
– shop co-ordination progress reporting;
– site co-ordination progress reporting;
– project progress reports and meetings; and
– completion of contract.

6.3.4 Materials and workmanship

This subclause should specify the general requirements for materials and workmanship in the following sequence:

– materials specifications and tests;
– castings;
– forgings;
– plate and structural steel;
– welding process;
– protective coatings;
– mechanical standards – equipment and systems;
– piping standards;
– standards for structural components;
– electrical standards – equipment and systems;
– standards for instrumentation and control devices;
– electrical wiring and hardware;
– interchangeability of components; and
– spare parts.

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6.3.5 Quality assurance (QA) and quality control (QC) programmes

The general requirements of the Contractor's QA and QC programme should be in accordance with ISO 9000 and 9001 or equivalent other standards established by the Employer.

6.3.6 Shop assembly and tests

This subclause should provide general requirements for:

– shop assembly;
– shop functional tests; and
– shop pressure tests.

6.3.7 Surface preparation and protective coatings

Establish a range of coating systems for the project and identify each system by a code number and title. Each system should include:

– surface preparation requirements;
– description of paint and other corrosion protection systems and their use;
– application requirements before shipment and at site;
– number of coats (primer and finish coats);
– film thickness per coat and total; and
– inspection and quality control provisions.

6.3.8 Packaging and transportation

This subclause should define:

– identification and marking of contents of each package or component;
– protection and packing for shipment and storage; and
– transportation and delivery to site;
– transport limitation (size and weight).

6.3.9 Model acceptance tests

This subclause should provide only general and not the specific requirements for the model acceptance tests according to the relevant IEC publications. Refer to annex G and to the relevant sections of this technical report such as clause 13 of Part 2.

6.3.10 Site installation requirements

This subclause should include:

– site installation requirements;
– site installation space allocation;
– special tools and devices for installation;
– site handling limitations;

6.3.11 Field acceptance tests

This subclause should provide general information relating to the commissioning and field acceptance tests.

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Annex A

Sample table of contents for Tendering Documents for Francis turbines

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IECNORM.COM : Click to view the full PDF of IEC TR 61366-1:1998

IECNORM.COM : Click to view the full PDF of IEC TR 61366-1:1998

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Annex B

Comments on factors for evaluation of tenders

As stated in 4.1.15, the Employer shall ensure that the methods proposed for evaluation of tenders are clearly described and presented in the instructions to Tenderers (ITT), (section 1.1 of the Tendering Documents). The following factors and recommendations should be considered by the Employer when establishing the criteria and method(s) for tender evaluation of hydraulic turbines, storage pumps and pump-turbines. Additional relevant factors may have to be considered depending on the type of plant and any special project requirements.

B.1 Tender price and payment schedule

The tender price in conjunction with the payment schedule should be adjusted to a common reference base. Data to be specified by the Employer in ITT include currency base, interest rate, inflation rate and price adjustment formulae.

B.2 Manufacturing and installation schedule

If the start of commercial operation as proposed by the Tenderer is later than the scheduled target date specified by the Employer, an anticipated delay may be penalised for added project costs and for loss of revenue unless the target date is not negotiable. The loss may be determined from the daily fixed construction and administration costs plus daily interest changes during the time of delay, and/or from the cost of daily replacement energy.

For evaluation purposes, the Employer should state in the ITT, an amount for each day of delay in the delivery and/or in the final in-service schedule to be used in the evaluation. Likewise, this procedure may be applied to determine the bonus payable for accelerated start of commercial power production. In this case, however, the earliest possible date should be specified by the Employer taking into account the schedules for other pertinent contracts.

B.3 Civil construction costs

If the design of the machine offered, requires a larger or smaller powerhouse or cavern and/or additional or less excavation than that shown on the Employer's drawings in the Tendering Documents (because of machine setting, maintenance and erection space requirements, access, crane capacity and hook height), the incremental change in civil construction costs may be calculated for evaluation.

To determine the effect of an increase or decrease in the dimensions of the civil structures, the Employer should state appropriate unit prices and/or range of permissible variations of dimensions that may have a major influence on civil engineering and construction costs. Such dimensions may include:

- setting of machine;
- minimum centre distance between units;
- access level;
- minimum maintenance area;
- floor heights, width of passages, and space requirements; and
- draft tube length, depth and exit area.

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If incremental civil costs are to be evaluated, data to be given by the Employer in the ITT should include unit prices for such items as excavation, substructure concrete (volume), powerhouse superstructure (height), etc.

If other costs, such as gate or valve equipment costs are sufficiently significant and change with turbine size, cost parameters should be provided.

B.4 Efficiency and energy production

B.4.1 General

Machine efficiency may have a major influence in the revenue yield of the project. The manner in which the Employer proposes to make the evaluation, therefore, needs to be based on the importance placed by the Employer on the end use of the plant and its intended operation. The significance of efficiency is usually expressed by the price per 0,1 % of incremental energy change (gain or loss) from the variation in machine efficiency guaranteed by the Tenderers. This unit price or value for tender evaluation is established and stated in the ITT by the Employer. It should be recognised that the initial capital cost may be the driving factor in the economic evaluation of the project and that this could have some influence on the efficiency evaluation criteria. The Employer will need to establish data to be specified in the ITT, which are based on his own assessment of the proper balance between maximizing efficiency and reducing initial capital investment. Guaranteed efficiency figures, which are substantiated by the Tenderer, are normally used in the evaluation.

The unit value, which the Employer places on the evaluation of efficiency of hydraulic machines, is determined by calculations of the value of energy produced (absorbed). These calculations use discharge (flow) and specific hydraulic energy (head) characteristics for the plant; planned operation strategy; expected efficiency values, expected revenue or cost of energy during various seasons; expected service life; etc. The calculations can be made in various ways; two different methods are currently in common use:

– *Weighted average efficiency:* The Employer calculates the hydraulic energy production (absorption) and converts the results into a table of weighting factors at specified operating points. This table is provided in the ITT by the Employer, together with the unit value of energy gain or loss the Employer proposes to use for evaluation (refer to B.4.2.1); or

– *Energy production (absorption):* The Employer specifies in the ITT, various data (including the Employer's value of energy gain or loss to be used for evaluation) and preferred methods to be used by Tenderers to calculate energy production (from power produced by the turbine or absorbed by the pump) using the Tenderer's expected performance curves of the proposed hydraulic machine (refer to B.4.2.2).

The Employer should select one of these methods which best suits the conditions under which the proposed plant will operate.

Efficiency of gear units, generators, transformers, etc. can be neglected, unless they are part of the Tendering Documents.

B.4.2 Power stations

B.4.2.1 Reservoir and pondage power stations

For this type of project, tender evaluation criteria is typically based on guaranteed weighted average efficiency of the hydraulic machine. A list (or matrix table for multiple specific hydraulic energies (heads), discharges and/or load cases of the machine) of efficiency weighting factors for absolute figures at selected specific hydraulic energies (heads) and power/discharge should be calculated and specified by the Employer from daily or annual load patterns and reservoir operating curves for operation at specified specific energies (heads) and discharge. Weighting factors for each load case should be proportional to energy production at that load case.

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The weighted average efficiency formula with weighting factors developed by the Employer should be provided in the ITT for calculation of the efficiency guarantee by Tenderers in the following form:

$$\eta_w = \frac{w\eta_1 + w_2\eta_2 \ldots + w_n\eta_n}{w_1 + w_2 \ldots w_n\eta_n}$$

where

η_w = weighted average efficiency;

$\eta_1, \eta_2 \ldots \eta_n$ = hydraulic machine efficiency at specified operating conditions;

$w_1, w_2 \ldots w_n$ = weighting factors.

For evaluation purposes, with each 0,1 % deviation of the weighted average efficiency from a given base (such as an assumed base efficiency of 90 % or the average of guaranteed weighted efficiency of the tenders received), the tender price should be increased/decreased by the unit price or value of energy specified in the ITT by the Employer. The unit value of energy should have a reasonable relationship to the energy loss/gain and the subsequent revenue decrease/increase over the assumed financial service life of the hydraulic machine (see note).

NOTE – For tender evaluation purposes, the Employer may elect to discount the unit value of energy to avoid effects of excessively high weighted efficiency guarantees in the tenders; e.g. use 50 % of the value specified for 0,1 % in liquidated damages for non-compliance of machine performance.

Data which should be specified in the ITT are as follows:

- table of efficiency weighting factors versus specific hydraulic energy (head) and power or discharge;
- price adjustment for each 0,1 % deviation of the weighted average efficiency from a specified base or from the average of the guaranteed weighted average efficiency of the tenders received;
- Financial service life of the machines for evaluation purposes.

B.4.2.2 Run-of-river power stations

B.4.2.2.1 General

For this type of station, it is recommended that annual energy calculations be used for evaluation of machine performance and that the Tenderer calculate such production from data and methodology provided by the Employer in the ITT. To make certain that the calculations are consistent between Tenderers, the Employer should issue PC computer programme discs as part of the ITT in which the discharge (flow), water levels, specific hydraulic energy (head), energy value and other data with calculation methodology are provided for the Tenderer's use to be returned with its tender. Annual energy production may be calculated from discharge (flow), specific hydraulic energy (head) and tailwater data in conjunction with the turbine efficiency and specified operating criteria. If duration curves for dry, average, and wet years and their frequency or for summer and winter seasons are available, the respective annual yields can be weighted (in accordance with their frequency) and a mean annual energy production computed. Data for evaluation which should be provided in the ITT are as follows:

- discharge (flow), headwater level and tailwater level data;
- energy value per kWh; and
- financial service life of the machines for evaluation purposes.

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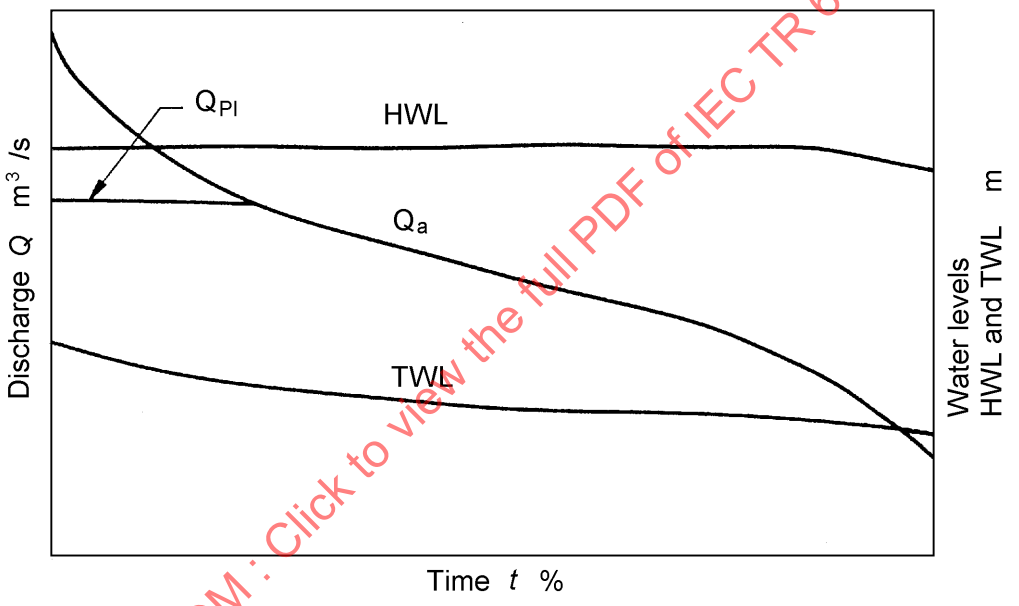
B.4.2.2.2 Flow duration characteristics

The discharge (flow) duration characteristics may be specified by the Employer in two basic forms:

a) in table form or by PC disc (preferred): The table or computer disc should present the following data as a function of the period of time expressed in either number of hours (h) or of days (d):
   - available discharge (m^3/s);
   - maximum plant discharge (see note 2) (m^3/s);
   - headwater level (m);
   - tailwater level (m);
   - plant specific hydraulic energy (plant head) (see note 1) (J/kg); (m);

or

b) in graphical form:



IEC 473/98

t is the percentage of time
HWL is the headwater level
Q_a is the available discharge
TWL is the tailwater level
Q_{Pl} is the maximum plant discharge (see note 2)

NOTE 1 – Plant specific hydraulic energy (head) is defined in 2.5 of this report.

NOTE 2 – Q_{Pl} represents maximum discharge to be absorbed by all machines.

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B.4.2.2.3 Calculation of annual energy production

For calculations of annual energy production, the Employer, in addition to flow duration characteristics, should provide:

- elevation above sea level (m);
- latitude (degree);
- water temperature (°C);
- generator efficiency (%);
- transformer efficiency (%);
- maximum generator power (kW) or maximum turbine power (kW);
- specific hydraulic energy (head) loss coefficients (see note below) from headwater level to high-pressure reference section and specific hydraulic energy (head) loss coefficients (see note below) from low-pressure reference section to tailwater level:
  - corresponding to total plant discharge (J/kg); (m);
  - corresponding to discharge of one unit (J/kg); (m).

NOTE – These coefficients may be defined through the formula: $E_L = k_L \times Q^2$.

Information on the following data, which each Tenderer could submit with its tender, may assist the Employer's understanding of the Tenderer's calculations of annual energy production:

- number of units in operation;
- unit discharge (m^3/s);
- maximum plant discharge (m^3/s);
- specific hydraulic energy (head) of plant (J/kg); (m);
- specific hydraulic energy (head) of machine (J/kg); (m);
- turbine efficiency (%);
- turbine power (kW);
- turbine energy (kWh);
- gear box efficiency (if applicable) (%);
  and, if part of the Tendering Documents:
- generator efficiency (%);
- generator power (kW);
- generator energy (kWh);
- transformer efficiency (%);
- bus bar power (kW);
- bus bar energy (daily, weekly or monthly) (kWh).

The value of average daily, weekly or monthly energy production is added to determine the total average annual production.

B.4.3 Pump storage plants

The efficiencies for pumped storage stations should be evaluated in a manner similar to that described in B.4.2.1 of this annex. For the case of pump-turbine applications, the evaluation is usually different for the two modes of operation. The Employer should state means (i.e. weighting formula) for evaluating weighted efficiency in turbine and pump modes.

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B.5 Substantiation of guaranteed efficiency or energy production

Previous experience and responsiveness of the tender to the Tendering Documents should be taken into account when reviewing the Tenderer's substantiation of guaranteed efficiency or guaranteed energy production submitted with its tender for use in the tender evaluation process. Relevant items which may be considered in this review are:

- availability of model acceptance test results from similar projects;
- availability of field test results from similar prototypes;
- uncertainties of efficiency measurements from similar models or prototypes in conformity with relevant IEC publications.

B.6 Other evaluation factors

Evaluation of tenders may take other factors into consideration in addition to those mentioned in clauses B.3 and B.4, such as:

- operating data and restrictions imposed;
- maximum and minimum permissible power;
- cavitation guarantee;
- proposed technical and performance deviations;
- technical experience of Tenderer in design, quality control, fabrication and workmanship for the range of hydraulic machine specified (Tenderer should be required to provide references with tender);
- quality of design offered;
- material proposed for major components;
- reliability;
- control system;
- runaway speed;
- waterhammer calculations (if specified);
- flywheel effect (if critical);
- crane capacity;
- energy consumption of auxiliaries;
- location of manufacture (i.e. local content which can effect local economy);
- project financing available by the Tenderer.

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B.7 Assessment

With above criteria, an economic appraisal can be made, and the direct investment costs, revenues, cost/benefit ratio, and other assessment factors can be computed. Care should be exercised in the manner in which values (or costs) are specified in the Tendering Documents so that Tenderers know exactly how their tenders will be evaluated. Without such care, an accurate investment appraisal (or evaluation of tenders) may be misleading or difficult to make. It is assumed that when an investment appraisal is made, it will be done taking into account the total capital expenditures, operating and maintenance expenses for the project, and revenues from the project.

Annex C

Checklist for tender form

- Name of the Employer
- Name of project
- Reference number and title of Tendering Documents
- Space for Tenderer's name and address
- Declaration that the Tenderer has examined the Tendering Documents and received addenda (by number) and agrees to enter into a formal contract if its tender is accepted
- Itemised contract price schedule using payment items established in subsection 6.1.1
- Itemised price adjustments for changes to contract for such items as draft tube liner, pit liner, main shaft, etc.
- Tenderer's proposed schedule for design (drawings), model acceptance tests (if any), operation and maintenance manual, manufacturing and delivery, site installation, commissioning and field acceptance tests
- Tenderer's field storage, electrical and compressed air requirements for installation and testing
- Summary of Tenderer's previous experience
- List of attachments to tender such as technical data sheets, performance guarantee data and Tenderer's drawings, schedules and other data
- Tenderer's exceptions (if any) to Tendering Documents
- List of Tenderer's proposed subcontractors and subsuppliers
- Statement as to time limitations for validity of tender (e.g. 90 days from tender opening date)
- Tenderer's name, authorized signature and seal (if necessary)

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Annex D

Example for technical data sheets

(Refer to 4.3)

The following shows an example for a plant with single stage pump-turbines.

D.1 General

D.1.1 Legend for classification of data (indicated in the last column)

g to be guaranteed
b binding (can be modified only by mutual agreement and has to be early identified, without guarantee)
i for information

D.1.2 Data supplied by

E Employer
T Tenderer

D.2	**Project name: *Environment-friendly pump-hydro project***	
D.3	**Type of machine: *Pump-turbine, Francis type, vertical, regulated***	b, E
D.4	**Number of units** **Two**	b, E

D.5	**Specified data**				
D.5.1	**Turbine operation**				
D.5.1.1	Specified specific hydraulic energy (E)		2 353,4	J/kg	b, E
	(Specified head H)		(240,0	m)	
D.5.1.2	Specified power (P)		41,5	MW	b, E
D.5.1.3	Discharge[1] (Q)		19,7	m^3/s	i, T
D.5.1.4	Specified rotational speed (n)		10	/s	b, E[2]
			(600	rpm)	
D.5.2	**Pump operation**				
D.5.2.1	Specified specific hydraulic energy (E)		2 451,5	J/kg	b, E
	(Specified head H)		(250,0	m)	
D.5.2.2	Power (P)		43,9	MW	i, T
D.5.2.3	Specified discharge (Q)		16,4	m^3/s	b, E
D.5.2.4	Specified rotational speed (n)	(600 rpm)	10	/s	b, E[2]
D.5.3	**Power limitations**				
D.5.3.1	Turbine operation		44,0	MW	b, E
D.5.3.2	Pump operation		47,0	MW	b, E
D.5.4	**Frequency variations**				
D.5.4.1	Turbine operation		49,5 to 50,1	Hz	b, E
D.5.4.2	Pump operation		49,9 to 50,5	Hz	b, E

[1] In other examples discharge could be specified and power given as information only.
[2] Rotational speed may also be defined by Tenderer

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D.6	**Plant data**			
D.6.1	**Head water level z_3 (above mean sea level)**			
D.6.1.1	maximum	327,00	m	b, E
D.6.1.2	average	315,20	m	b, E
D.6.1.3	minimum	310,00	m	b, E
D.6.2	**Tailwater level z_4 (above mean sea level)**			
D.6.2.1	maximum	73,00	m	b, E
D.6.2.2	average	64,80	m	b, E
D.6.2.3	minimum	56,00	m	b, E
D.6.3	**Specific hydraulic energy loss (head loss)**			
D.6.3.1	High-pressure side			
	2 turbines $E_{L_{3\text{-}1}} = 0{,}301 \times Q^2$ [J/kg]			b, E
	1 turbine $E_{L_{3\text{-}1}} = 0{,}190 \times Q^2$ [J/kg]			b, E
	2 pumps $E_{L_{1\text{-}3}} = 0{,}304 \times Q^2$ [J/kg]			b, E
	1 pump $E_{L_{1\text{-}3}} = 0{,}177 \times Q^2$ [J/kg]			b, E
	Q = discharge of one unit (m^3/s)			
D.6.3.2	Low-pressure side			
	2 turbines $E_{L_{2\text{-}4}} = 0$ [J/kg]			b, E
	1 turbine $E_{L_{2\text{-}4}} = 0$ [J/kg]			b, E
	2 pumps $E_{L_{4\text{-}2}} = 0$ [J/kg]			b, E
	1 pump $E_{L_{4\text{-}2}} = 0$ [J/kg]			b, E
D.6.4	**Design elevations for the plant**			
D.6.4.1	Setting of distributor centreline above mean sea level (i.e. reference level)			
	For preliminary layout purposes (approximation)	32,00	m	i, E
	Recommended setting level (reference level)	33,00	m	b, T
D.6.4.2	Lowest point of draft tube above mean sea level	28,00	m	b, T
D.6.5	Acceleration due to gravity g	9,806	m/s^2	b, E
	Latitude of plant	North 45°		b, E
D.6.6	Temperature of water – maximum / average / minimum	28 / 18,5 / 6	°C	b, E
D.6.7	Properties of water – chemical, silt,...	.....	.....	b, E
D.6.8	Temperature of air – maximum / average / minimum	30 / 19 /2	°C	b, E
D.6.9	Humidity (relative) – maximum / average / minimum	95 / 80 / 70	%	b, E
D.6.10	Seismic conditions	$1{,}0 \times g$	m/s^2	b, E

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D.7 Operation characteristics

D.7.1 Turbine operation (prototype)

Number of units operating		One	Two	One	Two	
E_g	J/kg	2 657,4	2 657,4		2 324,0	b, E
H_g	m	271,0	271,0		237,0	
E	J/kg	2 600,5	2 564,2	2 353,4[3)]	2 209,5	b, T
H	m	265,2	261,5	240,0	225,3	
Q	m^3/s	17,3	17,6	19,7	19,5	i, T
$P_{100\ \%}$[1)]	MW	41,5	41,5	41,5[3)]	38,3	g, T
$P_{overload}$[2)]	MW	44,0	43,8	41,5	38,3	i, T
$\eta_{P,overload}$	%	91,9	91,5	–	–	i, T
η_P = 100 %	%	92,3	92,0	89,5	88,9	g, T
η_P = 90 %	%	95,5	92,2	90,8	90,6	g, T
η_P = 50 %	%	85,8	85,6	84,7	82,1	i, T

1) $P_{100\ \%}$ = specified power
2) $P_{overload}$ = admissible overload
3) Refer to D.5 for specified data

D.7.2 Pump operation (prototype)

Number of units operating		Two	One	One	One	
E_g	J/kg	2 657,4	2 657,4		2 324,0	b, E
H_g	m	271,0	271,0		237,0	
E	J/kg	2 708,8	2 688,2	2 451,5[1)]	2 377,0	b, T
H	m	276,2	274,1	250,0	242,4	
Q	m^3/s	13,0	13,2	16,4[1)]	17,3	g, T
P	MW	39,2	39,4	43,9	44,9	g, T
η	%	89,8	90,0	91,6	91,6	g, T

1) Refer to D.5 for specified data.
2) These two tables may also contain weighting factors for efficiency values.
3) Efficiency values may also be given or guaranteed for the model.

D.7.3 Pump zero-discharge (shut-off)

D.7.3.1 Specific hydraulic energy

– maximum value	3 400	J/kg	g, T
– guide vanes closed	3 180	J/kg	g, T

D.7.3.2 Power, guide vanes closed

12 MW g, T

D.7.4 Synchronous condenser operation

D.7.4.1 Water depression air volume at ambient pressure (p = 1 bar)	16	m^3	b, T
D.7.4.2 Absorbed power in turbine direction	0,5	MW	g, T
D.7.4.3 Absorbed power in pump direction	0,5	MW	g, T

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D.7.5	Cavitation pitting (after 3 000 h of operation) NOTE – Refer to IEC 60609.	1,5	kg	g, T
D.7.6	**Hydraulic axial thrust**			
	– maximum downward	100	kN	g, T
	– maximum upward	200	kN	g, T
D.7.7	**Pressure fluctuations (percent of specified specific energy)**			
D.7.7.1	**Turbine operation**			
	– spiral case inlet	±2	%	i, T
	– draft tube cone (after runner)	±6	%	i, T
	– draft tube outlet	±3	%	i, T
D.7.7.2	**Pump operation – normal range**			
	– spiral case outlet	±6	%	i, T
	– draft tube inlet	±2	%	i, T
D.7.7.3	**Pump operation – zero discharge**			
	– spiral case outlet	±20	%	i, T
D.7.8	**Vibration (normal operation)**			
	– radial vibration of the shaft referred to bearing (p-p)	160	µm	i, T
	– radial bearing vibration (p-p)	80	µm	i, T
D.7.9	**Noise (to be mutually agreed, refer to Part 2, 3.4.7)**			

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D.8	**Transient behaviour**				
D.8.1	**Spherical valve**				
	– opening time		30	s	b, T
	– closing time		30	s	b, T
D.8.2	**Guide vanes**				
	– opening time		30	s	b, T
	– closing time		30	s	b,T
D.8.3	**Moment of inertia**				
	– generator		85	$t \times m^2$	b, E
	– pump-turbine		15	$t \times m^2$	b, T
D.8.4	**Maximum/minimum momentary pressure**				
D.8.4.1	**Turbine operation (worst case)**				
	– number of turbines operating		two		
	– E_{max}		2 564,2	J/kg	
	– $P_{overload}$		43,8	MW	
	– maximum momentary pressure (spiral case)		3,55	MPa	g, T
D.8.4.2	**Pump operation (worst case)**				
	– number of pumps operating		one		
	– E_{min}		2 377,0	J/kg	
	– minimum pressure (spiral case)		1,65	MPa	g, T
D.8.5	**Maximum momentary overspeed/reverse speed**				
D.8.5.1	**Turbine operation (worst case)**				
	– number of turbines operating		two		
	– E_{max}		2 564,2	J/kg	
	– $P_{overload}$		43,8	MW	
	– maximum momentary overspeed	(850 rpm)	14,17	/s	g, T
D.8.5.2	**Pump operation (worst case)**				
	– number of pumps operating		one		
	– E_{min}		2 377,0	J/kg	
	– maximum momentary reverse speed	(100 rpm)	1,67	/s	g, T
D.8.6	Maximum steady-state runaway speed				
	Turbine operation				
	– number of turbines operating		one		
	– E_g		2 657,4	J/kg	
	– maximum guide vane opening				
	– maximum steady-state runaway speed	(872 rpm)	13,7	/s	

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D.8.7	**Change-over times** Starting method(s) to pump mode – in air with static frequency converter			b, E
D.8.7.1	Standstill – pump	300	s	b, T
D.8.7.2	Standstill – turbine full load	80	s	b, T
D.8.7.3	Pump direct to turbine full load (emergency)	80	s	b, T
D.8.7.4	Pump – standstill	80	s	b, T
D.8.7.5	Turbine full load – standstill	420	s	b, T
D.8.7.6	Standstill – synchronous condenser operation, pump direction (SCP)	110	s	b, T
D.8.7.7	SCP – pump	190	s	b, T
D.8.7.8	Pump – SCP	100	s	b, T
D.8.7.9	SCP – standstill	600	s	b, T
D.8.7.10	Turbine full load – synchronous condenser operation, turbine direction (SCT)	100	s	b, T
D.8.7.11	SCT – turbine full load	170	s	b, T
D.8.7.12	SCT – standstill	600	s	b, T

D.9	**Model tests**			
D.9.1	**Pump-turbine model**			
	– reference diameter D of model runner	230	mm	i, T
	– diameter D_1 (at high-pressure side of model runner)	400	mm	b, T
D.9.2	**Test conditions**			
	– test speed in pump mode (n)	26,67 (1 600	/S rpm)	b, T
	– test specific hydraulic energy in turbine mode (E)	800	J/kg	b, T
D.9.3	**Scale effects**			
	Scale-up conforming to IEC 60193			
	– turbine mode	$\Delta\eta =$ 2,2	%	b, E
	– pump mode	$\Delta\eta =$ 1,7	%	b, T
D.9.4	**Measurement uncertainties**			
	– specific hydraulic energy	±0,1	%	b, T
	– discharge	±0,3	%	b, T
	– torque	±0,2	%	b, T
	– speed	±0,1	%	b, T

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D.10	**Component/system details**			
D.10.1	**Runner**			
D.10.1.1	Material		13Cr+4Ni st. st.[1)]	b, T
D.10.1.2	Maximum stress		350 MPa	b, T
D.10.1.3	Reference diameter *D*		1 400 mm	i, T
D.10.1.4	Diameter D_1		2 300 mm	i, T
D.10.1.5	Maximum outer diameter		2 360 mm	i, T
D.10.1.6	Runner inlet height (turbine)		230 mm	i, T
D.10.1.7	Total height		1 000 mm	i, T
D.10.1.8	Number of blades		seven	b, T
D.10.1.9	Weight		6 t	i, T
D.10.2	**Main shaft**			
D.10.2.1	Material		CK35N	b, T
D.10.2.2	Maximum stress (τ)		40 MPa	b, T
D.10.2.3	Shaft diameter		600 mm	b, T
D.10.2.4	Internal bore diameter		150 mm	b, T
D.10.2.5	Length		4 000 mm	b, T
D.10.2.6	Flange diameter		1 000 mm	b, T
D.10.2.7	Weight		12 t	i, T
D.10.2.8	Critical speed	(950 rpm)	15,83 /s	b, T
D.10.3	**Main shaft seal**			
D.10.3.1	Type		Gland	b, T
D.10.3.2	Material		Teflon	b, T
D.10.3.3	Cooling water flow rate		(50 l/min)[2)]	i, T
D.10.3.4	Cooling water pressure		0,2 MPa	b, T
D.10.4	**Labyrinth seal**			
D.10.4.1	Rotating seal ring material		13Cr + 4Ni st.st.[1)]	b, T
D.10.4.2	Rotating seal ring material hardness		250-290 Hb	b, T
D.10.4.3	Stationary seal ring material		Bronze	b, T
D.10.4.4	Stationary seal ring material hardness		170-200 Hb	b, T
D.10.4.5	Seal ring cooling water flow rate with runner rotating in air		400 l/min[2)]	i, T
D.10.4.6	Pressure of cooling water		0,2 MPa	b, T
D.10.5	**Guide bearing**			
D.10.5.1	Type		Shell	b, T
D.10.5.2	Material		Babbitt	b, T
D.10.5.3	Guide bearing diameter		640 mm	i, T
D.10.5.4	Running clearance		0,5 mm	i, T
D.10.5.5	Distance from reference level to guide bearing centreline		930 mm	i, T
D.10.5.6	Oil quality		ISO VG 68	i, T
D.10.5.7	Oil volume in bearing		2 m^3	i, T
D.10.5.8	Dissipated energy (normal operation)		40 kJ	i, T
D.10.5.9	Maximum bearing temperature		65 °C	b, T

[1)] st. st = stainless steel

[2)] 1 l = 10^{-3} m^3

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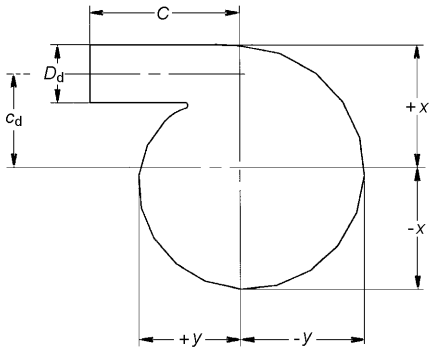
D.10.6	**Spiral case**		
D.10.6.1	Construction	welded	b, T
D.10.6.2	Material	StE 355	b, T
D.10.6.3	Standards applied to stress calculations	ASME Sect. VIII	b, T
D.10.6.4	**Spiral case main dimensions**		
	– diameter of spiral case at high-pressure side limit D_d	1 400 mm	b, T
	– distance from unit centreline to high-pressure side limit C	3 000 mm	b, T
	– distance from unit centreline to centreline of spiral case c_d	400 mm	b, T
			
		+ x 3 100 mm	b, T
		– x 2 700 mm	b, T
		+ y 2 400 mm	b, T
		– y 2 900 mm	b, T
D.10.6.5	**Plate thickness**		
	– inlet (maximum)	50 mm	b, T
	– nose (minimum)	20 mm	b, T
D.10.6.6	Weight	12 t	i, T
D.10.6.7	Design pressure	3,95 MPa	b, T
D.10.6.8	Test pressure	5,93 MPa	b, T
D.10.7	**Stay ring**		
D.10.7.1	Construction	welded	b, T
D.10.7.2	Material	StE 355	b, T
D.10.7.3	Maximum stress	σ < 100 MPa	b, T
D.10.7.4	Maximum diameter	3 900 mm	b, T
D.10.7.5	Inner diameter	2 920 mm	i, T
D.10.7.6	Height	1 300 mm	i, T
D.10.7.7	Number of stay vanes	twenty	b, T
D.10.7.8	Number of sections	one	i, T
D.10.7.9	Weight per section	14 t	i, T
D.10.7.10	Design pressure	3,95 MPa	b, T
D.10.7.11	Test pressure	5,93 MPa	b, T

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