TECHNICAL REPORT

IEC TR 61364

First edition
1999-07

Nomenclature for hydroelectric powerplant machinery

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

NOMENCLATURE FOR HYDROELECTRIC POWERPLANT MACHINERY

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 specifications, 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 technical report 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. However, a technical committee may propose the publication of a technical report when it 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 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful by the maintenance team.

IEC 61364, which is a technical report, has been prepared by IEC technical committee 4: Hydraulic turbines.

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

Enquiry draft	Report on voting
4/112/CDV	4/123/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.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

This document which is purely informative is not to be regarded as an International Standard.

The contents of the corrigendum of August 2000 have been included in this copy.

NOMENCLATURE FOR HYDROELECTRIC POWERPLANT MACHINERY

1 Scope and object

This technical report provides a basic nomenclature for hydraulic machinery used in hydroelectric power stations and defines their components.

The object of the report is to:

- standardize the names of components by giving a preferred name where more than one exists;
- define components diagrammatically to facilitate their identification;
- aid in translation of component names from one language to another.

1.1 Reference documents

IEC 60041: 1991, Field acceptance tests to determine the hydraulic performance of hydraulic turbines, storage pumps and pump-turbines.

IEC 60193: 1999, Hydraulic turbines, storage pumps and pump-turbines – Model acceptance tests

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

2 Languages

The following International Electrotechnical Vocabulary (IEV) languages are used in Clause 6:

English	(Principal IEV language)
French	(Principal IEV language)
Russian	(Principal IEV language)
German	(Additional IEV language)
Italian	(Additional IEV language)
Spanish	(Additional IEV language)

Any further translation into other languages may be done by the National Committees concerned.

3 General Principles

3.1 Definitions of hydraulic and electrical machines

3.1.1 The term "hydraulic machinery" refers to turbines, storage pumps, pump-turbines, valves, guide and thrust bearings used in hydroelectric power and pumped storage stations. Terms related to hydro turbine control systems are not included; refer to IEC 60308.

3.1.2 The term "hydraulic machine" refers only to hydraulic impulse and reaction turbines, storage pumps and pump-turbines.

3.1.3 The term "turbine" includes a pump-turbine functioning as a turbine and the term "pump" includes a pump-turbine functioning as a pump.

3.1.4 The terms "generator" and "motor-generator" include synchronous and asynchronous electrical machines.

3.2 Commentary on the presentation of the technical report

3.2.1 Whenever possible, names and terms have been defined by reference to simple figures assisted by brief written descriptions.

3.2.2 Machine definitions are not intended to be exhaustive descriptions, but are sufficient to distinguish each type of hydraulic machine.

3.2.3 Component parts of hydraulic machines often have several possible names in common use. In these cases, one term has been selected as the preferred name and others are listed in curved ( ) parentheses. In general, the preferred term is the most widely used one, therefore its use is recommended.

3.2.4 In some cases, the equivalent component for turbines and pumps is named differently. The term for pump is shown in square [ ] parentheses.

3.2.5 Reference data, main dimensions, some standard and dimensionless terms describing the principal hydraulic conditions of a hydraulic machine are listed in clauses 7, 8 and 9. For definitions and more details on quantities and parameters, refer to the relevant IEC publications.

3.3 Schematic representation of a hydroelectric plant

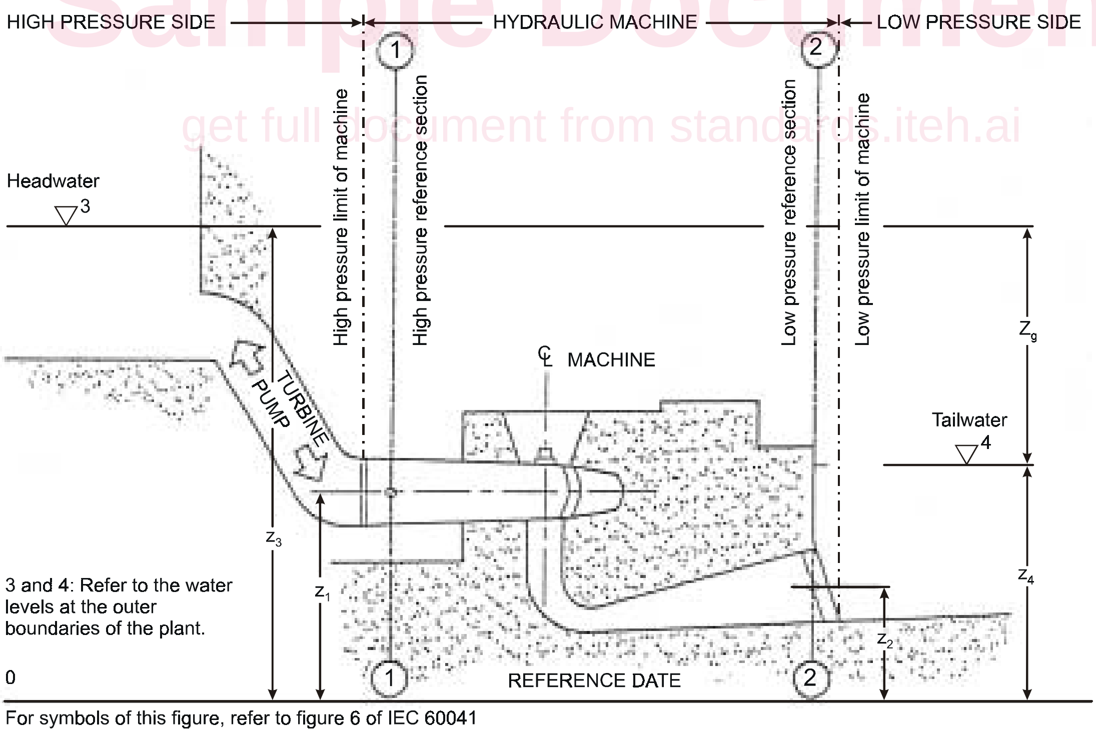

Figure 1 – Schematic representation of a hydroelectric plant

Geodetic height of plant $Z_g = z_3 - z_4$

For specific hydraulic energy (head) of the machine and further details, see IEC 60041.

3.4 Schematic representation of a hydraulic machine

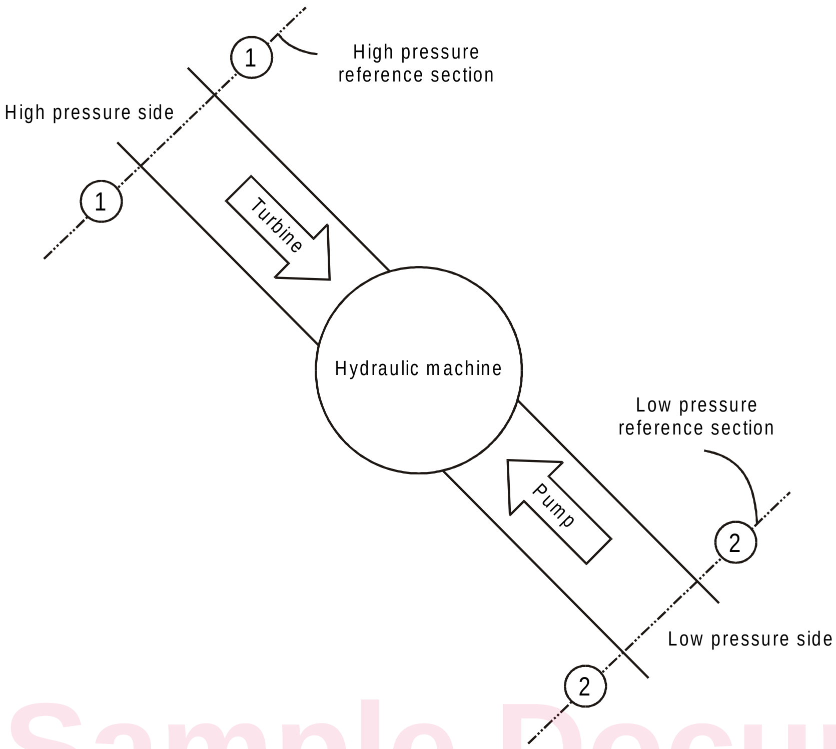

Figure 2 – Schematic representation of a hydraulic machine

4 Definition of types of hydraulic machines and valves

4.1 Types of hydraulic machines

4.1.1	Turbine	Machine for transforming hydraulic energy into mechanical energy. The term does not include the inlet or outlet valves nor the associated generator or regulator.
4.1.2	Storage pump	Machine for transforming mechanical energy into hydraulic energy in order to store water that will be used later on to produce electric energy. The term does not include the inlet or outlet valves nor the associated motor.
4.1.3	Pump-turbine	Single machine designed to operate at one time as a turbine and at another time as a pump.

4.2 Types of units

4.2.1	Unit	Complete set of hydraulic and electrical machines used for generating or pumping or both.
4.2.2	Reversible unit	Complete motor-generator set combined with a pump-turbine.
4.2.3	Tandem (ternary) unit	Complete motor-generator set combined with a turbine and a storage pump.
4.2.4	Direct-driven unit	Unit in which the runner or impeller is directly connected by shaft(s) to the generator or motor without an intermediate gear box.
4.2.5	Unit with gear box (speed increaser)	Unit in which the runner or impeller is connected through a gear box to the generator or motor.
4.2.6	Unit with starting device	Unit in which a special device is used to start in pumping mode, such as auxiliary turbine, pony motor, hydrodynamic torque converter, or electric motor.
4.2.7	Vertical shaft, horizontal shaft, inclined shaft	The orientation of the machine's rotational axis.
4.2.8	Direction of rotation of runner [impeller]	The direction, clockwise or anti-clockwise, in which the runner [impeller] rotates when viewed from the generator or motor looking towards the turbine or pump. For tubular units, the direction of rotation shall be viewed from the high-pressure side of the unit. The primary direction of rotation of a pump-turbine shall be the direction of rotation when operating as a turbine.

4.3 General description of hydraulic machines

4.3.1	Regulated machine	Machine in which the flow is controlled by a flow control device such as needles, adjustable guide vanes and/or runner [impeller] blades.
4.3.2	Single-regulated machine	Regulated machine with one flow control device.
4.3.3	Double-regulated machine	Regulated machine with two flow control devices.
4.3.4	Non-regulated machine	Machine in which no flow control device is provided. Flow may be temporarily controlled by the main gate or valve.
4.3.5	Single-stage machine	Turbine, storage pump or pump-turbine which has only one runner or impeller.
4.3.6	Multi-stage machine	Turbine, storage pump or pump-turbine which passes fluid through more than one runner or impeller in series on a common shaft.
4.3.7	Double-flow turbine	Turbine with a double runner such that the flow leaves the runner in two directions.
4.3.8	Double-suction pump	Pump with a double impeller such that flow enters the impeller from two directions.

4.4 Types of turbines

4.4.1	Reaction turbine	Turbine in which only part of the available hydraulic energy is converted into kinetic energy at the inlet of the runner.

NOTE – For definitions of energy terms, see IEC 60041 and IEC 60193.

4.4.1.1	Radial turbine, Francis turbine	Reaction turbine with meridional flow which is approximately radial between usually adjustable guide vanes and changes gradually direction inside the fixed runner blades so that the flow approaches axial flow at the outlet of the runner.
4.4.1.2	Diagonal turbine, (mixed-flow turbine), (semi-axial turbine)	Reaction turbine with radial or diagonal flow to guide vanes and diagonal inflow to the runner. Guide vanes may be adjustable or fixed and the runner blades may be adjustable or fixed. The Deriaz machine is characterized by diagonal flow between the stay vanes, guide vanes and runner blades, and may have adjustable guide vanes and runner blades.

4.4.1.3	Axial turbine	Reaction turbine having approximately axial meridional flow between the runner blades.
4.4.1.3.1	Kaplan and propeller turbine	Axial turbine with radial inflow to the guide vanes, usually with vertical shaft and elbow draft tube.
	• Kaplan turbine	Adjustable guide vanes and adjustable runner blades, double-regulated.
	• Propeller turbine	Adjustable guide vanes and fixed runner blades, single-regulated.
	• Semi-Kaplan turbine	Fixed guide vanes and adjustable runner blades, single-regulated.
4.4.1.3.2	Tubular turbine	Axial turbine with axial or diagonal inflow to the guide vanes, usually with horizontal or inclined shaft. The unit may be double, single or non-regulated. Tubular turbines include bulb (figures 3 and 3a), pit (figure 4), rim-generator (figure 5) and S-type units (figures 6 and 7).

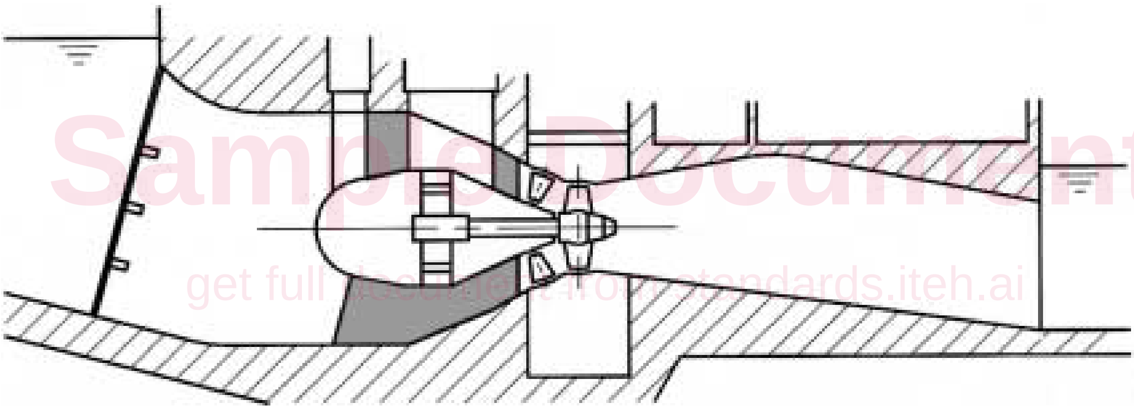

Figure 3 – Bulb unit The generator is housed in a bulb in the water passage. The unit may be directly driven or equipped with a gear box.

NOTE - The term "Bulb unit" includes turbines with bevel gear and shaft which drive the generator externally mounted outside the water passage, see figure 3a.

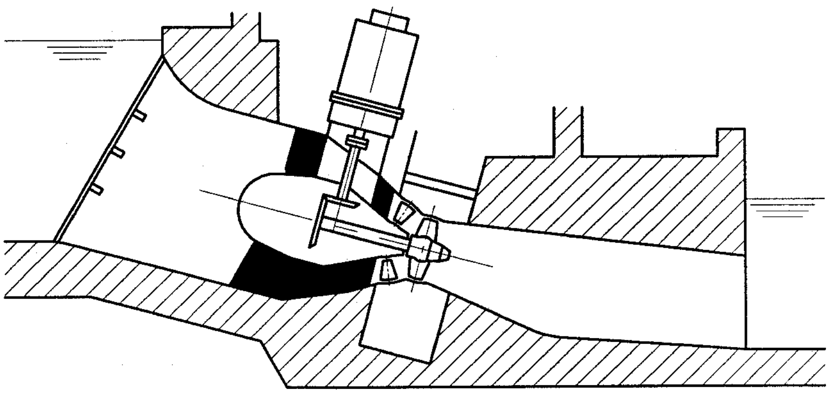

Figure 3a - Turbine with bevel gear

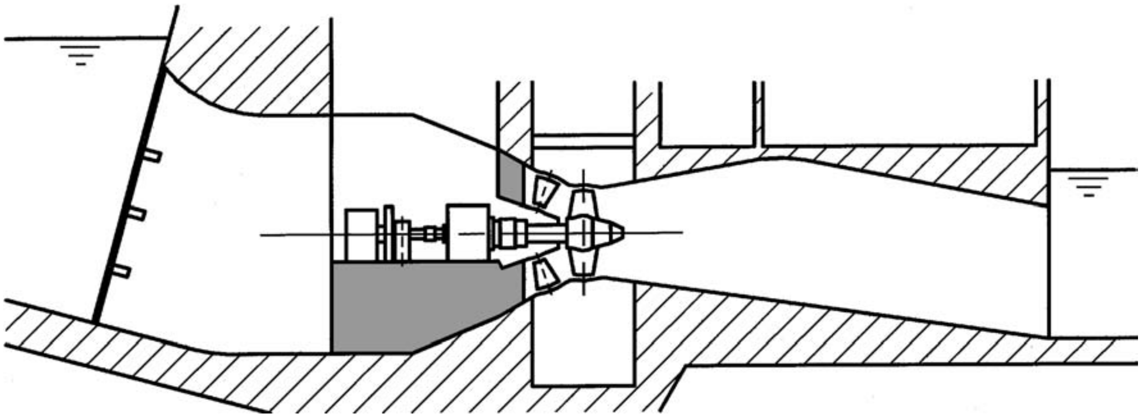

Figure 4 – Pit unit The generator is housed in a pit in the water passage. The generator is most frequently connected to the turbine shaft through a gear box. The pit allows direct dismantling of the generator and the gear box from above.

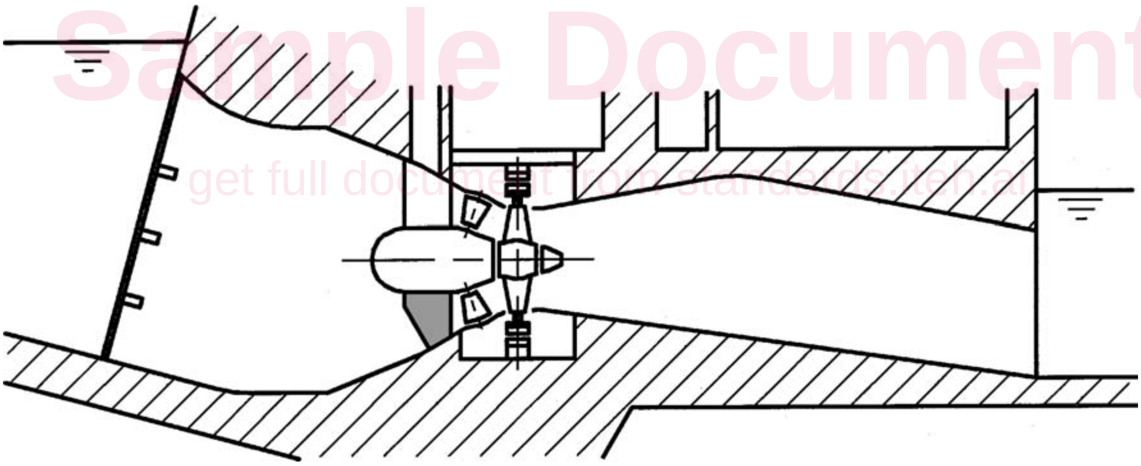

Figure 5 – Rim-generator unit The generator rotor is directly attached to the runner periphery. The Straflo®[1)] turbine is part of this type of unit.

1) Straflo® is an example of a suitable product available commercially. This information is given for the convenience of users of this report and does not constitute an endorsement by IEC of this product.

- S-type unit (S-turbine)

The S-type unit is characterized by a turbine with an S-shaped water passage. The turbine drives an externally mounted generator which may be driven directly or by a gear box. The S-type turbine may have several configurations, such as

- downstream S-type unit, see figure 6;
- upstream S-type unit, see figure 7.

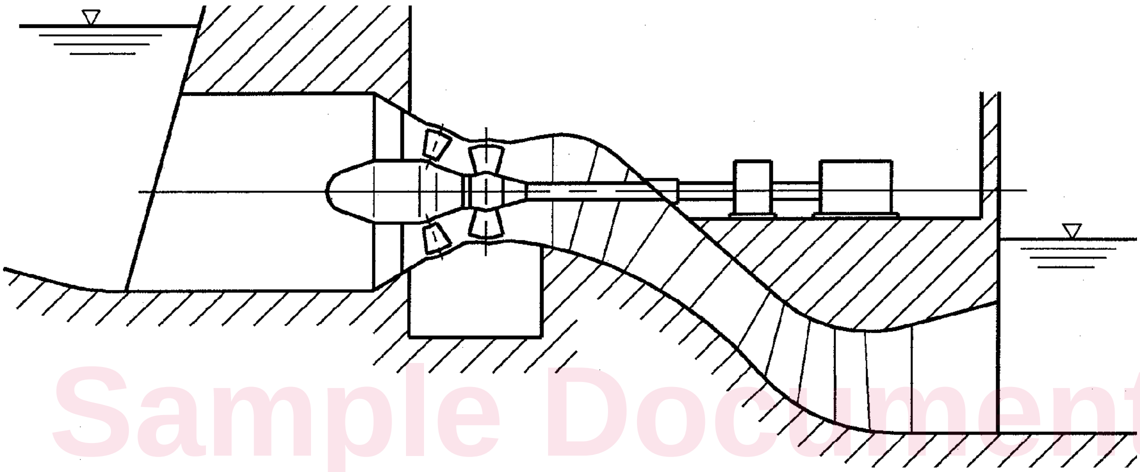

Figure 6 – Downstream S-type unit

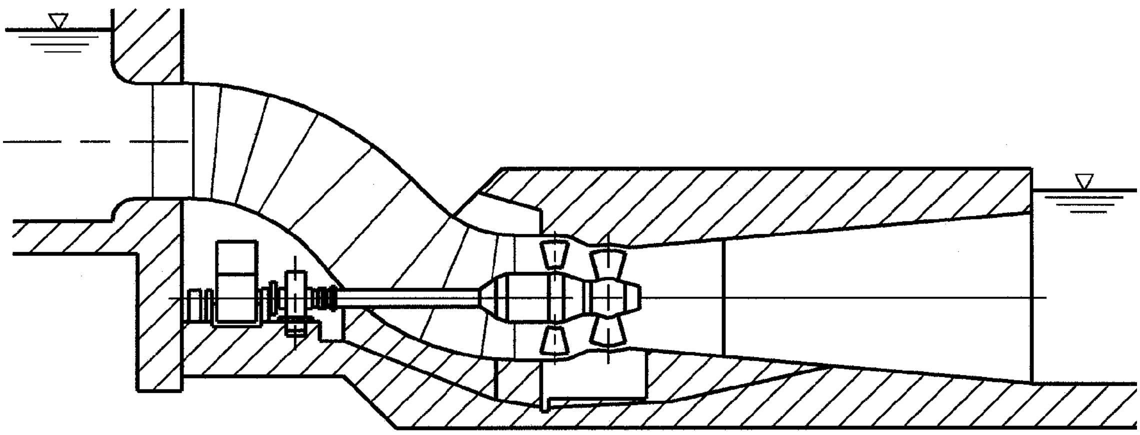

Figure 7 – Upstream S-type unit

4.4.2	Impulse (action) turbine	A turbine in which the available hydraulic energy is fully converted into kinetic energy at the outlet of the nozzle. Flow regulation is by means of one or more nozzles.
4.4.2.1	Pelton turbine	Impulse turbine in which the runner has double bowl buckets and the nozzle axes are located in the plane of symmetry of the buckets.
4.4.2.2	Inclined-jet turbine	Impulse turbine in which the runner has single bowl buckets. Nozzle axes are inclined to the plane of the runner. This type of machine includes the Turgo turbine (figure 8).

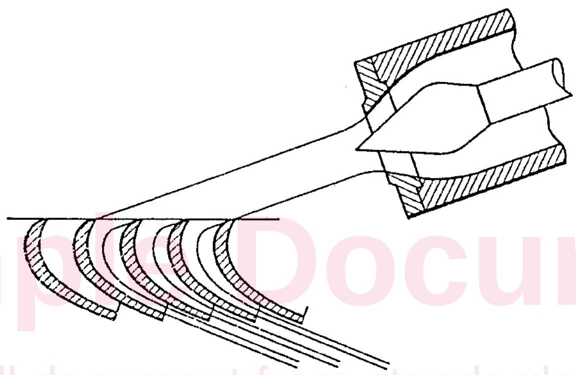

Figure 8 – Inclined jet turbine, Turgo turbine

4.4.3	Cross-flow turbine (Michell-Banki-turbine)	Action turbine with a very small degree of reaction. The flow crosses the runner twice perpendicularly to its axis of rotation and the runner blades are arranged cylindrically (figure 9).

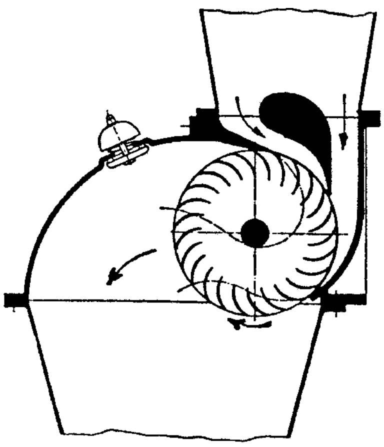

Figure 9 – Cross-flow turbine

4.5 Types of storage pumps

4.5.1	Radial pump (centrifugal)	Pump having axial inflow to and radial outflow from the impeller whose blades are fixed and bounded by a crown and band. Discharge from the impeller is to a diffuser and/or spiral case.
4.5.2	Diagonal pump (mixed-flow), (semi-axial)	Pump having axial or diagonal inflow to and diagonal outflow from the impeller with fixed or adjustable blades. Discharge may be to a diffuser and/or spiral case or in an axial direction.
4.5.3	Axial pump	Pump having axial inflow to and axial outflow from the impeller with fixed or adjustable blades.

NOTE - Booster pump is a pump of any type delivering a part of the specific hydraulic energy, installed on the low pressure side of the main storage pump.

4.6 Types of pump-turbines

In agreement with 3.3, the classification of pump-turbines is similar to that of turbines (see 4.4) and pumps (see 4.5).