



Bakhvi 2

Offer No.: 021602

Short project description

A Voith and Siemens Company
Date: 04 November 2019



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1 Technical Description

1.1 Technical Data

Turbine		
Turbine type	PV4i 1200/260	
Number of units	2	pcs
Rated gross head	858,50	m
Rated net head	817,60	m
Design Discharge (per unit)	2,600	m ³ /s
Max. Turbine output (per unit)	19.820	kW
Rated speed	1.000	rpm
Static runaway speed at rated net head	1.804	rpm
Number of nozzles	4	pcs
Runner pitch diameter D1	1.200	mm
Bucket width	265	mm
Distance between turbine runner – tail water level	2,9	m
Elevation of runner C.L.	509,9	m.a.s.l.
Elevation of tail water level at design discharge	507,0	m.a.s.l.
Hydraulic Power Unit		
Type	electro-hydraulic	
Accumulator charging pressure	dependent on manufacturer	bar
System pressure	max. 120	bar
Number of pump assemblies	2	pcs
Turbine Inlet Valve		
Type	Spherical valve	
Nominal diameter	600	mm
Design pressure	100	bar

Method of closing	closing weight	
Method of opening	hydraulically	
Bypass valve nominal diameter	50	mm
Synchronous Generator (for further information refer to the generator data-sheet)		
Mounting	V1	
Max. Output power	23.440	kVA
Speed	1.000	rpm
Runaway speed	1.804	rpm
Nominal current		A
Frequency	50	Hz
Power factor	0,85	
Voltage	10.000	V
Enclosure	IP44	
Insulation / Temperature rise	F / B	
Ambient temperature	40	°C
Cooling system	IC81W	
Bearings type	Sleeve Bearings	
Bearing cooling	Oil / Water	
Altitude	509,9	m.a.s.l.
Mass of generator	79.000	kg
Natural generator inertia (I)	4.505	kgm ²
Operating Condition		
Water way	Pressure tunnel / penstock	
Penstock material	steel	
Length	7.512	m
Diameter	700 - 2000	mm
Unit operation	parallel with grid	
Turbine closing time	120	s

Pressure rise in penstock	see water hammer diagram enclosed	% of H_{gross}
Standards of Measuring		
Mechanical Vibration of non-Rotating Parts	ISO 10816	
Mechanical Vibration of Rotating Parts	ISO 7919	
Efficiency	IEC 60041	
Cavitation	IEC 60609-2	

The layout is based on all valid and applicable EU-directives concerning manufacturers according AEUV 114.

1.2 Guarantees

1.2.1 Turbine Output and Efficiencies

Two units in operation

Rated net head (m)	Discharge (m³/s)	Turbine efficiency (%)	Turbine output (kW)	Number of Jets in Operation
818,59	2,600	91,75	19,14	4
824,21	2,400	91,83	17,81	4
829,38	2,200	92,15	16,48	4
834,1	2,000	92,19	15,07	4
838,38	1,800	92,08	13,62	4
842,2	1,600	92,03	12,16	4
845,57	1,400	91,77	10,65	3
848,5	1,200	91,69	9,15	3
850,97	1,000	91,33	7,62	2
852,99	0,800	91,23	6,1	2
854,57	0,600	90,82	4,56	1
855,69	0,400	90,33	3,03	1
856,37	0,350	89,98	2,64	1

One unit in operation

Rated net head (m)	Discharge (m³/s)	Turbine efficiency (%)	Turbine output (kW)	Number of Jets in Operation
847,09	2,600	91,82	19,82	4
848,5	2,400	91,98	18,36	4
849,79	2,200	92,17	16,89	4
850,97	2,000	92,15	15,37	4
852,04	1,800	92,03	13,83	4
852,99	1,600	92	12,31	4
853,84	1,400	91,77	10,75	3
854,57	1,200	91,68	9,22	3
855,18	1,000	91,32	7,65	2
855,69	0,800	91,22	6,12	2
856,08	0,600	90,82	4,57	1
856,37	0,400	90,32	3,03	1
856,53	0,350	89,98	2,64	1

The guarantees shall be in accordance with the IEC-Standard Publ. 41.

Please refer also to the Performance Curve enclosed.

1.2.2 Cavitation

See cavitation guarantee enclosed.

1.3 Scope of Supply and Description

The scope of supply includes two (2) vertical shaft single runner, 4 nozzles Pelton turbine with overhang arrangement, i.e. the turbine runner is mounted on the extended generator shaft.

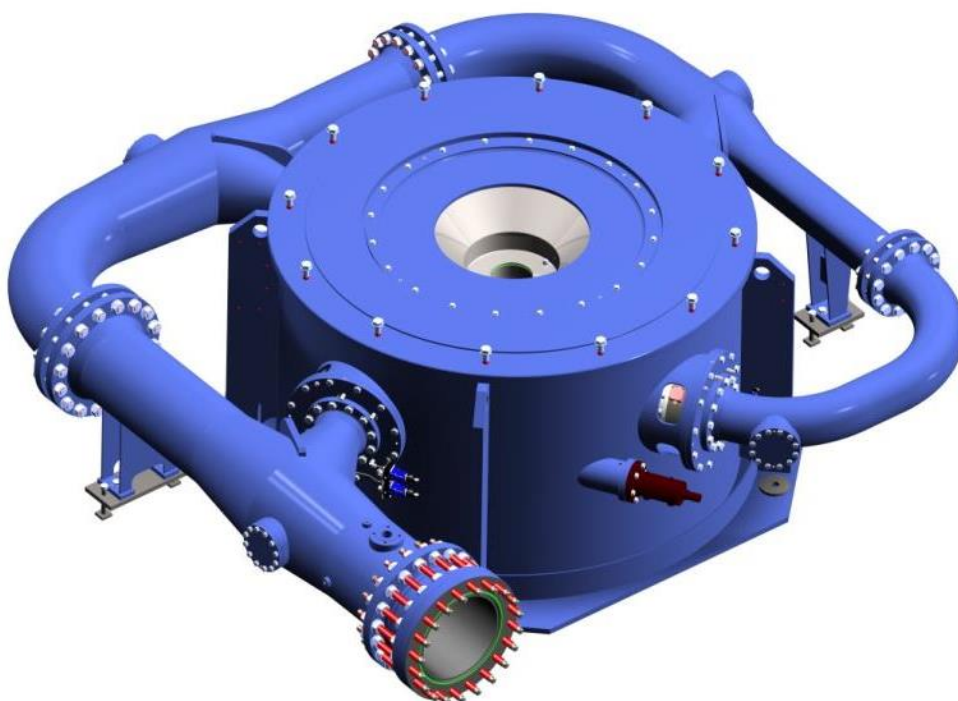


Figure 1 - Turbine

Each consists of the following components:

1.3.1 Turbine

Runner:

The Pelton type runner is made of one high grade stainless steel casting with integral buckets, completely finished ground and dynamically balanced.

The runner is connected to the generator shaft by means of flanged coupling which securely transmit the torque generated by the runner to the generator shaft.



Figure 2 - Runner

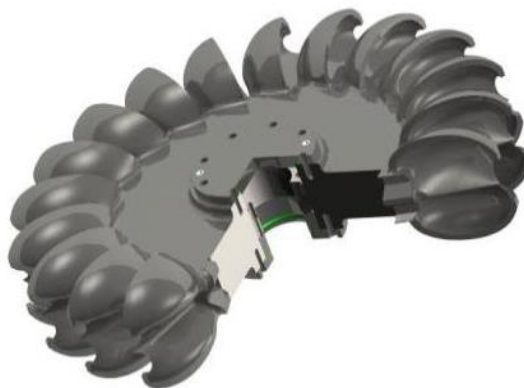


Figure 3 - Runner (Section)

Turbine Housing:

The turbine housing is made of a welded construction. It is designed for embedment in concrete. The housing is shaped and constructed in such a way to guide the water back to the tail water channel after leaving the bucket and to support the generator and all axial forces.

The turbine housing is furnished with suitable openings for inserting and alignment of the nozzles with the turbine runner and to support the actuator of the deflectors.

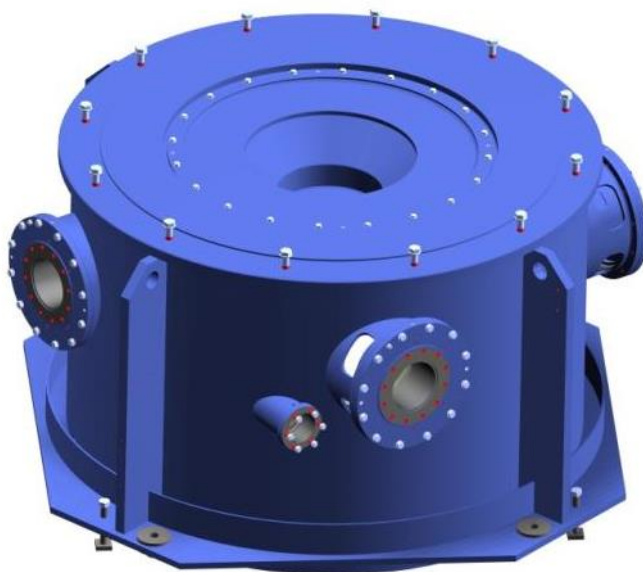


Figure 4 - Turbine Housing

Nozzles:

Part of the offer are 4 nozzles, needle regulated by means of integral double operated servomotor.

Each nozzle consists of:

- outer nozzle body made of cast steel, hand hole , water contacted surface nickel plated
- inner nozzle body made of chrome steel and cover are integrated
- replaceable nozzle seal ring made of chrome steel
- needle tip made of chrome steel
- nozzle head in cast steel, water contacted surface is nickel plated
- adjusting mechanism complete with seals and guides,
- balancing spring for closing tendency



Figure 5 - Nozzle

Distribution Pipe (Bifurcation Pipe):

The inlet pipe section consists of the bifurcation with dismantling flange for connecting to the turbine inlet valve and flange connections for each nozzle inlet bend.

The pipe section is designed for embedment in concrete.

A drainage pipe is provided for the lowest point of the distribution pipe.

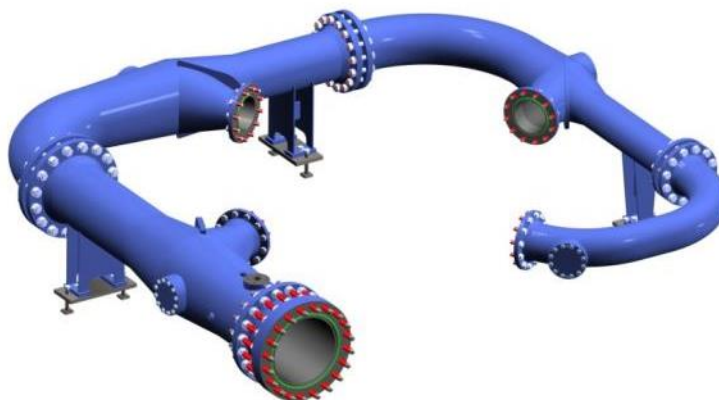


Figure 6 – Distribution Pipe

Jet Deflectors:

A jet deflector, actuated by a common servomotor for all jet deflectors, will be provided for each nozzle.

The jet deflectors are furnished with stainless steel.

The deflector shafts are made of stainless steel and each shaft will be supported by two bearings provided in the nozzle casing, angle levers and connecting rods with sealing for connection to the deflector servomotor.



Figure 7 - Jet Deflector

Shaft Seal:

A simplified shaft seal arrangement is provided.

Assembly of Turbine:

The turbine is assembled directly at our production site in St.Georgen/Austria, where we can guarantee accurate and clean work through our highly qualified staff. We pay great attention to work safety and the sustainability of our products as well as of our manufacturing conditions is very important for us. All electrical energy for our company and manufacturing is drawn from renewable sources.

(The turbine is tested and adjusted in the workshop prior to shipping.)

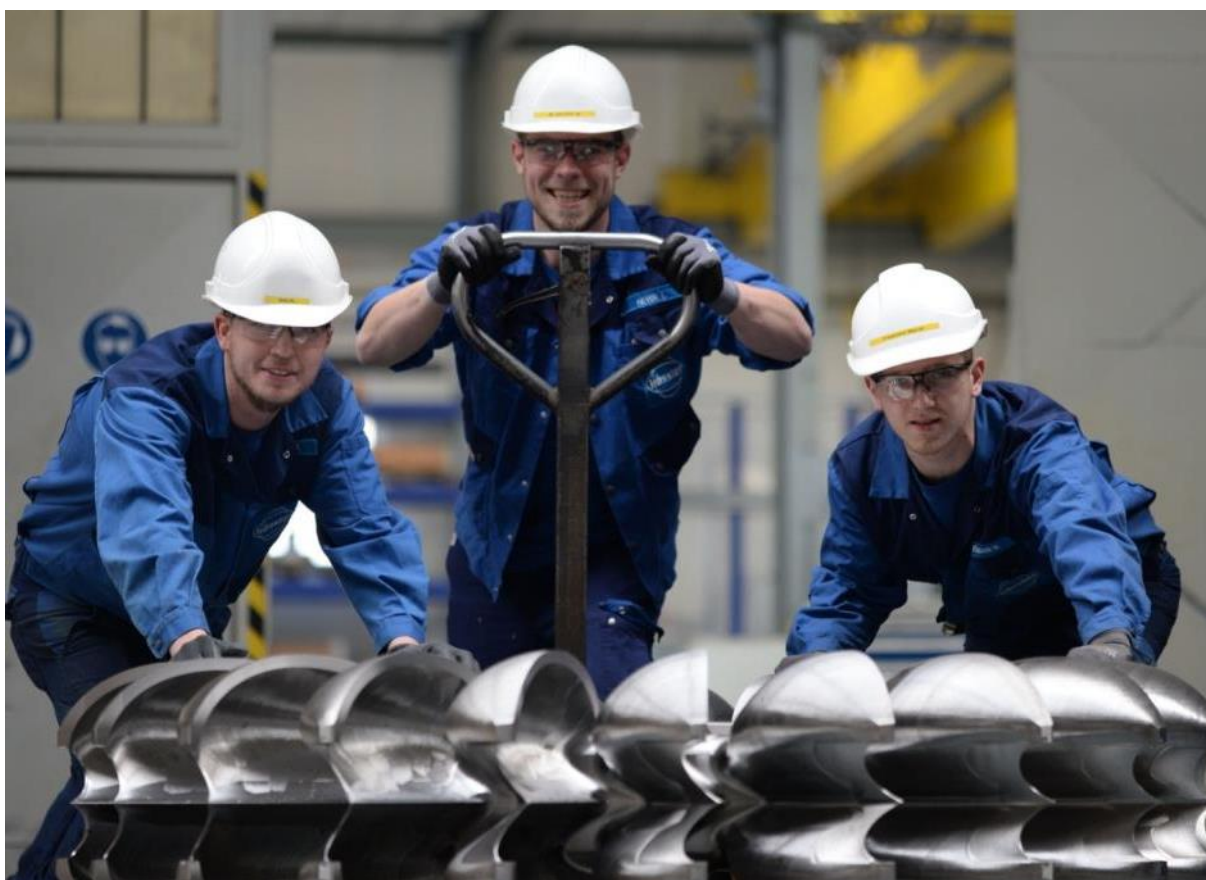


Figure 8 - Staff Workshop Assembly at Kössler

1.3.2 Control and Safety Devices, Instruments

Device	Digital	Analogue	Consumption	No. of Devices
Jet deflector position transducer		4-20 mA	24VDC	1
Nozzle position transducer		4-20 mA	24VDC	4
Speed transducer	impulses		24VDC	2
Penstock pressure before TIV		4-20 mA	24VDC	1
Penstock pressure after TIV		4-20 mA	24VDC	1
Penstock pressure gauge				1
Limit switch turbine inlet valve open	NO/NC			1
Limit switch turbine inlet valve closed	NO/NC			1
Bypass valve motor			400VAC	1
Bypass valve limit switch open	NO/NC			1
Bypass valve limit switch closed	NO/NC			1
Bypass valve torque switch open	NO/NC			1
Bypass valve torque switch closed	NO/NC			1

1.3.3 Turbine Inlet Valve

Spherical Valve

The Spherical valve type turbine inlet valve closes the inlet valve by means of a closing weight actuated by a control valve located at the hydraulic power unit of the governor. The opening of the inlet valve is managed by means of a hydraulic cylinder, pressurized by the hydraulic power unit of the governor. The turbine inlet valve and the closing weight are kept in the open position under sustaining hydraulic pressure.

Limit switches are furnished for the indication of open and closed positions of the valve. The valve can be secured in closed position by means of a safety bolt, which is monitored by a switch.

A bypass line with an electrically or hydraulically operated valve and a hand operated maintenance valve will be installed for filling the distribution pipe and pressure equalization between penstock and distribution pipe. Pressure equalization will be recognized by pressure transducers installed before and behind the spherical valve.

Upstream Pipe

The pipe section is located upstream of the turbine inlet valve. The upstream end is prepared for weld connection with the penstock. The downstream end is furnished with a flange for the connection to the turbine inlet valve.

1.3.4 Hydraulic Power Unit (Pressure Oil Supply System)

The hydraulic power unit is suitable for the control of the turbine unit operation in parallel with the grid, and/or isolated operation, the braking system and the control of the turbine inlet valve and the bypass valve. It consists of:

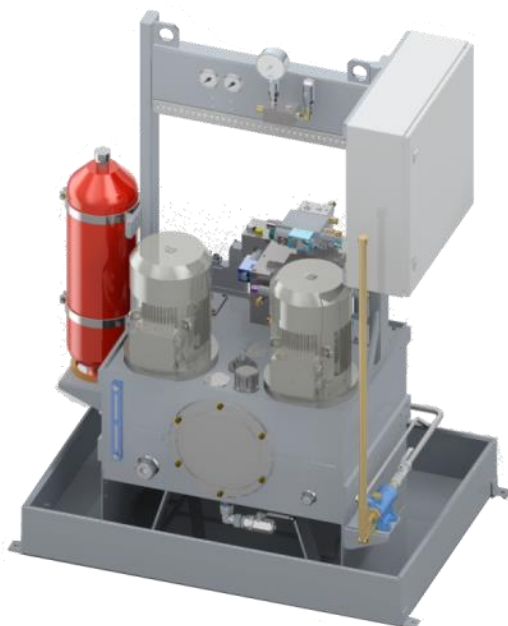


Figure 9 - Hydraulic Power Unit

- 2 AC-motor pumps with check valve and relief pressure valve
- 1 hand pump and valves for manual operation
- 1 oil tank with oil level gauge and drainage system
- temperature sensor and level switches
- pressurised single / double filter
- 1 oil sump
- 1 nitrogen pressure accumulator designed for safe operation of all hydraulic cylinders in case of pump power supply fault
- pressure transducer
- min. pressure switch
- quick shut off solenoid valve
- solenoid valves for brake, TIV, nozzle, jet deflector
- additional control valves for turbine inlet valve and turbine brake operation
- all necessary fittings and piping from the power pack to the turbine and turbine inlet valve
- proportional valve

The hydraulic power unit unit is completely wired to a common terminal box.

Control, Instruments and Safety Device of Hydraulic Power Unit

Device	Digital	Analogue	Consumption	No. of Devices
Hydraulic pump motor			400VAC, 50Hz	2
Quick shut down solenoid valve			24VDC, 38W	1
Jet deflector open proportional valve			24VDC, 60W	1
Jet deflector close proportional valve			24VDC, 60W	1
Nozzle open solenoid valve			24VDC, 38W	4
Nozzle close solenoid valve			24VDC, 38W	4
Turbine inlet valve solenoid valve			24VDC, 38W	1
Brake on solenoid valve			24VDC, 38W	1
System pressure transducer	4-20 mA		24VDC	1
Oil temperature transducer		PT 100	24VDC	1
Pressure switch min. oil pressure	NO/NC			1
Pressure switch oil filter clogged	NO/NC			1
Level switch oil level min.	NC			1
Level switch oil level max.	NC			1
Pressure switch brake on	NO/NC			1
Switch thermostat heater on	NO/NC			1
Switch thermostat heater off	NO/NC			1
Heating rod			400VAC, 50Hz	1

1.3.5 Braking System

A hydraulic braking system operated by the oil derived from the hydraulic governor of the turbine is provided. The brake is part of the turbine supplier part of the generator supplier's scope. Oil pipe from governor to the brake will be supplied by the turbine supplier.

The brake will be sized to stop the turbine-generator set from 25% of its rated speed to standstill.

1.3.6 Cooling Water System

For the cooling of the bearing lube oil unit, a closed cooling water circuit is provided consisting of

- a pump unit
- a flow and pressure control
- a temperature element
- all necessary piping between the lube-oil system and the water-cooler mounted in the tail water channel
- valves
- stainless pipes (1.4521)
- press connection fittings (1.4401)

1.3.7 Special Tools and Maintenance Equipment

- 1 set of special tools (torque wrench for maintenance)
- 1 set of nitrogen filling device with adaptor
- 1 set of erection device for runner
- 1 set of lifting equipment such as suspension bands, hangers, bolts

1.3.8 Engineering and Documentation

Three sets of all necessary maintenance and operating instruction documents are provided in the official language of the member state, one set in English (for qualified staff) and one set in German. They contain the most relevant data for maintenance and operating according to the actual Directive of Machinery (EU)/Annex I/1.7 (please refer to the attached file) and IEC 82079 international standard.

Further documentation is optional at an additional charge.

Our solid data archiving ensures the availability of project documents over the years.

1.3.9 Transport

The CIP site shipment of the ordered equipment is included in the offer. The equipment is securely packed and the transport is carried out by our trusted long-term partners.

1.3.10 Erection - Supervision, Commissioning

The erection is carried out by our qualified and experienced staff.
The commissioning is according to IEC 62006 Class A.

1.4 Protective Coating for Turbine

Water Contacted Surfaces

- sandblasting SA 2 ½
- 1 basic coat Agrozinc SW (60 µm)
- 3 finishing coats Agrovan 209 120 µm each
RAL 7030 Stonegrey, according to A1.20 (DIN EN ISO 12944-5)

Air Contacted Surfaces

- sandblasting SA 2 ½
- 1 basic coat Agrozinc SW 60 µm
- 1 intermediate coat Agropox 250 EG 60 µm
- 2 finishing coats Agropur Color ST 40 µm each
RAL 5007 brilliant blue for turbine (stationary parts)
RAL 3004 purple red for turbine (moving parts)
- galvanized (small parts)

Oil Contacted Surfaces

- sandblasting SA 2 ½
- 2 finishing coats with color varnish 40 µm each

Concrete Contacted Surfaces

- rust removal by use of brush
- no treatment

Machined Surfaces

- washable protective coating

Flanges

- Sandblasting SA 2 ½
- 1 basic coat Agrozinc SW 40 µm

Protective coating for purchasing components such as generator, hydraulic power unit, etc. is carried out according to sub-suppliers' standards.

Water contacted surfaces of the turbine inlet valve are coated according to DIN EN ISO 12944-5, not less than classification A1.20 / IM1.

The offered protective coating considers a water quality not worse than described in the attached water quality appendix.

1.5 List of Material Specification

1.5.1 Turbine

Please refer to the attached inspection and test plan.

1.6 List of Supplier

Item	Company	Country
Turbine	Kössler GmbH & Co KG	Austria
Hydraulic Power Unit	Bosch Rexroth or equal	Germany
Turbine Inlet Valve	Armatury or equal	EU
Generator	Gamesa or equal	EU
Electrical Equipment	Voith Bucharest optional: Schubert	Romania Austria

1.7 Spare Parts (recommended, not included in price)

Turbine

- 4 pc sealing rings of nozzle body (stainless steel)
- 4 pc nozzle-needle tips of stainless steel
- 1 pc jet deflector
- 1 set of packing and seals for entire turbine
- 1 set seals for servomotors
- 1 pc position-transducer nozzle
- 1 pc position-transducer jet-deflector
- 1 pc pressure transducer
- 1 pc manometer

Turbine Inlet Valve (see spare parts on enclosed graph)

- 1 set of shaft sealing (No. 1)
- 1 body/cover sealing (No. 2)
- 1 set of seat sealing (No. 3)
- 1 set of seat (No. 4)
- 1 set of seals for the hydraulic cylinder (No. 5)
- 1 limit switch (No. 6)

Hydraulic Power Unit

- 1 pump
- 1 motor (including coupling)
- 1 bladder for nitrogen accumulator
- 1 pressure sensor
- 1 pressure switch
- 1 manometer 0 to 250 bar

- 1 4/3 proportional directional-control valve
- 1 set of solenoid valves (one of each type used)
- 4 filter elements PI Mic 10

Generator

- 1 set rotating diodes
- 1 PT100 for bearing
- 1 set bearing pads for NDE & DE
- 1 voltage regulator (basic module)

1.8 Quality and Process Control

Turbine

The extent of tests and non-destructive control shall be carried out according to the inspection and test plan, corresponding to the internal Q/A process, which is in compliance with the ISO 9001-Standards.

The finished runner will be dynamically balanced according to DIN-ISO 1940.

The commissioning printout is according to IEC 62004 class A.

Hydraulic Power Unit

The factory acceptance test (FAT) for the hydraulic power unit is carried out according to DIN-Standard.

Turbine Inlet Valve

The inspection test certificate is according to DIN EN 10204 3.1 on equipment testing.

- Pressure tests: 1,5 x nominal pressure for housing
- Leak test: 1,0 x nominal pressure in closed position

1.9 Responsibilities of the OWNER

The OWNER shall be responsible to provide at his costs and at his risk (but not limited to):

- Environmental licences and approvals by governmental authorities required for the project
- Proper storage of the EQUIPMENT against environmental influences, losses, etc. after arrival of the EQUIPMENT at SITE
- Customs clearance (the OWNER shall inform well in advance which documents are needed from CONTRACTOR for custom's clearance)
- All kind of construction works
- Installation of windows and doors and powerhouse roof closed
- Safe and clean working conditions at SITE
- Overhead line and water ways ready and water available for 1st synchronization according Contractual Time Schedule
- Construction of the tail water channels
- Forming the in-concrete cabling canals, foundation plates and anchoring bolts in the 1st stage concrete, according to the drawings given by the CONTRACTOR
- Ventilation, cooling and heating of the powerhouse
- Powerhouse building and SITE lighting
- Powerhouse building grounding
- Lightning rod
- Supply and assembly of the penstocks and branching from the loading pool to the turbine inlet valve
- Fire extinguishing system
- Site Conditions which enable CONTRACTOR'S personnel to comply with health and work safety requirements
- Electricity in the required voltage levels and uninterrupted, including distribution and cabling within the SITE up to the working places
- Transportation facilities for the EQUIPMENT within the SITE, including a (overhead) crane or mobile crane for heavy EQUIPMENT according to the required capacity
- Access-roads and -ways to SITE prepared for heavy, low-platform trucks according required transport capacity
- Water management and flooding protection including corresponding insurance
- Cable from MV switchgear to the first tower
- A lockable room for storage of the small parts and tools
- Supply and installation of fibre optic cable between weir-system(s), head pond and the POWER PLANT
- Weir system sensors and cables
- Power house drainage system
- Air ducts (if any)
- Energy supply for EQUIPMENT at weir-system(s) and head pond

1.10 List of Enclosures

- A Slide Valve for dewatering pipe
- B Performance Curve_4 nozzle vertical
- C Performance Curve_4 nozzle vertical vs. 3 nozzle horizontal
- D Operating Range
- E Cavitation Guarantee
- F Generator Technical Description

The above shown photos are for proposal purposes only.

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