DOCUMENTATION REGARDING PUBLIC PROCUREMENT

SHPP KNEŽA – LOT TG – execution of power unit in two parts

PART A: **Supply of the turbine and the generator with the related equipment, supervision of the assembly and commissioning tests**

PART B: **Supply of control and protection equipment, measurements, auxiliary power supply, all other necessary equipment, supervision of the assembly and commissioning tests**

Internal Public Procurement No.: **JN06/2016**

Technical part - General and Special Technical Specifications

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1 SUBJECT OF THE TENDER

The subject of the tender is SHPP Kneža - LOT TG - Execution of the power unit in two parts:

LOT TG Part A:

Supply of the turbine and the generator with the related equipment, supervision of the assembly and commissioning tests includes the supply of a Francis turbine, flywheel with hydraulic brake, electronic overspeed safety device with speed monitoring, inlet elbow and cone, pressure regulating (plunger) and turbine bypass valve, main inlet valve with bypass, assembly/disassembly pieces, turbine hydraulic governor, auxiliary equipment with steel structures, various measurements and a generator with excitation system. The supplied equipment with few exceptions shall be assembled by the Customer in accordance with the instructions and under the supervision of the Contractor. The Contractor shall manage and perform all the required commissioning tests in which the Customer, engineer and contractors from other LOTs will participate.

The Contractor for Part A shall deliver the equipment to the site in accordance with the Time Schedule and with regard to the progress of works in the construction of the power house. This shall apply particularly to the concreted parts of the first and second concreting phase.

LOT TG Part B:

Supply of control and protection equipment, measurements, auxiliary power supply, all other necessary equipment, supervision of the assembly and commissioning tests includes supply of control equipment, electrical protection equipment, equipment for measurements of electric energy and other quantities, auxiliary power supply, telecommunication equipment with satellite and optical connection to Kneške Ravne 2 SHPP, generator circuit breaker, electrical connections to the turbine and the generator and other necessary equipment. The supplied equipment with few exceptions shall be assembled by the Customer in accordance with the instructions and under the supervision of the Contractor. The Contractor shall manage and perform all the required commissioning tests in which the Customer, engineer and contractors from other LOTs will participate.

The Contractor for Part B shall deliver the equipment to the site in accordance with the Time Schedule and with regard to the progress of works in the construction of the power house.

2 GENERAL DESCRIPTION

2.1 LOCATION

The Kneža SHPP site is located in the NW part of Slovenia, approx. 20 km east from the town Tolmin, under the Kneške Ravne settlement.

2.2 CLIMATIC AND HYDROLOGICAL CONDITIONS FOR CONSTRUCTION

Typical monthly climate data for Tolmin station (20 km from the location of Kneža SHPP) for the period between 1961 and 1990 is available at http://www.arso.gov.si/.

Hydrological data is taken from the “Hydrological data for SHPP locations - Kneža River basin with tributaries” report, issued by the Hydro meteorological institute of Slovenia (6757-2/1988, y. 1988). Kneža watercourse is the right tributary of Bača River with the river mouth in Kneža village where a water gauging station is also located. Data used for the project purposes was obtained between 1954 and 1966 at the mentioned water gauging station in Kneža and contains the following hydrological data:

- Precipitation area: $F = 35.5\ km^2$
- Average precipitation: $P = 3397\ mm/year$
- Mean flow: $sQs = 2.68\ m^3/s$
- Minimum flow: $nQn = 0.28\ m^3/s$

- Mean small flow: sQn = 0.68 m^3/s
- Flow according to duration: 9-month Q_9 = 1.49 m^3/s
  6-month Q_6 = 2.02 m^3/s
  3-month Q_3 = 3.15 m^3/s
- Mean high flow: sQv = 26.3 m^3/s
- Maximum flow: vQv(k) = 67.0 m^3/s
- Probable 100-year water flowrate: vQv(100) = 98.0 m^3/s

2.3 DESCRIPTION OF THE ENTIRE PLANT

Kneža SHPP is a derivation run-of-river power plant located in the middle section of the Kneža waterway. The power plant has a Tyrol type intake structure and a power house approx. 2300 m downstream. The intake structure and the power house are connected by a buried polyester penstock (GRP) running within the Kneža-Kneške Ravne road. Outflow water is channelled through concrete channel which is completely buried directly into the Kneža waterway.

The power plant exploits the water potential between elevations of 403.20 m and 329.50 m. The total gross head, i.e. the difference between the water level in the intake structure and the water level in the outflow channel of the power house, is 73.70 m.

Kneža SHPP is composed of the following facilities:

- Tyrol type intake structure with a sand trap;
- polyester penstock (GRP);
- power house with an outflow channel.

The required water quantity is captured in the Tyrol type intake structure which is with penstock connected to the turbine in the power house. The penstock is almost entirely buried into the local road Kneža-Kneške Ravne, except at two bridge structures. The power house is located on the left bank and its platform is located at an elevation safe from a hundred-year flood. Water from the turbine returns to Kneža directly via an outflow channel.

SHPP Kneža's basic characteristics are:

- head water elevation: K_z = 403.20 m a.s.l.
- tailwater elevation: K_s = 329.50 m a.s.l.
- gross head: H_b = 73.70 m
- installed flow: Q_{inst} = 1.50 m^3/s
- net head at Q_{inst}: H_n = approx. 64 m
- penstock diameter: D_n = 1000/900/800 mm (looking from top)
- penstock length: L = 2296 m
- nominal power: P_n = 850 kW
- annual production: E_i = 3300 GWh (estimated)

2.4 DIVISION OF CONSTRUCTION INTO LOTS

The construction is divided into several LOTs and parts:

LOT A		Civil works for construction of intake structure and power house, installation of penstock - phase II from stat. km 2+260 to km 2+290 and hydro mechanical equipment at the intake structure and the outflow channel.
LOT C	Part A	Supply of polyester penstock from stat. km 0+000 to km 2+290.
	Part B	Installation of polyester penstock - phase I from stat. km 0+001 to km 2+260. Installation is already taking place.
LOT EE	Part A	Supply and installation of MV and LV cable connection.
	Part B	Supply and installation of 20 kV cubicles.
LOT TG	Part A	Supply and assembly of power unit with related equipment and commissioning tests
	Part B	Supply and assembly of control and protection equipment, measurements, auxiliary power supply, all other necessary equipment and commissioning tests

2.5 EXECUTION OF THE WORKS

2.5.1 Basic considerations

Site set-up is shown in the drawing No. HIK3---6G4001 Power house - site area. The site set-up plan shall be prepared by the Contractor.

During the construction the required temporary structures (sheds, carports) and facilities (offices, toilets, warehouses, dump sites etc.) shall be organized by Contractor . All areas affected by the construction shall be reinstated to their original condition by the Contractor after the completion of the construction.

The planned power supply to the site is with movable low-voltage generating units. All the required technical water for the entire site shall be obtained from the Kneža waterway.

Contractors from individual LOTs shall coordinate their site set-ups with other contractors and arrange for mutual financial relationships.

The site manager for the construction of Kneža SHPP is the responsible head of works for LOT A.

The site manager shall coordinate works and site organisation with contractors for all LOTs in order to ensure undisturbed operation compliant with the time schedule.

2.5.2 Access to the site

The existing local road shall be used for accessing individual work areas. Four houses with ten inhabitants and occasional visitors of additional seven buildings are located above the site. The Contractor(s) for LOT TG shall ensure an undisturbed access and passage over the site. The site set-up and transport costs to the site shall not be borne by the Contractor.

The Contractor shall observe all applicable conditions and transport restrictions for the local road and shall keep the Customer informed of any changes, as well as coordinate the usage of the local road with the local inhabitants.

2.5.3 Transportation and dumping areas

Transportation for Kneža SHPP construction shall take place via public roads with only a few passing bays. The Contractor shall inspect the site location and the access road to be aware of the site conditions and to not make any additional claims regarding this. During and after completing the construction the Contractor shall repair any damage to the traffic routes at their own cost.

Larger dumping areas for storing equipment, material and machinery during the construction will not be available at the site. It is expected that such areas will not be required. The equipment shall be supplied to the site when necessary (just in time). Any costs of consents, approvals and usage shall be borne by the Contractor.

The areas for temporary dumping areas shall be restored to their original state by layers of humus and grass.

2.5.4 Contractor's obligations regarding environmental protection and human health

The Contractor's general obligation is to implement the necessary measures at their own cost to prevent pollution of the environment (water, air, noise, soil) in accordance with the applicable legislation and to suitably monitor the environmental impacts for the entire duration of performing the works according to the applicable legislation, technical regulations and as instructed in different consents and permits.

Dust formation shall be prevented by wetting the transport routes and work areas. The Contractor shall provide for the collection, removal and disposal of all types of waste from the site at their own cost. Use of chemical toilets is envisaged for the duration of the works. The contractors shall provide for cleaning and removal of waste.

2.5.5 Expected impacts of the plant on the direct surrounding and statement of measures

2.5.5.1 Description of the existing environmental situation

The Customer and the Engineer shall photo-document the existing condition of the local road including the road's support walls from Kneža village to the Kneža SHPP intake structure and the condition of the residential buildings (particularly Kneža 15 and 16) together with the Contractor, representatives from the municipality and the local community and house owners before and after the construction. Any damage to the mentioned section shall be repaired by the Contractor at their own cost.

2.5.5.2 Expected environmental impacts during construction

No greater environmental impacts are expected during the construction.

2.5.5.3 Description of measures for preventing expected environmental impacts during construction

Public roads:

- The transport regime shall be coordinated with the users and the operator of the road; no road closures are not foreseen;

Water regime and water status:

- All measures shall be taken during the construction to ensure that in the case of the accident there will be no effects on the water regime, waters, aquatic and inshore land, neighbouring buildings and environment in general and to not increase the threat of flooding;
- Filling of the penstock and the commissioning tests shall be coordinated with the Customer, the Engineer and the owner of the downstream hydroelectric power plant - as well as others which shall be determined at a later date.

Nature conservation:

- The Contractor shall coordinate the works in the Kneža River riverbed with the Tolmin fishing society. The Contractor shall inform the fishing society on the planned works in the aquatic and inshore land at least 7 days before the beginning of the construction;
- All works on the Kneža River riverbed and its immediate vicinity shall be performed between 1st July and 1st October - i.e. outside the breeding season of the protected fish species: marble trout and bullhead;

- All works shall be performed in a way that prevents water turbidity and pollution, and thus endangerment of the protected fish species;
- All measures shall be implemented to prevent landslides and other erosion events, filling or back-filling of the riverbed and banks with construction material or disposal of any material into the riverbed or the banks of the Kneža River and its tributaries;
- The construction area shall be limited as much as possible while still being able to perform the works in a safe and suitable manner;
- Only existing access roads shall be used during the construction; no new access routes (except for access to the power house) are planned or being constructed;
- Parking and stopping with the machinery shall only be done on the provided surfaces (road, parking area etc.). Driving, turning around, stopping or parking vehicles outside of existing, intended surfaces is not permitted.
- Due to monitoring of the protected area during the works, the Contractor shall inform The Institute of the Republic of Slovenia for Nature Conservation, regional unit Nova Gorica, Delpinova 16, 5000 Nova Gorica, of the beginning of works at least 8 days before the commencement of works;
- Machinery shall be used in the aquatic environment only when necessary;
- Spilling of fuel, oil, protective coating and other and/or toxic substances into the waterway or into the area of the aquatic land shall be prevented during the construction;
- During the performance of works the existing bank vegetation of the Kneža River and Liščak waterway shall be preserved as much as possible.

2.5.6 Waste management and fire safety during construction

In accordance with the Decree on management of waste arising from construction work, Official Gazette of the RS, No. 34/08, the key obligations regarding management of construction waste shall be borne by the Customer. The Customer shall authorise the selected civil works contractor or a group of contractors to perform certain obligations stipulated in the waste management plan on behalf of the Customer, i.e. to supervise waste management, to dispose of waste at the authorised waste collector, disposer or processor and to keep records on the construction waste generated at the site. The Customer shall also authorise the selected contractor to collect all records of the waste generated at the site and submit them to the Customer prior to the preparation of the report on the construction waste management. The waste management plan shall be elaborated as part of the documents required for acquiring the building permit.

Fire safety during the construction of the plant shall be under full responsibility of the Contractor. Fire safety during the construction shall be defined in the Fire safety plan.

2.6 QUALITY ASSURANCE PLAN

	IZVEDBENI PLAN KONTROLE KAKOVOSTI				Štev.:
					List:
Naročnik	SENG d.o.o.	Projekt		Objekt	mHE Kneža

Ime skupine Group name		Ime podskupine Subgroup name		Št. izvedb No.of units	
Potrdila o kvaliteti - v jeziku Language to be used in Quality Certificates		Št. izvodov No. of copies		Prevzemni organ Inspection officer	

Indeks Index	Datum / Date	Popravil / Modified by	Pregledal / Checked by	Odobril / Approved by	Opis spremembe in status dokumenta Description of modification and document status

A (R/W)	Pred uporabo je potrebna potrditev dokumenta s strani kontrolnega organa. Prior to the application the document shall be approved by the inspection authority.	Y	Interni pregled all preizkus - kontrolo izvaja izvajalec v proizvodnji. Internal inspection or testing – checked by the operator in manufacturing department.	R	Predložitev zapisov o kontroli in preizkusih (poročilo o preizkusu, atest). Submission of inspection and test records (test certificates).
W	*Pozivna točka*-zahtevana prisotnost kontrolnega organa; če se kontrolni organ na dogovorjeni termin ne pojavi, se aktivnost nadaljuje Witness point – the presence of inspection authority required; in case that inspection authority fails to appear on the date agreed upon, the process continues.	H	*Zastavna točka* - zahtevana prisotnost kontrolnega organa; če se kontrolni organ na dogovorjeni termin ne pojavi se aktivnost ustavi in se počaka na njegov prihod Hold point – the presence of inspection authority required; in case that inspection authority fails to appear on the date agreed upon, the process stops and does not proceed until inspection authority is present.		

	Izdelal / Designed by:	Pregledal / Checked by:	Odobril / Approved by:	Uradni nadzornik / kupec: Official supervisor / purchaser:	Zunanji pooblaščeni urad External authorised office
Ime / Name:					
Datum / Date:					
Podpis /					

	IZVEDBENI PLAN KONTROLE KAKOVOSTI				Štev.:
					List:
Naročnik	SENG d.o.o.	Projekt		Objekt	mHE Kneža

Št.	Predmet in vrsta kontrole	Risba št.	Material Material	Kontrola				Predpis Standard	Številka poročila Datum in podpis inšpektorja	Opomba	Št. kos/izvedb o
				Poddobavitelj/ podizvajalec	Izvajalec	Naročnik	Prevzem				

OPOMBA:

The Contractor shall prepare complete QA/QC documentation with all the required or requested material attestations, test certificates, dimension controls, surface protection and suitable certificates regarding the qualification of the measuring or testing staff. All attestations and certificates shall be suitably marked to be able to correctly establish as to which element or equipment they refer. A sample of the QA plan can be seen above.

2.7 TAKING-OVER OF THE WORKS

It shall be deemed that the Contractor has completed the works if the works were completed within the time period stipulated in the contract, if a Statement of Plant Reliability for the works under contract has been submitted and if all defects or deficiencies found by the Customer during their inspection have been remedied.

Upon the completion of works the Contractor shall:

a) enter the date of completion of works in the construction logbook;

b) inform the Customer in writing that the works have been completed;

c) invite the Customer to take-over the works at least 8 (eight) days prior to taking-over the works.

The Contractor undertakes to remedy all defects and deficiencies established at the technical inspection within 30 days after the date of the technical inspection or within a time period at the Customer's discretion. It shall be deemed that the Final Taking-Over takes place after all defects and deficiencies have been remedied and the final settlement of the works (stating all quantities and quality of works) has been done. The Contractor shall submit the final settlement; the latter has to be checked and confirmed by the Customer. If deficiencies are established upon the final taking-over, the Contractor undertakes to remedy them within 10 days or within a time period at the Customer's discretion. After remedying the defects, the Contractor shall re-invite the Customer to the Final Taking-Over of the works.

The Customer shall take-over the works by issuing the Taking-Over Certificate and upon the completion of the following conditions:

a) issued Taking-Over Certificate from the previous paragraph;

b) proof of Plant Reliability, As-built documentation (PID) and maintenance instructions (NOV) submitted to the Customer;

c) the Contractor provides the Customer with a Defects Liability Security within 30 days after the final taking-over.

If the Customer begins to use the plant under this contract before the taking-over of works, it shall not be deemed that the works were taken-over on the day of the use.

Taking-over of works means a quantity and quality related taking-over of individual works according to the stipulations of the contract and the requirements of the Technical Specifications.

There are three types of taking-over of works with regard to the construction stage:

a) temporary taking-over (for a temporary settlement of works);
b) final taking-over and
c) complete taking-over

Temporary taking-over

During the construction the Engineer shall temporarily take-over the performed works from the Contractor. While doing so, the quantities and quality are verified and compared to the Technical Specifications and the design documentation. This taking-over shall form a basis for interim statements and for the recognition of temporary periodic settlements for the payment of the performed works. Disputed quantity and quality of works does not have to be approved in the temporary taking-over; the actual state in terms of contractual provisions shall be determined by a committee.

All works which were temporarily taken-over shall be entered into the book of measurements and be suitably documented and confirmed. The documents shall be prepared by the Contractor and submitted to the Engineer for approval on a monthly basis; the Engineer shall confirm or reject (with explanation) all entries within seven days. As regards temporarily taken-over works, the final quantity and quality shall be established at the final taking-over; the quality shall be partially established also at the complete taking-over upon the expiry of the liability period.

Final taking-over

The final taking-over shall be performed after the completion of the construction or on the basis of the contract provisions. The final settlement submitted by the Contractor according to Technical Specifications shall be used as the basis for the final taking-over if the quantities and quality of the performed works have been mutually confirmed.

If an agreement on the quantities and quality has not been reached, the Contractor shall have the right to submit their final settlement with the corresponding documents to the Engineer for a review.

As regards taking over of works where the quality is also evaluated, the Customer shall deduct payment for poorly performed works. The taking-over shall be final as regards the installed quantities, but does not encompass the warranty. The Defects Notification Period shall begin on the date of taking-over in accordance with the contract.

As regards the final taking-over, the Engineer shall name a committee for a thorough examination of the quality of the performed works. The Contractor shall prepare a Proof of Plant Reliability in accordance with the applicable regulations for the final taking-over. The costs of the preparation of the Proof of Plant Reliability shall be borne by the Contractor. The final taking-over shall be completed by the issue of the Taking-Over Certificate.

Complete taking-over

The complete taking-over shall take place after the expiry of the liability period according to the provisions of the contract concluded between the Customer and the Contractor. The complete taking-over shall be completed by the issue of the Performance Certificate. During the liability period all Contractor's obligations in the sense of the contract provisions shall apply.

3 LOT TG PART A

3.1 GENERAL TECHNICAL SPECIFICATIONS FOR MECHANICAL SCOPE

This general technical specifications shall apply to the production, supply and assembly of the Francis turbine with a horizontal shaft and generator, flywheel, turbine governor, inlet elbow and cone, pressure regulating valve, main inlet valve and all other necessary and auxiliary equipment. The equipment supply means supply to the site.

3.1.1 Standards and regulations

The production, supply and erection of the equipment shall be in accordance with the relevant EN standards, ISO/IEC standards and other national standard applicable in Slovenia, unless otherwise instructed.

In addition to the above, other standards may also be used if approved by the Customer.

Special requirements shall be stated in the tender documentation.

3.1.2 General criteria for designing

All supplied equipment and components must be accurate and reliable designed. Stress levels shall not be too high and the equipment shall not have excessive deformations and vibrations.

All equipment shall be designed for the highest anticipated operating pressure or rotational speed and for the highest head and flow. Where it is necessary, other external influences (earthquake, wind etc.) shall also be taken into account in accordance with the engineering practice and applicable regulations.

The estimated life-time of the equipment is 40 years so attention has to be paid to components with dynamic loads, such as permanent dynamic strength and material fatigue.

Basic stress levels may be calculated using the “Von Mises” method for medium voltage.

Basic stress level for individual materials shall not exceed 1/3 of the material’s ultimate strength. Torsional strength of max. 35MPa shall be taken into consideration for the shafts.

The supplier of turbine and generator equipment is required to give all the forces which will be transferred to the civil structures and all other information for making the detailed design drawings of civil structures.

Water hammer pressure in the penstock shall not exceed the value of 1.5 x static pressure (H_{gross}) measured at the turbine axle elevation due to any operational condition or incident.

3.1.3 Manufacturing of equipment

3.1.3.1 General requirements for welded constructions

The Contractor shall prepare the necessary documentation on the welding procedures, heat treatment and procedures for verifying the welds on steel constructions, which will be confirmed by the Customer/Engineer.

All welding shall be done by certified welders and verified according to standards series EN ISO 9606.

Welding shall be done in accordance with the requirements of the standards series EN 1011 and EN ISO 15614.

4 mm is the smallest permitted dimension of fillet welds.

Undercuts are not permitted on elements which are subjected to material fatigue.

3.1.3.2 General requirements for equipment design

Various bearings and sliding (wear) rings shall be designed for easy access and inspection. Important sealing elements which are not accessible shall be equipped with a drain.

Structure vibrations due to water flow shall be prevented.

The structure shall be such that corrosion effects are minimised and that a surface protection is possible to do easily. Galvanic links shall be prevented.

Bolts and nuts, smaller and the same as M16 shall be stainless. The rest can be hot-dip galvanized or brominated. Washers shall be of the same quality as the nuts. Screw connections shall be properly sized for its intended use and protected against loosening due to vibration.

High-tension bolts of quality 8.8 or more for use in corrosive media shall be allowed by the Customer.

Heavier elements shall have foreseen preparing's and attachments for transport and an assembly.

Equipment for pressure, flow and temperature measurements shall be made of stainless steel materials.

Flanged connections shall be made in accordance with EN 1092-2. Full face flange gaskets shall be made of EPDM with a metal reinforcement ring. "O-Ring" type seals shall be made in accordance with EN 12560. One bolting link on the flanged connection shall have a toothed washer on both sides and a bolt head painted red.

Valves shall be made according to DIN 3230, with leaking class 1 according to DIN 3230 part 3.

3.1.4 Materials

3.1.4.1 General

Materials used shall be suitable for conditions of use and the parts exposed to cavitation shall be made of cavitation resistant material. Only standardised materials shall be used. The Customer has the right to require additional tests, which would be necessary to demonstrate the suitability of materials.

3.1.4.2 Attestations and certificates

All materials used for main structures shall be attested and taken over according to EN 10204, type 3.1.B. While the forgings and castings for turbine parts and shafts after 3.1.C.

Material certifications shall demonstrate the chemical composition and mechanical properties (tensile strength, yield point, elongation and Charpy Impact Test at 0ºC).

All certifications for installed materials shall be enclosed to the Takeover documentation. Traceability of materials shall be ensured for the most important equipment.

3.1.4.3 Material for turbine runner and turbine guide vanes

Forged chrome-nickel-molybdenum steel according to EN10088 like X3CrNiMo13-4 (1.4313) with an additional Q&T treatment shall be used for the runner. The same or similar material shall be used for the guide vanes.

Stainless steel materials for general use shall be austenitic chromium-nickel steel, X5CrNi18-10 type.

3.1.5 Assembly and installation

3.1.5.1 General requirements

All welds shall be done as continuous welds. Areas which cannot be completely plugged-in shall be filled-in with a suitable mixture prior to painting.

Welding of combined materials (stainless with regular) shall be done only with higher quality electrodes or with higher-alloyed electrodes than the stainless material.

Welding of stainless steel pipes shall be carried out by TIG procedure. Welds shall be suitably passivated. On the side where the welds are in contact with water, they shall be ground smooth and without any undercuts.

Foundation bolts and similar material shall be welded only to the outer elements support in a way that the load capacity of the welds and bolts is equal. Bolts not fully embedded in concrete shall be made of stainless steel.

3.1.5.2 Heat treatment

Welded and coldly or warmly processed structures, which will be during operation under high loads, shall be heat-treated to release internal tensions. A heat treatment diagram shall be enclosed to the Takeover documentation.

3.1.6 Assembly

Assembly works except assembly works for hydraulic governor with all pipes and connections shall be done by the Customer.

The Contractor shall provide the instructions and supervision of the assembly, perform all the required measurements according to the control plan, and supply all the required special tools and measurement devices.

The Contractor for LOT TG, Part A shall install the supplied hydraulic governor and all the pipes and connections from the governor to the servomotors.

3.1.7 Commissioning tests

The Contractor for LOT TG, Part A shall manage and perform all the required commissioning tests for the entire SHPP in collaboration with the Customer and other contractors (LOT TG Part B, LOT C Penstock, LOT A Civil works and hydro mechanical equipment).

3.1.8 Control and testing

3.1.8.1 General

The equipment and components shall be subject to all the required controls and tests to prove their compliance with the planed requirements. Taking-over at the supplier shall also be included. See in item 2.6 a sample of the QA plan which shall be taken into consideration to prepare final one. The QA plan will be confirmed by the Customer.

The Customer shall be able to access to the supplier's workshop during equipment manufacturing.

All testing and checks shall be documented and the relevant documents submitted to the Customer at any time upon their request; the relevant documents shall be enclosed to the Takeover documentation. All testing and inspection where required shall be announced in due time.

The Contractor shall perform the checks and controls also at their approved subcontractors.

All measuring equipment used for the controls and testing shall be available to the Customer free-of-charge and be properly certified, i.e. calibrated.

3.1.8.2 Material destructive testing

Material testing shall conform to the relevant EN standard. In general, a suitable number of test tubes for chemical analyses and mechanical testing shall be provided.

3.1.8.3 Material non-destructive testing

All elements shall be 100% visually inspected and in accordance with the QA plan also by other methods.

Surface defects:

A magnetic inspection shall be used to detect surface defects, except for non-magnetic material where penetration inspection can be used. A combination of both can be used or requested in special cases.

Internal defects:

An ultrasound inspection shall be generally used for detecting internal defects. Radiographic inspection can be also requested in special cases.

Scope of inspection:

Scope of inspection shall be defined in the QA plan.

All metal sheets for supporting elements thicker than 30mm shall be inspected regarding its laminations in accordance with EN 10164. All main castings and forgings parts shall be 100% inspected for surface and internal defects.

Welded parts stressed by internal pressure shall be 100% inspected for surface defects and 50% for internal defects.

Material for the shaft and turbine (runner) shall be 100% inspected for surface and internal defects.

Defect acceptance criteria shall be defined according to the envisaged stress and relevant standards.

Acceptance criterion according to ISO 5817 class C shall be used for welded joints and according to CCH 70, class 2 for castings.

3.1.8.4 Dimension control and balancing

All the main dimensions of the equipment or the elements shall be in line with the stated requirements and drawings. Suitable measuring protocols shall be prepared for all the important dimensions (in the factory and at assembly). Rotating parts shall be correctly static and/or dynamic balanced.

3.1.8.5 Pressure tests

Equipment sizing pressure shall be the highest static pressure increased by water hammer pressure which shall not exceed 1.5 x static pressure (H_{gross}).

Pressure tests (e.g. elbow, cone and inlet valve, spiral case, pressure regulating valve, pressure vessels, hydraulics piping etc.) shall be done at a minimum of 50% above the designed pressure for at least 30 minutes.

The main penstock will be tested as part of LOTs C and A. The inlet elbow and cone shall be tested together with the penstock.

3.1.9 Vibrations, run-outs and noise

Vibrations and run-outs on the turbine and the equipment shall not exceed category A according to ISO10816-5 standard and category A according to ISO 7919-5 standard for new equipment in the whole field of operation. Shaft run-outs shall not exceed 60% of the estimated radial bearing clearance.

Noise level shall not exceed 85dB(A) in the area of 1 m away from the power unit.

3.1.10 KKS marking

Classification and marking of individual parts of the equipment shall follow the internal HSE coding standard KKS for hydroelectric power plants. This marking system allows for a unified plant maintenance according to equipment function, installation location and building areas. The equipment shall be marked with a KKS code:

a) in the technical and design documentation, on diagrams and all drawings;

b) directly on equipment and components with nameplates;

c) the Contractor will receive the coding manual according to the KKS standard after signing the contract.

3.1.11 Spare parts

3.1.11.1 Obligatory spare parts

The Contractor shall enter the price for obligatory spare parts in the Schedule of Prices. The sum (total price) shall be added to the total tender price.

3.1.11.2 Recommended spare parts:

The Contractor shall enter the price for spare parts that they recommend in the Schedule of Prices. The price shall be valid for three years after signing the contract and won't be included in the total tender price.

The Customer shall purchase the spare parts from the Contractor if needed within three years at the stated price.

3.1.12 Documentation

The Contractor shall prepare all the required workshop documentation, instructions for installation, operation and maintenance instructions and takeover documentation. The workshop documentation shall include calculations, drawings, dimensional drawings, instructions, procedures etc. for the manufacturing and assembly of the equipment under this contract. All changes shall be documented during the manufacturing and assembly. The documentation shall be used also for preparing the detailed design drawings and as-built documentation.

The instructions, technical descriptions and requirements shall be in Slovenian language.

All elements shall be defined in the bill of materials. Relevant technical certificates and brochures shall be prepared for the smaller purchased elements.

Unless otherwise agreed, the following documents are required as a minimum:

a) turbine calculations and its parameters, pressure regulating valve (turbine bypass valve) and turbine hydraulic governor;
b) calculation of the mass moment of inertia of the unit's rotating parts by determining the flywheel;
c) shaft calculations and critical rotational speed (turbine - generator);
d) strength calculations for the pressurized equipment (inlet elbow and cone with bifurcation, turbine inlet valve, turbine spiral casing, covers etc.)
e) slide bearing loads;
f) calculation of transient phenomena in the whole water system for defining closing lows of the turbine guide vanes, inlet valve and the pressure regulating valve (plunger) etc.

The documentation shall contain all the required information on the bolt tightening torque, assembly or tolerances between the elements, levels of lubricating or cooling liquids etc.

3.1.13 Anti-corrosion protection

Anti-corrosion protection shall be provided to all elements manufactured from materials which can corrode, in accordance with the anti-corrosion protection plan prepared by the Contractor and confirmed by the Customer. The protection shall meet the requirements of at least class C3E of the SIST EN ISO 12944 standard.

Special attention shall be given to the galvanic protection of the embedded parts. The Contractor's galvanic protection plan shall be confirmed by the Customer.

All work regarding surface protections shall be properly documented.

Color shades and types of material shall be confirmed in the anti-corrosion plan.

Individual elements (valves etc.) can be factory protected without a prior confirmation by the Customer if requirements are met. The basic requirements for surface control are stated in the following table:

ANTI-CORROSION PROTECTION

No.	Surface	Preparation	Surface protection system								
				Primer			Intermediate/final coating			RAL shade	Total thickness
		Sandblasting Cleaning	Manufacturer*	Name	No. of layers	Thickness of dry film µm	Name	No. of layers	Thickness of SF µm		Nominal (minimal) µm
1	Surfaces in constant contact with water	Sa 21/2	SIKA	SikaCor Zinc R	1	60	Sika Poxitar F	3	(3x) 130	black/ brown/black	450 (360)
			AGRO	Agrozinc SW	1	60	Avertol Epotar	3	(3x) 130		
3	Surfaces exposed to air and moisture condensation (C4)	Sa 21/2	SIKA	SikaCor EG Phosphat	1	60	SikaCor EG1 EG5	1 1	120 60	Determined later	250 (200)
			AGRO	Agropox Phosphat	1	60	Agropox 10EG Agropur MG	1 1	120 60		
4	Treated surfaces (storage up to 2 months)	Cleaning with aliphatic hydro-carbons	Valvoline	Tectyl 506	1	30					30 (30)
5	Surfaces in contact with concrete	250mm long passage air/concrete made into concrete according to system No. 1									450 (360)
6	Surfaces in contact with oil	Sa 1/2	AGRO	Agropox 240 Thix	1	60	Agropox 240 Thix	1	60		120 (90) max160
7	Hot-dip galvani-zed parts	Life-time min. 15 years in corrosion category C4 (compliant with ISO 14713 and ISO 1461)									45-85

* Manufacturers are given for reference only.

3.2 SPECIAL TECHNICAL SPECIFICATIONS FOR MECHANICAL SCOPE

3.2.1 General

These specifications refer to the design, manufacture and testing during manufacture, transport to the site, assembly, testing and commissioning tests at site for one (1) Francis turbine with a horizontal shaft and related mechanical installations and equipment.

In order to simplify maintenance of the equipment, it is important that the Contractor shall use in the design and execution standardized equipment which is available on the European market.

The electrical scope including the generator is specified in items 3.3 and 3.4 of these specifications.

The scope of supply means all the required equipment and elements necessary for complete, functional and safe operation. All supplied equipment shall be fully installed, tested and provided for operation.

The scope of supply shall include all parts, accessories, etc., which are essential for the construction, operation and maintenance of the entire power unit although they are not individually or specifically mentioned in these specifications.

The turbine manufacturer and supplier (the Contractor) shall coordinate all that is required with the supplier of the generator, such as the method of coupling the generator to the turbine shaft, flywheel to the generator, rated rotational speed, runaway speed, mass moment of inertia, (over)load capacity for all operating conditions and all other relevant requirements.

In the sense of unit configuration and operation, the Supplier shall be responsible for a stable, safe and reliable operation of the entire water system from the intake structure to the outflow into the tail water. All because of transient phenomena such as pressure fluctuation in in the penstock due to turbine starts and stops, increasing and decreasing turbine power, with a maximum allowable water hammer pressure, etc.

Occurrence of the negative pressure (vacuum) in the penstock due to operation of the turbine is not allowed.

All construction products (equipment) shall be equipped with a declaration of performance and/or a CE marking and an EC declaration of conformity according to Regulation (EU) 305/2011 and the Construction Products Act (OG of the RS 82/2013).

The arrangement of equipment in the power house is shown in the drawings (see in Enclosures).

3.2.2 Basic hydraulic data for a Francis turbine with horizontal shaft

3.2.2.1 Data for designing the turbine and related equipment:

a) Head water elevation:	
• Maximum operating elevation:	405.00 m a.s.l.
• Rated operating elevation:	403.20 m a.s.l.
• Minimum operating elevation:	403.20 m a.s.l.
b) Tailwater elevation:	
• nominal level at turbine flow of 1.5 m^3/s:	329.70 m a.s.l.
• nominal level at turbine flow of 0 m^3/s and at sQ_s*1 in the Kneža River:	329.50 m a.s.l.
• maximum level (100-year water level) and Q_{100}*2 in the Kneža River:	331.25 m a.s.l.
c) Power house floor elevation:	331.95 m a.s.l.
d) Flow:	
• Maximum flow:	Q_{max} = 1.5 m^3/s
• Minimum flow:	Q_{min} = ca 0.35 m^3/s
e) Gross head:	
• Rated gross head at the rated operating head water and tailwater elevation at turbine flow of 0 m^3/s:	73.70 m H_2O
• Minimum gross head at the rated operating head water elevation and maximum tailwater elevation at turbine flow of 0 m^3/s:	71.95 m H_2O
f) Average water temperature:	12 °C
g) Water density:	ρ = 999 kg/m^3
h) Gravitational acceleration:	g = 9.81 m/s^2
i) Earthquake design acceleration:	a_0 = 0.26 x g
j) Ambient temperature (min/max):	-20 °C / +35 °C
k) Minimum temperature in the powerhouse:	+5 °C

Note:

*1 Mean annual flow,

*2 Maximum flow at 100-year return period

3.2.2.2 Data for penstock and outflow channel:

a) Maximum allowed water hammer pressure at turbine runner axle:	110.6 mH_2O (1085 kPa)			
b) Minimum allowed water pressure at turbine runner axle:	Vacuum not allowed			
c) Total penstock length:	2297 m			
d) Ratio between the length and gross head:	31.2			
e) Polyester (GRP) penstock dimensions, rigidity SN10000 (divided into three equally long parts with an average length of 766 m):	*Pipe type:*	*Dimension (mm):*	*Transient wave speed propagation (m/s)*	*Elastic module (MPa)*
	Upper part DN1000/PN6	$1026^{+1}_{-2.6} \times 19.2$	410	10000
	Middle part DN900/PN10	$924^{+1}_{-2.6} \times 17.3$	415	9900
	Lower part DN800/PN16	$820^{+1}_{-2.4} \times 14.0$	495	15700
f) Surge tank:	It is not foreseen			
g) Typical design turbine net head for GRP penstock*1:				
• Rated net head at the rated head water and tailwater elevation at maximum turbine flow of 1.5 m^3/s:	approx. 64 m H_2O			
• Formula for calculating the net head acc. to flow for GRP penstock*1:	$H_{netoGRP} = -3{,}9908Q^2 - 0{,}8833Q + 73{,}785$			
h) Outflow channel dimensions a x h:	1.0 x 1.2 m			
i) Outflow channel length:	43.0 m			
j) Outflow channel material:	Prefabricated reinforced concrete pipe			
k) Pressure loss in outflow channel:				
• Pressure loss at maximum flow of 1.5 m^3/s and at rated tailwater elevation:	approx. 0.25 mH_2O			
Note	*1 For calculation of the net head were considered pressure losses in the penstock, inlet butterfly valve and in the outflow channel at the rated gross head and the given flow. Penstock roughness coefficient C = 150 according to Hazen-Williams was considered.			

The Contractor shall be responsible for a stable, safe and reliable operation of the entire water system. This shall be proven by all the required calculations (such as calculations of transient phenomena and other) and during the unit's commissioning tests.

Known data for the waterway and the operational characteristics of the provided power unit as a whole shall be taken into account. Increase of pressure in the penstock, increase of runaway speed, flow and closing the guide vanes and main inlet valve shall be presented in a combined diagram. All data shall be provided for the most unfavorable operating conditions without including the operation of the pressure regulating and bypass valve including sudden generator load rejection at fully open guide vanes when the guide vanes are closed according to the planned closing law, and if the guide vanes or other closing mechanism fail to close.

3.2.3 Scope of supply for the main and auxiliary mechanical equipment, for LOT TG

3.2.3.1 Scope of supply of the main mechanical equipment:

a)	One (1) set	Francis Turbine with horizontal shaft	More detailed descriptions of the individual sets are provided below.
b)	One (1) set	Flywheel with hydraulic brake	
c)	One (1) set	Electronic overspeed safety device	
d)	One (1) set	Inlet elbow and cone	
e)	One (1) set	Pressure regulating and turbine bypass valve (plunger) with outlet pipe	
f)	One (1) set	Main inlet valve (MIV) with bypass	
g)	One (1) set	Assembly/disassembly piece	
h)	One (1) set	Turbine hydraulic governor	

3.2.3.2 Scope of supply of the auxiliary mechanical equipment:

a)	One (1) set	Steel structures, platforms and fence	More detailed descriptions of the individual sets are provided below.
b)	One (1) set	Generator bearings cooling system	
c)	One (1) set	Turbine drainage system	
d)	One (1) set	Pressure and temperature measurements	
e)	One (1) set	Monorail crane	
f)	One (1) set	Console monorail crane	
g)	Two (2) sets	Cover for carrying out pressure test	
h)	Two (2) sets	Axial fan with grille	

3.2.4 Francis turbine

The unit, composed of the turbine, flywheel and generator, shall be assembled on a rigid steel sub-structure to enable simple assembly and mutual centering of all rotating parts. A preliminary assembly shall be done at the Contractor's workshop.

The acceptance tests shall be performed in accordance with SIST EN 62006:2011 (IEC 62006), Acceptance tests of small hydroelectric installations. The Contractor shall prepare testing plan to be confirmed by the Customer.

Summary of data for the turbine:

a)	Turbine:	Francis, horizontal shaft.
b)	No. of turbines	1
c)	Turbine's direction of rotation:	Clockwise viewing from generator side.
d)	Runner axis elevation:	approx. 332.70 m a.s.l.

Summary of turbine's operational characteristics:

a)	Maximum flow:	1.5 m^3/s
b)	Minimum flow*1:	0.35 m^3/s
c)	Max. mechanical power*1:	> 850 kW
d)	Submersion of turbine runner:	approx. +3.00 m (above tailwater)
e)	Nominal speed:	N_n = 1000 min^{-1}
f)	Maximum runaway overspeed*1:	N_{pmax} = ≤ 2000 min^{-1}
g)	Moment of inertia of all rotating mass*1:	min 250 kgm^2
h)	First critical speed of rotating parts*1:	N_{kr1} = 1.2 x N_{pmax} = ≤ 2400 min^{-1}
i)	Runaway duration:	at least 60 min

Note: *1 Preliminary data. The Contractor shall make detailed calculations.

3.2.4.1 Spiral casing with stay vanes and turbine cover

a) One (1) set	Spiral casing with stay vanes, made from blended steel plates and welded together

The turbine's spiral casing shall have a suitable hydraulic shape and shall be directly bolted onto the common turbine and generator supporting structure which is (partly) concreted into the floor of the power house.

A stay vane ring with a suitable number of fixed hydraulic shaped stay vanes shall also be part of the spiral casing.

The robust casing shall be equipped with at least two revision openings with a cover for control and cleaning of the interior, the necessary fittings for analogue and digital measurements (pressure etc.) and standard lifting hooks for carrying and transport.

Adequate pressure relieving of the turbine cover shall also be ensured if it is necessary.

The DN50/PN16 drainage connection shall be installed on the turbine spiral casing inlet.

The spiral casing shall be:

a) designed for maximum pressure, forces and torque which could occur under any operating conditions and during the shut-down under full flow, and so that excessive vibrations during operation are prevented;
b) positioned so that the forces and vibrations due to the water flow and pressure under all foreseen operating conditions have no adverse impact on the power house building and to unit's other equipment;
c) completely workshop tested (pressure and functional test) prior to the supply to the site.

3.2.4.2 Turbine guide vanes mechanism

a) One (1) set	Turbine guide vanes mechanism

The turbine guide vanes shall be composed of a suitable number of movable and controlled vanes made from the same or similar material as the runner. The number of guide vanes and runner vanes shall be different and harmonized to prevent any undesired vibrations, pulsations and resonance.

Individual vanes shall be made of one piece and shall be equipped with extensions on both sides for installation of self-lubricating bearings. The hydraulic shape shall be carefully selected to ensure that the hydraulic torque which is applied to the vane at the full operational opening A0 is directed toward closing.

They shall be positioned inside the left and the right guide vane ring and around the runner. The rings to which the standard self-lubricating bearings of the vanes are inserted can be made of stainless steel and shall be attached to the spiral casing with bolts.

The vanes shall be moved by the turbine governor's servomotor via the regulation ring and the related levers to regulate the flow from the completely closed to completely open position.

The levers and the ring shall be made of stainless steel. The ring's bearings shall be arranged in a way which ensures a precise and long-term operation without an increase in clearance.

The hydraulic servomotor shall have a built-in device with a 4-20 mA signal for a continuous measurement of the guide vanes opening. Where necessary, all the relevant limit switches shall be installed.

Guide vanes extensions shall be elongated on one side for installing the levers which shall be connected to the regulation ring on the other side. The lever mechanism shall have a suitable number of shear pins. The ring shall be connected to the servomotor's piston rod.

3.2.4.3 Runner

a) One (1) set	Runner

The Francis runner shall be made of special stainless steel with good mechanical, chemical, anti-corrosion, anti-abrasion and anti-cavitation properties. Examples include forged chromium-nickel-molybdenum steel according to EN10088:2005 standard, such as X3CrNiMo13-4 (1.4313) with additional Q&T processing.

The runner as a whole shall have a suitable geometrical hydraulic shape with regard to the operating parameters, whereby the estimated efficiency without cavitation in the entire operating area is ensured. It shall be built onto the extended generator shaft. The runner shall be correctly balanced (static and dynamic balance).

3.2.4.4 Turbine shaft seal

a) One (1) set	Turbine shaft seal

A seal shall be positioned on the guide vane ring on the generator side and shall be of a disassembly and contactless type and ensure a reliable long-term operation without maintenance. A replaceable bushing from a more durable and harder material than the shaft's material shall be installed on the generator shaft extension.

A drainage connection shall be positioned on the external side of the turbine shaft seal casing.

3.2.4.5 Draft tube

a) One (1) set	Draft tube made from blended steel plates and welded together

The turbine's draft tube shall be of a suitable hydraulic shape to ensure maximum efficiency and the lowest possible vibrations and pulsations.

The draft tube's elbow shall be equipped with a flange on both side to enable an easy assembly and dismantling. On the upper side it shall be screwed onto the turbine outlet side and on the lower side into the draft tube.

The lower inclined draft tube part where it passes through the concrete slab into the tailrace chamber shall be concreted using a sealing and anchor flange. The lower part will be constantly submerged in the tailwater.

The draft tube shall be designed in such a way to withstand all forces in all operating conditions.

3.2.5 Flywheel with hydraulic brake

a) One (1) set	Flywheel with hydraulic brake

A flywheel made from one piece shall be installed on the non-drive end of the generator shaft to increase the moment of inertia of the unit's rotating parts.

Due to the foreseen large rotating mass of the flywheel shall be carefully statically and dynamically balanced.

The flywheel shall be designed with a harmonized diameter and thickness to ensure that the moment of inertia meets the condition so that the maximum allowable waterhammer pressure in the penstock will never be exceeded at any type of shut-down, even when the pressure regulation valve fails. Particularly in this case it shall guarantee the maximum allowed increase in pressure and speed.

The flywheel brake shall enable a faster stopping of the rotation and be equipped with a servomotor controlled via a turbine governor. It shall begin to brake at approx. 30% of the nominal speed. The servomotor's movement shall be detected by inductive limit switches.

3.2.6 Electronic overspeed safety device and speed monitoring

a) One (1) set	Electronic overspeed safety device

An electronic overspeed safety device shall be built into the shaft between the turbine and the generator (or on the non-drive end of the generator) It shall be protected with a cover.

The electronic overspeed safety device shall monitor the turbine's speed with at least two inductive sensors via a toothed ring to ensure operation according to SONDO requirements. The equipment shall also be included in the operating protection system referred to in LOT TG Part B. It shall initiate the turbine shut-down when the nominal speed is increased by 15%.

The speed required for regulation shall be monitored via sensors on the toothed ring.

3.2.7 Inlet elbow and cone

a) One (1) set	Inlet elbow DN800, R = 3 x DN.
b) One (1) set	Inlet cone DN800/DN700.

An inlet elbow and cone shall be positioned at the entry to the powerhouse. Both shall be made of bended steel plates and welded together. They shall be connected to the penstock with flange. The flange on the steel part shall be rotating. The connection shall be performed by the LOT TG Contractor in the presence of the LOT A Contractor. The flange's standard dimension shall be DN800/PN16.

The elbow shall be equipped with reinforcements and concreted into the anchor block. An anchor and seal flange shall be welded onto the elbow where it passes through the concrete power house wall. The welded joint between the elbow and the cone is foreseen in the powerhouse inner side, using a so-called at-site assembly weld.

A main inlet valve shall be screwed onto the cone other side using a flanged connection - expected DN700/PN16.

The following shall be built onto the cone:

a) Bifurcation with a flanged fitting for installing the bypass valve;
b) Flanged inspection opening with a removable cover of DN300/PN16 dimensions. The cover shall be properly designed with a hydraulic shape on the inner side so that water flow is not disturbed.
c) A flanged connection (expected DN80/PN16) is foreseen for the by-pass pipe of main inlet valve and required attachments for pressure and temperature measurements.

3.2.8 Pressure regulating (plunger) and turbine bypass valve

a) One (1) set	Pressure regulation (plunger) valve and turbine bypass

The valve shall have the following functions:

a) Regulating pressure in the penstock in case of any type of turbine shut-down. Such a valve is usually called a "Plunger valve" or a "Pressure Regulating Valve". In the following text will be named "PRV" valve.

b) It shall also function as a turbine bypass valve which enables the water to bypass the turbine when it is not in operation. Generation of electricity of the downstream power plant with an intake structure at the Kneža SHPP's outflow will thus be less disturbed.

c) It shall also be possible to empty the penstock through the valve.

d) It shall be installed on the flanged fitting of the inlet cone.

3.2.8.1 Pressure regulation

Due to a relatively a large penstock length and gross head ratio and therewith related pressure increase in the penstock at any kind of turbine shut-down, the PRV shall begin to open synchronously to reduce the increase in pressure and overspeed. It can also prevent occurrence of vacuum.

If the PRV fails to open or does not begin to open due to any reason, it shall be ensured that the pressure increase and the run-away speed are not too great. This shall be ensured by long-enough closing laws of the MIV and the turbine guide vanes mechanism, and by a sufficient moment of inertia of the unit's rotating parts.

3.2.8.2 Turbine bypass

In this case, the valve shall also perform the role of a turbine bypass, or so-called ramping. After the pressure regulating has been done and the guide vanes and the main inlet valve remain closed, the valve shall remain open. In temporary shut-downs the valve shall remain open the entire time to ensure that the disturbance of the water flow to the downstream power plant is minimized. Opening of the valve shall be controlled via the same systems as those used for regulating the turbine. In the ramping function the flow shall be regulated according to the level in the upper intake reservoir. When the unit is restarted, the closing of the valve shall be harmonized.

When the unit is out of operation for a longer of time, the closing of the valve shall be done slowly enough so that over-spilling water comes down from the upper reservoir to the downstream power plant by riverbed in such a way that the operation of the downstream power plant is not influenced too much. It is estimated that this procedure would take several hours. The exact method and duration of the procedure shall be determined during commissioning tests. In any case, the closing law shall never be shorter than the laws applicable for the main inlet valve and the turbine guide vanes.

3.2.8.3 General description

Flanged needle valve shall be of an angular type due to space restriction. A straight type is also possible if it can be positioned in the powerhouse. The valve is a needle valve with flanged fittings on both sides. The valve shall be designed and constructed in a way that cavitation damage is prevented. To ensure this, it shall be equipped with an air inlet connection, anti-cavitational mesh or another suitable element.

Opening, closing and regulating of the valve shall be done with a built-in servomotor of the hydraulic governor. It shall be controlled via its own proportional valve and equipped with device with a 4-20 mA signal for a continuous measurement of the valve opening. Where necessary, all the relevant limit switches shall be installed.

3.2.8.4 Valve's outlet pipe and energy dissipation

An outlet pipe with a suitable hydraulic shape which passes to the lower tailrace chamber shall be screwed onto the outflow end of the valve using a flanged connection. The pipe shall be made of metal plates, welded together and embedded in a concrete block. An energy dissipater shall be embedded if required.

3.2.9 Main inlet valve with bypass

a) One (1) set	Main inlet valve with bypass (MIV)

The main inlet valve shall be a butterfly valve DN700/PN16.

The hydraulic shape of the valve's rotating body shall be of an eccentric type and ensure minimum pressure losses when it is fully opened and shall operate cavitation free.

It shall be opened using the turbine governor's servomotor and closed with a counter-weight. Opening and closing times shall be adjustable via a control valve which is locked after setting or via a fixed throttle (orifice). Closing time shall be adapted to the condition that the pressure in the penstock at the turbine runner axis never exceeds 110.6 mH2O at any of the turbine's operating points.

The MIV bypass pipe with a main ball or angular needle valve (expected dimension DN80) shall serve for equalizing the pressure on both sides of the MIV before it is opened. No cavitation is permitted during operation. The valve shall be opened and closed using the hydraulic governor's servomotor.

A service ball valve with a full intersection of the expected dimension DN80 and a lever for manual manipulation shall be installed on the bypass pipe upstream side.

The MIV and the main bypass valve shall be equipped with inductive limit switches for open and closed position. The MIV shall also be equipped with a switch for correcting the movement from an open position if it is necessary.

The valve as a whole shall be:

a) designed that it can withhold all pressure, forces and torque which could occur under any operating conditions and during the closing under full flow, and that excessive vibrations during operation are prevented;
b) installed is such a way that the forces and vibrations from the water pressure are not transmitted onwards to the turbine. This shall apply to all operating conditions, when the valve is closed, and when closing or opening under the flow is under way;
c) workshop tested (pressure and functional test) prior to the supply to the site.

3.2.10 Assembly/disassembly piece

a) One (1) set	Assembly/disassembly piece

This flanged piece with expected dimension DN700/PN16 shall be installed between MIV and turbine spiral case.

All flanged bolting material shall be made of stainless steel (e.g. A2-70 quality) and the flange gaskets shall be made of EPDM with a steel reinforcing ring.

3.2.11 Turbine hydraulic governor

a) One (1) set	Turbine hydraulic governor with a control unit, oil pressure device and a pressure accumulator.

3.2.11.1 Hydraulic control unit

The hydraulic control unit shall provide all the movement required for controlling the turbine guide vanes, MIV and the related by-pass valve, PRV and the hydraulic brake on the flywheel via the servomotors.

In addition to the automatic operation via proportional valves, manual operation shall also be envisaged using three-way valves with two magnets. At least the turbine guide vanes and the PRV valve shall be controlled via the proportional valves.

The system shall enable the unit's operation in one operational mode:

a) Regulation by flow (level in the upper reservoir) parallel to the grid operation.
b) Water level regulation in the upper reservoir with the PRV valve when the turbine is not in operation short time. This is when the PRV also functions as a parallel bypass. Regulation of PRV opening shall be adapted to the water inflow to the upper intake reservoir where the water level shall remain the same. See also PRV description under item 3.2.8.
c) Water level regulation in the upper reservoir with the PRV valve when the turbine is not in operation long time. See also PRV description under item 3.2.8.

The equipment's service voltage shall be 400 V AC, and its control voltage shall be 24 V DC.

3.2.11.2 Oil pressure device

The oil reservoir shall be welded from steel sheets with a volume for a sufficient quantity of oil used within the system. A bottom collecting container with at least 5% larger volume shall be mounted below the oil reservoir. The reservoir shall be equipped with at least a visual oil level indicator, oil and temperature gauge, rotational low-temperature electric heater, a large enough opening for inspection and maintenance with a cover, filling and emptying connections, venting connection with a filter and a moisture absorber.

Oil cleanliness shall be at least 19/17/14 according to ISO 4406. Oil shall be filtered using a double filter of a suitable capacity with a visual and electric clogging control. Filter replacement shall be possible during the operation. Water drops are not permitted in the oil. Up to a max. 30% relative humidity is permitted.

The recommended maximum oil working pressure is 6.4 MPa.

Two identical, motor driven high-pressure pumps shall be mounted on the oil reservoir. One of the pumps is spare for operation during servicing of the other. The selected type enables a stable and quite operation. The flow shall be selected in such a way to enable a double volume of all servomotors per minute. A non-return, relief valve shall be built in on the pressure side, which is set to 10% higher pressure than the maximum working pressure and is designed for the flow of one pump. A safety pressure switch shall be set to a 15% higher pressure. The pump's operation shall not cause any unnecessary overheating of the oil. The oil temperature shall be up to approx. 40°C; thus an additional cooler is not planned.

A pressure accumulator shall also form part of the device. It shall ensure constant pressure in the hydraulics system, prevent excessive starting of the pump and possible oil overheating, and shall ensure a safe shut-down

of the unit including a parallel opening of the PRV valve. The accumulator shall be of a membrane type and pre-filled with nitrogen. It shall be equipped with manometers, fittings for filling and emptying of the nitrogen and oil, and a safety discharge valve.

The device shall be connected to the servomotors (hydraulic cylinders) via high-pressure hydraulic pipes made of stainless steel and via high-pressure flexible pipes where necessary. All other valves, fittings and fixing material shall be installed. Pipes and fittings shall be made according to a cold forming process, such as Parker EO2 Form or similar. A strength and leakage (pressure) test in the duration of at least one hour and with a pressure exceeding the maximum operating pressure by 50% shall be performed after the assembly.

3.2.12 Auxiliary equipment

3.2.12.1 Steel structures, fences and protections

All the required steel structures, platforms, fences and step ladders shall be supplied and installed.

Steel structures:

a) a one-piece supporting steel structure made from standard hot-rolled profiles for assembling the turbine and generator unit with a flywheel.

Fences, protections and step ladders:

a) hot dip galvanized fence with gates and step ladders shall be positioned around the lowered area of the MIV;
b) a suitable protection shall be erected around the flywheel and in the area of the main inlet valve counter-weight, if required.

3.2.12.2 Drainage system

A drainage system shall be provided due to the accumulation of condensed water (leakage of turbine seal, relieving of the turbine cover) and for emptying of the turbine.

All water shall be channeled to the lowered area of the MIV and into a small, deepened shaft. From there water shall run through the pipe, supplied and installed within LOT A, to the external oil separator.

The drainage of the turbine seal and the relieving of the turbine cover shall be done via stainless pipes which run into the tailrace chamber under the turbine.

Emptying of the spiral casing shall be done using a knife gate valve or a ball valve of DN50/PN16 dimensions and the relevant stainless pipes and fittings. The drainage shall run into the tailrace chamber underneath the turbine.

3.2.12.3 Generator bearing cooling system and generator's cooling system

The Contractor shall set the parameters and supply the equipment for the generator bearing cooling system with regard to their standard requirements. Cooling can be done by air or by water.

The generator shall have an own standard forced air cooling.

3.2.12.4 Pressure and temperature measurements

Digital water pressure sensors with a 4-20 mA signal and analogue pressure gauge for a visual indication shall be installed on the suitable places. They shall be connected via valves with a ventilation function. The manometers' stainless housing shall be filled with liquid. Pressure gauges (manometers) shall be of 1.0 class and with a diameter of at least 100 mm and with a range which is 1,5 times higher than the measured pressure..

Temperature sensors (PT100) with a 4-20 mA signal and thermometers for measuring the water temperature shall be inserted into the protective sleeves which are sufficiently submerged in the medium being measured. The sleeves shall be filled with a contact liquid or paste prior to the installation of the sensor or the thermometer.

The sensors and thermometers shall be also embedded into the generator's sliding bearings and elsewhere if so required. The bearings shall be equipped with sensors for monitoring vibrations.

3.2.12.5 Heating and ventilation of the powerhouse

The supply and installation of a natural and forced air ventilation system are part of the scope of works. This shall be designed so that due to the generator's operation the powerhouse will not overheat in the summer and to maintain a suitable temperature during the winter. The estimated air temperature is between +10 and +35˚C.

The fresh air shall enter via gratings on the main door and exit with the help of axial fans via gratings under the ceiling on the opposite wall. It shall be possible to change the flow rate (EM speed) on the fan. The operation shall be regulated by a thermostat mounted on the powerhouse wall.

The Contractor of the LOT TG Part A shall define the appropriate fans and gratings on the basis of the generator's operational characteristics and the requested air flow.

Fans, related gratings and a thermostat shall be supplied under LOT TG Part A and installed under LOT A according to the supplier's instructions. Door inlet ventilation grilles shall be supplied and installed under LOT A.

No other supply of equipment has been envisaged for additional heating of the powerhouse.

3.2.12.6 Monorail crane

a) One (1) set	Monorail crane

The scope of supply for the crane includes a monorail beam, including concreted parts, manually operated chain trolley and an EM rope hoist with a remote control unit.

The monorail beam, mounted on the powerhouse ceiling, shall be of the standard HEB300 (or other suitable) profile and shall run above the longitudinal axis of the turbine and the generator. The length of the beam shall cover the entire length of the powerhouse and shall be 8500 mm long. Suitable bumpers for limiting the hoist movement shall be mounted on both sides of the monorail beam.

The Contractor shall submit all the design data (load, type of installation, dimensional drawings, static calculations etc.) to the LOT A design engineer for the preparation all civil calculations and drawings for powerhouse.

The EM rope hoist shall be mounted on the monorail beam via the trolley. The trolley operation shall be manual via a chain. The trolley shall be equipped with rubber bumpers on both sides. The hoist shall be equipped with a travel limiter. The bearings shall be rolling contact bearings and maintenance free.

The crane's load capacity shall be sufficient to lift the heaviest assembled set on the turbine generator axis during the assembly or disassembly works. The estimated load capacity is 7.5 tones. The exact load capacity shall be defined by the Contractor responsible for the turbine and generator equipment.

The equipment shall be supplied with a CE certificate, standard report on the workshop testing according to the standard procedure of the hoist and trolley manufacturer, and with a certificate for the hook.

After the erection an on-site load test shall be performed according to the procedure prescribed in the Contractor's documentation. An operating permit shall be granted by an authorized crane expert after their inspection and performance of site tests.

3.2.12.7 Monorail console crane

a) One (1) set	Monorail console crane

The scope of supply includes the supply and erection of the monorail beam and manual chain hoist with a trolley.

A rotating monorail console crane shall be mounted on the back wall of the powerhouse, slightly misaligned from the axis of the penstock if necessary. The main console shall be of the standard INP or IPE 240 profile and with a length (expected to be 3000 mm) to cover the assembly and disassembly works of the equipment from the turbine to the back powerhouse wall (inlet cone, main inlet valve, PRV valve etc.) The rotating set shall be equipped with rolling bearings.

Suitable steel bumpers for limiting the hoist movement shall be mounted on both sides of the beam. Bumpers for limiting the rotation of the beam shall also be installed.

The Contractor shall submit all the design data (load, type of installation, dimensional drawings, static calculations etc.) to the LOT A design engineer for the preparation all civil calculations and drawings for powerhouse.

The manual chain hoist shall be mounted on the monorail beam via the trolley. The trolley operation shall be manual via a chain. The trolley shall be equipped with rubber bumpers on both sides. The hoist shall be equipped with a travel limiter. The bearings shall be rolling contact bearings and maintenance free.

The crane's load capacity shall be such that lifting of the heaviest assembly on the turbine and last powerhouse wall axis during the erection and dismantling of the turbine equipment is possible. The estimated load capacity is 1 tone. The exact load capacity shall be defined by the Contractor.

The equipment shall be supplied with a CE certificate, standard report on the workshop testing according to the standard procedure of the hoist and trolley manufacturer, and with a certificate for the hook.

After the erection an on-site load test shall be performed according to the procedure prescribed in the Contractor's documentation. An operating permit shall be granted by an authorized crane expert after their inspection and performance of site tests.

3.2.12.8 Covers for carrying out pressure testing

a) One (1) set	Cover for carrying out the DN700/PN16 pressure test
b) One (1) set	Cover for carrying out the DN350/PN16 pressure test

A DN700 flanged cover with an adapted bottom for closing of the penstock shall be used during the construction stage for the final pressure testing of the penstock and later also for maintenance purposes. The cover shall be equipped with fittings for measurement equipment and attachments for filling and emptying. It shall be designed for the maximum pressure of the pressure test, expected to be PN16.

The flanged cover with an expected rated diameter of DN350 shall be used for closing the branch-off for the bypass valve and pressure regulation. The pressure level shall be the same as for the DN700 cover.

The DN800 inlet elbow and DN800/DN700 cone shall be included in the pressure test.

3.2.13 Various other measurements

Measurements which are part of the other LOTs are described below. Collaboration from the LOT TG Part A Contractor is required as described in LOT TG Part B, electrical scope.

3.2.13.1 Water flow measurement for an ecologically acceptable flow at the upper intake structure

A radar type flow measurement device for the continuous monitoring of ecologically acceptable flow shall be installed on the upper reservoir overspill channel.

The sensor shall be supplied and installed during LOT A.

3.2.13.2 Pressure drop measurements at the R2 intake trash rack at the upper intake structure

The Δp pressure drop sensor (device) with 4-20 mA signals shall be installed in the upper reservoir for measuring the clogging of intake trash rack. The sensors shall be installed into the designated openings and pipes in the wall of the inlet channel if/when the cleaning machine is installed.

The sensors shall be supplied and installed during LOT A.

3.2.13.3 Water level measurements in the upper intake reservoir

The supply and installation of a pressure sensor for a continuous measurement of the water level in the upper intake structure's reservoir (sand trap) with a 4-20 mA signal is envisaged. Namely, the power plant shall operate according to the level in the upper reservoir.

The sensor shall be supplied and installed during LOT A.

3.2.13.4 Measurement of the water flow in the penstock

The supply and installation of an ultrasonic system for measuring the water flow in the penstock is also envisaged. At least one pair of sensors shall be installed in the shaft for the powerhouse, on the GRP DN800 penstock. Sensors shall be installed so that there is at least 10 x DN of the penstock's straight length on the upstream side and 3 x DN on the downstream side. Sensors shall enable measurements through the penstock's wall. See also the description in the Electrical scope of these specifications.

The concrete shaft shall be supplied and installed under LOT A and the flow measurement equipment under LOT TG Part B.

3.2.14 Points of contact with other LOTs

3.2.14.1 Connecting the penstock with the inlet elbow

A bolting flanged connection between the GRP penstock and the steel DN800 inlet elbow shall be performed under LOT A with the participation of LOT TG.

3.2.14.2 Penstock pressure test

The pressure test of the last part of the penstock together with the inlet elbow and cone shall be performed under LOT A and with the participation of LOT C and LOT TG.

3.2.14.3 Hydro-mechanical equipment

The hydro-mechanical equipment (gates at the upper intake structure and in the outflow channel, measurement of the ecologically acceptable flow rate, measurement of water levels in the sand trap etc.) shall be supplied and installed under LOT A.

Collaboration from the LOT TG Part A Contractor is required as described in LOT TG Part B, electrical scope.

3.2.14.4 Civil works

The civil works shall be performed under LOT A. LOT TG shall monitor the activities and participate mainly in the following activities:

a) installation of embedded parts of the first stage (such as base slabs) for the inlet elbow, outlet pipe of the bypass valve, turbine draft tube, turbine and generator's supporting structures, monorail crane, monorail console crane etc.
b) concreting of the inlet elbow, outlet pipe of the bypass valve, turbine draft tube, drainage of the turbine seal and emptying of the turbine, relieving of the turbine cover, turbine and generator's supporting structures etc.
c) The GRP penstock shall be supplied under LOT C and erected under LOT A. The DN800 flanged connection shall be made under LOT TG in the presence of LOT A. The connection shall be installed in a concrete shaft supplied and erected under LOT due to easier access and revisions.

3.3 GENERAL TECHNICAL SPECIFICATIONS FOR ELECTRICAL SCOPE

3.3.1 Medium and low voltage equipment

3.3.1.1 Low voltage equipment

The following standard voltage levels according to SIST IEC 60038 shall be respected for all low-voltage equipment, power and control installations within cubicles, panels, desks etc.

Low voltage AC equipment:

a) Rated voltage: 3x230/400 V
b) Rated frequency: 50 Hz
c) Maximum voltage variation: - 10%, + 15%

Frequency variation:

a) during normal operation 42.5 – 57.5 Hz (±15%)
b) transient changes 42.5 – 65 Hz

Grounding:

a) System configuration: 3-phase (4-wire and 5-wire system),
b) solidly grounded (TN-C and TN-C-S)
c) Test voltage (1 min): 2.5 kV

Minimum insulation resistance:

a) Phase-to-phase: 400 kΩ
b) Phase-to-earth: 230 kΩ

Locally arranged 230 V AC inverter:

a) Nominal voltage and frequency: 230 V, 50 Hz, 3-wire (L,N,PE)
b) Voltage variation: -10% to +10%
c) Frequency variation:
d) during normal operation -10% to + 5%
e) transient changes +10%

Inverters shall be generally used only for the local needs at the SHPP intake structure.

Low voltage DC control and data acquisition system:

a) Rated voltage: 24 V DC
b) Test voltage (1 min): 1.5 kV
c) Minimum insulation resistance: 220 kΩ

3.3.2 Cables and conductors identification

Cables and conductors identification shall follow harmonized colour or/and alphanumeric marking according to CENELEC SIST HD 308 S2:2001,

Identification of cores in cables and flexible cords, and SIST EN 60446, Basic and safety principles for man-machine interface, marking and identification - Identification of conductors by colours or alphanumeric code.

Function	Alpha numeric code	Colour
Protective conductors in TN-C systems		Green-and-yellow
Functional earthing conductor		Yellow
AC power circuit (1):		
Phase of single-phase circuit	L	Brown
Neutral of single-or three-phase circuit	N	Blue
1. Phase 1 of three-phase circuit:	L1	Brown
2. Phase 2 of three-phase circuit:	L2	Black
3. Phase 3 of three-phase circuit:	L3	Grey
Two-wire unearthed DC power circuit		
Positive of two-wire circuit	L+	Brown
Negative of two-wire circuit	L-	Grey
Two-wire earthed DC power circuit:		
Positive (of negative earthed) circuit	L+	Brown
Negative (of negative earthed) circuit (2)	M	Blue
Positive (of positive earthed) circuit (2)	M	Blue
Negative (of positive earthed) circuit	L-	Grey
Three-wire DC power circuit:		
Outer positive of two-wire circuit derived from three-wire system	L+	Brown
Outer negative of two-wire circuit derived from three-wire system	L-	Grey
Positive of three-wire circuit	L+	Brown
Mid-wire of three-wire circuit (2)(3)	M	Blue
Negative of three-wire circuit	L-	Grey
Control circuits and other applications		
Phase conductor	L	Brown, Black, Red, Orange, Yellow, Violet, White, Grey, Pink or Turquoise
Neutral or mid-wire (4)	N or M	Blue

NOTES:

(1) Power circuits include lighting circuits.

(2) M identifies either the mid wire of a three wire DC circuit, or the earthed conductor of a two wire earthed DC circuit.

(3) Only the middle wire of three-wire circuits may be earthed.

(4) An earthed PELV conductor is blue.

3.3.3 Color coding for mimic diagrams and displays

Mimic diagrams and VDU/touch screen displays arranged on switchgear cubicles, control panels/desks, etc., shall be color coded as follows:

20 kV:	230 / 400 V:	24 V DC:
green	violet	orange

3.3.4 Electromagnetic compatibility (EMC) and resistance to electromagnetic radiation (EMS)

From the viewpoint of electromagnetic compatibility it shall be ensured that the devices are suitably protected from interference from other devices and from extraneous effects. All installed devices shall have the relevant certificates which prove compliance with the relevant standards.

All relevant international standards which deal with this field (EN, IEC - e.g. IEC61000) shall be complied with. The Slovenian Rules on electromagnetic compatibility (EMC) and the related by-laws shall be complied with. In general, the following measures for limiting electromagnetic interference shall be observed:

a) use of devices which can most effectively withstand electromagnetic interference (filters, galvanic separation, shielded boxes, optical connections) and
b) use of shielded cables and their correct earthing.

Electromagnetic interference which can influence sensitive electrical devices shall be appropriately limited.

Suitable functional connections between electromagnetic devices are required for controlling electromagnetic devices via controllers.

Electromagnetic interference impact shall be limited with the following selectively applied measures:

a) use of shielded cables for signalling, control, and information connections (energetically weak);
b) equipment with electronic components shall be installed in such way that it is closed off by metal screens and thus separated from the other energy equipment.
c) equipment in the cabinets shall be arranged so that the crossing of electrical connections is kept at a minimum (if crossing is inevitable, it shall be done at a 90˚ angle) and wiring or conduit connections of different voltage levels are appropriately separated;
d) shield of protective and measuring cables shall be earthed at both ends;
e) equipment in cabinets shall be arranged according to recommendations on EMC;
f) structure/design of the devices shall ensure that there is no impact from external electromagnetic interference to the devices inside (and vice-versa);
g) casing for equipment with electronic circuits (protection modules etc.) shall be earthed at a common earthing bar with a stranded wire ECu 16 mm2;
h) control and signalling cables between the control equipment and the installed primary equipment shall be shielded cables earthed at both ends;
i) special metal earthed glands or a similar solution shall be used for cable entries to ensure EMC;
j) all metal parts in the cabinets which are not usually live parts, shall be earthed with Cu 16 mm2 at the earthing bar at the bottom of the cabinet;
k) the earthing bar which is not longer than 300 mm shall be connected to the earthing bar from the middle of the said earthing bar, if the earthing bar is longer than 300 mm it shall be earthed on each side;
l) all cable screens shall be earthed on both sides on the entire surface (pigtail not permitted);
m) all metal cable management equipment (trays, carriers, tray covers, pipes) shall be suitably galvanically connected and earthed with standard EMC equipment;
n) to reduce parasitic capacitance of the wire and cable connections to the device, the cable screen shall be finished close the connection of the wires to the device. Cable screen connection to the earthing shall be as short as possible and of a suitable quality;
o) free, unused cable wires for secondary circuits shall be earthed at both ends to the earthing bar by the most direct route;
p) secondary circuit cables from instrument transformers (voltage and current) shall be routed separately from the other cables (e.g. supply, control etc.).

3.3.5 Protection

Limit switches, terminal boxes etc. shall be designed according to IEC standards. They shall provide protection class IP 55 or higher.

Motors and electrical enclosures shall meet the requirements of class IP 54.

3.3.6 Heating elements

Electrical enclosures and other elements if required shall have a suitable capacity for preventing condensation. Heating elements shall be turned on using a switch.

3.3.7 Electrical control panels

Control panels shall be equipped with the required number of contactors, relays, switches, fuses etc. for local and remote control. Indicating lamps, gauges and meters shall be illuminated. The structure shall be appropriate and reliable.

In general, the control panels shall have an approximately 30% spare capacity.

3.3.8 Electric motors and frequency converters

3.3.8.1 General

The service voltages and corresponding power ratings for AC electric motors to be used in the project shall be as follows:

a) Service voltage: 3-phase 230/400 V, 50 Hz
b) Mode of starting: direct on line except when otherwise stated

All motors shall be an original product of approved manufacture, manufactured according to IEC and EN standards and compliant with all requirements. Motors of the same type and size shall be fully interchangeable and shall comply with IEC Standard motor dimensions, as far as applicable.

The following standards related to the manufacture and testing of rotating electrical machines shall be taken into consideration:

a) SIST EN 60034 Rotating Electrical Machines,
b) SIST EN 60529 Degrees of Protection Provided by Enclosures (IP Code).

The general construction shall be stiff and rigid, no light metal alloy casings shall be accepted for motors above 10 kW. All precautions shall be taken to avoid any sort of corrosion.

All motors shall be fitted with approved types of lifting hooks or eye bolts as suitable. Wherever possible the motors shall be installed with driven machines to common base. They shall be carefully levelled and fixed to the base.

All induction AC motors shall have squirrel cage type rotors.

3.3.8.2 Rating

Motors shall have a power rating which corresponds to the requirements of the technological process for each individual drive.

All induction AC motors shall be capable of operating continuously under rated output conditions:

a) At any frequency between 95% and 105% of the rated frequency,
b) And/or with any voltage variation between 90% and 110% of the nominal voltage,
c) A transient overvoltage of 130% of the nominal voltage shall be sustained.

The motors shall keep on a stable operation when running at 70% nominal voltage for a period of 10 seconds. The pull-out torque for continuously loaded motors shall be at least 160% of the rated torque. For intermittently loaded motors, the pull-out torque shall reach 200% of the rated torque.

3.3.8.3 Starting and transients

Induction motors shall be designed for direct on-line starting. They shall sustain without damage a switch-on to an infinite busbar at 110% of the nominal voltage with an inherent residual voltage of 100% even in phase opposition.

All motors shall withstand without harmful overheating:

a) 3 cold starts per hour, considering equal standstill periods between starts,
b) 3 successive starts with the motor initially at operating temperature, or once every 20 minutes and
c) all other additional sequent starts if required by the supplied equipment of the technological process.

3.3.8.4 Windings and insulation class

The insulation of all motors and the generator shall comply with class F specification according to SIST EN 60034-1. Sufficient motor rating for the particular drive shall be selected to maintain the temperature rise in normal operation within the values specified for class B.

3.3.8.5 Embedded temperature sensors

All AC motors rated 1.5 kW and above shall be fitted with at least two resistance temperature sensors of NTC or PTC type embedded in stator winding. Sensors shall be used for stator winding temperature monitoring and motor protection.

3.3.8.6 Terminal boxes and earthing

Terminal leads, terminals, terminal boxes or equivalent equipment as well as related equipment shall enable terminating the respective type of cables. Mechanical and electrical properties of boxes shall in general correspond to the requirements and conditions specified by SIST EN 62208, Empty enclosures for low-voltage switchgear and control gear assemblies.

3.3.8.7 Tests

Each motor shall be type test certified according to SIST EN 60034. Each motor shall be factory tested and shall undergo a test at Site procedure. The following tests shall be performed at minimum under full responsibility of the Contractor.

Type Tests:

a) Measurement of insulation resistance
b) Measurement of winding resistance at cold condition
c) Heat run test at PN, UN and fN
d) Load characteristic (efficiency, power factor and slip) at UN and fN
e) Noise measurement
f) No-load characteristic
g) Vibration measurement
h) Locked rotor characteristic at reduced voltage
i) Run-up characteristic at reduced voltage after reversing
j) Measurement of insulation resistance

Tests at site:

a) Measurement of insulation resistance
b) Checking of nameplates data acc. to enclosed documentation.

3.3.9 Low voltage and control cubicles

Panels, cubicles, and marshalling racks shall be of standardized, modular design, produced by a well-known manufacturer. They shall be free standing or in some cases wall mounted enclosures. They shall be constructed of folded sheet steel with minimum thickness of 1.5 mm to ensure rigid support for the electrical distribution, control, marshalling and monitoring equipment. They shall be built on a rigid and robust galvanized steel framework, equipped with a plinth. The plinth shall be modular with the possibility of a subsequent dismantling/installation. They shall be supplied complete with all fixing and lifting lugs and brackets, with eyebolts, with all required base frames, anchors, fixing lugs, coupling elements, reliable locking system and padlocks, document pockets etc.

Mechanical and electrical properties of LV distribution boards shall in general correspond to the requirements and conditions for electrical enclosures specified by SIST EN 62208, Empty enclosures for low-voltage switchgear and control gear assemblies and by SIST EN 60947, Low-voltage switchgear and control gear standards. The panels for electrical distribution and control shall be subject to verification according to standard SIST EN 61439-2. They shall be delivered with the appropriate certificates and reports on executed tests and/or other type of verification.

Wall mounted cubicles shall be mounted with 3 cm distance elements (included in the scope of supply) from the wall and/or placed on self-supporting frames supplied with all elements necessary for such fixation.

All cubicles, enclosures and marshalling racks for outdoor installations shall be made of stainless steel 1.4301. All cubicles for outdoor use shall be designed with stainless sheet canopy for additional protection against meteoric water penetration.

All cables will enter from below. Cable connections to panels and cubicles must be provided with suitable seals as to prevent the ingress of dust or vermin, or the propagation of possible flames.

Each panels/cubicles shall be provided with earthing devices for earthing the incoming cables as requested by EMC regulations. An earthing bar with a minimum cross-section of Cu 50 mm2 shall run the full length of the cubicles, panels or boards. All metallic cable shields shall be clamped to the earthing bar.

All dial instruments, relays, control and selector switches, indicating lamps, push-buttons and trip levers shall be flush-mounted and located at convenient heights on the front of the cubicle in a logical and clear manner. The layout of these panels is subject of the Engineer's approval.

Adequate vibration and shock-absorbers shall be installed wherever required for the correct operation of instrument and relays.

Clearances between live parts and to earth shall be in accordance with the latest relevant regulations and according to SIST EN standards.

The following auxiliary installations shall be provided within the cubicle:

a) one socket 230 V/10 A with protection contact,
b) one incandescent lamp with door switch,
c) earthing of cubicle door with flexible flat wire Cu 16 mm2.

3.3.9.1 Miniature circuit breakers

Miniature circuit-breakers (m.c.b.) shall be single-pole or triple-pole with adequate current ratings and characteristics of the protected equipment. The operating and the overload mechanism in these breakers shall be sealed.

One auxiliary switch with switchover contacts for 5 mA/24 V d.c. shall be provided on each m.c.b. and wired to the nearest terminal block.

M.c.b.s for DC applications must type tested for the DC application.

3.3.9.2 Contactors

LV contactors shall be of the air break type with arc shields class AC-3 according to latest edition of SIST EN 60947-4-1. When closed, the contactors shall withstand the system prospective fault current determined by the subsequent coordinated short-circuit tripping device. The related thermal overcurrent releases shall be adjustable in order to fit the motor requirements. A thermal release shall be temperature compensated for the ambient temperature.

The following control voltage variations shall be respected:

a) 80% to 110% of the rated control voltage for closing of contactors.
b) The contactor shall still hold closed contacts at applied 70% of the rated voltage.

3.3.9.3 HRC Fuses

The high rupture current (HRC) fuses shall be suitably selected to comply with the local climatic conditions, the feeding system and the characteristics of the protected user. They shall be of the current limiting type with characteristic corresponding to the protected equipment.

The fuses shall meet the requirements of the SIST EN 60269, Low-voltage fuses, standard.

3.3.9.4 Load disconnecting switches

The load disconnecting switches shall ensure local manual operation from the front panel. They shall have self-cleaning contacts with a high resisting anti-arc case and with quick-making and quick-breaking action, capable of switching the specified rated currents.

3.3.9.5 Overcurrent discrimination of low-voltage AC and DC circuits

The overcurrent devices must respond selectively in order to restrict any fault to the affected part of the system. The Contractor shall be responsible for proper overcurrent discrimination of protective devices within his scope of Works.

3.3.9.6 Auxiliary switches

Each item of the plant shall be equipped with all the necessary auxiliary switches, contactors and mechanism for indication, protection, metering, control, interlocking, supervisory and other services as applicable. They shall be suitable for use with 24 VDC depending on the requirements and wired to the terminals in the cubicle.

All auxiliary switches and mechanisms shall be mounted on easy accessible location.

3.3.9.7 Small wiring and terminal blocks

All panels, cubicles, and racks shall be factory wired.

Wiring within panels etc. shall be laid on trays, segregated according to voltage levels and meet the EMC requirements. Wiring carrying AC and DC voltage shall also be segregated from one another.

The minimum cross-section of each copper wire shall be as follows:

a) 2.5 mm^2 for all consumers such as motors, heaters and current transformer circuits,
b) 1.5 mm^2 for control wiring above 60 V service voltage, and trip protection circuits,
c) 0.75 mm^2 for control wiring below 60 V,
d) About 0.2 mm^2 in case the applied connection technique of standard electronic equipment does not permit the use of larger cross-sections, in such cases the application is subject to the Engineer's approval.

All secondary wiring shall be arranged and protected to prevent damages caused by arching, or by mechanical effects. It shall be neatly run in PVC free rigid plastic raceways or trunks clear of any metal panels and filled not more than 60% of the available cross section.

Compression type cable lugs shall be provided for the connections of cable cores with a cross-section of 1.5 mm^2 or larger. The terminals shall be designed to ensure that no pinch-off of the cable cores may occur. Bimetallic clamps shall be provided if conductors of different material are connected.

The ends of every cable core and all the secondary panel wiring shall be fitted with numbered identification plates.

Terminal blocks shall be snapped on rails according to DIN, and shall be numbered consecutively beginning from left to right (or top to bottom).

All measuring circuits of voltage and current transformers shall be equipped with measuring terminals (e.g. Weidmuller WTL6/1EN, WTD 6/1 EN, WTQ 6/1 EN etc.)

All terminal blocks shall contain minimum 30% spare terminals of category C.

3.3.9.8 Labels

The front side of the panels/cubicles shall be labelled with the designation according to the Equipment Identification System, which shall denominate its function.

Each and every component mounted on/in panels/cubicles shall be labelled with a visible item designation (on the element as well as at the installation point).

3.3.9.9 Tests

The workshop tests shall be performed on completely wired cubicles/panels in accordance with applicable standards.

The following tests shall be performed:

a) Visual inspection,
b) Megger test (to include equipment and internal wiring, excluding electronic equipment),
c) Functional tests of controls, interlocks, measurements,
d) Setting of protection relays and other devices, where applicable, by means of special testing equipment and operational check by the primary injection method (secondary method will not be accepted),

3.3.10 Instrumentation and control equipment

3.3.10.1 General

This Clause gives general requirements for technical performance of this type of equipment as well as for applicable interfaces. Detailed requirements of tasks to be performed by the control systems and the scope of supply for each item are given in the related Particular Technical Specifications. Reference to the relevant IEC Standards shall be respected.

General requirements to fulfil this approach are:

a) Each control sub-system included in this overall scheme (excitation system etc.) shall be furnished with standard field proven elements.
b) All I&C circuits shall be designed for 24 V DC.
c) Signals to be processed in several systems, e.g. for control systems, protection etc. shall be suitably repeated and mutually electrically completely de-coupled to avoid any interference.

3.3.10.2 Software requirements

The Contractor shall provide all software necessary for the operation/maintenance/parameterization of individual parts and system as a whole. System software shall be provided by the manufacturer as a standard, fully supported set of software products. Human machine interface (HMI) for parameterizations which can be used also as a test-tool shall also be delivered.

3.3.10.3 Hardware requirements for microprocessor based equipment

Modules shall be designed for dedicated functions where basic requirements are as follows:

a) expansion and easy changing of operating environment,
b) modular design,
c) field proven standard equipment.

The connection of high-impedance test equipment to any test or metering plug shall not result in damage to the equipment.

The parts shall be arranged in such a way, that they may be inspected, removed, or replaced without disturbing, or damaging other parts, or wiring. The components with high operating temperatures shall be suitably located (in the upper part of the equipment cabinet and supplied with sufficient space for ventilation etc.).

3.3.10.4 Sensors and actuators

Respective equipment must comply with technological, ambient, mechanical, chemical and electrical conditions at the place of installation. Measuring ranges of delivered sensors and other elements shall be adapted to the ranges where the measuring values are normally expected, as required by the technological process.

Sensors and actuators shall be provided with connector or terminal connection with adequate IP protection.

All transducers shall have a current output of 4-20 mA DC; isolated output is strictly requested. Two wire connections are preferred. If this is not possible, a power supply 24 V DC is requested.

a) Current capacity and contact resistance of changeover contacts must enable reliable direct connection to the PLC. Minimum current of 5 mA at 24 V DC shall be considered.
b) Respective sensors' and transducers' own supply must not exceed 10 mA.
c) All supplied equipment must enable satisfactory terminating and earthing of cables.

Level switches and transducers, this type of equipment shall meet the following requirements:

a) Level switches shall be located close to the process in an accessible location.
b) Each changeover contact must be galvanically separated from others.
c) Measuring points must be carefully selected and outfitted with all the necessary elements to achieve reliable data acquisition.

Flow meters and indicators, this type of equipment shall meet the following requirements:

a) Flow meters shall be directly connected, removable bezel, glass front or with digital display.
b) Flow meter switches (flow indicators) shall have at least one adjustable changeover contact.
c) Each changeover contact must be galvanically separated from others.
d) Measuring points must be carefully selected and outfitted with all the necessary elements to achieve reliable data acquisition.

Pressure switches and transducers, this type of equipment shall meet the following requirements:

a) Pressure switches shall have at least one adjustable changeover contact.
b) Each changeover contact must be galvanically separated from others.
c) Measuring points must be carefully selected and outfitted with all the necessary elements to achieve reliable data acquisition.

Position switches and Transducers shall be suitably mounted for easy adjustment and for locking in position after being adjusted. They shall be of heavy-duty rating and shall have two (2) changeover contacts.

Connectors:

For specific purposes as part of the state-of-the-art installation system connectors (splitter boxes or sensor-actuator-integrator blocks) shall also be requested. These elements must be modular with four, six or eight separate connectors for sensor connections.

Element tests:

Each element shall be factory tested and shall undergo a test at the Site. The following tests shall be performed under full responsibility of the Contractor:

a) Workshop Tests and
b) Tests at Site, as requested.

3.3.10.5 Parameterisation tools

Tools (hardware and software) for parameterisation and diagnostic purposes for electrical equipment and elements shall be supplied according to the latest standards for this type of equipment.

All the respective hardware interfaces including cables and connectors must be supplied.

Software packages that are needed for parameterisation and diagnostic purposes must be part of delivery. All the respective documentation and licenses shall be enclosed to this software.

3.3.10.6 Implementation of control equipment

Testing:

Final acceptance shall be granted only after all equipment has been installed, its operation verified and after all the required documents have been received.

The tests shall exercise every specified function and shall be performed as indicated in the detailed test procedure prepared by the Contractor and approved by the Engineer.

The basic tests are sequenced as follows:

a) Workshop Tests,
b) Commissioning tests,
c) Site Tests.

Training:

Hardware training shall give the Customer's personnel sufficient knowledge on the design and operation, so that they can adequately maintain all equipment.

Software training shall give the Customer's software personnel sufficient knowledge of the software system so they can perform all required software modifications, maintenance, and extensions.

All training courses shall cover the following topics, some of which may be more or less emphasized:

a) Documentation
b) Hardware overview
c) Basic parameterization
d) System initialization
e) Diagnostic functions

The training program shall be proposed by the Contractor and shall include all the necessary details (hourly descriptions, timeline, list of lecturers, locations, listeners' previous knowledge, training goals).

3.3.11 Cables

3.3.11.1 General

The Contractor shall:

a) specify in detail all the cables needed for the project, which will connect their equipment to that supplied by others;
b) provide any other information and instruction for cable connections that shall be provided by others.

For his scope of supply the Contractor shall perform all relevant design and engineering of the cable system. The documentation shall include cable plans, connection diagrams, list of cables and cable routing plans.

The Contractor shall select the most suitable cable routing ensuring that it does not interfere with other installations. All cable routing must be clearly indicated in the drawings.

However, the Contractor's scope of supply, laying and connecting of the cables shall include the following as a minimum:

a) all cables and conductors necessary for all power supply systems, for connection to voltage and current transformers and all other equipment,
b) all necessary nameplates for cable-identification,
c) all necessary standard (by manufacturers) fixing materials,
d) all necessary fire protection material for sealing cable openings through walls and ceilings as well as between cubicles,
e) all necessary UPVC (or similar) protecting tubes for cable runs,
f) all necessary cable connections elements including compression cable lugs, fixing and clamping material…
g) all necessary cable sealing ends and cable connecting sleeves including fixing materials,
h) all necessary compression connectors,
i) all necessary cable glands.

The maximum continuous current carrying capacity of each individual cable type and cross-section used shall be determined by the Contractor taking into account the site environmental conditions and other requirements.

The conductor cross-section of each cable, moreover, shall be adequate for carrying the prospective fault current determined by the next relevant short-circuit protection device when operating under the specified load conditions without deterioration of the dielectric. All the above data and their calculation shall, accompanied by the short-circuit calculations, appear in the documents to be supplied by the Contractor according to these requirements.

3.3.11.2 LV power cables

Wiring between electrical equipment shall be done by cables. Cables shall run in cable trays with covers, embedded cable ducts etc. Cables shall be properly fastened and marked with PVC plates at entry to the cabinet.

Power cables shall be envisaged for voltage 0.6/1 kV, and insulation voltage 300/500 V is required for control cables. All cables shall be flameless in accordance with HD 405 (IEC 60332) and shall have halogen free, low smoke emission properties in accordance with IEC 60754 and 61034. Individual cable wires shall be numbered.

Wiring within switchgear panels shall be done with fine copper conductors with a cross-section of at least 0.75 mm2 for control cables and at least 2.5 mm^2 for powering equipment and drives.

Over sheath:	The PVC over sheath shall be oil-resistant, treated in order to prevent the insulation from spreading fire The PVC over sheath shall be coloured black for all LV power cables. The sheath shall contain the manufacturer's name, the voltage levels Uo/U in kV and the cable type.
Screen:	Screen shall be of braided copper or braided tinned copper and shall have coverage of at least 80%.
Recommended current carrying capacity of power cables	The cables shall be designed for continuous loading, taking into account the fact that one cable is in the air at temperature of 40°C:

PVC cable	
Reduction for layers of 9 cables and 6 vertical trays	66 %
Reduction for 40°C ambient temperature and conductor temperature of 70°C	87%
Reduction factor	0.57
XLPE cable	
Reduction for layers of 9 cables and 6 vertical trays	66 %
Reduction for 40°C ambient temperature and conductor temperature of 90°C	91%
Reduction factor	0.60

3.3.11.3 Measuring and control cables above 60 V

The control cables shall be of the multi-core, PVC-insulated type withstanding without deterioration the conditions prevailing at the individual place of installation.

Fieldbus Cables

Special fieldbus cables are to be used for connecting distributed parts of the control system. They should be dimensioned for suitable power supply and relevant data rates. They shall correspond to and be selected with their differing demands according to standard EN 50288.

3.3.11.4 Instrument transformer cables

The design of these cables must comply with item "Measuring and control cables above 60 V". The minimum conductor cross-section for instrument transformer cables is 2.5 mm^2.

3.3.11.5 Cable connections and cable joints

For the connections of cable cores with a cross-section of 1.5 mm2 or larger, compression type cable lugs shall be provided. The terminals shall be designed to ensure that no pinch-off of the cable cores occurs.

Cable jacket:	The cable jacket shall be oil-resistant and flame-retardant. It shall contain the manufacturer's name and cable type.
Terminal boxes and terminal cabinets:	Terminal boxes or, wherever suitable, terminal cabinets shall be fitted on all the necessary points in order to simplify local grouping of cables and distribution of signals.

If the terminal boxes are not suitable, suitable intermediate terminal cabinets are to be used. Terminal boxes and cabinets must be equipped with the necessary terminal strips, cable glands, cable screw couplings and attachment components for the connection of the cables.

Terminals used for connection of current transformers shall be suitable for measuring circuits and fitted with short-circuit links. The necessary earthing terminals are to be provided for the earthing of the boxes and cabinets.

3.3.12 Spare parts

3.3.12.1 Obligatory spare parts

The Contractor shall enter the price for obligatory spare parts in the Schedule of Prices. The sum (total price) shall be added to the total tender price.

3.3.12.2 Recommended spare parts

The Contractor shall enter the price for spare parts that they recommend in the Schedule of Prices; the price shall be valid for three years after signing the contract. The price of these spare parts shall not be included in the total tender price.

The Customer shall purchase the spare parts from the Contractor if needed within three years at the price stated in the Schedule of Prices.

3.3.13 Documentation

The Contractor shall prepare all the required workshop documentation, instructions for installation, operation and maintenance instructions (NOV) and supporting documents and submit it in and electronic (PDF, DWG, DOC) and printed form. The workshop documentation shall include calculations, plans, dimensional drawings, instructions, procedures etc. for the manufacturing and installation of the equipment under this contract. All changes shall be documented during the manufacturing and installation. The documentation shall be used also for preparing the detailed design drawings and as-built documentation.

The instructions, technical descriptions and requirements shall be in Slovenian.

All elements shall be defined in the bill of materials. Relevant technical certificates and brochures shall be prepared for the smaller purchased elements.

Unless otherwise agreed, the following documents are required as a minimum:

a) calculation of parameters of the generator with excitation system.

3.4 SPECIAL TECHNICAL SPECIFICATIONS FOR ELECTRICAL SCOPE

3.4.1 Synchronous generator with equipment and connections

The equipment for a synchronous generator with an excitation system shall be supplied by the Contractor for LOT TG, Part A, and installed and connected by the Customer under the supervision of the Contractor.

Supply under Part A shall end and under Part B shall begin with the generator and the excitation system terminals.

A three-phase synchronous generator, 1000 kVA, brushless (contactless), with an excitation system for exciting generators and a digital voltage regulator shall be erected in the powerhouse. The generator shall be equipped with sliding bearings on the drive end and the non-drive end. The generator shaft shall be extended on both sides so that the turbine runner is mounted on the drive end and the flywheel on the non-drive end.

The synchronous generator shall be manufactured for rated voltage of 400V ±10%.

The tenderer shall select a generator which completely conforms to all the parameters of the selected turbine.

3.4.1.1 Basic technical data of the three-phase synchronous generator

a)	Number of generators:	1
b)	Type:	synchronous self-excitation
c)	Nominal power:	1000 kVA at cooling air 40°C
d)	Service voltage:	3x231/400V±10%
e)	Frequency:	50 Hz
f)	Cos φ:	0.8
g)	Rated rotational speed:	1000 min^{-1}
h)	Runaway speed:	2100 min^{-1}
i)	Insulation class:	F
j)	Cooling method:	IC01
k)	Mechanical protection of the generator:	IP23
l)	Mechanical protection of the terminal box:	IP54
m)	Duty type in all conditions:	parallel with grid
n)	Efficiency	>96% at full power
o)	Bearings	sliding

The stator winding shall be made of electrolytic copper and insulated with thermostable materials classified as IEC class F. The generator shall be equipped with Pt100 resistance type temperature sensors to control heating, where at least one sensor shall be installed in each phase of the stator winding. During normal operation the heating of the generator shall not exceed class B.

Forced air cooling via the rotor fan blades shall be used for generator cooling.

Thermal losses from the generator shall be discharged to the powerhouse and, if required, from the powerhouse outside via two multilevel fans.

To prevent condensation during standstill periods, heaters with a thermostat shall be installed in the generator for maintaining the temperature inside the generator frame at approx. 5 K above the ambient temperature. The heaters' supply voltage shall be 230 V, 50 Hz.

The generator shall be equipped with sliding bearings (oil bath) on the drive and the non-drive end. A suitable (forced water - closed system) cooling of the bearings shall be provided with regard to the requirements of the generator manufacturer. Each bearing shall be equipped with one Pt100 temperature sensor.

Since the unit's speed will temporarily increase to almost run-away overspeed, the entire generator shall be designed to withstand maximum runaway overspeed in the duration of at least 60 min.

Generator connecting cables shall run in a cable duct from the generator to the control panels where they shall be connected to the generator terminal box.

Excitation system:

The excitation system shall fully meet the excitation requirements of the generator. It shall continuously provide at least 10% higher voltage and at least 20% higher current than as requested by the generator characteristics under normal operation.

The excitation system shall be equipped with a reactive energy regulator and shall fully comply with the SONDO (Rules on the system operation of electricity distribution grid) requirements.

It shall enable the measurement of generator voltage, three generator currents, excitation current and the grid voltage and enable a calculation of the frequency, active and reactive power, excitation current and the conditions for the operation of the limiters and protection on the basis of these parameters.

Analogue inputs:

3 generator voltages,

3 generator currents,

excitation current,

grid phase-to-phase voltage

In addition to analogue variables, the controller shall also read and set the digital inputs or outputs.

Signalling inputs:

generator switch on/off,

synchronisation stage,

switch between island operation to grid operation

voltage regulation activation, reactive power regulation, cosφ (tanφ) regulation

increasing/decreasing parameters.

The excitation system shall comply with the characteristics of the reactive power as requested by SONDO using correctly selected constants − and − and by entering the new desired voltage upon synchronisation to the grid.

SONDO prescribes the following equation:

$$Q_{GEN-required} = 0{,}75 * P_{NG} * \left(\frac{P_{GEN}}{2*P_{NG}} + \frac{U_{CG}-U_D}{STAT*U_N}\right)$$

$Q_{GEN-required}$	required reactive power
P_{NG}	rated operating power of the generator
P_{GEN}	actual value of active power
U_{CG}	agreed (desired) generator voltage
U_{GEN}	actual value of the voltage
U_N	rated voltage of the generator
$STAT$	static characteristic (0.1 for LV connection, 0.05 for MV connection)

In addition to the regulation part, the system shall also enable the protection and limitation of critical quantities at potential grid defects or defects within the power plant. The function of these segments shall have a direct impact on the critical quantities of the excitation system or an indirect impact of the power plant shut-down.

Limiting functions:

V-Hz limiter:	Under-frequency limitation function of the excitation system shall enable an automatic reduction of the desired voltage when the frequency drops below the critical value. When the frequency drops below the critical value, the system shall begin to also reduce the generator voltage according to the curve dependent on the type of the generator excitation.
Excitation current limiter:	Limitation of the excitation current is in effect dependent on the characteristics of the generator. To provide voltage upon grid short circuits, the system shall be able to generate 1-3-times higher excitation current than the rated current (forcing).
Minimum excitation current limiter	(torque-angle limitation)
Minimum excitation current limiter:	It shall ensure that the generator never exceeds the critical torque-angle and remains synchronised with the grid.
Stator current limiter	(torque-angle limitation) It shall ensure that the generator does not exceed the rated current of the stator winding for too long.

The tenderer may offer an EIMV excitation system, type NES 230-20-100-5 or similar.

Generator and excitation system tests

a) Generator factory tests

1. Visual inspection of completenes and name plate.
2. Dimensional control.
3. Sense of rotation and phases.
4. Measurement of isolation resistant.
5. Measurement of ohmic resistance of the stator and rotor.
6. Measurement of capacitivity of stator windings.
7. Characteristics of three-pole short circuit to 1.5 and for a period of 2 minutes.
8. No load characteristic 1.3 Un for 3 minutes (measurement or calculation).
9. Measurement of frequency and voltage on the axis at reactive load.
10. Determination of partial losses of friction and ventilation losses, losses in iron, copper, stator copper and rotor copper and determine the efficiency of the generator.
11. Runaway test at 2nv for 2 minutes.
12. Measurement of vibration before and after runaway test.
13. High-voltage test of stator winding with external voltage 2kV for a time of 1 minute and rotor winding with voltage 1o Unrot for a time of 1 minute by re-checking the insulation resistance.
14. Noise measurement.

b) Site tests

1. The first rotation of the generator
   1.1 Mechanical no load run - vibration.
   1.2 Measurement of bearings temperature.
   1.3 Test of turbine control at no load operation,
2. Measurement of the insulation of the generator.

3. Primary Functional testing of generator protection
   3.1 Overcurrent.
   3.2 Overvoltage – under voltage.
   3.3 Over frequency – under frequency.
4. Excitation of the generator at full voltage
   4.1 Mechanical no load run - vibration.
   4.2 Measurement of bearing temperature.
   4.3 Voltage control at no load operation
5. Network check at the generator's terminals.
6. Synchronization generator to the grid.
7. Full load tests
   7.1 Mechanical no load run - vibration.
   7.2 Measurement of bearings temperature.
   7.3 Test of turbine control at load operation.
   7.4 Test of voltage control at load operation.
   7.5 Heat run at load operation.
8. Turbine and voltage control test at load rejections at ¼, 2/4, ¾, 4/4 of nominal power.
9. Assessment of achieving the nominal parameters of the generator.

3.4.1.2 Generator terminal cubicle BAA01

The cubicle shall be supplied under LOT TG, Part B and connected by the Customer. A generator circuit breaker, instrument current and voltage transformers and part of the generator protection equipment shall be installed in the cubicle.

3.4.1.3 Medium-voltage unit equipment

The medium-voltage equipment shall be supplied under LOT EE and by the Customer.

The unit shall be connected to the grid transformer 0.4/20kV and connected to the Kneške Ravne 2 SHPP via a MV switchyard and a MV cable. The Kneške Ravne 2 SHPP is connected to the 20kV distribution grid.

The basic equipment is shown in the enclosed single-line diagram of the power plant.

3.4.2 Generator circuit breaker and auxiliary equipment

The equipment shall be supplied by the Contractor for LOT TG, Part B, and installed and connected by the Customer under the supervision of the Contractor.

Supply under Part A shall end and under Part B shall begin with the generator and the excitation system terminals.

3.4.3 Control, signalling, measurement and protection equipment

The equipment shall be supplied by the Contractor for LOT TG, Part B, and installed and connected by the Customer under the supervision of the Contractor.

Supply under Part A shall end and under Part B shall begin with the terminals in terminal boxes of the individual equipment from Part B.

In addition to the turbine, generator and the valve, the Contractor for LOT TG, Part A shall supply all the related transducers, indicators, and limit switches to ensure a complete SHPP automation and control. Transducers shall be equipped with the original connecting cable.

3.4.4 Flow measurement

The equipment shall be supplied by the Contractor for LOT TG, Part B.

Ultrasonic water flow measurement shall be performed in the penstock to measure the water flow during SHPP operation and when bypassing the turbine using the bypass valve. Flow sensors shall be installed on the external side of the penstock, in the shaft in front of the powerhouse, and connected by cables with the control cubicle in the powerhouse.

3.4.5 Distribution and auxiliary power supply

The equipment shall be supplied by the Contractor for LOT TG, Part B, and installed and connected by the Customer under the supervision of the Contractor.

Supply under Part A shall end and under Part B shall begin with the terminals in terminal boxes of the individual equipment from Part A.

3.4.5.1 Auxiliary power supply distribution +BFA01 in the powerhouse

Distribution of 0.4 kV auxiliary power supply shall have only one sector +BFA01. All technological and general consumers with the lighting and electrical installations shall be connected to this sector. Special, more powerful consumers shall be connected to two 100 A auxiliary power supply branch-offs. In case of external power supply failure, urgent consumers shall be powered from the rectifier equipped with battery and inverter.

The basic equipment is shown in the enclosed single-line diagram of the power plant.

3.4.5.2 Auxiliary power supply on intake

The auxiliary power supply on intake shall be supplied under LOT EE and LOT A. The supply shall be done from Kneške Ravne 2 SHPP.

3.4.5.3 24 V rectifier and distribution of DC consumers

A 24V rectifier and distribution of DC auxiliary power supply consumers shall be built into the BUA01 cubicle. A sealed lead - leakproof acid battery type VRLA shall be built into the cubicle depending on spatial possibilities.

3.4.6 Cables and cable routing

3.4.6.1 Cable connections

The scope of works includes the supply and laying of cables and cable trays for all connections to the terminal boxes for individual equipment. Supply under Part A shall end and under Part B shall begin with the terminals in terminal boxes.

The scope of works includes the supply of cables and the relevant equipment, including all the connecting and fixing material and coding according to the KKS standard.

The newest applicable standards shall be taken into consideration when selecting the cables. The following important standards shall serve as a reference:

IEC 60189	Low frequency cables and wires with PVC insulation and PVC sheath.
IEC 60227 450/750V	Polyvinyl chloride insulated cables of rated voltages up to and including.
IEC 60228	Conductors of insulated cables.

Cables shall not be laid directly on the ground but shall be laid in cable galleries, channels, tubes or trays. The price for all vertical cable routing shall include the fixing material and mechanical protection up to the height of 2 m.

Cable connection to cubicles, cabinets etc. shall be done at least 300 mm above ground. Vertical parts of the cable connections shall be affixed with clamps to ladder or to channel supports. All cables shall be safely supported no more than 0.5 m away from the clamps.

Cables shall not contain T-joints or be coupled between the end points. All wires shall be terminated with ends.

Suitable cable glands shall be used to connect cables to the terminal boxes.

All internal connections in the cubicles, cabinets, panels etc. shall contain a label with a clearly legible identification number.

All damage on cables or related material shall be remedied by the Contractor at their expense.

Power cables:

Power cables for low-voltage installations shall be single and multi-core cables with polyethylene (PVC) insulation.

The conductor shall be made of fine copper according to IEC 60227.

The conductor shall be colour insulated with regard to the number of cores and thickness defined in the IEC 60227.

The average insulation thickness measured at the cross-section shall not be less than the value stipulated in the IEC 60227.

The polyethylene protection layer shall tightly cover the fine-core conductor. Thickness of the protection layer shall not be lesser than the value stipulated in the IEC 60227.

Control and signaling cables:

The control and signaling cables between the unit's devices and the related control panel shall be of LiYCY type.

NYCY type cables shall be used for instrument transformers and trip protection circuits. For connecting current instrument transformers, the cross-section shall be at least 2.5mm^2, and at least 1.5 mm^2 for connecting voltage instrument transformers.

Connecting control and signaling cables to the control panel shall be done using terminal blocks or connectors.

Signaling and control cables shall be multi-core with polyethylene (PVC) insulation, tinned copper screen and a minimum conductor cross-section of 1.5 mm2.

All control and signaling cables shall meet the requirements of IEC 60227.

The conductor shall be made of fine copper according to IEC 60227.

The conductor shall be color insulated with regard to the number of cores and thickness defined in the IEC 60227.

The average insulation thickness measured at the cross-section shall not be less than the value stipulated in the IEC 60227.

The polyethylene protection layer shall tightly cover the fine-core conductor. Thickness of the protection layer shall not be lesser than the value stipulated in the IEC 60227.

Wiring requirement:

Each multi-core/multi-pair cable shall be used for only one function and for only one voltage level.

Cable trays:

Cable trays shall be standard, made from hot tip galvanized steel plates, with sufficient ventilation openings, suitable grooves and slots for fixing standard cable fixing material.

Hot tip galvanizing shall be at least 50 μm v in accordance with DIN 50976 or ISO 14713 and ISO 1461.

Bolting material shall be hot tip galvanized, with a coating thickness of at least 40μm.

Trays with control cables shall have covers.

The trays shall be filled only up to 80% of the estimated spatial and load capacity.

The Contractor shall select a suitable density and dimension of the supporting wall with regard to the trays used and their estimated load.

The cable trays shall be connected to the earthing network.

3.4.7 Grounding of devices

The main purpose of grounding the devices is:

a) to protect people in contact with the devices,

b) to protect the devices themselves and other equipment connected to them and reduce electric interference.

3.4.8 Ensuring electromagnetic compatibility

All measures shall be implemented in such way to ensure efficiency at high frequencies and thereby efficiency at low frequencies. The basis for the calculation shall be 50 Hz.

a) all primary and secondary system devices in the room shall be connected to the potential equalization system;

b) potential equalization systems shall be an integral part of the grounding system;

c) cable screens for secondary systems shall be connected to the potential equalization system at both ends - i.e. grounded;

d) cubicle casings shall be grounded.

3.4.9 Assembly works and commissioning tests

Assembly works, except for assembly works for the hydraulic governor with all the pipes and connections, shall be performed by the Customer.

LOT TG Part A Contractor shall deliver appropriate written assembly instruction, they shall manage and supervise the assembly works and perform the commissioning tests for the entire SHPP.

4 LOT TG PART B

4.1 GENERAL TECHNICAL SPECIFICATIONS FOR ELECTRICAL SCOPE

4.1.1 Medium and low voltage equipment

4.1.1.1 Low voltage equipment

The following standard voltage levels according to SIST IEC 60038 shall be respected for all low-voltage equipment, power and control installations within cubicles, panels, desks etc.

Low voltage AC equipment:

a) Rated voltage: 3x230/400 V
b) Rated frequency: 50 Hz
c) Maximum voltage variation: - 10%, + 15%

Frequency variation:

a) during normal operation 42.5 – 57.5 Hz (±15%)
b) transient changes 42.5 – 65 Hz

Grounding:

a) System configuration: 3-phase (4-wire and 5-wire system),
b) solidly grounded (TN-C and TN-C-S)
c) Test voltage (1 min): 2.5 kV

Minimum insulation resistance:

a) Phase-to-phase: 400 kΩ
b) Phase-to-earth: 230 kΩ

Locally arranged 230 V AC inverter:

a) Nominal voltage and frequency: 230 V, 50 Hz, 3-wire (L,N,PE)
b) Voltage variation: -10% to +10%
c) Frequency variation:
d) during normal operation -10% to + 5%
e) transient changes +10%

Inverters shall be generally used only for the local needs at the SHPP intake structure.

Low voltage DC control and data acquisition system:

a) Rated voltage: 24 V DC
b) Test voltage (1 min): 1.5 kV
c) Minimum insulation resistance: 220 kΩ

4.1.2 Cables and conductors identification

Cables and conductors identification shall follow harmonized colour or/and alphanumeric marking according to CENELEC SIST HD 308 S2:2001,

Identification of cores in cables and flexible cords, and SIST EN 60446, Basic and safety principles for man-machine interface, marking and identification - Identification of conductors by colors or alphanumeric code.

Function	Alpha numeric code	color
Protective conductors in TN-C systems		Green-and-yellow
Functional earthing conductor		Yellow
AC power circuit (1):		
Phase of single-phase circuit	L	Brown
Neutral of single-or three-phase circuit	N	Blue
4. Phase 1 of three-phase circuit:	L1	Brown
5. Phase 2 of three-phase circuit:	L2	Black
6. Phase 3 of three-phase circuit:	L3	Grey
Two-wire unearthed DC power circuit		
Positive of two-wire circuit	L+	Brown
Negative of two-wire circuit	L-	Grey
Two-wire earthed DC power circuit:		
Positive (of negative earthed) circuit	L+	Brown
Negative (of negative earthed) circuit (2)	M	Blue
Positive (of positive earthed) circuit (2)	M	Blue
Negative (of positive earthed) circuit	L-	Grey
Three-wire DC power circuit:		
Outer positive of two-wire circuit derived from three-wire system	L+	Brown
Outer negative of two-wire circuit derived from three-wire system	L-	Grey
Positive of three-wire circuit	L+	Brown
Mid-wire of three-wire circuit (2)(3)	M	Blue
Negative of three-wire circuit	L-	Grey
Control circuits and other applications		
Phase conductor	L	Brown, Black, Red, Orange, Yellow, Violet, White, Grey, Pink or Turquoise
Neutral or mid-wire (4)	N or M	Blue

NOTES:

(1) Power circuits include lighting circuits.

(2) M identifies either the mid wire of a three-wire DC circuit, or the earthed conductor of a two-wire earthed DC circuit.

(3) Only the middle wire of three-wire circuits may be earthed.

(4) An earthed PELV conductor is blue.

4.1.3 Color coding for mimic diagrams and displays

Mimic diagrams and VDU/touch screen displays arranged in switchgear cubicles, control panels/desks, etc., shall be color coded as follows:

a)	20 kV	green
b)	230/400 V	violet
c)	24 V DC	orange

4.1.4 Electromagnetic compatibility (EMC) and resistance to electromagnetic radiation (EMS)

From the viewpoint of electromagnetic compatibility it shall be ensured that the devices are suitably protected from interference from other devices and from extraneous effects. All installed devices shall have the relevant certificates which prove compliance with the relevant standards.

All relevant international standards which deal with this field (EN, IEC - e.g. IEC61000) shall be complied with. The Slovenian Rules on electromagnetic compatibility (EMC) and the related by-laws shall be complied with. In general, the following measures for limiting electromagnetic interference shall be observed:

a) use of devices which can most effectively withstand electromagnetic interference (filters, galvanic separation, shielded boxes, optical connections) and
b) use of shielded cables and their correct earthing.

Electromagnetic interference which can influence sensitive electrical devices shall be appropriately limited.

Suitable functional connections between electromagnetic devices are required for controlling electromagnetic devices via controllers.

Electromagnetic interference impact shall be limited with the following selectively applied measures:

a) use of shielded cables for signalling, control, and information connections (energetically weak);
b) equipment with electronic components shall be installed in such way that it is closed off by metal screens and thus separated from the other energy equipment.
c) equipment in the cabinets shall be arranged so that the crossing of electrical connections is kept at a minimum (if crossing is inevitable, it shall be done at a 90°angle) and wiring or conduit connections of different voltage levels are appropriately separated;
d) shield of protective and measuring cables shall be earthed at both ends;
e) equipment in cabinets shall be arranged according to recommendations on EMC;
f) structure/design of the devices shall ensure that there is no impact from external electromagnetic interference to the devices inside (and vice-versa);
g) casing for equipment with electronic circuits (protection modules etc.) shall be earthed at a common earthing bar with a stranded wire Electrical Cu 16 mm2;
h) control and signalling cables between the control equipment and the installed primary equipment shall be shielded cables earthed at both ends;
i) special metal earthed glands or a similar solution shall be used for cable entries to ensure EMC;
j) all metal parts in the cabinets which are not usually live parts, shall be earthed with Cu 16 mm2 at the earthing bar at the bottom of the cabinet;
k) the earthing bar which is not longer than 300 mm shall be connected to the earthing bar from the middle of the said earthing bar, if the earthing bar is longer than 300 mm it shall be earthed on each side;
l) all cable screens shall be earthed on both sides on the entire surface (pigtail not permitted);
m) all metal cable management equipment (trays, carriers, tray covers, pipes) shall be suitably galvanically connected and earthed with standard EMC equipment;
n) to reduce parasitic capacitance of the wire and cable connections to the device, the cable screen shall be finished close to the connection of the wires to the device. Cable screen connection to the earthing shall be as short as possible and of a suitable quality;
o) free, unused cable wires for secondary circuits shall be earthed at both ends to the earthing bar by the most direct route;
p) secondary circuit cables from instrument transformers (voltage and current) shall be routed separately from the other cables (e.g. supply, control etc.).

4.1.5 Protection

Limit switches, terminal boxes etc. shall be designed according to IEC standards. They shall provide protection class IP 55 or higher.

Motors and electrical enclosures shall meet the requirements of class IP 54.

4.1.6 Heating elements

Electrical enclosures and other elements if required shall have a suitable capacity for preventing condensation. Heating elements shall be turned on using a switch.

4.1.7 Electrical control panels

Control panels shall be equipped with the required number of contactors, relays, switches, fuses etc. for local and remote control. Indicating lamps, gauges and meters shall be illuminated. The structure shall be appropriate and reliable.

In general, the control panels shall have an approximately 30% spare capacity.

4.1.8 Electric motors and voltage converters

4.1.8.1 General

The service voltages and corresponding power ratings for AC electric motors to be used in the project shall be as follows:

a) Service voltage: 3-phase 230/400 V, 50 Hz
b) Mode of starting: direct on line except when otherwise stated

All motors shall be an original product of approved manufacture, manufactured according to IEC and EN standards and compliant with all requirements. Motors of the same type and size shall be fully interchangeable and shall comply with IEC Standard motor dimensions, as far as applicable.

The following standards related to the manufacture and testing of rotating electrical machines shall be taken into consideration:

a) SIST EN 60034 Rotating Electrical Machines,
b) SIST EN 60529 Degrees of Protection Provided by Enclosures (IP Code).

The general construction shall be stiff and rigid, no light metal alloy casings shall be accepted for motors above 10 kW. All precautions shall be taken to avoid any sort of corrosion.

All motors shall be fitted with approved types of lifting hooks or eye bolts as suitable. Wherever possible the motors shall be installed with driven machines to common base. They shall be carefully levelled and fixed to the base.

All induction AC motors shall have squirrel cage type rotors.

4.1.8.2 Rating

Motors shall have a power rating which corresponds to the requirements of the technological process for each individual drive.

All induction AC motors shall be capable of operating continuously under rated output conditions:

a) At any frequency between 95% and 105% of the rated frequency,
b) And/or with any voltage variation between 90% and 110% of the nominal voltage,
c) A transient overvoltage of 130% of the nominal voltage shall be sustained.

The motors shall keep on a stable operation when running at 70% nominal voltage for a period of 10 seconds. The pull-out torque for continuously loaded motors shall be at least 160% of the rated torque. For intermittently loaded motors, the pull-out torque shall reach 200% of the rated torque.

4.1.8.3 Starting and transients

Induction motors shall be designed for direct on-line starting. They shall sustain without damage a switch-on to an infinite busbar at 110% of the nominal voltage with an inherent residual voltage of 100% even in phase opposition.

All motors shall withstand without harmful overheating:

a) 3 cold starts per hour, considering equal standstill periods between starts,
b) 3 successive starts with the motor initially at operating temperature, or once every 20 minutes and
c) all other additional sequent starts if required by the supplied equipment of the technological process.

4.1.8.4 Windings and insulation class

The insulation of all motors and the generator shall comply with class F specification according to SIST EN 60034-1. Sufficient motor rating for the particular drive shall be selected to maintain the temperature rise in normal operation within the values specified for class B.

4.1.8.5 Embedded temperature sensors

All AC motors rated 1.5 kW and above shall be fitted with at least two resistance temperature sensors of NTC or PTC type embedded in stator winding. Sensors shall be used for stator winding temperature monitoring and motor protection.

4.1.9 Low voltage and control cubicles

Panels, cubicles, and marshalling racks shall be of standardized, modular design, produced by a well-known manufacturer. They shall be free standing or in some cases wall mounted enclosures. They shall be constructed of folded sheet steel with minimum thickness of 1.5 mm to ensure rigid support for the electrical distribution, control, marshalling and monitoring equipment. They shall be built on a rigid and robust galvanized steel framework, equipped with a plinth. The plinth shall be modular with the possibility of a subsequent dismantling/installation. They shall be supplied complete with all fixing and lifting lugs and brackets, with eyebolts, with all required base frames, anchors, fixing lugs, coupling elements, reliable locking system and padlocks, document pockets etc.

Mechanical and electrical properties of LV distribution boards shall in general correspond to the requirements and conditions for electrical enclosures specified by SIST EN 62208, Empty enclosures for low-voltage switchgear and control gear assemblies and by SIST EN 60947, Low-voltage switchgear and control gear standards. The panels for electrical distribution and control shall be subject to verification according to standard SIST EN 61439-2. They shall be delivered with the appropriate certificates and reports on executed tests and/or other type of verification.

Wall mounted cubicles shall be mounted with 3 cm distance elements (included in the scope of supply) from the wall and/or placed on self-supporting frames supplied with all elements necessary for such fixation.

All cubicles, enclosures and marshalling racks for outdoor installations shall be made of stainless steel 1.4301. All cubicles for outdoor use shall be designed with stainless sheet canopy for additional protection against meteoric water penetration.

All cables will enter from below. Cable connections to panels and cubicles must be provided with suitable seals as to prevent the ingress of dust or vermin, or the propagation of possible flames.

Each panels/cubicles shall be provided with earthing devices for earthing the incoming cables as requested by EMC regulations. An earthing bar with a minimum cross-section of Cu 50 mm2 shall run the full length of the cubicles, panels or boards. All metallic cable shields shall be clamped to the earthing bar.

All dial instruments, relays, control and selector switches, indicating lamps, push-buttons and trip levers shall be flush-mounted and located at convenient heights on the front of the cubicle in a logical and clear manner. The layout of these panels is subject of the Engineer's approval.

Adequate vibration and shock-absorbers shall be installed wherever required for the correct operation of instrument and relays.

Clearances between live parts and to earth shall be in accordance with the latest relevant regulations and according to SIST EN standards.

The following auxiliary installations shall be provided within the cubicle:

a) one socket 230 V/10 A with protection contact,

b) one incandescent lamp with door switch,

c) earthing of cubicle door with flexible flat wire Cu 16 mm2.

4.1.9.1 Miniature circuit breakers

Miniature circuit-breakers (m.c.b.) shall be single-pole or triple-pole with adequate current ratings and characteristics of the protected equipment. The operating and the overload mechanism in these breakers shall be sealed.

One auxiliary switch with switchover contacts for 5 mA/24 V d.c, shall be provided on each m.c.b. and wired to the nearest terminal block.

M.c.b.s for DC applications must type tested for the DC application.

4.1.9.2 Contactors

LV contactors shall be of the air break type with arc shields class AC-3 according to latest edition of SIST EN 60947-4-1. When closed, the contactors shall withstand the system prospective fault current determined by the subsequent coordinated short-circuit tripping device. The related thermal overcurrent releases shall be adjustable in order to fit the motor requirements. A thermal release shall be temperature compensated for the ambient temperature.

The following control voltage variations shall be respected:

a) 80% to 110% of the rated control voltage for closing of contactors.

b) The contactor shall still hold closed contacts at applied 70% of the rated voltage.

4.1.9.3 HRC Fuses

The high rupture current (HRC) fuses shall be suitably selected to comply with the local climatic conditions, the feeding system and the characteristics of the protected user. They shall be of the current limiting type with characteristic corresponding to the protected equipment.

The fuses shall meet the requirements of the SIST EN 60269, Low-voltage fuses, standard.

4.1.9.4 Load disconnecting switches

The load disconnecting switches shall ensure local manual operation from the front panel. They shall have self-cleaning contacts with a high resisting anti-arc case and with quick-making and quick-breaking action, capable of switching the specified rated currents.

4.1.9.5 Overcurrent discrimination of low-voltage AC and DC circuits

The overcurrent devices must respond selectively in order to restrict any fault to the affected part of the system. The Contractor shall be responsible for proper overcurrent discrimination of protective devices within his scope of Works.

4.1.9.6 Auxiliary switches

Each item of the plant shall be equipped with all the necessary auxiliary switches, contactors and mechanism for indication, protection, metering, control, interlocking, supervisory and other services as applicable. They shall be suitable for use with 24 VDC depending on the requirements and wired to the terminals in the cubicle.

All auxiliary switches and mechanisms shall be mounted on easy accessible location.

4.1.9.7 Instrument transformers

Current and potential transformers are to be housed and designed to suit their intended use and shall comply with the newest standards. The CTs shall withstand without any damage or deterioration:

a) The continuous thermal current rating of the associated switchgear and

b) The maximum short-circuit level of the circuit for a period of one (1) second.

All CTs shall be able to carry the rated primary current with an open-circuited secondary winding for one minute without damage, or deterioration.

The secondary of CTs shall be earthed by means of a heavy copper conductor. Such earth connection shall be easily accessible.

Transformation ratios of CTs used for multi-phase protection or metering shall not vary one from each other by more than ten (10) % of the rated ratio.

The instrument transformers shall have adequate accuracy, saturation factor and rated burden. The Contractor shall determine the burdens and accuracy class of the secondary windings taking into consideration the most unfavorable conditions. The instrument current transformers used for the same purpose shall be the same.

The Contractor shall supply manufacturer's test certificates of tests and measurements to be performed in accordance with the applicable standards. The CTs and their associated circuits shall be tested on site by the primary injection method.

4.1.9.8 Dial instruments

Reed type frequency meters will be accepted for synchronizing equipment only. Digital instruments are accepted in some cases also, especially in cases when they combine different measuring and displaying functions. Purpose for their use shall be submitted to the Customer for approval.

4.1.9.9 Indicating lamps and push buttons

Where conventional indicating lamps and push buttons are used for control boards, insulation for service voltage shall be provided.

The lamp and push button colors shall conform to standards set out under SIST EN 60073, Basic and safety principles for man-machine interface, marking and identification - Coding principles for indication devices and actuators, and SIST EN 60204-1, Safety of machinery - Electrical equipment of machines -- Part 1: General requirements, as follows:

a)	Push button with back indication (general purpose)	white
b)	Indicating lamps (general purpose)	white
c)	Abnormal positions of selector and test switches	yellow
d)	Disturbance lamps	red
e)	Push button for emergency tripping	red
f)	Push button and indicating lamp for ON position	green
g)	Push button and indicating lamp for OFF position	red

A switch for switch-off and a test switch for testing of lamps shall be provided. The indicating lamps shall be LED lights.

4.1.9.10 Alarm annunciation

The alarm annunciation shall be integrated into a touch screen mounted on the front side of the cubicle.

The window of each illuminated alarm annunciation device shall be transparent, with engraved legend and shall be clearly readable only when the alarm is activated. Special care has to be paid to visibility and readability of screen announcements.

Requested alarm annunciation function will be implemented into the respective equipment.

4.1.9.11 Selector switches

All selector switches and test switches for control boards shall be of the switchboard type, with the necessary positions and engraved plates.

4.1.9.12 Small wiring and terminal blocks

All panels, cubicles, and racks shall be factory wired.

Wiring within panels etc. shall be laid on trays, segregated according to voltage levels and meet the EMC requirements. Wiring carrying AC and DC voltage shall also be segregated from one another.

The minimum cross-section of each copper wire shall be as follows:

a) 2.5 mm^2 for all consumers such as motors, heaters and current transformer circuits,

b) 1.5 mm^2 for control wiring above 60 V service voltage, and trip protection circuits,

c) 0.75 mm^2 for control wiring below 60 V,

d) 0.2 mm^2:in case the applied connection technique of standard electronic equipment does not permit the use of larger cross-sections, in such cases the application is subject to the Engineer's approval.

All secondary wiring shall be arranged and protected to prevent damages caused by arching, or by mechanical effects. It shall be neatly run in PVC free rigid plastic raceways or trunks clear of any metal panels and filled not more than 60% of the available cross section.

Compression type cable lugs shall be provided for the connections of cable cores with a cross-section of 1.5 mm2 or larger. The terminals shall be designed to ensure that no pinch-off of the cable cores may occur. Bimetallic clamps shall be provided if conductors of different material are connected.

The ends of every cable core and all the secondary panel wiring shall be fitted with numbered identification plates.

Terminal blocks shall be snapped on rails according to DIN, and shall be numbered consecutively beginning from left to right (or top to bottom). All terminal blocks shall contain minimum 30% spare terminals of category C.

4.1.9.13 Labels

The front side of the panels/cubicles shall be labelled with the designation according to the Equipment Identification System, which shall denominate its function.

Each and every component mounted on/in panels/cubicles shall be labelled with a visible item designation (on the element as well as at the installation point).

4.1.9.14 Tests

The workshop tests shall be performed on completely wired cubicles/panels in accordance with applicable standards.

The following tests shall be performed:

a) Visual inspection,

b) Megger test (to include equipment and internal wiring, excluding electronic equipment),

c) Functional tests of controls, interlocks, measurements,

d) Setting of protection relays and other devices, where applicable, by means of special testing equipment and operational check by the primary injection method (secondary method will not be accepted),

4.1.10 Instrumentation and control equipment

4.1.10.1 General

This Clause gives general requirements for technical performance of this type of equipment as well as for applicable interfaces. Detailed requirements of tasks to be performed by the control systems and the scope of supply for each item are given in the related Particular Technical Specifications. Reference to the relevant IEC Standards shall be respected.

General requirements to fulfil this approach are:

a) Each control sub-system included in this overall scheme (excitation system etc.) shall be furnished with standard field proven elements.

b) All I&C circuits shall be designed for 24 V DC.

c) Signals to be processed in several systems, e.g. for control systems, protection etc. shall be suitably repeated and mutually electrically completely de-coupled to avoid any interference.

4.1.10.2 Software requirements

The Contractor shall provide all programs necessary for the operation/maintenance/parameterization of individual parts and system as a whole.

System software shall be provided by the manufacturer as a standard, fully supported set of software products.

Human machine interface (HMI) for parameterization, inspection and management, which can be used also as test-tool must be delivered.

4.1.10.3 Hardware requirements for microprocessor-based equipment

Modules shall be designed for dedicated functions where basic requirements are as follows:

a) expansion and easy changing of operating environment,

b) modular design,

c) field proven standard equipment.

The connection of high-impedance test equipment to any test or metering plug shall not result in damage to the equipment.

The parts shall be arranged in such a way, that they may be inspected, removed, or replaced without disturbing, or damaging other parts, or wiring. The components with high operating temperatures shall be suitably located (in the upper part of the equipment cabinet and supplied with sufficient space for ventilation etc.).

4.1.10.4 Sensors and actuators

Respective equipment must comply with technological, ambient, mechanical, chemical and electrical conditions at the place of installation. Measuring ranges of delivered sensors and other elements shall be adapted to the ranges where the measuring values are normally expected, as required by the technological process.

Sensors and actuators shall be provided with connector or terminal connection with adequate IP protection.

All transducers shall have a current output of 4-20 mA DC; isolated output is strictly requested. Two wire connections are preferred. If this is not applicable, a power supply 24 V DC is requested.

a) Current capacity and contact resistance of changeover contacts must enable reliable direct connection to the PLC. Minimum current of 5 mA at 24 V DC shall be considered.

b) Respective sensors' and transducers' own supply must not exceed 10 mA.

c) All supplied equipment must enable satisfactory terminating and earthing of cables.

Level switches and transducers, this type of equipment shall meet the following requirements:

a) Level switches shall be located close to the process in an accessible location.

b) Each changeover contact must be galvanically separated from others.

c) Measuring points must be carefully selected and outfitted with all the necessary elements to achieve reliable data acquisition.

Flow meters and indicators, this type of equipment shall meet the following requirements:

a) Flow meters shall be directly connected, removable bezel, glass front or with digital display.

b) Flow meter switches (flow indicators) shall have at least one adjustable changeover contact.

c) Each changeover contact must be galvanically separated from others.

d) Measuring points must be carefully selected and outfitted with all the necessary elements to achieve reliable data acquisition.

Pressure switches and transducers, this type of equipment shall meet the following requirements:

a) Pressure switches shall have at least one adjustable changeover contact.

b) Each changeover contact must be galvanically separated from others.

c) Measuring points must be carefully selected and outfitted with all the necessary elements to achieve reliable data acquisition.

Position switches and transducers shall be suitably mounted for easy adjustment and for locking in position after being adjusted. They shall be of heavy-duty rating and shall have two (2) changeover contacts.

Connectors:

For specific purposes as part of the state-of-the-art installation system connectors (splitter boxes or sensor-actuator-integrator blocks) shall also be requested. These elements must be modular with four, six or eight separate connectors for sensor connections.

Element tests:

Each element shall be factory tested and shall undergo a test at the Site. The following tests shall be performed under full responsibility of the Contractor:

a) Workshop tests and tests at site, as requested.

4.1.10.5 Parameterisation tools

Tools (hardware and software) for parameterisation and diagnostic purposes for electrical equipment and elements shall be supplied according to the latest standards for this type of equipment.

All the respective hardware interfaces including cables and connectors must be supplied.

Software packages that are needed for parameterisation and diagnostic purposes must be part of delivery. All the respective documentation and licenses shall be enclosed to this software.

4.1.10.6 Implementation of control equipment

Testing

Final acceptance shall be granted only after all equipment has been installed, its operation verified and after all the required documents have been received.

The tests shall exercise every specified function and shall be performed as indicated in the detailed test procedure prepared by the Contractor and approved by the Engineer.

The basic tests are sequenced as follows:

a) Workshop tests,

b) Commissioning tests,

c) Site tests.

Training:

Hardware training Hardware training shall give the Customer's personnel sufficient knowledge on the design and operation, so that they can adequately maintain all equipment.

Software training Software training shall give the Customer's software personnel sufficient knowledge of the software system so they can perform all required software modifications, maintenance, and expansion.

All training courses shall cover the following topics, some of which may be more or less emphasized:

a) Documentation

b) Hardware overview

c) Basic parameterization

d) System initialization

e) Diagnostic functions

The training program shall be proposed by the Contractor and shall include all the necessary details (hourly descriptions, timeline, list of lecturers, locations, listeners' previous knowledge, training goals).

4.1.11 Cables

4.1.11.1 General

The Contractor shall:

a) specify in detail all the cables needed for the project, which will connect their equipment to that supplied by others;

b) provide any other information and instruction for cable connections that shall be provided by others.

For his scope of supply the Contractor shall perform all relevant design and engineering of the cable system. The documentation shall include cable plans, connection diagrams, list of cables and cable routing plans.

The Contractor shall select the most suitable cable routing ensuring that it does not interfere with other installations. All cable routing must be clearly indicated in the drawings.

However, the Contractor's scope of supply, laying and connecting of the cables shall include the following as a minimum:

a) all cables and conductors necessary for all power supply systems, for connection to voltage and current transformers and all other equipment,

b) all necessary nameplates for cable-identification,

c) all necessary standard (by manufacturers) fixing materials,

d) all necessary fire protection material for sealing cable openings through walls and ceilings as well as between cubicles,

e) all necessary UPVC (or similar) protecting tubes for cable runs,

f) all necessary cable connections elements including compression cable lugs, fixing and clamping materials etc.,

g) all necessary cable sealing ends and cable connecting sleeves including fixing materials,

h) all necessary compression connectors,

i) all necessary cable glands.

The maximum continuous current carrying capacity of each individual cable type and cross-section used shall be determined by the Contractor taking into account the site environmental conditions and other conditions/requirements.

The conductor cross-section of each cable, moreover, shall be adequate for carrying the prospective fault current determined by the next relevant short-circuit protection device when operating under the specified load conditions without deterioration of the dielectric. All the above data and their calculation shall, accompanied by the short-circuit calculations, appear in the documents to be supplied by the Contractor according to these requirements.

All power cables shall be copper conductor type. Cables having a cross section greater than 16 mm2 are to be of XLPE insulated type; LV cables of smaller size may be of PVC type. All cables are to be suitable for ambient temperature of 40°C.

Teflon- or silicone- based insulation must be provided for cables exposed to ambient temperature above 60°C.

The cables must be suitable for lying indoor, outdoor (direct or indirect sunlight), in ducts, on trays, underground and in water. The cable-sheaths must be resistant to solar radiation, the effect of oil, bacterial action, insects and rodents.

4.1.11.2 LV power cables

Low voltage power cables shall be standard single and multi-core cables with a copper conductor and CLPE or PVC self-extinguishing insulation. The common core covering shall consist of non-hygroscopic filler.

To ensure the elimination of excessive contact potentials on any object, effective earthing must be carried out as a safety measure. A suitable type of 3-core, 4-core and 5-core low-voltage power cables shall be provided.

The minimum conductor cross-section of the low-voltage power cables is 2.5 mm2.

Conductors

Cable conductors shall be made of stranded copper. Conductor design shall meet the following requirements:

a) from 2.5 mm^2 to 4 mm^2 circular stranded conductor

b) from 6 mm^2 to 25 mm^2 circular stranded conductor

c) from 35 mm^2 to 500 mm^2 circular stranded conductor

Over sheath

The PVC over sheath shall be oil-resistant, treated in order to prevent the insulation from spreading fire The PVC over sheath shall be coloured black for all LV power cables. The sheath shall contain the manufacturer's name, the voltage levels Uo/U in kV and the cable type.

Screen

Screen shall be of braided copper or braided tinned copper and shall have coverage of at least 80%.

Recommended current carrying capacity of power cables

Cables shall be designed for continuous loading, considering that one cable is in the air at temperature of 40°C:

PVC cable		
Reduction for layers of 9 parallel cables and 6 vertical trays	66%	
Reduction for 40°C ambient temperature and conductor temperature of 70°C		87%
Reduction factor		0.57
XLPE cable		
Reduction for layers of 9 cables and 6 vertical trays		66%

Reduction for 40°C ambient temperature and conductor temperature of 90°C	91%
Reduction factor:	0.60

4.1.11.3 Measuring and control cables above 60 V

The control cables shall be of the multi-core, PVC-insulated type withstanding without deterioration the conditions prevailing at the individual place of installation.

Fieldbus Cables

Special fieldbus cables are to be used for connecting distributed parts of the control system. They should be dimensioned for suitable power supply and relevant data rates. They shall correspond to and be selected with their differing demands according to standard EN 50288.

4.1.11.4 Instrument transformer cables

The design of these cables must comply with item "Measuring and control cables above 60 V". The minimum conductor cross-section for instrument transformer cables is 2.5 mm^2.

4.1.11.5 Optical cables

The Contractor's scope of works also includes laying, welding, marking and connection of optical cables and performance of control measurements. The Contractor shall perform all works and provide all additional installation material necessary for successful cabling.

Optical cables for outdoor installation resistant to water and rodents OS2, 24xFO 9/125/250 shall be used. Fibres shall meet the requirements of ITU-T G.652D.

The following shall be performed and ensured:

a) all the required optical connections between cubicles and inside cubicles,
b) welding and connecting optical cables,
c) all required number plates for identification of cables and individual cores,
d) all required cable trays, fixing material and protective PVC tubes (including inside cubicles),
e) everything else which is required in accordance with the general specifications for cabling, and
f) relevant measurements of the optical connections after completing the cabling and installing the connectors.

The Contractor's scope of works includes the connection and supply of the connectors for optical fibre cables. Optical connectors (as separate elements) shall be supplied by the Contractor according to precise specifications provided by the Customer. Only the estimated quantity and type of connectors to be supplied and connected by the Contractor is included in the installation specifications. The requirements stated therein shall be taken into consideration as appropriate as regards connecting between cubicles and between devices, as well as within cubicles and within devices.

Optical cable routing:

All optical cables in the power plant shall be routed in ribbed PVC tubes or other suitable tubes.

Tube pieces shall be connected with a standard straight coupling in a way that ensures a smooth and unhindered insertion of the cable.

The cable shall be suitable mechanically protected where the tubes are interrupted. The cable entry to the PE tube shall be sealed with a patent cable gland which shall be attached to the tube and equipped with a Pg gland.

A large thermal expansion coefficient of the PE tube, approximately 0.2 mm/m°C, shall be taken into account since it can lead to a retraction of the tube from the clamp when cooled down. Because of this, after being laid in the channel and before coupling the tube shall be cooled down, since, for example, when cooled down by 10 to -30 °C the length can shrink by 0.8 m at a distance of 100 m. This spare length shall be calculated in when the

tube is being laid in the channel. Temperature differences can be even larger in metal trays - this means the tubes shall be laid in a sinuous fashion or terminated at both ends in a flexible manner.

The laid cables shall be marked with the following:

a) “INFORMATION CABLE”, inscribed above,

b) sign for optical cable (laser danger) and

c) cable designation.

Laying of cables:

Before the laying or inserting of the optical cable, takeover checking of the cable shall be done:

a) appearance, structure, packaging, quantity,

b) attenuation and effective bandwidth,

c) cable and fibre geometrical properties,

d) cable resistance and inserting and bending characteristics, and

e) cable climate characteristics.

The Contractor shall be suitably qualified and shall ensure an adequate number of workers and provide all the equipment necessary for testing and inserting the cable without exceeding the maximum allowed stresses. The pulling force shall be managed by a dynamo meter and a blocking device. The cables shall only be laid at temperatures prescribed by the cable manufacturer. The optical cable routing shall ensure that a mechanical damage to the optical cable is not possible.

Optical cable coupling:

The optical couplings shall be done by qualified workers using a suitable welding/coupling and measuring equipment. The fiber coupling process is a routine process and shall cover the following steps:

a) cable preparation,

b) fiber preparation and

c) coupling, measurement and protecting.

To control the quality of the optical connections, the geometrical, mechanical, optical and transmission characteristics of all optical cable fibres shall be verified after the completion of works. The following shall be performed:

a) measurement of the length, and of fiber and optical line attenuation, measurement of all fibers after laying, whereas the length of the fibers shall not differ by more than 2% and attenuation not more than 0.05 dB/km, and

b) reflectometric verification of the optical weld attenuation, where the average coupling attenuation shall not exceed 0.1 dB, or 0.25 dB by each coupling.

c) attenuation and reflection measurements at the couplings of individual fibers,

d) attenuation measurements of individual fibers.

The measurement results shall be presented in tables and enclosed to the measurement minutes.

4.1.11.6 Cable connections and cable joints

For the connections of cable cores with a cross-section of 1.5 mm2 or larger, compression type cable lugs shall be provided. The terminals shall be designed to ensure that no pinch-off of the cable cores occurs.

Cable jacket

The cable jacket shall be oil-resistant and flame-retardant. It shall contain the manufacturer's name and cable type.

Terminal boxes and terminal cabinets

Terminal boxes or, wherever suitable, terminal cabinets shall be fitted on all the necessary points in order to simplify local grouping of cables and distribution of signals.

If the terminal boxes are not suitable, suitable intermediate terminal cabinets are to be used. Terminal boxes and cabinets must be equipped with the necessary terminal strips, cable glands, cable screw couplings and attachment components for the connection of the cables.

Terminals used for connection of current transformers shall be of a measuring type and fitted with short-circuit links. The necessary earthing terminals are to be provided for the earthing of the boxes and cabinets.

4.1.12 Spare parts

4.1.12.1 Obligatory spare parts

The Contractor shall enter the price for obligatory spare parts in the Schedule of Prices. The sum (total price) shall be added to the total tender price.

4.1.12.2 Recommended spare parts:

The Contractor shall enter the price for spare parts that they recommend in the Schedule of Prices; the price shall be valid for three years after signing the contract. The price of these spare parts shall not be included in the total tender price.

The Customer shall purchase the spare parts from the Contractor if needed within three years at the price stated in the Schedule of Prices.

4.1.13 Documentation

The Contractor shall prepare all the required workshop documentation, instructions for installation, operation and maintenance instructions (NOV) and supporting documents and submit it in and electronic (PDF, DWG, DOC) and printed form. The workshop documentation shall include calculations, plans, dimensional drawings, instructions, procedures etc. for the manufacturing and installation of the equipment under this contract. All changes shall be documented during the manufacturing and installation. The documentation shall be used also for preparing the detailed design drawings and as-built documentation.

The instructions, technical descriptions and requirements shall be in Slovenian.

All elements shall be defined in the bill of materials. Relevant technical certificates and brochures shall be prepared for the smaller purchased elements.

Unless otherwise agreed, the following documents are required as a minimum:

a) calculation of parameters of the switches,

b) calculation of parameters of auxiliary power supply,

c) calculation of parameters of electrical protection,

d) calculation of parameters of uninterrupted supply system 24V DC,

e) calculation of other equipment necessary for safe and reliable operation.

4.2 SPECIAL TECHNICAL SPECIFICATIONS FOR ELECTRICAL SCOPE

4.2.1 Synchronous generator and turbine with equipment

The Contractor for LOT TG, Part B shall supply all cables and equipment required for electrical connection of the unit supplied under Part A. The generator with excitation system and turbine shall be supplied under Part A.

Equipment on site assembly shall be performed by the Customer under the supervision of the Contractor.

A three-phase synchronous generator 100 kVA with excitation system for contactless generator exciting and with a digital voltage regulator shall be installed in the powerhouse.

4.2.1.1 Basic technical data of the three-phase synchronous generator

a)	Number of generators:	1
b)	Type:	synchronous self-excitation
c)	Nominal power:	1000 kVA at cooling air 40°C
d)	Service voltage:	3x231/400V±10%
e)	Frequency:	50 Hz
f)	Cos φ:	0.8
g)	Rated rotational speed:	1000 min^{-1}
h)	Runaway speed:	2000 min^{-1}
i)	Insulation class:	F
j)	Cooling method:	IC01
k)	Mechanical protection of the generator:	IP23
l)	Mechanical protection of the terminal box:	IP54
m)	Duty type in all conditions:	parallel with grid
n)	Efficiency	>96% at full power
o)	Bearings on the drive end and on the non-drive end:	sliding

4.2.1.2 Generator terminal cubicle BAA01

The equipment shall be supplied by the Contractor for LOT TG, Part B. The assembly of the equipment shall be performed by the Customer under the supervision of the Contractor.

A generator circuit breaker, instrument current and potential transformers and part of the generator protection equipment shall be installed in the cubicle.

4.2.1.3 Medium-voltage unit equipment

MV equipment shall be supplied under LOT EE and by the Customer.

The unit shall be connected to the grid transformer 0.4/20kV and connected to the Kneške Ravne 2 SHPP via a MV switchyard and a MV cable. The Kneške Ravne 2 SHPP is connected to the 20 kV distribution grid. All MV equipment without the grid transformer shall be supplied under LOT EE. The grid transformer shall be supplied and connected by the Customer. Scope of supply shall end with LV connections of the grid transformer. The Contractor for LOT TG, Part B shall supply LV power and signaling cables for the grid transformer and for the rest of the LV wiring for LV equipment, and provide control and protection of the LV switchyard. The installation and connection of the cables shall be performed by the Customer under the supervision of the Contractor.

The Contractor for LOT TG, Part B shall also supply the equipment for energy metering and for the control system of the intake reservoir's hydro-mechanical equipment. They shall also provide suitable GSM communication connections between energy metering system and the control center.

The basic equipment is shown in the enclosed single-line diagram of the power plant.

The layout of the equipment in the cubicles shall be specified by the Contractor and confirmed by the Engineer or the Customer.

4.2.2 Generator circuit breaker and auxiliary equipment

The scope of supply shall include all equipment for connecting the generator and auxiliary power supply to the grid transformer.

The most important equipment shall include:

a) metal cubicle, powder coated to RAL 7035, dimensions 2000x600x600mm, with 100 mm pedestal, with mechanical protection not less than IP 44, lighting with a switch, heater with a thermostat, socket and other material;

b) three-pole generator circuit breaker Un=690V, In=2000A, motor driven, ON and OFF coil 24V DC, under voltage coil 400V AC, anti pumping relay, operation counter and 10+10 auxiliary contacts and accumulated energy for shut-down (spring);

c) Power switch (circuit breaker) with time setting of protection functions (it shall also enable time delay of the short circuit function for ensuring selectivity with the generator short circuit protection), Un=690V, In=2000A, with a lever mounted on the door;

d) voltage transformer 0.4/0.1kV;

e) current transformer 2000/5/5A;

f) switches and voltmeters mounted on the door;

g) control buttons, switches, indicating LED lamps, terminal blocks, all labels and signs, cable and conductor designations, single line circuit diagram (blind diagram) attached to the door and other material required for assembly.

The Contractor shall supply and the Customer connect all the LV power and signalling cables to the envisaged connections all the way to the LV side of the grid transformer. The Contractor for LOT TG, Part B shall also supply cables for connecting the grid transformer and MV switchyard to the SHPP control system.

4.2.3 Control, signaling, measurement and protection equipment

Assembly, assembly supervision and commissioning tests of the SHPP shall fall under the scope of works for LOT TG, Part B with the collaboration of the other contractors. The assembly and the connection of the equipment on site shall be performed by the Customer.

Supply under LOT TG, Part A shall end and under Part B shall begin with the terminals in terminal boxes of the equipment from Part A. The Contractor for Part B shall supply all equipment for connecting the control and protection system to the terminal box of the turbine, generator, excitation system, turbine governor, valve, MV switchyard, grid transformer, CND01 cubicle at intake etc. The Contractor for LOT TG shall provide all primary electrical protection and signalization of the MV switch gear and the grid transformer (Buchholz relay, contact thermometers). The scope of supply shall end with the terminals on individual equipment.

Local automation and SHPP control shall include all the functions required for a safe and reliable operation of the SHPP. The more important functions of the foreseen system shall be: unit start-up, normal shut-down, quick shut-down (emergency shut-down), turbine regulation, measurement and indication of basic operating parameters, signal acquisition, optical/acoustic indication of mechanical protection alarms, electrical protection, manual unit control, completely automatic unit control, diagnostics of all circuits and electrical protection of the generator and the electrical equipment. The correct functioning of the PRV valve shall also be ensured. To ensure this, the contractors for both parts of LOT TG shall closely collaborate.

The SHPP's local control system shall measure and ensure the ecologically acceptable flow and, with the help of the turbine bypass, ensure an unchanged amount of water for the SHPP downstream in the event of unit shut-down or down-time for at least as long as the SHPP downstream does not record any significant deviations in the water flow due to the Kneža SHPP shut-down.

Unit controller and all relevant equipment shall be installed in the +1CNA01 cubicle. The cubicle shall be a metal cubicle, powder coated to RAL 7035, with mechanical protection not less than IP 44, dimensions 2000x600x600mm, and with a 100 mm pedestal. A LCD touch-screen is foreseen on the door of the unit's control cubicle, which shall be the main point for local control and for accessing all operating modes, electrical and temperature measurements and other signaling of the SHPP.

The following operating considerations shall be followed in the selection of the equipment and the manufacture of the software to ensure that the system enables:

a) parallel operation with the public grid in accordance with the requirements of the SONDO,

b) completely automatic local or remote operation without a permanent crew. The power plant's control equipment shall enable a remote control of the power plant from the SENG control center. At commissioning only a remote control from the SENG control center is foreseen, and the remote control of the SHPP shall be used after completing the modernization of the other SHPP's control systems;

c) completely automatic local operation to always ensure the ecologically acceptable flow. If the value is approaching the limit value, the unit shall reduce its power and shut-down if so required;

d) automatic restart in case of grid failure;

e) activation (trip) of the generator circuit breaker and SHPP shut-down at the external control box if the grid system operator needs to separate the SHPP from the grid;

f) regulation of the pressure regulating and turbine bypass valve. In the event of any kind of turbine shut-down, the turbine regulator shall synchronously open the PRV and thereby additionally reduce the increase in unit's pressure and overspeed.

g) regulation of the water flow to the power plant downstream in case of unit's shut-down or down-time. Using the pressure regulation valve (PRV) in the powerhouse, the control system shall regulate the water quantity supplied to the power plant downstream for at least as long as the lowered water flow due to Kneža SHPP shut-down does not have a significant effect on the power plant downstream. In temporary shut-downs the valve shall remain open the entire time to ensure that the disturbance of the water flow to the power plant downstream is minimized. Opening of the valve shall be controlled via the same systems as those used for regulating the turbine; thus, in the ramping function the flow shall be regulated according to the level in the upper intake structure.

   When the unit is out of operation for a longer period of time, the closing of the valve shall be done slowly enough so that over-spilling water comes down from the upper reservoir to the downstream power plant by riverbed in such a way that the operation of the downstream power plant is not influenced too much. It is estimated that this procedure would take several hours. The exact method and duration of the procedure shall be determined during commissioning tests. In any case, the closing law shall never be shorter than the laws applicable for the main inlet valve and the turbine guide vanes.

h) in addition to operating settings, the software shall enable simple changing of the more detailed operating parameters.

The Contractor shall provide any other equipment and systemic functions which are required for a safe and reliable operation of the entire SHPP, including those not specified.

4.2.3.1 Control and regulation

The power plant's basic control system is composed of a processor with software, operation panel, input/output analogue and digital units, primary providers of analogue measurement quantities. In addition to the protection and measuring systems, the electronic part of the turbine regulator and start-stop automation shall be installed in the unit control cubicle to enable the following operating modes:

a) parallel operation with regulation by flow,

b) parallel operation with power regulation,

c) frequency regulation when free run (speed control)

d) automatic regulation of reactive energy (with the possibility of regulator shut-down) according to the requirements of the SONDO and the related enclosures,

e) local and remote control,

f) manual and automatic control.

The requested regulation and logical functions shall be implemented as control functions with adjustable parameters. All logical functions shall be implemented in the form of a ladder diagram.

Parallel operation with regulation by flow

The basic operation shall be parallel to the grid. This operation shall entail:

a) automatic start-up with synchronization to the grid with regard to the starting water level in the reservoir, grid ratios and ecologically acceptable flow;

b) automatic regulation of unit's active power according to the natural water flow and continuously ensured ecologically acceptable water flow of not dammed water in the riverbed;

c) automatic regulation with pre-set desired reactive power according to the requirements of the SONDO and the related enclosures;

d) unit's automatic normal shut-down by disconnecting from the grid following relieving of the unit with regard to the water level;

e) automatic quick shut-down during the activation of protection systems which enable a restart after the activation of HZ3 protection;

f) unit's automatic quick shut-down during the activation of electrical protection whose activation is the power plant's defect;

g) unit's automatic quick shut-down during the activation of mechanical protection whose activation is the power plant's defect;

h) measurement and indication of basic operational quantities;

i) unit's temperature monitoring with the indication of the measured quantities;

j) indication of positional signalization;

k) manual control of the unit via programmed technological blockages.

The unit's start-up and shut-down shall be controlled by start-stop automation whose operation includes water level, grid conditions and protection. The synchronization to the grid shall be performed by an automatic synchronizer. The turbine regulator shall perform the regulation according to the power and the level in the level regulation mode with respect to the continuous level measurement. Abnormal level drops shall be controlled via the pressure in the penstock - in such case, the unit shall undergo a quick shut-down.

The regulation of the reactive power or the generator's operating area shall be done by the automatic reactive power regulator via the voltage regulator and generator excitement. Power regulation shall meet the requirements of the SONDO.

Control system functions

The SHPP control system shall enable at least the following functions which shall be presented in detail for the offered type of primary energy equipment:

a) manual operation of the unit,

b) automatic operation of the unit,

c) unit start-up to free run,

d) automatic and manual synchronization with the grid - with installed suitable instruments,

e) turbine power and water level regulation,

f) unit's normal shut-down with a prior load lowering and trip of the generator circuit breaker,

g) quick unit shut-down in the event of activation of mechanical or electrical protection,

h) automatic restart, synchronization and load acceptance under suitable conditions,
i) generator's reactive power regulation within the limits of the pre-set desired value according to the requirements of the SONDO,
j) measurement and indication of basic operational parameters,
k) unit's temperature monitoring with indication of the measured value of the requested measuring point,
l) acquisition and optical/acoustic indication of alarms for the mechanical and electrical protection,
m) acquisition and optical indication of the positional signalisation and switching states,
n) manual control of the unit via programmed technological blockages.
o) local manual control on the actual devices bypassing the technological blockades in the event of electronic equipment defects,
p) diagnostics of all circuits,
q) penstock's water flow regulation by using the bypass valve during unit down-time,
r) local and remote control of the intake gates Z1,
s) local control of the wash-out gates of the inlet channel Z2,
t) local control of the wash-out gates of the sandtrap Z3.

The equipment suppliers for other LOTs and parts shall submit a draft technical (functional) description for the each system on the basis of which the Contractor for LOT TG, Part B shall provide a suitable controller, suitable number and type of input/output modules, optical converter and prepare the suitable software for equipment control and supervision.

Using the disconnection point (generator circuit breaker)

The disconnection point elements which enable the use of the system operator shall be accessible also in the event that the owner i.e. power plant operator is not available. Elements for using and signalling at the disconnection point are as follows:

a) changeover (circuit breaker blockage at the disconnection point),
b) voltage indicator on the distribution side and
c) position indicator for disconnection point circuit breaker, and shall be installed in the cubicle on the plant's façade and equipped with the SODO (Elektro Primorska d.d.) key lock.

4.2.3.2 Acquisition of input analogue and binary signals and device control

Input/output modules of the central processor controller and regulation shall be suitably adapted for a direct connection of analogue and binary signals of the following levels:

a) converted measurements: 4÷20 mA,
b) binary inputs: 24 V DC,
c) control voltage: 24 V DC.

The auxiliary voltage of the control, signal and protection circuits shall be 24 V which shall be ensured by the rectifier with an accumulator battery.

The information about the upper water level is forwarded to the regulator and the control system by a level sensor installed in a special shaft and connected to the powerhouse with an optical cable laid along the penstock.

The temperature sensors Pt 100 with a three-wire connection shall be connected directly to the controller's input units. Separate transducers shall be avoided.

The control system at the SHPP level shall also control all hydromechanical equipment of the plant, including the intake equipment which is under the scope of supply for LOT A. The control system shall include the control and diagnostics for the following systems of the hydromechanical and measuring equipment:

a) intake gates Z1,

b) wash-out gates of the inlet channel Z2,
c) wash-out gates of the sandtrap Z3.
d) measurement of the ecologically acceptable flow (height of not dammed water) and flow calculation,
e) measurement of water level in the reservoir (expected behind trash rack),
f) foresee a possibility for a subsequent installation of equipment for measuring the clogging of intake trash rack and to monitor and control the cleaning machine,
g) measurement of the water flow in the penstock,
h) communication with a superimposed SENG remote control system via a satellite modem,
i) measurement of the clogging of intake trash rack, supply of pressure transducer does not fall under the scope of supply for LOT TG, it falls under LOT A,
j) control of the cleaning machine's main functions, cleaning machine does not fall under the scope of supply for LOT TG and shall be supplied subsequently if required,
k) control of two gates at the Kneža SHPP's outflow channel.

4.2.3.3 Protection system of the unit, transformer and disconnection point

In addition to other protection systems, the Contractor for LOT TG shall also provide all primary electrical protection of the MV switch gear and the grid transformer (Buchholz relay, contact thermometers etc.). The scope of supply shall end with the terminals of individual equipment.

The consequence of protection activation is unit's shut-down. There are several causes for protection activation and unit shut-down:

a) Protection of the disconnection point where the cause of protection activation is not the power plant's equipment and which impacts the trip of the generator circuit breaker and the unit's quick shut-down with the chance of an automatic restart. Restarting shall be possible when the situation has stabilised. The protection of the disconnection point shall include the following functions:
    - 2-stage undervoltage protection and 2-stage overvoltage protection;
    - under and over frequency protection;
    - 20 kV earth-fault protection.
b) Generator protection caused by a failure of the unit's electrical equipment; the protection shall simultaneously impact the unit's quick shut-down and the trip of the generator circuit breaker. The unit's quick shut-down means quick closing of the turbine's closing mechanisms. Restarting the unit shall be possible only after the defect which caused the activation of the protection has been remedied and accepted. Generator protection shall include the following functions:
    - overvoltage protection,
    - short circuit protection,
    - overcurrent protection,
    - reverse power,
    - underimpedance protection.
c) Unit overspeed protection using electronic overspeed safety device. The protection shall simultaneously impact unit's quick shut-down and the trip of the generator circuit breaker. The unit's quick shut-down means quick closing of the turbine's closing mechanisms. Restarting the unit shall be possible only after the defect which caused the activation of the protection has been remedied and accepted.
d) Transformer protection and indication of Buchholz relay operation, temperature, with the possibility of quitting protection and viewing trends for individual quantities in the control system.

e) Mechanical protection shall impact the unit's quick shut-down, generator shut-down shall be done following relieving of the unit. Restarting the unit shall be possible only after the defect which caused the activation of the mechanical protection has been remedied:
   - excessive temperature of generator winding,
   - excessive temperature of generator bearings,
   - abnormal pressure drop in the penstock measured with a pressure switch in the powerhouse,
   - governor oil level or pressure too low,
   - excessive pressure difference at the fine intake trash rack,
   - water pressure in penstock too low.

Type of mechanical protection depends on the selected unit type and shall be presented in detail in the tender.

Generator protection and loss of mains shall be done in a numerical form with an adjustable activation point and time delay.

Generator protection and loss of mains shall be installed with separate numerical relays.

Earth-fault protection within the loss of mains shall be done with an overvoltage function connected to the so-called "open delta" winding 20 kV of the voltage transformer.

Electrical protection shall have a free, watch dog contact which signalises failure or power loss of individual electrical protection.

The generator protection shall always include protection from the generator circuit breaker failure which leads to transformer shut-down in the event of generator circuit breaker failure. The condition for activating the said protection is inclusion of the generator circuit breaker, generator current and activity of protection functions.

Loss of mains shall always include protection from the generator circuit breaker failure which leads to transformer shut-down. Circuit breaker failure detection shall be done with auxiliary contacts of the generator circuit breaker.

Numerical generator protection relay and loss of mains relay shall have at least 10 outputs. Both relays shall have an integrated cut control circuit. Both relays shall enable oscillography recording (disturbance recording) and a remote access to oscillography results.

Both protection relays shall enable remote communication via Ethernet RJ45 interface with a Modbus and IEC61850 protocol. They shall also enable transfer of analogue measurement quantities with a Modbus protocol to SCADE SENG. Both protection relays shall be connected to the power plant's communication computer.

Loss of mains shall enable transfer of S, P, Q, f, U, I, pf measurements on 20 kV level to SCADE SENG, and generation protection shall enable transfer of S, P, Q, f, U, I, pf measurements on the generator level.

The relays shall cover all 3-phase or phase-to-phase voltage values and 3-phase current measurements. Loss of mains shall also include the measuring voltage of the open delta.

A numerical protection terminal, such as ABB REG615 with the order number HBGCAEAGNBC1ANN21G can be used for generator protection.

To unify SENG's protection system equipment, the standard configured numerical protection terminal ABB REF615 with order number HBFKBCADNBC1BNN2XG, with a large screen and synoptic display shall be used.

Protection of the disconnection point:

The disconnection point shall be done in accordance with the Instructions for connecting and operating power plants with installed power up to 10 MW (OG RS No. 41/11).

a) Voltage failure in the distribution grid shall always lead to the separation of the power plant from the distribution grid at the disconnection point. Manual disconnection shall be possible with the blocking of the reconnection.

b) Circuit breaker at the disconnection point (LV generator switch in the powerhouse) shall definitely disconnect the power plant from the distribution grid which is not able to accept the available electric

energy. It shall be equipped with an ON and OFF coil regulated by protection devices. The generator circuit breaker shall have enough accumulated energy (from the spring) for tripping without electricity.

c) Control voltage failure shall lead to circuit breaker tripping. Failure of a auxiliary DC voltage source for power plant control and protection shall lead to the separation from the Elektro Primorska d.d. grid and power plant shut-down.

d) The disconnection point elements which enable the use of the system operator shall be accessible also in the event that the owner i.e. power plant operator is not available. Elements for using and signalling at the disconnection point installed in the cubicle on the plant's façade and equipped with the SODO (Elektro Primorska d.d.) key lock, are as follows:

- changeover (circuit breaker blockage at the disconnection point),
- switch or changeover with the possibility of unit shut-down,
- voltage indicator on the distribution side and
- position indicator for disconnection point circuit breaker.

e) Protection devices at the disconnection point:

	operational setting:	time delay:
earth-fault protection:	$t \leq t_{RTP}+5s \leq 5.2s$	$3U_0=0.25U_{SN}$
undervoltage protection:	Un-15%	0.2s
overvoltage protection:	Un+10%	0.2s
underfrequency protection:	47Hz	0.2s
overfrequency protection:	51Hz	0.2s

f) The circuit breaker at the disconnection point shall be turned-on using a synchronisation device which ensures the following synchronisation conditions:

- maximum difference in voltage $\pm 2\%U_n$;
- maximum difference in frequency ±0.9Hz;
- maximum allowed voltage surge when connecting the generator to parallel operation shall not exceed $\pm 0.6\%U_n$.

Protection device power supply shall be done with a separate 24 V DC miniature circuit breaker. Trip circuit requirement:

a) power supply with a separate 24 V DC miniature circuit breaker.

All protection shall be adapted to standard AC measuring inputs 100 V, 5 A and auxiliary voltage 24 V DC.

Measurement of all three phase to phase voltages is required for all voltage protection.

Protection relay's detailed technical information shall be included in the tender.

Microprocessor based multi-functional protection relay with supply and measurement inputs adapted to the rest of the equipment shall be used.

The protection system shall also include suitable test switches, separate for the generator protection and for the loss of mains, in accordance with the unification of SENG's protection equipment, and connection to 20 kV and 0.4 kV instrument transformers. Instrument transformers with suitable fuses shall be supplied by the Contractor for LOT EE.

Electrical protection equipment shall be installed in the +1CNA01 cubicle.

All equipment shall be set and tested in accordance with the SODO instructions, applicable regulations, and the consent for connection, prior to the completion of works.

4.2.3.4 Meter and control measurements of the produced energy

The billing point of the electric energy production is at the 20 kV side. Supply under LOT TG, Part B shall end at the terminals on the instrument transformers in the 20 kV cubicle AJA3. The Contractor for LOT TG, Part B shall supply, install and test a digital four quadrant electronic energy meter, class 0.5, with a GSM connection to the existing system for remote control and reading the SENG energy metering.

The control point of the gross electric energy production shall be at 0.4 kV generator terminals. The meter shall be connected to the instrument transformers of the generator terminals. The Supplier for LOT TG, Part B shall supply, install and test the digital four quadrant electronic energy meter.

Measuring devices for capturing electric energy P2 shall include:

a) metering and registration of 15 min. of average value of consumed and produced active, reactive energy and peak power,
b) indirect metering, metering voltage 3x58/100V to 3x230/400V, metering current 5//1A, 50 Hz,
c) active energy class 0.5; reactive energy class 1.0,
d) 2 or more inputs 58 to 240V for energy meter control (switch between energy tariffs, periods, time synchronisation),
e) auxiliary power supply 100-240VAC,
f) battery auxiliary power supply,
g) IEC1107 and DLMS communication protocol,
h) optic probe (converter) for setting,
i) LCD display according to EDIS/OBIS code,
j) 4 or more free programmable optoMOS outputs, 2 additional measuring inputs,
k) built-in GSM/GPRS module with additional RS485 output,
l) equipment shall be equipped with a bar code, valid USM stamp and sealed,
m) equivalent/comparable to ZMD405CT44.0457 with module CU-P42.

Meter readings for both measurements shall be transferred to the SENG, HSE and Elektro Primorska control centre via an optical cable running along the penstock and the existing GSM connection.

Measuring terminals of the billing measurements shall have a sealing option.

It is estimated that all energy metering equipment shall be installed in BAA01.

4.2.4 Telecommunication

The Contractor for LOT TG, Part B shall supply, blow, lay, connect and test all optical cables. The Customer shall assemble all the other telecommunication equipment on site and connect the other wiring connections under the supervision of the equipment supplier.

4.2.4.1 Equipment

The main telecommunication equipment shall be installed in the SHPP's powerhouse in the +DYT01 cubicle and partially in the Kneške Ravne 2 SHPP's powerhouse. A cubicle for installation of 19'' telecommunication devices, with estimated dimensions 600x600x2000, and powder coated to RAL 7035 shall be used.

The power plant shall have a communication connection with the intake structure, Kneške Ravne 2 SHPP and SENG control centre.

The scope of works for LOT TG, Part B includes equipment supply, commissioning and testing, including blowing in cable ducts, laying in cable channels and trays and optical cable measurements between the powerhouse and Kneške Ravne 2 SHPP and between Kneške Ravne 2 SHPP and the new intake structure of Kneža SHPP. The optical ducts shall be prepared by the civil works contractor for LOT C, LOT A and LOT EE - Part B. The Contractor shall examine the actual length of the routing before ordering the optical cables.

4.2.4.2 Connection to the intake control system

Unit's control and supervision system will be connected to the remote input/output modules at the intake structure via optical cables.

For the purposes of connecting to remote intake units, the Contractor for LOT TG shall supply a +CND01 cubicle; in the said cubicle and in the control cubicle in the powerhouse they shall install an optical converter for Single Mode optical cable (e.g. Siemens OLM/G11) and connect it with the SHPP's control and supervision system; the cubicle shall also be equipped with a suitable type and number of input/output modules for controlling the intake equipment. The Contractor shall supply and install also the power supply and all other necessary equipment.

The +CND01 cubicle with the energy and hydromechanical intake equipment shall be supplied under LOT A.

The software shall obtain all the basic operating parameters from the intake, and indications which are necessary for a safe and reliable operation. In the event of an accident in the powerhouse or the penstock, the software shall initiate the safety closing of the main intake gates.

4.2.4.3 Connection to the control centre

SHPP controller shall be connected to the communication computer via an Ethernet connection and to the optical switch via an Ethernet router. The optical switch shall be connected to the optical cable laid along the penstock route to Kneške Ravne 2 SHPP.

The connection to the SENG control centre shall be via a satellite. The Contractor shall supply and install a satellite modem and related satellite internet equipment. The antenna shall be installed at a location which enables high enough quality of signal receiving and transmitting. The receiver/transmitter and the modem will be installed in the Kneža SHPP's powerhouse in a DYT01 cubicle or in the Kneške Ravne 2 SHPP's powerhouse. The exact location shall be determined during the preparation of detailed design documentation, depending on the quality of signals. The IEC 104 protocol shall be used for communication with the SENG control centre.

Technical requirements for the communication computer:

a) Linux operating system,

b) 3 x LAN port 10/100 Mbps (RJ45),

c) 8 x RS-232/422/485 ports, programmable connectors (8-pin RJ45) (e.g. Moxa UC8420).

Software and communication requirements:

a) support for TC57, MasLink, ISO TCP, Modbus and Siemens S7 protocol,

b) support for communication converters ADSL, ISDN modem, GSM modem, GPRS, HSCSD, UMTS, PSTN modem, short range modem, RS232 and RS485,

c) support for multiple IEC 60870-5-104 communications.

Technical requirements for the router:

a) it shall operate as a firewall with

b) 8 or more ports,

c) 10 or more IpSec VPN simultaneous sessions,

d) at least 3 VLAN support,

e) console access,

f) 220V power supply (e.g., Cisco ASA5505, Mikrotik CCR1009-8G-1S).

The assembly and commissioning of the router shall be done by the Customer (SENG).

4.2.5 Flow measurement

The assembly on site shall be performed by the Customer. The Contractor for LOT TG, Part B shall supply the equipment, supervise the assembly, start-up and testing of the equipment in collaboration with the contractor for LOT TG; Part A.

A ultrasonic water flow measurement shall be performed in the penstock to measure the water flow during SHPP operation and when bypassing the turbine using the bypass valve. Flow sensors shall be installed on the external side of the penstock, in the shaft in front of the powerhouse, and connected by cables with the control cubicle in the powerhouse.

The flow measurement system will be connected to the SHPP' control system to enable regulation of a parallel bypass and indication of measurements on the unit's operating panel.

Flow sensors installed in the shaft shall have suitable IP protection.

4.2.6 Tailwater measurement

The assembly on site shall be performed by the Customer. The Contractor for LOT TG, Part B shall supply the equipment, supervise the assembly, start-up and testing of the equipment in collaboration with the contractor for LOT TG; Part A.

The measurement probe for measuring the tailwater level shall be installed in the outflow channel, and protected with an INOX pipe, protective netting and a suitable cable gland. The connection cable shall be connected to the controller's I/ unit. If the tailwater is too low, the controller will sound the alarm and shut-down the unit after a specific time period.

4.2.7 Distribution and auxiliary power supply

The assembly of the equipment on site shall be done by the Customer, whereas the Contractor for LOT TG, Part B shall supply the equipment, and supervise its assembly, start-up and testing. The scope of supply shall end with the LV connections of the grid transformer and the terminal boxes of the turbine, generator, excitation system, hydraulic regulator, valve, crane and other equipment which is not supplied under LOT TG, Part B.

4.2.7.1 Auxiliary power supply distribution +BFA01 in the powerhouse

Distribution of 0.4 kV auxiliary power supply shall have only one sector +BFA01. All technological and general consumers with the lighting and electrical installations shall be connected to this sector. Special, more powerful consumers shall be connected to two 100 A auxiliary power supply branch-offs. In case of external power supply failure, urgent consumers shall be powered from the rectifier equipped with a battery.

The basic equipment is shown in the enclosed single-line diagram of the power plant.

The auxiliary power supply distribution shall also include a suitable number of branch-offs for lighting, electrical installations and back-up.

The lighting and electrical installations fall under the scope of LOT A. The scope of supply shall end with the terminals in the +BFA01 cubicle of the auxiliary power supply distribution.

The auxiliary power supply distribution equipment shall be assembled to the +BFA01 cubicle, dimensions 2000x800x600 with a 100 mm pedestal.

All branch-offs shall be protected with suitable load disconnecting switches with relevant bimetallic and electromagnetic actuators and suitable signalling contacts.

The Contractor shall prepare a list of the AC power consumption stating the installed power of each consumer, starting current and estimated maximum simultaneous power of the entire supply in the least favourable operating conditions. Rated input power of 55 kW shall be considered for lighting and electrical installations which are not part of this tender.

The data on the maximum simultaneous power of the auxiliary power supply is a guaranteed value and shall be entered as a technical data.

Each motor drive shall have its own motor protection switch.

At least 10% of spare run-offs shall be envisaged.

4.2.7.2 Auxiliary power supply on intake

The auxiliary power supply on intake shall be supplied under LOT EE and LOT A. The supply shall be done from Kneške Ravne 2 SHPP.

4.2.7.3 24V rectifier and distribution of DC consumers

A 24V rectifier and distribution of DC auxiliary power supply consumers shall be built into the BUA01 cubicle. A sealed lead - leakproof acid battery type VRLA shall be built into the cubicle depending on spatial possibilities.

The system shall enable a connection to the existing common control system for uninterrupted supply.

Basic functions:

The 24 V rectifier shall be intended for reliable supply to the equipment with a standard DC voltage 24 VDC. The supply system shall be pre-set for use in systems with a sealed lead acid battery with a rated voltage of 24 V (12 cells). The control unit shall enable adjusting the charging voltage with regard to the temperature and according to the battery manufacturer's recommendations.

The system shall be designed for supplying consumers and battery charging or floating with a min. 1200 W without a redundancy module (N+1).

A sine inverter of at least 350 W shall be installed in the rectifier's cubicle to supply power to the modern telecommunication equipment and other demanding consumers with inverter output voltage 230 VAC (e.g. COTEK, SE350 model).

The system shall be of a modular type with a module redundancy (N+1). Power supply to DC consumers and battery charging at the rated voltage shall be ensured also in the event of a module's failure. In the event of a failure of several modules, the supply to DC consumers and battery charging shall be ensured if the current system load does not exceed the power of the operating modules. It should be possible to replace all the modules during system operation without interrupting the supply. Modules shall have natural air-cooling.

Rectifier modules shall be quickly replaceable during operation and under load. Adjustable module parameters shall be adjustable via the control unit without the use of additional hardware and software.

The modular system shall be composed of at least 3 rectifier modules with the possibility of adding at least 1 additional module to increase the power and the system's redundancy without additional works.

The system shall be adapted for connecting to supply of 3x250 V, 50 Hz. Module arrangement in stages shall enable a symmetrical load.

The system shall be protected with load disconnecting switches at the input and with fuses or load disconnecting switches on both poles in the battery circuit and on the consumers' side.

The DC system shall be pre-set for a connection to a battery type VRLA 24V with 12 cells. Temperature compensation shall be ensured for the charging voltage. With regard to the battery condition, the system shall enable the following voltage operating modes: floating mode (battery charging) with temperature compensation, manual battery charging, equalize mode, battery capacity test. Charging and battery floating modes shall be adaptable. The system shall enable a subsequent adaptation to a different battery.

System configuration and analogue input calibration shall be done exclusively via a web browser (Windows Internet Explorer).

The system shall include protection and control functions which enable a fully automatic operation and maintaining the battery in an optimal condition which will ensure meeting the declared product life of the battery.

System control electronics shall control and report the condition of all battery and system parameters. In the event of a failure of the system control electronics, the supply shall not be interrupted.

To control the ground fault (L+, L- toward the earth) on the side of DC consumers, a ground fault monitoring device shall be installed in the system which reports a ground fault via at least two output relays (NO,C, NC). Supply range min. 19-40 VDC. Measurement range min. 1–200 kΩ. The ground fault monitoring device shall not be affected by the system's capacitance to the ground which is smaller than 20 µF.

The system shall be equipped with a suitable LVBD contactor which protects the battery from over-discharging.

The system's control unit shall be equipped with standard interfaces which enable communication with control systems (local and remote):

CAN, RS232, RS485,

TCP/IP: Modbus, SNMP, online access (WEB), e-mail notifications,

modem.

The said connections shall enable a complete control of the system and data transfer from the system. For remote reporting the control unit shall be equipped with at least 6 digital outputs (voltage-free contacts) wired to the terminals and at least 6 digital inputs for signalling logical conditions of internal switching elements (load disconnecting switches, fuses, switched etc.), two digital inputs shall be wired to the terminals for controlling the external elements with discrete outputs.

Mechanical design:

The rectifier shall be installed in a free-standing metal cubicle powder coated to RAL 7035 with the dimensions (HxWxD) 2000x600x600mm, and with a 100 mm pedestal. The cubicle shall have natural air-cooling. All installed elements shall be accessible from the front side. Connections (grid, DC output, inverter output voltage, battery connections, signalling connections) shall be installed in the bottom front side of the cubicle.

Cooling and over-heating protection:

Installed rectifier modules shall have natural air-cooling. The cubicle shall enable suitable cooling of the installed equipment without fans. Rectifier modules shall be protected from overheating by limiting the output power. If there is an unforeseen rise in temperature, the modules shall be selectively disconnected and restarted when the temperature has dropped.

Operation, control and regulation:

The rectifier shall be equipped with protection and control circuits which enable completely automatic system operation in all operating modes.

The control unit shall enable optimised rectifier operation with a power saving function, where the number of active modules is adapted to the current needs; active modules and modules in stand-by shall alternate in set intervals (weekly). The operating modules shall be optimally loaded to achieve the best efficiency and lower temperature in the cubicle. In the event of a transient in the system load, the supply needs shall be covered by the battery while the additional modules are being activated. The redundancy of the modules in operation as well as limiting their load shall be adaptable.

It shall be possible to replace, remove or add rectifier modules during system operation without any module or system setting, even if the modules are new or from a different system.

Control:

Remote or local system control and regulation via the control unit shall be possible.

Planned local signalisation and measurements:

a) LED signalisation on rectifier modules,

b) indication of all parameters and conditions, and LED signalisation on the control unit,

c) voltmeter and ammeter (indicators for DC branch-off) on the front side of the rectifier.

Planned remote signalisation:

a) voltage-free contact (rectifier fault and disturbance - delayed 5s, inverter fault and ground fault on DC system)
b) TCP/IP: Ethernet (WEB - online access, e-mail, SNMP (NMS), Modbus),
c) programmable voltage converters 4-20 mA for transferring system voltage meter readings and current converters 4-20 mA for transferring consumer current meter readings.

The supply system shall be included in SENG's existing system (Pricom).

Rectifier module:

Rectifier modules shall use high-frequency switch technology in electric energy conversion which shall ensure a completely regulated and insulated DC output from the AC grid. Rectifier input shall enable a wide range of input voltage. Modules shall operate in connection with the control unit; at every entry in the system via the CAN guide, the control unit shall first set their values of basic operating parameters and then control them during operation. All

module connections, energy and signalling, to the system shall be implemented exclusively via a fixed connector (e.g. ALPHA CORDEX CXRC 24-400W).

Inverter:

The inverter shall be ready for installation to the assembly panel in the inverter cubicle. It shall be equipped with an input for remote turning on/ off which shall be wired to the digital output of the inverter's control unit. A programmable undervoltage relay wired to the digital input of the control unit shall be installed for inverter output voltage drop signalisation.

The inverter shall be protected with a 2p DC circuit breaker at the DC input and a 2p circuit breaker at the AC output, and equipped with all other protection to ensure the highest safety level and suitable selectivity of the protection.

The inverter shall be equipped with a manual bypass switch to enable switching the consumers to direct supply from the grid for the purposes of servicing etc.

Control unit:

The control unit shall control the supply system and the rectifier modules with regard to the supply system condition. The control unit shall display measurements, active alarms and alarm history (such as APLHA CORDEX CXC).

Quick and simple monitoring of all the settings and system parameters values (voltage, current etc.) shall be possible. A physical resetting of the control unit shall be possible which shall not affect the reliability of the system operation. Additionally, it shall be possible to completely control and set all the parameters of the control unit via a computer with an installed web browser (e.g. Windows Internet Explorer), either locally via a crossover cable or remotely via the internet.

The control unit shall control all modules via a CAN (Control Area Network) guide.

Battery functions:

a) temperature compensation,
b) possibility of manual, automatic and periodic activation of voltage equalizing mode,
c) dynamic control of charging current, charging current limitation
d) control (indication) of battery autonomy/capacity and discharge depth with the possibility of alarm setting,
e) automatic or manual mode of battery testing.

Files with history:

Daily statistics: Min., max and average values of analogue inputs with date and time designation. Battery current, inverter current and grid AC voltage for at least last 90 days.

Event history: All events, such as alarms, turning on, change in digital input conditions and other events.

Battery history: Battery condition for the last 20 discharges with the time of discharging and battery capacity.

Data history: History of adjustable system signals including external smart units.

Technical data

Inverter input:

a) Voltage:	3x400/230V ±20% (supply protected with surge arresters)
b) Frequency:	50Hz, wider 45-70 Hz
c) Starting current:	soft start, <rated current
d) Static regulation:	more than ±0.1% for any kind of change in input voltage within rated limits
e) Dynamic regulation:	more than ±1% for any kind of change in input voltage within rated limits, stabilisation time <10ms
f) Power factor:	>99% (at 50-100% load) >98% (at 30-50% load)
g) Efficiency:	>93% (at 50-100% load)
h) Initial time:	<5 s (soft start excluded)
i) Start delay:	Adjustable initial time up to 120 seconds for reducing influence on power supply
j) Soft start:	adjustable to at least 5 seconds (without start time delay), set with the limitation of the output current
k) T.H.D.:	<5% at 100% load
l) Interference suppression:	according to ANSI/IEEE C62.41 category B3
m) Protection:	input load disconnecting switches, internal fusible fuse in each module, overvoltage protection at supply

Rectifier output:

a) Rated voltage:	24VDC
b) Voltage Range:	from 20 to 29VDC
c) Withstand voltage:	27.3VDC (Pb VRLA battery, 12 cells 2.275V/cel at 25°C)
d) Rated current:	>45A, (N+1)
e) No. of modules:	min 3
f) Time stability:	0.5% per year
g) Temperature stability:	<100ppm/°C in operating range
h) Operating characteristics	IU according to DIN 41772/DIN 41773
i) Static regulation:	more than ±0.5% for any kind of change in load within rated limits
j) Dynamic regulation:	more than ±0.5% for any kind of change in load in the range of 50%-100%-50%, stabilisation time <2ms
k) Module current division:	<±5% rated current (microprocessor control)
l) Electrical noise:	<10mVrms, up to 10MHz (broadband) <100mVp-p, up to 100MHz
m) Protection:	automatic current limitation, load disconnecting switches, fusible fuse in each module

Inverter:

a) DC nominal voltage:	24VDC
b) Input voltage range:	20-31VDC
c) Nominal power:	≥ 350W
d) Output voltage:	230VAC ±5%, pure sinus

e)	THD:	<3% at nominal voltage
f)	Output frequency:	50Hz ±0.%
g)	Efficiency:	≥ 90%
h)	Input protection:	Wrong polarity (fuse), undervoltage protection, overvoltage protection, 2p autom. load disconnecting switch
i)	Output protection:	Short circuit, overloading, excessive temperature, 2p autom. load disconnecting switch
j)	By-pass switch:	3-position changeover switch 1-0-2
k)	Inverter output voltage drop signalisation	Programmable undervoltage relay, equipped with 2xNO and 2xNC voltage-free contacts

Accumulator battery

a)	Battery type:	sealed lead acid battery type VRLA 24V (12 cells)
b)	Rated voltage:	24V
c)	Charging voltage:	27.3VDC (+25°C)
d)	Nominal capacity:	at least 161Ah at C10/1.8V
e)	Protection:	2× fuse NV/NH, gL-gG, 63A temperature compensation of charging voltage
f)	Life-time:	≥ 12 let in accordance with Eurobat standard (long-life)

DC output – distribution

a)	Protection:	5× MCB, C-2p, 6A-DC 5× MCB, C-2p, 10A-DC 2x MCB, C-2P, 16A-DC
b)	Voltage:	27.3VDC (+25°C)
c)	Connection:	4mm² terminal (L+, L-) 25 mm² terminals for connecting external load (L+, L-) or external battery

Other data

a)	Compliance with standards:	SIST EN 60439-1
b)	Insulation voltage	2.5kVAC input to ground 3kVAC input to output 2kVAC output to ground 0.5kVAC signals to ground
c)	Safety:	SIST EN60950, class 1
d)	Mechanical protection:	IP20
e)	Grounding system type:	TN-S (input), IT (output)
f)	Radio-frequency interference:	SIST EN 61000, class B
g)	Electromagnetic interference:	EN55022
h)	Noise:	<32dB
i)	Operating conditions:	for indoor use
j)	Operating temperature:	-5ºC - +40ºC
k)	Cooling:	natural (no fans)

Discharger tester and capacity tester

Supply of discharge tester and capacity tester for discharging and testing 48/24V batteries with an adaptable current from 0-150A, such as PKT150-60. System current adaptable according to steps 1A. The system shall enable:

a) continuously constant discharging current,
b) low voltage,
c) discharge time,
d) discharge charge,
e) low block/cell voltage.

The system shall ensure own supply from two sources, from a DC and an AC source. The test shall not be interrupted even if the supply from the grid source fails during the test.

DC supply source: 20-60.0 V DC.

AC supply from external source: 230V (-20% to +30%).

The device shall be equipped with an internal memory to which all data from independent measurements are automatically stored.

The device shall be equipped with measuring modules for measuring voltage at individual blocks/cells. Data from measuring modules shall be wirelessly transferred to the device where the measurements are stored.

Voltage measurement accuracy: ≤±0.5%,

current measurement accuracy: ± 0.5A.

Protection and alarms:

a) incorrect input voltage,
b) incorrect polarity,
c) current overload,
d) thermal overload.

4.2.8 Cables and cable routing

4.2.8.1 Cable connections

The scope of works includes the supply of cables and cable trays for all connections between the unit and the remaining equipment, including all the connecting and fixing material and coding according to the KKS standard. The scope of supply also includes the following cable connections which connect the hydromechanical equipment and the switchyard:

a) Power and signalling cables for the transformer, MV switch gear, generator, turbine with equipment, control system, protection system and power supply.
b) Supply, laying and measuring optical connections (24xFO SM) between CNA01, DYT01 cubicles and CND01 cubicle at intake. An optical cable shall be laid between the powerhouse and the intake reservoir. Civil works and the cable routing shall be done under LOT A.

The Contractor for LOT TG, Part B shall provide the laying, fixation, connection and measurement of all SHPP's optical cables, and the Customer shall be responsible for the installation of all other cables and trays from Part B.

The Contractor shall include suitable fixing material and implement fire-resistive filling and firestop at the entrance to the channel, through the wall and where the cables enter the related cubicle.

All cable shall be marked with nameplates in accordance with the KKS standard.

Control and signalling cables which will be laid outside of the SHPP shall be equipped with overvoltage protection.

The newest applicable standards shall be taken into consideration when selecting the cables. The following important standards shall serve as a reference:

IEC 60189 Low frequency cables and wires with PVC insulation and PVC sheath.

IEC 60227 Polyvinyl chloride insulated cables of rated Voltages up to and including 450/750V.

IEC 60228 Conductors of insulated cables

Cables shall not be laid directly on the ground but shall be laid in cable galleries, channels, tubes or trays. The price for all vertical cable routing shall include the fixing material and mechanical protection up to the height of 2m.

The cables shall be laid in cable ducts where crossing the road or entering a building.

The openings in framework, in the ceiling, floors and walls must be fire-proof sealed. Fire-proofing shall be performed and marked by a qualified contractor.

The supplier shall supply and assemble all supports, joints and other material necessary for cable installation. All clamps shall be made of non-magnetic material.

Cable connection to cubicles, cabinets etc. shall be done at least 300 mm above ground. Vertical parts of the cable connections shall be affixed with clamps to ladder or to channel supports. All cables shall be safely supported no more than 0.5 m away from the clamps.

Cables shall not contain T-joints or be coupled between the end points. All wires shall be terminated with ends.

Suitable cable glands shall be used to connect cables to the terminal boxes.

All internal connections in the cubicles, cabinets, panels etc. shall contain a label with a clearly legible identification number.

Power cables

Wiring between electrical equipment shall be done by cables. Cables shall run in cable trays with covers, embedded cable ducts etc. Cables shall be properly fastened and marked with PVC plates at the entry to the cabinet.

Power cables shall be envisaged for voltage 0.6/1 kV, and insulation voltage 300/500 V is required for control cables. All cables shall be flameless in accordance with HD 405 (IEC 60332) and shall have halogen free, low smoke emission properties in accordance with IEC 60754 and 61034. Individual cable wires shall be numbered.

Control and signalling cables

The control and signalling cables between the unit's devices and the related control panel shall be of LiYCY type.

Connecting control and signalling cables to the control panel shall be done using terminal blocks or connectors.

Wiring within switchgear panels shall be done with fine copper conductors with a cross-section of at least 0.75 mm2 for control cables and at least 2.5 mm2 for powering equipment and drives.

Cables shall be manufactured in accordance with HD21 (IEC 60227), foreseen for voltage 300 / 500V. All conductors shall be laid in PVC channels and readily accessible. The conductors shall terminate in terminal blocks. Both conductor ends shall be marked with coloured ferrules.

The conductor shall be made of fine copper according to IEC 60227.

The conductor shall be colour insulated with regard to the number of cores and thickness defined in the IEC 60227.

The average insulation thickness measured at the cross-section shall not be less than the value stipulated in the IEC 60227.

The polyethylene protection layer shall tightly cover the fine-core conductor. Thickness of the protection layer shall not be lesser than the value stipulated in the IEC 60227.

Wiring requirement

Each multi-core/multi-pair cable shall be used for only one function and for only one voltage level.

Cable management equipment

The Contractor for LOT TG, Part B shall supply material for complete cable routing.

Cable trays

Cable trays shall be standard, made from hot tip galvanised steel plates, with sufficient ventilation openings, suitable grooves and slots for fixing standard cable fixing material.

Hot tip galvanising shall be at least 50 μm v in accordance with DIN 50976 or ISO 14713 and ISO 1461.

Bolting material shall be hot tip galvanised, with a coating thickness of at least 40μm.

Trays with control cables shall have covers.

The trays shall be filled only up to 80% of the estimated spatial and load capacity.

The Contractor shall select a suitable density and dimension of the supporting wall with regard to the trays used and their estimated load.

The cable trays shall be connected to the earthing network.

4.2.9 Grounding of devices

The main purpose of grounding the devices is:

a) to protect people in contact with the devices,

b) to protect the devices themselves and other equipment connected to them and reduce electric interference.

On the basis of the above, grounding can be divided into:

a) protective earthing, i.e. earthing of those parts of equipment which do not belong to electric circuits. Usually, this means insulated parts where dangerous voltage can appear due to insulation damage.

b) system earthing, i.e. grounding of that part of the equipment which is continuously or occasionally part of the operating electric circuit.

4.2.10 Ensuring electromagnetic compatibility

All measures shall be implemented in such way to ensure efficiency at high frequencies and thereby efficiency at low frequencies. The basis for the calculation shall be 50 Hz.

a) all primary and secondary system devices in the room shall be connected to the potential equalisation system;

b) potential equalisation systems shall be an integral part of the grounding system;

c) cable screens for secondary systems shall be connected to the potential equalisation system at both ends - i.e. grounded;

d) cubicle casings shall be grounded.

4.2.11 On site assembly works and commissioning tests

The Contractor for LOT TG, Part B shall perform the laying, connecting and testing of all optical cables; the other equipment on site shall be assembled and connected by the Customer under the supervision of the Contractor. Cable routing for optical cables shall be prepared by the civil works contractors.

During the commissioning tests of the SHPP, the Contractor for LOT TG, Part B shall collaborate with the Contractor for LOT TG, Part A and the contractors for all other LOTs.

5 ENCLOSURES:

The following is enclosed:

- ENCLOSURE 1: TECHNICAL DATA SHEETS FOR LOT TG PART A AND B
- ENCLOSURE 2: DRAWINGS

Enclosure 1

HPP Kneža - LOT TG

TECHNICAL DATA SHEETS

1 TECHNICAL DATA SHEETS FOR LOT TG PART A

1.1 Technical data for the mechanical scope of supply

1.1.1 Table A1: Main and auxiliary equipment

Contractor shall fulfill in the column “Offer data” with their technical data with binding status.
In the column “Design data” the technical data in bolded text shall not be changed.

Contractor: ……..

No	Description	Unit	Design data	Offer data
1.	**Francis turbine (constant rotational speed):**			
1.1.	Number of unit:	pcs	**1**	
1.2.	Turbine type with horizontal shaft:	/	**Francis**	
1.3.	Turbine rated rotational speed:	min^{-1}	**1000**	
1.4.	Typical turbine flows at rated gross head and corresponding net head:			
	- Max (rated) flow:	m^3/s	**1,5**	
	- Flow at max turbine efficiency:	m^3/s	-	
	- Min flow:	m^3/s	0,35	
1.5.	Turbine power at rated gross head and corresponding flow and net head and with bearing losses:			
	- Max (rated) power at flow 1,5m^3/s:	kW	**> 850**	
	- Power at max turbine efficiency:	kW	-	
1.6.	- Specific speed $n_{s\ at}$ at max power:	/	-	
1.7.	Max rotational overspeed:	min^{-1}	**max 2000**	
1.8.	Time at max rotational overspeed:	min	**min 60**	
1.9.	First critical speed:	min^{-1}	**max 2400**	
1.10.	Max allowable penstock water pressure at runner axis elevation:	kPa	**max 1085**	
1.11.	Transient phenomena’s without opening the PRV (plunger) valve (fulfil all empty cells):			

Emergency shut down from power (%)	Guide vanes closing time (s)	Max transient increase of rotational speed (min^{-1})	Penstock water pressure at runner axis (kPa)		Vacuum in the penstock:
			min	max	YES / NO
100					
75					
50					

1.12.	Unit min mass moment of inertia:			
	- Turbine rotational parts:	kgm^2	-	
	- Flywheel:	kgm^2	-	
	- Generator rotational parts:	kgm^2	-	
	- Total not less then:	kgm^2	**250**	
1.13.	Runner axis elevation:	mnm	ca 332,70	
1.14.	Runner submersion (suction head):	m	ca +3,0	
1.15.	Cavitation in whole operational range:	/	**NO**	
1.16.	Thoma number $\sigma_{plant}/\sigma_{tur}$ at 100% power:	/	-/-	
1.17.	Max axial hydraulic load:	kN	-	

No	Description	Unit	Design data	Offer data
1.18.	Turbine starting and stopping times:			
	- From standstill to free run:	s	-	
	- From free run to max power:	s	-	
	- Stopping time from full power:	s	-	
1.19.	Noise level in the power house:	dB(A)	85	
1.20.	Max water leakage through closed guide vanes and rated gross head:	l/min	-	
1.21.	Direction of the hydraulic torque on the guide vanes between 10 to 100% opening:	-	**in the closing direction.**	
1.22.	Slide bearings pads max temperature:	°C	≤65	
1.23.	Max deviation of rotational speed at free run (in accordance with the SONDO):	±Hz	-	
1.24.	***Turbine mechanical efficiency*** (fulfil all empty cells, **efficiency value rounded to one decimal place**)			

Flow (m^3/s)	(%)	Efficiency (%)	**Guaranteed weighted turbine efficiency (%)** (Calculated according to the formula in General and Special Technical Specifications Item.3.2.15. This is criterion for assessing the bids.)
1,5	100		
1,35	90		
1,2	80		
1,05	70		
0,9	60		
0,75	50		
0,6	40		

1.25.	***Spiral case with stay vanes:***			
	- Design pressure:	bar	**16**	
	- Test pressure:	bar	**24**	
	- Nominal inlet diameter:	DN	700	
	- Material:	po EN	S355J0+N	
	- Number of stay vanes:	/	-	
1.26.	***Runner:***			
	- Manufacturer:	/	-	
	- Number of runner vanes:	/	-	
	- Runner rotational direction viewing from generator side:	/	**in clockwise direction**	
	- Material:	po EN	1.4313	
	- Turbine/generator shaft diameter:	mm	-	
	- Runner diameter:	mm	-	
1.27.	***Turbine guide vanes:***			
	- Number of guide vanes:	pcs	-	
	- Guide vanes height:	mm	-	
	- Material:	po EN	1.4313	
	- Number of guide vanes mechanism servomotors:	pcs	-	
	- Max servomotor load:	kN	-	
	- Manufacturer/type of position transmitter:	/	-	

No	Description	Unit	Design data	Offer data
	- Type of guide vanes bearings:	/	-	
	- Type of regulation ring bearings:	/	-	
1.28.	***Turbine shaft seal:***			
	- Seal type:	/	-	
	- Material of sealing ring:	po EN	-	
	- Cooling (lubricating) water flow:	l/s	-	
	- Max leakage:	l/s		
2.	**Flywheel with hydraulic brake**			
2.1.	- Flywheel diameter:	mm	**max 1200**	
2.2.	- Flywheel width:	mm	-	
2.3.	- Shaft connection type:	/	-	
2.4.	- Material:	po EN	-	
2.5.	- Brake type:	/	-	
2.6.	- Brake segments material:	/	-	
2.7.	- Flywheel mass:	kg	-	
3.	**Generator sliding bearings**			
3.1.	Manufacturer:	/	-	
3.2.	Bearing type on Drive End:	/	-	
3.3.	Bearin type on Non Drive End:	/	-	
3.4.	Bearing segments material:	/	-	
3.5.	Shaft diameter at bearings (DE/NDE):	mm	-	
3.6.	Oil type:	/	-	
3.7.	Method / required power to cool beraings:	/	-	
3.8.	Bearing segments max temperature:	°C	**≤65**	
4.	**Main inlet valve with bypass**			
4.1.	Manufacturer and type (butterfly):	/	-	
4.2.	Opening / Closing method:	/	**servomotor / counterweight**	
4.3.	Nominal diameter and pressure:	DN/PN	**700/16**	
4.4.	Test pressure:	bar	**24**	
4.5.	Max pressure drop at Q_{max}:	mVS	**0,3**	
4.6.	New valve max leakage:	l/s	**0**	
4.7.	Method of flap rotation:	/	double eccentric	
4.8.	Valve closing time (adjustable):	s	20 - 90	
4.9.	Valve opening time (adjustable):	s	-	
4.10.	Bypass nominal diameter:	DN	80	
4.11.	Bypass main valve type:	/	-	
4.12.	Bypass service valve type:	/	-	
4.13.	Counterweight mass:	kg	-	
5.	**Pressure regulation (plunger) valve and turbine bypass:**			
5.1.	- Valve manufacturer and type:	/	-	

No	Description	Unit	Design data	Offer data
5.2.	- Valve orientation (straight / angular)	/	straight	
5.3.	- Operational method:	/	**servomotor**	
5.4.	- Body material:	po EN	-	
5.5.	- Air vent connection (YES/NO):	/	-	
5.6.	- Nominal inlet / outlet diameter:	DN/DN	300/340	
5.7.	- Nominal pressure:	PN	**16**	
5.8.	- Manufacturer/type of position transmitter:	/	-	
5.9.	- Cavitation in whole range (YES/NO):	/	NO	
5.10.	- Energy dissipation (YES/NO):	/	-	
5.11.	- Valve opening time (adjustable from/to)	s	-/-	
5.12.	- Valve closing time (adjustable from/to)	s	-/-	
6.	**Hydraulic Power Unit**			
6.1.	- Reservoir capacity:	lit	-	
6.2.	- Oil quantity and type:	lit	-	
6.3.	- Bottom collecting container (YES/NO):	/	**DA**	
6.4.	- Number of oil pumps:	/	**2**	
6.5.	- Max oil working pressure:	MPa	6,4	
6.6.	- Min number of proportional valve:	/	**2**	
6.7.	- Pressure accumulator (YES/NO)	/	**YES**	
7.	**Power house ventilation**			
7.1.	Number of axial funs:	/	**2**	
7.2.	Manufacturer and type:	/	-	
7.3.	Max air flow:	m^3/s	-	
8.	**Monorail crane (EM rope crane with manual operated chain trolley)**			
8.1.	Capacity:	t	7,5	
8.2.	Type and dimensions of monorail beam:	/	HEB300	
8.3.	Length of monorail beam:	mm	**8500**	
8.4.	Lifting range from power house floor:	mm	4300	
8.5.	ISO classification:	/	**M2**	
8.6.	Manufacturer and type of crane and trolley:	/	-	
8.7.	Overload protection (YES/NO):	/	**YES**	
9.	**Monorail console crane (manual operated chain crane and trolley)**			
1.1.	Capacity:	t	1,0	
1.2.	Type and dimensions of monorail beam:	/	INP/IPE 240	
1.3.	Length of monorail beam:	mm	2800	
1.4.	Lifting range from power house floor:	mm	3200	
1.5.	ISO classification:	/	**M2**	
1.6.	Manufacturer and type of crane and trolley:	/	-	
1.7.	Overload protection (YES/NO):	/	**DA**	

1.1.2 Table A2: List of the AC power consumption

Remark: Contractor shall fulfill empty cells.

Contractor: .....

No	Description	Nominal power (kW)	Starting Current (A)
1.	**Hydraulic Power Unit:**		
a)			
b)			
c)			
2.	**Generator bearings cooling system:**		
a)			
b)			
3.	**Power house ventilation:**		
a)			
b)			
4.	**Monorail crane:**		
a)			
b)			
5.	**Generator and excitation:**		
a)			
b)			
c)			

1.1.3 Table A3: List of the 24V DC AC power consumption

Remark: Contractor shall fulfill empty cells.

Contractor: .....

No	Description	Nominal power (kW)	Starting Current (A)
1.	**Turbine unit with all other equipment:**		
a)			
b)			
c)			
d)			
2.	**Generator, excitation and all other equipment:**		
a)			
b)			
c)			
d)			
3.	**Other auxiliary equipment:**		
d)			
e)			
f)			
g)			

1.1.4 Table A4: Transport and assembling data

Remark: Contractor shall fulfill empty cells.

Contractor: .....

No	Description	Unit	Offer data
1.	**Weights:**		
1.1.	Max weight of transported set of equipment:	t	
1.2.	Max weight of one set of equipment during assembly works in the power house:	t	
2.	**Dimensions:**		
2.1.	Max dimensions of transported set of equipment (a x b x h):	m	
2.2.	Max dimensions of one set of equipment during assembly works in the power house:	m	

1.1.5 Table A5: Descriptions of individual set of equipment

Contractor shall attach to the offer detail descriptions for each set of equipment, as follows:

- Francis Turbine with horizontal shaft;
- Flywheel with hydraulic brake;
- Electronic overspeed safety device;
- Pressure regulating (plunger) and turbine bypass valve with outlet pipe;
- Main inlet valve with bypass;
- Hydraulic Pressure Unit (HPU);
- Generator bearings cooling system;
- Monorail crane;
- Console monorail crane.

1.1.6 Table A6: Technical deviations of the Tender

Remark: Contractor shall fulfil the table with any deviations or suggestions. It can also be attached a separate description

Contractor: .....

Description of deviations or suggestions

1.2 Technical data for the electrical scope of supply

1.2.1 Table B1: Synchronous generator and excitation system

Contractor shall fulfill in the column “Offer data” with their technical data.
Contractor: .....

No	Description	Unit	Design data	Offer data
1.	**Generator**			
1.1.	Manufacture	/		
1.2.	Type	/		
1.3.	Nominal power	kVA	1000	
1.4.	Nominal voltage	V	400 ±10	
1.5.	Nominal power factor	/	0,8	
1.6.	Nominal	Hz	50	
1.7.	Nominal speed	min-1	1000	
1.8.	Run away speed	min-1		
1.9.	Isolation Class – stator coil	/	F	
1.10.	Isolation Class – rotor coil	/	F	
1.11.	Cooling system - IEC60034-6	/	IC21	
1.12.	2 min overload	%		
1.13.	Permanent asymmetric overload	%		
1.14.	Radio disturbance according to VDE 0879			
1.15.	Generator efficiency measured on generator terminals at nominal voltage, nominal frequency, cos φ = 1 and at generator power:			
	- 1/4 . P_{ng}	%		
	- 1/2 . P_{ng}	%		
	- 3/4 . P_{ng}	%		
	- 4/4 . P_{ng}	%	>96	
1.16.	Reactance:			
	- x_d	%		
	- x_q	%		
	- x_d'	%		
	- x_q'	%		
	- x_d''	%		
	- x_2	%		
	- x_o	%		
1.17.	Ohm resistant stator coil at 75°C	Ω		

No	Description	Unit	Design data	Offer data
1.18.	Ohm resistant rotor coil at 75°C	Ω		
1.19.	Maximal allowed permanent cruet of third harmonic component	%		
1.20.	Maximal characteristic torque	x M_n		
1.21.	Stator shape according to IEC60034-7			
1.22.	Stage of generator mechanical protection			
1.23.	Stage of terminal box mechanical protection			
1.24.	Bearings:			
	- type			
	- lubrication			
	- cooling			
1.25.	Generator hitters (231 V AC)	kW		
1.26.	Generator total weight	kg		
1.27.	Maximal separated piece for assembling: - dimension (length x width x height) - weight	 m kg		
1.28.	Maximal separated piece for assembling: - dimension (length x width x height) - weight	 m kg		
2.	**Excitation system**			
2.1.	Manufacture			
2.2.	Type			
2.3.	Voltage regulator manufacture			
2.4.	Voltage regulator type			

2 TECHNICAL DATA SHEETS FOR LOT TG PART B

2.1 Technical data

2.1.1 Table C1: Protection Equipment, Control Equipment and Measuring Equipment

Contractor shall fulfill in the column all “Offer data” with their technical data.
Contractor: .....

No	Description	Unit	Design data	Offer data
1.	**Unit electrical protection system**			
1.1.	Protections relay manufacture	/		
1.2.	Protection relay type	/		
1.3.	Protection relay function:			
	- overvoltage protection	/	YES	
	- short circuit protection	/	YES	
	- overcurrent	/	YES	
	- reverse power	/	YES	
	- underimpedance	/		
1.4.	Supply voltage input	V	24 DC	
1.5.	Relay power consumption	VA		
1.6.	Output switched contact in normal open contacts :			
	- nominal voltage	V		
	- nominal current	A		
	- switch on capacity	A		
	- breaking capacity 250 VAC	A		
	- breaking capacity 220 VDC (L/R<40ms)	A		
1.7.	Cut control circuit	/		
1.8.	Analogue inputs			
	Nominal secondary current	A	5	
	Nominal secondary voltage	V	100	
	Number of voltage inputs		≥3	
	Number of current inputs		≥3	
1.9.	"watch dog" contact:	/	**YES**	
1.10.	Number of outputs relay	/	≥ "watch dog" +9	
1.11.	Communication connector	/	Front side RJ45 and RJ45 in the back side	
1.12.	Communication protocol		IEC61850, Modbus…	
1.13.	Test switch	/	RTXP 18	

No	Description	Unit	Design data	Offer data
2.	**Disconnection point protection system**			
2.1.	Protections relay manufacture	/	ABB	
2.2.	Protection relay type	/	REF615	
2.3.	Order number		HBFKBCADN BC1BNN2XG	
2.4.	Protection relay function: - undervoltage 2 stage - overvoltage 2 stage - under frequency - over frequency - 20 kV earth-fault protection		YES	
2.5.	Supply voltage input	V	24 DC	
2.6.	Relay power consumption	VA		
2.7.	Outputs contacts switch and normal open:			
	- Nominal voltage	V		
	- Continuous current	A		
	- switch on capacity	A		
	- breaking capacity 250 VAC	A		
	- breaking capacity 220 VDC (L/R<40ms)	A		
2.8.	Cut control circuit	/		
2.9.	Analogue inputs			
	Nominal secondary current	A	5	
	Nominal secondary voltage	V	100	
	Number of voltage inputs		≥4	
	Number of current inputs		≥3	
2.10.	"watch dog" contact	/	YES	
2.11.	Number of outputs relay	/	≥ "watch dog" +10	
2.12.	Communication connector		Ethernet - Front side RJ45 and RJ45 in the back side	
2.13.	Communication protocol		IEC61850, Modbus…	
2.14.	Test switch	/	RTXP 18	
3.	**Unit controller**			
3.1.	Manufacture			
3.2.	Controller type			
3.3.	CPU	bit		
3.4.	Power supply:			
	- external	V		

No	Description	Unit	Design data	Offer data
	- internal	V		
3.5.	Control system communication type			
3.6.	Software and license		YES	
3.7.	Distributed IO		YES	
4.	**Digital input module**			
4.1.	Inputs number per unit / total			
4.2.	Rated input voltage	V		
4.3.	Rated input current	mA		
4.4.	Overvoltage protection	kV		
4.5.	Module type and label			
5.	**Analogue input module**			
5.1.	Inputs number per unit / total	/		
5.2.	A/D converter	bit		
5.3.	Accuracy	/		
5.4.	Input signal range			
	- Current input	mA		
	- voltage input	V		
5.5.	Inputs overvoltage protection	kV		
5.6.	Module type and label	/		
6.	**Digital output module**			
6.1.	Outputs number per unit / total	/		
6.2.	Output signal voltage	V		
6.3.	Continuous output current	mA		
6.4.	Outputs overvoltage protection	kV		
6.5.	Module type and label	/		
7.	**Analogue output module for pilote (proportional) valve**			
7.1.	Manufacture	/		
7.2.	Type	/		
7.3.	Supply voltage input	V	24 DC	
8.	**Operation Panel**			
8.1.	Manufacture	/		
8.2.	Type	/		
8.3.	Touchscreen	/	YES	
8.4.	Diagonal	cm		
9.	**Communication processor for dislocated unit**			
9.1.	Manufacture	/		
9.2.	Type	/		

No	Description	Unit	Design data	Offer data
9.3.	Rated input voltage	V	24 DC	
10.	**Optical to electrical converter**			
10.1.	Manufacture	/		
10.2.	Converter type	/		
10.3.	Supply input voltage	V	24 DC	
11.	**Speed measuring device**			
11.1.	Manufacture	/		
11.2.	Type	/		
11.3.	Power supply input voltage	V	24 DC	
12.	**Turbine governor control system**			
12.1.	Manufacture	/		
12.2.	Type	/		
12.3.	Power control	/	YES	
12.4.	Level control	/	YES	
12.5.	Frequency control	/	YES	
12.6.	Speed control	/	YES	
13.	**Telecommunication**			
13.1.	Communication computer manufacture	/		
13.2.	Communication computer type	/		
13.3.	Compatibility to exist remote control system	/	YES	
13.4.	Operating system	/	Linux	
13.5.	Connector numbers LAN 10/100 Mbps (RJ45)	/	≥3	
13.6.	Connectors numbers RS-232/422/485, programmable connectors (8-pin RJ45)	/	≥8	
13.7.	Software	/		
13.8.	Protocol support TC57, MasLink, ISO TCP	/	YES	
13.9.	Communication converter support ADSL, ISDN-modem, GSM-modem, GPRS, HSCSD, UMTS, PSTN modem, short range modem, RS232 in RS485	/	YES	
13.10.	Support for multiple IEC 60870-5-104 communications	/	YES	
13.11.	Manufacture of Ethernet router for technical (industrial) and business network	/		
13.12.	Ethernet router type	/		
13.13.	Ports number	/		
13.14.	Max simultaneously number of IpSec VPN tunnels	/		
13.15.	3 VLAN support		YES	

No	Description	Unit	Design data	Offer data
13.16.	Console access		YES	
14.	**Control system functions**			
14.1.	Remote and local control of HPP	/	YES	
14.2.	Automatic and manual control of unit, auxiliary equipment and hydro mechanical equipment	/	YES	
14.3.	Measuring and data distribution	/	YES	
14.4.	Equipment protection	/	YES	
15.	**Optic cables**			
15.1.	Manufacture	/		
15.2.	Type	/		
15.3.	Rodent resistant	/	YES	
15.4.	Outdoor use	/	YES	
16.	**Ultrasonic water flow measurement**			
16.1.	Manufacture	/		
16.2.	Type	/		
16.3.	Accuracy on ≥ DN 800 at > 0.5 m/s	%	1	
16.4.	Penstock diameter at measuring location	DN	800	
16.5.	Penstock wall thickness	mm	14	
16.6.	Penstock material	/	polyester (GRP)	
16.7.	Diagnostic function	/	-	
16.8.	Operating temperature range	°C	-30 do 55	
16.9.	Analog output	mA	4-20mA	
16.10.	Power supply input voltage	V	-	
16.11.	Mechanical protection level	IP	≥ 67	
17.	**Energy metering**			
17.1.	Manufacture	/		
17.2.	Type			
17.3.	Accuracy class for active energy		0,5	
17.4.	Accuracy class for reactive energy		1	
17.5.	Rated voltage	V		
17.6.	Rated current	A		
17.7.	Number of inputs for external control		≥ 2	
17.8.	Communication protocol			
17.9.	Number of optic MOS outputs		≥ 4	
17.10.	Equipped with communication module GSM/GPRS with additional RS485 outputs		YES	

2.1.2 Table C2: Generator circuit breaker, auxiliary equipment and auxiliary power supply

Contractor shall fulfill in the column all “Offer data” with their technical data.

Contractor: .....

No	Description	Unit	Design data	Offer data
1.	**Generator circuit breaker**			
1.1.	Manufacture	/		
1.2.	Type	/		
1.3.	Rated voltage	V		
1.4.	Rated current	A		
1.5.	Rated breaking current	kA		
1.6.	Rated short circuit current (1 s)	kA		
1.7.	Rated peek current	kA		
1.8.	Operating time - open/close	ms		
1.9.	Motor driven:			
	- Voltage	V		
	- Power	VA		
1.10.	Control voltage:			
	- Undervoltage trip coil	V		
1.11.	Rated withstand voltage	kV		
2.	**Circuit breaker**			
2.1.	Manufacture	/		
2.2.	Type	/		
2.3.	Rated voltage	V		
2.4.	Rated current	A		
2.5.	Rated short circuit current (1 s)	kA		
2.6.	Manual operating	/		
2.7.	Protection type	/		
2.8.	I > time set	/	YES	
2.9.	I >> time set	/	YES	
3.	**Unit current transformer**			
3.1.	Manufacture	/		
3.2.	Type	/		
3.3.	Rated primary current	A	2000	
3.4.	Rated secondary current	A	5	
3.5.	Metering core:			
	- class	%	0,5	
	- F_s	/		
	- Power (Burden)	VA	10	

No	Description	Unit	Design data	Offer data
3.6.	Protection core:			
	- class	/	5P10	
	- Power (Burden)	VA	10VA	
3.7.	Rated withstand voltage	kV		
4.	**Voltage transformer**			
4.1.	Manufacture	/		
4.2.	Type	/		
4.3.	Rated primary voltage	V	400	
4.4.	Rated secondary voltage	V	100	
4.5.	Class /Power (Burden)	%/VA	0,5/10	
4.6.	Rated withstand voltage	kV		
5.	**Power analyzer**			
5.1.	Manufacture	/		
5.2.	Type	/		
5.3.	Number of 5A current inputs	/		
5.4.	Number of 1A current inputs	/		
5.5.	Voltage L-N	/		
5.6.	Number of NPN outputs	/		
5.7.	Number of relay outputs	/		
5.8.	Communication type	/		
5.9.	Number of analog inputs	/		
5.10.	Number of analog outputs	/		
5.11.	Dimension	mm		
5.12.	Display dimension	mm		
5.13.	Accuracy class U	%		
5.14.	Accuracy class I	%		
5.15.	Accuracy class kWh	%		
5.16.	Accuracy class kVArh	%		
5.17.	Power supply voltage	V		
6.	**Auxiliary power supply 24V DC – Battery charger**			
6.1.	Manufacture	/		
6.2.	Type	/		
	Input			
6.3.	Power supply input voltage	V	400/230 AC	
6.4.	Rated input power	VA		
6.5.	Rated current	A		
6.6.	Soft start	/	YES	
6.7.	Static control	%		
6.8.	Dynamic control	%		

No	Description	Unit	Design data	Offer data
6.9.	Power factor 50-100% load	%	>99	
6.10.	Power factor 30-50% load	%	>98	
6.11.	Efficiency 50-100% load	%		
6.12.	Initial time	s		
6.13.	Adjustable initial time for reducing influence on power supply	s		
6.14.	T.H.D. at 100% load	%		
6.15.	Interference suppression according to ANSI/IEEE C62.41 category B3	YES/NO		
6.16.	Full remote control by using web browser and full local control by using touch screen display	/	YES	
	Battery charger outputs			
6.17.	Rated DC voltage	V	24 DC	
6.18.	Voltage Range	V		
6.19.	Output floating voltage range	mV		
6.20.	Psophometric noise	mV		
6.21.	Withstand voltage	V		
6.22.	Module number		≥ 3	
6.23.	Time stability	%/year		
6.24.	Temperature stability	ppm/°C		
6.25.	Static Regulation	%		
6.26.	Dynamic regulation	%		
6.27.	Mechanical protection IP	/	≥20	
6.28.	Noise	dB		
7.	**Battery 24V (4 x 6V block)**			
7.1.	Type battery		VRLA	
7.2.	Nominal voltage	V	24V	
7.3.	Charging voltage	V		
7.4.	Nominal capacity C10/1,8V	Ah	≥ 161	
7.5.	Module weight	kg	≥ 31	
7.6.	Battery thermal runaway protection		YES	
7.7.	Life time according to Eurobat standard	let	≥ 12	
8.	**Inverter**			
8.1.	Manufacture	/		
8.2.	Type	/		
8.3.	DC nominal voltage	V	24	

No	Description	Unit	Design data	Offer data
8.4.	Nominal power	W	≥ 350	
8.5.	Output voltage	V	230VAC ±5%, pure sinus	
8.6.	THD, at nominal voltage	%	< 3	
8.7.	Inverter output voltage drop signalization	/	YES	
8.8.	Under voltage relay number of potential free contacts	/	2xNO in 2xNC	
9.	**Electrical cubicle**			
9.1.	Manufacture	/		
9.2.	Type	/		
9.3.	Dimensions of cubicle BAA01 (width x depth x height):	mm		
9.4.	Dimensions of cubicle BUA01 (width x depth x height):	mm		
9.5.	Dimensions of cubicle CNA01 (width x depth x height):	mm		
9.6.	Dimensions of cubicle DTY01 (width x depth x height):	mm		
9.7.	Number of cubicles in the transport unit	/		
9.8.	IP mechanical protection degree	/		
9.9.	RAL color number	/		
10.	**Distribution cubicle BLE01**			
10.1.	Manufacture	/		
10.2.	Type	/		
10.3.	Dimensions of cubicle (width x depth x height):	mm		
10.4.	IP mechanical protection degree	/		
10.5.	Residual current device	A	0,03	
10.6.	Number of sockets 400V, 32A	/	≥1	
10.7.	Number of sockets 400V, 16A	/	≥1	
10.8.	Number of sockets 230V, 16A	/	≥2	
11.	**Circuit breaker**			
11.1.	Manufacture	/		
11.2.	Type	/		
12.	**Motor protection switch**			
12.1.	Manufacture	/		
12.2.	Type	/		
13.	**Relay**			
13.1.	Manufacture	/		
13.2.	Type	/		

2.1.3 Table C3: List of the AC power consumption

Contractor shall fulfill tender data.
Contractor: .....

No	Description	Nominal power (kW)	Starting current (A)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			

2.1.4 Table C4: List of the 24V DC power consumption

Contractor shall fulfill tender data.
Contractor: .....

No	Description	Nominal power (kW)	Starting current (A)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			

2.1.5 Table C5: Technical deviations of the Tender

Remark: Contractor shall fulfil the table with any deviations or suggestions. It can also be attached a separate description

Contractor: .....

Description of deviations or suggestions

Enclosure 2

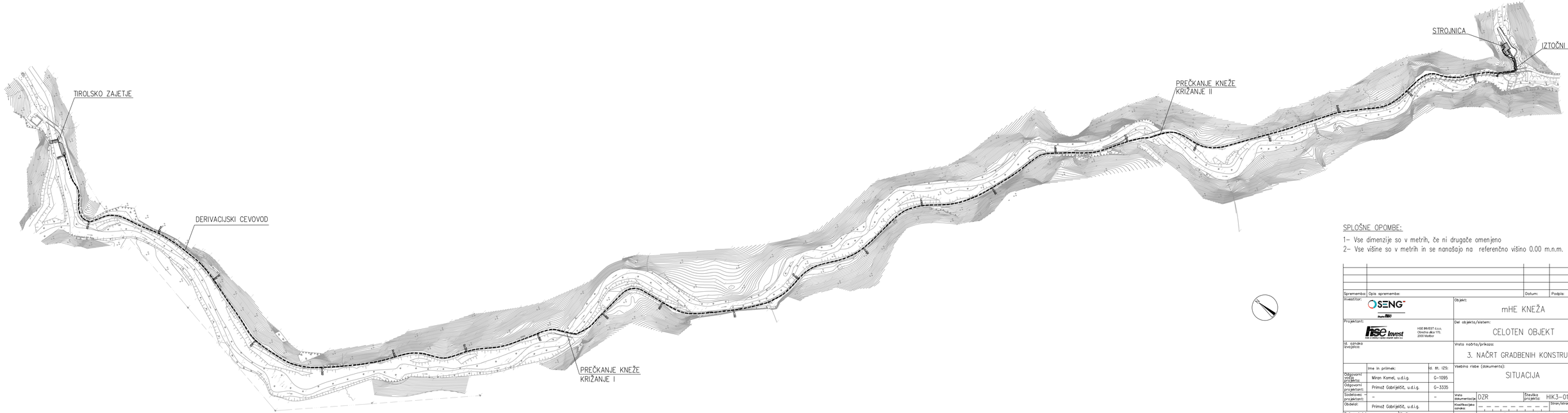
HPP Kneža - LOT TG

Drawings

1. **General part**
   - HIK3---6G2000 SHPP Kneža - total area lay out
   - HIK3---6G3001 Intake
   - HIK3---6G4001 Powerhouse - site organization

2. **Mechanical part**
   - HIK3---6S5001 Equipment lay out

3. **Electrical works**
   - HIK3---6E4001 Single line diagram
   - HIK3---6E4002 Equipment lay out
   - HIK3---6E4003 Control system



SPLOŠNE OPOMBE:

1– Vse dimenzije so v metrih, če ni drugače omenjeno
2– Vse višine so v metrih in se nanašajo na referenčno višino 0.00 m.n.m.

Sprememba:	Opis spremembe:	Datum:	Podpis:

Investitor: OSENG

Projektant: HSE Invest — HSE INVEST d.o.o., Obrtniška 17C, 2000 Maribor

Id. oznaka zveze/plica:

	Ime in priimek:	Id. št. IZS:
Odgovorni vodja projekta:	Miran Komel, u.d.i.g.	G-1095
Odgovorni projektant:	Primož Gabrijelčič, u.d.i.g.	G-3335
Sodelavec projektant:	–	–
Obdelal:	Primož Gabrijelčič, u.d.i.g.	
Datum izdelave: 05.2016	Merilo: 1:2000	

Objekt: mHE KNEŽA

Del objekta/sistem: CELOTEN OBJEKT

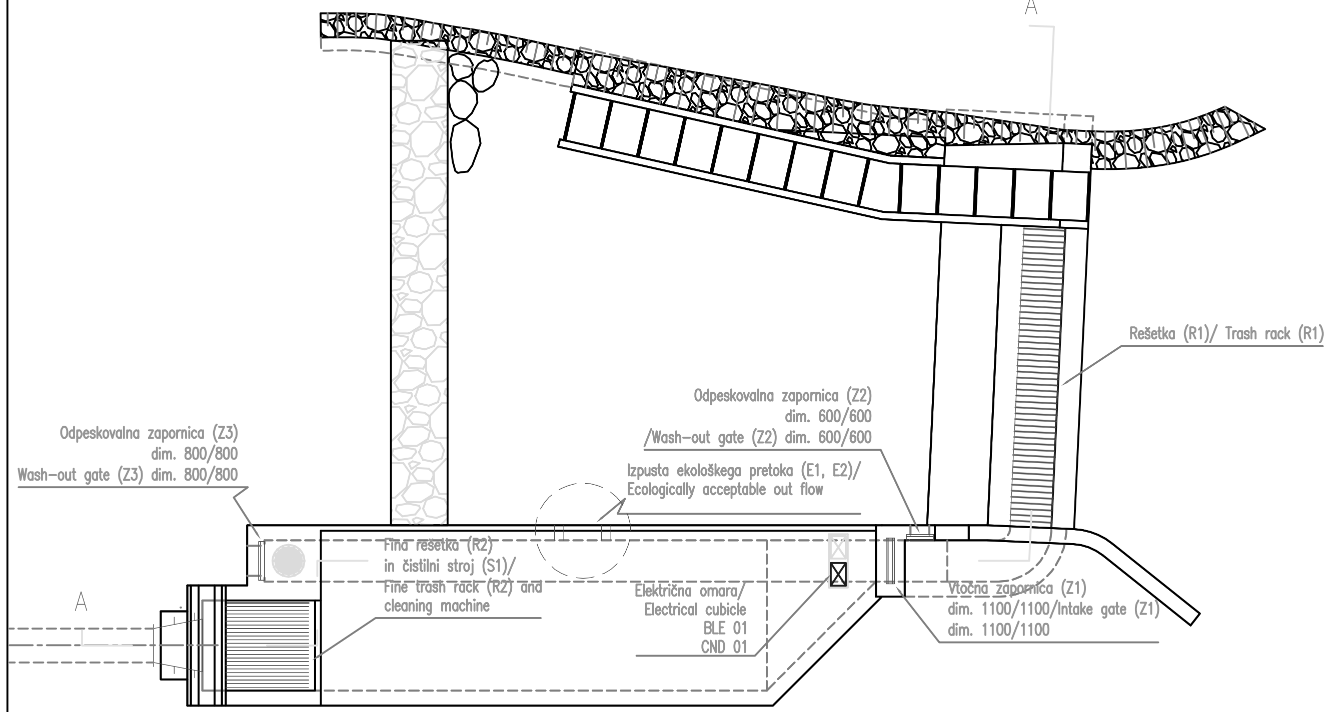
Vrsta načrta/prikaza: 3. NAČRT GRADBENIH KONSTRUKCIJ

Vsebina risbe (dokumenta): SITUACIJA

Vrsta dokumentacije:	DZR	Številka projekta:	HIK3-01/10
Klasifikacijska oznaka:	– – – – – – – – – –	Stran/strani:	1/1
Identifikacijska oznaka:	H I K 3 – – – 6 G 2 0 0 0		0

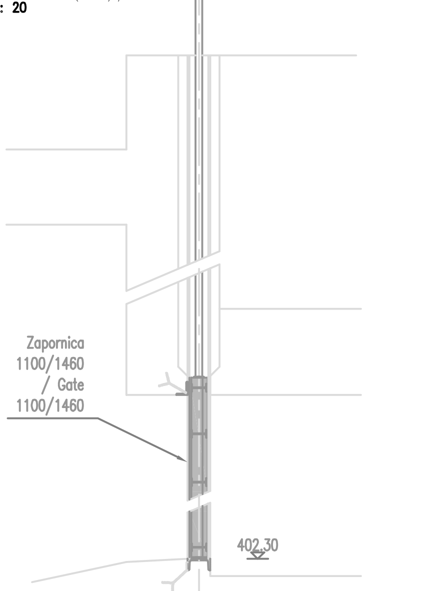
OPREMA ZAJETJA/INTAKE EQUIPMENT

SITUACIJA/LAYOUT



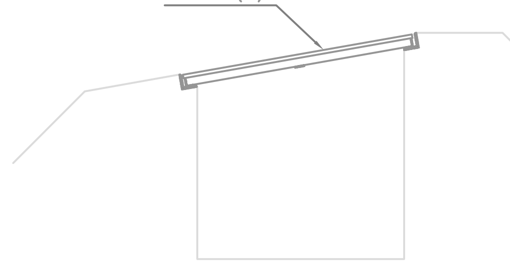
DETAJL 4 – VTOČNA ZAPORNICA (Z1)/DETAIL 4 – INTAKE GATE

Merilo/Scale 1 : 20

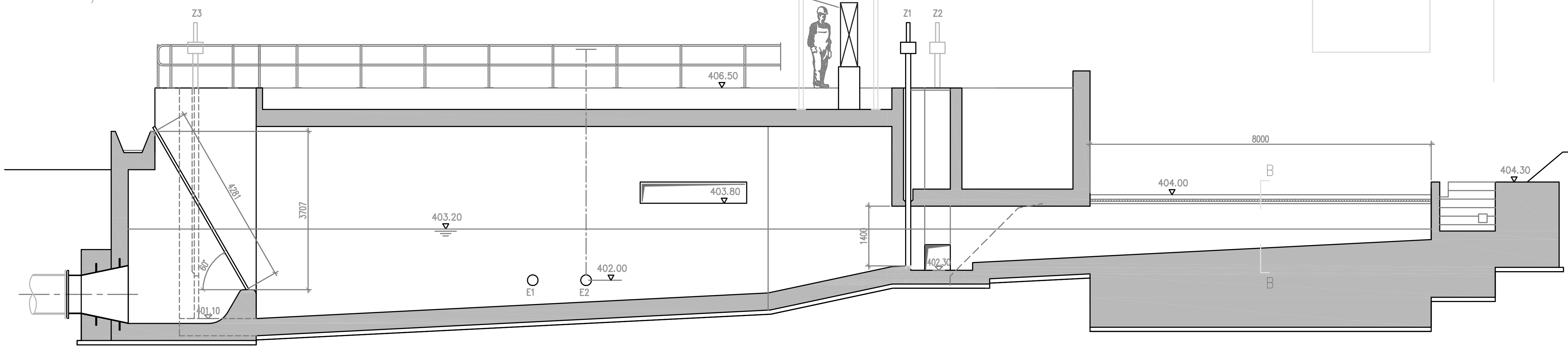


PREREZ/SECTION B-B

Merilo/Scale 1 : 20

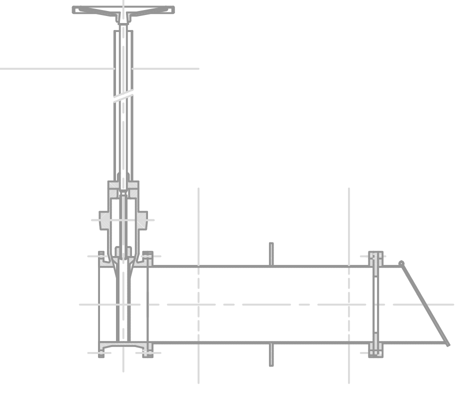


PREREZ A-A/SECTION A-A



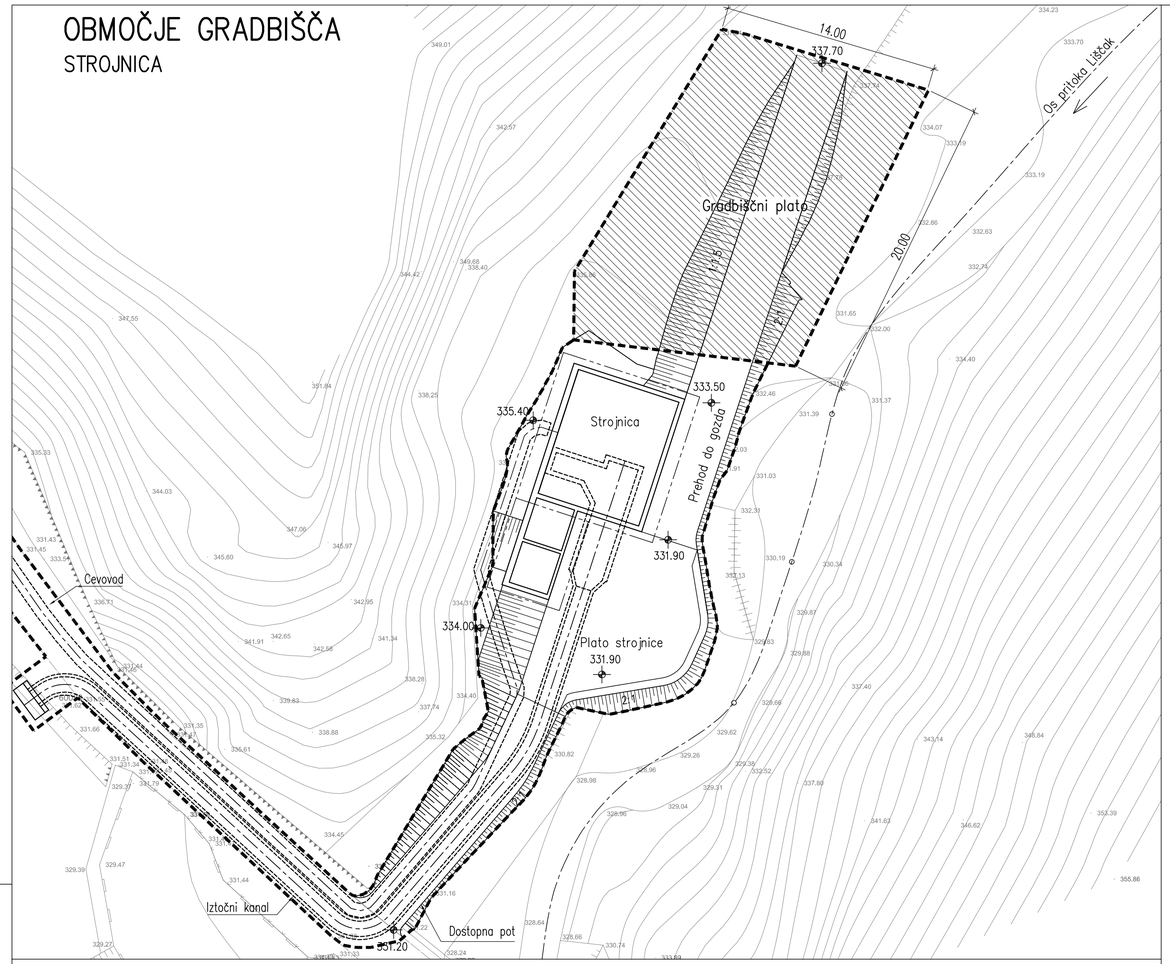
IZPUST EKOLOŠKEGA PRETOKA/ ECOLOGICALLY ACCEPTABLE FLOW

Merilo/Scale 1 : 10

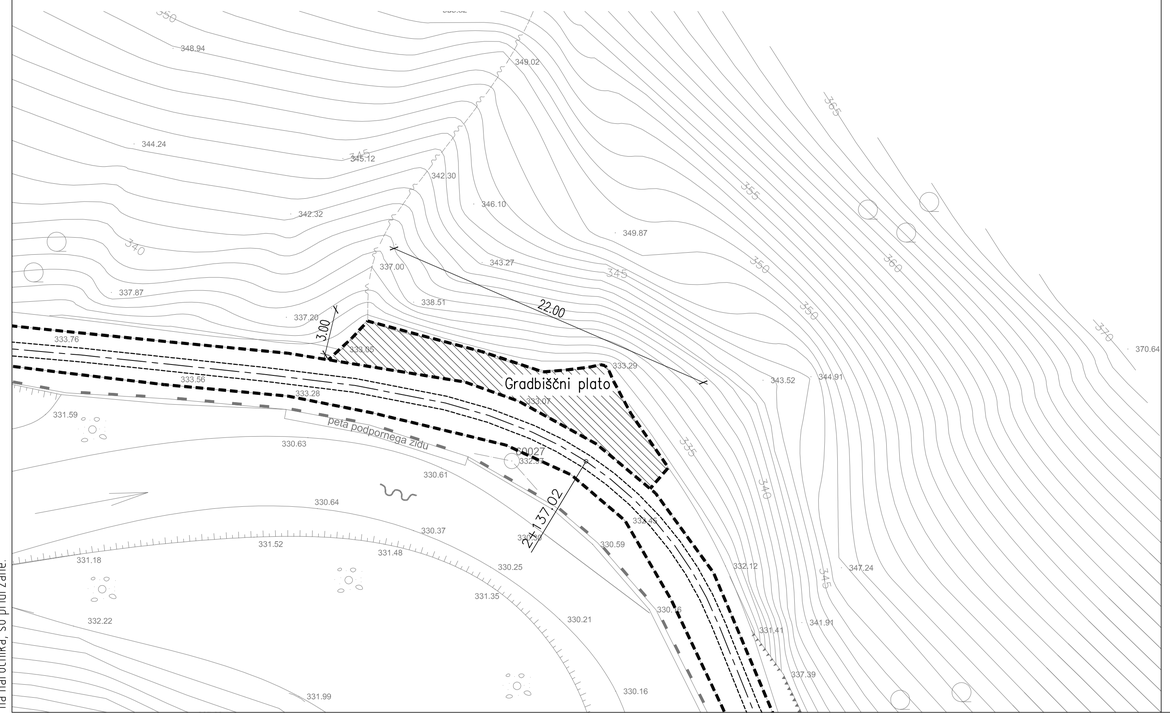


Sprememba:	Opis spremembe:	Datum:	Podpis:
Investitor: SENG Skupina HSE		Objekt: mHE KNEŽA/SHPP KNEŽA	
Projektant: hse Invest — HSE INVEST d.o.o, Obrežna ulica 170, 2000 Maribor		Del objekta/sistem: ZAJETJE/INTAKE	
Id. oznaka izvajalca:		Vrsta načrta/prikaza:	
	Ime in priimek:	Id. št. IZS:	Vsebina risbe (dokumenta): ZAJETJE/INTAKE
Odgovorni vodja projekta:	Miran Komel, u.d.i.g.	G-1095	
Odgovorni projektant:	Primož Gabrijelčič, u.d.i.g.	G-3335	
Sodelavec – projektant:	–		Vrsta dokumentacije: DZR / Številka projekta: HIK3-01/10
Obdelal:	Primož Gabrijelčič, u.d.i.g.		Klasifikacijska oznaka: – – – – – – – – – / Stran/strani: 1/1
Datum izdelave: 01.2016	Merilo: 1:5, 1:10, 1:20		Identifikacijska oznaka: H I K 3 – – – 6 G 3 0 0 1 / Spr.: 0

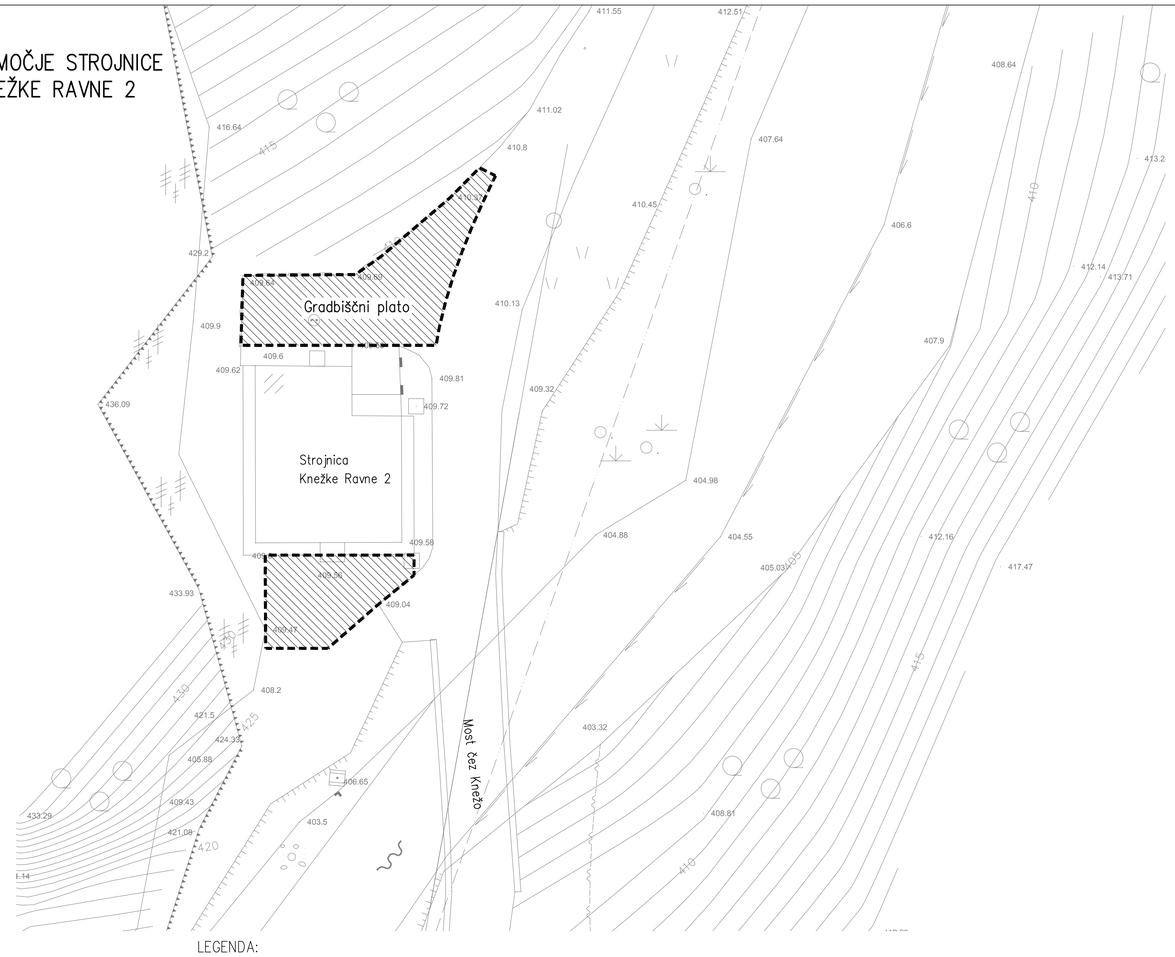
OBMOČJE GRADBIŠČA
STROJNICA



CEVOVOD



OBMOČJE STROJNICE KNEŽKE RAVNE 2



LEGENDA:

OBMOČJE GRADBIŠČNEGA PLATOJA

OBMOČJE GRADBIŠČA

SPLOŠNE OPOMBE:

1– Vse dimenzije so v metrih, če ni drugače omenjeno
2– Vse višine so v metrih in se nanašajo na referenčno višino 0.00 m.n.m.

Sprememba:	Opis spremembe:	Datum:	Podpis:

Investitor: SENG, Skupina HSE

Objekt: mHE KNEŽA

Projektant: HSE Invest, Družba za inženiring in izgradnjo energetskih objektov d.o.o.
HSE INVEST d.o.o,
Obrežna ulica 170,
2000 Maribor

Del objekta/sistem: STROJNICA

Id. oznaka izvajalca:

Vrsta načrta/prikaza: 3. NAČRT GRADBENIH KONSTRUKCIJ

	Ime in priimek:	Id. št. IZS:
Odgovorni vodja projekta:	Miran Komel, u.d.i.g.	G–1095
Odgovorni projektant:	Primož Gabrijelčič, u.d.i.g.	G–3335
Sodelavec – projektant:	–	
Obdelal:	Primož Gabrijelčič, u.d.i.g.	

Vsebina risbe (dokumenta): OBMOČJE GRADBIŠČA

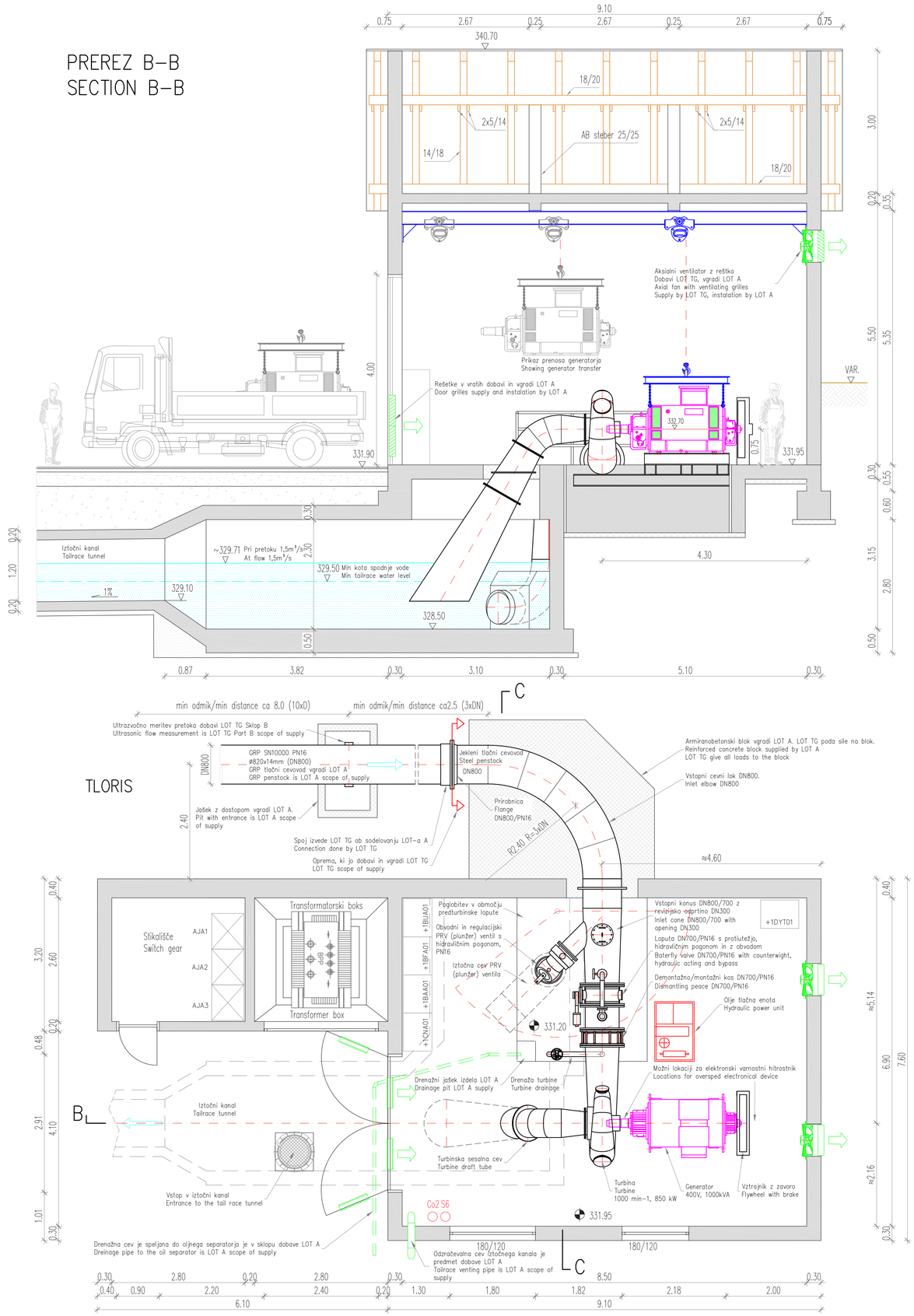
Datum izdelave: 01.2014 | Merilo: 1:50, 1:100, 1:200

Vrsta dokumentacije: DZR | Številka projekta: HIK3–01/10

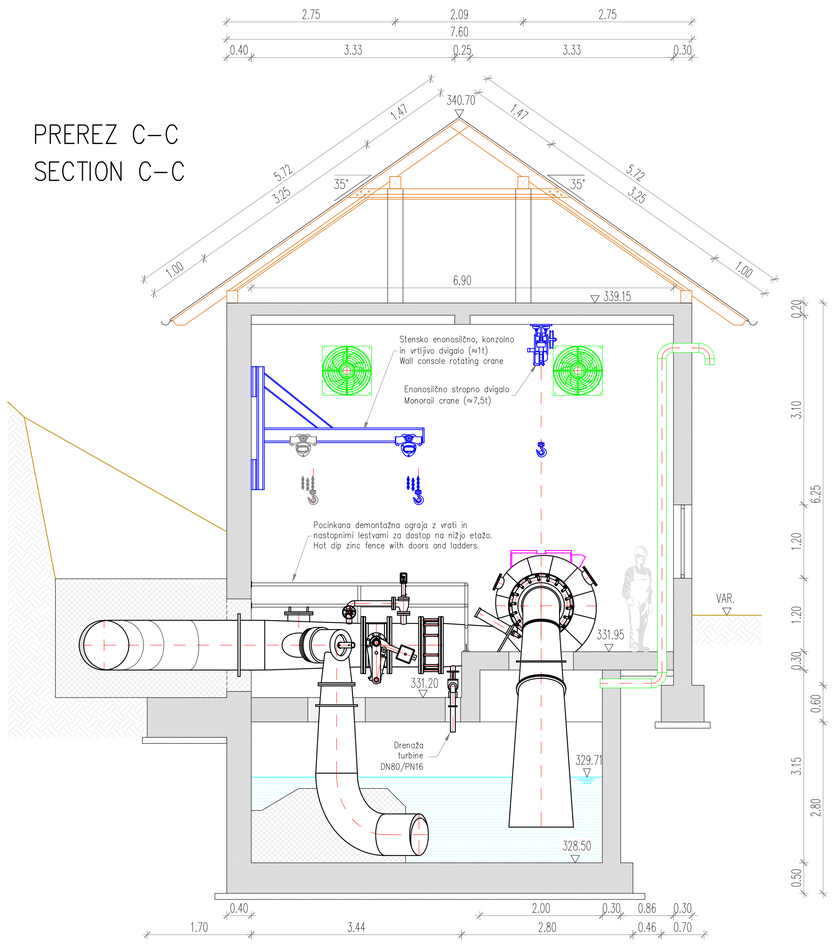
Klasifikacijska oznaka: – – – – – – – – – | Stran/strani: 1/1

Identifikacijska oznaka: H I K 3 – – – 6 G 4 0 0 1 | Spr.: 0

PREREZ B–B
SECTION B–B



PREREZ C–C
SECTION C–C



SPLOŠNE OPOMBE:

1– Vse dimenzije so v metrih, če ni drugače omenjeno
2– Vse višine so v metrih in se nanašajo na referenčno višino 0.00 m.n.m.

GENERAL REMARKS

1– All dimension are in meters, unless otherwise written
2– Vse višine so v metrih in se nanašajo na referenčno višino 0.00 m.n.m.

PRELIMINARNA RISBA. SAMO V INFORMACIJO.
PRELIMINARY DRAWING. FOR INFORMATION ONLY.

Sprememba:	Opis spremembe:		Datum:	Podpis:

Investitor:	SENG Skupina FGG	Objekt:	mHE KNEŽA
Projektant:	HSE INVEST d.o.o. Obrežna ulica 170, 2000 Maribor	Del objekta/sistem:	STROJNICA POWER HOUSE
Id. oznaka izvajalca:		Vrsta načrta/prikaza:	LOT TG Sklop A LOT TG Part A
	Ime in priimek: / Id. št. IZS:	Vsebina risbe (dokumenta):	Razporeditev opreme v strojnici Equipment Lay Out
Odgovorni vodja projekta:	Miran Komel, u.d.i.g. / G–1095		
Odgovorni projektant:	Egon Faganel, d.i.s. / S–0372		
Sodelavec – projektant:	Gregor Koron, e..i.s.	Vrsta dokumentacije: DZR	Številka projekta: HIK3–01/10
Odobril:	Egon Faganel, d.i.s.	Klasifikacijska oznaka: – – – – – – – – –	Stran/strani: 1/1
Datum izdelave: 01.2016	Merilo: 1:20	Identifikacijska oznaka: H I K 3 – – – 6 S 5 0 0 1	Spr.: –

LOT EE - SKLOP B

AJA1 — AJA3 — 3x20kV 50Hz — AJA2

2x50/5/5A

MERITVE
MEASURING

24V DC
24kV 630A
24kV 80A
F1 24kV 10kA
24kV 630A

ARE4H5(AR)E*
1x70mm²
L=2400m

NA CELICO AJA4
V mHE KNEŽKE RAVNE 2
To cubicle AJA4
in HP KNEŽKE RAVNE 2

24kV 6A
20/√3/0,1/√3/0,1/√3/0,1/3kV
10 / 10 / 10 VA
0,2 / 0,5P / 6P

24V DC
24kV 630A
24kV 63A

ARE4H5(AR)E*
1x70mm²

F2
20 kV
10kA

MR.TRANSFORMATOR
TRANSFORMER

1000kVA
20,2/0,4kV
Dzn6
Uz=6,59%

Zašč. transfo
Transformer protection
Bu
tr.>1,2

DOBAVI NAROČNIK /
OWNER (SENG) SUPPPLY

3X(4X(NYY1X240mm2))
2X(NYY1X240mm2)

+BAA01

OG1
2000A
690 V
40MVA
I>; I>>

+1CNP01
Izklop gen. stikala.
Generator circuit breaker remote control.

El. omarica na zunanji steni strojnice.
Control cubicle outside of the power house, wall mounted.

+BAA01

3x231/400V 50Hz

+BFA01

+1CNA01

Zašč. ocepa.
Loss of mains protection.
U< U>
f< f>
Uo

Zaščita agregata
Generator potection
I>> I>
U< U>
P

0,4/0,1kV
4A
4A
kWh kVArh
sinhronizacija
synchronization
Sy
2000A
690V
50MVA
M
2000/5/5A
4A
4A
0,4/0,1kV
kWh kVArh

MERITVE
MEASURING

3X(4X(NYY1X240mm2))
2X(NYY1X240mm2)

=MKA

1000kVA
3x231/400V±10%
cosØ=0,8
1000/min
npr.
1FC6 564-8
G
A

6QF3 16A

PPOO 2x10mm²

Tehnološki porabniki
Tehnološki porabniki
Vtičnice 400V
Vtičnice 230V
Razsvetljava 1
Razsvetljava 2
100A
100A
F8
F3
0,5kV
2,5kA

LASTNA RABA AC
AUXILIARY SUPPLY AC
+BFA01

+1BUA01

F1,F2 16A

220V /24V=
12X15 A

F5 50A
k 18
F7 63A
24V
170Ah

16A 16A 10A 10A 10A 10A 10A 6A 6A 6A 6A 6A 24V=

LASTNA RABA DC, AUXILIARY SUPPLY DC

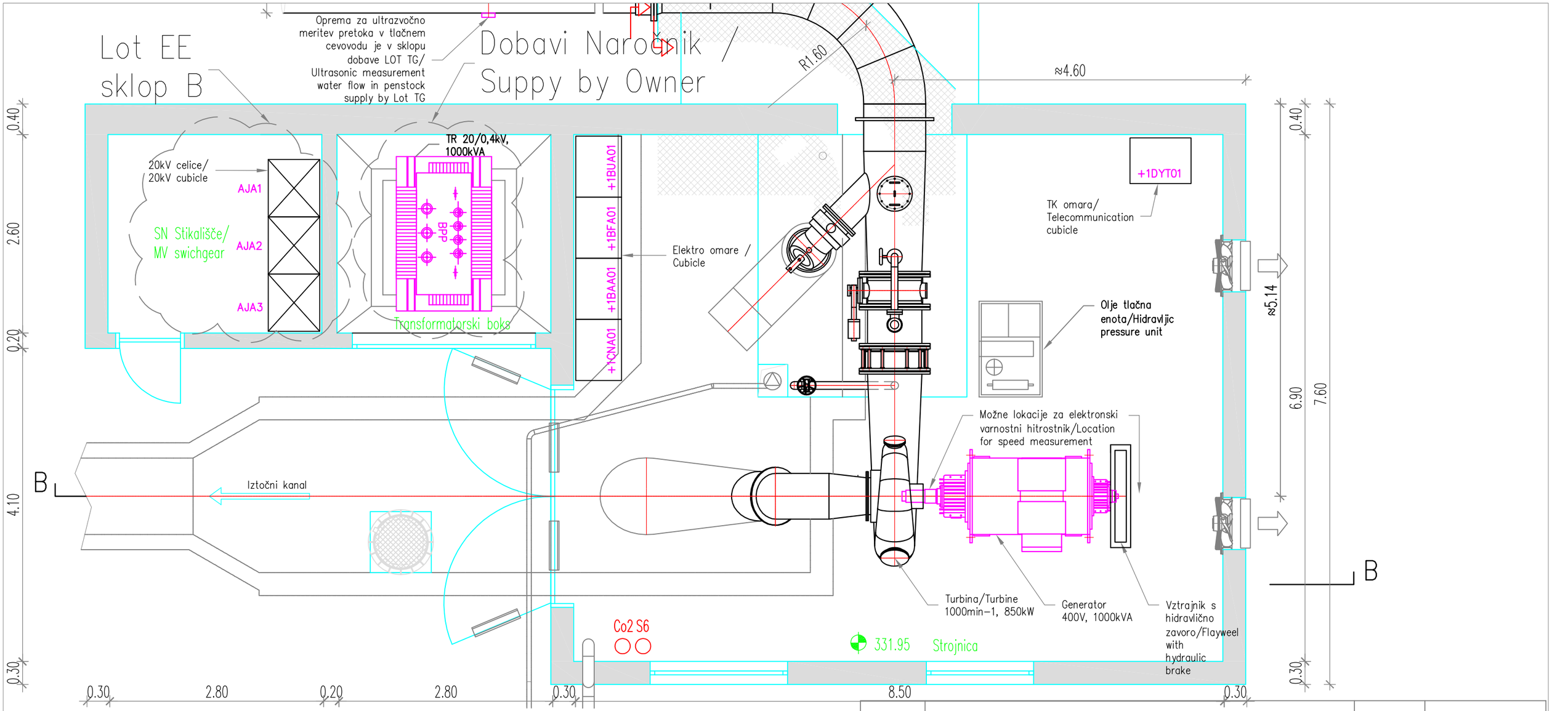
					Ime in priimek (podpis)	Identif.št.:
				Odg.vod.proj.:	M. Komel, udig	G-1095
				Odg.projekt.:	F. Primc, udie	E-0367
				Projektanat:	F. Primc, udie	E-0367
Revizija:	Opis spremenbe:	Podpis:	Datum:	Obdelal:	G. Koron, die	E-1958

Objekt: MHE KNEŽA / *HPP KNEŽA*
Del objekta: ELEKTRARNA / POWERHOUSE

Naročnik: OSENG
Projektant: hse Invest
Izvajalec:

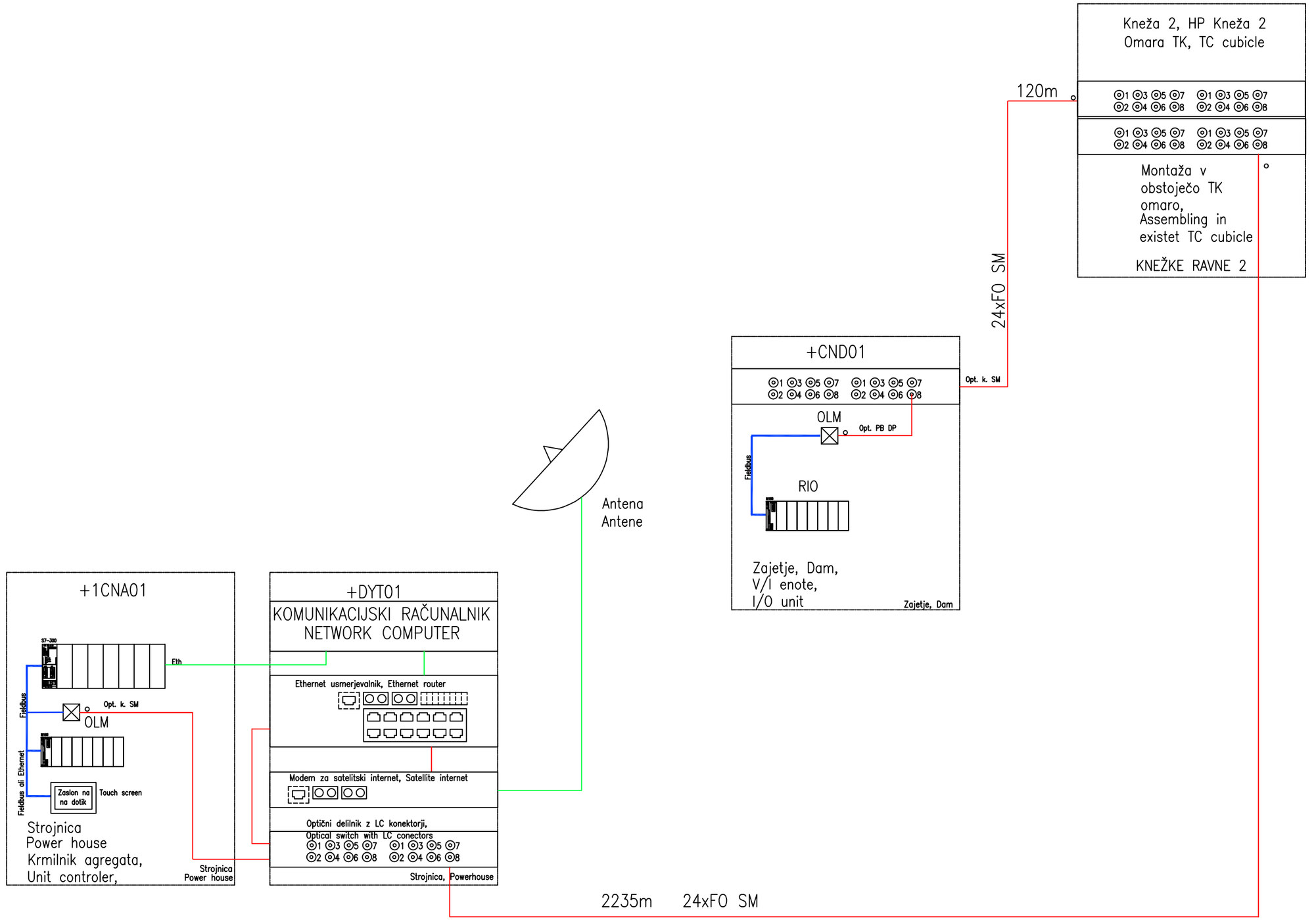
ENOPOLNA SHEMA ELEKTRARNE
SINGLE LINE DIAGRAM HPP

Vsebina načrta: 4 – NAČRT ELEKTRIČNIH INSTALACIJ / *IN ELEKTRIČNE OPREME*
Ident oznaka: HIK3---6E4001
Rev.: –
Klas.oznaka:
Stran:
Št.strani:
Št.projekta: IHK3-01/10 | Vrsta projekta: DZR | Datum: 31.3.2016 | Merilo: | Naprava: | Lokacija:



Sprememba:	Opis spremembe:	Datum spr.:	Podpis:

Investitor: SENG, Skupina HSE		Objekt: mHE KNEŽA	
Projektant: HSE INVEST d.o.o, Obrežna ulica 170, 2000 Maribor; HSE Invest, Družba za inženiring in izgradnjo energetskih objektov d.o.o.		Del objekta/sistema: STROJNICA	
Id. oznaka izvajalca:		Vrsta načrta/prikaza: 4. NAČRT ELEKTRIČNIH INŠTALACIJ	
	Ime in priimek: / Id. št.:	Vsebina risbe (dokumenta): ELEKTRIČNE INŠTALACIJE IN OPREMA	
Odgovorni vodja projekta:	Miran Komel, u.d.i.g. / G−1095		
Odgovorni projektant:	Franko Primc, u.d.i.e. / E−0367		
Sodelavec − projektant:	−	Vrsta projekta: DZR	Številka projekta: HIK3−01/10
Obdelal:	Gregor Koron, d.i.e. / E−1958	Klasifikacijska oznaka: − − − − − − − − −	Stran/strani: 1/1
Datum izdelave: 11.4.2016	Merilo: 1:50	Identifikacijska oznaka: H I K 3 − − − 6 E 4 0 0 2	Spr.: −



					Ime in priimek (podpis)	Identif.št.:	Objekt: MHE KNEŽA	Naročnik: OSENG	SHEMA VODENJA ELEKTRARNE	Vsebina načrta: 4 – NAČRT ELEKTRIČNIH INSTALACIJ IN ELEKTRIČNE OPREME			
				Odg.vod.proj.:	M. Komel, udig	G-1095							
				Odg.projekt.:	F. Primc, udie	E-0367	Del objekta: ELEKTRARNA	Projektant: hse Invest		Ident oznaka: HIK3–––6E4003	Rev.: –	Klas.oznaka:	Štran: Št.strani:
				Projektant:	F. Primc, udie	E-0367		Izvajalec:					
Revizija:	Opis spremembe:	Podpis:	Datum:	Obdelal:	G. Koron, die	E-1958			Št.projekta: IHK3–01/10	Vrsta projekta: DZR	Datum: 28.6.2016	Merilo:	Naprava: Lokacija: