TECHNICAL SPECIFICATION

**Replacement of control equipment, relay protection, excitation and turbine governor for Pļaviņas HPP units PHA02 and PHA08**

Technical specification on 44 pages

Annexes:

No.1 - Scope of Work Lot 1 "Designing, equipment manufacturing and supply, and replacement of control equipment, relay protection, excitation and turbine governor for Pļaviņas HPP Unit PHA02"

No.2 - Scope of Work Lot 2 " Designing, equipment manufacturing and supply, and replacement of control equipment, relay protection, excitation and turbine governor for Pļaviņas HPP Unit PHA08"

No.3 - Scope of Work Lot 3 "Designing, equipment manufacturing and supply, and replacement of control equipment, relay protection, excitation and turbine governor for Pļaviņas HPP Units PHA02 and PHA08"

2025

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# Brief description of the object and its technical condition

Control system of the hydro unit is intended for automatic control of the hydro unit and its auxiliaries, monitoring of operation parameters and alarm on the changes of essential parameters outside admissible settings. Control system consists of: hydro unit controller - for providing main automation processes of the unit; circuits for control of the unit equipment state: protection relays; instrument transformers and circuits connecting current transformers and voltage transformers with protection relays, and protection output relays with circuit breaker, AFS (automatic field suppressor), S/S (Start/Stop) valve and emergency closing valve; different sensors, e.g., level switches thermal resistance, pressure sensors and transducers. Unit protection protects the hydro unit from operation in inadmissible modes to prevent its damage.

Excitation equipment is necessary for feeding excitation winding of the generator rotor; voltage and reactive power of the generator changes in each mode depending on the excitation current. Oscillation damper in the excitation equipment provides for the suppression of active power oscillations. Excitation equipment consists of excitation control equipment (controller, thyristor control signal generators, measuring transducers), thyristor rectifiers, AFS, excitation winding and excitation transformer.

Turbine governor provides for the control of active power and frequency of the hydro unit. Turbine governor consists of electric cabinet, hydro mechanical equipment and main slide valve and guide vane feedback.

Technical condition of equipment is satisfactory, equipment is in working order. Still many components containing electronic elements have high probability of failure.

Unit controller is outdated and supports only ABB MasterBus protocol that is not compatible with equipment of other manufacturers. It is not possible to make communication with excitation and turbine governor to meet the requirements of the grid code (Grid Code in electricity sector).

Controller of the excitation governor is outdated; its spare parts are no longer manufactured. Excitation governor has no possibility of communication. It is not possible to ensure signals that are required by the grid code.

Equipment of the turbine governor electrical part is outdated, spare parts are available, but the new ones are not manufactured. Turbine governor has no possibility of communication. Frequency control dynamics does not meet the requirements of the grid code, turbine governor does not ensure signals that are required by the grid code.

# Description of work

## General description of work to be performed

### Development of the Technical design (hereinafter referred to as the "Design") and the work performance program (WPP), approval by the Employer.

### Development of simulation module of power generation modules (PHA02 and/or PHA08).

### Unit controller program development/ converting to the new controller, development of additional functions.

### Performance of the following main work for hydro units PHA02 and/or PHA08:

replacement of the unit control equipment (control panels, unit controller),

replacement of the unit protections,

replacement of the excitation equipment,

replacement of electrical part of the turbine governor,

refurbishment of hydromechanical part of the turbine governor,

assembly of cooling flow control valves and replacement of flow meters,

replacement of the unit auxiliary switchboard,

replacement of OPE level meters,

replacement of OPE and control oil pressure system pumps control box, installation of OPE soft starting equipment,

displaying of every position of the brake jack limit switch in the control system,

displaying of every position of the guide vane shear pins control limit switch in the control system,

development of automatic control of the guide vane locking device;

replacement of the turbine cover drainage pump and control box,

replacement of turbine bearing level sensor,

replacement of shaft seal control equipment,

replacement of thrust bearing and generator bearing level sensors.

### Integration/connection of hydrounit to Pļaviņas HPP distribution control system (DCS) and to the common Daugava HPP control system (TMS).

### Hydrounit testing after the replacement of equipment.

### Preparation and formatting of As-built documentation.

### Employer's personnel training.

### Taking Over of the Unit.

### Taking Over of the Work.

# Scope of work

## Distribution of work into lots

Lot 1: Designing, equipment manufacturing and supply, and replacement of control equipment, relay protection, excitation and turbine governor for Pļaviņas HPP Unit PHA02.

Lot 2: Designing, equipment manufacturing and supply, and replacement of control equipment, relay protection, excitation and turbine governor for Pļaviņas HPP Unit PHA08.

Lot 3: Designing, equipment manufacturing and supply, and replacement of control equipment, relay protection, excitation and turbine governor for Pļaviņas HPP Units PHA02 and PHA08"

Detailed scope of work can be found in the annexes

### During the procurement procedure the Employer will assess the tenders and considering the risks of future operation he will assess which is the lot the contract will be concluded.

### Scope of work will also include all the works without which the adequate performance of main work in a technologically correct way, in good quality and in accordance with the existing standards is not possible in full scope.

### The Contractor shall dismantle all old equipment which is not going to be used. This refers to switchgears, components and equipment, cables, their fastenings and protection elements.

### After dismantling the renovation of damaged surfaces shall be performed, and the closing of holes in the places of dismantled equipment.

### In the scope of work the Contractor shall include all the necessary equipment, drawings, instructions etc. required for the execution of work according to the requirements of technical specification.

### Before commencement of work all measures shall be taken to protect and avoid damage to nearby engineering network, facilities and installations. In the event of damage, the Contractor shall eliminate the defects caused to the constructions and mechanisms/equipment during the performance of work. Construction defects shall be eliminated according to the surrounding constructions (material, colour etc.), but the damaged mechanisms/equipment shall be repaired or replaced by equivalent ones previously agreed by the Employer

# Requirements for designing

## Inspection of the Site

### Developer of the design shall study required available documentation and shall inspect the Site.

### Before the development of the design the inspection of the Site shall be performed in person and getting acquainted with the location of the existing engineering network and equipment in nature and on layouts to evaluate the possibilities of developing the design.

### The developing of the design based only on archive materials is unacceptable. Reports of previously performed inspections cannot be the grounds for designing work. All disclosed information shall be studied and checked by the project manager during the inspection and development of the design.

### Statement on the inspection of the Site shall be drawn up as a separate part of the design and it shall be submitted to the Employer before the development of the design. It shall contain the following information:

explanatory note;

photos of fixed situation with comments;

analysis and conclusions of the study results;

recommendations;

other parts at the discretion of the person performing inspection.

## Development of the design

### The design shall be developed following the recommendations given in the statement on the inspection of the Site.

### The designer is responsible for:

#### proper choice of all construction elements and equipment, calculations and functional conformity, as well as that all offered and developed solutions meet the Employer's requirements;

#### involvement of necessary specialists for the project execution time, including the development of its separate parts;

#### obtaining information required for the approval of design by the Employer and other competent institutions.

### The design, drawings, schemes, layouts etc. shall be developed and formatted in accordance with the requirements of LBN 202-18 "Formatting of construction intention documentation."

### The design shall be developed to such degree of detailed elaboration that work can be performed according to it. Scope of work of the design shall be clear and unmistakable. All elements and solutions necessary for performing work shall be included in the design. The solutions offered in the design shall satisfy up-to-date trends thus reducing time and expenses of the work performance, as well as scope of future maintenance.

### In the description of work to be performed the developer of the design shall include instructions and requirements for the quality of work to be performed, applied technologies of work, materials and equipment. Quality control plan shall be developed to lighten work and its acceptance, as well as to exclude subjectivity regarding the quality of performed work during the acceptance of work. Quality control plan shall be included in the designing work organization project as a separate chapter.

### At performing work, the quality control plan shall be developed in the form of a separate table. In it there shall be given the following: kind of work, references to normative documentation, criteria for quality assurance audits (control method, value under test, frequency of controls, and criteria for acceptance), performer of audits, way of documentation of results and other necessary information.

### In the designing only certified materials marked with CE marking shall be used. All applied materials, equipment and technologies shall comply with LVS, EN, ISO, IEC or equivalent standards and with the Cabinet regulations and other norms effective in the Republic of Latvia.

### In the developing of the design solutions the following shall be taken into consideration:

#### In all open areas cables shall be designed for assembling in cable ducts or in protective tubes. For the installation of cables through the walls, partition walls and coverings they shall be designed for the assembly in tubes or in special cable ducts by using the existing openings in the constructions (walls, coverings etc.). In the case new openings are required or widening of the existing ones, the making of such holes shall not decrease the load carrying capacity indicators of the construction and they shall be previously approved by the Employer. Depending on the dimensions, location and number of planned openings it is necessary to add also calculations of the constructions planned to be drilled through, and solutions for strengthening the constructions.

#### Fire-proof materials shall be provided for packing the holes, Fire safety degree of packing shall comply with the fire safety degree of the wall or covering according to Latvian Construction Standard LBN 201-15 "Fire Safety of Structures".

### All new equipment/elements, switchgears, cables in the design shall be with designations and marking according to RDS-PP marking that shall be approved by the Employer.

### The Employer reviews the submitted design and submits comments and notes to the developer of the design. The developer of the design makes corrections and submits the design again.

### During the designing and execution of work all imperfections occured in the design are corrected at the Contractor's expense without additional payment. If work cannot be performed in the scope and solution provided in the design, the developer of the design will make technical solutions and amendment to the design, if necessary. The introduced corrections and amendments shall be formatted in accordance with the requirements of AS „Latvenergo” procedure K162 „ Procedure for the formatting, submission and use of technical documentation in the technical archive of HPP Technical management”.

### SI (metric) system for measurement shall be used in all drawings and documents.

## Composition of design

Title page.

Table of contents.

General part:

Explanatory description with information on technical parameters of the site;

Technical inspection statement/report

Technical regulations;

Documents and materials necessary for commencing the designing;

Necessary approvals as stated in the normative acts;

Environmental protection measures;

Detailed time schedule of the work performance.

Technological part power supply (internal):

Electric facility diagrams (primary, secondary, switching, calculation and other diagrams);

Layout and description of cables; cable log where cable connection addresses, length of cables, cross-section and number of cable strands are given. Nominal voltage shall be given for power cables.

Electrical calculations stated in the technical specification, scope of work (e.g. choice of short-circuit protections, overload protection, selectivity and earth calculations, choice of cables and other);

Mechanical calculations stated in the technical specification, scope of work (e.g. load carrying capacity of structures, diameter, material, thickness of piping, and other);

Descriptions of equipment and facilities, their layout and cross-sections;

Drawings of nonstandard constructions;

And other drawings and diagrams that are regarded necessary by the developer of design.

Summary of equipment, constructions and articles;

List of scopes of work;

Work organization programme, including quality control plan.

And other parts of the design that are regarded necessary by the developer of design.

# Technical requirements for the performance of work

## Organization of work

### During the performance of work Latvenergo AS procedure K233 “The procedure of performance of work carried out by the contractors at the generation facilities” and Latvenergo AS regulations of pass regime are binding for the Contractor.

### To get the access to the sites the Contractor shall submit a complete list of employees for issuing the pass cards in accordance with Latvenergo AS regulations of pass regime (NOP020). For commencing work the Contractor shall have the employees instructed in accordance with K233 “The procedure of performance of work carried out by the contractors at the generation facilities”

### The Employer shall provide the Contractor with the possibility of getting acquainted with the documentation of the facility that is available at the HPP technical archive in accordance with Latvenergo AS procedure K162 “The procedure of processing and filing the documents and access to the technical archives of HPP Technical management”.

### The Work Performance Programme shall be developed in accordance with Latvenergo AS Generation procedure K233 “The procedure of performance of work carried out by the contractors at the generation facilities”. The Work Performance Programme shall be submitted by the Contractor 3 weeks before commencement of work at the site.

### Electric installation work shall be performed in accordance with the requirements of IEC, ISO, LVS, LEK (or equivalent) standards.

### In the performance of work the Contractor shall observe all relevant standards, regulations and requirements effective in the Republic of Latvia (their current versions) for performing respective works, including:

Cabinet regulation No.1041 "Regulations on mandatory applicable energy standard regulating the requirements for organizational and technical safety of operation of power supply objects",

Cabinet regulation No.238 "Fire safety regulations",

Cabinet regulation No.500 "General construction regulations",

Cabinet regulation No.253 "Construction regulations of particular engineering structures",

Cabinet regulation No.92 "Labour protection requirements in performing construction work",

Cabinet regulation No.359 " Labour protection requirements at workplaces"

and other corresponding regulations and requirements effective in the Republic of Latvia for performing such work.

As well as Latvian energy standards binding at Latvenergo AS, including:

LEK 025 " Safety requirements working on electric facilities";

LEK 037 "Safety requirements working on hydro technical structures and facilities of hydro power plants";

LVS 1082 series standards "Technical maintenance of electric facilities".

### Latvenergo AS normative documents necessary for the work execution are available at the website <https://latvenergo.lv/lv/par-mums/saistosie-dokumenti-darbuznemejiem>.

### The Contractor shall appoint responsible employees in sufficient number. During the performance of work at least 1 responsible employee shall be present at the site who knows all the work to be performed.

### The Employer is entitled to suspend the performance of work in the case of gross offence of safety, fire security or establishment regulations endangering health of the employees, safety of equipment in operation or could cause material damage. In the case of repeated offence, the Employer reserves the rights to take away the pass cards from the guilty persons and expel them from the workplace ineligible for coming back there.

### When performing the work in the course of which dust or welding fumes are released the Contractor shall provide for the local exhausting of dust and gas in order to avert the pollution of ambient air and nearby equipment. If necessary, the nearby equipment shall be covered. Welding areas shall be fenced with radiation proof shield.

### The dismantled equipment, cables and waste metal (scrap metal) from the working places shall be delivered by the Contractor to HPP site specified by the Employer and handed over to the technical supervisor by statement in accordance with K248 "Procedure for getting and selling of ferrous and non-ferrous scrap metals and waste at Latvenergo AS". Scrap metal shall be sorted (ferrous metal, aluminium, copper). The Contractor's work manager is responsible for handing them over to the Employer's responsible person.

### The Contractor shall hand over by statement to the Employer the dismantled equipment, if there is such, that would not be used in the further assembly, stating the name and weight of dismantled equipment in the statement.

### The Contractor shall bear full responsibility, including the liability for all its subcontractors, for performing the work safely in the allocated area under provisions of the contract observing the requirements stated in the normative acts of the Republic of Latvia and other safety regulations, labour protection, sanitary, fire security, nature protection regulations and instructions.

### For connecting the Contractor’s mechanisms, electrical equipment or using other resources the Contractor shall submit a letter (according to the Employer’s procedure K233) stating technical parameters (electric power (kW), supply of compressed air (m3) etc.) and the persons responsible for the technical condition of the equipment to be connected. The letter shall be submitted to the manager of the HPP who decides on the availability and procedure of using the required resources. If a temporary electrical facility is arranged for performing work and it is connected to Latvenergo AS electrical facilities, the Contractor shall submit the following information (according to procedure K233) about the person in charge of electrical facility (name, surname, electrical safety group (at least Cz group, but foreign contractors shall give relevant electro-technical qualification that is the responsibility of the Contractor, mobile phone number), as well as technical information: required load (kW), rated current of input protective device (A), voltage (V), number of phases.

### For the supervision of project course of the Employer shall call project meetings at least once a month where the time schedule is checked, separate changes in the schedule and technical solutions are coordinated.

### The Contractor shall ensure:

#### involving specialists necessary for the developing of design and performance of work;

#### all materials, tools, equipment, materials and measuring instruments necessary for the performance of work, and shall bear full responsibility for the technical condition of these devices;

#### application of materials according to the description of technical requirements and their use.

#### power connection cables and distribution cabinets required for the performance of work;

#### all safety fencing, warning signs, safety and protective means required for safe performance work (regarding work performance technology);

#### required number of bio-toilets, modular houses, containers for storing materials, equipment and other tools;

#### placing the waste container and collecting and removing of all construction waste from the site to the waste management and utilization company that has permit for storage and recovery of waste;

#### cleaning and keeping the work place/area in order during the performance of works;

#### receiving of all documents/approvals necessary for commencement of work.

### At the site there is a possibility of risks that at the work place the Contractor’s personnel may have contact with asbestos, asbestos fibres, asbestos dust or asbestos containing material (risks presented by asbestos).

### If during the performance of work the Contractor establishes that work is going to be performed having contact with asbestos, asbestos fibres, asbestos dust or dust of asbestos containing material, he shall provide for the inspection of work places in order to approve or deny possible contact with asbestos, that is, the Contractor shall ensure the assessment of risks presented by asbestos and primary measurements of asbestos fibre exposition in the air at the work place (amount of asbestos fibres in a definite volume unit of air (fibres/ cm3)) at the work place.

### The Contractor shall observe the labour protection requirements in regard to work with asbestos to protect the safety and health of employees against the risks which arise or may arise when coming into contact with dust from asbestos or asbestos-containing material at the workplace in accordance with the requirements of the normative acts of the Republic of Latvia (incl. Labour protection requirements in work with asbestos, Cabinet Regulation No.852, Riga, 12.10.2004; Labour protection requirements when coming in contact with chemical substances at workplaces, Cabinet Regulation No.325, Riga, 15.05.2007; Labour protection requirements when coming in contact with carcinogenic substances at workplaces, Cabinet Regulation No.803, Riga, 29.09.2008) and Regulations and Directives of European Parliament and Council of Europe.

### When performing work, the Contractor shall consider the following unhealthy and hazardous risk factors of labour environment that might affect the employee during the performance of work:

#### physical risk factors of labour environment - microclimate (air temperature, air flow speed, dust, environmental conditions, insufficient light at the workplace, noise), surface temperature – intensity of heat radiation, fire hazard;

#### physical risk factors of labour environment - working for long periods in a forced position, local muscular tension, manual handling of loads);

#### traumatic risk factors of labour environment – getting trauma from sharp corners or edges;

#### chemical risk factors of labour environment – dust and fumes of chemical substances and products.

## Requirements for preparing the workplace

### In accordance with procedure K233 the Employer prepares workplace for the Contractor by organizing admitting to work or by allocating work area.

### The Contractor shall bear full responsibility, including the liability for all its subcontractors, for performing the work safely in the allocated work place/area under provisions of the contract observing the requirements stated in the normative acts of the Republic of Latvia and other safety regulations, labour protection, sanitary, fire security, nature protection regulations and instructions.

### The Contractor is responsible for providing fencing required for the performance of work, as well as for providing the workplace with information board (construction board) if it is required by the normative acts.

### Before commencement of work all measures shall be taken to protect and avoid damage to nearby facilities and installations. In the event of damage, the Contractor shall renovate the damaged facilities/sites at his own expense.

### The Employer shall indicate the connection point of electricity supply for the installation equipment and facilities. The switchgear and cables necessary for the connection shall be provided by the Contractor. The Contractor is responsible for the repair switchgear, connection of using equipment, connected cables and technical condition of using equipment by appointing person in charge of electrical equipment. The Employer reserves the right to disconnect this switchgear from voltage if the technical condition of outgoing lines and using equipment does not comply with the provisions or if the connection is unwarranted.

## Environmental and occupational safety requirements

### To exclude or to minimize environmental impact the Contractor shall ensure working with environmentally friendly methods and work on site considering the following environmental risks:

#### Chemical substances and compounds:

##### At the work performance site there shall be available safety data sheets (SDS) in Latvian language according to Regulation REACH EK 1907/2006 for all hazardous chemical substances and chemical mixtures used at the object;

##### During the performance of work the Contractor shall observe demands of SDS for storage, use and disposal of chemical substances and compounds;

##### All chemicals and compounds on site shall be registered by indicating name, quantity, classification and labelling;

##### Considering the amount of chemicals and compounds on site the Contractor shall provide sufficient volume of means for localization and collection of chemical substances and compounds (absorbers etc.) in case of leakage (damage of container, defects of equipment and devices) as well as ensure preventive measures during the storage of chemicals and compounds.

#### Waste:

##### The Contractor shall daily ensure separate collection and utilization of construction, household, hazardous, electrical and electronic waste. The locations of waste containers shall be coordinated with the Employer.

##### The Contractor shall ensure separate collection of hazardous waste according to its type (containers of used oil, chemical substances, absorbents, solvents, degreasing agents and others) according to classes given in SDS and waste classification.

##### Waste containers shall be marked by indicating waste title and warning signs (for hazardous waste).

##### The Contractor shall periodically organize the disposal of construction and hazardous waste by transferring it to a licensed hazardous waste manager.

### The Contractor shall periodically submit and add to as-built documentation the Registration Card-Bills Lading of hazardous waste and Registration Card-Bills of Lading of Construction Waste. If during the performance of work there was no hazardous waste the Contractor shall submit the Employer a statement on the absence of hazardous waste (1 copy).

### Waste that has appeared during the work shall be managed in accordance with Cabinet Regulation No.113 of 1 July 2021 "Procedures for record-keeping of transportation of waste".

## Technical requirements, technologies, criteria, parameters, conditions

### All cables, their mechanical fastening and protection equipment, equipment fastening hangers, necessary pins, clamps etc. shall be included in the scope of supply according to the design.

### Unit control system and protections shall be designed and constructed in such a way that they are damage resistant. In the case of fault in any electric system of the power plant or in the case of any control signal disappeared there shall be an option to stop the unit safely and its auxiliary systems.

### Critical functions, e.g. disconnection from power grid and closing of guide vane, braking of the unit etc., shall be designed and constructed in such a way that they operate also in the case of damage.

### Control and protection systems shall ensure continuous and safe unit operation in the case of power plant auxiliaries' faults.

### Stand-by supply shall be provided for all the necessary equipment. Safety and stand-by systems shall be selected based on the possible damage risks and their potential consequences, by ensuring safe operation of equipment for the staff and environment.

### If one or several control signals or supply voltage have disappeared for any controller or any other equipment of unit control system, or appears and disappears again, all inputs, outputs and parameters of process shall switch over to safe values. It means that in the case of supply voltage or control signals disappearing no dangerous situations arise. When supply voltage and control signals are renewed, the system shall continue working without process interruption.

### The unit shall not switch off during the automatic changeover of alternating voltage.

### Control of voltage presence shall be provided for all auxiliaries of the unit.

### The unit shall not switch off if one of the direct current supply sources is not available.

### After completion of work the loading of all the used controllers shall be measured and recorded. Calculation of critical conditions shall be performed to evaluate the possibility of future extension.

### For all the new and existing cables that are in use all required tests shall be performed and recorded to check on their compliance and possibility to be used further on.

### All new cables shall be with halogen-free insulation.

### The Contractor shall dismantle all not used equipment.

### For new switchgears and cables all the necessary tests shall be performed including insulation resistance and continuity of earthing measurements.

### Spare parts shall be supplied that are necessary for 10-year work and spare parts that are necessary for providing non-failure operation of equipment.

### All signals and indications that are available in the power plant control system DCS shall be implemented and available also in the common control system DHES TVS.

### Control of safety guide vane

#### Control of safety guide vane shall be reconstructed, every status of safety guide vane sensor shall be shown in the unit control system.

### Guide vane locking device

#### The existing guide vane locking device shall be reconstructed making possible its automatic putting in or taking out of the unit control system. Electric drive shall be provided for the control of lock mechanism. Signalling in the control system shall be provided for the lock mechanism indicating its in or out position. In the case of lock mechanism being put in, the availability of the unit shall be blocked. Next to the lock mechanism there shall be local control buttons and signalling of positions. Put in of the lock mechanism shall be blocked if it's putting in is inadmissible.

### Turbine governor

#### Turbine governor shall ensure the following operating modes:

##### No-load operation;

##### Operation in isolated network;

##### Operation in generator mode;

##### Operation in synchronous compensator mode.

##### Turbine governor shall ensure the following functions:

##### Unit starting

##### No-load operation

##### Operation in generator mode

##### Operation in compensator mode

##### Control of rotations and synchronization with the power grid

##### Stable operation in isolated network

##### Stable operation in the power grid

##### Variable frequency control

##### Limiters

##### Changeover from compensator mode to generator mode

##### Changeover from generator mode to compensator mode

##### Normal shutdown of the unit

##### Emergency shutdown

##### Manual control of the guide vane

##### Providing for the measurement, fault and emergency signals.

#### Requirements for the turbine governor

##### Turbine governor shall be electronic programmable device that is designed in accordance with standard IEC 61850-7-410.

##### Turbine governor shall be proportional integral differential (PID) governor with electric-hydraulic operation. Turbine governor shall be equipped with rotation measuring sensors and power control.

##### Turbine governor shall be with redundant processor blocks. The required backup shall be provided to ensure unit operation in case of one control equipment fault. In case of fault of one processor it shall be switched over to the backup processor. The switching over shall be momentary without steps in the process. The fault of processor and switching over shall be notified in the operator panel and in the unit control system. There shall be an option to replace one module of processor without stopping the whole process. All specific features of the operation of the redundant equipment shall be described in the documentation. Personnel training shall include training for work with redundant system. The Contractor can offer other solutions for excitation governor that increase its availability. The offered solution shall be compared with solution with redundant processor modules. There shall be an option for performing changes to the programme (put in new block) online, without re-starting the controller, re-starting is acceptable only if controller's configuration is changed. The controller shall have an option to perform operations with 10 ms cycle.

##### Turbine governor shall support popular communication protocols, at least Modbus TCP or RTU, IEC 61850, IEC 60870-104, OPC DA, OPC UA.

##### Turbine governor shall be equipped with operator panel for control of turbine governor parameters and changing of settings. In the local turbine governor control mode, there shall be an option of changing guide vane opening or active operating point from the operator panel.

##### Turbine governor shall be connected to the power plant and unit control system. There shall be an option to change all parameters of the turbine governor from control system, e.g. power and opening operating point, operating mode (power, opening), frequency dead band, droop, isolated network mode etc.

##### All signals of the turbine governor shall be available in the unit control system.

##### Turbine governor shall comply with Commission Regulation (EU) No.2016/631 of 14 April 2016 according to which the Grid Code is made on the requirements applicable to generators (hereinafter referred to as Regulation 2016/631), Latvian Grid Code and TSO requirements. Droop shall be set 5% with control option 2 – 30%. Full frequency action shall end within 30 seconds. Unit power changing due to frequency control shall start in at least 2 seconds from the variation of frequency. Active power range that is used for frequency control 10% of the maximum power. Frequency sensitivity shall be at least 10 mHz. Frequency control dead band 0-500 mHz.

##### Turbine governor functionality shall comply with the requirements of guidelines "Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation for grid connection of generators" clause 153, 154, 157 and 158, regarding the provision of frequency containment reserve (FCR) and frequency restoration reserve (FRR).

##### There shall be an option of setting minimum and maximum power and opening limiters from the unit control system to prevent the unit operation in unacceptable mode.

##### In the turbine governor there shall be idle run opening limiter depending on the actual head to allow unit start at different heads.

##### The unit shall operate stably in LFSM-U and LFSM-O mode. When LFSM-U and LFSM-O mode is active, no other governors (except aFRR) shall change the unit active power operating point.

##### The unit shall be capable of maintaining invariable output power with the set operating point regardless of frequency change if the frequency change is lower than the dead band.

##### Automatiton of water depression from runner in compensator mode shall be made in turbine governor or in the unit controller.

##### The required signals from the turbine governor shall be provided according to the requirements of the Grid Code and TSO. The exact number of signals shall be stated during the development of the design.

##### The Contractor shall include in the scope of work all the required functional tests to examine the operation of the turbine governor and to prove the compliance with the requirements TSO and technical specification. Test report shall be submitted, and it shall be approved by the Employer and TSO.

##### During the acceptance/handing over of the equipment the Contractor shall submit actual design of the turbine governor controller and operator panel programmes. The Employer shall have an opportunity to modify the submitted designs to add new signals or some other functionality. All the necessary tools and software and licenses required for modifying the designs shall be included in the scope of supply.

##### Turbine governor shall be fed from two 220V direct current sources. All the required auxiliaries, power supply modules, filters etc. for feeding the supplying of controllers and output auxiliaries shall be included in the scope of supply.

### Rotation measuring equipment

#### The existing rotation measuring sensors, their cables and fastenings shall be replaced. If the existing rotation measuring tooth wheel on the shaft do not comply with the requirements of the new turbine governor the new one shall be supplied. The new tooth wheel shall be manufactured so that the unit frequency can be measured in the whole possible range of rotations with 1 mHz preciseness. At least two sensors shall be installed. Control of rotation sensors shall be provided, if any of sensors is damaged it shall switch over to backup sensor. Signal about the sensor damage shall be in the turbine governor and unit control system.

#### Frequency measurement on excited generator shall be performed by using voltage from voltage transformers.

#### Rotation measurement shall ensure electric overspeed protection that stops the unit by activating emergency closing valve.

### Renovation of hydraulic part of the control oil pressure system

#### The existing proportional, pressure control valve, start shutdown valve, pressure tank isolating valve shall be replaced. As far as possible standard components and those that are easily available in the market shall be used.

#### In case of voltage loss, the proportional valve shall tend to close the guide vane.

#### Control oil pressure system measuring transducer with analogue outlet shall be installed. There shall be local oil pressure indication. Measurement signal shall be connected to the unit controller and shown in the control system and operator panel.

#### Manometer shall be installed for pressure control in the pressure tank, the manometer shall be connected behind the isolating valve at the pressure tank side.

#### Automatics of pumps control shall be made in the unit controller. Oil pressure measurement shall be connected to the unit controller. Changing of pumps shall be ensured for their equal load. Working hours of each pump shall be registered. Isolating valve shall be opened after the activation of pump and closed after the stop of pump. In case of pressure drop, a backup pump shall be activated.

#### Control oil pressure system direct current pump shall be dismantled, and its assembly place shall be sealed.

### Renovation of electric part of the control oil pressure system

#### Pump control switchgear shall be delivered and installed. Local indication of pump state and control buttons in manual mode shall be provided. In the switchgear safety switches shall be provided to switch off the pump during the repair. Position of the switch shall be displayed in the unit control system.

### Renovation of hydraulic part of OPE

#### Replacement of level gauge of OPE pressure tank and collecting tank. The level gauge shall use magnetic striction measuring principle and shall be with 4 20 mA analogue outlet (sensor with protocol outlet might be used). Signal shall be connected to the unit controller and shall be displayed in the operator panel and in the unit control system. Level sensors shall be low level switch that shall be connected to protection. Level gauge shall be equipped with visual indicator and a scale showing oil level in mm. Such sensor shall be supplied that fits in the existing assembly point.

#### In the unit controller design the oil leak control shall be made by comparing the levels of pressure tank and collecting tank.

#### Automatics of oil level control in the OPE shall be made that it uses new analogue level signal for level measurement.

#### In the emergency closing valve control pipeline pressure control equipment shall be installed with local indication for the control of the emergency closing valve state. The signal shall be connected to the unit control system.

### Renovation of electric part of OPE

#### New OPE pump control switchgear shall be delivered. For the activation of pumps (30 kW each) soft start equipment shall be installed in the switchgear. Automatics of OPE pumps control shall be installed in the unit controller (pressure control, backup pump activation, relief valve control). Changing of pumps function shall be ensured for their equal working hours. Working hours of each pump shall be registered. In the switchgear there shall be local, remote switches of disconnected mode and local control buttons. Active mode of the pump shall be displayed in the unit control system. Local indication of pump operation (on/off) shall be provided. Working hours of the pump shall be registered in the unit control system.

#### The existing switchgear OPE pumps control and control switchgear with intermediate relays shall be dismantled.

#### OPE pumps shall have safety switches to disconnect for repair.

### Replacement of feedback coupling of the main slide valve

#### Feedback coupling of the main slide valve shall be replaced by magnetostriction sensor which shall be connected to the new turbine governor. When installing the sensor, the modification of the main slide valve shall be performed for fastening the new sensor.

### Replacement of the feedback coupling of the guide vane

#### Feedback coupling of the guide vane shall be replaced by magnetostriction sensor which shall be connected to the new turbine governor. When installing the sensor, the modification of the fastening place shall be performed. The existing switches that relate to the feedback coupling sensor, if they are necessary for the unit control, shall be replaced or relocated to some other place.

### Requirements for replacement of the turbine bearing sensors

#### The existing level gauges shall be replaced by magnetostriction sensors with 4-20 mA analogue output and shall be connected to the unit control system.

#### The existing bearing linings and oil thermal resistances and contact thermometer shall be replaced and shall be connected to the unit control system.

#### The necessary cables, their protective tubes and fastenings shall be replaced.

### Requirements for the replacement of shaft seal sensors

#### Pressure sensors of the shaft seal shall be replaced and connected to the unit control system.

#### In the unit controller there shall be calculation of the sealing differential pressure, and signaling about reduced pressure provided.

### Automatics of opening the reserve water motor valve.

#### Seal filters at the el. mark 32m and el. mark 39m shall be equipped with analogue differential pressure sensors for determining clogging of filters. Sensors shall be connected to the unit control system.

#### Positions of reserve water motor valve and fault signal shall be displayed in the unit control system. There shall be an option to shut down the reserve water motor valve from control unit.

### The existing shaft seal flow meter shall be replaced, and elctro-magnetic flow meter with direct current supply shall be installed.

### Replacement of the turbine cover drainage pump

#### Alternating current pump having the same yield capacity as that of the existing direct current pump shall be supplied. Control switchgear of the new pump shall be delivered and placed in the turbine pit.

#### Pump control shall have new level switches replaced. Pump control switchgear shall be equipped with safety switch for the pump repair, with local control buttons and indication of pump position. Indication of pump operation and fault and control mode shall be displayed in the unit control system. If the switchgear of the existing level sensors connections is not used, it shall be dismantled.

#### The switch of very high level on the turbine cover shall be in operation during the shutdown of the unit.

### Connecting of the leakage pump signals to the unit control system

### Signals from the leakage control switchgear shall be connected to the unit control system:

Pump in operation

Fault of the pump

High level of oil in the leakage tank.

### Renovation of equipment for air dewatering for compensator mode

#### The existing 7.8 bar pressure control contact manometer shall be replaced. It shall be connected to the unit control system.

#### Positions of dewatering valve and fault signal shall be displayed in the unit control system.

### Thermocontrol of stator

#### All 24 sensors of the stator thermocontrol (stator winding, stator core) shall be connected to the unit controller and shall be displayed in the unit control system.

### Renovation of the generator bearing equipment

#### All temperature sensors of generator bearing shall be connected to the unit control system.

#### Bearing level sensor shall be replaced by magnetostriction analog level sensor. The sensor shall be connected to the unit control system. There shall be valves provided for checking sensor during the repair, to disconnect sensor from the bearing case, to add and drain oil. Meter shall be equipped with very high level and very low-level switches they shall be connected to the unit protections.

#### The existing cooling flow meter with analog 4-20 mA output shall be connected to the unit control system.

#### Outgoing cooling water temperature control sensor shall be installed and connected to the unit control system.

### Renovation of thrust bearing equipment

#### All temperature sensors of thrust bearing shall be connected to the unit control system.

#### Bearing level sensor shall be replaced by magnetostriction analog level sensor. The sensor shall be connected to the unit control system. Meter shall be equipped with very high level and very low-level switches, they shall be connected to the unit protections.

#### There shall be valves provided for checking sensor during the repair, to disconnect sensor from the bearing case, to add and drain oil.

#### The existing cooling flow meter with analogue 4-20 mA output shall be connected to the unit control system.

#### Outgoing cooling water temperature control sensor shall be installed and connected to the unit control system.

### Connection of filtration equipment of generator bearing and thrust bearing

#### The existing filtration equipment of the generator bearing and thrust bearing shall be connected, automatics shall be made in the control system that activates each filtration equipment when generator bearing and thrust bearing temperature has reached 35°C. Fault and filter clogging signalling shall be made. Working hours of filter shall be registered. Filtration equipment shall be stopped if the unit does not operate. All cables for the equipment connection shall be supplied. All available filtration equipment signals shall be connected to the control system.

### Connection of oil vapour fan

#### Signals from the oil vapour fan switchgear shall be connected to the unit control system. There shall be signals of fan in operation and damaged. Working hours of fan shall be registered. Fan shall be in operation when the unit is in operation.

### Renovation of braking system equipment

#### Solenoid valve of the braing system shall be replaced.

#### Limit switch of each braking jack (6 pcs) position shall be connected to the unit control system and its position shall be displayed. Switchgear of braking jack position indication shall be installed in the thrust bearing room.

### Development of automatics for cooling system control

#### Automatics of the unit control system shall ensure control of thrust bearing and generator bearing oil temperature and cooling air temperature in accordance with the set working point. Control of cooling system regulating valves shall be provided with PID governors. Regular movement of regulating valve in full range shall be provided in order to avert jamming of valve and reducing range of control.

#### The existing cooling flow meter with analogue 4-20 mA output shall be connected to the unit control system.

#### All temperature sensors of cooling system shall be connected to the unit control system.

#### The existing temperature sensor of inlet water shall be replaced.

#### All the existing (6 pcs) hot air temperature sensors shall be connected to the unit control system.

#### Behind each air cooler (12 pcs) the temperature sensor of outlet air shall be installed and connected to the unit control system.

### Renovation of the generator firefighting system

#### The unit control system shall provide for the control of the existing firefighting motor valves.

#### At actuation of the unit firefighting there shall be signal passed to the firefighting automatics of the power plant for the opening of inlet motor valves.

#### On the unit control panel there shall be button for manual activation of the unit firefighting. The button shall be made so that it is not possible to press it by mistake. Firefighting motor valves shall be opened only after the switching off the circuit breaker and excitation field breaker.

#### Signals from the firefighting automatics shall be connected to the unit control system.

#### At actuation of the unit firefighting there shall be signal passed to the firefighting automatics of the power plant for the opening of inlet motor valves.

#### Pressure relays behind the firefighting motor valves shall be connected to the unit control system.

### Renovation of the stator heaters control

#### Signals on fault or operation of heaters shall be connected to the unit control system.

### Requirements for replacement of excitation system

#### New static excitation system shall be supplied. Scope of work shall include all required components of equipment – thyristor rectifier, field breaker, initial excitation and deexcitation equipment and automatic voltage regulator (AVR). The limit of supply is to the cables outgoing to the generator excitation winding.

#### Excitation equipment shall ensure operation of the unit AVR, MVAr, cos φ and excitation current control mode. There shall be an option of setting working point for each mode from excitation and unit operator panel and from the power plant control system. All the necessary signals for ensuring this mode shall be passed to the control of the power plant. Switching over the modes there shall not be leap changes, the changing shall be after the input of the new working point.

#### Excitation equipment shall have limiters of excitation current, stator current and V/Hz that do not allow operation of the unit outside P/Q characteristic. Excitation equipment shall ensure maximum and minimum reactive power measurement in the actual working point. These signals shall be passed to the unit control system. There shall be signals about value of each limiter in the actual working point. Signals shall be provided on the activation of each limiter. All signals shall be connected to the unit control system.

#### In case of voltage measurement fault the excitation shall switch over to the excitation current control mode.

#### Excitation equipment shall comply with the requirements of Regulation 2016/631, Grid Code and TSO.

#### Scope of work shall include all the necessary calculations to check the impact of settings on stability, vibrations and heating of the unit.

#### Scope of work shall include designing, calculations, manufacture of equipment, tests at the manufacturing plant (FAT), supply, assembly, assembly instructions, adaptation, connection, adjustment, site and operation tests, participation in the unit tests, preparing documentation and training of Employer's personnel. The equipment shall be assembled, connected to the existing or to the newly supplied equipment. Scope of work shall include all possible adjustments to the new and to the existing equipment.

#### Testing of the whole excitation equipment (including excitation transformer) shall be performed to be satisfied that the whole equipment complies for future operation. In case of any non-compliances the elimination of these shall be included in the Contractor's scope of work.

#### The Contractor shall do all calculations required for the adjustment of PSS function.

#### The scope of excitation equipment adjustment work shall include tests stated by the TSO. Mathematic models required by TSO shall be supplied and verified in tests.

#### Scope of supply shall include all tools, software, actual designs of controllers and operator panels, licences, data carriers, special cables required for the assembly, adjustment of equipment, change of settings and testing.

#### The developed solution shall ensure safe operation of power and control equipment.

#### Excitation equipment shall be redundant by redundant control channels. The required backup shall be ensured to provide for the unit operation in case of one damage of the control equipment. Excitation controller shall be at least with redundant processors. In case of damage of one processor it shall be switched over to backup processor. Switching over shall be momentary without leaps in the process. Damage of the processor and switching over shall be notified to the operator panel and unit control system. There shall be an option to replace one module of the processor without interrupting the whole process. All specific features of the operation of the redundant equipment shall be described in the documentation. Personnel training shall include training for work with redundant system. The Contractor can offer other solutions for the excitation controller that increases its availability. The offered solution shall be compared to the solution with redundant modules of the processor.

#### If the excitation controller is implemented with the help of controller there shall be an option for performing changes to the programme (put in new block) online, without re-starting the controller, re-starting is acceptable only if controller's configuration is changed. The controller shall have an option to perform operations with 10 ms cycle.

#### Initial excitation shall be provided from alternating current. Backup initial excitation shall be provided from direct current.

#### The excitation equipment shall implement all functions of the existing equipment. Excitation shall have local operator panel for parametrs control and for changing the settings. Operator panel shall be in an energy saving mode to extend its service life.

#### During the acceptance/handing over the Contractor shall submit to the Employer the actual design of controllers, list of settings, configurations, compiled firmware for equipment that are adjusted during the implementation of design.

#### Excitation equipment shall ensure redundant communication with the unit control system or power plant control system by using standard protocols, at least Modbus TCP or RTU, IEC 61850, IEC 60870-104, OPC DA, OPC UA. There shall be an option to control all parameters of excitation equipment, read out measurements and give commands.

#### There shall be an option to set excitation working point from communication protocol and more/less buttons on the unit control panel.

#### Switching over control modes without leaps shall be ensured. There shall be an option to switch over control modes from communication and buttons on control panel.

#### Excitation equipment shall be capable of operation in island mode of the power grid by magnetizing step-up transformer during the restoration of the power grid.

#### Emergency switching signals from excitation equipment shall be implemented with the help of cables and wiring.

#### Excitation equipment shall be capable continuing operation after short circuit that is defined in the Grid Code and TSO requirements. In case of short circuit, the unit shall not switch off due to excitation equipment.

#### Excitation equipment shall ensure:

##### Effective suppression of oscillations in the conditions of local oscillations.

##### Positive suppression of oscillations effect shall be ensured in frequency range from 0.3 to 0.6 Hz.

##### There shall be ensured non-amplification of oscillations in the frequency range from 0.1 to 2 Hz.

#### Excitation equipment shall ensure protections against thermal overload (ANSI 49), excitation maximum current (ANSI 76), excitation maximum voltage (ANSI 59R) and excitation earth fault (ANSI 64R). They can be in excitation equipment or included in the unit protections.

#### In case of fault, excitation equipment shall switch over to backup thyristor converter.

#### Excitation voltage and excitation current measuring equipment and measuring transducers shall be supplied.

#### During the operation of excitation limiters (excitation current limiter, stator current limiter etc.) the unit with power grid stabilizer switched on (PSS) shall operate stably without oscillations.

#### Field breaking equipment shall be provided for interruption of monopolar and bipolar direct current. It shall be capable of interrupting current that may originate in all possible excitation operation modes, also in the case of two-phase and three-phase short circuit on generator output terminals. Excitation field breaker shall have one switching on and two switching-off coils. Field breaker shall be protected against frequentative switching on/off. Field breaker shall have several no-voltage contacts of on/off position. Field breaker shall be provided for at least 20000 switching on/off cycles.

#### For the discharge of excitation field non-linear resistor shall be used. The resitor shall be automatically connected after field breaker switching off and in case of excitation overvoltage. Discharge circuit shall be controlled and protected with special equipment. Control equipment for control of excitation overvoltage and discharge shall be supplied. Accurate operation of excitation overvoltage and discharge equipment shall be controlled.

#### Excitation rectifiers shall be fully controllable thyristor rectifiers. Their parameters shall be selected so that the unit output power is not limited with maximum admissible voltage. There shall be an option to operate the rectifier in negative direction in the case of load-off and runaway. Maximum excitation voltage shall be at least 2x of nominal excitation voltage. Inverse voltage of semiconductors used in the rectifier shall exceed maximum supply voltage at least 2.5 times. The rectifier shall be protected with fuses. Thyristor rectifier shall control temperature. Excitation equipment shall ensure control over thyristor fault and shirt circuit in direct current circuits.

#### Live parts of excitation equipment, also those that are accessible only by opening the door of the cabinet, shall be protected by transparent screens.

#### If new excitation transformer is supplied, it shall be with vacuum impregnated epoxy resin insulation. Transformer shall be with IP21 class casing. On the casing there shall be transformed data plate. Transformer shall comply with the requirements of standards EN 60076-1, EN 60076-2, EN 60076-3 un EN 60076-11. Transformer shall be connected in the generator breaker cell. The existing protective current transformers of excitation transformer can be used if they are suitable, or the new ones shall be supplied. The Contractor is responsible for connection of transformer and its protection and for preparing documentation. Control of high and very high temperature of transformer shall be provided. Temperature sensors shall be installed at the high voltage side. Temperature signals shall be connected to excitation equipment.

#### Excitation polarity switch shall be installed in the excitation panels. The switch shall be in off position, when all voltages are disconnected from rotor. There shall be an option with the help of switch to change the direction of current in the rotor circuits. The position of polarity switch shall be displayed in the unit control system.

#### All the necessary cables shall be included in the scope of supply. Cables or busbars in the generator cell shall be protected with screens. All the necessary changes to the existing screens shall be included in the scope of supply. The existing medium voltage cables may be used if their length is sufficient for the new equipment. The Contractor shall perform all tests required to be satisfied that the existing cables conform with the new equipment.

#### Excitation equipment shall meet all the requirements of technical specification and its annexes in regard to designing, calculations, documentation, electric and control equipment etc.

#### Wear of excitation brushes shall not exceed 2 mm in 1000 working hours.

### Replacement of metering current transformers and cables

#### The existing metering current transformers in the breaker housing behind the power breaker shall be replaced.

#### Current transformers shall be with voltage level corresponding to medium voltage and 0.2s precision class. Winding of current transformer that is used for metering shall be connected only to electricity meter.

#### Metering shall be designed and constructed in accordance with Annex 2 of the Grid Code and LEK 123 requirements.

#### Current transformers shall meet the requirements of the regulatory provisions. First verification of the current transformers shall be performed. During the adjustment all the required measurements of the current transformers shall be performed.

### Replacement of metering voltage transformers and cables

#### The existing metering voltage transformers in the breaker cell behind the power breaker shall be replaced.

#### Voltage transformers shall be with voltage level corresponding to medium voltage and 0.2s precision class. Winding of voltage transformer that is used for metering shall be connected only to electricity meter. Voltage measurement circuits shall be reconstructed to provide the required voltage measurement for all the consumers.

#### Metering shall be designed and constructed in accordance with Annex 2 of the Grid Code and LEK 123 requirements.

#### Voltage transformers shall meet the requirements of the regulatory provisions. First verification of the voltage transformers shall be performed. During the adjustment all the required measurements of the voltage transformers shall be performed.

### Electricity metering

#### Electricity metering shall be developed in accordance with the requirements of LEK 123 and the Grid Code.

#### New electricity meter shall be supplied that is compatible with the existing electricity metering system. Precise electricity meter shall be selected during the designing. The meter shall be equipped with the other communication port, and there shall be an option to read the data of meter and actual measurements in the unit control system.

#### Electricity meter shall measure voltage and current in all phases, shall meter active energy with 0.2s and reactive with 0.5 precision class.

#### Electricity meter shall have first verification conformity to the regulatory provisions done.

### Replacement of the unit auxiliary switchboard

#### The existing unit auxiliary switchboard shall be replaced, all users (equipment) shall be connected to the new switchboard.

#### The switchboard shall be equipped with automatic changeover equipment or automatic changeover algorithm shall be built in the controller of the unit. The presence of voltage in the switchboard, active inlet feeding the switchboard, damage of automatic changeover equipment shall be controlled. The switchboard shall be equipped metering equipment for measuring voltage, current, active power, consumed active energy, the measurements shall be connected to the unit control system. There shall be an option to state priority supply bushing.

#### Protective circuit breakers shall be used in the switchyard. Fuses shall be used only in the case when the protective circuit breakers cannot be used.

#### All protective devices shall be with sufficient breaking capacity and sufficient sensitivity.

#### All protective circuit breakers of auxiliary switchboard shall be equipped with interlock contacts. Information about the position of interlock contacts shall be available in the unit control system. Control system shall be capable of decoding which protective circuit breaker is open.

#### All required electrical measurement shall be performed.

### Generator circuit breaker

#### Control and signalling circuits of the generator circuit breaker shall be connected to the unit control system. All signals shall be displayed in the unit control system.

### Generator disconnector and earthing switches

#### Generator disconnector and earthing switches position and control circuits shall be connected to the unit control system. Interlocking shall be developed to avert incorrect switching on of the equipment. Position signals and control commands shall be displayed in the unit control system.

### Requirements for simulation model of power generation modules (PHA02, PHA08)

#### Simulation model shall be developed in PSS-E programme, version v.33 or higher;

#### Simulation model shall contain at least the following components that are implemented with PSS-E standard library models:

Turbine and Governor;

Excitation System;

Over-Excitation Limiter;

Under-Excitation Limiter;

Power System Stabilizer (PSS)

#### Simulation model shall be verified (its performance shall be compared to the test data of the power generation modules and a satisfactory congruence shall be presented). The congruence shall be approved by the Employer and TSO.

#### Description of the simulation model shall include turbine governor, excitation system, over-excitation and under-excitation limiter, PSS and protection affecting the range of frequency and voltage activity, block schemes and adjusted settings.

### Common requirements for the unit control system

#### The existing control system shall be replaced.

#### Functionality that was used in the existing control unit shall be implemented also in the new control system. The Contractor upon the Employer's approval can modify, delete or change the existing function in conformity of the new equipment of the unit.

#### All available signals shall be implemented in the unit control system to be able fully control the whole equipment of the unit.

#### All series of terminals for input/output equipment, protective circuit breakers and other number equipment shall be in full scope for connecting all equipment of the unit and after completion of work there shall be 20% left in storage for future changes.

#### In the switchgears at least 20% free space shall be provided for equipment that might be installed in the future.

#### In the switchgears at least 20% reserve shall be provided for cable entries and a place for the assembly of 20% new cables and wires in the ducts.

#### Communication channels with all equipment shall be redundant. Exact solution for communication channels shall be stated during the detailed designing.

#### The scope of supply shall include all unit control system software licences that are required during its lifetime. The scheduled lifetime of each licensed application shall be given in the offer. If updating or modification of supplied software requires special licences, they shall be included in the scope of supply.

#### If any software function is down due to any reason, the Contractor has a duty to eliminate the fault in the shortest possible time. The same refers to the licensed programmes developed by the subcontractor.

#### The unit control system shall be provided for operation both in "normal" mode and in emergency when many signals of events are generated like an avalanche. The control system shall be designed and implemented so that it is capable of operating in all possible conditions.

#### The unit controller and operator panel shall provide for the local control also after losing communication with the control system of the power plant. Such conditions shall be tested during the adjustment.

#### In automatic mode all working points and commands shall be passed through communication channels. Such functionality shall be provided if communication errors and faults do not cause emergency outage of the unit. If communications do not work, there shall be an option to change working points with commands "more/less".

#### Preparing and passing all signals that are required for external systems (e.g. power plant control system, TSO communication, reports etc.) shall be provided in the unit control system.

#### Unit control system shall perform control of all auxiliary systems of the unit.

#### There shall be an option to expand control system by connecting new equipment.

#### For all programmable equipment including communication equipment free resources shall be provided to make it possible expanding system in the future.

#### Maximum extent of expanding the system shall be provided in the design. The expanding extent shall be stated considering permissible software performance and reaction time, maximum number of outputs, number of sensors, connection of new equipment, new functions to the existing programmes, new programmes, options of changing the rights of users and groups etc.

#### For all programmable intelligent equipment processor loading, used memory amount, reaction time and loading of communication ports in "normal" operation mode shall be given.

#### Maximum loading of processor, used memory amount, reaction time and loading of communication ports in emergency operation mode shall be given. The mentioned conditions shall be simulated and capacity for work of the system shall be satisfied with to state the option for expanding in the future.

#### There shall be provided at least 20% free space, calculation capacity and reserve of output after the commissioning of the unit.

#### Synchronization of time for all equipment with built-in clock in the unit control system shall be provided. At least the clocks of controller,excitation and turbine governor, and protection relays shall be synchronized. Time source of the power plant control system shall be used.

#### In the new unit control system there shall be designed and constructed, and provided the following:

Compliance to IEC 61850 standards;

Connections with the existing facilities of the power plant for remote control of the unit from external systems;

Monitoring of processes and indication of equipment condition;

Automatic control of equipment;

Configuration online;

Monitoring and control of equipment, starting, shutdown sequence in local and remote mode;

Required interlocking of equipment, if necessary;

Communication with programmable equipment (IED) and equipment with communication options;

Communication with local operator panel;

Registration and saving of operation and fault data;

Communication by using open standard protocols.

#### After replacement of control system the unit shall ensure:

Frequency control (FCR, aFRR, mFRR services);

Voltage control;

Load-off without emergency shutdown of the unit;

Required control droop;

Reactive power control;

Initial excitation during the start;

Capability of magnetizing step-up transformer and 330kV busbars from the undervoltage;

Operate in isolated system with variable load when restoring power system after the failure.

### Requirements for the unit controller

#### Unit controller shall be immune to disturbances and shall operate in case of non-critical damage.

#### Operational system shall be embedded, and data shall be stored on non-rotating data carriers.

#### In case of loss and renewing of supply the controller shall start automatically and keep to the actual operation mode.

#### Controller shall be equipped with internal control function (watchdog).

#### It shall operate without fans.

#### Equipment performance shall be provided for industrial environment.

#### In order to improve availability and safety of controller it shall be with redundant process modules. Process module in operation shall be controlled, in case of fault there shall be automatic switching over to backup processor module. The switching over to backup processor module shall be instantaneous without leaps in the process control. The started processes shall be continued, in case of switching over the unit shall not be stopped by emergency shutdown. In case of processor module fault and in case of switching over there shall be a signal about it in the operator panel and in the control of the power plant.

#### It must be possible to disable one processor module for repair, inspection, or replacement without disrupting the operation of the other processor and the entire process.

#### For redundant systems, full documentation shall be provided. All necessary equipment, such as operator panels, control logic, and notifications, shall be adapted to the redundant system. All instructions as well as training shall include topics specific to systems with redundant processor units.

#### It shall be possible to make program changes (insert a new block) online, without restarting the controller, restarting is only allowed if the controller configuration changes.

#### It shall be possible to execute operations with a cycle time of 10 ms.

#### The unit controller must communicate directly with the unit's excitation and turbine regulators, protection relays, and other devices with communication capabilities.

#### The controller shall include analogue signal control for safe operation of the unit. The necessary warning and emergency signals shall be generated. If different settings are required for the implement in reserve and when it is operating, two groups of settings must be created.

#### The controller must provide the control of discrete signals, which ensures safe operation of the unit. The necessary readiness and alarm signals must be generated.

#### The controller shall include a calculation of the actual water flow through the unit, considering the actual net head, the opening of the control valve and the flow characteristic curve.

#### The contractor may present other technical solutions to replace the redundant controller of the processor module. The solution must provide at least an equivalent or higher level of availability than a controller with redundant processor modules. The expected higher level of availability should be compared to a controller solution with redundant processor modules.

#### Requirements for controller processors

#### Powerful processors of modern design must be used

#### Must have high resistance to damage (MTBF at least 100,000 h)

#### The processor unit shall be equipped with status indicator LEDs.

### Requirements for operator panel

#### The unit operator panel (HMI) must be at least 20" in size.

#### After the implementation of all functions, the operator panel must not have a delay, it must respond to pressure after at least 2 seconds.

#### All information from the unit controller must be available on the operator panel.

#### Control from the panel shall be in local control modes only.

#### The visual appearance of the panel screens shall be as similar as possible to the screens in the station management system. The entire interface operation and control principles should be as similar as possible.

#### The panel must be in energy-saving mode, which turns off the backlight after a while.

#### The event and damage timestamps must be the same as elsewhere in the system.

#### The clock on the operator panel must be synchronised with the time source of the station.

#### The operator panel must function even if there is no communication with the station control system and external equipment.

#### Requirements for new switchboards

#### New switchboards should be equipped with a "circle-with-fins" or "two-way key" profile key. It is also possible to use cabinet doors that open with a handle.

#### Each new switchboard must provide space for documents, diagrams.

### Switchboards higher than 1000 mm shall be provided with lighting and a connection socket for external equipment.

### Requirements for connection points

#### Separable or interruptible terminals shall be used for control and signalling circuits.

#### Special terminals shall be used for voltage circuits to allow easy and safe disconnection.

#### For power circuits, terminals shall be used that allow the current transformer circuits to be shortened and disconnected if necessary.

#### All terminals shall be equipped with test plug sockets, such as a 4 mm banana plug or similar.

### Each switchboard shall have voltage distribution terminals to which all supply voltages used in the switchboard are connected. Voltages in the switchboard should be supplied from these terminals.

#### Programming tools (software)

#### All necessary licensed software shall be supplied, to perform:

Testing and modifying the software of the supplied controllers in both online (on line) and offline (off line) modes.

Maintenance, testing, setting and configuration changes to the supplied protection relays.

Inspection, renewal and modification of the operator panels supplied (operator panel software projects).

Checking other equipment and changing settings.

### Controllers programming language

#### Controller software must be developed using high-level functional languages ​​defined in the IEC 61131 standard, such as Function block diagram, Lader, Structure Text. Sequential functional chart. The software must be designed to control the hydropower processes and be understandable to industry professionals. Each functional element must be represented as a single module with inputs and outputs.

#### There must be an available library of tested and documented functional objects that can be used to modify the software and create new functionality.

#### It should be possible to export the controller application in a graphical format, for example in PDF format.

#### The structure of the software design must reflect the functional structure of the hydropower unit. Each component of the structure must be placed in a separate software module. It shall be possible to assign priority and execution cycle time to each module.

#### The Employer must be able to modify the controller application and add new software modules. It must be possible to make software changes that do not change the structure of the project but suspend the controller program.

### Design requirements for all systems

#### The new unit control system shall be a decentralised system with locally installed programmable devices (IEDs) with input-output functionality and local command and control capabilities.

#### Optical cable links in a ring topology shall be used for equipment communication. Optical communication shall be designed to minimise the number of cables.

#### Equipment that performs measurements should be placed as close as possible to voltage transformers and current transformers to reduce the length of copper cables and the number of connections. Contractor solution shall support IEC 61850-9-2 standard communication.

#### All new computers shall be designed to operate in an industrial environment. All desktop computers shall be installed in a way that protects them from adverse environmental conditions.

#### The control and protection system must be designed to ensure maximum safety for the operating personnel and a comfortable working environment for them.

#### Standard components from industry-recognised manufacturers shall be used.

### Common management functions of the station

#### The new unit control system shall implement all the necessary functions required for the operation of the unit in the common (group) adjustment mode. The functions related to excitation and turbine governor be implemented in the new unit control system, excitation equipment and turbine governor. They must work in harmony.

#### All changes related to the replacement of the PHA02 and PHA08 unit control system shall be made to the common control functions in the existing station control system. The units shall operate according to the specified active and reactive power operating point of the station. Power distribution shall be ensured in accordance with the operating limits of the turbine and generator. The station management system shall provide all necessary signals for the operation of these functions. The maximum effective power curve should be predicted depending on the net drop. Reactive power limits shall be provided according to the PQ characteristic curve.

#### Other control functions

#### MVAr control of reactive power shall be provided, both at station and unit level.

#### The adjustment of cos φ shall be ensured at both station and unit level.

#### Active power regulation shall be provided at both station and unit level.

### The possibility of controlling the unit from a remote dispatch centre shall be ensured.

### Unit control functions

#### At least, the following functions for the control of the unit shall be implemented:

#### Automatic start and stop in both generator and compensator modes, switching to/from compensator, generator mode. The unit controller shall have a program for changing unit modes using sequences. All necessary actions shall be carried out automatically. The start-up time of the unit must be the same as the old control system.

#### In the event of a power outage, the unit must be not stopped using emergency shut down. If the network connection is lost, the unit must operate in idle mode, ready for resynchronization.

#### Local control and remote control. In normal mode, the units are controlled from the HPP station control system or the Daugava HPP TVS.

#### Voltage-free start-up and voltage supply to 330 kV busbars for grid restoration, stable operation with low power operating points.

### Requirements for connecting the unit to the Daugava HPP TVS

#### All signals available in the unit control system and the station control system shall also be implemented in the TVS of the Daugava HPP.

#### The visual appearance and operating logic of the equipment shall be the same as that of similar equipment in the system. Functionality shall be implemented to the same or greater range as other units.

#### The coding of equipment and signals shall be the same for both the station control system and the TVS of the Daugava HPP.

### Unit local control panels

#### New unit local controls shall be designed as similar as possible to existing unit control panels. It must be possible to operate the unit from local control if the remote control is not working. Local control functions shall operate independently of higher level programmable equipment (IED). Local control must operate even if the station control system is not operational or communication with it is not working.

#### For equipment that can be operated from local control, the control panels shall be equipped with control buttons or switches and local equipment status indication. Systems that must include local control panels include at least the turbine regulator, excitation system (ESI), braking system, etc.

#### From the local control panels of the unit, it must be possible to start the unit in all modes, synchronize, and stop the unit. The necessary subsystems of the unit must be operable in a safe manner. It shall be possible to set the operating points for the control device’s opening, speed, active power, and reactive power.

#### The unit control panels shall be able to control the unit in "Local Manual" mode independently of the unit controller. Operation in "Local Manual" mode shall be implemented with the minimum number of programmable devices. All control is carried out via local control buttons or switches. Critical buttons, such as the power switch and LDA activation, must be controlled using two buttons.

#### In the unit's control panels at 47 m, analogue instruments shall be provided for measuring voltage, current, active power, reactive power, speed, control device opening, excitation voltage, and excitation current. The active power meter shall also be able to display the maximum negative active power when the unit operates in water with the control device closed.

#### The unit's power converter shall have communication capabilities to read all necessary operational parameters of the unit. The converter shall have at least a 0.5s class for active power measurement.

#### A three-color signal tower – red, white, and blue – shall be installed on the unit's control panel. The red light should be activated when there is an emergency signal. The blue light should be activated when there is a fault signal, and the white light when the generator's power switch is turned on. The red and blue lights must remain on until the fault signal is confirmed with a button or remotely. The signal tower shall be equipped with a two-tone sound alarm – for emergency and fault signals.

### Unit control levels

#### The following unit control levels shall be implemented:

Control from the Daugava HPP TVS.

Control from the station control system DCS.

Control from the unit control panels in automatic mode.

Control from the equipment local control panels.

#### Control and protection functions shall operate in all control modes, such as for elevated temperature and pressure.

#### Emergency stop signals, emergency stop buttons, and other safety mechanisms shall operate independently of the unit's control level.

#### The display of measurements and status signals on the unit operator's panel and in the station control system shall operate independently of the control level.

#### Remote mode is the normal operating mode of the machine. Local and remote controllers control the unit. The control of the unit shall be carried out by the overall control of the station, by the remote control centre controller, or by the HPP controller. The unit mode switch shall de-energise the local control circuits.

#### In local auto mode, the unit is controlled from its controller, operator panel, and control panel buttons and switches. All remote control operations are blocked. The unit mode switch shall disconnect the voltage from the remote control and local manual control circuits.

#### In the local manual mode, the unit is controlled only from the local control. Automatic sequences do not operate. Remote control commands are locked. The unit mode switch must disconnect the voltage from the remote control and local automatic mode control circuits.

#### In the off mode, the unit is not intended to operate. The controllers are active, but all control signals are locked. The unit mode switch must disconnect the voltage from all control circuits. This mode is intended for unit maintenance and testing.

### Equipment mode switch

#### The unit equipment control mode must be switched with a switch on each equipment control panel. The switch position shall be indicated on the local operator panel and the station control system. Switching the switch must generate an event in the unit control system.

#### The unit mode switch shall have four positions:

Remote

Local auto

Local Manual

Disabled/Off

#### The switching between control modes must be done without mode changes and variations in operating points. When switching from manual mode to automatic, regulation must continue with the previously set operating point. When switching from automatic mode to local, the starting and stopping sequences must be interrupted. In automatic mode, switching to a different operating point should only occur after receiving new operating points.

### Unit synchronization equipment

#### The unit control system shall be equipped with the capability for automatic and manual synchronization with the power system. Automatic synchronization must be used in all modes, except for the local manual mode. Manual synchronization can only be performed in the local manual control mode. The synchronization process shall be monitored with a synchronism control relay. In the event of a failed synchronization, if the auto-synchronizer is locked, there must be an option to unlock it from the unit control system. There must be a signal in the unit control system regarding the locking/unlocking of the auto-synchronizer.

#### For manual synchronization, the unit control panel must be equipped with all necessary measuring instruments and control tools. At least a synchroscope with a synchronism control relay must be installed.

#### It shall be possible to restore the power system and close the circuit breaker before excitation is applied. A secure lockout shall be implemented to prevent the closing of the power switch if there is voltage from the transformer side. All voltage change protection switches must also be monitored to prevent erroneous lockout operation.

### Requirements for unit protection

#### The unit protection shall protect the entire hydropower unit, its auxiliary systems, such as the turbine, generator including excitation and its transformer, AC and DC power supply from unacceptable modes that occur in the event of internal or external damage. The protection shall be created using modern digital protection relays from well-known manufacturers. The Contractor shall ensure that the selected equipment is suitable for the protected unit in all aspects and for the entire Plavinu HPP. The protection systems must be designed for continuous and safe operation of the plant and the unit in the event of AC self-consumption damage.

#### The protection relays shall ensure the storage of event and fault records without the need for additional batteries. It must be possible to download event and fault records.

#### The protection relays must communicate using the IEC 61850-8-1 protocol and an optical communication network. If possible, the IEC 61850-9-2 standard must also be supported.

#### The unit protections must be divided into primary and backup protections to ensure redundancy of protection functions. The primary and backup protections should have as few common components as possible. The primary and backup protections must be capable of detecting and disconnecting all primary equipment faults, and as much as possible, different fault detection methods should be used.

#### The primary and backup protections (equipment and cables) shall be separated to prevent damage to both systems, for example, in the event of a fire. The cables for primary and backup protections must use separate cable routes.

#### The protection device must be powered by 220V DC.

#### The protection relay schemes must use modern digital protection relays and IEC 61850 communication functions.

#### All existing relaying functions shall be retained and may be supplemented or replaced by other functions agreed in writing with the Employer.

#### The Contractor shall develop a protection setting map according to the Employer's format. The map shall include the protection settings and a table with the relay settings, designations, and values.

#### The contractor must select the protection schemes and protection relays in such a way as to ensure the complete operation of the unit and auxiliary equipment.

#### At least the protection functions specified in the LEK 035 standard for a synchronous generator shall be provided. Other requirements of the standard shall also be considered.

#### The unit must be equipped with duplicated electrical overspeed protection.

#### The scope of delivery shall include hydromechanical protection and output (Trip) relays. All necessary mechanical protections must be installed.

#### The scope of delivery of protective equipment must include all necessary communication equipment.

#### Event data from the protection relays shall be connected to the unit control system and displayed on the operator panel and the station control system.

#### The protection relay clocks shall be synchronized with the station clock time source.

#### The generator has a high impedance differential. When changing the generator's differential protection type, the contractor must take all necessary measures to prevent the unit from disconnecting during transformer switching or other transient processes.

#### Protection acceptance testing shall be carried out in accordance with LVS 1082-6:2024 and other related standards. After the test, the Contractor shall submit and have the test protocol agreed upon in writing.

#### Upon completion of the work, the Contractor must submit to the Employer all current electronic relay designs and the necessary software with licenses, etc.

#### The protection relays must be equipped with test sockets and plugs to allow for secondary injection testing of the protection without disconnecting the circuits. All measures must be taken to ensure that no unnecessary commands are generated to external systems during testing. The documentation must describe the preparation work and the testing procedure.

### Emergency stop buttons

#### An independent emergency stop function shall be implemented. It should be used in cases of serious threats, such as in the event of a fire. The emergency stop is activated by the emergency stop buttons. The status of the emergency stop buttons must be monitored in the unit control system. Emergency stop buttons must be installed in appropriate locations within the unit area. The emergency stop buttons must be of standard emergency button design, ensuring protection against accidental pressing. Additionally, signs must be installed with an explanation of the button’s function.

#### The emergency stop buttons shall directly activate the shutdown devices.

#### The emergency stop buttons shall remain in the pressed state until they are returned to their initial position. After the emergency stop button is released, the equipment must remain in the shutdown state until a start command is received.

#### In emergency stop mode, the actuator must be closed with an emergency shut-off valve.

### Station control system

#### The new unit control systems must be integrated into the existing station control system. Necessary changes must be made to signal configurations, screens, etc.

### Open functions, program code, and settings

#### All automation functions must be documented in such a way that the Employer’s personnel, by reading the documentation, can understand every aspect of the system and equipment’s operation. The Contractor must submit all necessary documentation to enable the Employer to perform equipment modifications, system updates, and function upgrades in the future.

#### The entire controller program code must be well-documented and available to the Employer. The documentation and training must explain the logic of the main functions, locking mechanisms, etc., at a level that enables the Employer to perform maintenance and troubleshooting tasks.

#### The Employer must have the ability to change all configurable parameters in the control system software and hardware, including controllers, servers, firewalls, operator panel screens, texts, etc. To perform these actions, special users with the necessary permissions must be provided in the systems.

#### The Contractor's delivery scope must include all necessary equipment to amend the controller programs and configurations, as well as other equipment that is part of the unit control system. The equipment may include software (compiled, source code), licenses, license keys (hardkey), instructions, cables. Table 1 lists the types of documentation required for various components. The Contractor, based on this table and functional requirements, must supply all necessary documentation for each system and component.

Table 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Documentation Type  Component Type | Source code of the program | Compiled program | General function logic | Overall process flow diagrams |
| Unit controller | X | X | X | X |
| Process controllers (e.g., excitation) | X | X | X | X |
| Sub-process controllers, e.g., PID controller | X | X | X | X |
| Physical locking |  |  | X | X |
| Software locking | X | X | X | X |

### Control and protection system interfaces.

#### The Contractor must define the interfaces between the unit control system, protection communication links with other unit systems and equipment. The scope of work must also include the design, supply, and installation of necessary existing cables and their cable trays, if cable relocation is required to carry out the work in accordance with the technical specification requirements.

#### The following interface points with other systems, which need to be adjusted as necessary but are otherwise not included in the scope of work:

Links with DC and AC self-consumption

Links to specific medium voltage equipment

Links to the station control system. The unit control system must be connected to the existing station control system.

### Requirements set by the transmission system operator:

#### Ensure that the power generation modules are capable of operating without time limitations in the frequency range from 49.0 Hz to 51.0 Hz. For the newly installed equipment (including the turbine speed governor, excitation regulator, and protection relays), comply with the requirements specified in Article 13(1)(a) of Regulation 2016/631.

The equipment supplied and constructed by the Contractor shall be such, that the unit is able to remain connected to the network and operate within the frequency ranges and periods specified in Table 2.

Table 2

The minimum period within which the power generation module must be able to operate at different frequencies deviating from the nominal value without disconnecting from the grid:

|  |  |
| --- | --- |
| 47,5–48,5 Hz | 30 minutes |
| 48,5–49,0 Hz | 30 minutes |
| 49,0–51,0 Hz | Unlimited |
| 51,0–51,5 Hz | 30 minutes |

#### For the limited frequency sensitivity mode at increased frequency, as specified in Article 13(2)(a), (e), and (g) of Regulation 2016/631;

Requirements for the unit in LFSM-O mode:

The power generation module must be able to activate frequency-dependent active power response in accordance with Figure 1 at the frequency threshold value and the static settings specified by the TSO;

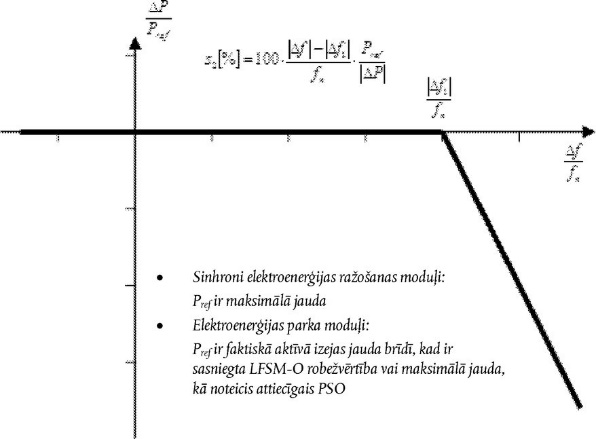


Figure 1

The power generation module must be able to activate the power-frequency response with an initial delay as short as possible. If the delay exceeds two seconds, the delay must be justified by submitting technical evidence;

In the LFSM-O mode, the power generation module must operate stably. When the LFSM-O mode is activated, the LFSM-O setting dominate over other active power settings.

#### On the controllability of active power, as defined in Article 15(2)(b) of Regulation 2016/631;

The generator must comply with the requirements regarding frequency stability, even when automatic remote control systems are not operational. In such cases, manual and local actions are allowed.

#### On the limited frequency sensitivity mode for reduced frequency, as specified in Regulation 2016/631, Article 15, paragraph 2, subparagraph (c);

The following requirements apply to the unit, which apply to LFSM U mode:

The unit can activate a frequency-dependent active power response at a frequency limit and with droop settings (Figure 2):

* The frequency threshold value is in the range from 49.8 to 49.5 Hz (inclusive).
* The static settings range from 2% to 20%.

The actual implementation of frequency-dependent active power response in LFSM U mode considers:

* The surrounding environmental conditions at the moment when the response is triggered,
* The operating mode of the unit, specifically the limitations regarding operation close to maximum power at low frequencies and the impact of the surrounding environmental conditions, in accordance with Articles 13(4) and 13(5) of Regulation 2016/631,
* availability of primary energy sources.

the activation of the frequency-dependent active power response of the power generation module must not be unreasonably delayed;

In LFSM-U mode, the electricity generation module must be capable of providing power up to its maximum capacity;

In LFSM-U mode, the electricity generation module must ensure stable operation.

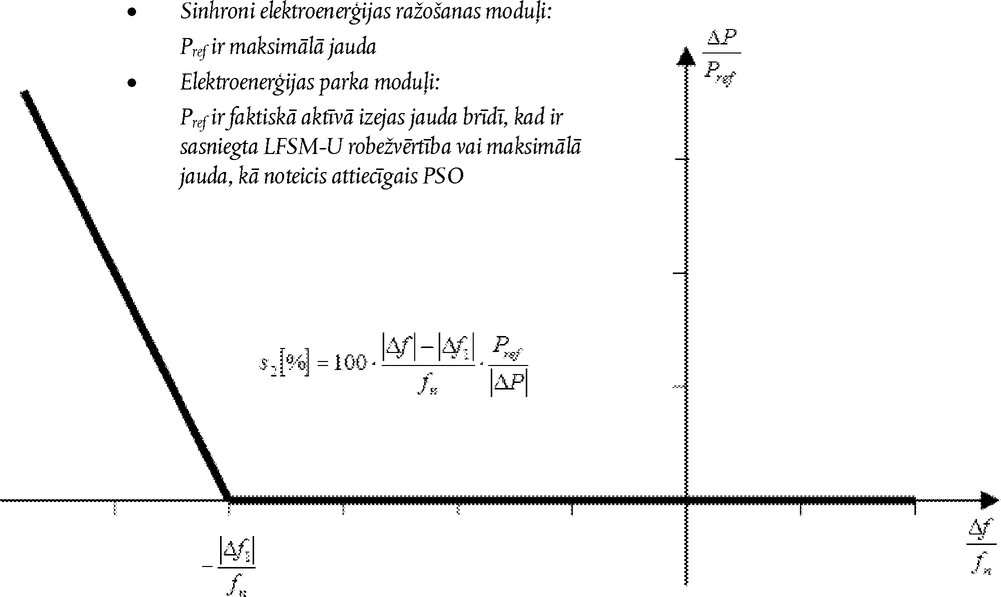


Figure 2

#### Regarding the frequency sensitivity mode, as specified in Regulation 2016/631, Article 15, paragraph 2, point d).

The unit in FSM mode shall cumulatively meet the following requirements:

The unit must be capable of providing frequency-determined active power response according to the given parameters, in line with the ranges specified in Table 3.

* If the frequency is increased, the frequency-dependent active power response is limited to the minimum regulation level.
* If the frequency is reduced, the frequency-dependent active power response is limited to maximum power.
* The actual implementation of frequency-dependent active power response depends on the operation of the power-generating module and the ambient conditions at the time of invoking the response, namely the limitations regarding operation close to maximum power at low frequencies.

Table 3

Parameters for the frequency characteristic curve of active power in FSM mode (explanation in Figure 3)

|  |  |  |
| --- | --- | --- |
| Parameter | | Range |
| Active power range in relation to maximum power Formula | | 1,5–10 % |
| Frequency-dependent reaction's dead zone | Formula | 10–30 mHz |
| Formula | 0,02–0,06 % |
| Frequency-dependent reaction's non-operation zone | | 0–500 mHz |
| Static condition s 1 | | 2–12 % |

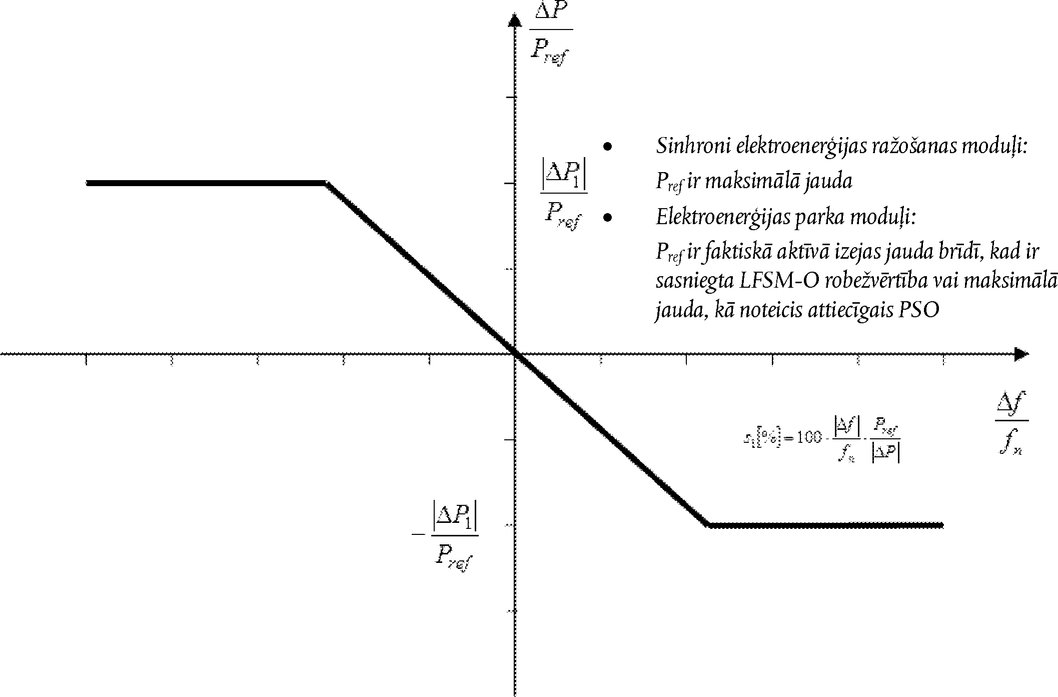


Figure 3: The frequency-dependent active power response capability of the unit in FSM mode, where the non-operation zone and dead zone are zero (Pref is the reference active power related to ΔP. ΔP is the change in the active output power of the electricity generation module. fn is the nominal grid frequency (50 Hz), and Δf is the frequency deviation in the grid.)

It should be possible to reset the frequency deviation of the frequency-dependent reaction's non-operation zone and stasis repeatedly.

In the case of frequency step changes, the power generation module is capable of fully activating the frequency-dependent active power response according to the bolded line in Figure 4 or within the ranges specified in Table 4.

the required initial activation of the frequency-dependent active power response must not be unreasonably delayed. If the initial activation of the frequency-dependent active power response is delayed by more than two seconds, technical evidence must be provided to justify why a longer time is required.

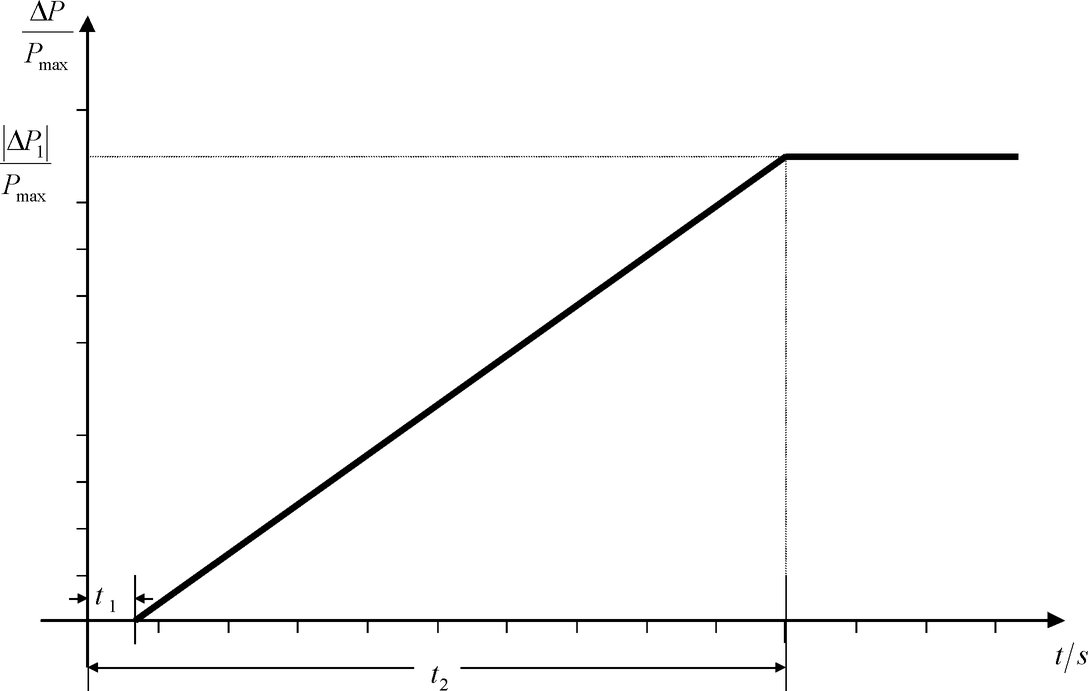


Figure 4 Frequency-dependent active power response capability (Pmax is the maximum power to which ΔΡ is related.) ΔΡ is the change in the active output power of the generator. The unit must provide active output power ΔΡ up to the value of ΔΡ 1 according to the times t 1 and t 2; the values ​​of ΔΡ 1, t 1 and t 2 are given in Table 4.4. t1 is the initial delay time. t2 is the time for full activation)

The power generation module can provide a full frequency-dependent active power response for 15–30 minutes.

Table 4

Parameters for full activation of frequency-dependent active power response after frequency step changes (explanation Figure 4)

|  |  |
| --- | --- |
| Parameters | Range or value |
| Active power range in relation to maximum power (frequency-dependent response range)Formula | 1,5–10 % |
| Maximum permissible initial delay t 1 for power-generating modules with inertia, unless another time is justified in accordance with point (iv) of Article 15(2)(d) | 2 seconds |
| Maximum permissible selectable full activation time t 2, unless the relevant TSO has allowed a longer activation time for the sake of system stability | 30 seconds |

#### On frequency restoration control as defined in Article 15(2)(e) of Regulation 2016/631;

Regarding frequency restoration control, the unit has functions that comply with the specifications provided by the relevant TSO, aimed at restoring the frequency to match the nominal value, or maintaining the power exchange flows between control areas to ensure they are equal to the planned values;

The unit replacement equipment must be capable of executing TSO aFRR and mFRR commands.

#### On simulation models as defined in Article 15(6)(c)(i) of Regulation 2016/631;

The simulation models accurately reflect the operation of the power generation module in steady-state and dynamic mode simulations (50 Hz component) or electromagnetic transient simulations. The simulation model is verified and complies with Section 4.6.33.

#### For the submission of power-generating module performance data as required by Article 15(6)(c)(iv) of Regulation 2016/631;

Submission of registered unit module performance data to the TSO.

#### On the installation and settings of synchronization devices, as specified in Article 16(4)(b), (4)(c) and (4)(d) of Regulation 2016/631;

The unit must comply with the following general system management requirements:

* It is equipped with the necessary synchronization devices;
* Synchronization of the unit is possible within the ranges specified in Table 2.
* The settings of the synchronization devices, and an agreement must be concluded before the start of the operation of the power generation module. The mentioned agreement covers the following indicators:
* voltage;
* frequency;
* Phase angle range;
* phase sequence;
* Voltage and frequency deviations.

#### On fault tolerance as defined in Article 16(3) of Regulation 2016/631;

The unit installation must meet the following requirements regarding robustness (damage resistance):

* The power generation modules must remain connected to the grid and continue stable operation after the power system operation has been disturbed by identified faults. This capability must comply with the voltage-time profile at the connection point concerning the fault conditions as specified in Table 5.
* The voltage-time profile represents the lower boundary of the interphase voltage actual recovery curve at the grid voltage level at the connection point in the case of a symmetrical fault, as a function of time, namely before, during, and after the fault.

Table 5

Parameters of fault ride-through capability for synchronous generators

|  |  |  |  |
| --- | --- | --- | --- |
| Voltage parameters (p. u.) | | Time parameters (in seconds) | |
| Uret: | 0 | tclear: | 0,14–0,15 (or 0.14–0.25, if necessary for the protection and safe operation of the system.) |
| Uclear: | 0,25 | trec1: | tclear–0,45 |
| Urec1: | 0,5–0,7 | trec2: | trec1–0,7 |
| Urec2: | 0,85–0,9 | trec3: | trec2–1,5 |

#### Regarding voltage stability, as specified in Article 19, Paragraph 2 of Regulation 2016/631;

The unit must comply with the following requirements related to voltage stability:

The settings of the excitation regulator must be coordinated with the Employer and the TSO.

The settings must cover the AVR specifications and performance regarding steady-state voltage and transient voltage control, as well as the excitation control system specifications and performance. The excitation control system specifications and performance include:

* Output signal bandwidth limitations, ensuring that the highest frequency of response cannot induce oscillations in other power generation modules connected to the grid;
* Under excitation limiters, which prevent the AVR from reducing the excitation of the AC generator to a level that could jeopardize synchronization stability;
* Over excitation limiters, which ensure that the excitation of the AC generator is not lower than the maximum value that can be achieved, while also ensuring that the synchronous power generation module operates within the specified limits of the design;
* Stator current limiter;
* PSS functions that reduce power fluctuations.

### All equipment must be labelled according to the project after installation. Each installed piece of equipment, device, and additional unit of equipment must be labelled in accordance with the VGB RDS-PP system requirements and the Employer's instructions. In the control system and equipment, where applicable, signals must be encoded according to the RDS-PP standard. Equipment and signal codes must be coordinated with the Employer.

### All systems and equipment must be clearly identifiable using the RDS-PP designation, which must be used for labeling the equipment, documentation, drawings, displays, etc. To facilitate operation, the Employer may assign additional simplified designations to the equipment and systems.

### The Contractor must submit a list of RDS-PP codes and their corresponding descriptions (explanations) for clarification, supplementation, and approval by the Employer during the initial design phase. Only after the Employer's approval can these RDS-PP codes be used in the technical documentation, including drawings, equipment labelling, and other related documents.

### All RDS-PP designations and their explanations must be consistent throughout the project documentation to ensure clarity and unambiguous identification. The Contractor is obligated to ensure that any changes or additional codes made in equipment labeling, documentation, drawings, etc., are promptly updated and resubmitted for approval by the Employer.

### Control buttons, switches, control keys, signal lamps, etc., must have clearly understandable labels indicating their functional meaning and designations according to the diagram. Switching devices (automatic circuit breakers, fuses, toggle switches, etc.) must have labels indicating which equipment they disconnect. All distribution cabinets and panels, as well as control, signaling, protection, automation, and terminal strip cabinets, must have a name and designation according to the diagram. If the equipment is also serviced from the rear, the same designations must be present at the rear. The labels must be in Latvian.

### The cable trays must be installed in accordance with the LEK049 'Main Technical Requirements for Cable Power Lines with Voltages up to 20 kV'.

### All metal structures must be grounded in accordance with LEK 048 'Earthing of Electrical Installations and Electrical Safety Measures. Main Technical Requirements.

### All electrical equipment with metal enclosures, as well as protective conduits for wires and cables, must be properly grounded with a dedicated grounding conductor, the minimum cross-sectional area of which is no less than 10 mm². It must be securely fastened and protected against mechanical damage.

### The cross-sectional area of the cables to be used must be selected based on the permissible current calculations.

### After cable installation, fire-resistant materials must be used for sealing holes in walls and ceilings, in accordance with the requirements of LEK049 and LBN 201-15 ''Fire Safety of Buildings''.

### TSO shall ensure at least the following signals. The exact scope of these signals must be determined during the design phase:

#### TSO SCADA system must obtain the following measurements

Total active power on the average voltage side (MW)

Total reactive power on the average voltage side (MVAr)

Frequency (Hz)

Current value of the active power setpoint (MW)

Maximum available active power (MW)I

Minimum available active power (MW)

Current value of the voltage setpoint (kV)

Current value of the reactive power setpoint (MVAr)

Regulation speed for increasing power (MW/min)

Regulation speed for decreasing power (MW/min)

LFSM-O droop (%)

LFSM-U droop (%)

FSM droop (%)

FSM dead zone (Hz)

Minimum reactive power limit (MVAr)

Maximum reactive power limit (MVAr)

Available aFRR power for upward regulation (MW)

Available aFRR power for downward regulation (MW)

Activated aFRR power for upward regulation (MW)

Activated aFRR power for downward regulation (MW)

#### TSO SCADA system must obtain the following signals:

FSM status (on/off)

Frequency restoration control status (on/off)

Active power control status (on/off)

Reactive power control status (on/off)

Voltage regulation control status (on/off)

#### TSO SCADA system must have the ability to execute the control of the following objects (all control commands must normally be locked, with the possibility to allow each command separately from the station control or Daugava HPP SCADA):

Active power control from TSO (on/off)

Reactive power control from TSO (on/off)

Voltage regulation control from TSO (on/off)

FSM mode (on/off)

FSM mode droop setting (%)

Frequency restoration control activation command (on/off)

Active power setpoint (MW)

Reactive power setpoint (MVAr)

Voltage setpoint (kV)

aFRR activation volume for upward direction (MW)

aFRR activation volume for downward direction (MW)

## Personnel training

The Contractor shall organize training for the Employer’s personnel, which must be conducted prior to the commencement of the overall testing of the hydro unit. The training shall cover all supply elements related to the requirements specified in these technical specifications.

The Contractor cannot impose requirements regarding the qualifications of the Employer's personnel.

### Training of dispatcher service personnel

Dispatch service employees must be trained to use the new equipment at the operator level, introducing the operating features of the new equipment. Training must be carried out in 2 groups, a total of 16 people. The Contractor provides training and training materials in Latvian and/or English.

#### Content of the dispatcher personnel training program:

##### Unit control system;

##### Turbine governor;

##### Excitation equipment;

##### Turbines and all mechanical parts, taking into account the extent of the changes made by the Contractor;

##### Generator and all electrical parts, taking into account the extent of changes made by the Contractor.

#### Topics include:

##### Main components of the equipment, its structure and operating principle;

##### Auxiliary devices and their operating principle;

##### Main equipment parameters;

##### Monitored parameters – sensors, measuring instruments, their operation, signals, and emergency settings;

##### Operational disturbances and actions in case of disturbances and emergencies;

##### Operating modes;

##### Starting and stopping of the hydro unit, including from local control panel;

##### Switching off the hydro unit for repair;

##### Switching on the hydro unit in reserve;

##### Handling control and management panels;

##### And other topics to ensure the service, maintenance, and operational work of the hydro unit.

#### Upon completion of training, a certificate of completed training must be issued.

### RID and RAAD staff training

RID and RAAD staff must be trained at an advanced level. The contractor shall provide training and training materials in Latvian or English.

The training shall include information about the unit's control equipment, the unit controller, the excitation system, the internal structure of the turbine governor, configuration, parameter changes, fault finding, and replacement of spare parts.

#### Content of the training course for the Employer's personnel (4 people responsible for equipment monitoring, maintenance, regulation, and repairs):

##### Information about the control equipment of the unit and specific information about the equipment used;

##### Training on the unit controller and its components, component replacement;

##### Training on the unit controller program – structure, changes, troubleshooting, backup creation, configuration changes;

##### Training on the implement operator panel;

##### Training on protection relays and equipment protection, protection used, testing methodology, changing relay settings, recording analysis;

##### Training on the excitation equipment and its components, operating algorithms, maintenance work and volumes, fault finding and elimination, component replacement

##### Training on the excitation regulator and operator panel – block diagram, operating algorithms, possible faults, parameter changes, checks, communication;

##### Training on the turbine controller and operator panel – block diagram, operating algorithms, possible failures, parameter changes, inspections, communication;

##### Scope f periodic maintenance, repair, regulation, and inspection work:

#### After the training, a document (certificate, diploma, or similar document) must be issued confirming the completion of the training, which allows for the operation and maintenance of the installed equipment as specified in the maintenance instructions.

### Training abroad

The Contractor must inform the Employer at least 2 weeks in advance about the exact time and location of the training. The Employer will cover the travel and accommodation expenses of their staff. If there are any changes to the schedule or location, the Contractor will compensate the Employer for any additional expenses incurred due to the rescheduling or cancellation of the planned business trip.

# Quality control

### The Contractor ensures and independently carries out quality control of the work to be performed.

### Quality control is carried out in the following areas:

#### precise compliance with work performance technologies in general and separately for each type of work;

#### compliance of the mechanical properties and strength parameters of the materials used with those specified by the manufacturer;

#### compliance of the technical characteristics of the mechanisms and equipment used with those specified by the manufacturer;

#### during the work, the Contractor specifies the actual scope of work;

#### during the work, the Contractor shall fill out a construction work log;

#### when handing over the works, the Contractor shall prepare the assembly acts of the covered works or structures, the execution diagrams of the performed works and attach documents certifying the conformity of the materials used.

### The scope of work to be performed in parallel and the quality of its execution shall be assessed by the responsible technical supervisor of the Employer or the Employer's representative, along with any specialists invited by them.

### For on-site supervision of the work, including quality control, the Employer will appoint a sufficient number of technically qualified supervisors, and the Contractor will be informed about this.

### The responsibilities of the technical supervisors include:

#### participate in the inspections and tests of existing and supplied equipment, review and approve all report documents and inspection protocols;

#### visit the work sites during installation, monitor the scope and quality of work performed by the Contractor and their subcontractors;

#### participate in the acceptance of covered works and individual assemblies, prepare a conclusion on quality compliance, etc.;

### For each completed (performed) repair work, before starting the next work stage, the Contractor shall present it to the Employer's representative. The Contractor shall coordinate all work stages with the Employer's representative.

### The Employer's technical supervisor must be invited to the acceptance of covered works, who, by signing the covered work acceptance report, certifies the scope and quality of the work performed in accordance with the project.

### Measurements shall be carried out by qualified or certified personnel of the Contractor, using certified measuring instruments, as required by regulatory documents.

### On-site inspections at the facility must be carried out in the presence of the Employer's technical supervisor, who will sign (approve) the inspection protocols.

### The Contractor shall carry out equipment/mechanism inspections in accordance with applicable regulatory documents and the manufacturer's instructions.

### The Work Performance Programme (WPP) shall include a description of the necessary quality control and quality assurance measures, ensuring that the Employer's representatives can sequentially and as objectively as possible evaluate the quality of each work stage. The quality control of works includes: the initial control of the work execution documentation, delivered products, and materials; technological control of individual work operations or processes; and the final control of the completed (handover) work type (structural element).

# Energy efficiency assessment, requirements, and calculation

Not applicable

# Technical documentation (composition and requirements for preparation and submission)

Technical documentation refers to all types of documents, both paper and electronic, developed by the Contractor and submitted to the Employer, related to the execution of contract works, including: the Project, the work execution plan, as-built documentation, reports, drawings, etc.

## Requirements for preparation

### The documentation submitted by the Contractor must be in Latvian. If the documentation is in English, a translation into Latvian must be provided. Documents from equipment or software manufacturers that are in English and are not required for operational personnel may be submitted in English.

### The Contractor must submit the documentation in 2 (two) copies, one of which must be submitted in paper form, and the other in electronic form.

### The documentation must be prepared in accordance with the applicable laws and regulations of the Republic of Latvia, as well as in accordance with the Employer's requirements regarding the preparation of documents to be transferred to technical archives (Procedure K162 " Procedure for the formatting, submission and use of technical documentation in the technical archive archive of HPP Technical management ").

### All graphical materials (drawings, diagrams, plans) shall be submitted, in addition to the .pdf format, in their original developed format (.dwg or \*.vsd format), unless it has been otherwise agreed between the Employer and the Contractor.

## As-built documentation shall contain the following:

### Equipment measurement and testing protocols/reports at the factory;

### Assembly and covered works deeds;

### Measurement and inspection protocols;

### Equipment calibration protocols or deeds;

### Inspection programs;

### As-built diagrams and drawings;

### Cable log;

### Spare parts list;

### Personnel training protocols;

### Declarations of materials and equipment operating properties in accordance with LVS EN ISO/IEC requirements and other quality certification documents;

### Documents certifying the quality of equipment (certificates, declarations of conformity);

### Deed on the transfer of dismantled equipment and scrap metal to the Employer;

### Documents about hazardous waste management

### Operating and maintenance instructions for the systems installed by the Contractor and the equipment supplied.

### Technological cards for maintenance and repair works specified in the equipment operating and maintenance manuals.

## Operating and maintenance manuals

### All equipment that was designed and installed must have the following information in the operating instructions:

#### A brief description of the device/equipment.

#### The permissible operating modes of the equipment, safety performance criteria, and limits;

#### The procedure for preparing and performing a change in the equipment’s operating modes under normal and unforeseen (emergency) conditions;

#### The procedure to be followed by personnel when carrying out equipment inspections, tests, repairs, and other operational tasks;

#### Occupational safety and health, explosion protection, and fire safety requirements specific to the particular equipment.;

#### Emergency measures to be taken to address disruptions and damages in the relevant equipment, including the procedure for their elimination;

#### The scope of technical maintenance and repair works or the principles for determining the scope of repairs.

#### Safety and health protection measures required when performing work on all equipment that was designed.

#### Operating, maintenance, and troubleshooting procedures, including:

Operational maintenance instructions (equipment description, operating principles, control and operating modes, and tools).

Maintenance instructions (periodic tasks, scope, and execution technology)

Repair instructions (disassembly and assembly instructions for components)

#### Description of the functions of all systems.

#### For local control of each unit and overall control of the unit in Local Manual mode.

#### Manufacturer’s manuals for equipment with technical data and maintenance instructions. Equipment declarations of conformity.

#### List of equipment.

#### Settings list (electrical, mechanical parameters). All adjusted settings must be included in the settings list.

#### General diagrams, single-line diagrams, block diagrams, start-stop sequence diagrams.

#### Principal diagrams.

#### Cable list and cable conductor connection diagrams. Cable connection diagrams.

#### Internal connection diagrams and tables of the switchgears.

#### List of inscriptions and symbols with parameters (size, font size, colour, etc.).

#### Grounding connection diagrams.

#### Drawings of assembly units and their parts, layout plans, cross-sectional drawings, equipment list with specifications.

#### Component drawings and specifications required for operation.

#### Adjustment and inspection protocols.

#### Copies of all software projects.

#### Excitation and turbine equipment calculation models.

#### Drawings of equipment manufactured specifically for the given project.

#### Inspection protocols during adjustment and inspections.

#### Other instructions and descriptions.

## Technological cards

### The technological card must contain information about the conditions for performing the work, the scope of technical maintenance and repair works, safety requirements, personal protective equipment, environmental and workplace protection, the measuring instruments used, materials, spare parts, work tools, instruments, and auxiliary devices for performing repairs, as well as the sequence of work execution.

### The Contractor shall provide a list of components that require periodic maintenance, repairs or other maintenance measures, indicating the frequency of these measures. This schedule shall also include estimates of the working hours and costs of the components. The Contractor shall also identify maintenance or other maintenance measures that may require the shutdown of the plant/equipment and shall determine and indicate the duration of the shutdown required.

### The contractor must provide a detailed description of the maintenance, repair, or other maintenance procedures for each system component, which must be included in a specific Maintenance Manual. This document must include:

#### Clear identification of each component or subsystem that requires maintenance, repair, or other maintenance actions.

#### For each maintenance, repair, or other maintenance task, the estimated execution duration (number of person-hours) must be specified.

#### detailed step-by-step description of the work to be performed must be provided for each maintenance, repair, or other maintenance task. This should include pre-inspection, execution steps, and post-inspection.

#### Specific safety requirements that must be followed during the work, including requirements for the use of personal and collective protective equipment (PPE), lockout (LOTO) procedures, and the necessary shutdown of electrical or mechanical systems.

#### A detailed list of special tools, measuring instruments, or equipment required for each task. It should also include calibration instruments necessary for testing.

#### Procedures for testing, calibrating, or adjusting components after task completion to ensure continued efficient operation and safety.

#### Clear indication of potential hazards (e.g. electrical, chemical, thermal) that may arise during the performance of tasks and specific measures to prevent them.

## Maintenance manual

### The maintenance manual must be written in a clear and understandable manner to ensure comprehension by maintenance personnel with varying levels of knowledge.

### Available in both digital and printed formats.

### Include high-quality diagrams, illustrations, and photographs to assist in component identification and understanding of tasks, where appropriate.

### Structured in such a way that it can be easily updated with any changes or amendments, ensuring its relevance throughout the life of the system.

### Each maintenance procedure should be linked to the overall maintenance schedule in the general service plan to ensure that the personnel can associate specific tasks with the recommended maintenance intervals.

### The maintenance manual should include or refer to all applicable manufacturer instructions and recommendations regarding the tasks.

# Acceptance of the works

Inspections are conducted to ensure the proper and safe operation of equipment/systems, quality, and compliance with the requirements specified in this Technical Specification, applicable regulatory documents, as well as to verify compliance with the developed project.

## FAT - Factory Acceptance Tests

### All equipment components for the excitation system, turbine governor, and unit control system, as well as the system as a whole, must be tested at the factory, as much as practically possible. Using simulation, the quality and proper operation of the equipment/system must be verified to ensure compliance with technical requirements. Identified defects and non-conformities must be corrected, and the tests must be repeated.

### The Employer reserves the right to visit the factory at their own expense to familiarize themselves with the equipment manufacturing procedures and quality, as well as to participate in the factory tests. The Contractor shall ensure the client's personnel access and safety during the factory visit.

## Measurements and inspections during equipment assembly

### Before adjustments and tests of the equipment, the Contractor must perform the necessary measurements and checks during the assembly of the equipment. The scope of measurements and checks is determined by the applicable regulatory documents and the requirements/norms of the manufacturer. They must include, but are not limited to:

Wire and cable insulation tests;

Testing of grounding connection transition resistance, etc.

Phase zero- loop measurements for circuit breakers and fuses.

## SAT – Site Acceptance Tests

### The Contractor prepares and submits a detailed test program for the installed equipment/system to the Employer for approval in a timely manner. The Employer must approve the program no later than 2 weeks before the start of the tests. The Employer will review the initially submitted test program and provide comments within 5 working days. A resubmitted program will be reviewed by the Employer within 3 working days. The scope of the tests to be performed during the installation and adjustment of the equipment is determined by the Contractor's standards and regulations.

### The Contractor is responsible for the execution of the test program. After each test is completed, a record is made in the test program. The tests must be conducted in the presence of the Employer's personnel.

### The inspection program must list the HA inspections to be performed:

With dry HA water flow path (spiral chamber);

With flooded HA water flow path.

### Tests for the control system of the hydro unit:

#### Connection tests;

#### Tests of all used equipment;

#### Signal tests;

#### Functional tests;

#### Tests of the overall station control functions.

### Tests for the turbine governor with a dry spiral chamber:

#### Connection tests;

#### Tests of all used equipment;

#### Functional tests;

#### Signal tests;

#### Feedback tests;

### Tests for the excitation system:

#### Connection tests;

#### Tests of all used equipment;

#### Functional tests;

#### Signal tests;

### Tests during the unit's operation, including:

#### Tests of the execution of all operational and control functions and other technical specification requirements;

#### Tests of the excitation regulator in all regulation and control modes, test of switching to the backup channel, tests of the power system stabilizer. Tests of TSO requirements and verification of mathematical models4;

#### Functional testing of the turbine controller in all control and regulation modes;

#### Load shedding tests;

#### Hydromechanical protection operational tests;

#### Automatic startup testing;

#### Overspeed protection system tests.

#### Inspections prescribed by the transmission system operator

#### LFSM-O mode operation test (dynamic and static test);

#### LFSM-U mode operation test (dynamic and static test);

#### FSM mode operation test (dynamic and static test);

#### Active power controllability test;

#### Frequency restoration control test;

#### Reactive power capability test;

#### PSS operation test;

#### LFSM-O mode simulation;

#### LFSM-U mode simulation;

#### FSM mode simulation;

#### Reactive power capability simulation;

#### PSS operation simulation;

#### Fault tolerance simulation;

#### Signal checks for FCR, aFRR, and mFRR services provision

#### Other tests to meet the requirements of the TSO (Transmission System Operator).

## General Hydro-Unit Testing

### The overall inspection of the HA shall commence from the moment when all inspections or tests have been carried out in accordance with the inspection program, which must be carried out before the overall inspection and must meet the conditions of LVS 1082-1:2024 5.9.

* 1. The acceptance committee, convened by the Employer's project manager, reviews the execution and quality of the work, visually inspects the installed equipment, examines the results of measurements and tests, and evaluates the content, accuracy, and completeness of the submitted as-built documentation. The committee signs the deed confirming the readiness of the hydro-unit for the start of the general testing. Handing over - acceptance deed shall be prepared by the Employer’s project manager.

### The start of the overall test shall be considered the time when the HA is connected to the power system and loaded with the working load and the intended parameters.

### The overall inspection of the HA is carried out in accordance with the conditions of LVS 1082-1:2024, 5.12.d). p. and 5.12.h). p.

## Handover of the facility (hydro-unit) for operation

The hydro-unit is accepted for operation in accordance with the conditions outlined in LVS 1082-1:2024, sections 5.15 - 5.18.

## Handover and acceptance of works

### Acceptance of the completed works shall be carried out in accordance with the Employer's procedure K172 "Procedure for acceptance of services received, construction works performed and repair works carried out under the HPP and the CHPP Technical Management".

### After the completion of all works, including the preparation and submission of all the as-built documentation specified in the contract to the Employer, the Contractor shall notify the Employer in writing of the readiness to hand over the Works.

### The work acceptance commission appointed by the Employer shall inspect the execution of the Contract Works within five working days of receipt of the written notification from the Contractor that the Works is ready for handover, during which time the Employer shall examine the scope of works, quality and documentation submitted by the Contractor.

### If no deficiencies or non-compliance are found, the Employer’s commission shall sign the handing over - acceptance deed.

### The contract Works are considered accepted when the handing over - acceptance deed has been signed by the Employer.

### Handing over - acceptance deed shall be prepared by the Employer’s project manager.

# Warranty

The Warranty period for all materials, equipment, and works provided by the Contractor is 36 months after the handover and acceptance of the facility (hydro-unit) for operation.

# The planned execution time for the works is from 2025 to 2028.

The duration of work for each hydro unit from the moment of disconnection of the unit to the commissioning of the hydro unit is 6 months.

Planned execution of works:

For one hydro-unit (PHA02 or PHA08) in 2027 (no earlier than after the spring floods, and to be completed no later than before the 2027 spring floods)

For the second hydro-unit (PHA08 or PHA02) in 2028 (no earlier than after the spring floods).

The exact shutdown time for the hydro-units for the execution of works will be specified.

# Annexes

## Nr.1 Scope of work 1.lot;

## Nr.2. Scope of work 2.lot;

## Nr.3. Scope of work 3.lot.