DIVISION 16

ELECTRICAL

SECTION 16200

INDUCTION GENERATORS

PART 1 - GENERAL

1.01 SCOPE

This section covers the requirements for two induction generators with terminal compartments with surge protection and associated instrumentation and controls.

1.02 REFERENCE STANDARDS

A. ANSI C50.12 IEEE Standard for Salient-pole 50 and 60 Hz Induction Generators for Hydro Application Rated 5 MVA and Up.

B. ANSI Z55.1 Gray Finishes for Industrial Equipmen.t

C. IEEE 112 Standard Test Procedure for Polyphase Induction Motors and generator.

D. IEEE 115 Test Procedures for Induction Machines.

E. ANSI C52.1/NEMA MG1 Motors and Generator.

F. ANSI C51.1/NEMA MG 2 Safety Standards for Construction and Guide for Selection of Induction Generator.

1.03 SUBMITTALS

A. Submit in accordance with Section 01300: Shop Drawings and Product Data.

PART 2 - PRODUCTS

2.01 GENERATOR

A. Generator shall be induction alternating-current machine and designed to match operating characteristics of the connected hydraulic turbine.

B. Generator shall be either ODP air cooled or totally enclosed water and air cooled (TEWAC), fully guarded for horizontal mounting with suitable shaft extensions for connection to the turbine.

2.02 GENERATOR RATINGS

250 kW Francis Turbine:

Generator Type	Induction
Rotational Speed	Match turbine
Rating	250 kW
Power Factor	97.5%, lead and lagging
Number of Phases	3
Frequency	60
Terminal Voltage	480 VAC
Stator Winding Configuration	By Vendor
Winding Insulation Class	Class F

Generator Cooling	OPEN DRIP PROOF
Design Ambient Temperature	40°C
Temperature Rise Limit	80°C
Full Load Efficiency (Minimum, Guaranteed)	96.0%
Enclosure	OPEN DRIP PROOF
Overspeed Capability (two hours)	Match turbine's or 200% rated turbine speed, whichever is higher

50 kW Turgo or Pelton Turbine:

Generator Type	Induction
Rotational Speed	Match turbine
Rating	50 Kw
Power Factor	97.5%, lead and lagging
Number of Phases	3
Frequency	60
Terminal Voltage	480 vac
Stator Winding Configuration	By Vendor
Winding Insulation Class	Class F
Generator Cooling	OPEN DRIP PROOF
Design Ambient Temperature	40°C
Temperature Rise Limit	80°C
Full Load Efficiency (Minimum, Guaranteed)	96.0%
Enclosure	OPEN DRIP PROOF
Overspeed Capability (two hours)	Match turbine's or 200% rated turbine speed, whichever is higher

2.03 GENERATOR DESIGN AND CONSTRUCTION FEATURES

A. Generator

1. Generator shall be designed for operation under varying loads at rated voltage, power factor and frequency. Generator' mechanical characteristics shall be matched to the relevant characteristics of the turbine, including maximum runaway and critical speeds. Speed changers shall not be used. Generator shall be designed to allow daily start-up and shutdown so the output can be maximized each day during peak load hours.
2. 250 kW Generator shall have horizontal shaft arranged to be directly driven by a horizontal shaft Francis Turbine.
3. 50 kW Generator shall be arranged to be directly driven by as per manufacturer's specifications for a Turgo or Pelton Turbine.
4. Generator shall be designed and tested in accordance with referenced standards in effect at the date of the Contract and shall be suitable for automatic unattended operation.

B. Generator Stator

1. Generator frame shall be supported on sole plates laid in the concrete foundation as part of the powerhouse structure. Generator shall be provided with bolts and dowels for fastening the frame to the sole plates, and for preserving the alignment between the frame on the generator and the sole plates. An adequate number of dowels shall be provided in order to prevent any undue movement of the stator frame on the sole plates when the generator is subject to stresses resulting from short-circuit conditions.
2. Stator windings shall be copper and shall be provided with Class F insulation, or better, with a Class B temperature rise at nameplate rated output.
3. Resistance temperature detectors (RTDs) shall be provided and embedded in the winding slots of the generator and wired out to a separate terminal box as specified in Paragraph 2.04.

C. Generator Rotor

1. Generator rotor assembly including couplings and turbine rotating elements shall be designed for operation at turbine runaway speeds for the specified period of time without damage.

2.04 PROTECTIVE DEVICES

A. Resistance Temperature Detectors (RTDs)

1. RTDs of 100 ohms platinum at 0 degree C shall be furnished and installed on the unit as follows:

Quantity	**Location**
6 minimum	Generator stator winding located in accordance with rule 5.2 of ANSI C50.10. Provide two per winding.
2 minimum	Each bearing
1 minimum	Each oil reservoir

Each detector shall be connected to terminal blocks located in the generator auxiliary cabinet.

C. Speed sensors: Generator shall be equipped with a speed transmitter, compatible with speed switch supplied by control panel vendor.

D. Supplier shall furnish suitable generator protection device, Multilin, SEL or approved equal

2.09 SPARE PARTS

A. All spare parts shall be packed separately in containers plainly marked SPARE PARTS ONLY. A packing list, indicating the contents of each such container, shall be securely fastened in a moisture-proof envelope, to the outside of the container. The packing list shall also provide the following information:

1. Manufacturer
2. Contract number
3. Identification, including manufacturer's drawing number reference, of each spare part in the container.

PART 3 - EXECUTION

3.02 INSTALLATION

A. Furnish approved erection supervisor to supervise installation work performed by others. SUPPLIER shall provide detailed installation procedures.

3.03 STARTUP AND COMMISSIONING

A. Furnish approved erection supervisor to supervise startup, testing and commissioning.

B. SUPPLIER shall provide detailed startup and commissioning procedures.

3.04 FIELD TESTS

A. Pre-commissioning Tests

1. Insulation resistance measurement
2. Functional tests for generator cooler cooling water system.
3. Continuity checks on low voltage circuits for VT and CTs
4. Calibration of instrumentation
5. Alignment checks and documentation

B. Commissioning Tests

1. No load mechanical runs
2. Phase sequence test
3. Stator voltage tests
4. Overspeed test/runaway speed test
5. Load runs
6. Load rejection tests
7. 24-hour heat run at maximum rating
8. Time – RPM deceleration curve
9. Ten day commercial test run

END OF SECTION

SECTION 16340

GENERATOR SWITCHGEAR

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Low Voltage, (600 Volt) freestanding motor control or metal enclosed switchgear. The generator switchgear must ramp the application of the voltage to minimize power system disturbance. Please refer to Central Electric Coop System Impact Study for this project.

1.02 REFERENCES

A. ANSI C37.20.2 - Standard for Metal-Clad Switchgear.

B. ANSI C37.04 and .06 - Standard ratings and preferred ratings for Indoor AC Medium-Voltage Circuit Breakers used in Metal-Clad Switchgear.

C. ANSI C37.11 - Requirements for electrical control for AC High-Voltage Circuit Breakers rated on a symmetrical-current basis or a total-current basis.

D. ANSI C37.09 - Standard Design and Production Testing.

E. ANSI Z55.1 - Gray Finishes for Industrial Apparatus and Equipment.

F. ANSI C57.13 - Requirements for Instrument Transformers.

G. NEMA SG4 - Alternating Current High Voltage Circuit Breakers.

H. NEMA SG5 - Power Switchgear Assemblies.

1.03 SUBMITTALS

A. Submit shop drawings indicating outline dimensions, enclosure construction, shipping splits, lifting and supporting points, electrical single-line diagram, and equipment electrical ratings.

1.04 OPERATION AND MAINTENANCE DATA

A. Include circuit breaker recommended spare parts list.

1.05 QUALITY ASSURANCE

A. Manufacturer: Company specializing in 600 volt metal enclosed switchgear with at least five years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept equipment on site and inspect for shipping damage.

B. Protect equipment from weather and moisture by covering with heavy plastic or canvas and by maintaining heat within enclosure in accordance with manufacturer's instructions.

1.07 EXTRA MATERIALS/ACCESSORIES

A. Submit one racking handle(s) with equipment for each set installed. Charging handle to be furnished on each breaker mechanism.

B. Provide one set of spare control fuses for each set installed.

C. For all switchgear with circuit breakers in upper compartments, provide one circuit breaker lifting device - portable, floor-supported with a roller base.

D. Generator controller shall include surge arrestors suitable for the application.

END OF SECTION

SECTION 16450

TURBINE GENERATOR CONTROL PANELS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Requirements to design and furnish a turbine generator control panel and associated instrumentation and controls.
2. Requirements to design and furnish an intake control system to be installed at the Project intake and communicate with powerhouse control panel over fiber optic or wireless link to coordinate intake operations with powerhouse operations

1.02 QUALITY ASSURANCE

A. Referenced standards

1. UL 508 listing.

B. Qualifications

1. The supplier shall have a minimum of five years of experience in providing turbine generator control panels similar to the control panel specified.

1.04 CONTROL SYSTEM DESIGN AND PERFORMANCE REQUIREMENTS

A. Load Controls

1. The turbine-generator unit, accessories, and instrumentation shall be capable of continuous automatic control from the powerhouse or remotely from an internet connection. A programmable logic controller based load control program shall be provided that will maximize plant output based on available water.

2. Control of plant startup, restart on line outage or low water, shutdown and load adjustments, and plant monitoring shall be possible in local manual, local automatic, and fully remote operating modes.

3. The normal mode of operation will be for the plant to be unattended and in fully automatic operating mode. Fault shutdowns will be automatic to the extent that the wicket gates will close and the plant will shut down safely.

C. Equipment Performance and Operating Modes

1. Operating Condition Definition:

a. Normal condition is defined as any operation in which the powerhouse equipment functions normally, as required by the Specifications.
b. Upset condition is defined, for consideration of penstock transients, as a temporary condition due to separation from the power grid.

2. Faulted condition is defined, for consideration of penstock transients, as failure of the wicket gates to close following separation from the power grid.

3. Normal operation: The design shall provide smooth operation without excessive

vibration through the full range of head and discharge specified.

D. Philosophy of Operation

1. The following is intended to describe the DISTRICT's intended philosophy of operation for the plant, for background information to control system supplier. The Equipment Supplier shall design the control scheme to meet or exceed the operations described herein. Supplier shall prepare a control schematic diagram as part of the first drawing submittal to confirm this control scheme has been implemented. Refer to the Drawings for preliminary control logic block diagrams.
2. All critical plant functions such as start-up, shutdown, voltage control, power factor control, and water level control at the intake to maximize power generation shall be fully automatic, PLC based controls. The Project must be capable of full manual operation of all auxiliary systems (hydraulic power unit, lube oil, cooling water, etc.) from the HMI in the project control room. This control of auxiliaries may be accomplished through the PLC based control system.

E. General Requirements and Expected Plant Operations

1. 250 kW Turbine: The water supply for this project is diverted from Watson Reservoir through a trash rack, into the 42" diameter project penstock. The diverted flow is a maximum of 40 cfs.
2. 50 kW Turbine: The water supply for this project is diverted from Whychus Creek through a trash rack, then through fish screens, and finally into the 54" down to 18" diameter project penstock. The diverted flow is a maximum of 4 cfs.
3. Plant shall be normally unmanned. Monitoring of the plant's status and initiation of the control to achieve each operating mode described below shall be incorporated totally within a PLC. Full monitoring and control will also be capable of being performed from an internet connection to laptop or other computer.
4. The SUPPLIER shall provide control in accordance with the following:
5. Operating Modes:
   a. Normal Startup.
   b. Restart after Trip or Shutdown. c.Normal Operation.
   c. Abnormal Condition Operation.
   d. Normal Shutdown (with and without lock-out).
   f. Fast Shutdown.
   e. Emergency Shutdown.
   f. Other Emergency Operations.

6. Control Modes
   a. Manual
   b. Local Automatic
   c. Remote Automatic

7. Normal Start-up:
   a. Under start-up conditions, adequate water must be available at the head works. A level signal from the intake will indicate when adequate water is available and should be used in the permissive start sequence.
   b. Through the use of a level transmitter at the intake, a permissive to run shall be recognized by the turbine control system.
   c. Wicket gates shall be used to initially control the quantity of the water entering

the runner.

d. Normally, start-up should be accomplished by a “one-button” action by the operator, either locally from the panel or HMI or from the remote location, which will start a programmed start-up sequence that will start-up and load the turbine-generator unit in a safe manner in the shortest practical time, consistent with flow ramping limitations.

8. Restart after Trip or Shutdown: The DISTRICT desires an automatic restart after clearing of trips caused by loss of utility, or low water, conditions that should not generate a lockout (86) operation. Once the utility line is re-energized the plant shall automatically restart after a one minute delay. It must be possible to restart the unit and begin the start sequence while the unit is still rolling from a previous trip (rolling start), as well as starting up from a fully stopped condition.

F. Normal Operation:

1. Under normal operation, the turbine will be controlled automatically to maximize energy generation. When operating normally, plant output shall be determined by the turbine controller looking at the headwater flow transmitter at the intake. This flow transmitter and the communications equipment necessary to send its signal to the powerhouse communication link shall be provided by the Turbine Supplier. Under this type of control, the turbine controller will position the wicket gates to control the flow (indicated by level in the intake head pond). This will result in generating the maximum power with the water available.

G. Abnormal Condition Operation:

1. Abnormal condition operations include:
   a. Manual operation.
   b. Failure of nonessential or non-vital instrumentation.

2. The turbine-generator controls will allow for continuous manual operation from the powerhouse. Controls for load set point, block loading and manual load adjustment will be provided. It can be assumed by the designer that for the manual operating mode, a plant operator will be present at all times to monitor and adjust the turbine output as required for intake level control and any other required adjustments. This manual mode will be a semi-automatic mode of operation with the operator using the HMI to perform the necessary action to operate the plant. Typically this mode will only be used during commissioning or maintenance activities.

3. In the event of nonessential or non-vital instrumentation failure, the turbine-generator controls will allow continued operation in the “manual” mode. If damage to the turbine-generator is a possibility, then the turbine-generator will initiate a shutdown sequence appropriate for the type of instrumentation failure.

H. Normal Shutdown without Lock-out:

1. If any of the following occurs, the turbine controls will initiate a normal shutdown sequence, without 86 relay lock-out:
   a. Not enough water available to provide minimum generation.
   b. An operator manually initiates a normal shutdown either locally (with panel push button or HMI) or remotely.

2. The shutdown sequence will consist of immediately closing the wicket gates. The generator breaker will also be opened and tripped off line.

3. The generator brakes will engage at SUPPLIER selected speed, and complete stopping of the unit must be achieved within 10 minutes of the trip signal.

4. No 86 or lockout relay shall be tripped after a normal shutdown.

K. Emergency shutdown:

1. If any of the following occurs, the turbine controls will initiate an emergency shutdown sequence:
   a. Turbine controller failure or loss of DC control power.
   b. Operator initiated emergency shutdown by panel pushbutton or HMI.
   c. Failure of vital instrumentation or PLC.

2. The emergency shutdown sequence will consist of immediately opening the generator main breaker and closing the wicket gates to allow the generator to be taken off the line immediately and the turbine to coast and be braked to a stop from a runaway condition.

3. An 86 lockout relay will also be tripped.

2.08 PROGRAMMABLE LOGIC CONTROLLER

A. Control logic for turbine and generator shall be implemented through the use of programmable logic controller (PLC), along with manual backup capability. The SUPPLIER is responsible for detailed designs of control circuits based on specific turbine and generation equipment being supplied and the operating requirements specified in these Contract Documents.

B. PLC design and programming shall be such remote monitoring and control can be made from a remote computer by way of an internet connection.

C. PLC controls shall incorporate the following general requirements:

1. An over-speed tripping device shall be incorporated into the design.

2. Transfer from automatic control modes to manual control and back shall be accomplished bumplessly.

3. Provide means of storing the sequence of alarms and events leading to a turbine-generator shutdown. Store in the system a minimum of 30 shutdown sequences before purging its memory. The alarm and event history shall be retrievable on operator request.

4. PLC shall include a minimum of 25 percent spare (unused) points of each type for input/output cards used.

5. PLC system shall be calibrated, tested, and in all aspects set up such that operators can operate the system after specified training without need for SUPPLIER assistance. All components and devices shall be furnished and installed to provide a complete, operable and reliable system to meet the functional and performance requirements set forth hereinafter.

6. Surge Suppression: All incoming wires to PLC shall be protected by suitable surge

suppression circuits to protect PLC electronics.

D. Configuration: PLC and control system shall be configured to provide centralized control and monitoring of intake equipment, turbine and generator operation and protection. Human-machine interface (HMI) for the PLC shall be provided by a panel mounted HMI

   1. HMI software shall be Intouch 10.0, or current version, by Wonderware or Rockwell Automation RS View

END OF SECTION

SECTION 16650

STATION SERVICE EQUIPMENT

It is anticipated that the station service equipment will be installed by the building contractor's electrical contractor. The plan is to provide single phase, 120/240 service to the building.

The motor for the governor hydraulic system is the "large", (maybe 3 to 5 horsepower), motor in the plant. This can either be a single phase motor or a three phase motor powered by a suitable variable frequency drive.

END OF SECTION