SECTION- IV

SPECIFICATIONS FOR HORIZONTAL TYPE HYDRAULIC TURBINES, INLET VALVES, GOVERNING EQUIPMENT AND AUXILIARIES

4.1 SCOPE

This section of the specifications covers the design, manufacture, tests at works, supply, delivery at site, erection, testing at site and commissioning of 2 (two) Nos. Horizontal Francis hydraulic turbines and associated auxiliary and ancillary equipment, main inlet valve, equipment for auxiliary systems such as compressed air, Cooling water, draft tube dewatering, station drainage, centralized grease lubrication system, oil, water and air piping with valves and fittings, instrumentation, Controls and safety devices(as required): speed increasing gear box (if required): spares for five year operation of the plant, special tools etc., as described and detailed in the specification and listed in the schedule of requirements.

The scope of supply shall include all parts, accessories, spares etc., which are essential for construction, operation and maintenance of the complete prime mover even though these are not individually or specifically stated or enumerated. Corresponding components, of all the turbines and associated equipment and spares shall be of the same material, dimensions and finish and shall be inter-changeable.

The turbine manufacturer shall co-ordinate with the generator supplier so that the generator to be coupled to the turbine is matched in respect of speed, runaway speed, moment of inertia, overload capacities, coupling and other relevant requirements.

4.2 TYPE AND RATING

The turbine shall be of the Horizontal shaft Francis suitable for coupling directly/through speed increaser (gears) to horizontal shaft synchronous/induction generators. The direction of rotation shall be clock-wise when viewed from drive end. The turbines shall be capable of giving outputs higher than rated outputs to match the overload capability of the generators.

The details of the hydraulic system and basic data for design of turbines are given below :

(i)	Net Head	=	31.00 m
(ii)	Turbine Rated Output (kW)	=	125
(iii)	Continuous Overload (%)	=	10
(iv)	Rated Discharge (Cumec)	=	0.97
(v)	Normal Speed (RPM)	=	1000
(vi)	Runaway Speed (RPM)	=	2000

(vii)	Forebay Tank;			
	a.	Size	:	7.75 m X 6.00 m X 2.80 m
	b.	Free board	:	0.30 m
(iii)	No. of Penstock		=	1 (one) No.
(iv)	Diameter of Penstock		=	7000 mm (OD) X 6 mm thick
(v)	Length of Penstock		=	160.00 m
(vi)	Permissible speed rise		=	+ 35 %
(vii)	Permissible pressure rise		=	+ 25 %

Each turbine shall be designed to give a rated output of 125 KW at rated head with guide vane opening of about 80-85 Percent. The turbine shall have adequate capacity commensurate with the 10 % continuous overload capacity of the generators. The turbine would have output higher than the rated output when operating at heads higher than the rated head. The supplier may offer his nearest standard design. The maximum output both at maximum and minimum heads shall be stated in the offer.

The specific speed of the turbine shall be as per the best modern practice and of proven design and operation.

Manufacturer shall confirm the head and discharge data from the Executive Engineer concerned before actual manufacturing of the turbine starts.

4.3 OUTPUTS AND EFFICIENCY GUARANTEES AND PENALTIES

4.3.1OUTPUT AND EFFICIENCY GUARANTEES

The rated output of the turbine at rated head shall be stated and guaranteed. The efficiency of the turbine at rated head for 100%, 80% and 60% rated output shall also be guaranteed. These figures shall be applicable for purpose of penalties, rejection limits and bid evaluation as defined in following clauses 4.3.2, 4.3.3 and 4.9. In addition, the output of the turbine at full gate opening at net head and rated head shall be stated in the tender.

4.3.2 PENALTIES

Penalty for Shortfall in Weighted Average Efficiency and Output

For any shortfall in the tested values of rated output and weighted average efficiency (as determined on the basis described in clause 4.3.4) from the guaranteed values penalty shall be applied at rate of 0.5 (Half) percent of ex-works price of turbine including governing system

for every 0.1(one tenth) percent or part there of by which test figure is less than the corresponding guaranteed figure. The penalties for output and efficiency shall be computed separately and the total amount of penalty shall be the sum of these two. No tolerance shall be permissible over the test figures of rated output. In case of efficiency, tolerance will be allowed as per appropriate IEC test code.

The ceiling on the total amount of penalty on account of shortfall in the weighted average efficiency and output shall be 10% of the total unit price of turbines and governing system.

4.3.3 REJECTION LIMIT

The purchaser has the right to reject the turbine if the test value of either weighted average efficiency or the rated output is less than the corresponding guaranteed value by 2(two) percent or more after allowing tolerance in computation of efficiency.

4.3.4 WEIGHTED AVERAGE EFFICIENCY

The weighted average efficiency of the prototype turbine shall be determined from the field test or model test values of efficiency at rated head in accordance with the following formula for purpose of penalty and rejection limit and bid evaluation.

$$T\mu av = k1 \times T\mu 100 + k2 \times T\mu 80 + k3 \times T\mu 60$$

Where Tμav Weighted average efficiency of the turbine, Tμ100, Tμ80 and Tμ60 are efficiencies of turbine at 100%, 80% and 60% rated output at rated head respectively. The value of k_1, k_2 and k_3 are to be decided as per flow duration curve and discharge dependability.

4.3.5 RECTIFICATION TO MEET GUARANTEES

The contractor shall be given 4 months or mutually agreed time to improve/modify the design of turbine or to carry out rectifications, etc., as may be required so that the guarantees are met in case the tests prove unsuccessful in meeting the guarantees. If the second meeting is also unsuccessful, penalty or rejection of the equipment, as the case may be, shall be applied. However, no delay in the original delivery schedule shall be allowed if the model test results do not meet the guarantees and rectifications are made by the contractor thereafter within a period of 4 months or mutually agreed period as stated above.

4.4 CAVITATION GUARANTEES

The tenderer shall guarantee the runner against excessive pitting caused by cavitation for 18 months from the date of commissioning or 8000 hours of operation, whichever is more. If the 18 months of guarantee period expires before completion of 8000 hours of operation, the guarantee shall apply to the actual hours of operation proportionately.

Excessive pitting shall be defined as the removal of metal from the runner of a weight of $W= 0.15\ D^2$ per 1000 hours of operation, where, D = Discharge diameter of the runner and W = weight in Kg.

In case of cavitation pitting exceeding the guarantee, the turbine supplier shall, at his cost, take corrective measures such as modification of design, finish, replacement, repair, etc., and the turbine after modification, etc. shall be subject to cavitation guarantee as for the original equipment. In determining whether or not excessive pitting has occurred metal removal by erosion, corrosion or by the presence of injurious elements in water, etc., shall be excluded.

4.5 CRITICAL AND PLANT SIGMA

Values of critical sigma as determined from cavitation model tests as per IEC 193A shall be given in the forms of curves for different heads of operation. Plant sigma curves as recommended by the manufacturer shall also be plotted on it clearly to show the safety margin available.

4.6 SPEED RISE AND RUNAWAY SPEED

The moment of inertia of the unit and the normal wicket gate closing time and runner blade angle shall be so adjusted that the maximum momentary speed rise of the unit shall not exceed 35% and the maximum pressure rise in the penstock shall not exceed 25% of the maximum rated head under any condition of operation. The turbine manufacturer shall co-ordinate with the generator manufacturer for limiting the speed and pressure rise values. The maximum runaway speed of the unit, both off– cam and on- cam, under any combination of head and load conditions shall be stated in the tender. The turbine shall be capable of running safely at maximum runaway speed without any damage to its parts for a period of not less than 15 minutes for every such occurrence, with cooling water supply on.

4.7 NOISE LEVEL

Maximum noise level resulting from any of the operating conditions shall not exceed 90 db (A) at any place 1.0 m away from operating equipment in the machine hall.

4.8 STRESS AND FACTOR OF SAFETY

All parts of turbine shall be designed and constructed to safely withstand the maximum stresses during the normal running and runaway and short circuit conditions, out of phase synchronizing and brake application. The maximum unit stresses of the rotating parts shall not exceed two-thirds of the yield point of the material. For other parts, the factor of safety based on yield point shall not be less than 3 at normal conditions. For over-load and short circuit conditions, a factor of safety of 1.5 on yielding point shall be permitted.

4.9 BID EVALUATION

In the comparison of the tenders; the equalization on account of differences in the efficiencies of various offers will be made on the basis of weighted average efficiency as calculated by the formula given below:

Tμav = K1 x Tμ100 + K2 x Tμ80 + K3 x Tμ60 at rated head.

Where Tμav = weighted average efficiency and Tμ100, Tμ80, and Tμ60 are efficiencies at 100%, 80% and 60% outputs, respectively, at rated head. The highest figures of weighted average efficiency will be the basis for comparison of prices of turbines with lower efficiencies and will be loaded at the rate of 0.5% of their ex-works prices for each 0.1% difference in weighted average efficiency as compared with the highest weighted average efficiency.

The weighted average efficiency of the turbine will be multiplied by the efficiency of the gear box (if provided) for obtaining overall weighted average efficiency which will be used for bid evaluation.

The basis for selection of the offers shall be the overall economy to the purchaser considering power house civil works, monetized values of efficiencies, prices of matching generator, prices of powerhouse crane required, etc. The speed and setting of the turbine and its design shall be such as to result in the installation of the best generating unit at least cost.

4.10 MODEL TEST

The rates for model test as per relevant standards may be quoted separately. The purchaser shall have the option to get the model test performed by the contractor at an extra cost after the award of the contract. In that event, the manufacture of any part of prototype turbine shall be started only after the efficiency and other guarantees and requirements of the turbine are established and fulfilled on the basis of model tests. In case the contractor has already performed model tests on homologous models, the purchaser may, at his discretion, permit the contractor to proceed with the manufacturer after approval by the purchaser of the model test report.

The performance of the model tests either afresh or that had been done earlier shall be as per IEC 193 and 193A in all respects. Hydraulic performance tests shall be made at various guide vane openings to determine machine characteristics including regimes of safe operations, zones of cavitation and vibration, etc. The phenomenon of cavitation and vibration, particularly at lesser guide vane openings shall be specially investigated. These tests shall include determination of capacity, cavitation limits, hydraulic thurst, runaway speed, wicket gate torque relationship, etc., and such other details as covered in IEC 193 and 193A. Prototype efficiencies shall be derived from model tests by Moody’s step-up formula as

contained in IEC 193 for Francis turbines. Model tests shall simulate all possible normal operating conditions of the prototype for entire range of foreby/reservoir and tailrace levels.

The tenderer shall clearly mention the time within which the model tests including manufacture of a new model, if required, will be completed. The delivery schedule given by the tenderer shall be reckoned from the date of approval of model tests or model test report or from the time of permission to proceed with the prototype manufacture. If the model test is already available, this shall be submitted within 1(one) month after the award of the contract if required by the purchaser.

4.11 GENERAL ARRANGEMENT AND CONSTRUCTION

The turbine shall be of spiral casing type so constructed as to allow all the removable parts to be dismantled conveniently. The design shall also permit removal of rotating parts without disturbing the guide apparatus. The design shall also permit horizontal/vertical* movement of runner shaft by an amount sufficient for adjustment of bearings and for clearing the joint at the coupling between the turbine and the generator.

All equipments in the turbine pit shall be neatly arranged and shall be readily and easily accessible for operation and maintenance. Necessary walkways, ladders, hand rails, chequered plates, platforms, etc., required in the turbine pit shall be provided by the contractor.

4.11.1 Runner

The runner shall be of 13/4 chromium-nickel stainless steel. The composition of the material and the source of runner casting shall be stated in the tender. The runner shall be cast integrally of stainless steel. The runner will be a one-piece construction. The runner will have adequate number of blades which shall be polished and ground smooth and shall be free from roughness, cracks, high spots, etc. The finished machine and ground runner shall be dynamically balanced in the works before dispatch. For runner of diameter more than 1000 mm., renewable wearing rings shall be provided.

4.11.2 Shaft And Coupling

The turbine shaft shall be forged carbon steel or alloy steel conforming to IS or other equivalent international standards. Wherever the flanges are integral with the shaft, the same should be conform to American standard ANSI-49.1, 1967. For long larger size shafts, tubular construction of proven design will also be considered. The turbine shaft shall be connected to the runner on one side and to the gear box/flywheel generator shaft on the other side. It shall be of ample size to transmit torque at rated speed without excessive vibration or any distortion.

A renewable and removable sleeve of stainless steel shall be provided wherever the shaft passes through a shaft seal or a gland.

The turbine manufacturer shall co-ordinate and co-operate with the generator manufacturer for proper design and construction. The final alignment of the shaft at site shall be the responsibility of the generator manufacturer.

4.11.3 Bearings

The turbine bearings can be:

(i) The pad type or sleeve type or Babbitt lined, oil/grease lubricated either self-lubrication or forced lubrication type.

(ii) Anti-friction ball, roller bearings, oil or grease lubricated.

These bearings shall be guaranteed for a minimum continuous operation of 100,000 (one hundred thousand) hours and the design and performance shall be well proven and established.

The turbine shall be provided with adequate number of bearings. The bearings shall be designed to withstand operation at maximum runaway conditions with cooling water supply on (if cooling water is provided) for a period of not less than 15 minutes and also for operation at normal speed without cooling water supply for 15 minutes. The bearings shall be provided with a dial type or resistance type thermometer and a pressure gauge with provision for alarm annunciation/shut down on excessive bearing temperatures. The number and type of bearings shall be stated in the tender.

4.11.4 Shaft Gland

The shaft gland shall be of the stuffing box/carbon ring type with self-lubricated packing and lantern ring. Any other suitable type of shaft gland will also be considered. The gland shall effectively prevent leakage of water along the shaft under all operating conditions and at standstill and prevent entry of air. In case the location of the gland is below maximum tail water level, an inflatable rubber seal shall be provided for attending the main gland without dewatering the draft tube. A stainless steel sleeve shall be provided on the shaft where it passes through the gland.[8]

Arrangement for providing clean water supply to the gland, if required, shall be made by the contractor.

4.11.5 Spiral Casing And Speed Ring

The spiral casing shall be fabricated from welded steel plate/mild steel plates and shall have suitable sections for ease of shipment and to be within transport limitation. The spiral case shall be designed to withstand maximum water pressure including water hammer and shall be complete with anchors, supports, sole plates, turn buckles, hold-down rods, all types of clamps, etc. The speed ring shall be low alloy cast steel or of welded plate steel and shall be in suitable number of sections. The assembled stay ring shall be suitable for welding on to the casing.

4.11.6 Draft Tube

Each turbine shall be provided with a draft tube liner/suction bend of welded construction of structural steel. The draft tube cone shall have machined flange for bolting with the runner chamber. Drain box and drain pipes for dewatering the draft tube (if applicable) shall be included in the scope of supply. The design of the draft tube shall be such as to ensure the best overall efficiency for the turbine and stable and pulsation-free operations of the machines.

4.11.7 Guide Vanes

The guide vanes shall be made from stainless steel. Sleeves of stainless steel at the bearing and sealing surfaces shall be provided, if required. The guide vane bushes shall be of the self-lubricating type with protective seals or shall be suitable for grease lubrication. In case of grease lubrication, arrangement for manual and automatic grease lubrication to all bushes shall be made.

4.11.8 Operating Mechanism

The operating mechanism shall have ample strength to withstand the maximum load that can be imposed on it by the most severe operating condition. All working points with relative motion shall be bronze bushed, grease lubricated/ self lubricated. Means shall be provided for adjusting the position of the individual guide vanes to ensure close contact with adjacent guide vane in the closed position.

Each guide vane shall be individually connected to the regulating ring through suitable levers and links. Shear/ breaking link or some other suitable arrangements shall be provided on each guide vane to protect guide vane and to provide alarm on foreign body getting wedged between guide vanes.

The regulating ring shall be fabricated from welded steel plates. It shall be supported on the outer casing of top/side cover on bronze strips with provision for grease/ self-lubrication.

4.11.9 Guide Vane Servomotor

The guide vane shall be operated by two double acting oil operated servomotors of adequate capacity. The servomotors shall be capable of moving guide vanes smoothly during full opening and closing in required time. Standard available hydraulic cylinders of approved make, proven design and of suitable material can also be used as a servomotor.

4.11.10 Top Cover/ Side Cover

The top/side cover shall be of cast steel or welded plate construction. Suitable stainless steel labyrinth rings or similar sealing arrangements shall be provided in the covers.

4.11.11 Turbine Platform, Walkways, Handrails Etc

Necessary platforms, walkways, handrails, chequered plates, ladders, etc., complete with supporting steel structure, shall be supplied.

4.12 INLET VALVES

The main inlet valves of the turbines shall be butterfly valve type suitable for Gross Head and discharge required for over load capacity of the turbine / generator and connecting to the proposed penstock. The valve shall be suitable for all operating conditions of transient and maximum water hammer. The valves shall be operated by oil, pressure and closed by oil pressure/counterweight, so that it is capable of being closed under all emergencies. All associated equipments such as servomotors, oil pressure units, counterweights, etc., shall be included in the offer. The valve shall close automatically under normal and emergency shut down conditions. The valve will be complete with inlet pipe, outlet pipe, with expansion joint, by-pass arrangement if required for equalization of pressure on either side of the valve, etc.

4.13 GOVERNING EQUIPMENT

Each turbine shall be equipped with suitable electronic governor conforming to IEC No. 308. The governor shall be of proven design capable of maintaining control of speed under all conditions of heads and loads. Such governing system shall be complete with actuator unit comprising speed responsive element, restoring mechanism having adjustable temporary and permanent droop setting, load limiting device, speed level control, etc.

The speed responsive element of the governor can be operated by a toothed wheel mounted on the generating unit shaft with speed pick-ups or its equivalent is normally used as an input to speed sensing device. Standard protections like overspeed device, brake control, emergency shut down and alarms, etc., shall be provided in the governing systems.

4.14 PRESSURE OIL SYSTEM

Oil pressure Units system shall comprise a sump tank and a pressure tank separate for each generating unit. Two numbers of electrically operated governor oil pumps will be provided, one for normal running and the other acting as standby for each unit.

Provision for emergency shut down of the unit without any oil pump running shall be made. Gauges, pressure switches etc., will be provided as may be necessary.

4.15 COMPRESSED AIR EQUIPMENT

A centralized high pressure compressed air system common for all the units, if applicable, shall be provided for charging the governor oil pressure vessels. The system shall comprise two numbers of high pressure compressors of suitable capacity, one of them being a standby, a common air receiver and necessary pipes, fittings, valves, pressure switches, etc. The capacity of the system shall be sufficient to cater to all the generating units. The compressed air system shall be of the automatic start-stop design operating under pressure switches control sensing the pressure in the receiver.

The high pressure system shall also be used to supply low pressure air requirements for generator brakes, inflatable seals and the centralized grease system, if required. Suitable outlet connections shall be provided for the above purpose and pressure reducers wherever necessary shall be supplied by the turbine contractor to meet the turbine requirements. For generator brakes, pressure reducer, and air-lines will be arranged by the turbine contractor. The compressors and receivers shall have necessary fittings, mountings, safety devices, etc.

The tenderer may also quote as an alternative for providing necessary equipment and devices including nitrogen filled cylinders requires for pressuring the oil pressure vessels with nitrogen gas.

4.16 DEWATERING AND DRAINAGE SYSTEM

Complete equipment for the draft tube dewatering system common for all the units and the station drainage system shall be supplied by the contractor. The equipment for each of the dewatering and the drainage system shall include two motor driven dewatering

pumps, necessary piping fittings/gate valve/non-return valves/float switches, controls, accessories, etc.

4.17 COOLING WATER SYSTEM

The cooling water for generator air coolers (if applicable) generator and turbine bearing coolers, turbine shaft seal if applicable and for other equipment in the powerhouse needing cooling water shall be provided by tapping the penstock. If a higher pressure is needed at low head conditions, booster pumps to obtain the required pressure shall be provided for each tapping. In case the pressure at the tapping is high, suitable pressure reducer shall be provided. The system shall be complete with required number of duplex strainers, fine mesh filters, flow meters, flow indicators, flow relays, pressure gauges, etc.

4.18 GEAR BOX (OPTIONAL)

A gearbox of suitable gear ratio to match the turbine and generators shall be supplied. The speed increasing gear box shall be connected to the turbine and to the generator flywheel. The gear box shall be designed to be capable of withstanding runaway operation for 15 minutes and shock loads due to load variation and due to pressure pulsations in the turbine. The gear efficiency shall be as high as possible and shall be considered in evaluating the turbine efficiency for purpose of bid evaluation.

4.19 TURBINE INSTRUMENTATION, CONTROL AND SAFETY DEVICES

Each turbine shall be provided with a complete set of instruments, gauges, controls and safety devices on unit control board, if provided, for monitoring the conditions of the unit during normal running and emergencies. These shall permit the unit to be started and brought upto speed at the governor location and control during normal running. The instruments and gauges for the turbines include, inter alia, pressure gauges, level indicators, temperature and flow indicators, position indicator, indicating lamps for status indication etc. These shall be placed near the locations of apparatus or in the UCB or both. The safety devices shall comprise equipment and devices for sensing abnormal operating conditions, for giving visual and audible annunciation and shut down the unit, if required. A list of these instruments, controls and safety devices are given in Tables A, B, & C. The items, quantities and location are to suit the requirements for safe and satisfactory operation of the generating units and the auxiliary systems.

All the instruments, indicator, gauges, controls, safety devices, etc., shall be complete with necessary detecting element, auxiliary relays, etc.

4.20 SPECIAL TOOLS, SLINGS, CONSUMABLES ETC.

All special tools, slings, lifting devices, jacks, turn buckles, foundation plates/ bolts, etc., required for erection of the equipments shall be listed and supplied. First filling of oil and grease (if applicable) with 10% extra quantity is included in the overall scope shall be and supplied along with equipment. Welding electrodes as required for site welding and paint for finishing coat shall be supplied by the contractor.

4.21 SPARES

The spare parts for the turbine and associated equipment considered necessary for 5 years of operation of the generating units shall be supplied by the contractor along with the turbines. The unit prices of the spares shall be indicated as per enclosed Table –D and additional spares if considered necessary by the Engineer i/c shall be provided by the contractor within the overall contract price. Over and above those listed in Table – 'D' and list provided by contractor.

4.22 SHOP ASSEMBLY AND TESTS

The following assemblies and tests shall be carried out on the turbines and associated equipment at the manufacturer's works before dispatch in the presence of the purchaser's representatives if desired by the purchaser and test certificates shall be submitted whether or not the tests were witnessed by the purchaser.

(i) One turbine, manufactured first, shall be assembled in the shop to the extent possible.

(ii) Static and dynamic balancing of runners.

(iii) Hydrostatic testing at 1.5 times the maximum working pressure including water hammer for not less than 15 minutes for the main inlet valve, spiral case, servomotors, etc.

(iv) Non-destructive testing of welds.

(v) Performance tests for individual auxiliary equipment.

(vi) Complete assembly and operational tests of governors.

(vii) Assembly of spiral case and draft tube liner.

(viii) All motors/pumps/compressors, etc., shall be tested as per relevant Indian or other standards.

4.23 FIELD ACCEPTANCE TESTS

The turbines shall be tested at site for establishing fulfillment of guarantees in respect of turbine output and efficiencies including weighted average efficiency. The tests shall be carried out as per IEC 41 for Field Acceptance Tests of hydraulic turbines.

The arrangements for these tests will be made, including the testing devices, by the contractor.

4.24 COMMISSIONING TESTS

The contractor shall carry out the commissioning tests in accordance with IEC 545. The turbine, after continuous operation during the trial operation of one month, shall be free from problems of leakages, overheating, failure, damage etc. The machine will be handed over to purchaser thereafter. Subject to fulfillment of all other conditions laid down in the contract elsewhere.

4.25 ERECTION

The contractor shall depute experts in erection, testing and commissioning of turbines, governors and associated equipments for erection, testing and commissioning of these.

4.26 TENDER DRAWINGS

The following drawings shall be furnished by the tenderer :

(a) Drawings of the main cross section of the turbine showing the various components, parts/assemblies of the turbine to the extent possible.

(b) Layout drawings of the power house showing the overall dimensions and layout of turbines, etc., clearly indicating unit spacing dimensions of spiral casing, draft tube and all important elevations.

(c) Schematic drawings of piping system, control system and instrumentation.

(d) Physical and schematic drawings and descriptive literature on the governor and governor mechanism.

(e) Charts/curve showing performances and cavitation characteristic of the turbine

(f) Curve showing areas and velocities at different sections of draft tube.

(g) A list of tests to be performed at site on sub-assemblies and equipments.

(h) A complete list of equipments auxiliaries, etc. covered in the quotations.

(i) Model Test Report

(j) Quality Assurance Plan

4.27 GUARANTEED TECHNICAL PARTICULARS

The tenderer shall furnish all the data, information and other particulars called for in the schedule at the end of section under guaranteed technical particulars along with the offer.

4.28 SCHEDULE OF REQUIREMENTS

(i) Two (2) nos. of Horizontal Francis turbines to provide 125 kW power at generator terminals rated capacity on 31.00 m rated head complete with essential auxiliaries like lubrication equipment oil, water and air piping, instruments, controls, safety devices as per detailed specifications.

(ii) Two (2) nos. of governing equipment including governor actuator, oil pressure pumping units, etc.

(iii) Two (2) nos. inlet valves with complete operating mechanism.

(iv) Two (2) nos. set of turbine control instruments, indicating and metering systems and switches etc for (control panels shall be provided by generator supplier)

(v) One set of equipment for common auxiliary system like compressed air draft tube dewatering and station drainage, cooling water, etc.

(vi) One set of special tools, slings, consumables.

(vii) One set of spares for 5 years of operation.

TABLE-A

SCHEDULE OF INDICATING/RECORDING INSTRUMENTS

Sl. No.	Description	Device Type	Total Quantity per unit	Location
1.	Pressure of shaft seal cooling water			
2.	Gate limit and gate position indicators			
3.	Unit speed indication (speed indicator)			
4.	Speed level setting indicator			
5	Speed droop setting indicator			
6.	Unit output meter			
7.	Pressure of governor oil pressure system on panel, pressure accumulator & Governor separately			
8.	Level of oil in oil pressure vessel			
9.	Level of oil in sump tank			
10.	Standby oil pump in operation indication			
11.	Penstocks Pressure			
12.	Pressure of turbine casing			
13.	Pressure of draft tube			
14.	Turbine bearing temperatures			
15.	Indication of runner blade position			
16.	cooling water pressure			
17.	Oil level in Turbine bearings			
18.	Oil level in oil leakage unit			
19.	Level of leakage water in turbine core			
20.	Turbine discharge			
21.	Servomotor locked/unlocked			
22.	G.V. Shear pins fail			

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TABLE-B

CONTROLS

Sl. No.	Description	Total Quantity per unit	Location
1.	Gate Limit Control		
2.	Auto-manual selection switch		
3.	Speed level controller		
4	Speed droop controller		
5.	Manual turbine gate controller		
6.	Control for oil pump motor		
7.	Control for compressor		
8.	Turbine shut down control etc.		

TABLE-C

SAFETY DEVICES (FOR ALARM/SHUT DOWN)

Sl.No.	Device		Annunciation at	
	Type	Qty. per unit		
1.	2	3	4	5
1.	Governor oil pressure low			
2.	Unit over speed shut down			
3.	Manual emergency shut down			
4.	Turbine bearing temperature high			
5.	Trubine bearing oil low/high			

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TABLE -D
LIST OF SPARES

Sl. No.	Item of Spare	Qty	Unit price	Remarks
1	2	3	4	5
I.	**TURBINE**			
1.	Wearing rings (stationary) if any	1 set		
2.	Wearing rings (moving) if any	1 set		
3.	Shaft seal packings	2 set		
4.	Guide vane stem packings	1 set		
5.	Shear pins/friction clutch components	½ set		
6.	Guide vanes	4 Nos.		
7.	Shaft sleeves	1 set		
8.	Piston rings for servomotor cylinder	2 sets		
9.	Packings and sealings, all types and sizes	2 sets		
10.	Guide vane bearing bushes	1 set		
11.	Bushes/bearings for regulating mechanism	1 set		
II.	**GREASE LUBRICATING SYSTEM** (if required)			
1.	Grease feeders	1 set		
2.	Timer equipment	2 sets		
III.	**GOVERNING EQUIPMENT**			
(a)	In case of hydro mechanical governor			
1.	Springs for dash pot	1 set		
2.	Bearings for governor pendulum	2 sets		
3.	Pilot valve complete with rods sleeves, etc	1 No.		
4.	Piston for relay valve	One		
5.	Pressure gauge	One		
6.	Check valve	One		
7.	Oil level gauge	One		
8.	Setting device	One		
(b)	In case of electronic governor			
1.	PCBs	1 Set		
2.	Electronic Cards	2 Sets each		
(c)	Oil Pressure Vessel Sump Tank and Pumps			
1.	Oil pump for pressure oil supply	One		
2.	Seals/packings (all types)	1 Set		
3.	Twin filter for oil	One		

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4.	Solenoids/coils	1 Set
5.	Level relays	1 Set
6.	Pressure switches	1 Set
7.	Pump unloader	1 Set
8.	Safety relief valve	1 Set

IV. INSTRUMENTS AND SAFETY DEVICES

1.	Resistance type temperature detectors	2 Nos.
2.	Level switches	1 Set
3.	Dial type thermometers	1 Set
4.	Coils/contacts/springs for auxiliary relays solenoids and switches, etc.	1 Set

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Note :- ***Final list shall be finalised in consultation with the Engineer-in-Charge.***

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