No. DGPC/CMPD/CPD/17-A/2022/**103** April 25, 2022

Request for Expression of Interest (RfEOI)

for

"Replacement of Unit II and Unit IV Generators and Ancillaries of all Four Units of Chhukha Hydropower Plant"

Druk Green Power Corporation Limited (DGPC) invites Expression of Interest (EOI) for "**Replacement of Unit II & Unit IV Generators and Ancillaries of all Four Units of Chhukha Hydropower Plant**". The scope of work stipulated in the abridged Technical Specifications, under Section IV-Abridged Technical Specifications, is provided for information and reference. Through this EOI, the finalized Bidding Document including Technical Specifications will be provided to the shortlisted Bidders only.

The Bidders shall be shortlisted as per the procedures and provisions under this RfEOI. The Expressions of Interest must be delivered in a written form to the address below **on May 26, 2022** by 3:00 PM (Bhutan Standard Time) and shall be opened on the same day at 3:30PM. Bidders shall also be permitted to submit their EOI Proposals through email, which shall be in PDF format with password protection. The password shall be provided on the Bid opening date, prior to the Bid opening time.

The RfEOI comprising of the following documents shall be available for downloading from the website: www.dgpc.bt

Section I – Instruction to Bidders
Section II – Qualification Criteria
Section III – Forms
Section IV – Abridged Technical Specifications

Please acknowledge receipt of the RfEOI.

Head, Contracts Management and Procurement Divisions (CMPD)
Contracts and Procurement Department (CPD)
Druk Green Power Corporation Ltd. (DGPC)
Post Box 131, Thimphu, Bhutan
Telephone Number: +975 2 330979
Email: t.wangchuk792@drukgreen.bt

SECTION I: INSTRUCTIONS TO BIDDER

i) **Scope of Work:** The scope of work shall be as specified under Section IV –Abridged Scope of Work of this RfEOI.

ii) **Qualifications**: Prospective Bidders shall demonstrate in their EOI that they meet the required qualifications and experiences criteria and are fully capable of carrying out the work.

iii) **Conflict of Interest:** The Bidders shall hold DGPC's interest paramount, without any consideration for future work, and strictly avoid conflict with other work or its own corporate interests.

iv) **Preparation of EOI:** The EOI shall be typed or written in indelible ink in English language and shall be signed by the firm. The Bidder shall complete all the forms under Section III – Standard Forms and complete set of documents including supporting documents to substantiate the qualification and experience of the firm.

v) **Power of Attorney** of the person submitting the EOI proposal on behalf of the bidder shall be attached. An authorized representative of the bidder shall sign the original submission letters in the required format for EOI submission and shall initial all pages. The authorization shall be in the form of a written power of attorney attached along with the EOI.

vi) **Submission of Proposals**: Bidder shall submit only one EOI Proposals. If a Bidder submits more than one Proposal, all such Proposals shall be disqualified and rejected.

vii) All applications including all related correspondences and documents shall be submitted in English language only.

viii) In addition to the information sought under this RfEOI, Bidders are required to review the Technical Specifications in detail and point out gaps and provide recommendations for improvement of the Technical Specifications.

ix) **Modifications of EOI**: The EOI Proposals may be modified or substituted before the deadline for submission. DGPC may at its sole discretion, extend the deadline for submission. However, DGPC shall not entertain any request for extension of the Bid submission deadline. No claims whatsoever will be entertained if submission is not received on due date and time.

x) **Amendments:** At any time prior to the deadline for submission of the EOI, DGPC for any reason or on its own initiative may revise the RfEOI by issuing an amendment, which shall form an integral part of the RfEOI.

xi) The EOI Proposals shall be marked as "EOI for Replacement of Unit II & Unit IV Generators and Ancillaries of all Four Units of Chhukha Hydropower Plant and addressed to:

Head, CMPD
Contracts and Procurement Department
Druk Green Power Corporation Ltd.
Post Box 131, Thimphu, Bhutan
Telephone Number: +975 2 330979
(email: t.wangchuk792@drukgreen.bt)

xii) Opening of EOI: EOI proposal shall be opened by DGPC on stipulated date and time in the presence of authorized representative, if any.

Opening Date : May 26, 2022 at 1530 hrs
Place : DGPC Corporate Office, Thimphu, Bhutan

xiii) **Clarifications**: Any clarifications related to the RfEOI shall be sought in writing from Head, CMPD at the address given above.

xiv) **Site Visit:** Site visit is recommended to examine the site situation and its surroundings where the works are to be executed and obtain all information that may be necessary for preparing the EOI Proposal and if shortlisted, for preparing the Bid and entering into a Contract for execution of the Works. The costs of visiting the site shall be fully borne by the Bidder. Employer shall facilitate the site visit and Bidder is required to furnish advance intimation of his site visit.

xv) The Bidder shall bear all costs associated with the preparation and submission of their EOI Proposal and DGPC in no case shall be responsible or liable for these costs, regardless of the conduct or outcome of the selection process.

xvi) DGPC reserves the right to reject any EOI Proposal without assigning any reasons thereof at any stage.

xvii) **Shortlisting of Bidders:** A minimum score of 80 points against the Shortlisting Criteria will be required for shortlisting. Only top 3 Bidders who have obtained a minimum score of 80 points shall be shortlisted for issuance of the Bidding Documents for submission of their Bids (Technical and Financial Bids) for the Work.

SECTION II: SHORTLISTING CRITERIA

Interested Bidders shall provide information, as stipulated hereunder, demonstrating that they have the required qualifications and relevant experience to perform the Work. The Bidders shall be evaluated and shortlisted based on criteria indicated below:

SN	Criteria	Points
1	**Successfully implemented "Design, Engineering, Supply, Installation, Testing and Commissioning of hydro generator of atleast 65 MW capacity in the last 10 (ten) years.** Documentary evidences required: i) Work order with clear scope of supply ii) Completion Certificate from the Client/Employer	**10**
2	**The hydro generators implemented under Sl. No. 1 does not require major maintenance (as specified in General Requirement) for at least 5 years interval.** Documentary evidences required: i. Certificate/customer testimony on the performance of the hydro generator.	**15**
3	**The hydro generators implemented under Sl. No. 1 has been successfully integrated with SCADA system and is fully automated and has been functional for at least 5 years without any problem.** Documentary evidences required: i. Certificate/customer testimony on the performance of the hydro generator.	**15**
4	**Manufacturing facility for generator and ancillaries equipped with advanced manufacturing technology and adequate manufacturing capacity**. Documentary evidences required: i. Profile/brochure of manufacturing facilities and capacities ii. Details of available technology at the manufacturing facilities iii. Details of manufacturing capacities	**5**
5	**Relevant project experience of the following professional staff to be engaged for the work:** **a) Design Engineer (2.5)** **b) Commissioning and Testing Engineer (2.5)** Documentary evidences required: xviii) Complete CV of the personnel, indicating the number of project experiences in the relevant field for similar Generator size (min. 65 MW Generator)	**5**

6	**Response to the technical requirements and innovations/value additions for increased operational /maintenance efficiencies.** Weightages for the criteria shall be as under: a) Compliance to technical Requirements **(25)** b) Innovations/Value additions for increased operational /maintenance efficiency **(10)**	**35**
7	**Demonstrate proper understanding of the scope of work and have provided detailed technical approach, work methodology with time line and manpower requirement.** Weightages for the criteria shall be as under: a) Technical approach and work methodology along with manpower deployment plan **(5)** b) Understanding of the integrability/compatibility of the proposed system with the existing system and conditions of CHP **(5)** c) Understanding of the tentative Completion Time and Milestones (provided by CHP) and compliance to the same by the bidders. The bidder may comment or proposed their own scheduling but it shall be acceptable to DGPC **(5)**	**15**

xix) DGPC has the right to verify the credentials/documentary evidences submitted by the Firms. The fulfilment and award of points against the criteria at Sl. No. 2, 3 and 6 will not only be based on the documentary evidences/credentials submitted by the Bidder but also on the performance of the generator and ancillaries of other projects implemented by the same Bidder which shall be verified through field visit, where ever possible.

xx) Bidders shall demonstrate strong credentials in terms of technical approach and state of the art manufacturing facilities suitable for the aforementioned work.

xxi) Bidders having new designs, new technology interventions and evidence of deploying such technologies shall earn additional scores.

xxii) A Bidder can be either Sole or a Merged/Acquired/Subsidiary Company. A Joint Venture (JV) or Consortium Bid **is not** allowed.

xxiii) In case of Bids submitted by a Merged/Acquired/Subsidiary Company, the qualification requirements shall be as under:

a) Commitment by the Parent/Holding company to sign a separate agreement with the Employer (i.e. DGPC) confirming their full support for the technical and financial requirements of the Merged/Acquired/Subsidiary Company and to take up the work itself in case of non-performance by the Merged/Acquired/Subsidiary Company in the event of award of the work.

b) Parent/Holding Company shall submit an undertaking letter along with the Bid that, in case the Merged/Acquired/Subsidiary Company is awarded the work on the strength of the Parent/Holding Company, the Parent/Holding Company shall furnish an additional Performance Bank guarantee for an amount equivalent to 5% of the awarded work value, in addition to the normal Performance Bank Guarantee to be submitted by the successful Bidder.

xxiv) No firm shall make any unsolicited communication to DGPC. Such an attempt to influence DGPC in its decisions on the examination, evaluation, and comparison of the EoIs may result in rejection of the EOI.

SECTION III: STANDARD FORMS

Form 1: Letter for Expression of Interest
Form 2: Information Sheet
Form 3: Format for Relevant Experience of the Bidder

Form 1: Letter for Expression of Interest (EOI)

Date:

To
[Insert address of Procuring Agency]

Sub: **Expression of Interest (EoI) for the work …….***[Insert name of work]*

Dear Sir/Madam,

This is in response to your RfEOI on *[……insert date……]*, inviting Expression of Interest for *[insert description of work]*. We hereby submit our Expression of Interest and have attached necessary information according to the standard forms.

The information furnished by us in this expression of interest is correct to the best of our knowledge. Based on this information, we understand you would be able to evaluate our proposals in order to shortlist for the above-mentioned assignment. We, however, understand that the DGPC reserves the right to decide whether or not to shortlist our firm without disclosing the reason whatsoever.

Sincerely yours,

On behalf of the firm: Signature: …….
Name of signatory:
Designation:
Company Seal

Form 2: Information Sheet

2.2 Services Data

Name of the Bidder	
Brief Description of the Assignment	

2.3 Bidder's Information

Name of the Bidder:	Country of Registration:
Name of the owner:	Day, month & Year of Establishment:
Name of Authorized Representative (*if applicable*):	Position/Designation:
Contact Person details: Name, Designation, email and phone number	

[Attach valid Trade License /Registration certificate]

2.4 Core Area of expertise ***[Provide a brief Description]***

2.5 **Company Profile** [Provide a brief Description]

2.6 Available Software/latest Technology *[where applicable]*

Provide list of software proposed by the firm for the assignment (*As available)*

2.7 Comments on Technical Specifications *[If any]*

Provide comments if any on the Technical Specifications with special focus on scope of work, adequacy, latest technology and technical specification.

Form 3: Format for Relevant Experiences (General and Specific) of the Bidder

1. Name of Project: …….
2. Description of Project: …….
3. Installed Capacity: ……
4. Contract Amount: ……..
5. Start & End date (month & Year): ……..
6. Description of services provided: ……
7. Employer (With complete address, contact details):……

Notes:

(i) The bidder shall fill in the details in separate form for each experience/credential claimed.

(ii) For each credential the certificate issued by the Employer shall be attached.

SECTION IV: ABRIDGED TECHNICAL SPECIFICATIONS

1 Background

Chhukha Hydropower Plant (CHP) is a run-off-the-river scheme located on the Wangchu River in Chhukha Dzongkhag, Western Bhutan. The Hydropower Plant (hereafter referred to as the Plant) has an installed capacity of 336 MW (4X84) and is owned by Druk Green Power Corporation (DGPC). The generating units were manufactured and supplied by Bharat Heavy Electricals Ltd. (BHEL), India. The four vertical generating units are propelled by Pelton Wheels at a net head of 435m. The Plant is located about two and half hours' drive from Paro airport and the Indo-Bhutan border town of Phuentsholing. The Generating Units I and II were commissioned in the year 1986, while the other two units were commissioned in the year 1988. The units are continuously loaded at 92 MW (10% overload) during peak seasons when the inflow is high typically from mid-May to October and then partly loaded during off-peak seasons. Therefore, the units are subjected to varying load cycles.

To keep abreast with the latest technologies, series of phase-wise renovation and modernization works are being carried out in the plant. During R&M Phase I, governor system and excitation were replaced. In R&M Phase II, top and bottom brackets of generator were replaced in Unit I and Unit II in 2011 and 2013 respectively. In R&M Phase III, stator winding, stator core, stator frame and field windings were replaced in Unit III and Unit I in 2017 and 2018 respectively. However, Unit II and IV have been in service since commissioning and no major upgradation was carried out in the last 30 plus years of its operation.

Moreover, there are technical issues and problems with the existing components of the generator and systems. Hence, DGPC intends to replace the generator components of Unit II and Unit IV along with auxiliaries in all other generating Units. The plant shall soon implement SCADA system, hence all the components and system going to be replaced shall be compatible with plant SCADA system.

2 Scope of Work

The scope of work for **"Replacement of Unit II & Unit IV Generators and Ancillaries of all Four Units of Chhukha Hydropower Plant"** shall comprise, but not limited to, engineering, designing, manufacturing, supplying, installation, testing and commissioning of following components of the generator:

2.1 Generator Unit II and Unit IV

2.1.1 Stator Winding

i) Stator winding bars

ii) Stator winding connectors/jumpers and bus rings

iii) Stator winding terminals including shorting bar at neutral end

iv) Stator winding insulation items including support ring and packers.

v) Resistance Temperature Detectors (RTD) for stator winding monitoring including spare

vi) Stator bar handling tools

2.1.2 Stator Core

i) Stator core lamination including lamination for RTDs

ii) Stator core glued-packets

iii) Core assembly items like pressing plate, horse-shoe (C-shaped) plates, core studs and nuts, key bars etc.

iv) RTDs for core and core tooth temperature monitoring including spare

v) One set of stator core pressing and building tools

2.1.3 Stator Frame

i) Stator frame assembly

ii) Frame-joining nut and bolts

iii) Tools and tackle for assembling stator frame at site

2.1.4 Generator air coolers along with temperature transmitters for monitoring inlet and outlet air

2.1.5 Rotor field winding:

i) Field winding

ii) Insulation items including insulation flange, steel washer and body insulation

iii) Bolting material for pole-to-pole joint

2.1.6 Slip-ring assembly with carbon dust collector system

2.1.7 DC lead assembly including DC cables

2.1.8 Online condition monitoring system of generator

2.1.9 Generator ancillaries:

i) Vapour sealing system

ii) Brake/jack system with dust collector

iii) Hydrostatic lubrication system

iv) Air guides

v) Air baffle ring

vi) Stator heater

2.2 Generating Unit III

2.2.1 Slip-ring assembly with carbon dust collector system

2.2.2 DC lead assembly including DC cables

2.2.3 Online condition monitoring system of generator

2.2.4 Generator ancillaries:

i) Vapour sealing system

ii) Brake/jack system with dust collector

iii) Hydrostatic lubrication system

iv) Air guides

v) Air baffle ring

vi) Stator heater

2.3 Generating Unit I

2.3.1 Slip-ring assembly with carbon dust collector system

2.3.2 Online condition monitoring system of generator

2.3.3 Generator ancillaries:

i) Vapour sealing system

ii) Brake/jack system with dust collector

iii) Hydrostatic lubrication system

iv) Stator heater

3 Summary of Unit-wise list of components to be replaced are as under:

The summary of the scope of work is as provided in the table below:

Unit II and Unit IV	Unit I	Unit III
Stator frame	Slip-ring assembly	DC lead assembly
Stator core	Vapour sealing system	Air guides
Stator winding	Brake/jack system	Air baffle ring
Field winding	Hydrostatic lubrication system	Slip-ring assembly
Air guide	Stator space heater	Vapour sealing system
Generator air coolers	Generator condition monitoring system	Brake/jack system
Stator core and winding RTDs		Hydrostatic lubrication system

Unit II and Unit IV	Unit I	Unit III
DC lead assembly		Stator space heater
Air baffle ring		Generator condition monitoring system
Slip-ring assembly		
Vapour sealing system		
Brake/jack system		
Hydrostatic lubrication system		
Stator space heater		
Generator condition monitoring system		

The bidder shall examine the scope of work critically and ensure adequacy and completeness of scope of work under this EOI.

4 Technical Requirements

4.1 Stator

The complete stator along with generator auxiliaries shall be replaced in Unit II and Unit IV of Chhukha Hydropower Plant. The rotor rim punching, spider casing, top bracket, guide and thrust bearings, rotor shaft and underwater components shall be retained. The new stator shall be capable of withstanding maximum forces which could occur due to most severe short circuit conditions. The stator shall be lowered to the existing foundation sole-plates without any problem. The design of stator shall be well coordinated with the existing rotor since the existing rotor, shaft and top bracket shall be retained. The assembly of stator shall be carried out at site. There are 192 slots in the existing stator and it shall remain unchanged in the new stator.

The new stator shall be capable of safely withstanding maximum stress which may act during normal operation, runaway-speed conditions, two phase and three phase short-circuit conditions or single-phase earth fault at maximum output, out-of-phase synchronization, magnetic unbalance at rated speed and Seismic forces. The new stator shall be capable of withstanding a three phase short-circuit at the generator terminals when operating at maximum power output i.e. 92 MW at rated power factor with ±10% rated voltage for a period not less than 3 seconds. The new stator shall be also capable of withstanding occasional current equal to 1.5 times the rated current for not less than 30 seconds each time.

The generator air gap with new stator shall be studied and proposed accordingly by the bidder as to achieve the best possible efficiency. The existing design air gap is 23 mm. The stator shall consist of frame, core and winding. The technical data of existing generating Unit II and Unit IV are provided in Annexure-1. The detailed technical requirements are provided hereafter.

4.2 Stator frame

The stator frame shall hold the new stator core and new winding. It shall be assembled at site and lowered on the existing foundation at site. The technical requirements are as follows:

i) It shall be of robust design to withstand maximum forces acting on it under worst condition of operation as well as under fault conditions/system disturbances and to withstand the existing operating forces.

ii) The stator frame shall be split in three sections (maximum) consistent transport limitations and shall have bolted and doweled joints with seal welding.

iii) The frame shall be fabricated of steel plate, suitably ribbed for rigidity and strength to allow it to support the clamping forces needed to retain the stator punching in the correct core geometry under all operating conditions.

iv) The stator frame shall have robust intermediate plates rigidly attached to the frame with provision for levelling, centering and bolting on to existing foundations.

v) The fastening of the stator frame to the sole plates will have provision for radial movement of the stator due to thermal expansion.

vi) The stator frame shall be designed for lifting the completely built stator including core and windings. Suitable lifting lugs and devices for lifting the stator shall be also provided. The lifting operation plan (LOP) shall be provided.

vii) Appropriate tools shall be provided to precisely check and correct the level of the stator frame during the assembly at site.

viii) All the relevant drawings to be submitted by the bidder.

The details of loading on the existing generator foundation (loading on stator frame and lower bracket) is give below.

S.NO.	TYPE OF FORCES	LOADING ON GENERATOR FOUNDATION					
		LOADING ON EACH SOLE PLATE OF STATOR (POINT'A') TONNES			LOADING ON EACH SOLE PLATE OF LOWER BKT.(POINT'B') TONNES		
		VERTICAL DOWNWARD	TANGENTIAL	HORIZONTAL (IN ANY DIRECTION)	VERTICAL DOWNWARD	TANGENTIAL	HORIZONTAL (IN ANY DIRECTION)
		V	HT	H	V	HT	H
1	DUE TO DEAD LOAD (ROTOR ON THRUST PADS)	78.00			4.5		
2	DUE TO LIVE LOAD	3.40					
3	DUE TO HYDRAULIC THRUST	0			0		
4	DUE TO UNBLANCED MAGNETIC PULL			18.34			9.18
5	DUE TO NORMAL TORQUE		13.34				
6	DUE TO SHORT CIRCUIT TORQUE (MOMENTARY)		152.71				
7	DUE TO BEARING SEIZURE		2.47			0	
8	DUE TO BRAKING				4.34	0.79	
9	DUE TO DEAD LOAD (WHEN ROTOR ON JACKS)	36.03			65.99		
10	DUE TO EARTHQUAKE (ROTOR ON THRUST PADS)	6.16		13.20	0.36		5.22
11	DUE TO EARTHQUAKE (ROTOR ON JACKS)	2.88		13.20	5.28		5.22

FOLLOWING FORCES MAY ACT TOGETHER :

1. DURING STANDSTILL CONDITION: FORCES AT SR.NO.1 2 & 10
2. DURING NORMAL OPERATION: FORCES AT SR.NO. 1 TO 5 & 10.
3. DURING SHORT CIRCUIT CONDITION: FORCES AT SR.NO.1 TO 4 & 6.
4. DURING THRUST BEARING SEIZURE CONDITION: FORCES AT SR.NO.1 TO 5 &7.
5. DURING BRAKE APPLICATION: FORCES AT SR.NO.1,2,3,8 & 10.
   FOR CIVIL DESIGN THE HORIZONTAL FORCES SHALL BE SUPERIMPOSED ON TANGENTIAL FORCES.
6. DURING LIFTING OF ROTOR ON JACK: FORCES AT SR.NO. 2,9 & 11.
7. EARTH QUAKE LOADS ARE BASED ON FACTOR HORIZONTAL = 0.15g AND VERTICAL= 0.08g.

NOTE :

1. FOR FOUNDATION DESIGN, LOAD IN TANGENTIAL DIRECTION SHALL BE THE SUM OF LOADS IN TANGENTIAL AND HORIZONTAL DIRECTION.

Table: Details of loading on existing generator foundation

4.3 Stator Core

The stator core shall be built at site as a continuous ring (joint-less ring core) without having any issue with the existing rotor assembly and generator foundation. It shall be built using laminations. Following are the technical requirements of a core:

i) The core laminations shall be manufactured of low-carbon, low loss factor, high grade non-ageing, cold rolled silicon steel with non-oriented grains and high permeability. The laminations shall be thin sheet steel of having thickness not more than 0.5 mm.

ii) Each lamination shall be coated on both sides with thin electrically insulating coating of high temperature resistant varnish which corresponds to insulation class 'F' to minimize eddy current losses.

iii) Laminations shall be piled on aligned-dovetail keys which shall be accurately and securely fastened with clamping tools to the stator frame during the core building. Those dovetail keys shall be firmly held tight with C-shaped plates (sometimes called horse-shoe plates), which shall be fully welded to the stator frame as per the standard practice.

iv) The lamination design shall be such that when it is stacked, it does not form stamping

protruding in the slot and buckling formation in any side of the core. While stacking the laminations to the dovetail keys, it should be such that it does not cause any mechanical bents to the laminations which result in formation of buckling. The core must be built without any signs of buckling at any locations.

v) The connection between the stator core and the stator frame must ensure that the stator bore tolerance is maintained up to the largest diameter. It must also permit a clearly defined transfer of the operating torque and other forces to the stator frame and from there to the foundation.

vi) The core shall be ventilated by means of radial air ducts throughout the stack length. The ducts, formed by space blocks or spacers will direct the air uniformly with minimum obstruction. Spacers shall be of non-magnetic 'I' beam strips spot welded to the support laminations from the cooling ducts. The shape and distribution of the spacers shall be chosen to secure uniform transfer of pressure as well as smooth flow of ventilation air.

vii) Appropriate tools shall be provided to check the uniformity of verticality in the slots, to check the diameter of the core, and to check the level of the bottom finger plates.

viii) The stator core shall be clamped by means of finger plate assemblies at both ends of the core. The required pressure shall be provided and maintained through core studs. The clamping system shall be designed so as to ensure that clamping pressure is maintained over time and the core laminations shall not become loose during generator's service life.

ix) The pressing fingers must be configured such that it does not cover the slit in the step punching which shall make the slit ineffective.

x) After completion of core assembly, core consolidation and heating shall be carried out by magnetic induction to produce a compact core. Any shrinkage in core height shall be made up by make-up laminations to produce desired core length.

xi) The core pressing shall be carried out as per the standard practices to ensure no air gap remains between the laminations.

xii) All the necessary tests shall be conducted after completing the core building and before the insertion of winding at site for detection of hot spots. A detailed procedure shall be provided by the bidder for attending any hot spots detected during the hot spot test.

xiii) The core building tool should be such that its usage should not cause any mechanical damage to the core laminations. The core building tool made up of glass fiber material shall be preferred.

xiv) Adequate number of resistance temperature detectors of latest technology including 50% standby shall be provided for temperature measurement of the core including

core tooth.

xv) The detailed QAP as per the latest international standards and norms related to stator core shall be submitted by the bidder.

xvi) All the drawings related to above to be submitted by the bidder.

4.4 Stator Winding

The stator winding including jumpers/connectors and bus ring shall be assembled at site after the completion of building new core at site. The winding shall be double layer, star (Y)-connected with line and neutral leads brought out to the terminals. With new stator and new generator air coolers, the maximum rise of winding temperature shall be 90°C (with other prevailing site conditions such as ambient temperature inside the power house, cooling water flow rate and cooling water temperature). The new stator windings shall have larger copper section than existing one because of advancement in insulation system and new size of the slots. Thus, new stator winding shall have lesser copper losses and load losses compared to existing stator and guaranteed values of the same shall be submitted by the bidder. Following are technical requirements for stator winding:

xxv) Each phase winding shall be distributed around the stator such as to minimize unbalanced magnetic pull.

xxvi) The stator winding shall be of Roebel bar type (360° transposition and higher), with strands completely transposed within the slot length.

xxvii) The design of winding should be such that the number of connectors is minimized in order to avoid overlapping. The multiple overlapping of connectors cause inconvenience while brazing joints, tapping insulations, and creating a safe gap between the conductors. The number of bus rings and jumpers/connectors shall be also minimal.

xxviii) The winding design shall be such that bars can be replaced in case of fault by removing one or two rotor poles thus creating space between stator and rotor for carrying out replacement of bars without having to take out the rotor and upper bracket.

xxix) All the winding strands shall be insulated suitably so that no short circuit between adjacent strands occurs.

xxx) The reliability of the stator winding is determined primarily by the quality of its insulation. The main insulation of stator winding will be made of high-quality material corresponding to Class F insulation and suitably impregnated insulation method (VPI) employed which shall give a homogeneous insulation without any voids, high thermal stability and insensibility against humidity, oil and other pollution. All the required insulation materials pertaining to Class F insulation shall be provided.

xxxi) Stator bars shall have a partial discharge suppression system as per the latest standard practices so that no potential gradient exists which could result in damaging partial discharge. The partial discharge suppression system shall include inner potential grading applied over Roebel bars, outer corona protection applied over applied after the main

insulation, and end potential grading applied on the bars where it exits the slot.

xxxii) The insulating materials must have high dielectric strength and voltage endurance values with low loss factors; must be resistance to oil, water and other coolants, which may come into contact with the insulation in case of a fault; must have excellent mechanical properties and must be excellent corona-resistance.

xxxiii) The maximum accepted temperature rise in the winding at maximum output will be limited to the temperature rise of less than 90° C (considering ambient temperature of 25°C in the summer, and other existing prevailing conditions at site).

xxxiv) The winding connections, bus ring (circuit ring), jumpers/connectors, main and neutral leads shall be of epoxy cast resin type, corresponding to class 'F' insulation. The jumpers/connectors shall have bents made at factory.

xxxv) The design of bus ring conductors shall be of latest design with skin effect reducing mechanism (such as a hollow copper conductor instead of copper bar).

xxxvi) End connections of stator bar shall be brazed at site using a latest and effective method which is clean and fast.

xxxvii) All the end connections shall be capped and sealed with insulating solutions corresponding to class F insulation after brazing.

xxxviii) The stator winding shall be adequately wedged with ripple spring or any latest and reliable looseness counter system, supported and braced to withstand the full stresses due to electrical short-circuiting and normal operating stress.

xxxix) At the driving end, the wedges shall be secured against sliding out, by means of binding to the winding bars.

xl) A special hydraulic stator bar pusher shall be provided to uniformly press the bars into the slots. Gauges in bar pushers shall be provided to indicate the hydraulic pressure required and these will be recorded for each bar in every slot as part of the installation quality control (QC) records.

xli) The bars shall be so installed that removal and replacement shall be possible without damaging the bar insulation and the lamination in the slots.

xlii) To facilitate proper insertion of the bars and to ensure a good fit and a good heat transfer between the insulation surface and the stator core, there should be a standard system to fill up the air gaps or make gap-free installation of bars in the slots.

xliii) The bottom layer of winding bars shall be cord lashed continuously to the supporting rings by fiber glass tape both at top and bottom end. The support ring shall be closed ring, made of thick continuous fiber glass ring. The lashing shall be then impregnated with resin and then cured to form a stable arched structure with support ring that will

withstand all the forces that may occur during normal operation and abnormal conditions such as short circuits and faulty synchronization.

xliv) Adequate number of temperature detectors including 50% standby per parallel circuit per phase as per the standard practice shall be embedded in various parts of the stator winding. All the temperature detectors in and around generator shall be wired by shielded cables and its junction box shall be securely installed on the generator barrel wall.

xlv) A tool with higher precision shall be also there and provided to ensure that the winding bars inserted at same height as specified in the drawing.

xlvi) The detailed QAP as per the latest international standards and norms related to stator winding bars shall be submitted by the bidder.

xlvii) The part drawing of the stator including the cross-section diagram of stator winding bar showing the insulation system and wedging system should be submitted by the bidder.

xlviii) The detailed capability curve of a new generator shall be also submitted by the bidder.

4.5 Rotor field winding

The existing spider, rim, pole shoe, pole keys and brake ring shall be retained. Only the field winding/coils along with insulation systems shall be replaced with new one. There are 20 number of field windings. The existing poles are fastened to the rotor rim by means of T-heads and are secured in place by means of tapered keys. With the advancement in insulation systems, the new field winding shall have larger copper section than the existing one and lesser operating temperature of field winding. The normal operating DC field current and voltage shall be 1020 A and 276 V respectively. The ceiling DC current and voltage shall be 1760 A and 462 V respectively.

Following are the requirements of new field coils:

i) New field winding shall be designed to suit with existing pole body and shall be assembled at site.

ii) Field coil shall be manufactured from high quality half-hard electrolytic grade copper rectangular profiled strips. These shall be fabricated in rectangular shape with brazed dove-tail joints. Field coil shall be designed with number of turns and conductor size so selected to produce lower field currents and temperature rises.

iii) Turns shall be insulated with Class F epoxy loaded Nomex paper. Coils shall be consolidated under pressure and temperature to produce monolithic coil such that these do not delaminate during operation.

iv) Any insulation materials/supports must be of Class F epoxy glass laminated which shall provide adequate insulation to pole body to withstand electrical, thermal and mechanical stresses during operation of the machine.

v) The field winding shall be designed to withstand normal or accidental over voltages and over-currents without any deterioration. In addition, it shall have sufficiently low

inductance to avoid a slow de-excitation speed. The field winding shall be adequately braced to withstand the stresses due to worst condition of short circuit and also due to centrifugal forces.

vi) All field winding electrical connections shall be provided from a top position to facilitate ease of inspection, separation and reconnection.

vii) Inter-pole connections shall be designed so that thermal expansions and mechanical stresses do not cause damage (cracks) which could be detrimental to efficient electrical continuity and mechanical durability. The connections shall be located alternatively on the rim side and air gap side.

viii) Pole to pole connections shall be bolted. Connections shall be soldered and bolted ensuring a proper electrical contact. Connections shall also be designed for easy inspections, tests and subsequent dismantling.

ix) Retaining ring shall be of heat-treated non-magnetic steel forging and body mounted to hold the rotor coils under the action of centrifugal forces.

x) The pole supports should be designed such that it eases the dismantling and assembling work (present system has V-blocks which has to check for tightness on regular basis).

xi) The assembly of poles shall be carried out at site.

xii) The detailed QAP as per the latest international standards and norms related to field winding shall be submitted by the bidder.

xiii) All the relevant drawings shall be submitted by the bidder.

4.6 Rotor DC Lead Assembly

In the existing DC lead assembly, the slip-ring assembly is keyed to a tubular shaft bolted to the top of thrust block. The DC cable from the slip-ring assembly to the poles run through the shaft bore and terminates to lower collector semi-circle ring on the top of the rotor. The leads connect the lower collector ring to the poles. The DC cables and leads are joined at suitable points to facilitate dismantling. The bidder shall replace complete section of the rotor lead from slip-ring to field poles. Following are the requirements in the new system:

i) The cables running inside the shaft must be multi-strand, single core, flexible enough to bend and properly insulated. The cable should be anchored/clamped to prevent free movement during rotation of the machine.

ii) The removable copper strip (with nut and bolt) should be provided to the lead running over the rotor spider/rim at suitable location so that it can be disconnected wherever required.

iii) Positive locking pins and wedge on lead supports must be properly designed and

provided so that the copper lead/lead support does not come out from its place due to centrifugal force at run-away speed even when the lead is disconnected/delinked.

iv) All the relevant drawings related to new design shall be submitted by the bidder.

The normal operating DC current and voltage of DC leads shall be 1020 A and 276 V respectively. The ceiling DC current and voltage shall be 1760 A and 462 V respectively. The existing DC lead assembly is shown below.

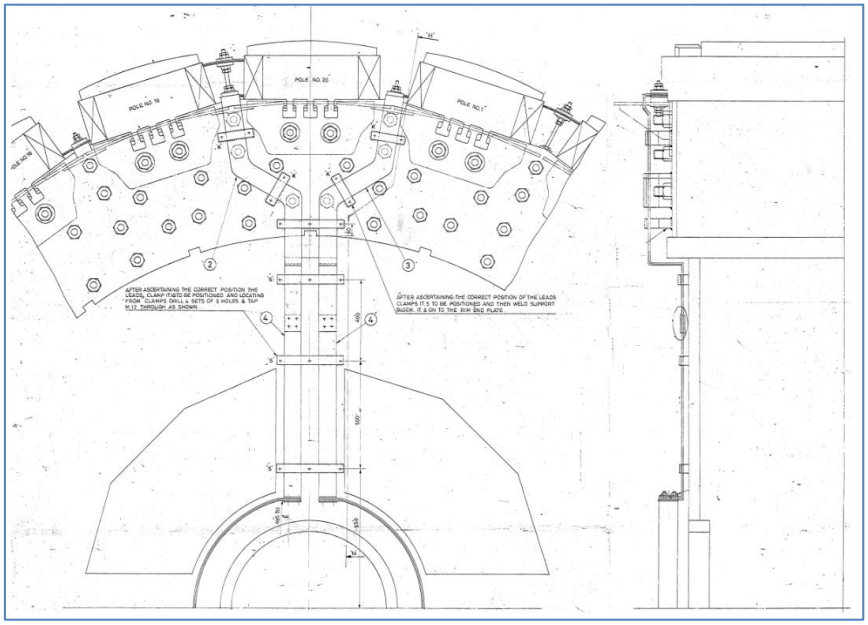

Figure: The existing DC lead assembly

4.7 Slip-ring assembly

The existing slip-ring assembly consists of outer collector ring mounted on the fixed bracket and slip-rings fixed to the tubular shaft mounted on the thrust collar block. 30 Nos. of carbon brushes are placed on the outer collector ring and are kept consistently pressed by a spring in the brush holder. However, the present system does not have carbon brush dust collector instead exhaust fans are provided to drive out the carbon dust. The new slip-ring assembly shall have following requirements:

i) The DC current ratings are specified under Rotor field winding and Rotor DC lead assembly.

ii) The new system shall have a suitable arrangement for effective collection of carbon dust produced/emitted by the carbon brushes so as to avoid the conduction through carbon deposition resulting in rotor earth faults.

iii) The filters used shall be replaceable and regenerable.

iv) It shall have a new system to hold the carbon brush with controllable force.

v) All the insulation supports in the new slip-ring assembly shall be corresponding to

class F insulation.

vi) The brushes and collector rings shall also be so positioned as to avoid contamination by oil vapors or oil leakage from the bearing chamber.

vii) With new slip-ring assembly, no carbon dust should be found on its insulated support blocks and on the vapor seals. Accordingly, there should not be requirement of regular cleaning works in the slip-ring area.

viii) The bidder shall submit, along with the bid, a design of 'carbon dust collection system' that suits the existing set up as per the site condition and space available.

4.8 Generator Condition Monitoring System

Presently, there is separate online generator shaft vibration monitoring system and generator partial discharge monitoring system installed for the generators. The new system shall have integrated monitoring system which will have minimum of following three features:

i) Online shaft vibration monitoring system

ii) Online generator partial discharge monitoring system and

iii) Online generator air gap monitoring system (AGMS).

However, any additional features/tools related to generator shall be submitted by the firm.

The above mentioned three systems shall be integrated and shall have complete analysis software with dedicated computer and accessories installed at central control room with provision of integration with plant SCADA system. The overall system/package shall be of latest version and compatible with SCADA for annunciation and data storage to plant data storage for long term trending. The systems shall have self-diagnostic features. The system shall be of an international repute having proven performance and acceptability in the field of hydropower. Following are the details of technical requirements against each system:

4.8.1 Online shaft vibration monitoring system

A continuous online vibration monitoring system complete with sensors, input/output module, control/process unit, relays, junction boxes, cabling and associated accessories for measuring, monitoring and data acquisition of shaft vibration/run-out shall be provided for each unit. The system shall comprise following:

i) Non-contact proximity probes which shall monitor dynamic motion of the generator/turbine shaft relative to the bearings. The location of the probe shall be 2 in upper guide bearing, 2 in lower guide bearing and 2 in turbine guide bearing to measure radial vibration in both axes.

ii) Velocity/acceleration type contact probes which shall monitor the absolute vibration on the stator and bearing covers/brackets. The location of the probe shall be 2 in upper bracket, 2 in lower bracket and 4 in stator frame all 90° apart.

The probes shall be resistant to dust, oil vapor, humidity, shaft current, electrical run-out, magnetic field and imperfection in the mechanical surface of the shaft.

4.8.2 Online generator partial discharge monitoring system

A continuous online partial discharge measurement system completes with sensors, input/output module, control/processor unit, junction boxes, cabling and associated accessories for measuring, monitoring and data acquisition of the partial discharges over the complete spectrum shall be provided to monitor the healthiness of the stator insulation. Following are some of the technical requirements:

i) The system shall be able to record, trend, analyse and diagnose the acquired data.

ii) The software required shall be included and provided in the dedicated system.

iii) The rating of coupling capacitor for measuring partial discharge shall be as per the latest standards and norms.

iv) The coupling capacitor shall be of latest design and of high-quality material which can withstand the all types of faults expected in the stator winding.

v) For Unit II and Unit IV, the capacitors shall be installed in each parallel path during the installation of windings and bus rings.

vi) For Unit I and Unit III, it shall be installed during the annual maintenance time.

4.8.3 Online air gap monitoring system

A continuous online air gap monitoring system complete with sensors, input/output module, control/processor unit, junction boxes, software, cabling and all accessories shall be provided to measure and monitor the dynamic air gap in each Unit. Following are some of the technical requirements:

i) It shall have adequate number of sensors as to get the realistic air gap measurements.

ii) The system shall have a trending and diagnostic feature.

iii) The system shall be of the latest art of technology on the date of supply.

4.9 Generator Ancillaries

4.9.1 Generator air coolers (heat exchangers)

In the existing generator cooling system, recirculating air-cooling system is actuated by the sole effect of the rotor movement. The air pressure is generated by the centrifugal fan effect of the rotor which allows a uniform radial air flow through the stator by passing through the inter poles areas, the air cools rotor field windings, then it cools the stator winding and the core. The air flow is shared between the air-to-water cooler tube fins. At the cooler outlets, the air is gathered in the generator pit and it is directed towards the rotor spider openings by passing between the upper bracket and the stator. The work shall include replacement of all air coolers/heat exchangers along

with valves and pipelines up to main incoming and outgoing line at site. Following are requirements related to air coolers (generator heat exchangers):

i) Coolers shall be mounted on the outer periphery of the stator frame without bolting. It should be ensured that coolers shall not interfere with the phase and neutral terminals of the stator winding and shall comply with safe distance.

ii) The existing winding temperature of generator goes as high as 130°C during the peak load in the summer. The new generator air coolers shall be designed in such way that it brings down the winding temperature below 90°C during the peak season considering 15% reduction of cooler capacity due to internal and external deposits of foreign materials.

iii) In order to achieve the required winding temperature, the new air coolers/heat exchangers shall be re-designed with new dimensions as per the available space in the new stator frame and prevailing site conditions. The heat exchangers shall be made of materials which are anti-corrosion and having a good heat transfer/dissipation property.

iv) The inlet and outlet valves in each cooler shall be also replaced along with pipelines till existing incoming and outgoing common pipelines.

v) The coolers shall be fitted with a device to collect and discharge water due to condensation, to existing drainage system.

vi) The heat exchangers shall be designed for at least 10 bars nominal pressure and pressure test at 50% above the nominal pressure.

vii) The cooler assembly shall withstand the machine's vibrations and all elements shall be fully protected against corrosion.

viii) Coolers shall be arranged for easy removal through the generator top covers. Lifting lugs shall be provided to facilitate the lifting through the top of the generator cover.

ix) New set of temperature transmitter gauge complete for monitoring inlet and outlet air temperature shall be also provisioned and installed which shall be compatible with SCADA.

4.9.2 Oil vapor sealing system

Usually, vapor seals are provided at the guide bearing location to seal the oil vapors coming out from the top and lower bracket oil chamber. The air pressure requires to seal the oil is taken from the generator air cooling system through a pipeline. The present vapor sealing system has not been able to seal the vapor from the oil chambers at both top and bottom brackets. During every shutdown, maintenance team has to remove/clean the leaked oil which consumes lot of time. The new system shall be designed in such a way that it completely seals the oil vapor coming out from the system. Following are some of the important requirements regarding the vapor sealing system:

i) The new vapor sealing system should be able to seal the lube oil. There should be zero-leakage from the system. There should not be presence of any oil in the slip-ring chamber and LGB chamber from vapor seal all the time during the operation.

ii) The system shall have one common drain pipeline outlet to drain the oil vapor accumulated in the system. This drain outlet shall be located at a suitable location and height so that there is free movement of oil vapors. To make the system effective, the movement of oil vapor shall be forced out to the collector system if required.

iii) If required, the modification/replacement of existing oil retainers and brackets shall be also considered. The details of proposal shall be submitted by the bidder after studying the existing system.

iv) The scope shall include installation of new set of vapor seals along with all the accessories including pipelines, valves and clamps.

4.9.3 Generator brake/jack system

In the present system, the brake is applied using air pressure and jacking of rotor is achieved by oil pressure from a portable power pack. 8 Nos. of brake/jack cylinders are installed on the lower bracket. The brake is put on manually through a local control panel located outside the lower generator barrel. And jacking of rotor is done by applying oil pressure through a portable pressure unit. Following are the requirement for the new brake/jack system:

i) The brake/jack system shall be designed and provided to reduce coast-down time and to bring the machine swiftly to a halt in the event of a fault. During a normal shutdown the brakes should not be operated at higher rotational speeds in order to protect the brake lining. In case of danger, however, the brakes shall be designed to be used at rated speed at any time.

ii) When the generator is at standstill, the system should be used as hydraulic jack. The cylinders shall be used as supporting elements or for relieving the load on the thrust bearing.

iii) One of the issues in the brake/jack system is generation of dust from the brake shoe which contaminants generator lower part of winding and core. Hence, the new brake/jack system shall have an effective brake dust collector. With new system, no brake dust must reach on the stator winding, core and rotor body.

iv) The brake/jack cylinders should be leakage-free and maintenance-free system.

v) There shall be a retaining spring or any other mechanism attached to brake/jack cylinder to retract the brake plates and piston so that the brakes do not stay stuck after application.

vi) The operation of brake shall be in both auto and manual. However, operation of jacking shall be manual.

vii) All the required pipelines and clamps shall be provisioned and installed and the pipelines

shall be leakage free system.

viii) The brake lining should be of asbestos-free material and high-quality material which would generates very minimal amount of dust.

ix) The brakes shall be normally applied automatically by drawing air from the dedicated air compressor unit. It shall be also be possible to apply the brakes both from unit control board and brake control panel. Its control panel shall be compatible with the Plant SCADA system.

x) The availability of braking, i.e., the presence of the required air pressure, shall be monitored by a pressure switch. If the air pressure is too low, or if there is no air pressure, an optical or acoustic alarm in the control room shall be activated. The air pressure shall be also read from local pressure gauges.

xi) Each brake shall be provided with a limit switch with auxiliary contacts to provide the position of the piston of brake cylinders.

xii) A reliable limit switch shall be also installed in the slip-ring area for controlling the jacking operation when maximum permissible raised position of the rotor is reached.

xiii) For each generator, a manual and motor operated high-pressure oil pump shall be supplied.

xiv) The jacks shall be lockable in any desired position to permit release of the jacking oil pressure.

xv) Mechanical locks shall limit the rotor lifting range. It shall be ensured that after jacking operations the entire oil is drained from the braking system.

xvi) Each generator installation shall include a complete control unit for manual and automatic control. A control cabinet shall be installed outside the generator room for controlling the brakes and providing compressed air and hydraulic pressure.

xvii) The connecting pipes between the main components shall be made of precision seamless steel tubes. The distribution of the pressure medium shall be provided by means of the manifold. The pipelines shall be subdivided into pressure lines for oil and air; pressure line for oil return; and leakage oil lines.

xviii) The new brake/jack system should be designed considering the existing space at site.

4.9.4 Hydrostatic lubrication system

The hydrostatic lubrication system which is also called high pressure lubrication system shall create a lubricating oil film between the thrust bearing runner and the thrust pads during start-up and shutdown phases of the generator. The present hydrostatic lubrication system has only AC pump which can develop the peak oil pressure up to 136 kg/cm^2 and the oil flow rate of 20 liters per

minute. The oil is pumped to the openings of thrust bearings in the top bracket. However, the present system does not have a standby DC pump in case the AC supply fails and it is a standard practice to have one DC pump in the hydrostatic system. Following are the requirements of new system:

i) New HS system shall have complete one main AC pump and one DC standby pump whereby automatic changeover from main AC pump to standby DC pump should be there in case of loss of oil pressure or loss of main AC power supply.

ii) All the necessary high-pressure hose, pipelines, fittings, valves, pressure transmitter and control panel have to be provisioned and installed.

iii) The system must be leakage-free, and pipelines should be provided with proper supports to withstand the stress from high pressure oil.

iv) The HS system shall be installed on the safely-raised rigid platform from the floor.

v) Facilities for both auto and manual mode of operation of pump shall be provided and should be integrated with SCADA.

4.9.5 Air guide and air baffle ring

Air guides are fitted to the top and bottom end of the stator to ensure proper distribution of air for generator cooling system. The existing air guides are made up of fiber material, however it has aged. The present air guides are also found too heavy to handle during dismantling and assembling. Therefore, new guides shall be convenient while handling and installing, and should be of non-metallic material.

Air baffle rings helps to divert the air from the coolers into the winding and core. The existing air baffle rings are made of metal. The new air baffle ring shall be of fiber material which shall have secure fixing mechanism to the top bracket. Adequate gap shall be maintained all the time between the air baffle rings and the rotating rotor.

4.9.6 Stator heater

Space heaters are required to prevent the condensation and to avoid accumulation of moisture in the generator windings. It shall be put on whenever there is shutdown. Space heaters shall be installed at the foot of the stator in the inner periphery of the generator barrel.

i) Space heaters shall be capable to prevent condensation in generator with barrel diameter of 7000 mm.

ii) Space heater shall be uniformly spaced and shall have a dedicated control panel wherein the heating can be control as per the site condition. Temperature sensors shall be also provided to sense the temperature in the generator barrel.

iii) The control panel shall be compatible with the SCADA.

iv) All the cables, clamps and safety enclosures shall be provided.

5 General Requirement

Currently, one of the most common issues faced by O&M personnel at CHP and other plants in the country is the contamination of the generator and its ancillaries. The main sources of contamination are:

a) Lubricating oil leakage from the oil chamber of top and bottom brackets due to ineffective vapor sealing system.

b) Lubricating oil leakage from the oil retaining ring of top and bottom brackets due to design related issues.

c) Brake shoe dusts spreading all over the stator winding, stator core, and rotor body from the brake lining.

d) Carbon dusts from the slip-ring assembly.

Because of above issues, the contamination level is alarming in the generator and its ancillaries. Thus, frequent cleaning is required. The regular topping-up of lubricating oil is also required. Electrical faults like rotor earth fault are, most of time, caused due to accumulation of carbon dust paste in the slip-ring area. This has increased the overall generation loss and maintenance cost of the plant.

The other pertinent issue with the existing generator and its ancillaries of CHP is the requirement to carryout major maintenance on an annual basis which includes activities such as rotor levelling, shaft alignment, shaft centering and bearing gap setting. With the replacement of the generator and the ancillaries of Unit II and Unit IV, the firm should ensure that the major maintenance is not required for at least 5 years interval.

Further, CHP has plans for implementation of SCADA system for full automation of the power plant. There are lot of issues with the existing components of generators of CHP as well as most other power plants in Bhutan in terms of its compatibility with the SCADA system. With the replacement of the generator and its ancillaries of Unit II and Unit IV of CHP, the generators should be compatible with the SCADA system and should be able to achieve full automation (single push button).

The firm should ensure that the following requirements are fulfilled while submitting the technical proposal for replacement of Unit II and Unit IV generator and its ancillaries.

a) The generator and its component must be contamination-free throughout the operation. There should not be any oil leakages in the generator and its ancillaries. There should not be any accumulation of dusts in the generator and in the ancillaries. The generator and its components should be completely dry and clean all the time.

b) The generator must be maintenance-free except for routine inspection work when the unit is under shutdown. There must not be a requirement to carry out major maintenance for a period of at least 5 years interval. The designs, equipment and system proposed should support condition-based maintenance.

c) The firm shall consider carrying out replacement or modification works in the existing

systems/component which are not in the list of scope of work, in order to make the proposed new system maintenance-free and contamination-free. The details of such proposal shall be submitted by the bidder.

d) All the instrumentation supplied and installed in the generator such as RTDs used for measuring stator core and winding temperature should be reliable, robust and must be functional for more than 10 years after commissioning. It should not fail right after few months from commissioning.

e) With new generator and generator air coolers, the maximum accepted temperature in the winding at maximum output will be limited to **90° C** (considering ambient temperature of 25°C in the summer, and other existing prevailing conditions at site). Currently, the winding temperature is as high as 130°C in Unit II and IV.

f) The proposed generator and its ancillaries should be compatible and have a smooth integration with the SCADA system and full automation (single push button start/stop) should be possible.

g) The workmanship and quality of work executed by a firm/bidder should be as per the best international practices.

6 Tentative Schedule

The lowering of new stator including installation, testing and commissioning of generator auxiliaries must be scheduled as per the annual maintenance schedule of CHP which is usually from November to April. During the other months of the year, materials can be supplied and new stator can be built at the service bay, inside the power house. Only one stator can be built at a time due to space constrain at site. It will be the discretion of CHP to decide on which Unit to take up the first replacement work at site. A tentative schedule has been attached as **Annexure-2** considering award of work by August 1, 2022. The schedule of the bidder shall be in accordance with the tentative schedule attached.

Annexure-1

Technical Data of the existing generator of Unit II and Unit IV, CHP

Sl. No.	Descriptions	Design Values
1	Manufacturer	M/s BHEL, India
2	Year of commissioning	
2.1	Unit II	1986
2.2	Unit IV	1988
3	Continuous rated capacity	93.333 MVA
4	Frequency	50 Hz
5	Power factor	0.9
6	Voltage range	11 kV±5%
7	Maximum continuous output with a maximum cooling water temperature of 20°C and air temperature of 30°C, and the stator/rotor temperature not exceeding 106/115°C	102.550 MVA
8	Guaranteed overall efficiency of the generator at 11 kV terminal voltage an 0.90 p.f (lagging) and 75°C winding temperature computed by the summation of losses method in accordance with IS:4889-1968 subject to tolerance in IS:4722-1968	
8.1	Full load	98.00%
8.2	75% load	97.60%
8.3	50% load	96.80%
9	Short circuit ratio	1.26
10	Generator Reactance (p.u)	
10.1	Synchronous reactance	
	a. Director axis Xd	0.86
	b. Quadrature axis Xq	0.53
10.2	Direct axis transient reactance	
	a. Saturated, X'd	0.2
	b. Unsaturated, X'q	0.23
10.3	Sub-transient reactance	
	a. Direct axis, X"d	0.13
	b. Quadrature axis, X"q	0.17
10.4	Negative phase sequence reactance, X_2	0.15
10.5	Zero phase sequence reactance, X_0	0.08
11	Stator winding type	Double layer, wave type
12	Winding bar type	Roebel bar, 360° Transposition
13	Insulation class	Class F
14	Stator connection	Star (Y)
15	Total stator weight	130 ton

Sl. No.	Descriptions	Design Values
16	Core construction	3 parts
17	Material of stator core	Low loss silicon alloy
18	Core height	1530 mm
19	Air gap at pole center	23 mm
20	Insulation of field winding	Class F
21	No. of poles	20
22	Generator resistances	
22.1	Armature winding per phase at 20°C	0.00247 ohm
22.2	Field winding resistance at 20°C	0.1812 ohm
22.3	Damper winding resistance/direct axis	0.01634 p.u
22.4	Damper winding resistance/q axis	0.0183 p.u
23	Time constants	
23.1	Direct axis transient open circuit T'o	7.60 sec
23.2	Direct axis transient short Circuit, T'd	1.75 sec
23.3	Armature, Ta	0.22 sec
23.4	Direct axis sub transient Short circuit time constant, T'D	0.0235 sec
24	Fly-wheel effect of generator	
24.1	WR^2	$18.39X10^6$ lb ft^2
24.2	GD^2	$3.1x10^6$ $kg.m^2$
25	Inertia constant H	4.09
26	Runaway speed (which all parts are guaranteed to withstand safely)	525 rpm
27	Factor of safety at runaway speed	1.5 minimum
28	Excitation system	
28.1	Type	Static
28.2	Voltage	316 volts
28.3	Field current at full load on Generator at 0.9 p.f lag at rated voltage	935 amps
28.4	Field current at 110% load on Generator at 0.9 p.f lag at rated voltage	976 amps
28.5	Field current on no-load at rated voltage	576 amps
29	Generator air coolers	
29.1	No. of coolers	6
29.2	Cooling water requirement at full load on generator	3900 liters per minute
30	Air pressure for brakes	7 kg/cm^2
31	Oil pressure for jacking	85 kg/cm^2
32	Brake application speed	60 rpm
33	Slip-ring and brushes	
33.1	No. of carbon brushes	15 per rings, total 30
33.2	Size	25.4 x 38.1 mm
33.3	Spring load	1.7 kg on each brush

Sl. No.	Descriptions	Design Values
34	Anti-condensation heaters	10.2 kW total, 3-phase, 415 V, 8 Nos. per phase (total 24 Nos.) connected in star
35	Basic data of Turbine	
35.1	Type	Vertical Shaft Pelton Turbine
35.2	Number of jets	6
35.3	Speed	300 RPM
35.5	Rated output at rated net head	116,500 MHP (approx. 85.68 MW)
35.6	Maximum Output at maximum net head	128,150 MHP (approx. 94.25 MW)
35.7	Efficiency at rated output and rated net head	90.55%

Annexure-2

Tentative schedule for replacement of Unit II and Unit IV generators and ancillaries of all Unit.

Sl. No.	Activity	Start Date	End Date	Duration (Days)
1	Signing of contract agreement	01.08.2022	01.08.2022	1
2	Approval of drawings	02.08.2022	02.10.2022	60
3	Design, manufacture and supply of complete materials for replacement of one (01) generator (Unit IV).	03.10.2022	03.06.2023	240
4	Building of new stator at service bay, testing and ready for lowering.	04.06.2023	05.11.2023	150
5	Design, manufacture and supply of generator ancillaries of two (02) units (Unit 1 and Unit IV)	03.10.2022	04.10.2023	356
6	Complete replacement of generator stator of one (01) Unit (Unit IV) along with its ancillaries and generator ancillaries of one (01) Unit (Unit I)	05.10.2023	06.05.2024	210
7	Design, manufacture and supply of complete materials for replacement of one (01) generator (Unit II) along with its generator ancillaries and generator ancillaries of one (01) Unit (Unit III).	03.10.2022	04.05.2024	575
8	Building of new stator at service bay, testing and ready for lowering.	05.05.2024	05.11.2024	180
9	Complete replacement of generator stator of one (01) Unit (Unit II) along with its generator ancillaries and generator ancillaries of one Unit (Unit III)	06.11.2024	05.05.2025	210