



BHARAT HEAVY ELECTRICALS LIMITED
CORPORATE RESEARCH & DEVELOPMENT
DIVISION
VIKASNAGAR, HYDERABAD - 500 093, INDIA

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ENQUIRY

Ref: 431700991

Date 24-08-2017

Enquiry for High Temperature Vertical Spin Test Rig and Auxiliaries

Enquiry No:431700991 Enquiry Date : 24-08-2017 Due Date: 23-09-2017 Indicative Delivery Date : 31-12-2018

Sl.No	Item Description	Unit	Qty
1	High Temperature Spin Test Rig (HTSTR) & Auxiliaries	SET	1
2	Installation, Commissioning & Training of HTSTR at BHEL R & D	L.S.	1
3	Mandatory Spares beyond Warranty Period	SET	1

Please submit your quotation for the above material in sealed cover superscribed with enquiry no, enquiry date and due date subject to our enclosed terms and conditions. The quotations shall reach us on or before the due date by 12 noon. The tenders can also be dropped in the tender box kept at the security gate, BHEL R&D. In case you are not in position to submit the offer, please send reply suitably specifying the reasons.

Sl. No.	Description	Document Ref.
1	Pre-Qualification criterion (PQC), Commercial Terms & Conditions and Integrity Pact.	Volume - 1
2	Technical specifications, Scope of Supply etc.	Volume - 2

Virendra Dixit
AGM-P
virendradixit@bhel.in

Volume: 1

**Pre-Qualification criterion (PQC), Commercial Terms
& Conditions and Integrity Pact.**



PRE QUALIFYING CRITERIA(PQC)

Volume - 1
Enquiry No
431700991

High Temperature Vertical Spin Test Rig and Auxiliaries

SL.No.	Clause	BHEL REQUIREMENT	SUPPLIERS ACCEPTANCE / REMARKS
1	OEM of HTSTR	Vendor on whom PO will be placed must be the Original Equipment Manufacturer (OEM) and supplier of this "High Temperature Vertical Spin Test Rig System". Country of OEM must also be the country of origin. Country of origin certificate issued by the chamber of commerce to be submitted as a proof of compliance at the time of dispatch.	
2	Prior Experience	Only those vendors who have supplied and commissioned at least one test rig for spinning of Test rotors of weight 1000 kg (or more) and at temperature 600 deg. C (or more) and at speeds of 3600 rpm (or more), in the past ten years as on date of enquiry and the supplied test rig is working satisfactorily for a cumulative operating hours of minimum 500 hours in the last three years, prior to date of this enquiry.	
3	Prior Turnover	The vendor should have an annual turnover of 2.5 million dollars for the last two years.	
4	Reference details to be furnished	The vendor shall furnish following details (details to be given in the format as enclosed in Annexure-VI) of such customer to whom such equipment has been supplied: a) Name of the customer / company where such equipment is installed. b) Month and Year of commissioning c) Parameters of supplied spin facility: i. Capacity of test rig supplied, kg ii. Maximum spinning speed for 1000 kg (or more) test rotor. iii. Maximum uniform rotor temperature achieved in deg. C d) Complete postal address of the customer and Name and Designation of the contact person e) Phone, Fax no., and E-	

		mail address of the contact person of the customer. f) Equipment Performance certificate shall not be older than 18 months from the enquiry date. BHEL will carry out independent verification of performance certification. Hence, prospective vendors are required to give only reference of those customers who are willing to confirm independent verification and not refrain from the same on the grounds of confidentiality.	
	Relaxation of Norms for Startups	The condition of Prior Turnover and prior experience is relaxed for all startups whether Micro & Small Enterprises(MSEs) or otherwise subject to meeting of quality and technical specifications in accordance with the relevant provision of GFR,2005 and other DOE-PPD notifications for relaxation norms for startups issued from time to time.	

Signature of the bidder with Seal & Date

COMMERCIAL TERMS & CONDITIONS (CTC)-1

Commercial Clause / Term		BHEL Requirement	Vendor's Acceptance/ Deviation with Remarks
TWO PART	Paper Bid offers	Please submit your offer in one common sealed cover containing two parts in separate sealed covers as detailed below. 1) First Cover shall contain: a. Filled and Signed Commercial Terms & Conditions 1 to 5 (CTC) c. Filled and Signed Vendor Specifications against BHEL Specifications (Item wise) d. Signed commercial bid e. Copy of Price-bid with price(s) cells blank (un-priced price bid) 2) Second cover shall contain Price Bid Containing Price quotes, applicable taxes, Erection & Commissioning (E&C) charges. E&C charges shall be spelt out clearly taking into account total charges rather than quoting vaguely such as charges per man-day or charges per engineer per day etc.	
	e-offers	The offers can also be submitted through e-mail and have to be sent in PDF format (files with PDF extension only). Files having extensions other than PDF and with external links are not to be sent. They have to be sent to e-mail id: 'eoffers@bhel.in' only. Copies should not be marked to anyone. The e-mail offers should have two attachments. 1) One attachment shall contain a. Filled and Signed Commercial Terms & Conditions-1 to 5 (CTC) c. Filled and Signed Vendor Specifications against BHEL Specifications (Item wise) d. Signed commercial bid e. Copy of Price-bid with price(s) cells blank (un-priced price bid), 2) Second attachment shall contain Price Bid Containing Price quotes, applicable taxes, Erection & Commissioning (E&C) charges. E&C charges shall be spelt out clearly taking into account total charges rather than quoting vaguely such as charges per man-day or charges per engineer per day etc. The subject of the e-mail should contain Enquiry No, Enquiry Date and Due date	
Late Tenders		Tenders received after due date/time (12:00hrs) will not be considered	
Validity of Offer		90 days from date of techno-commercial bid opening.	
Over All L1		The Tender is non divisible type. Order will be placed on overall L1 basis. Vendors should quote for all items.	
Discrepancy in words and figures		If there is a discrepancy between words and figures, the amount in words shall prevail, unless the amount expressed in words is related to an arithmetic error, in which case the amount in figures shall prevail	
Packing		The supplier shall be responsible for the goods being properly and adequately packed so as to prevent any loss, damage or deterioration during transit.	
Relaxation of Norms for Start Ups		Relaxation of Norms for Start Ups is subject to meeting quality and Technical Specifications and having Technical Capabilities, Manufacturing, assembly and testing facilities The same will be assessed by BHEL through a committee. The vendor needs to submit all the necessary documents as per start up guidelines.	
Micro Small Enterprises (MSEs)		Preferences as mentioned in PPP of MSEs Order 2012 shall be given to MSEs for divisible tenders subject to production of statutory documents like Udyog Aadhar Memorandum etc. In tenders, participating MSEs quoting within L1+15% shall be allowed to supply a portion (20% for others incl. 4% for SC/ST if they match L1 Price subject to MSEs guidelines as per GOI.	

COMMERCIAL TERMS & CONDITIONS (CTC)-2

Commercial Clause / Term	BHEL Requirement	Vendor's Acceptance/ Deviation with Remarks
Delivery for Foreign Vendors	Destination-BHEL R.O.D Office, Mumbai, India for sea consignments. Quotes on CFR (Cost including Freight) –Mumbai/Nhava Sheva/Chennai Sea Port basis are preferred. or For Quotes on FOB (Free On Board) basis. Nearest Sea port & BHEL Freight Forwarder will be intimated. (For e.g. For USA, it is FOB-New York/Norfolk and for Germany-Hamburg etc.)	
Delivery for Indian Vendors	Destination shall be Stores, BHEL R&D, Vikasnagar, Hyderabad-500093	
AMC	AMC charges quoted shall be firm for the period quoted. If AMC order is placed on Indian Office/Agent, the payment will be in INR based on exchange rates on tender opening date with applicable TDS. If AMC is with Foreign vendor, the same will be as per DTAA rules.	
Evaluation of Foreign offers	1) All offers in price bid opening shall be evaluated in Indian currency based on unit price, packing & forwarding, taxes/duties, freight & Insurance charges. The exchange rate declared by State Bank of India under TT Selling rate on the techno-commercial bid opening date shall be adopted for evaluating the offer. 2) Loading due to non-acceptance of our standard commercial terms (payment terms, penalty) will be done. Details are provided at the respective terms (Commercial Terms & Conditions No.5). 3) Custom duty @ 5.15% & applicable IGST will be considered for items. 4) Freight & Insurance will be arranged by BHEL for FOB basis supplies. In such cases, an amount of 3% towards freight and insurance will be added for price comparison 5) Taxes & Duties quoted will be taken for evaluation of landed cost & order placement and no change will be entertained later except in the case of changes made by the government. 6) L1 status shall be decided on Cost to BHEL Basis.	
Evaluation of Indian offers	In case any Taxes/ Duties exempted, a self-declaration for the same may be attached to the offer. Changes in taxes and duties because of the changes in turn over etc. will be to supplier's account. Indian Vendors with GST registration only can participate in the tender. The evaluation of Indian Offers will be at total cost to the company including taxes and duties after deducting Input tax credit (ITC) where ever available.	
Banned List	The offers of the bidders who are in the banned list and the offers of the bidders who engage the services of the banned firms, shall be rejected. The list of banned firms is available on BHEL website www.bhel.com . Guidelines for suspension of business dealings with suppliers/contractors are available on www.bhel.com under supplier registration page	
Arbitration	Subject to the jurisdiction of Hyderabad/ Secunderabad, Andhra Pradesh, India in respect of any suit or other legal proceedings relating this contract.	
Fraud Prevention Policy	The Bidder along with its associate/collaborators/ sub-vendors/consultants/service providers shall strictly adhere to BHEL Fraud Prevention Policy displayed on BHEL website http://www.bhel.com and shall immediately bring to the notice of BHEL Management about any fraud or suspected fraud as soon as it comes to their notice	
Additional Information	Suppliers are requested to visit our web site regularly for any updates and additional information, "All corrigenda, addenda, amendments, time extensions clarifications, etc. to the tender will be hosted on BHEL website only". The corrigendum will not be published in newspaper. Latest D&B reports has to be submitted by foreign vendor.	

COMMERCIAL TERMS & CONDITIONS (CTC)-3

Commercial Clause / Term	BHEL Requirement	Vendor's Acceptance/ Deviation with Remarks
AGENCY AGREEMENT	Guidelines regarding dealing with Indian agents of foreign suppliers. 1. BHEL shall deal directly with foreign vendors, wherever required, for procurement of goods. However, if the foreign principal desires to avail of services of an Indian agent, then the foreign principal should ensure compliance to regulatory guidelines which require mandatory submission of agency agreement. 2. It shall be incumbent on the Indian agent and the foreign principal to adhere to the relevant guidelines of government of India, issued from time to time. 3. The agency agreement should specify the precise relationship between the foreign OEM and services to be rendered by Indian agent / associate, whether general in nature or in relation to the particular contract, must clearly be stated by the foreign supplier / Indian Agent. Any payment, which the Indian agent / associate receives in India or abroad from the OEM, whether as commission or as a general retainer fee shall be brought out in record in the agreement and be made explicit in order to ensure compliance to the laws of the country 4. Any agency commission to be paid by BHEL to the Indian agent shall be Indian currency. 5. Whenever Indian agents are representing on behalf of their principals, the relevant authorization letter and agreement copy to be enclosed along with technical bid to consider the offer	

COMMERCIAL TERMS & CONDITIONS (CTC)-4

Commercial Clause / Term	BHEL Requirement	Vendor's Acceptance/ Deviation with Remarks
INTEGRITY PACT & DETAILS OF INDEPENDENT EXTERNAL MONITOR (IEM)	Integrity Pact (IP) (a) IP is a tool to ensure that activities and transactions between the Company and its Bidders/ Contractors are handled in a fair, transparent and corruption free manner. A panel of Independent External Monitors (IEMs) have been appointed to oversee implementation of IP in BHEL. The IP as enclosed with the tender is to be submitted (duly signed by authorized signatory who signs in the offer) along with techno-commercial bid. Details of IEM for this tender is furnished below: Name : Shri D.R.S Chaudhary, IAS (Retd.) E-1/164 Arera Colony Bhopal 462016 dilip.chaudhary@icloud.com (b) Please refer Section-8 of IP for Role and Responsibilities of IEMs. In case of any complaint arising out of the tendering process, the matter may be referred to the IEM mentioned in the tender. Note: No routine correspondence shall be addressed to the IEM (phone/ post/ email) regarding the clarifications, time extensions or any other administrative queries, etc on the tender issued. All such clarification/ issues shall be addressed directly to the tender issuing (procurement) department For all clarifications/ issues related to the tender, Please contact: Name: Sri Virendra Dixit, AGM Dept: Material Management Dept. Address: Corporate R&D Division, Bharat Heavy Electricals Limited Vikas Nagar, Hyderabad-500093 Phone (Landline) : +91 40 23882304 Phone (Mobile) : +91 9818115562 Email: virendradixit@bhel.in Fax: :+91 40 23770698	

COMMERCIAL TERMS & CONDITIONS (CTC)-5

Commercial Clause / Term	Description	BHEL Requirement	Vendor's Acceptance/ Deviation with Remarks
PAYMENT TERMS	BHEL Standard Payment Terms for Indian Offers	90% payment along with taxes by EFT/RTGS within 30 days of receipt and acceptance of material at BHEL R&D Stores, Hyderabad. Balance 10% +E&C amount charges within 30 days of completion of E&C on submission of bank Guarantee. GST Payment on submission of proof of remittance.	
	BHEL Standard Payment Terms for Foreign Offers	90% Invoice value by wire transfer within 30 days of receipt and acceptance of material at BHEL R&D Stores, Hyderabad. B Balance 10% +E&C amount charges within 30 days of completion of E&C on submission of bank Guarantee.	
	Milestone Payment terms (Vendor to specify) Total Milestone Payments shall not exceed 90% of the Test Rig Price	If the Vendor does not agree for the above BHEL Standard Payment terms and insists for Milestone Payments, Bank guarantees equivalent to the mile stone payments are to be provided.	
		Validity period and Format of the Bank Guarantees will be mutually agreed before price bids are opened.	
		Interest @ (SBI Base Rate on tender opening date+6%) on the mile stone payments for the period from payment date till delivery will be loaded on the Test Rig Price as cost to BHEL for offer evaluation. SBI Base rate is approx. 9%	
DELIVERY PERIOD	Delivery Period for Supply	BHEL's preferred Delivery period for supply is 12 months from Date of Purchase Order. Vendors may quote the best possible delivery period. This will be finalised mutually before price bids are opened	
	Period for Erection & Commissioning	BHEL's preferred E&C period is 2 months from receipt of Test Rig at BHEL and readiness of Site. Vendors may quote the best possible E&C period. This will be finalised mutually before price bids are opened	
PENALTY FOR DELAYED DELIVERY / E&C	Penalty for Delay in Supply of Test rig from the mutually agreed delivery date which will be decided before price bids are opened	The rate of penalty for delay in supply shall be @0.5% per week of total PO Value for the delayed supply period subject to a maximum of 10% total PO value.	
		If Vendor prefers for X% which is less than 10% of the PO Value, Loading @ (10-X) % on the Total PO value will be applied as cost to BHEL for offer evaluation.	
	Penalty for Delay in E&C of Test rig from the mutually agreed E&C period which will be decided before price bids are opened.	The rate of penalty for delay in E&C shall be @0.5% per week of total PO Value for the delayed E&C period subject to a maximum of 5% total PO value.	
		If Vendor prefers for Y% which is less than 5% of the PO Value, Loading @ (5-Y) % on the Total PO value will be applied as cost to BHEL for offer evaluation.	
	GST on Penalty	GST on Penalty will be deducted for Indian vendors	
WARRANTY	BHEL Minimum acceptable Warranty	12 months from the date of completion of E&C or 18 months from date of dispatch whichever is earlier.	
	Bank Guarantee for the Warranty period	Bank Guarantee for this warranty period to be provided	
		Validity Period and Format of the Bank Guarantee will be mutually agreed before price bids are opened	

INTEGRITY PACT

Between

Bharat Heavy Electricals Ltd. (BHEL), a company registered under the Companies Act 1956 and having its registered office at —BHEL House“, Siri Fort, New Delhi æ 110049 (India) hereinafter referred to as —The Principal“, which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the ONE PART

and

_____,
(description of the party along with address), hereinafter referred to as —The Bidder/ Contractor“ which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the OTHER PART.

Preamble

The Principal intends to award, under laid-down organizational procedures, contract/s for

_____. The Principal values full compliance with all relevant laws of the land, rules and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder(s)/ Contractor(s).

In order to achieve these goals, the Principal will appoint Independent External Monitor(s), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1 - Commitments of the Principal

1.1 The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles:-

1.1.1 No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.

1.1.2 The Principal will, during the tender process treat all Bidder(s) with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential / additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.

1.1.3 The Principal will exclude from the process all known prejudiced persons.

1.2 If the Principal obtains information on the conduct of any of its employees which is a penal offence under the Indian Penal Code 1860 and Prevention of Corruption Act 1988 or any other statutory penal enactment, or if there be a substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions.

Section 2 - Commitments of the Bidder(s)/ Contractor(s)

2.1 The Bidder(s)/ Contractor(s) commit himself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the tender process and during the contract execution:-

- 2.1.1 The Bidder(s)/ Contractor(s) will not, directly or through any other person or firm, offer, promise or give to the Principal or to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material, immaterial or any other benefit which he / she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.
- 2.1.2 The Bidder(s)/ Contractor(s) will not enter with other Bidder(s) into any illegal or undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.
- 2.1.3 The Bidder(s)/ Contractor(s) will not commit any penal offence under the relevant IPC/ PC Act; further the Bidder(s)/ Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.
- 2.1.4 The Bidder(s)/ Contractor(s) will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.
- 2.2 The Bidder(s)/ Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

Section 3 - Disqualification from tender process and exclusion from future contracts

If the Bidder(s)/ Contractor(s), before award or during execution has committed a transgression through a violation of Section 2 above, or acts in any other manner such as to put his reliability or credibility in question, the Principal is entitled to disqualify the bidder(s)/ Contractor(s) from the tender process or take action as per the separate "Guidelines on Banning of Business dealings with Suppliers/ Contractors" framed by the Principal.

Section 4 - Compensation for Damages

- 4.1 If the Principal has disqualified the Bidder from the tender process prior to the award according to Section 3, the Principal is entitled to demand and recover the damages equivalent Earnest Money Deposit/Bid Security.
- 4.2 If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to section 3, the Principal shall be entitled to demand and recover from the Contractor liquidated damages equivalent to 5% of the contract value or the amount equivalent to Security Deposit/Performance Bank Guarantee, whichever is higher.

Section 5 - Previous Transgression

- 5.1 The Bidder declares that no previous transgressions occurred in the last 3 years with any other company in any country conforming to the anti-corruption approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.
- 5.2 If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

Section 6 - Equal treatment of all Bidders/ Contractors/ Sub-contractors

- 6.1 The Bidder(s)/ Contractor(s) undertake(s) to obtain from all subcontractors a commitment consistent with this Integrity Pact and report Compliance to the Principal. This commitment shall be taken only from those sub-contractors whose contract value is more than 20 % of Bidder's/ Contractor's contract value with the Principal. The Bidder(s)/ Contractor(s) shall continue to remain responsible for any default by his Sub-contractor(s).
- 6.2 The Principal will enter into agreements with identical conditions as this one with all Bidders and Contractors.
- 6.3 The Principal will disqualify from the tender process all bidders who do not sign this pact or violate its provisions.

Section 7-Criminal Charges against violating Bidders/Contractors/Sub-contractors

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

Section 8 -Independent External Monitor(s)

- 8.1 The Principal appoints competent and credible Independent External Monitor for this Pact. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.
- 8.2 The Monitor is not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the CMD, BHEL.

- 8.3 The Bidder(s)/ Contractor(s) accepts that the Monitor has the right to access without restriction to all contract documentation of the Principal including that provided by the Bidder(s)/ Contractor(s). The Bidder(s)/ Contractor(s) will grant the monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his contract documentation. The same is applicable to Sub-contractor(s). The Monitor is under contractual obligation to treat the information and documents of the Bidder(s)/ Contractor(s) / Sub-contractor(s) with confidentiality.
- 8.4 The Principal will provide to the Monitor sufficient information about all meetings among the parties related to the contract provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the Monitor the option to participate in such meetings.
- 8.5 As soon as the Monitor notices, or believes to notice, a violation of this agreement, he will so inform the Management of the Principal and request the Management to discontinue or take corrective action, or heal the situation, or to take other relevant action. The Monitor can in this regard submit non-binding recommendations. Beyond this, the Monitor has no right to demand from the parties that they act in a specific manner, refrain from action or tolerate action.
- 8.6 The Monitor will submit a written report to the CMD, BHEL within 8 to 10 weeks from the date of reference or intimation to him by the Principal and, should the occasion arise, submit proposals for correcting problematic situations.
- 8.7 The CMD, BHEL shall decide the compensation to be paid to the Monitor and its terms and conditions.
- 8.8 If the Monitor has reported to the CMD, BHEL, a substantiated suspicion of an offence under relevant IPC / PC Act, and the CMD, BHEL has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the Monitor may also transmit this information directly to the Central Vigilance Commissioner, Government of India.

8.9 The number of Independent External Monitor(s) shall be decided by the CMD, BHEL.

8.10 The word "Monitor" would include both singular and plural.

Section 9 - Pact Duration

9.1 This Pact begins and shall be binding on and from the submission of bid(s) by bidder(s). It expires for the Contractor 12 months after the last payment under the respective contract and for all other Bidders 6 months after the contract has been awarded.

9.2 If any claim is made / lodged during this time, the same shall be binding and continue to be valid despite the lapse of this pact as specified as above, unless it is discharged/ determined by the CMD, BHEL.

Section 10 - Other Provisions

10.1 This agreement is subject to Indian Laws and jurisdiction shall be registered office of the Principal, i.e. New Delhi.

10.2 Changes and supplements as well as termination notices need to be made in writing. Side agreements have not been made.

10.3 If the Contractor is a partnership or a consortium, this agreement must be signed by all partners or consortium members.

10.4 Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions.

10.5 Only those bidders/ contractors who have entered into this agreement with the Principal would be competent to participate in the bidding. In other words, entering into this agreement would be a preliminary qualification.

For & On behalf of the Principal
(Office Seal)

For & On behalf of the Bidder/ Contractor
(Office Seal)

Place-----

Date-----

Witness: _____

Witness: _____

(Name & Address) ____

(Name & Address) _____

Volume: 2

Technical specifications, Scope of Supply etc.

SPECIFICATIONS FOR HIGH TEMPERATURE VERTICAL SPIN TEST RIG SYSTEM

S.No	Description	BHEL Specification(s)	Vendor Specification	Remarks
1.	SCOPE	Design, Supply, Erection and Commissioning of High Temperature Vertical Spin Test rig System for LCF and Creep testing consisting of 1.1. Test Chamber to spin a solid rotor with controlled heating and cooling system 1.2. Safety provisions for rotor burst conditions 1.3. Electrical Heating system to provide radiation heating (Refer clause 3.7) 1.4. Cooling system by Nitrogen gas (Refer clause 3.8) 1.5. Sensor system consisting of high temperature strain measurement system using high temperature strain gauges, crack monitoring system, temperature measurement sensors and accessories, 1.6. Control logics for all the above 1.7. Data acquisition system Complying with specifications as detailed in the following sections.		
2.	PURPOSE & TEST ROTOR DETAILS	2.1. This specification is intended for spinning test rotors for 200 cycles continuously each with a mutually agreed periodic maintenance shutdown.(Refer Annexure-I for spin parameters and Annexure-III for test rotor drawing details)		
		2.2. Test rig should be capable of handling the test rotor with the following details: a) Test rotor Weight: 5000 to 9000kgs b) Speed: 0 - 3800 rpm c) Diameter: 800-1500 mm d) Temperature range: 25 - 800 deg. C e) Height of rotor: 750 to 1500 mm f) Polar mass moment of inertia: 400 to 1200 Kg-m²		
		2.3. Proposed Spin System will be used for spinning of test rotor. Spinning of test rotors shall be carried out at high temperature up to 800 deg. C at specified speeds and at less than one Torr absolute pressure, for continuous operation of 200 cycles (Refer Annexure-I).		

		2.4. Spin test methodology: a) Test Rotor shall be mounted on the Rotor Assembly Stand. b) Strain gauges and thermocouples shall be mounted at various pre-selected points as per Annexure-IV: A & IV: B. c) Chamber Lid shall be lifted from Spin Chamber by Lid Vertical Lift Mechanism and aligned with rotor on the assembly stand by Lid Swivel Arrangement. The rotor shall be assembled and secured with lid spindle. d) The Chamber Lid along with the test rotor shall be swiveled back and aligned to Spin Chamber, secured and vacuum sealed with Automatic Lid Locking Device. e) Vacuum System will be live during heating and soaking (steady state heating) and shall be off during cooling. Nitrogen gas will be circulated for cooling the rotor. f) Coast up, Heating, cooling cycle and coast down shall be as per Annexure-I		
		2.5. The spin test facility should have feature for in-situ balancing		
3.0	SPIN SYSTEM CONFIGURATION	The spin test system shall consist of the following subsystems/components: 3.1 Spin chamber 3.2 Chamber Lid with swivel arrangement for loading/unloading of rotor and with automatic locking and vacuum sealing system. 3.3 Drive system 3.4 Rotor Assembly Stand 3.5 Lube oil system 3.6 Vacuum system 3.7 Integrated heating System 3.8 Integrated cooling System 3.9 Instrumentation & Sensor system 3.10 Data Acquisition & Control System 3.11 Electrical System 3.12 Essential Tool kit 3.13 Recommended Spares Beyond Warranty Period Note: Vendor shall mention the make and model of the components which goes into the above systems and subsystems including software. If any subsystem or component procured from India, same shall be complied with Bureau of Indian Standard (BIS).		
3.1	SPIN CHAMBER	The spin chamber shall be designed to meet the parameters and test conditions (refer clause 2.2, 3.6, 3.7 and 3.8) 3.1.1 The Spin Chamber shall be so designed to withstand any failure of the test rotor during spinning and the damage shall be contained within the chamber		

		3.1.2 The Spin Chamber system shall have thermal insulation to maintain the metal temperature outside the chamber ≤ 60 deg. C		
3.2	CHAMBER LID	3.2.1 Vendor should ensure the following in chamber lid: a) Holding of test rotor which spins up to 3800 rpm b) Holding of entire drive system, coupling, thrust bearing, telemetry system, etc. c) Facilitate routing of electrical, control & instrumentation and sensors cables d) Vacuum sealing, thermal insulation and rotor expansion e) Automatic lid locking system with indicators f) Lifting and swivel mechanism with necessary lift and swivel angle with required clearances to bring the rotor outside the spin chamber and to park the rotor on the stand and vice versa g) Enable all operations such as rotation, opening, closing, lifting up and down etc. only if all the interlock permissions are cleared h) Ambient temperature of the Chamber lid outside the chamber shall be maintained less than ≤ 60 deg. C.		
3.3	DRIVE SYSTEM	3.3.1 The drive shall be capable of handling the test rotors with all the parameters mentioned in Annexure-III . 3.3.2 Vendor should provide the details of holding/coupling arrangement of the test rotor with the drive spindle and provision to be made in the test rotors for assembling in the Test rig within 60 days of purchase order acknowledgement. 3.3.3 Schematic of the Drive system along with bearing and supports details to be provided within 60 days of purchase order acknowledgement. 3.3.4 The drive shall have automatic stop for emergency situations such as abnormal increase in temperature of rotor, chamber temperature, excessive vibration and speed, vacuum drop, cooling gas pressure, bearing temperature, crack initiation and propagation beyond permissible limits as set by the user and any other situations envisaged by the vendor which do not meet the safety requirements. An option for manual override of any set limit shall be provided. Vendor also to provide manual switch for stopping the system. 3.3.5 Drive power (continuous duty) suitable for acceleration of rotors to rated speeds with acceleration of minimum 200 rpm/min (Refer Annexure-I) 3.3.6 Vendor shall provide variable frequency drive for drive system. Offers with hydraulic or pneumatic drive are not acceptable and they will be summarily rejected without any further correspondence 3.3.7 The speed shall be regulated within ± 15 rpm.		

		3.3.8 One additional drive motor to be supplied along with the system and the cost shall be included in the offer. 3.3.9 Drive system shall have thermal insulation to maintain the temperature of the drive shaft outside the chamber ≤ 60 deg. C. 3.3.10 The AC drive system shall have protection for • Short-circuits between motor and phases • Over current between motor phases and earth • Overheating (thermal protection) • Input phase loss protection, in three-phases • Line over voltage and under voltage • Over frequency/speed operation 3.3.11 The control panel shall be provided with following minimum controls • Start / stop • Speed control (Raise / lower) • Acknowledge/Accept/ Test Push Button for annunciation • Auto / Manual / Test Mode select • Emergency stop Note: Provisions for remote commands and monitoring from HMI shall be provided 3.3.12 Digital display of the following parameters shall be as a part of the Operator Control Panel, selectable by the operator • Input AC voltage, frequency and Current • Output voltage • Output current VFD • Output frequency • Motor running/Motor stopped • VFD System Fault and VFD ON & OFF • System ready to start • Motor speed • Necessary transducer shall be provided with 4-20mA output for indicating motor speed and motor current in control panel. • kW monitoring • kWh monitoring		
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		• Power factor 3.3.13 Vendor shall design the drive system such that the critical speed of rotors shall not fall in between 2700 rpm to 3960 rpm. Vendor shall submit the calculation details within 60 days of purchase order acknowledgement. 3.3.14 Vendor shall ensure the drive train to sustain the misalignment arising out of assembly with the test rotors		
3.4	ROTOR ASSEMBLY STAND	3.4.1 Vendor shall design and supply suitable assembly stand to hold, assemble the rotor and its tooling on to the lid cover. 3.4.2 Vendor shall supply suitable tool to measure the rotor diameter with an accuracy of ± 0.05 mm on the assembly stand.		
3.5	LUBE OIL SYSTEM	3.5.1 Vendor to supply Lube Oil Tank with initial fill and specify the tank capacity (in liters) to meet the continuous operations. Frequency of replenishment and replacement of lube oil to be specified. 3.5.2 Motor driven oil pump along with standby shall be provided by the vendor. 3.5.3 Filters, valves, mist elimination system, piping, auxiliaries and all necessary systems to be supplied. 3.5.4 Heat exchanger to cool lube oil. 3.5.5 Emergency lube oil supply in case of power failure, till the test rotor comes to stand still. 3.5.6 Monitoring and control equipment for oil level, oil temperatures, oil quality checking test kit, duplex filters with differential pressure measurements, discharge pressure, flow and any other control parameters which are essential for safe & continuous operation of the Test rig are to be provided. 3.5.7 Necessary interlock in controls shall be provided to safe guard the Test rig and rotor in case of failure in lube oil system. Interlock integration with main control and instrumentation to be provided. 3.5.8 Schemes, equipment technical data sheets and lube oil specification with grade to be submitted with the offer.		

3.6	VACUUM SYSTEM	3.6.1 Vacuum System shall be capable to create & maintain required vacuum of ≤ 1 Torr absolute pressure in spin chamber to meet the requirement of test cycles as given in Annexure-I. 3.6.2 Vacuum system shall have instrumentation to measure, indicate and record vacuum level and any other control parameters which are essential for safe & continuous operation of the system. 3.6.3 System shall have suitable provision to kill the vacuum in spin chamber whenever required, in the shortest possible time 3.6.4 All piping and conduit works between spin chamber and vacuum system shall be provided by vendor 3.6.5 100% redundancy in vacuum system to continuously maintain the required vacuum during heating cycle and steady state operation of the test rotor. In case of failure of one set of vacuum system, the redundant vacuum system shall start automatically for uninterrupted testing.		
3.7	INTEGRATED HEATING SYSTEM FOR TEST ROTORS	3.7.1 Vendor shall provide heating power requirement for heating of the rotors inside spin chamber to temperatures as per the test cycle indicated in Annexure-I 3.7.2 The system shall be capable of heating of the test rotor up to 800 deg. C 3.7.3 BHEL calculated heater power requirement is 200 kW. Vendor shall also calculate the heater power required for heating the mono metallic rotor (Annexure-III) up to 800 deg. C with at least 10% margin. Vendor shall supply the heaters with a capacity of higher of BHEL specified and vendor calculated. 3.7.4 Instrumentation for monitoring and recording of rotor surface temperature and difference between rotor surface & rotor bulk mean temperature during heating shall be provided along with audio visual indicator once the set value is reached. 3.7.5 Instrumentation for monitoring and recording of temperature of heating elements, chamber and any other control parameters which are essential for safe & continuous operation of the system. 3.7.6 Heating system shall have instrumentation to control heating power, temperature of heating elements for maintaining of rotor surface temperature and temperature difference between rotor surface & rotor bulk mean during heating as per Annexure-I. 3.7.7 Preliminary details of the proposed heating system shall be provided along with the offer. Vendor shall provide detailed design calculations for heating system and heating time within 60 days of purchase order acknowledgement.		

		3.7.8 Rotor bulk mean temp shall be calculated (weighted area average) by the measured temperatures from the 50 mm axially penetrated thermocouples on the rotor top and/or bottom end surfaces at different radial locations. 3.7.9 Vendor shall provide control logic/facility of heaters for achieving required heating cycle as per Annexure-I		
3.8	INTEGRATED COOLING SYSTEM FOR TEST ROTORS	3.8.1 Vendor shall provide closed loop nitrogen gas based cooling system for cooling of the rotors inside spin chamber to temperatures as per the test cycle indicated in Annexure-I 3.8.2 The system shall be capable of cooling the test rotors up to ambient temperature 3.8.3 BHEL minimum cooling requirements are • Nitrogen mass flow rate 1kg/s • Pressure to meet the system resistance as calculated by vendor • Maximum Inlet temperature of Nitrogen is 65 deg. C • Vendor shall calculate the cooling system requirement with at least 10% margin and supply the higher of BHEL specified and Vendor calculated. 3.8.4 Instrumentation for controlling, monitoring and recording of rotor surface temperature and rotor bulk mean temperature during cooling shall be provided along with audio visual indicator once the set value is reached. 3.8.5 Cooling system shall have instrumentation to measure, indicate and record temperature, pressure, mass flow rate and any other control parameters which are essential for safe & continuous operation of the system 3.8.6 Preliminary details of the proposed cooling system shall be provided along with the offer document. Vendor shall provide detailed design calculations for cooling system and cooling time within 60 days of purchase order acknowledgement. 3.8.7 100% redundancy of all compressor/blower/fan for continuous operation during cooling cycle of the test rotor. In case of failure of one compressor/blower/fan, the redundant compressor/blower/fan shall start automatically for uninterrupted testing. 3.8.8 Vendor to provide control logic/facility for cooling system to achieve the required cooling rate as per Annexure-I by varying mass flow rate and speed of the rotor. 3.8.9 Vendor shall provide all the required inputs such as Design calculations, drawings and documents which are mandatory for statutory approvals for nitrogen handling system. Vendor shall provide necessary support for obtaining approval and operational license from Chief Controller of Explosive, Nagpur, India prior to installation & commissioning of nitrogen cooling system.		

		3.8.10 Vendor to supply Nitrogen gas Tank and specify the tank capacity (in liters) to meet the continuous operations. Frequency of replenishment and replacement of Nitrogen gas to be specified. 3.8.11 Vendor has to supply suitable air cooled heat exchanger with 100% redundancy to cool the hot nitrogen.		
3.9	INSTRUMENTATION & SENSOR SYSTEM	The Instrumentation & sensor systems shall be provided as per the following: 3.9.1 Instrumentation to monitor the parameters for the main & sub systems such as speed of the test rotor, temperature (of the heaters, chamber, lid), flow rate and pressure (of nitrogen, lube oil and any other cooling medium), vacuum, accumulated test time etc. and any other control parameters which are essential for safe & continuous running of the Test rig. 3.9.2 Vendor shall supply strain measurement system with 52 no's of strain gauges at different locations on the test rotor (in two perpendicular directions) at elevated temperatures up to 820 deg. C. Vendor shall offer suitable high temperature strain gauges with a minimum drift and compensation for continuous operation. (Refer Annexure IV, IV: A, IV: B). 3.9.3 Vendor shall supply temperature measurement system with 34 no's temperature sensors (thermo couples) - at different locations on the test rotor at elevated temperatures. Vendor shall offer suitable temperature sensors for continuous operation (Refer Annexure-IV, IV:A, IV:B) 3.9.4 Hundred channel Digital Telemetry system for strain (60 no of channels) and for temperature (40 no of channels) of the test rotor during the testing as per Annexure - IV: C. 3.9.5 Fixing of thermo couples and strain gauges on test rotors are in BHEL scope. Fixing of thermo couples and strain gauges on PDI rotor is in Vendor scope. Vendor has to furnish the methodology of fixing as per gauges' supplier and has to supply tooling required for gauge fixing. Tooling Kit for strain gauges: Spot welder kit, MI cable fixing metal belts, weld test metal piece, temperature compensation resistor, bridge balance resistor, bridge adaptor and any other special tools for fixing the gauges need to be supplied 3.9.6 Rotor Radial growth measurement system. 3.9.7 Crack detection & monitoring system 3.9.8 Drive Shaft and bearing housing Vibration monitoring system (minimum three for shaft and three for bearing housing in triaxial directions) at suitable locations which are useful for ensuring the safe operation of the system		

		3.9.9 Rotor residual unbalance severity monitoring and assessment system meeting balance quality G2.5 grade of ISO 1940/1 3.9.10 Vendor has to supply temperatures and strain gauges ahead of Test rig supply in order to fix them on the test rotors during manufacturing at BHEL. The supply date of gauges (thermal and strain gauges) and associated tooling for fixing the gauges as per mutual agreement during PO placement. Note: Vendor shall supply 52 no of high temperature strain gauges and 34 no of thermo couples		
3.10	DATA ACQUISITION & CONTROL SYSTEM	The Data Acquisition & Control System shall be provided as follows: 3.10.1 System shall continuously acquire, monitor and store data for the parameters as mentioned in clause 3.9 during the Test rig operation. Conventional signals can be logged in the data acquisition system. Data from specialized systems like crack detection etc. shall be logged into the main or designated computer 3.10.2 All the above data must be acquired with sampling rate as required for the respective parameters and time stamped in HH:MM:SS format for logging 3.10.3 All the systems shall be operable from the control system through Human Machine Interface (HMI) and operations (including interlocks) required for functioning of all the systems as mentioned in the relevant sections (refer clause 3.1 to 3.8). 3.10.4 The sequence of operations that needs to be ensured before starting of the automatic test cycle. 3.10.5 Automatic control and operation of the test cycle for the test rotor as per Annexure-I. For the test cycle, user configurable parameters for automatic test cycle and corresponding default set values are mentioned in table: 1 of Annexure-I. Start and stop of automatic operation through HMI shall be provided. Stop operation should enable the operator to resume or restore the cycle to starting condition of the test cycle. 3.10.6 Configurable alarm and trip system for any abnormal operations & parameters like temperature, vacuum, speed, pressure, vibration etc. 3.10.7 Single pushbutton to shut down the entire system through HMI. 3.10.8 Automatic Protection system (with all safety interlocks) to shut down the system and ensure the rotor to stand still in case of any malfunction or trip conditions such as motor overload, lube oil low pressure, lube oil high temperature, vacuum failure, high vibration, erratic power supply, under voltage or over voltage etc. and any other control parameters which are essential for system safety 3.10.9 Display in HMI for the following - Flow diagram of the Spin Test rig with all auxiliaries and their operating parameters. - Voltage, Current and power for the main drive and all the auxiliaries		

		iii. Test rotor temperature of various thermo couples mounted on rotors- iv. Test rotor bulk mean temperature (Refer clause 3.7.8) v. Temperature difference between rotor surface and rotor bulk mean (Refer Annexure-I) vi. Chamber wall, lid surface and ambient temperature vii. Heating element temperature viii. Speed of the test rotor ix. Test duration x. No of test cycles completed, current test cycle number and current cursor position in the test cycle xi. Vibration level xii. Crack growth xiii. Vacuum level xiv. Lube oil parameters like flow rate, pressure, temperature, level, pump ON/OFF etc. xv. Nitrogen (Coolant) parameters like flow rate, pressure, inlet & Outlet temperature at chamber, inlet & Outlet temperature at cooler, tank level indicator, pumping system ON/OFF etc. xvi. kW and kWh of entire Test rig for monitoring xvii. AC mains ON, VFD ON & OFF and VFD system fault - xviii. Any other control parameters which are essential for safe & continuous monitoring of the Test rig 3.10.10 Data storage, online trending, retrieval of data to suitable formats (i.e. MS Excel, MS Access, “. CSV”) and provision for data backup. 3.10.11 Customized post processing software tools (Time/spectrum/trend/statistical) for analyzing the stored data. 3.10.12 Data acquisition and control will be through standalone hardware (Input/ Output i.e. I/O modules and real time based controller). The controller should NOT be computer based. The hardware shall be housed in panel or cabinet. Provision for addition of extra I/O modules in panel or cabinet for future use. Specialized sensing systems like crack growth, radial growth, etc. can have separate hardware (data acquisition system i.e. DAS) to send the data to main hardware console. 3.10.13 Hardware console (100% redundancy) with configuration as detailed in Annexure-V for HMI, display, data storage, online trending, retrieval of data, provision for data		
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		backup and Customized post processing software tool. Communication between real time controller and hardware console through LAN. Specification as per Annexure-V 3.10.14 Control system panel or cabinet shall have bottom entry for signal and electrical cables. Suitable no. of cable glands (weather proof) shall be supplied. 3.10.15 Vendor to supply requisite backup power to the control system with online UPS in case of power failure till the main system shuts down safely. 3.10.16 If the offered system (refer clause 3.0) requires hydraulic control for any control operations, corresponding power pack shall also be supplied by vendor. Compressed air will be provided by BHEL. Vendor shall indicate the compressed air requirement (Pressure, Mass flow etc.) along with the technical bid. 3.10.17 Supply of all the signal/control cables shall be in the scope of the vendor. 3.10.18 Vendor shall submit the required layout of control room as per mutually agreed schedule after purchase order acknowledgement. Control Room construction will be in BHEL scope. 3.10.19 Vendor shall develop and supply control logic for heating and cooling system to control heaters and coolant.		
3.11	ELECTRICAL SYSTEM	3.11.1 AC Power Supply of 415 V $\pm 10\%$, 50 Hz ± 2 Hz, 3 Phase and 230 $\pm 10\%$, 50 Hz ± 2 Hz, single Phase will be provided by BHEL at locations near the Test rig, as per layout proposed by vendor and approved by BHEL. All types of switches, cables, connections, circuit breakers etc. required for connecting BHEL's power supply point (Air Circuit Breaker) to different sub systems of the Test rig/control cabinets including UPS shall be supplied by the vendor. If UPS is Indian Make, then it should be Bureau of Indian Standards (BIS) compliant and quoted in INR only. All the electrical components shall have protection, control, indication and metering provisions. 3.11.2 Tropicalisation: All electrical & electronic equipment shall be suitable to the city of Hyderabad, Telangana, India (refer clause 4.2) 3.11.3 All electrical & electronic control cabinets & panels shall be dust proof, vermin proof, flame proof (standard BIS/IEC 60079 or equivalent) and water proof (standard IP65 or equivalent). 3.11.4 All electrical & electronic panels including operator's panel to be provided with adequate door locks, sufficient illumination, power receptacles and plug points of 230 $\pm 10\%$ Volts, 50Hz, 5 & 15 Amp AC with on/off switches. All electrical adapters/receptacles, fittings, consumables etc. shall have compatibility with Indian equivalent standards. Indian make items shall be Bureau of Indian Standard (BIS) compliant. Items procured in India and directly supplied to BHEL shall be quoted in INR only.		

		3.11.5 All motors shall conform to IEC standard. If the motor is Indian make it shall be BIS compliant and quoted in INR only. 3.11.6 All cables moving with traversing axes shall be installed in Caterpillar/ Drag chain. Additionally, all the cable trays required for laying of cables shall be included in the offer. 3.11.7 Vendor should ensure the proper earthing for the Test rig and its peripherals/accessories. Any material requirement for the same shall be informed with design/drawings. The vendor can take earthing connection from the nearest point at the test facility premises. 3.11.8 All the equipment, cards and modules shall be identified with appropriate permanent name plates with equipment description and designation/part No. 3.11.9 All electrical cables shall be tagged on terminal boards and at the panel mounted equipment. 3.11.10 All the control, power and signal cable shall be separately routed to protect from induced electromagnetic interference. 3.11.11 Required firefighting system and safety measures limited to test chamber to be followed are to be supplied and provided.		
3.12	ESSENTIAL TOOL KIT	Vendor shall design, manufacture and supply one set of necessary fixtures and fasteners required for spinning of two test rotors as indicated in Annexure-III . Successful vendor shall provide complete details of all fixtures and fasteners within 60 days of purchase order acknowledgement.		
3.13	RECOMMENDED SPARES BEYOND WARRANTY PERIOD	Necessary mechanical, electrical, electronic and hydraulic spares parts for 5 years of trouble free continuous operation after warranty period to be indicated. Itemized breakup price of spares for the following systems shall be quoted in the price bid. 3.13.1 Spin chamber 3.13.2 Chamber Lid 3.13.3 Drive system 3.13.4 Lube oil system 3.13.5 Vacuum system 3.13.6 Heating System 3.13.7 Cooling System 3.13.8 Instrumentation & Sensor system 3.13.9 Data Acquisition & Control system. 3.13.10 Electrical System 3.13.11 Any other spares which may be required		

		Note-1: Price of recommended spares beyond warranty period will be included in cost comparison. Note-2: Availability of spares is to be ensured for ordering beyond the warranty period, for a min. of 10 years.		
4.0	AMBIENT CONDITION S	4.1. Total system including all supplied items should work trouble free and should give specified performance under local power supply as per clause 3.11.1 and ambient operating conditions, as mentioned below. 4.2. Ambient Operating Conditions: Temperature = 10 to 45 deg. C; Relative Humidity = 95% max. Weather conditions are tropical. Atmosphere may be dust laden during some part of the year. The Test rig and all the subsystems other than the control room equipment shall be kept in the normal shop floor condition without temperature and humidity control. Max. Temperature variation is 25 deg. C in 24 hours. Location: Corp. R&D, BHEL, Hyderabad, Telangana India		
5.0	FOUNDATIO N REQUIRME NTS	The layout to be proposed by vendor and approved by BHEL. The vendor shall supply 3 copies of equipment General Arrangement and foundation drawings and acceptance norms within 60 days of purchase order acknowledgement. Vendor shall supply the design and drawing details to BHEL which shall include information like reinforcement details, construction joints details, details of load considered, Grade of concrete to be used, any anti-vibrational mounting if required. BHEL will provide the foundation as per vendor design. Vendor shall also indicate detailed specifications of grouting compound and any additives, grouting procedure and grouting bolts or any special parts required during the foundation. Any special foundation accessories to be supplied by the vendor shall be listed, quoted and supplied separately ahead of main supply. Vendor may request BHEL for any site data like Soil investigation data, foundation data of adjacent buildings. INDIAN STANDARDS code of practice (for machine foundation, other foundations, for geotechnical data, concrete design etc.) to be followed for the foundation design. Foundation will be made by BHEL.		
6.0	OPERATION AL SAFETY	Following safety features shall be provided: 6.1. Emergency Switches along with safety alarm provisions at suitable locations. Vendor shall provide manual emergency switches at least in two locations i.e. one in control room and one in Test rig area/location.		

		6.2. The rig shall have subsystem check functions for troubleshooting and maintenance purpose. 6.3. Automatic Alarms and protections for over load, overheating, excessive vibration and fire 6.4. Adequate protection for all moving and rotating parts to be ensured. 6.5. All the rotating parts used in the equipment shall be statically & dynamically balanced to avoid undue vibrations & noise. 6.6. Any other safety provisions required for the safe operation of the system to be included		
7.0	ENVIRONMENTAL SAFETY	The Test rig should conform to following factors related to environment: 7.1. Maximum noise level shall not be more than 85 dB (A) at one meter away. Vendor to demonstrate compliance to noise level during PDI and during installation at BHEL R&D. 7.2. No hazardous chemicals shall be used in the equipment. 7.3. If any safety /environmental protection enclosure is required it shall be built in the system by the vendor. 7.4. Paint of the equipment shall be oil/ coolant resistant and should not get peeled off and mixed up with coolant.		
8.0	DOCUMENTATION	8.1. Vendor shall submit following mandatory documents along with offer (all units shall be in SI) in English: 8.1.1. Technical description of complete system, working methodology with detailed write ups/sketches/figures, wherever required. Detailed catalogues and Brochures/Technical details / supporting information of the system & its accessories. 8.1.2. Preliminary details like heater power, type of heaters, maximum heater temp, heater material, heater arrangement in the spin chamber etc. of the proposed heating system shall be provided along with the offer. 8.1.3. Preliminary details of the proposed cooling system like coolant capacity, mass flow, pressure, temp, and subsystems like heat exchanger details etc. shall be provided along with the offer. 8.1.4. Vendor should provide tentative scheme of the holding/coupling arrangement of the test rotor with the drive spindle. Vendor shall also provide the information about additional length and size required in the test rotor for holding/coupling.		

		8.2. Vendor shall submit following documents within 60 days of purchase order acknowledgement (all units shall be in SI) in English: 8.2.1. All sub system make and model, data sheets, schematics, circuit diagrams, electrical system write-up along with tentative activity schedule/bar chart. 8.2.2. Vendor shall provide the details of holding/coupling arrangement of the test rotor with the drive spindle 8.2.3. Bill of materials (BOM) indicating all loose items, component detail drawings, catalogues, Cable schedules, Interconnection diagrams, termination details and detailed activity schedules/bar chart. 8.2.4. Carpet area required (Length, Width and Height) for layout of complete system & accessories. 8.2.5. Schemes, equipment technical data sheets and lube oil specification 8.2.6. Overall maximum and average power requirement in kVA for continuous operation of Test rig with all subsystems working. 8.2.7. Vendor shall provide detailed design calculations for heating system and heating time 8.2.8. Vendor shall provide detailed design calculations for cooling system and cooling time 8.2.9. Vendor shall submit the critical speed calculations for complete drive system along with rotor 8.2.10. All required consumables with in BHEL Scope along with quantities, make, grade are to be specified		
		8.3. Final General Arrangement (GA) layout drawings systems including control room location, for the complete system consisting of drive train, assembly stand shall be provided as per mutually agreed schedule (all units shall be in SI) in English 8.4. Foundation documentation details to be provided within 90 days of purchase order acknowledgement 8.5. Vendor has to state probable number of packages, their dimensions, Gross weight and Net weight, at least 90 days before PDI		
		8.6. Vendor shall submit following details during the process of execution (In line with monthly progress report refer clause 17) and before the Pre Dispatch Inspection (PDI) (all units shall be in SI): a) Total load (kVA) requirement of complete system b) Max Drive System Load (kVA) c) Max Heating System Load (kVA) d) Painting of Complete system / Electrical Panels: Colour as per vendor standard, e) Total weight of the system f) Weight of heaviest part		

		g) Weight of the heaviest assembly/ subassembly h) Dimensions of largest part/ subassembly/ assembly i) Hydraulic, Pneumatic & oil pipings shall be preferably metallic except places where flexible pipings are essential. All the pipes required for the same shall be included in the standard scope of the equipment. j) Quantity and parameters of cooling medium k) Redundancy of systems l) Make-up of consumables. m) Storage and handling of equipment prior to erection. n) Details of the heating system with all the sub systems like heaters, vacuum pump etc., with capacities and power consumption for each sub-system along with P&I diagram and relevant calculations on heating source. o) Details of the closed loop cooling system with all the subsystems like coolant storage system, blower/compressor, heat exchanger etc. with capacities and power consumption by each subsystem along with P&I diagram and coolant requirement for continuous operation with calculation of sizing of different sub systems. p) Details of Drive arrangement and power requirements for the test rotor. q) Schematic of the Drive system along with bearing and supports details r) Details of loading and unloading system for the test rotor along with capacities and power consumption. s) Details of lube oil system, oil tank capacity and oil grade. t) Details of vacuum system and sealing system. u) Details of coupling system between the test rotor and drive including thermal isolation. v) Details of the strain and temperature measurement system using telemetry system. w) Details of the test chamber along with calculations for burst withstand ability for the maximum weight of the test rotor up to maximum operating temperature and speed. x) Space requirement and lay out of the test set-up & Details of running cost y) Non-Disclosure Agreement (NDA) between BHEL and the development partners to maintain confidentiality.		
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9.0	WARRANTY	9.1. Warranty for all parts (for all systems and sub-systems): Warranty for 12 months from the date of successful commissioning or 18 months from the date of dispatch, whichever is earlier. Vendors shall quote and supply the spares (including low-shelf life spares) required for this warranty period. Warranty spares are to be identified (both in quantity and nomenclature) in the technical bid and supplied along with the equipment. All the warranty spares are to be classified and tagged along with the respective sub-systems for ease of identification. Unutilized warranty spares shall be retained by BHEL after expiry of warranty period. For low shelf-life items less than 18 months spares to be supplied at appropriate time for enabling continuous operation of entire system. 9.2. During warranty period, the repairs and maintenance of the system and sub-systems shall be carried out by the vendor free of cost at BHEL R&D, Hyderabad. 9.3. Replacements of system and sub-systems shall be carried out at BHEL R&D, Hyderabad. All incidental costs related to replacement (including freight, duties etc.) shall be to the account of the vendor. 9.4. During warranty period, all upgrades to the operation related to data acquisition, processing and data-logging software must be provided free of cost. 9.5. During warranty period, recommended spares procured along with equipment, intended to be used after warranty, shall not be utilized by vendor. If utilized during the warranty period, they shall be replaced free of cost within 15 days. All incidental costs related to replacement (including freight, duties etc.) shall be to the account of the vendor. 9.6. If during warranty period, there is any breakdown of the equipment for duration of 15 days cumulatively from the date of reporting. 9.7. Contact information of service engineers MUST be provided at the time of installation or E&C. 9.8. Availability of trained service engineers in India for attending to the problem in at most 7 days has to be ensured and complied to. Note: Price of mandatory spares will be included in cost comparison.		
10	PRE DISPATCH INSPECTION (PDI) AND TRAINING AT OEM WORKS	10.1. The vendor shall intimate for PDI and Training at least 45 days in advance from the proposed PDI and Training date at vendor works. 10.2. Scope, Duration and daily schedule for PDI for 4 BHEL officials shall be indicated in the offer. 10.3. Soft copies of all valid test reports of the main and sub systems shall be furnished to the satisfaction of BHEL review authorities fifteen days before starting for PDI. Consequences, if any, due to delay in furnishing valid and satisfactory certificates shall be to the account of vendor 10.4. Demonstration during PDI:		

		10.4.1. Vendor shall demonstrate test cycles as mentioned in Annexure-II on a sample plane cylindrical solid forged test rotor of material: SS316 (as per Annexure-II) while measuring/achieving the following i. Maximum surface temperature of the test rotor ii. Computation of bulk mean temperature iii. Difference between above i and ii iv. Maximum core temperature of the test rotor v. Vacuum level vi. Strain on the circumferential and axial direction on the rotor at 3 locations 10.4.2. Test cycle to be demonstrated in the automatic control mode. 10.4.3. The total system to be demonstrated compatible with Indian power supply requirements with three phase 415 $\pm$10% Volts, 50$\pm$2 Hz, AC power source. 10.4.4. Sample solid rotor of SS316 material shall be in the scope of the vendor and the same shall be supplied along with the Test rig to BHEL (refer Annexure-II). 10.4.5. Vendor has to do strain gauging (minimum 6 No's) and temperature gauging (minimum 10 No's) on PDI rotor for validating the high temperature strain & temperature sensors, telemetry and data acquisition system for heating and cooling cycles. However gauging on Test rotors will be done by BHEL. Vendor to supply the strain gauges for BHEL rotors. BHEL engineers to be trained by the vendor for the installation of the above strain and temperature sensors during PDI at vendor's work and at BHEL R&D during commissioning. 10.4.6. The strain gauges and temperature gauges used on PDI rotor are additional to the supply quantity 10.5. During PDI, suggested modifications/ changes, if any by BHEL official shall be carried out and intimated to BHEL for dispatch clearance. If suggestions/corrections warrant one more PDI, the additional travel costs shall be to vendor's account, 10.6. Dispatch clearance for consignment will be given by BHEL Official after carrying out PDI at OEM's works after coming back to India. 10.7. Training at OEM works shall be conducted subsequent to PDI. Detailed training at OEM work's / factory has to be provided by factory engineer to 4 BHEL officials on working of all modes of the equipment along with the accessories, handling the software for operation or data acquisition and maintenance procedures. Training shall also be provided on safety features, tasks to be performed in case of emergency, etc. 10.8. Detailed scope, duration and daily schedule for training at OEM works has to be indicated in the offer. The training charges, if any, have to be quoted separately. Training		
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		certificate/ report shall be submitted to BHEL official after successful completion of the same.		
		10.9. Travel and stay for personnel deputed for PDI and Training will be borne by BHEL		
11	PACKING	Sea worthy & rigid packing shall be provided for system, control and all other supplied items to avoid any damage/loss in transit. All small/loose items shall be suitably packed in boxes.		
12	OPERATION AND MAINTENANCE (O&M) MANUALS	2-sets of Operation & Maintenance Manuals in English language in hard copy and one set in soft copy shall be supplied along with the equipment. The manuals shall contain all revised drawings, sub-vendors catalogues, O&M instructions, Do's & Don'ts, warnings, periodic maintenance schedules & the spares information duly identified.		
13	AFTER SALES SUPPORT AND NON-COMPREHENSIVE ANNUAL MAINTENANCE CONTRACT (AMC)	13.1. Scope of AMC is indicative but not limited to the following i. Vendor shall make mandatory visit biannually and check the following ii. Heating system iii. Cooling system iv. Drive system v. Control and instrumentation system ➤ Vendor shall make break down visit within seven days wherever necessary. To the extent possible online support in the form of SMS/telephone/email/chat shall be within 24 hours. Reprisal mechanism to be indicated by the vendor ➤ During preventive visit, the vendor to ensure all the software upgrades are in place 13.2. Non-comprehensive Annual maintenance charges (AMC) charges shall be quoted for 5 years beyond the stipulated warranty period (of 1 year) quoted on per year basis. 13.3. These charges have to be valid for 5 years beyond the stipulated warranty period. 13.4. BHEL will add the quoted AMC charges of five years for cost evaluation while deciding the tender priorities 13.5. BHEL reserves the right to place a separate order/ orders for AMC contract for 5 years and/ or part thereof, at the rates quoted after warranty period. 13.6. All software upgrades have to be provided free of cost during service AMC period. 13.7. AMC charges will be paid on half yearly basis after completion of services including mandatory visit to BHEL Site, failure of which shall entail forfeiture of the half yearly payment.		

14	COMPLIANCE STATEMENT	14.1. The vendor should clearly indicate whether they are able to supply as per BHEL specifications for each item description. Vendors are advised to write specifications in detail and not to write like 'Complied/ Yes / No ' etc.in specifications. 14.2. The vendor may mention reasons for deviations from specifications		
15	FUTURE UPGRADATION	List of all upgradable components/features of “High Temperature Vertical Spin Test rig System” supplied as per PO to be provided		
16	TEST CERTIFICATES REQUIRED	16.1. Manufacturer’s test certificate shall be provided along with the items 16.2. Calibration certificates from internationally recognized authorities for the strain & temperature measurement systems shall be provided.		
17	MONTHLY PROGRESS REPORT	Vendor to submit the monthly progress report along with photographs and relevant documents as per the mutually agreed schedule after placement of PO.		
18	ERECTION AND COMMISSIONING (E&C) OR INSTALLATION	18.1. E&C or Installation has to be carried out at BHEL Corporate R&D Division, Hyderabad – 500093, India, by the OEM or their authorized service agency/ personnel only. 18.2. OEM has to provide supervision (in person) for carrying out the unpacking, handling and locating in position as per OEM drawings. 18.3. Start-up, testing of the system, its control & all types of other supplied equipment / accessories etc. has to be done by OEM. 18.4. Service requirement like Power, water, shall be provided by BHEL at identified locations. Vendor has to specify the locations in their foundation / layout drawings. 18.5. Other requirements during E&C like crane and man power will be provided by BHEL. Storage of equipment and spares will be done by BHEL as per the OEM guidelines 18.6. Vendor shall indicate Broad Schedule of Erection and Commissioning in the offer and number of days required to start the E&C after receiving intimation from BHEL on readiness of the site for E&C. 18.7. Vendor shall indicate duration (in weeks) for completion of E&C, demonstration and post-installation training at R&D. 18.8. All cables, adapters, etc. required for integration of each and every component of “High Temperature Spin Test rig System” must be supplied along with the system. Requirement of crane for handling the equipment(s) during E&C/ Installation shall be arranged by BHEL under the supervision of vendor’s engineer. It is the responsibility of the vendor to integrate (man power will be arranged by BHEL) all the systems (including		

		accessories, auxiliaries, if any) and ensure the functionality of the entire system as per technical scope of the enquiry. 18.9. E & C charges will include services to be rendered at R&D for installation like erection, commissioning, rotor test running, performance tests, and onsite training to operators etc. 18.10. E&C report shall be submitted to BHEL after successful completion of the same. E&C charges will be paid only after successful completion of E&C and submission of report subjected to BHEL certification. 18.11. All travel, boarding, lodging and other charges (if any) for authorized OEM personnel deputed for E&C/ Installation and demonstration shall be borne by the vendor.		
19	DEMONSTRATION AT SITE	19.1. Vendor shall demonstrate the achievement/ monitoring of the temperature difference and measurement of strain & temperature using telemetry system on one of the two test rotors as per the test cycle mentioned in the Annexure-I for at least two cycles at BHEL R&D, after successful erection & commissioning of the system. 19.2. Demonstration report should be submitted to BHEL after successful completion of the same. 19.3. Demonstration charges at R&D for installation shall be quoted separately. All travel boarding, lodging and other charges (if any) for authorized personnel deputed for demonstration shall be to vendors account.		
20	OTHER INSTALLATION REQUIREMENTS AT SITE	20.1. Vendor shall intimate all pre-installation and utility requirements such as: a) Power requirement(s); b) Earthing / grounding requirement(s); c) Temperature, humidity control requirement(s); d) Dimensions of equipment, weight and space requirements; e) Civil works such as head room requirement, special foundation requirement and procedure for laying foundation, crane etc.) with a mutually agreed schedule. 20.2. Any parts/ accessories of the equipment(s) to be incorporated in the civil works (such as steel reinforcements for foundation of equipment, etc.) have to be dispatched within 180 days of purchase order acknowledgement (from the OEM), to the site of installation. These have to be indicated in detail and quoted separately in the price bid.		
21	POST-INSTALLATION TRAINING	21.1. Post-installation training shall also be provided by the installation engineer(s) for all modes of “High Temperature Spin Test rig System” along with accessories (if any) being provided, at site of installation for at least 4 officials from BHEL 21.2. Scope of training and schedule to be worked out mutually. 21.3. Post-installation charges at site of installation shall be quoted separately.		

		21.4. Post-installation training certificate/ report shall be submitted to BHEL after successful completion of the same. 21.5. All travel, boarding, lodging and other charges (if any) for authorized personnel deputed for post installation training shall be to vendors account.		
22	NDA AND CONFIDENTIALITY OF THE SHARED TECHNICAL INFORMATION	22.1. Technical information shared by the Vendors during technical bid submission and evaluation process will remain confidential i.e. within BHEL and will not be disclosed outside. NDA with the bidders can be executed at an appropriate time. 22.2. Similarly, Technical information shared by BHEL at any point of time during contract execution (Enquiry to PO execution) shall remain confidential i.e. within Vendors organization and will not be disclosed outside. Bidders have to sign NDA with BHEL at an appropriate time		

Annexure-I

TEST CYCLE DETAILS

Each test rotor will be continuously tested for **200 cycles** (approximately 18000 Hrs.) and one tentative test cycle is as follows:

Tentative Test cycle for Monometallic Rotor (Ref: Figure III (a) of Annexure III) One Test cycle as detailed below (typical schematic of the cycles is given in Figure I).

- a) Purging of the chamber with pressurized nitrogen to drive out the trapped air at the start of the first cycle
- b) Before starting the actual test cycle the rotor shall be operated at 3750 RPM at room temperature for 2 minutes with coasting up at rate of minimum 200 rpm/min or more and coast down to 600 rpm with a minimum deceleration of 200 rpm/minute.
- c) Maintain the required vacuum of ≤ 1 Torr absolute before the start of heating cycle
- d) Preheating of the test rotor from ambient to metal temperature of 200 ± 10 deg. C in case of cold start from room temperature.
- e) Speed coast up from 0 rpm to 600 rpm with an acceleration of minimum 200 rpm/minute at the start of the pre-heating followed by steady state speed of 600 rpm during the preheating.
- f) **Heating:**
 - Speed coast up from 600 rpm to 3000 rpm with an acceleration of minimum 200 rpm/minute at the start of the heating from metal temperature of 200 ± 10 deg. C followed by steady state speed of 3000 rpm shall be achieved.
 - Heating of the test rotor from metal temperature of 200 ± 10 deg. C to 760 ± 10 deg. C. The radial temperature difference (ΔT) of 180 ± 20 deg. C shall be achieved at least once at one instance of heating period.
 - Radial temperature difference (ΔT) is defined as the difference between rotor surface temperature in middle of 2nd and 3rd stage (Ref: Figure III (a) of Annexure III) to rotor bulk mean temperature (refer: **clause 3.7.8** of Specification No: CRD/HTVSTR/2017/01-rev 01).
 - Test rotor should reach metal temperature of 760 ± 10 deg. C at the end of heating cycle (isothermal condition) with core temperature as 760 ± 5 deg. C in ≤ 20 hours and same has to be maintained for 50 hours with steady state 3000 rpm.
 - During steady state at 760 ± 10 deg. C rotational speed is to be increased from 3000 rpm to 3600 rpm, to be maintained at 3600 rpm for 1 minute and to be decreased to 3000 rpm with an acceleration/deceleration of minimum 200 rpm/ minute.
- g) **Cooling:**
 - Cooling of the test rotor from metal temperature of 760 ± 10 deg. C to 200 ± 10 deg. C. The radial temperature difference (ΔT) of 140 ± 20 deg. C shall be achieved at least once at one instance of cooling period.
 - Radial temperature difference (ΔT) is defined as the difference between rotor surface temperature in middle of 2nd and 3rd stage (Ref: Figure III (a) of Annexure III) to rotor bulk mean temperature (refer: clause 3.7.8 of Specification No: CRD/HTVSTR/2017/01-rev 01).
 - Test rotor speed coast down from 3000 rpm to 600 rpm at the end of the cooling cycle with a deceleration of minimum 200 rpm/ minute followed by steady state speed of 600 rpm.

- The rotor speed can be varied during cooling to achieve required temperature difference (ΔT).
- Test rotor should be cooled to reach metal temperature of 200 ± 10 deg. C (isothermal condition) in ≤ 20 hours and isothermal condition to be maintained for at least 5 minutes.

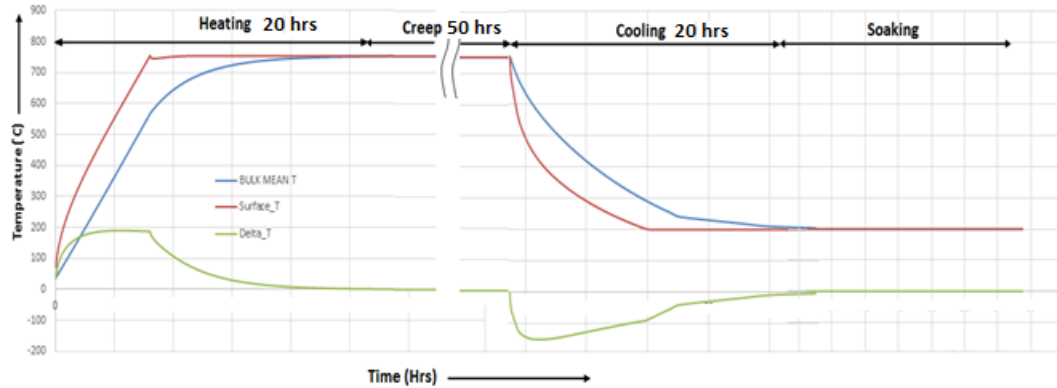


Figure I: Schematic of typical test (Heating –Steady State-Cooling) cycle (Temp vs. time)

Table 1. User configurable parameters for Automatic test cycle (not limited to below given)		
Sl. No.	Parameters for test rotor	Default Values
1.	Initial temperature	Ambient Temperature
2.	Initial over run	3750 rpm
3.	Speed during preheating	600 rpm
4.	Speed during heating and steady state	3000 rpm
5.	Speed during over speed	3600 rpm
6.	Acceleration	200 rpm/min
7.	Deceleration	200 rpm/min
8.	Rotor temperature after preheating	200 deg. C
9.	Rotor temperature at the end of heating cycle	760 deg. C
10.	Maximum Temperature difference between rotor surface and rotor bulk mean to be achieved at least once during heating	180 deg. C
11.	Duration of steady state heating	50 hours
12.	Rotor temperature at the end of cooling cycle	200 deg. C
13.	Maximum Temperature difference between rotor bulk mean and rotor surface to be achieved at least once during cooling	140 deg. C
14.	Speed at the end of cooling	600 rpm

Annexure-II
PDI SAMPLE ROTOR & PDI TEST CYCLE DETAILS

PDI on sample test rotor of sample plane cylindrical solid forged test rotor (material: SS316 of 1000 ± 5 mm diameter and length of 1000 ± 5 mm will be carried out as follows:

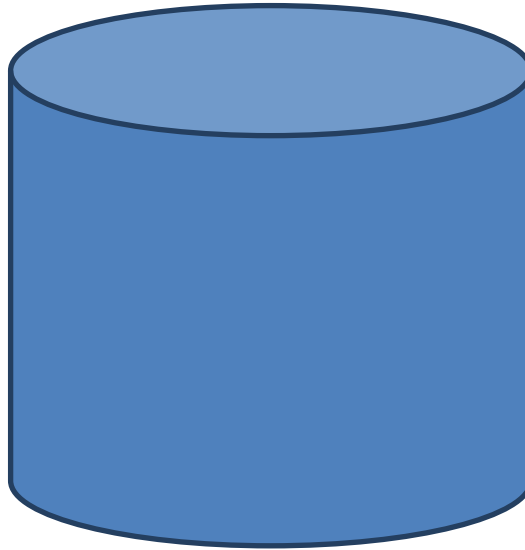


Figure II (a): PDI sample test rotor (length 1000 ± 5 mm and diameter 1000 ± 5 mm)

PDI Test cycle for full speed (refer Fig: II (b))

- i. Purging of the chamber with pressurized nitrogen to drive out the trapped air at the start of the first cycle and maintain the required vacuum of ≤ 1 Torr absolute before the start of heating cycle.
- ii. Preheating of the test rotor from ambient to metal temperature of 200 ± 10 deg. C in case of cold start from room temperature.
- iii. Speed coast up from 0 rpm to 600 rpm with an acceleration of minimum 200 rpm/minute at the start of the pre-heating followed by steady state speed of 600 rpm during the preheating.
- iv. Speed coast up from 600 rpm to 3000 rpm with an acceleration of minimum 200 rpm/minute after pre heating and to be maintained at 3000 rpm during heating cycle
- v. Test rotor shall reach metal temperature of 450 ± 10 deg. C at the end of heating cycle (isothermal condition) and rotor temperature is to be maintained at 450 ± 10 deg. C (steady-state) for 50 hours.
- vi. During steady state at 450 ± 10 deg. C rotational speed is to be increased from 3000 rpm to 3600 rpm, to be maintained at 3600 rpm for 1 minute and to be decreased to 3000 rpm with an acceleration/deceleration of minimum 200 rpm/ minute.
- vii. Cooling of the test rotor from uniform metal temperature of 450 ± 10 deg. C to 200 ± 10 deg. C. Test rotor speed coast down from 3000 rpm to 600 rpm at the end of the cooling with a deceleration of minimum 200 rpm/ minute and followed by steady state speed of 600 rpm.

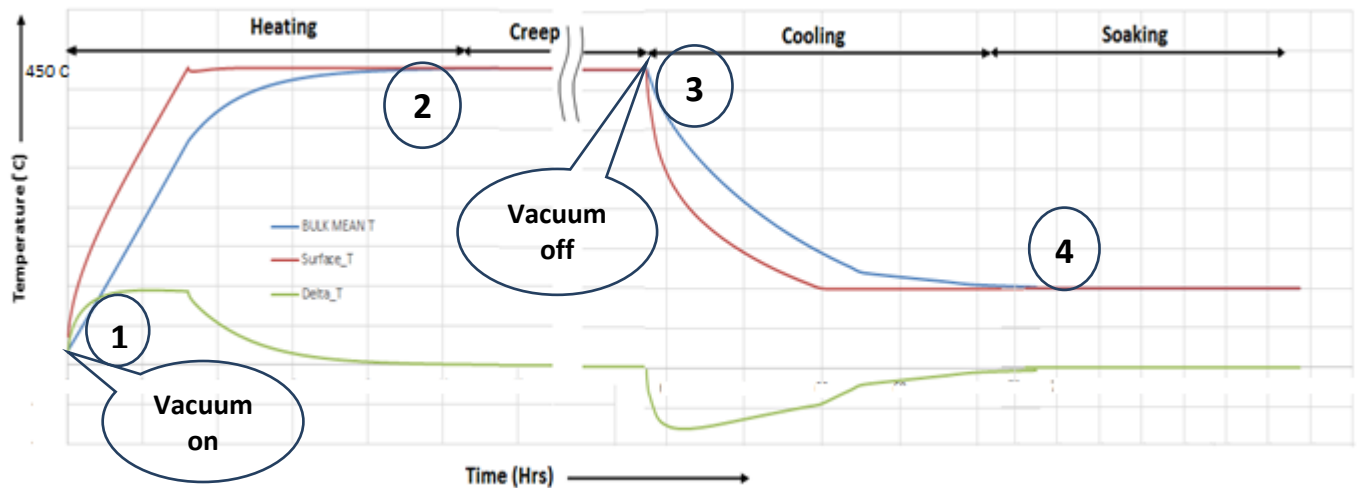
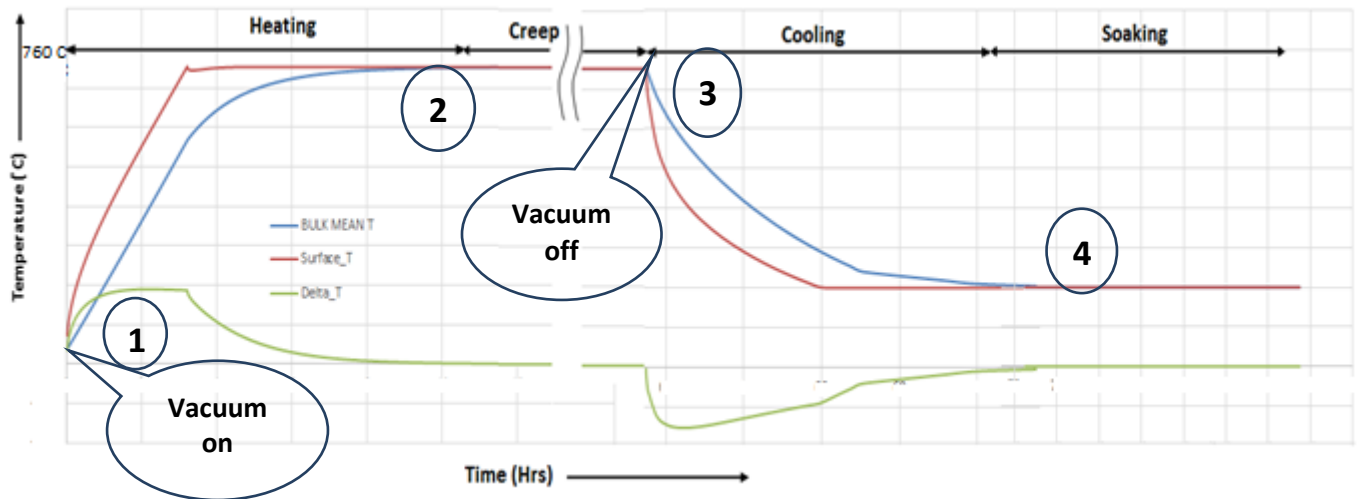


Figure II (b): Schematic of typical test cycle- speed vs. time (Maximum temperature 450 deg. C and maximum speed 3600 rpm)

PDI Test cycle for maximum temperature (refer Fig: II (c))

- i. Purging of the chamber with pressurized nitrogen to drive out the trapped air at the start of the first cycle
- ii. Maintain the required vacuum of ≤ 1 Torr absolute before the start of heating cycle
- iii. Heating of the test rotor from 200 ± 10 deg. C temperature to 760 ± 10 deg. C. The radial temperature difference (ΔT) of 180 ± 20 deg. C shall be achieved at least once at one instance of heating period.
- iv. Speed coast up from 600 rpm to 1500 rpm with an acceleration of minimum 200 rpm/minute at 760 ± 10 deg. C.
- v. Test rotor should reach metal temperature of 760 ± 10 deg. C at the end of heating cycle (isothermal condition) in less than 20 hrs. and rotor temperature is to be maintained at 760 ± 10 deg. C (steady-state) for 50 hours with a speed of 1500 rpm.
- vi. Cooling of the test rotor from metal temperature of 760 ± 10 deg. C to 200 ± 10 deg. C in less than 20 hrs. The radial temperature difference (ΔT) of 140 ± 20 deg. C shall be achieved at least once at one instance of cooling period.
- vii. At the end of the cooling cycle the rotor metal temperature shall be 200 ± 10 deg. C for 5 minutes and rotor speed coast down from 1500 rpm to 600 rpm at the end of the cooling cycle with a deceleration of minimum 200 rpm/minute followed by steady state speed of 600 rpm.
- viii. The rotor speed can be varied during cooling to achieve required temperature difference (ΔT).
- ix. Cooling of the rotor to ambient temperature and then reduce the speed to 0 rpm with a minimum deceleration of 200 rpm/minute.



**Figure II (c): Schematic of typical test (Heating –Steady State-Cooling) cycle (Temp vs. time)
(Maximum speed 1500 rpm)**

Annexure-III TEST ROTOR DETAILS

A schematic of the two test rotors is given in Figure III (a) and Figure III (b). (Test rotors are in the scope of BHEL).

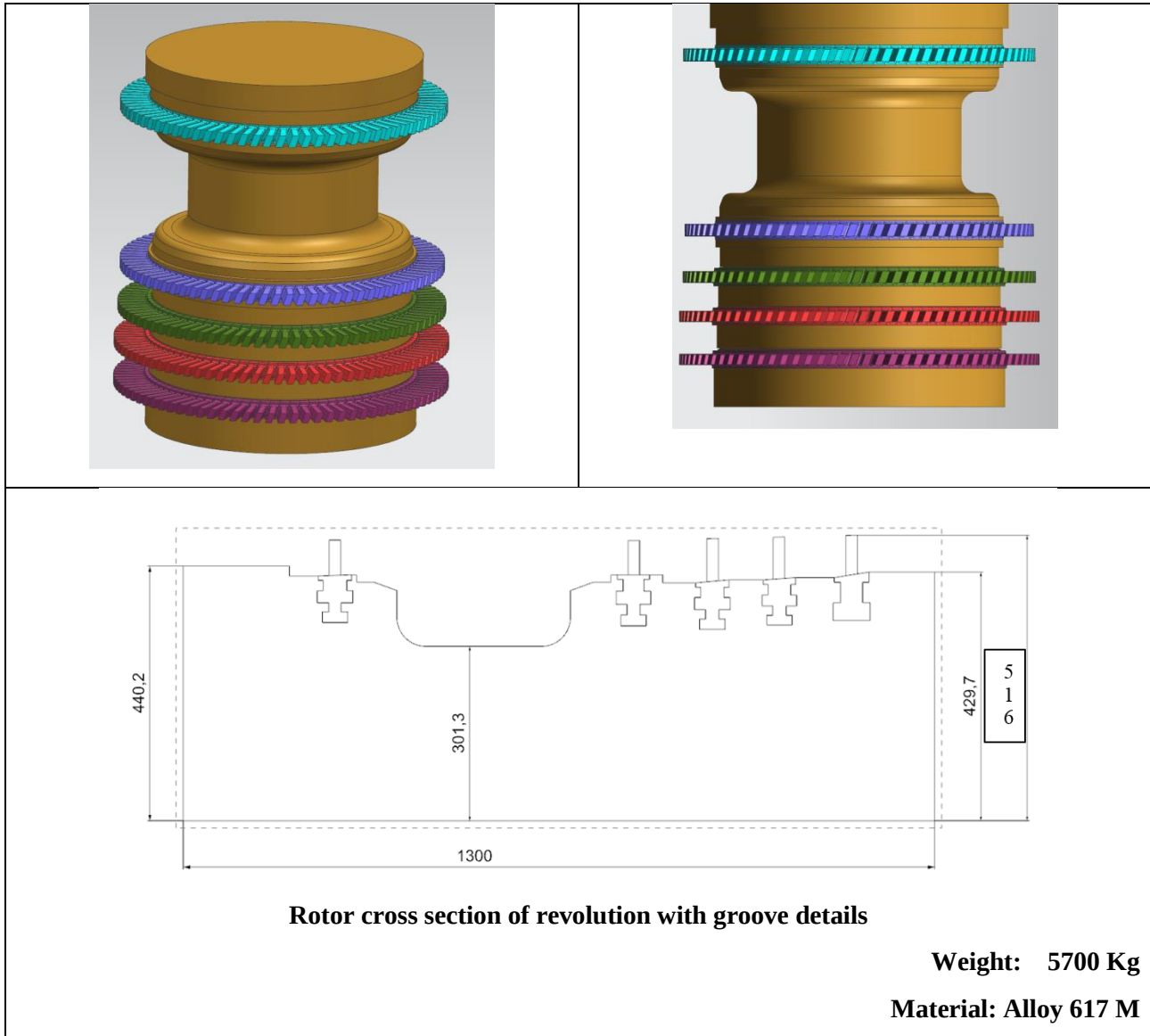


Figure III (a): Mono metallic Test Rotor

Note: Simplified 3D model of the rotor will be provided by BHEL based on the vendors request

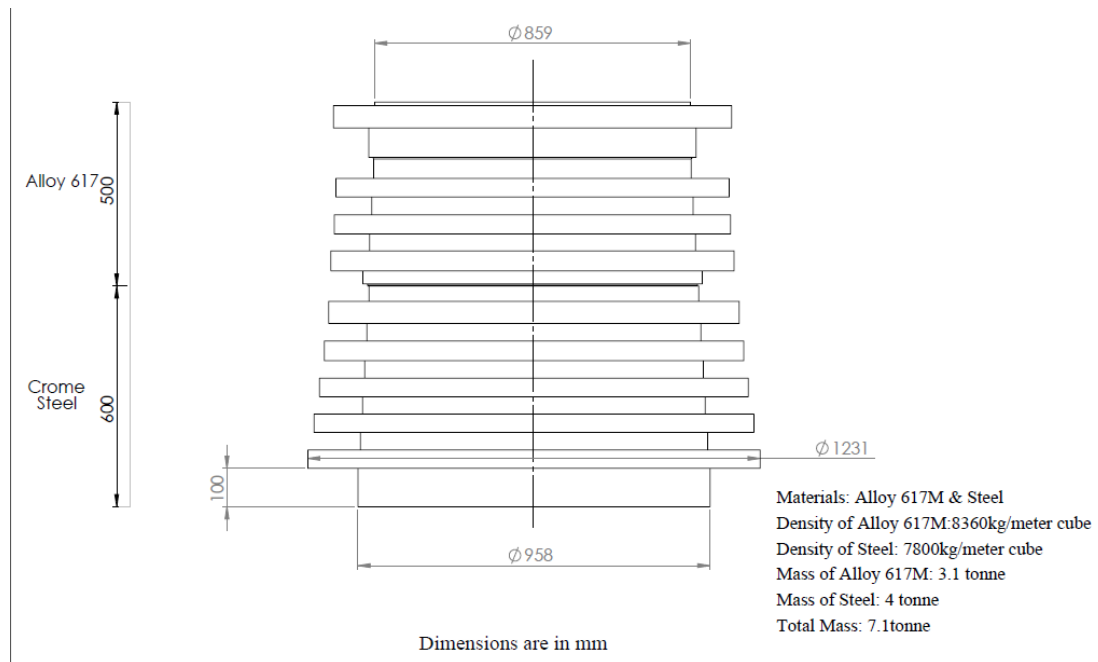


Figure III (b). Bi-metallic Test Rotor (to indicate minimum and maximum dimensions and rounded off to tons)

- Material of test rotor: Test rotor 1: Alloy 617M (Ni Based alloy)
- Test rotor 2: welded piece of Alloy 617M and 9-10% Chrome steel
- Tentative Length: 1200mm + 100mm extra (provisional) for holding – However holding arrangement details to be provided by the vendor including allowance in the test rotor for holding.

Annexure-IV

SPECIFICATION OF STRAIN AND TEMPERATURE MEASUREMENT SYSTEM ON TEST ROTOR

S.No	Description	Specification
1	Thermal transients subjected by the test rotor	Thermal cycling i.e. heating, steady state, cooling and no of cycles as per Annexure-I
2	Speed/orientation of the test rotor	0 to 3800RPM / Vertical
3	Operating medium	1 Torr absolute to Pressurized Nitrogen
4	Chemical exposure	No chemical
5	Duration of Test	18000 hrs. continuous
6	a) Static strain Range b) Accuracy c) Resolution	• Static strain Range: - 5000 micro strain to +5000 micro strain, • Accuracy: ± 20 micro strain for measurement levels upto ± 1000 micro strain and $\pm 2\%$ of measurement for levels beyond ± 1000 micro strain • Resolution: 1 micro strain
7	Min / Max temperature (Accuracy / Resolution) of temperature sensor	20 to 820 deg. C ($\pm 0.5\%$ / 1°C)
8	Lead wire length	Minimum 5 meters for all the strain gauges and temperature gauges.
9	Drift compensation for strain gauges and lead wires	Provision for drift compensation for high temperature application upto 800 deg. C to limit the measurement error not more than $\pm 2\%$ of measurement value with lower limit of measurement value as 1000 micro strain
10	Tentative Location and number of measurements	As per Annexure-IV: A (strain measurements – 52 nos.) Annexure –IV: B (Temperature measurements- 34 nos.)
10	Signal transmission methodology for strain and temperature	Telemetry system as per Annexure-IV:C

Annexure-IV: A
TENTATIVE LOCATION AND NUMBER OF STRAIN GAUGES

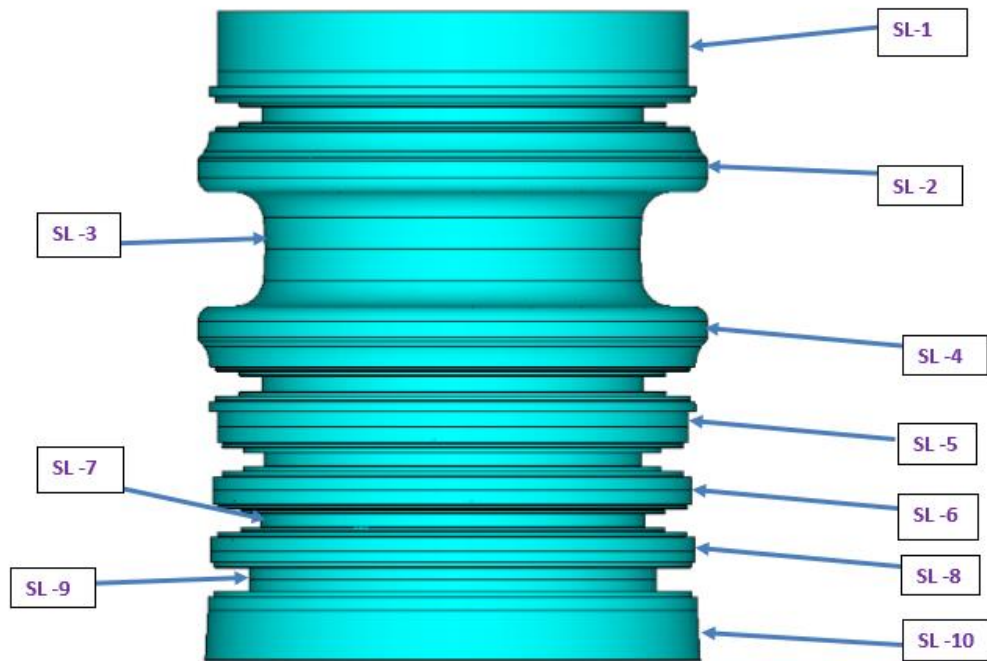


Figure IV (a). Location for strain gauges at different axial positions on the test rotor

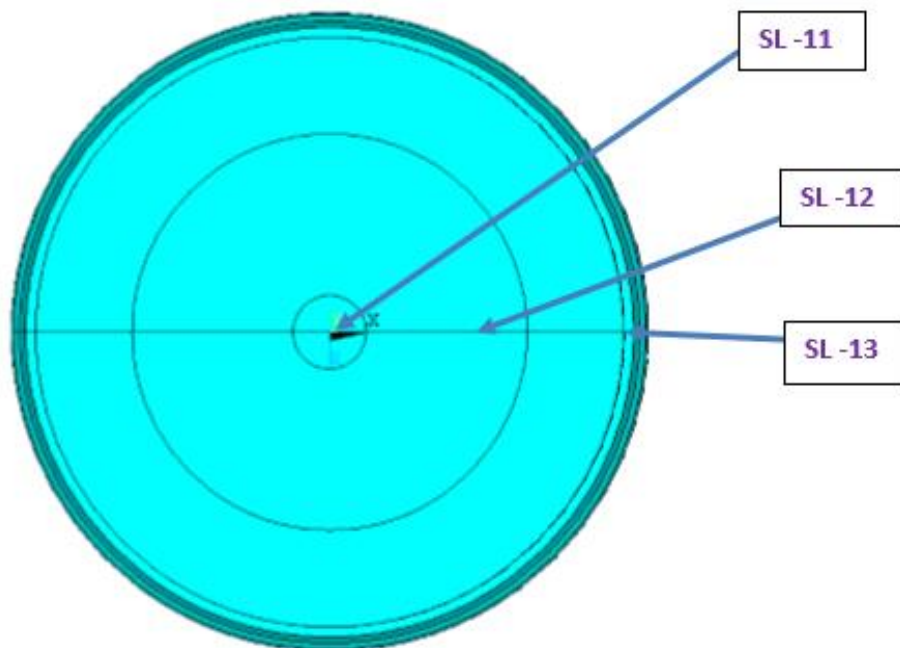


Figure IV (b). Location for strain gauges at different radial positions on the test rotor bottom end
Note: Two numbers of strain gauges (one each in axial and tangential direction) at each location

Annexure-IV: B

TENTATIVE LOCATION AND NUMBER OF TEMPERATURE SENSORS

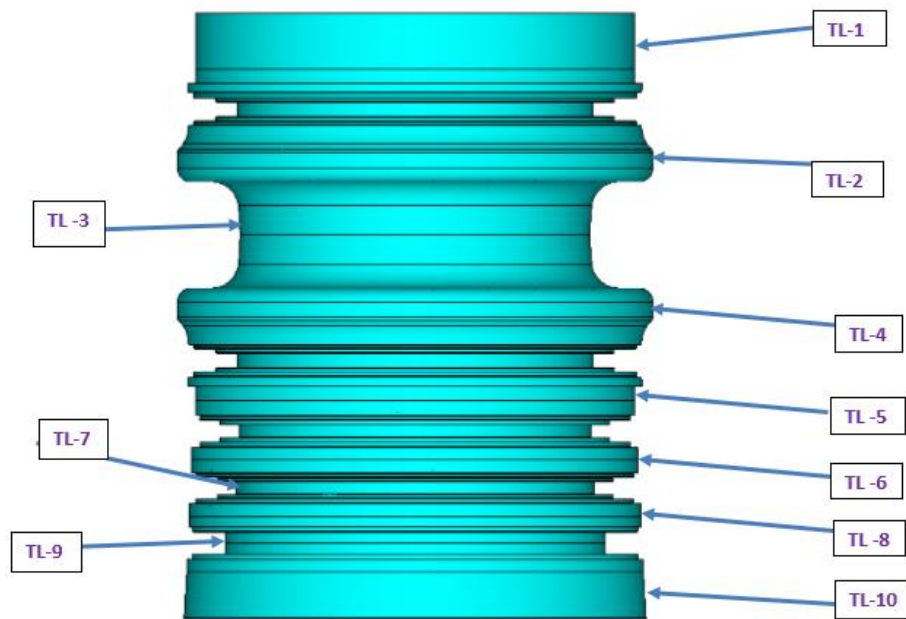


Figure IV(c). Locations of thermocouples at different axial positions on the test rotor

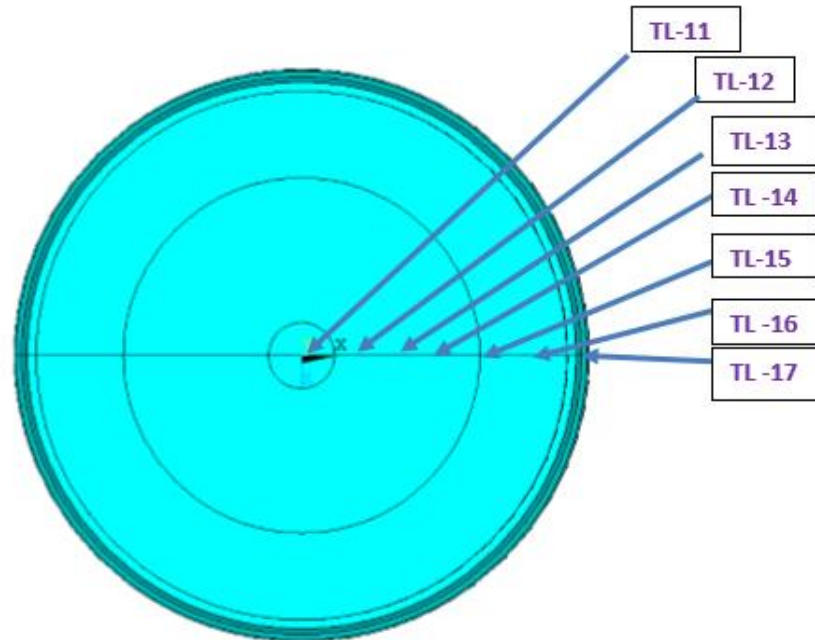


Figure IV (d). Locations of thermocouples at different radial positions on the test rotor bottom end

Annexure-IV: C

SPECIFICATION OF DIGITAL TELEMETRY SYSTEM

S.No.	Description	Specifications
1	Mounting configuration	Middle of Shaft
2	Number of Channels	minimum 100 (40 channels for temperature sensors and remaining 60 channels for strain gauges 120ohms/350ohms with half or quarter bridge configuration) including redundancy
3	Signal bandwidth	DC -Minimum 5KHz
4	Auto balance	System should have auto balance capability to automatically balance all the channels
5	Measurement range	Strain range(strain gauges) : Max mean static value +/- 10000 micro strain Temperature range : 20 to 820 deg. C
6	Accuracy of telemetry system	Strain: $\pm 1\%$ of measurement level Temperature: $\pm 0.5\%$ of full scale measurement
7	Environmental conditions	Minimum 85 deg. C for all components of the telemetry system to be mounted on the test rotor and adjacent to the test rotor and up to 60 deg. C for receiver which can be kept away from the test rotor. (on test rotors the components may be subjected to high temperature environment) • Vibration: min 20g (for components mounted on test rotor) • Speed: up to 5000rpm
8	Power Supply	Inductive power sources
9	Temperature overload indicator for telemetry system	The system should have status indicator to check the temperature within the telemetry system to prevent overheating.

Annexure-V

HARDWARE CONSOLE FOR DATA RECORDING, PROCESSING, DISPLAY AND STORAGE

Vendor should supply hardware console for Data recording, processing, display and storage with the following features, with 100 % redundancy

SL No	Description	Specification
1	Operating System/platform	Windows 10 Professional 64-bit with Restore / Recovery CD/disk & with OS media CD/DVD
2	Display	Shall have sufficient no of displays with minimum 36 inch LED Backlit IPS Monitors, Resolution 1920X1200@60 Hz or Better, for displaying all the data as per clause: 3.10.9 of BHEL Specification No: CRD/HTVSTR/2017/01.
3	Memory (RAM)	Shall have minimum 32 GB RAM to handle and process the multiple data with minimum lag. Should able to accommodate any future upgrades in next 5 years.
4	Graphic Controller	Shall have minimum 2 GB graphic card, sufficient enough to display clear images without out lag. Should able to accommodate any future upgrades in next 5 years.
5	Storage with fail safe back up	Should be sufficient to store 40000 hrs. Continuous running data with proper back up, in case of failure data shall be retrievable.
6	Optical Drive	Minimum 16x DVD +/- RW Drive (DVD Reader & writer)
7	IO Ports	Minimum 4 USB 3.0 port for data backup
8	Accessories	USB Keyboard and mouse

Annexure –VI

SUMMARY OF PRODUCT REFERENCE

Reference List: The Prospective supplier shall furnish a summary of their product reference as detailed below for major supplies in last 10 years with copies of the following

a. Letter of award and completion certificate clearly indicating the Customer Name, Reference Number and scope of work.

Sl. No	Name of the project, client, Geographical Location and contact details	Brief scope of work	Month, Year of Purchase order	Month, year of delivery completed/ under supply	Month, year of commission completed/ under commission	Weight of the test rotor (kg)	Rotor Diameter (mm)	Max Length of Rotor (mm)	Max temperature (Deg. C)	Max. Radial temp. difference	Remarks, if any

b. The offers of the vendors who are in the banned list and the offers of the vendors who engage the services of the banned firms, shall be rejected. The list of banned firms is available on BHEL website at www.bhel.com.

NOTE: BHEL will carry out independent verification of performance certification. Hence, prospective vendors are required to give only reference of those customers who are willing to confirm independent verification and not refrain from the same on the grounds of confidentiality.

(SIGNATURE)