



An ISO 9001
Company

Bharat Heavy Electricals Limited

(High Pressure Boiler Plant)

Tiruchirappalli – 620014, TAMIL NADU, INDIA

CAPITAL EQUIPMENT / MATERIALS MANAGEMENT

ENQUIRY

NOTICE INVITING TENDER

Phone: +91 431 257 7653
Email : karunanidhy@bhel.in
spsy@bhel.in
kmk@bhel.in
Web : www.bhel.com

TWO PART BID	Enquiry Number:	Enquiry Date:	Due date for submission of quotation:
Tender to be submitted in two Parts	2601800002	10.01.2018	02.02.2018

You are requested to quote the Enquiry number date and due date in all your correspondence. This is only a request for quotation and not an order.

Please note that under any circumstances both delayed offer and late offers will not be considered. Hence vendors are requested to ensure that the offer is reaching physically our office before 14.00 hrs on the Date of tender opening.

Item	Description	Quantity	(Indigenous Vendors) Matl. will be Delivered to
10	Servo Hydraulic Static and Dynamic Testing System as per the technical specification & commercial conditions applicable (to be downloaded from web site (http://www.bhel.com) http://www.bhel.com/tender/tender_home.php or https://eprocure.gov.in/epublish/app)	1.00 No.	FOR, BHEL Stores, High Pressure Boiler Plant, Tiruchirappalli - 620014

Important points to be taken care during submission of offer

1. Material shall be delivered to: Indigenous Vendors: As stated above.
Foreign Vendors: CFR Chennai Seaport / CFR Chennai Airport
2. Delivery required 20 Weeks including PDI from the date of purchase order.
3. Erection & Commissioning period required 4 Weeks from the date of intimation by BHEL to vendor for deputation of their Engineers for E&C.
4. EMD for this Tender will be (INR) : 2,00,000.00
5. Compliance Form Nos.: TRY/IMP/01 & TRY/IND/01A to be filled and enclosed along with the offer failing which, the offer will not be considered for evaluation.
6. All updates, amendments, corrigenda, etc., (if any), for each tender will be posted only on the above websites from time to time, as and when required, until each tender is opened. There will be no publication of such updates, amendments, corrigenda, etc., through newspapers or any other media.

BHEL's General guidelines / instructions (refer MM / CE / GENL / 001 - EMD) including bank guarantee formats and list of consortium banks, commercial terms check-list can be downloaded from BHEL web site (<http://www.bhel.com>) http://www.bhel.com/tender/tender_home.php or from the Government tender website <https://eprocure.gov.in/epublish/app> under above Enquiry reference.

(This is not an E-tender, please submit your offer in hard copies)
Tenders should reach us before 14:00 hours on the due date
Tenders will be opened at 14:30 hours on the due date
Tenders would be opened in presence of the tenderers who have submitted their offers and who may like to be present

Yours faithfully,
For BHARAT HEAVY ELECTRICALS
LIMITED

DGM / Capital Equipment / MM

S.PARTHASARATHY
MANAGER
CAPITAL EQUIPMENT / MM
BHEL, TRICHY-620014.

Servo Hydraulic Static & Dynamic Testing System

‘SERVO HYDRAULIC STATIC & DYNAMIC TESTING SYSTEM’

PART A

SECTION – 1: Qualifying Criteria

The BIDDER has to compulsorily meet the following requirements to get qualified.

S No.	REQUIREMENTS	BIDDER'S RESPONSE
1.1	Only BIDDER/ Original Equipment Manufacturer (OEM) who have a minimum of TEN Years (as on the first date of opening of tender) of Continuous Experience in the Design, Manufacture & Supply of ‘SERVO HYDRAULIC STATIC & DYNAMIC TESTING SYSTEM’ are eligible to quote for this tender. The bidder shall indicate the actual no. of years of experience in the field and submit Purchase Orders (PO) copies or relevant documents as proof of experience.	
1.2	Bidder/OEM must have supplied same capacity Servo-hydraulic static and dynamic testing machine (both item A & item B) in the last 5 (five) years to a minimum of 5 (five) customers in India/ abroad as on the date of tender opening mentioned in the enquiry.	
1.3	Bidder/OEM must also have supplied Servo-hydraulic static and dynamic testing machine of same capacity (both item A & B) in the last 5 (five) years to at least 2 countries outside the country of origin (manufacture).	
1.4	The Bidder shall submit a performance certificate for satisfactory performance of the Servo hydraulic static & dynamic testing system (model quoted against this tender for item A & B or a higher capacity model) for a minimum period of two years from the date of commissioning (as on the first date of opening of tender) from three of the customers^a to whom such equipment was supplied in the last 5 years. The performance certificate for Item A shall compulsorily include the TMF integration. A performance certificate without TMF integration shall not be acceptable. Full contact details of the customer to be provided from whom the performance certificate is obtained. For obtaining the Performance certificate, a suggestive format is given in Annexure-1. (a) The ‘customers’ mentioned above shall be a Government of India firm/PSU/CPSE/R&D institutes, manufacturing Industries, heavy industries/other industries outside India. Performance certificates from academic/educational institutions shall not be acceptable.	
1.5	BHEL shall visit the referred customer’s (this shall include the customer who has given <i>Performance Certificate</i>) works to verify the information provided by the vendor. It shall be the responsibility of the vendor to facilitate the visit of BHEL’s team at their referred customer works. The equipment subjected for such verification should be in fully operational condition during the visit for assessing the performance of the machine. The travel, boarding and lodging expenses for BHEL team shall be borne by BHEL.	
1.6	Country of OEM must also be the country of origin (manufacture). A declaration has to be submitted as a proof of compliance to this clause.	

BHEL reserves the right to verify the information provided by bidder. In case the information provided by bidder is found to be false/ incorrect, the offer shall be rejected.

Servo Hydraulic Static & Dynamic Testing System

SECTION – 2:

The BIDDER shall write the following details for both ITEM A and ITEM B in the ‘Bidder’s Response’ column:

S. No.	PARTICULARS	BIDDER’S RESPONSE
2.1	BIDDER shall write clearly the Country of Origin for the supply of the Servo hydraulic static & dynamic testing system.	
2.2	YEAR of LAUNCH of the MODEL quoted against this ENQUIRY.	
2.3	Number of such ‘Servo hydraulic static & dynamic testing system’ supplied, till date in the QUOTED MODEL	
2.4	A detailed list of customers with Purchase Order (PO) number and date of purchase, date of Erection and Commissioning (E&C), contact details (shall include contact number and email/fax) of customers to whom these equipment were supplied in last 5 (five) years as on the date of tender opening mentioned in the enquiry.	
2.5	The BIDDER shall give details about supply of similar Servo hydraulic static & dynamic testing system to BHEL units, if any, with Make, Model and Year of Supply & Commissioning etc.	
2.6	Details on International Standards followed in Design and Testing of the Servo hydraulic static & dynamic testing system.	
2.7	Comprehensive Details, on Performance Testing of the quoted model carried out at the Factory, to be furnished with the Technical Offer.	
2.8	The service after sales set up should be available in India. The details on SERVICE-AFTER-SALES Set-Up including the Addresses of Agents / Service Centres in India, to be furnished compulsorily. The OEM or authorized supplier shall have a well-trained service network available in India to cater the service requirements of the offered Servo hydraulic static & dynamic testing system. The details of the same shall be submitted along with the technical bid.	
2.9	Manufacturer’s Test Certificate for the offered machine should be provided before dispatch.	

Servo Hydraulic Static & Dynamic Testing System

SECTION – 3

The BIDDER to note and adhere the following:

S. No.	REQUIREMENTS	BIDDER's TO COMPLY
3.1	The BIDDER shall submit the offer in TWO PARTS – 1. Technical [with filled in PART A & PART B] 2. Commercial and Price Bid.	
3.2	The vendor should clearly indicate whether they are able to supply as per BHEL's specifications for each item. This should clearly be written in vendor compliance box of the enquiry as "Yes" or "No" and also key in the respective details. The vendor shall mention reasons for (i) deviations from specifications (ii) providing better than mentioned specifications wherever applicable (iii) mentioning "No" in the compliance box of enquiry. Explicit Compliance statement for each and every point mentioned in the enquiry shall be provided indicating clearly the items/parts quoted against each point. This shall include compliance, technical details, part numbers, description and quantity being offered for each items quoted against each requirement. Also in case any point being optional, the item/part quoted against the same should also be mentioned as optional.	
3.3	The BIDDER shall assure a continuous support for SPARES and SERVICE for TEN Years, from the date of commissioning of the equipment at BHEL Works. (for both item A & B). No advance payment shall be encouraged in any context.	
3.4	The Technical Offer shall be supported by Product Catalogue and Data Sheets in ORIGINAL and complete technical details / literature on the QUOTED MODEL of the Servo hydraulic static & dynamic testing system.	
3.5	The Commercial Offer (given with the Technical Offer) shall contain the Scope of Supply and the Un-Priced Part of the Price-Bid.	
3.6	BHEL reserves the right to take response from market field. Hence, BHEL officials will visit/contact customers in the market and take an opinion of the machine/similar machines they have in the laboratory (supplied by the OEM/bidder) and also get a feedback from them (like DRDO/HAL/NAL/CSIR/SERC/any other laboratory or organizations etc.) and if found that the supply is not up to mark, then the OEM/bidder shall be disqualified.	

Servo Hydraulic Static & Dynamic Testing System

ANNEXURE-1

The performance certificate shall be produced **on Customer's Letter Head only**.

Format of Performance Certificate

(On Customer's letter head)

PERFORMANCE CERTIFICATE

1. Supplier of the equipment :
2. Make & Model of the m/c :
3. Month & Year of Commissioning :
4. Quantity :
5. Equipment Details
 - a) Type :
 - b) Capacity :
6. Application/Tests Conducted : (please tick the appropriate)

Test Description	YES	NO	NA
High Cycle Fatigue test as per ASTM E 466			
LCF test as per ASTM E606			
Tensile test as per ASTM E8M			
Elevated temperature Tensile test as per ASTM E21			
Compression test as per ASTM E9			
3-point bent test as per ASTM E855 & ASTM E 190			
Fatigue crack growth rate test (da/dN) as per ASTM E 647			
K1c test as per ASTM E399			
J1c and CTOD test as per ASTM E1820			
TMF test as per ASTM E 2368			

7. Performance of the Machine : Satisfactory / Not Satisfactory
(Strike off whichever is not applicable)
8. After sales service : Satisfactory / Not Satisfactory
(Strike off whichever is not applicable)
9. Any Other remarks :

Date:

Signature & Seal of the Authority
Issuing the Performance Certificate

PART B

TECHNICAL SPECIFICATIONS FOR ‘SERVO HYDRAULIC STATIC & DYNAMIC TESTING SYSTEM’

		AA. APPLICATION :		
Sl.No.		FEATURES /BHEL SPECIFICATION	OFFER BY BIDDER	DEVIATIONS
AA.1	Scope of supply and testing	This specification is for : Item A: Supply, installation, commissioning, demonstration and user training of +/- 250 kN servo hydraulic Fatigue testing machine complete with all grips and accessories for carrying out the following tests: • High cycle fatigue test as per ASTM E466 • Tensile test as per ASTM E8M • Elevated temperature Tensile test as per ASTM E21 • Compression test as per ASTM E9 • 3-point bent test as per ASTM E399, E647 and E 1820 • Pre –cracking / fatigue crack growth rate test (da/dN) as per ASTM E 647 • K1c test as per ASTM E399 • J1c and CTOD test as per ASTM E1820 • LCF test as per ASTM E606 Machine shall be capable of running tests in ramp, sine wave, haversine, triangle, rectangle, sawtooth or pulse functions with Amplitude, Frequency, Break & Save Criteria The test system should possess the following items and features. Item B: Supply, installation, commissioning, demonstration and user training of 600 kN servo hydraulic Static testing machines for carrying out the following tests: • Tensile test as per ASTM E8M • Compression test as per ASTM E9 • 3-point bent test as per ASTM E855, ASTM E 190, AWS B.4.0		

Servo Hydraulic Static & Dynamic Testing System

		BB. MACHINE CONFIGURATION : [The scope of supply shall consist of the following]		
Sl.No.		FEATURES /BHEL SPECIFICATION	OFFER BY BIDDER	DEVIATIONS
ITEM -A				
BB.1	Load Frame	• Load frame shall be of fatigue rated two column self-reacting type with ± 250 kN Dynamic Capacity • Actuator to be mounted on top crosshead. • Total Day Light shall be 1300 mm or more (space between Actuator Piston and Load frame Base) • Space between columns shall be 620 mm or more. • Overall height of the machine should not exceed 3500 mm • Overall dimension of the frame not to exceed W 1200mm x D 1200mm x H 3500 mm and weight not exceeding 3000 kgs. • It should have hydraulic lifts & clamps for cross head movement and locking. Shall provide passive clamping where the cross head is to be clamped to the column without any hydraulic pressure applied and using only hydraulic pressure to clamp shall not be accepted. The hydraulic system to be pressurized to unclamp and during the height adjustment. • Minimum Frame Stiffness shall be 470 kN/mm or higher when distance between top of the actuator piston and to base of load cell is 1meter • It shall have Load frame mounted control, Crosshead position Up & Down, Hydraulic Grips Close and Open etc. • The remote handset/panel with display for Power Pack On/Off, Emergency Stop, Actuator jog UP & Down and to start the test. • Machine should be CE compliant • The load frame should be capable of taking test frequency from 0.01Hz to 30Hz or more. • Anti-rotation assembly shall be provided. • Provide a set of fast mounting detail for Grips & Fixtures or additional load cells via standardized Mounting-Stud with spiral washer, for providing easy, quick and accurate mounting of any accessories with mounting-stud with Pin. The supplied spiral (lock) nut should provide backlash-free accessories mounting.		

Servo Hydraulic Static & Dynamic Testing System

BB.2.	Servo Hydraulic Actuator and Manifold	• Actuator should be Hydrostatic bearing / Annular step or better • Actuator to be mounted on the top crosshead. • Actuator should be Integrated (bolt-on actuator in the Crosshead is unacceptable) • Direct Actuator Porting without the need for flanges or manifolds. • One set of Accumulators directly mounted on Actuator manifold • $\pm 250\text{kN}$ Fatigue rated dynamic capacity actuator with $\pm 75\text{mm}$ (total 150mm) displacement /stroke or better. • Coaxially mounted full stroke linear variable displacement transducer (LVDT) or digital positioner transducer for measurement and control of actuator displacement with resolution of 0.001 mm or as per ASTM E2309 or better. • Internal threads in the piston rod for mounting a grip and a load cell. • Direct Actuator Porting without the need for flanges or manifolds. • Dynamic force rating must be more than 90% of static force for generating optimistic dynamic performance • Low friction and wear resistant and high side load carrying capabilities. • It should be capable of achieving frequencies from 0.01 to 30Hz dynamic load applications or more. • Suitable flow rate servo valve (not proportional valves) shall be provided for conducting tests mentioned above • Dual manifold for two x two-stage flow control servo valves from Moog make with total flow of 100 lpm or more to be provided. • Close-coupled accumulators (1 liter) allowing maximum high frequency response of servo valve(s). • Maximum operating pressure: 210 bar or more • Operating temperature: preferably 40 deg-C to 50 deg-C where the actuator shall stop at high and low temperature interlock to protect the power pack, hydraulic oil, machine and to guarantee the performance of the hydraulic oil. • Rated full-flow input signal current for Servovalve : 25 mA		
-------	--	---	--	--

Servo Hydraulic Static & Dynamic Testing System

BB.3	Load Cell	• $\pm 250\text{kN}$ Dynamic Capacity Fatigue Rated Load Cell. • Machine accuracy according to ISO 7500-1, ASTM E4 • 150% over load capacity • Non-linearity & Hysteresis : $< 0.2\%$ of full scale or better • Full range calibration (traceable to NIST/NABL/equivalent International Standard) • All adapters for load cells compactible with the Actuator, Load frame and grips shall be provided.		
------	------------------	---	--	--

BB.4	Tensile, Compression Package and extensometer	4.1. Wedge Grips (as per ASTM E8/8M) 4.1.1. $\pm 250\text{kN}$ Hydraulic non shift wedge grip for static, pseudo-static and dynamic with flat and round specimen jaw faces for specimen thickness of up to 25mm, width upto 50mm and round diameter 6mm to 25mm with top or side loading. 4.2. 250kN Compression Platens (as per ASTM E9) , consisting of: • Platens made from case-hardened alloy steel with hard chrome plating feature a smooth face with etched concentric rings, enabling the specimen to be centered visually for better test results • Dynamic Rating: 250 MPa or more • Static Rating: 650 MPa or more • Diameter: 150 mm or more • Configuration: One Fixed, One Spherical Platen 4.3. Extensometer 4.3.1. Dynamic Extensometer for direct strain measurement and closed loop strain control. Suitable for tensile, compressive & fatigue testing, the extensometer with 25mm gauge length with a travel of +12.5mm to -2.5mm giving +50% to -10% strains. It shall include an extender to give a gauge length of 50mm and strain of +25% to -5% strain. This extensometer should also have the facility to keep it on specimen up to break on a static test setup. Should meet ASTM class B-1 and ISO 9513 class 0.5 for accuracy. Should work for both flat and round samples (Flats to 25 mm thick and rounds up to 25 mm diameter. Necessary strain card needs to be provided.		
------	--	---	--	--

		4.5. Software package to perform Tensile (according to ISO 6892-1), Compression test and bend test. The user interface should contain specimen description, loading parameters, pump controls, test run/stop, graph display, numeric readouts of multiple relevant test parameters. 4.5.1. Tests should be possible in stroke or strain control. 4.5.2. Online graphs of stress vs. strain and load vs. displacement. 4.5.3. Option to save the test profiles. 4.5.4. Auto data acquisition settings 4.5.5. Option to view multiple test graphs in one plot. 4.5.6. Option to run test in different rate of loading. 4.5.7. Option to remove the extensometer and continue the test in stroke control. 4.5.8. Option to stop the test after specified percentage load drop. 4.5.9. Limit settings on stroke, strain and load channels. 4.5.10. Offline post processing program to analyse the results in MS Excel and also Software offered should be capable of generating the final test report including Raw data in the general purpose MS Office (EX: Excel) format. 4.5.11. Advanced data filtering options on all feedback channels must be available.		
--	--	--	--	--

BB.5.	High Cycle Fatigue Test Software Package	5.1. High Cycle Fatigue Testing Software (As per ASTM E 466) ± 250kN Hydraulic non shift wedge grip for HCF test as per ASTM E466 with Flat and round specimen jaw faces for specimen thickness of up to 25mm, width of 50mm and round diameter 6mm to 25mm with top loading The user interface should contain specimen description, loading parameters, pump controls, test run/stop, graph display, numeric readouts of multiple relevant test parameters. Tests should be possible in force, and stroke control. Tests should be either possible in stress control, total strain control and plastic strain control. Online display of loading modulus, unloading modulus, yield stress, plastic strain, max-min stress and max-min strain, max-min stroke are required. 5.2.1. Limit settings on stroke and force. 5.2.2. Auto data acquisition settings. 5.2.3. Online graphs of stress vs strain, stress vs no.of cycles and transients. 5.2.4. Offline post processing program to analyze the results in MS Excel. 5.2.5. Option to save the test profiles. 5.2.6. Option to remove residual strain. 5.2.7. Option to add strain to gage length. 5.2.8. Option to terminate the test at specified modulus drop, stress drop and/or increase in strain. 5.2.9 Free Programmable Interface package: This package should offers the Flexible-multi-step environment designed to run everything from simple ramps to dynamic & fatigue single to complex multi-axial materials, component and simulation tests		
-------	---	---	--	--

BB.6.	Low cycle Fatigue test Package	6.1. Self-Aligning grips +/- 250 kN With female connection for sample with threaded ends with set (2 pcs) of Hardened inserts for threaded grips. Set of inserts for Bolts with two side thread inserts for diameter from 10 mm to 16 mm (M10, M12, M14, M16 M20) 6.2. Axial Extensometer for LCF Applications 6.2.1. Gage length: 25 mm 6.2.2. Travel: +5 mm/-2.5 mm 6.2.7. Full bridge, 350 ohms strain gauged design 6.2.8. Strain Range: +20% / -10% 6.2.9. It should be meet ASTM E83 Class B1 and ISO 9513 Class 0.5 Standard 6.2.10. NIST/NABL/equivalent International Standards traceable factory calibration The extensometers should be designed for testing wide range of materials including the metals. 6.3. Low Cycle Fatigue Testing Software (As per ASTM E606) The user interface should contain specimen description, loading parameters, pump controls, test run/stop, graph display, numeric readouts of multiple relevant test parameters. Tests should be possible in stroke and strain control. Tests should be either possible in stress control, total strain control and plastic strain control. Online display of loading modulus, unloading modulus, yield stress, plastic strain, max-min stress and max-min strain are required. 6.3.1. Limit settings on stroke and strain 6.3.2. Auto data acquisition settings. 6.3.3. Online graphs of stress vs strain and transients. 6.3.4. Offline post processing program to analyze the results in MS Excel. 6.3.5. Option to save the test profiles. 6.3.6. Option to remove residual strain. 6.3.7. Option to add strain to gage length. 6.3.8. Option to terminate the test at specified modulus drop, stress drop and/or increase in strain. Software-package in accordance with ASTM E606 to enable perform low-cycle fatigue tests on constant cross-section test specimens for the determination of fatigue properties of nominally homogeneous materials by the use of uniaxially loaded test specimens		
-------	---------------------------------------	--	--	--

BB.7	Fracture Mechanics Package	7.1. Clevis Grips (As per ASTM E399, E647 & E1820 standard) 7.1.1 Room Temperature Fracture Mechanics Grips used for fracture toughness and fatigue crack growth rate tests. Constructed of high-strength, aircraft-quality 4340 steel, they shall be machined to the exact tolerances required by ASTM standard to be centered visually for better test results • Dynamic Force: 30 kN or more • Static Force: 60 kN or more • Specimen Width: 50.8 mm or higher mm • Specimen thickness: 25 mm or higher • PIN Diameter: 12.7 mm or higher and with 5 set of spare pins of each specimen afore mentioned. 7.1.3 Fracture Mechanics Clip-on COD Gages for fracture mechanics studies, these gages shall be in compliance with standardized test methods, such as ASTM E1820 for determination of fracture toughness properties of metallic materials. One with Gage Length 10 mm and a measuring travel +4 mm Another with gauge length 10 mm and travel 10mm 7.1.4. 1000 Deg C High Temperature COD gauge complying to ASTM E1820 with 10mm GL and travel of +4.0/-1.0mm to be used for either of the above clevis grips. A set of Alumina rods should be provided. 7.1A. Bend Fixture (as per ASTM E399) 7.1A.1. 250 kN Dynamic Room temperature 3-point bend fixture with adjustable span of 80 to 300mm and roller of diameters between 20mm and 30 mm for maximum specimen width of 50mm or more. 7.2. Fracture Mechanics Software for K_{Ic}, J_{Ic} and CTOD Testing (As per ASTM E1820 and E399). The user interface should contain specimen description, loading parameters, pump controls, test run/stop, graph display, numeric readouts of multiple relevant test parameters. ASTM E647-13: Fatigue Crack Growth Software template to run Fatigue Crack Growth (FCG) in combination with clip gage. Compliance tests on CT (compact tension) specimens Compliance tests on SE(B) (single-edge-notched bend) specimens		
------	-----------------------------------	--	--	--

		ASTM E399: K_{Ic} test module to perform fatigue pre-cracking and to use the compliance method as the primary crack length measurement. K_{Ic} fatigue crack growth tests consist of crack size check, pre-crack. ASTM E1820: The J_{Ic}-CTOD Module to calculate J-R curves, CTOD R curves, critical J and critical CTOD values, with a predefined test template - Supported specimens CT specimen. - Supported specimens single-edge-notched bend specimens 7.2.1. Tests shall be done in stroke or COD control. 7.2.2. Real time graphs of J vs. Δa and load vs. displacement. 7.2.3. Option to save the test profiles. 7.2.4. Auto data acquisition settings 7.2.5. Auto scaling of graph. 7.2.6. Option to see J and Δa value online. 7.2.7. Option to select the previous data file and export the data. 7.2.8. Data file storage in same settings file. 7.2.9. Option to stop the test after specified percentage load drop. 7.2.10. Offline post processing program to analyze the results in MS Excel 7.3.1. Option to program multiple steps with different loading conditions and different frequencies. 7.3.2. Online graphs of da/dN, load vs. COD, crack length vs cycles, K vs cycles, etc. 7.3.3. Online display of crack length, K_{max}, K_{min}, ΔK, P_{max}, P_{min}, ΔP, da/dN and more Option to stop the test at specified crack length, crack increment, K_{max}, cycles etc. 7.3.4. Option to do variable amplitude test 7.3.5. Option to save the test profiles. 7.3.6. Auto data acquisition settings. 7.3.7. Auto scaling of graphs. 7.3.8. Option to enter material properties and specimen dimensions. 7.3.9. Option to measure incremental crack length with specimen mounted and while in test condition.		
--	--	---	--	--

		7.3.10. Offline post processing program to analyse the results in MS Excel and also Software offered should be capable of generating the final test report including Raw data in the general purpose MS Office (EX: Excel) format. 7.3.11. Advanced data filtering options on all feedback channels must be available.		
--	--	--	--	--

Servo Hydraulic Static & Dynamic Testing System

BB.5	Control Electronics	• Controller shall be of Digital closed loop controller. • 32 bit DSP (Digital Signal Processor) • 24 bit Data Acquisition on the control and feedback channels. • Data sampling rates of 5 kHz or more from all primary channels shall be available. • Controller must have minimum 3 DIO and 2 +/-V analog outputs in base configuration The controller can be equipped with minimum 03 sensor signals stroke, force, Extensometer for control mode and 5 or above as Analog Input and output lines - I/O selectable according sensors and A/D inputs or D/A outputs. • Auto Offset and digital Auto Zero capability. • Internal data sampling rate 100 kHz or more • Adaptive peak control • Adaptive control and PID parameter modification & compensation of sample stiffness gradient • Easy Downloadable Firmware for future up gradations, without making any changes in the controller. • Controller should be capable of conducting all Tests mentioned above. • Should be capable of acquiring data from all control and feedback channels. • It shall be compatible with industry standard Ethernet or USB communication ports. • User settable software safety limit interlocks on upper and lower limit readout on each of feedback channels with individual option of Stop/Hold/Trip. • Shall be able to run cyclic loading defined in various wave forms like ramp, sine, triangular, saw tooth, rectangle and pulse functions. • Control should be on Stroke, Load & Strain control modes with above referred frequency range.		
BB.6	Remote Control Hand Set with LCD Display	Multifunctional Remote Control Hand Set with LCD Display \ The Remote Control Hand Set with LCD Display should offer the convenient test Set-up and Operation of the Testing Machine. The Remote Control should offer: • course and fine adjustments of Actuator position through thumb wheel • Close / Open switch for Hydraulic grips • On and Off function of the Hydraulic Power Unit, Hydraulic Service Manifold		

BB.8.	Hydraulic power pack	• Safety features to trip at over temperatures, over pressure, low oil level, filter clogging, power failure, motor over load etc. shall be incorporated • Direct-coupled 60-hp submerged motor to improve operating efficiency. • Acoustic hood is mandatory such that noise level at 1m should be less than 65 db with the max. pressure of 3000 psi • Pump shall be supplied with a minimum working pressure of 210 bar • Pump should be of pressure compensated Variable-displacement type • Water cooled with Stainless steel heat exchanger • Should be a stainless-steel reservoir • First fill of the power pack should be filled by the vendor mineral based equivalent to DTE 25 or Servo 46 or shell tellus 46 AW or Mobil NUTO H46 (to be supplied), • 3 micron pressure-line oil filtration • Tank Capacity minimum 350 liters • Hydraulic oil for the HPU to be provided. • Hoses of min 7 m or higher length needs to be provided which is sufficient to connect the machine with the power pack. • The hydraulic power pack to be isolated through anti-vibration dampers. • PLC (Programmable Logic Controller) with Operation Panel • Power supply available is 415V +/-10%V, 3Ph, 50 Hz • Vendors should submit performance curve along with the technical offer. The performance curve should match or better the following table. <table><tr><th colspan="2">Dynamic Performance at 20% of rated Load (50kN)</th><th colspan="2">Dynamic Performance at 80% of rated Load (200kN)</th></tr><tr><th>Hz</th><th>+/-Amplitude</th><th>Hz</th><th>+/-Amplitude</th></tr><tr><td>0.2</td><td>74mm</td><td>0.2</td><td>74mm</td></tr><tr><td>1</td><td>7.5mm</td><td>1</td><td>6.5mm</td></tr><tr><td>5</td><td>4mm</td><td>5</td><td>3.25mm</td></tr><tr><td>10</td><td>1.9mm</td><td>10</td><td>1mm</td></tr><tr><td>20</td><td>0.875mm</td><td>20</td><td>0.075mm</td></tr></table>	Dynamic Performance at 20% of rated Load (50kN)		Dynamic Performance at 80% of rated Load (200kN)		Hz	+/-Amplitude	Hz	+/-Amplitude	0.2	74mm	0.2	74mm	1	7.5mm	1	6.5mm	5	4mm	5	3.25mm	10	1.9mm	10	1mm	20	0.875mm	20	0.075mm		
Dynamic Performance at 20% of rated Load (50kN)		Dynamic Performance at 80% of rated Load (200kN)																														
Hz	+/-Amplitude	Hz	+/-Amplitude																													
0.2	74mm	0.2	74mm																													
1	7.5mm	1	6.5mm																													
5	4mm	5	3.25mm																													
10	1.9mm	10	1mm																													
20	0.875mm	20	0.075mm																													

Servo Hydraulic Static & Dynamic Testing System

9	Chiller for power pack	Power pack should be supplied with suitable closed loop refrigerant based outdoor chiller unit.		
BB.10	Work Station	- High Performance compatible workstation & Printer shall be provided along with the machine with following specifications - Windows 10 OS (64bit) 4-core Intel Core i7, 3.1GHz processor 32GB DDR4-2400 memory - Hard disk: 2TB 2.5" 5400RPM HDD 23 Inch LCD monitor - Table of 1600mm x 800mm dimension for the accessories - HP Colour Laser Printer - Suitable Single phase online UPS for controller, computer & printer should be - provided for workstation (with 30 min back-up) - Shall be with pre-installed software Origin (2017), Creo Parameter		
BB.11	Calibration certificate	Vendors shall provide the NIST/NABL/ equivalent International Standards traceable factory calibration certificate for Load cell, all extensometers, COD gauges and LVDT		
BB.12	Spare parts kit	- Basic tools and spare parts kit with essential spares and consumables (grease, fuses etc) required for maintaining the machine for at least 10 years. - Basic kit should consist of: one spare set of filter element		

Servo Hydraulic Static & Dynamic Testing System

BB.13	Alignment Fixture, specimen and software	• Capacity: 250kN • Capability to perform alignment adjustments while the load train is fully preloaded • Round Strain-Gaged Specimen - 12 mm Shank • Overall Length: 200 mm. • Twelve quarter bridge strain gages bonded with heat-cured epoxy. • Shielded cable. • Alignment Software Perpetual License • This software package shall acquire, analyze, and display bending strains for alignment and bending strain verification. It's utilities shall save lab operator's time and insure they get better test data. • The software package shall allow lab operators to maintain a library of specimens, receive step-by-step instructions on how to perform alignment adjustments and obtain an alignment verification report for certification. • Shall provide Windows 10, one dedicated RJ45 Ethernet connector and a CD drive. • Alignment Data Acquisition and Conditioning System • The package shall include the hardware necessary to acquire, analyze, and display bending strains for alignment and bending strain verification. • Shall Include: data acquisition, conditioning, manual, quick reference guide and PCI 10/100 Ethernet card or controller.		
-------	---	---	--	--

BB.14	Furnace and accessories for LCF test	• 1000 Deg C high temperature 3 zone furnace with extensometer cut out • 3 zone temperature regulation • Rated furnace temperature 100°C to 1000°C • Heating rate 20°C/min or better • Temp. regulation accuracy $\pm 2^\circ\text{C}$ or less • Heating zone $\varnothing 100 \times 300$ mm or better • Internal Bore diameter min 110mm (for CT samples) • Weight shall not exceed 30 kg • Electronic 3-zone control unit complete with 3-PID controllers with Eurotherm 3216 series controller • Shall include: 3 thermocouples (Type K) • Single phase 220 V, 50 Hz or 3-phase power supply, 415V $\pm 10\%$. • Hinged furnace mounting bracket • Capability of a slideable thermocouple arrangement should be provided and should allow to go with the upper and lower thermocouple to the adapters and with the middle one onto the sample. Additional clamping holes for another two thermocouples with a distance of 25 mm to each side from the middle one should be available for additional two thermocouples for temperature measurement direct at the sample. For the above 5 port slideable thermocouple arrangement, minimum one thermocouple for mounting on the sample with a separate display should be provided. Thermocouple should be supplied with calibration certificate. • Set of connecting adapters, with spherical seat for High temperature (HT) Tensile Tests to insert the high temperature pull rods to be quoted. • Set of cooled quick connecting adapters, with open front and spherical seat to insert the high temperature pull rods. Should include water or air cooling connectors, for the most stable force measurement without any drift as required for long term tests as creep or relaxation. • Two pairs of high temp reverse stress pull rods made (Saratherm or Inconel material) to be fix onto pull rods for HT tests. • Thread adapters for M8, M10, M12, M16 and M20 to be provided.. • Water cooling unit complete including chiller for the HT Grips and Extensometers. • High Temperature Hot Mountable Furnace Extensometer to meet the stringent requirements of strain controlled testing as prescribed in ISO 6892. Gauge length (GL) 25 mm Travel: $\pm 10\%$ of GL ($\pm 5/-2.5$mm)		
-------	---	---	--	--

Servo Hydraulic Static & Dynamic Testing System

		Linearity $\leq 0.15\%$ of F.R Operating temperature up to 1200°C		
BB.15	Direct Potential Drop DCPD - 2 Channel	• The DCPD Module shall measure incremental crack length via a voltage that is correlated to the crack length even while the test is running. • The DCPD solution should be provided easy-to setup hardware combined with the power of test templates for performing tests and analyzing results with full integration to the supplied system controller. • The templates shall contain the algorithms so that as standard or customer testing needs change, the templates shall be customized to suit applications requirements. • Vendor should have prior experience to integrate Controller, Software and DCPD Hardware and it shall be the sole responsibility of the vendor to integrate the DCPD with the test system. • Controller requirements and cabling shall be included. • The Software shall run as standard template and shall be user friendly to modify the templates, specimen geometry and algorithms as standards or applications change. • The supplied Load frames should be electrically isolated so that electrical isolation methods for the specimen are not required. • DCPD hardware should have the current switching option to reduce noise with three main modes: fully reversing, always on, on/off and remote command for proportional current control (for test capabilities such that a wave-shape can be created for the current) • Automation using templates shall reduce operator interaction for test, enhancing productivity. • Shall provide differentiated levels of support for experienced or new users.		
BB.16	Additional Spares & accessories	• Magnification glass (round with handle) of 4X magnification • Liquid in glass and digital thermometer of temperature range -100 to +50 (with NABL/equivalent international standard traceable calibration certificate) • 2 Ton Hand pallet jack lift • Infrared thermometer in the range upto 600 deg-C		
	THE VENDOR SHALL MANDATORILY QUOTE FOR THE FOLLOWING:			
	Thermo Mechanical Fatigue Unit			
CC.1	Grips	Shall provide appropriate grips and accessories to hold and test the samples as mentioned in Annexure-2 complying to ASTM E 2368-10		

Servo Hydraulic Static & Dynamic Testing System

CC.2.	Thermo Mechanical Fatigue Software	This module shall contain test, analysis and report templates and calculations needed for thermo mechanical fatigue testing. This module shall be compliant with ASTM E2368-10 and European Validated Code of Practice for Strain-Controlled Thermo Mechanical Fatigue Testing, 2006, ISBN 92-79-02216-4. The test template shall be modifiable to conform to most single- or multi-axis TMF tests described in ASTM or ISO draft standards. Shall include: ■ Test template for strain controlled TMF tests. ■ Analysis definitions for review of test data. ■ Report template for strain controlled TMF tests. ■ Virtual specimen configuration files to simulate TMF tests. ■ Example station configuration and definition of calculated signals. ■ Thermal strain calibration calculator. ■ Run time view definitions to display all test data in graphical and tabular manner. Options for temperature correction of stress and gage length: ■ no correction ■ gage length correction ■ gage length and stress correction		
CC.3.	TMF Subsystem	This subsystem shall provide RF generator/induction heating system, control, coil, mounting brackets and coil positioner, external air cooling componentry. Temperatures up to 1000°C. Heat-up rates, dependent on specimen material, size, and temperature range. Typical rates shall be up to 10°C/s for TMF heat and cool applications or better. Higher rates with open loop heat-only applications. Standard 5 turn (minimum) tapered spiral induction coil, water cooled Type K control standard CE conformity declaration		

Servo Hydraulic Static & Dynamic Testing System

CC.4.	TMF RF Power and Temperature Control Cabinet (as applicable)	10kW RF Generator/Induction heating Suitable Water cooling requirement shall be provided for trouble free and safe operation of the system. Cooling water requirements for RF Power, oscillator, and coil: 10 lpm at up to 35 °C inlet temp., 4-6 bar pressure Frequency range 50 to 200kHz at 10 kVA Cooling water flow interlock Electrical power requirements: 400 V 3 Phase, 12.5 kVA Type K (Ni/CrNi) control thermocouple (standard) Controller interface Analog Control 0-10 Volt with Servo Controller Temperature output and external setpoint Eurotherm programmer-controller Model 2604 instead of 2408 Controller incl. 20 storable programs Oscillator interface 2 digital displays: temperature and set point, self tuning capability, user configuration Over temperature alarm contacts		
CC.5.	Remote RF Oscillator (as applicable)	Frame mounted with x, y, z manual positioning for fine positioning of induction coil Hybrid tuned to system RF Power connections and cables to controller cabinet		
CC.6.	RF / Induction Heating Coil	5 Turn standard tapered spiral, rectangular profile		

Servo Hydraulic Static & Dynamic Testing System

CC.8.	Thermocouple connector kit	- Thermocouple type K (Ni/CrNi) - Extension leads for spot welding - connector (or) Set (3 pcs) of Pt RH-Pt10% Type S Ribbon type thermocouples (Wire diameter 0.5 mm pressed to approx. 0.2 mm x 20 mm Width)		
CC.10.	High Temperature Axial Extensometer	Gage Length: 25 mm. Strain Range: +10%, -5%. Max. Specimen Temperature: 1200°C Contact Force per Rod: 100 grams. Maximum operating frequency, 2Hz or higher Mounting Bracket Air Regulator NIST/NABL or European standard or equivalent International Standard traceable factory calibration Self-identification capabilities adopted IEEE 1451.4 standard. Should meet existing ASTM E 83 class B-1 and ISO 9513 class 0.5 requirements for accuracy. Straight chisel tips. Include: Electronic amplifier on Electronic and calibration certificates. Set of spare Feelers		
CC.11.	TMF Digital Controller (as applicable)	Ultra-high-speed minimum 10kHz closed loop control and data acquisition rate on all channels combined with 24 bit high resolution transducer conditioning rate achieved by 64 bit processor running at 1 GHz Emergency stop circuit according actual safety norm. Hardware complete with force and piston stroke (displacement) channel (amplifier cards) and system plug including Amplifier cards for sensor transducers (force, displacement and strain). Conditioners max. up to 13 (extendable) (including one digital channel on board) selectable according sensors and A/D inputs / D/A outputs		
CC.12.	Vendor Responsibility includes	It shall be the sole responsibility of the Bidder/OEM to integrate the TMF setup with the ‘+/-250 kN static and dynamic testing system’ and run a prove out test as mentioned in Annexure-3		

ITEM -B				
DD.1	General Feature	• Shall be with rigid 6-column-construction with dual zone test space for reducing setup time (Tension on top, compression on bottom) high stiffness and precision aligned for static tension, compression or bending tests on different specimen and materials. • The machine should be with ergonomic dual test space design allowing both, tension and compression/bending testing to be performed without the need of remove fixtures from the load frame. • The machine should be CE compliant.		

Servo Hydraulic Static & Dynamic Testing System

DD.2.	Load Frame	• Rigid 6-column construction(4 solid and 2 screws (spindles)) - • Integrated hydraulic wedge grips in open front construction for easy sample loading/removable and changing of inserts (jaws) • Chrome plated columns for easy cleaning and longest life • Anti-rotation system for the actuator to prevent the natural tendency of the actuator to rotate • Piston stroke end-switch • Actuator mounted in the base of the machine • With integrated precision electronic load cell for direct force measurement • With high resolution digital displacement transducer with resolution less than 1 microns • Shall comply to the technical requirement as below: * Max. test load static ± 600 kN * Accuracy according to ISO 7500-1 Grade 0.5 from 0.6 kN to 600 kN * Piston stroke 200 mm or more * Piston stroke accuracy according ISO 9513 Grade 0.5 or 0.13 mm stroke (displacement), whichever is greater * Testing speed up to 75 mm/min. * Column spacing (test space width) 540 mm * Tension space (excluding piston stroke) 0-700 mm * Compression space (excluding piston stroke) Min 550 mm * Adjustable Crosshead Speed 200 mm/min. * Dimensions of frame (WxDxH) Not to exceed 850 x 600 x 2300 mm * Frame Stiffness 600 kN / mm * Weight of the frame Not to exceed 2900 kg		
DD.3.	Integrated Hydraulic Wedge Grips	• In open front construction for easy sample loading / removal, and quick exchange of inserts (jaws) and should include the following: • Set of Inserts for Flat Specimen 0 – 30 mm x width 90 mm • Set of Inserts for Round Specimen diameter 5 mm – 20 mm • Set of Inserts for Round Specimen diameter 20mm – 40 mm		

Servo Hydraulic Static & Dynamic Testing System

DD.4.	Load Cell	• +/- 600 kN high precision tension/compression load cell • With calibration certificate from laboratory accredited according to the latest standard (ISO 17025) • With integrated, high precision strain gage based load cell for direct load (force) measurement and closed loop control. Including amplifiers, transducer coding plug with automatic recognitions of transducer and calibration • Precision according to EN10002 and ISO 7500-1 . • from 1% to 100% of capacity class 0.5% • from 0.4% to 1% of capacity class 1%.		
DD.5	Hydraulic Power Pack	• Shall provide standard machine control rack console with integrated hydraulic power pack • The power pack shall be integrated in the base of the console, to furnish the necessary pressurised oil for hydraulic testing machine. • The following units should be built-in: Oil tank, pump, safety controls, pressure limited, filters, oil/water cooler or oil/air cooler (external) etc. • Integrated servovalve • Electrical switchboard in 19" rack with control panel • The free space in the upper part of the console to integrate the electronic system, personal computer & screen Shall comply to technical requirement as below: * Power supply Single Phase 220V (+/-10%), 50 Hz, 15 Amp. * Rack console dimensions, Not to exceed 600x900x2100 mm WxDxH * Weight Less than 350 kg * Cooling Oil/Air • Noise level of hydraulic power pack while operating shall be less than 65 db.		

Servo Hydraulic Static & Dynamic Testing System

DD.6.	Control System	- For static material testing in closed loop load (force / stress)-, displacement-, deformation (strain) mode. - Real-time, multitasking control system with high resolution and high control and data acquisition rate with synchronization of all channels. - Shall comply to the following features: * Control processor (digital signal processor) 32 bit * Data acquisition / signal conditioners 19 bit * Close loop control and data acquisition rate 1 kHz or more * Internal data acquisition rate 1 kHz or more at 24 bit * Control Modes any connected input including Force Stress Deformation Strain Displacement (Crosshead) * Digital In-/Output max. 3 * Interfaces to PC Ethernet / LAN		
DD.7.	Compression and Bending Fixtures	COMPRESSION PLATENS shall consist of: 1 upper spherically seated platen 1 lower fix platen - Platen Ø 150 mm/square 150mm or more - Including adapter to fix to the grips 100 kN BENDING AND FOLDING FIXTURE: - Load: 100 kN - Range of bending 0 degree to 180 degree - Adjustable span 0 to 250 mm - Including mandrels (upper fins / loading noses) with Ø12, 16, 20, 24, 32, 40 - Including connection detail - Including appropriate stainless steel angle protractor to measure any intermediate angle between 0 to 180 degree while bending operation.		

Servo Hydraulic Static & Dynamic Testing System

DD.8.	Extensometer	Dynamic Contact type extensometer (3 in 1) extensometer with GL 25mm, reducer and extender for 12.5mm and 50mm respectively. Measuring travel +50% / -10%. This extensometer should also have the facility to keep it on specimen up to break on a static test setup. Should meet ASTM class B-1 and ISO 9513 class 0.5 for accuracy. Should work for both flat and round samples (Flats and round). Necessary strain card needs to be provided		
DD.9.	Software Package	- Intuitive runtime displays - A selectable, multi-language testing interface (English, Korean, Japanese, Spanish, Chinese, German, French). - A large and, growing library of standards-compliant test methods (ASTM, ISO, DIN, EN, BS, and more) - Robust analysis and reporting features - Templates for tensile, compressive, bending testing. - Graphical drag-and-drop test layout design. - Test template creation - Data acquisition (timed, P/V, level crossing, cyclic/logarithmic). - Parallel branches for test execution and logical operators (if-else) and calls to external routines - Simulation mode to run a “virtual test” without using – or damaging – a physical test specimen - Limit sensing, sequencing triggers, and interface to digital I/O. - Data export to ASCII - Report generation during and after the test - Metal Methods Package the following standards: ASTM E8M, ASTM E9, ASTM E290, ASTM E 190, ASTM E 855, ASTM A370 (Tensile & Bend Only), AWS B4.0		
DD.10.	Hand set	- Multifunctional Remote Control Hand Set with LCD Display. - The Remote Control Hand Set with LCD Display should offer for convenient Test Set-up and Operation of the Testing Machine. - Digital Display of Force / Displacement - Opening and Closing of hydraulic, pneumatic or motorized grips - Digital Setting Mode of the piston or crosshead Emergency Button		
DD.12.	Basic tools and spares kit	Basic tools and spare parts kit with essential spares and consumables (grease, fuses, lamps, etc) required for maintaining the machine for at least 5 five years, typically longer		

EE. GENERAL POINTS :				
S.No.	PARTICULARS	BHEL SPECIFICATION	OFFER BY BIDDER	DEVIATIONS
EE.1.	Manufacturer's Test Certificate	Manufacturer's Test Certificate required and should be provided before dispatch.		
EE.1.	Erection & Commissioning (E&C)	• E&C or Installation has to be carried BHEL's work site by the OEM or their authorized service agency/ personnel only. • Supplier should indicate the site requirements for E&C in the offer itself including the layout of the machine and associated accessories, electrical, civil requirements, etc • All cables, adapters, etc. required for integration of each and every component of Servo hydraulic static & dynamic testing system must be supplied along with the system. It is the responsibility of the supplier to integrate all the systems (including Thermomechanical accessories, auxiliaries, software, etc.) and ensure the functionality of the entire Testing Machine and accessories, auxiliaries as per technical scope of the enquiry. • E&C report should be submitted to us after successful completion of the same.		
EE.2.	Pre-dispatch Inspection	The equipment(s) shall be submitted for pre-dispatch inspection (PDI) at the manufacturer's works by BHEL Engineers before despatching the same to the BHEL, Trichy. The OEM shall demonstrate basic operation of the machine to prove its compatibility with the requirements asked for. Acceptance of the machine will be based on the successful completion of trial tests as listed in the Annexure-3, which shall be demonstrated by OEM during PDI. The international air travel (to and fro – both the ways inclusive), boarding and lodging in connection with the PDI mentioned above for BHEL officials shall be in the scope of BHEL.		

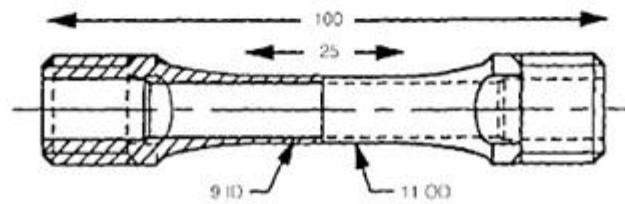
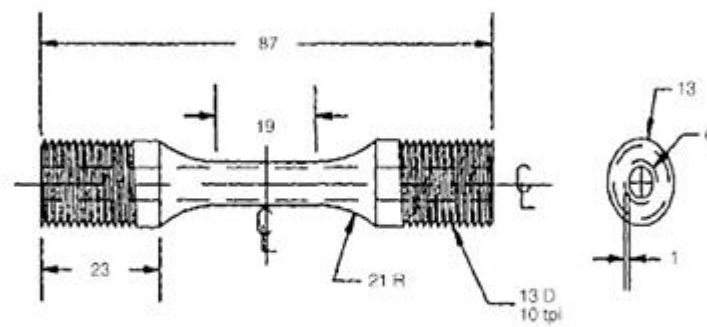
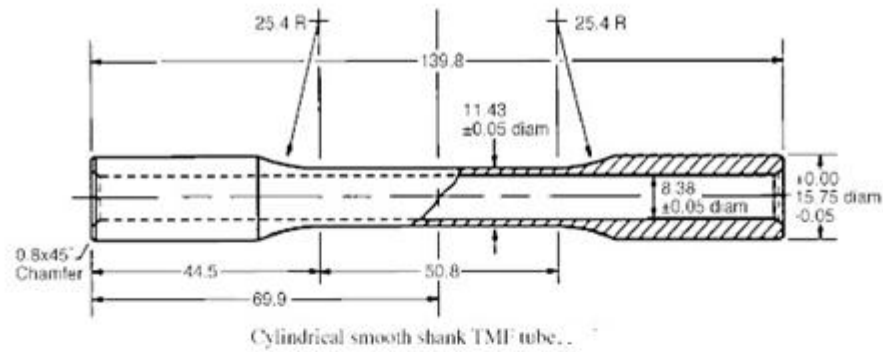
Servo Hydraulic Static & Dynamic Testing System

EE.3.	Training	- Detailed training at BHEL's works has to be provided by factory engineers of OEM/bidder to BHEL staffs on working of all modes of the equipment along with the accessories, handling the software for operation or data acquisition and maintenance procedures. - Training should also be provided on safety features, tasks to be performed in case of emergency, etc. - Detailed scope and daily schedule and duration of training has to be indicated. - Training charges, if any, have to be quoted separately.. - Training certificate and report should be submitted to BHEL officials after successful completion of the same.		
EE.4.	Warranty	The machine shall have warranty of atleast two years from the date of commissioning at WRI, BHEL.		
EE.5.	After sales support and Annual Maintenance Contract (AMC)	- OEM or Indian agent must take up responsibility for service of Servo hydraulic static and dynamic Testing System along with accessories, auxiliaries, etc. when requested for. - Bidder shall quote for service AMC charges for 5 years after expiration of the standard guarantee/ warranty. - BHEL reserves the right to place a separate order/ orders for service AMC contract before expiry of standard guarantee/ warranty period at the rates quoted. - During service AMC visit, 4 routine visits per year for general service and maintenance, calibration, etc. and one breakdown/ emergency visits (if any) per year have to be made for continuous operation of the equipment. - Scope of service AMC routine visit, to be carried out for ensuring continued operation of the system, has to be indicated in detail. - The service personnel should report within 3 days for attending the problem during breakdown/ emergency visit as a part of service AMC. - No advance payment shall be encouraged in any context.		

Servo Hydraulic Static & Dynamic Testing System

EE.6.	Brochures/ Technical details	Brochures/ Technical details/ supporting information compliance to all the item, specifications for the equipment along with its accessories, auxiliaries, etc. have to be provided. Softcopy of the same to be provided in pen drive.		
-------	------------------------------	---	--	--

Specimen drawing for Thermo mechanical fatigue testing compliant to ASTM E 2368-10



NOTE 1—All dimensions in mm.

NOTE 2—These are representative drawings of specimens that have been used in TMF studies.

Samples of Thin-Walled Tubular Specimens for TMF Testing

Pre-dispatch inspection and basic training at manufacturer's factory shall to be carried out by BHEL representatives before dispatch of machine. The OEM shall perform the below said tests during the PDI. The machine shall be acceptable only if the said tests are completed successfully and reports are submitted. This shall remain a main criteria for the acceptance of the machine.

DESCRIPTION	TESTING I	TESTING II	TESTING III	TESTING IV
Material	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel
No of samples:	3	2	6	1
Condition of Test:	Room temperature, Elevated Temperature (600 deg-C)	Room temperature	Room Temperature	Elevated temperature
Nature of Test	One tensile test complying to ASTM E8, Hot tensile test complying to ASTM E 21	Low cycle fatigue test complying to ASTM E 606 . High Cycle fatigue test in one sample complying to ASTM E466	K _{IC} , J _{IC} and fatigue crack propagation test complying to AST E 399, ASTM E1820 and ASTM E647 using CT specimen and 3-point bend specimen by using quoted DCDP for crack measurement	Demonstration of thermomechanical test complying to ASTM E2368-10