

## **Technical Specification for 250 kN Electromagnetic Resonance Fatigue Testing Machine**

### **The machine:**

- The Electro Magnetic Resonance is intended for life time fatigue cycle tests to generate S/N curves and other dynamic tests in order to evaluate the fatigue strength of various materials and components besides fracture mechanics studies as per relevant ASTM / DIN standards.
- Machine should have the capability to apply ranges of tensile stress, compression load, torsion, pulsating stress and alternate loads and test round, flat, 3 point bend, 4 point bend and Fracture toughness samples.

### **Detailed specification of the machine:**

#### **A. Machine details:**

##### **Main Features :**

1. Load capacity:  $\pm 250$  kN
2. Max. dynamic load : 250kN (  $\pm 125$  kN )
3. Max. Static load :  $\pm 150$  kN
4. Max. load amplitude :  $\pm 125$  kN
5. Dynamic stroke/displacement: 4mm ( $\pm 2$ mm) or higher
6. Frequency range of operation : covering a range of 45 – 250 Hz or better
7. Minimum 5 changeable frequency steps
8. Suitable mounting table with slots for mounting devices or components
9. Should have a remote control with digital display that can be used for static and dynamic load and position settings.
10. Static & dynamic load accuracy along with calibration method and standard adopted should be indicated. Static:  $\pm 1\%$  of displayed value from 2.5 kN - Dynamic:  $\pm 2\%$  of displayed value from 2.5 kN
11. Safety aspects: Overload, over current protection, upper and lower limit of the set load protection, automatic switching off the machine after completion of test or encounter emergency. Safety measures to be followed during operation should be furnished. Machine should comply with appropriate EMI/EMC standards and certificate to be provided.

##### **Other Features :**

12. The machine should be controlled directly in the top of the resonance curve; thus allowing crack detection with a sensitivity of 0.01 Hz.
13. The machine should offer automatic compensation of mass inertia.
14. Should be provided with Servo drive for fast and exact mean load control
15. The machine should have high guidance accuracy to avoid lateral oscillations and ensuring high degree of centricity.
16. Galvanic separation should be provided between the machine control system, the measuring and the evaluation computer
17. Should be provided with suitable displacement measurement gauges and attachment parts. Details to be provided.
18. The machine to be calibrated with load cell as per international practice for static and dynamic loads and details to be provided. Calibration certificate to be provided.

#### **B. Test requirements:**

1. Machine should be capable of carrying out fatigue tests on round and flat samples for generation of S/N curves as per ASTM / DIN standards
2. Machine should be capable of carrying out 3 point bending tests on metallic samples as per relevant ASTM / DIN standards. Suitable 3-point bending devices to be provided as given in **C**.

3. Machine should be capable of carrying out 4 point reverse bending fatigue tests. Suitable 4 point bending device to be provided as given in **C**.
4. Machine should be capable of carrying out precracking of CT samples(1/2" & 1"), SENB specimens as per relevant ASTM / DIN standards.
5. Machine should be capable of carrying out fatigue crack growth studies as per relevant ASTM / DIN standards.

### **C. GRIPS:**

Relevant grips / attachments for cyclic load testing of the following samples should be provided. **(Quotation to be provided for individual grips separately).**

- 1) **Grips for Round samples** : 6 to 25 mm diameter or better for loads upto
  - a) 50 kN (  $\pm$  25kN)
  - b) 250 kN ( $\pm$ 125kN)
- 2) **Grips for Three point bending samples** for loads upto
  - a) 20kN (0/-20 kN) &
  - b) 150 kN (0/-150 kN)
- 3) **Grips for Four point bending for flat samples:** Suitable for 50 kN ( $\pm$  25 kN) loads, flat sample thickness upto 14 mm. If higher sizes possible the same may be indicated. Bending moment calculation to be provided along with dimensions of the grip and weight.
- 4) **Grips for Fracture toughness (CT) samples:** 1/2" & 1" for loads upto 30 kN

Suitable wedges for round and flat samples to be provided. **Catalogues for grips to be enclosed. All details regarding size of samples (threaded or non threaded for round samples), type of grip & load should be clearly mentioned.**

### **D. Crack Length Measurement Systems:**

#### **a) COD gauge for measurement of crack opening of CT and SEB specimens:**

- Suitable COD gauge that can operate at up to 80 Hz (or higher), dynamic travel  $\pm$  0.5 mm with preamplifier to be quoted separately. Details to be provided.

### **E. Softwares:**

Software should perform all control functions and should be capable of carrying out various tests as per the relevant standards. Facilities such as real time graphical display, storage and play back of the test results, post processing, report generation and compatibility with Microsoft office products

Softwares capable of carrying out the following studies should be provided with backup:

- A software for statistical analysis of the fatigue data should be provided. Meant for statistical evaluation of stress controlled cyclic fatigue test data in the high cycle fatigue and the transition range to infinite endurance. Details of software to be provided
- Woehler diagrams and graphical S/N-curves with test points (online-display, plots, data export function) as per ASTM / DIN standard.
- Fatigue crack growth s/w according to ASTM / DIN Standard with possibility to use compliance COD. The software should support standard types of fracture mechanic specimens and several methods of crack length measuring techniques.
- Controlling of the machine to run the test via the stress intensity down to  $\Delta K$ -Threshold.
- Precracking of notched specimens software according to ASTM / DIN Standard using the frequency drop detection method.
- Block loading program for applying loads of varying amplitudes.

- The software should operate under **Latest Windows environment**.
- The Test data should be exported to ACSII, MS-EXCEL etc.
- **Latest PC along with LCD monitor (17"/21"), printer & scanner** to be provided with details All catalogues related to Software / Hardware to be provided.

#### F. Controller:

Should be latest state of art Intelligent DIGITAL signal processing controller with integrated process computer for online measuring, data processing, controlling servo amplifiers for static and dynamic drive with at least 4 channels for measurement & control.

#### G. Power requirements :

- a) Should be designed for use with 415 V  $\pm$  10% (3 phase) with a mains frequency of 50  $\pm$  1% Hz.
- b) **Suitable UPS (reputed make)** with backup power of upto 30 mts to be quoted with details.

#### H. Options:

1. **Grips for Flat samples:** Suitable Grips for testing flat samples, upto 20 mm thickness or better, upto loads 150 kN ( $\pm$  75kN) and 250 kN ( $\pm$  125 kN ) to be quoted as option.
2. **Acoustic hood** for noise reduction to be quoted. Details to be provided with extent of noise reduction.
3. **Optional 20 kN load cell** to be quoted.
4. **Potential drop method:** Crack length measuring system based on indirect potential drop method to be quoted. Details to be provided
5. The machine should have the capability to run the test in strain control mode and details to be provided.
6. **Suitable tools and gauges** required should be quoted.
7. **Spares:** Minimum spares required for trouble free operation should be quoted

#### I. Qualification Criteria & Other aspects:

1. The vendor **should have supplied minimum two resonant high frequency machines in India (any capacity) and details should be furnished.**
2. Should have agents in India to provide after sales service and maintenance.
3. The machine should be Guaranteed for a period of **2 years** from the date of commissioning. During warranty period, if there is any repair to be carried out at the suppliers works, transportation cost of equipment / component besides repair / replacement charges, if any, should be borne by the supplier.
4. **Catalogue related to each and every item should be enclosed.**
5. **Inspection and training:** Predespatch inspection of equipment & training should be provided for **two engineers at suppliers works.**
6. Travel expenses will be borne by BHEL. Training cost if any should be indicated.
7. Dimensions of equipment, weight and space requirements to be given
7. Installation & Commissioning should be carried out at BHEL R&D. **Pre-installation requirements should be furnished after visiting the site.**
8. After installation machine must be calibrated at site
9. Commissioning charges, if any, to be indicated.
10. Compliance statement of specification to be submitted along with the offer. Failure to give compliance statement, the offer is liable to be rejected. All tender specifications to be compared with machine offered line by line and documentary evidence must be enclosed by the supplier along with quotation.
11. Two copies of operating manual to be provided.

## J. Technical & Commercial bid submission:

A. Technical offer with all catalogues should be provided.

B. Compliance statement meeting the specification line by line should be provided.

C. UNPRICED PRICE BID (no price) in the following format should be submitted:

Sl.No	Details	Price	Remarks
1)	Basic machine with controller (refer A, B of spec)		
2)	GRIPS (Quotation to be provided for individual grips separately, refer C of spec ) <ul style="list-style-type: none"><li>• Grips for Round samples : 6 to 25 mm diameter or better for loads upto<ul style="list-style-type: none"><li>a) 50 kN ( ± 25kN)</li><li>b) 250 kN (±125kN)</li></ul></li><li>• Grips for Three point bending samples for loads upto<ul style="list-style-type: none"><li>a) 20kN (0/-20 kN) &amp;</li><li>b) 150 kN (0/-150 kN)</li></ul></li><li>• Grips for Four point bending for flat samples: Suitable for 50 kN (± 25 kN) loads, flat sample thickness upto 14 mm.</li><li>• Grips for Fracture toughness (CT) samples: 1/2" &amp; 1" for loads upto 30 kN</li></ul>		
3)	Crack Length Measurement System : COD gauge (refer D of spec)		
4)	Softwares (refer E of spec)		
5)	PC, Scanner, Printer (refer E of spec)		
6)	Options (refer H of spec) <ul style="list-style-type: none"><li>• Grips for Flat samples: Suitable Grips for testing flat samples upto loads 150 kN ( ± 75kN) and 250 kN ( ± 125 kN )</li><li>• Acoustic hood for noise reduction to be quoted.</li><li>• Optional 20 kN load cell to be quoted.</li><li>• Potential drop method: Crack length measuring system based on indirect potential drop method to be quoted.</li><li>• Strain control mode testing</li><li>• Suitable tools and gauges required should be quoted.</li><li>• Spares: Minimum spares required for trouble free operation should be quoted</li></ul>		
7)	Predespatch inspection & training charges on equipment.		
8)	Installation & Commissioning charges at BHEL R&D.		
9)	AMC charges for the machine beyond the warranty period.		
10)	Other charges, if any, with details.		

D. Commercial bid (PRICED BID) in the format given above also with terms and conditions to be submitted in a separate Sealed Cover

**Note : All covers should be clearly marked indicating the contents and should be SEALED.**

For any Technical Clarifications please contact :

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