

M/s OPEN TENDER

BHEL

HARIDWAR INDIA Vencd 00001

Emailid -

Item Description	Quantity	Unit	Lot	Quantity	Lot Date
1 ZZWE21051011	1	NO	1	1	14/03/22

DRG: AS ATTACHED REV:  
SUPPLY, INSTALLATION, COMMISSIO  
NING & PROVE OUT OF DIRECTED  
ENERGY DEPOSITION (DED) BASED  
LASER AM HEAD, ACCESSORIES, SO  
FTWARE ETC. FOR ESTABLISHING  
HYRID AM FACILITY IN EXISTING  
CNC VMC MACHINE AS PER  
ATTACHED SPECIFICATION

- \* You will not raise the prices for atleast 3 years. However, you will have the option to quote lower prices than the initial prices settled with you, if you so wish
- \* You will not use the design, toolings & technology passed on by BHEL or developed in this case to any third party. You will also not sell this product developed for us, to any third party without pre-consent of BHEL.

## General Instructions:

Please visit our site [www.bhelhwr.co.in](http://www.bhelhwr.co.in) for latest version of General Instructions and Standard Terms & Conditions (GISTC) for Tender Enquiries. All the bidders/vendors must ensure compliance of latest GISTC. Terms & Conditions printed overleaf of this Standard Tender enquiry format are null & void.

For this procurement, Public Procurement (Preference to Make in India), Order 2017 dated 15.06.2017 & 28.05.2018 and subsequent Orders issued by the respective Nodal Ministry shall be applicable even if issued after issue of this NIT but before finalization of contract / PO / WP against this NIT.

In the event of any Nodal Ministry prescribing higher or lower percentage of purchase preference and/ or local content in respect of this procurement, same shall be applicable.

Default purchase preference under Make in India order shall be 20% to suppliers with default minimum local content of 50% for all items / works / services.

For further details, please refer latest version of GISTC.

Procurements where the Estimated value to be procured is less than Rs. 5 lakhs shall be exempted from Public Procurement (Preference to Make in India),

संजय सिंह  
SANJAY SINGH  
व० अभियन्ता  
Sr. ENGINEER  
सामग्री प्रबन्धन  
MATERIALS MANAGEMENT  
बी.एल.एल. (हीप), हरिद्वार  
B.H.E.L., (HEEP), HARIDWAR

16/12/2021

Office Copy

SL	MATERIAL CODE	QUANTITY	UNIT	LOTNO	LOT DELIVERY QTY SCHEDULE
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Order 2017 dated 15.06.2017 & 28.05.2018

Kindly produce GeM seller Id with documentary proof along with your Bids/offers  
for case Value more than 25 Lacs.

SANJAY SINGH  
SR. ENGINEER

संजय सिंह  
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व० अभियन्ता  
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बी०एच०ई०एल०, (हीप), हरिद्वार  
B.H.E.L., (HEEP), HARIDWAR

16/12/2021

**Tender no. C/3991/2021/2174/T1**

**Date 16/12/2021**

**Subject: Expression of interest as detailed below:**

1. Sealed tenders with the Tender No. and opening date clearly super scribed on the cover are invited for the supply of the following items.
2. Last date for obtaining tender documents and opening of tenders is indicated below. Tenders will be received up to 1.45 P.M. on opening date and opened on the same day at 2.00 P.M. in the Tender Room.
3. BHEL will not be responsible for any type of postal delay / incomplete information from vendor.
4. The notification shall be published on [www.bhel.com](http://www.bhel.com) or [www.bhelhwr.co.in](http://www.bhelhwr.co.in).
5. No price bid is to be submitted along with this offer.
6. EMD and Tender Fee is not applicable.

**Details are as following:**

Sl. No.	EOI no.	Description of Equipment	Qty. (Nos.)	Last date for submission of the offer	Opening date
1.	C/3991/2021/2174/T1	SUPPLY, INSTALLATION COMMISSIONING & PROVE OUT OF DIRECTED ENERGY DEPOSITION (DED) BASED LASER AM HEAD ACCESSORIES, SOTWARE ETC. FOR ESTABLISHING HYRID AM FACILITY IN EXISTING CNC VMC MACHINE	01	16-01-2022 at 01:45 pm	17-01-2022 at 02:00 pm

- Technical Specifications & PQR are enclosed. Performa for performance feedback is also attached.
- **PREFERENCE TO MAKE IN INDIA**  
For this procurement, Public Procurement (Preference to Make in India), Order 2017 dated 04.06.2020 and subsequent Orders issued by respective Nodal Ministry shall be applicable even if issued after issue of this Tender Enquiry but before finalization of EOI.

As per Clause 3(b) of MII circular dt. 04.06.2021, Class I Local Supplier and Class II Local Supplier are eligible to participate in the tender and Non-Local Supplier are not eligible to participate in the tender. Offers received from Non-Local Supplier shall be straight away rejected.

## **Instruction to Bidders**

### **Clause 1.0 – Tender submission**

The following shall be super scribed on the envelope:

- 1. EOI TENDER NO. AND ITEM DESCRIPTION.**
- 2. DUE DATE FOR OPENING.**
- 3. “TECHNICAL BID”**

**Vendor’s full name and address should be clearly mentioned on the envelope and shall be addressed to:**

**To,**

**Tender Room  
4<sup>th</sup> floor, Main Administrative Building  
Heavy Electrical Equipment Plant,  
BHEL, Ranipur  
Hardwar- 249403**

Envelopes not marked as above are liable to be ignored and will not be opened.

- The bidders (originals manufacturers) will have to submit ink-signed offer / bid in original directly to BHEL. In case the bid is submitted by fax / email, the bidders shall simultaneously ensure submission of ink-signed original bid to BHEL also in the manner prescribed in this tender. Unsigned bids shall be ignored.  
However, the suppliers or their authorized person may be allowed to attend the tender opening, if duly authorized by their principals, through a specific letter for a particular enquiry for opening on that particular day. General authorization letter is not acceptable.
- Any corrections / amendments shall be properly & fully authenticated with signature.

### **Clause 1.1:**

TECHNICAL BID shall comprise of following documents:

- a) Complete Technical offer
- b) Catalogue of the Equipment, Complete reference of the past supply of equipment for the same or similar specification giving details of customer with Name of the contact person, Fax no, phone no, E-mail if available.
- c) Deviation with reference to Technical specification to be laid down on separate sheet.
- d) Any additional documents (please specify).

**Note: No price bid is to be submitted along with this offer.**

### **Clause 1.2:**

Technical Bid will be opened on the date and time specified above, in the presence of those **vendors**, who wish to attend **the tender opening**.

### **Clause 1.3:**

**BHEL reserves the right to evaluate vendor’s process capability / quality systems etc. by visiting vendor works (if required)**

### **Clause 1.4:**

The offers of the bidders who are on the banned list and also the offer of the bidders, who engage the services of the banned firm, shall be rejected. The list of banned firms is available on BHEL website [www.bhel.com](http://www.bhel.com)

Thanking You,

**For & on behalf of BHEL, Hardwar  
Sanjay Singh, Senior Engineer (Capital Purchase)**





**BHARAT HEAVY ELECTRICALS LIMITED  
HEAVY ELECTRICAL EQUIPMENT PLANT  
Ranipur, Haridwar**

**EXPRESSION OF INTEREST**

Subject	EXPRESSION OF INTEREST (EOI) FOR "SUPPLY, INSTALLATION, COMMISSIONING & PROVE OUT OF DIRECTED ENERGY DEPOSITION (DED) BASED LASER AM HEAD, ACCESSORIES, SOFTWARE ETC. FOR ESTABLISHING HYBRID AM FACILITY IN EXISTING CNC VMC MACHINE AS PER ATTACHED SPECIFICATION."
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Bharat Heavy Electricals Limited (BHEL), a leading Central Public Sector Enterprise of Govt. of India ([www.bhel.com](http://www.bhel.com)) catering to the core infrastructure sectors of energy, transportation, heavy engineering industry, defence, renewable & non-conventional energy etc. is in process to diversify business verticals and to strengthen its value proposition and realign its global positioning. BHEL is in process of making strategic efforts to develop indigenous technological capabilities to fully tap and then leverage the potential opportunities of the Fourth Industrial Revolution and a collective focus on Additive Manufacturing.

To move forward in the field of Additive Manufacturing, HEEP a manufacturing Unit of BHEL established in Haridwar engaged in manufacturing of power plant equipment's is interested in converting one of its CNC Machine into an Hybrid AM Facility as a pilot project. In view of this an **EOI is requested for identification of prospective vendors and finalization of tender specifications for the said project.**

**Special Instructions:**

1. Technical offers and inputs are required from vendors for establishment of Hybrid Additive Manufacturing facility at Heavy Electrical Equipment Plant, BHEL, Haridwar. Vendor to clearly describe their capabilities, deviations form specifications and should also suggest possible solutions.
2. This Expression of Interest (EOI) is for identification of prospective vendors and finalization of tender specifications only and not for procurement. There is no commercial aspects associated to this EOI.
3. BHEL reserves the right to evaluate the responses, based on technical merits, in the process of short-listing and identification of the participants for further discussions.
4. Vendor to submit compliance for fulfillment of PQR conditions. Documents regarding PQR conditions to be submitted at the time of final tender.

*[Handwritten signatures and initials]*

5. Vendors are advised to conduct a pre-bid meeting for any technical clarifications and site visit if required. In case any clarification is needed or site visit is required, parties may contact as per following details:
- a. Sh. Sandip Chakraborty, Email: [csandip@bhel.in](mailto:csandip@bhel.in) , Mobile: +91 9411501631
  - b. Ms. Sarbani Roy Choudhury , Email: [sarbani@bhel.in](mailto:sarbani@bhel.in) , Mobile: +91 9412074054

Enclosures:

1. Technical Specifications: Annexure-A
2. Technical Pre-Qualifying requirement (PQR): Annexure-B
3. Payment Terms: Annexure-C
4. Annexure-1 (Referred in Clause 2.7.1 of Annexure-A)

The block contains several handwritten signatures and initials in blue ink. On the left, there is a signature that appears to be 'Sarbani Roy Choudhury' with a large flourish above it. To its right is a signature that looks like 'Suman'. Further right are two sets of initials, 'RHR' and 'RHR:', each followed by a colon. On the far right, there are two more signatures, one above the other, both appearing to be 'Sarbani'.



**TECHNICAL SPECIFICATIONS FOR SUPPLY, INSTALLATION, COMMISSIONING & PROVE OUT OF DIRECTED ENERGY DEPOSITION (DED) BASED LASER AM HEAD, ACCESSORIES, SOFTWARE ETC. FOR ESTABLISHING HYBRID AM FACILITY IN EXISTING CNC VMC MACHINE**

Sl. No.	Description		Quantity	Accepted (Yes/No)	Vendor's comments/ specs
1.	<p><b>Brief about machine and requirements:</b> The machine comprises of X, Y &amp; Z axes, Spindle &amp; tool changer. X-axis (table longitudinal movement) traverse: 1500 MM; Y-axis (table transverse movement) traverse: 800 MM; Z-axis (spindle head vertical movement) traverse: 700 MM &amp; Table size: 1700*700 MM. All axes and spindle are CNC controlled. CNC System is Siemens Sinumerik 840D <b>Powerline</b> with Simodrive 611D drives for feed axes &amp; spindle.</p> <p><b>Purpose: The existing 3-Axis CNC VMC machine is to be converted into hybrid machine with DED based Laser Additive Manufacturing capability and should be capable of but not limited to the followings:</b></p> <ul style="list-style-type: none"> <li>a). Building metal parts with complex external and internal features layer-by-layer.</li> <li>b). Making metal parts with multiple layers of metals from scratch.</li> <li>c). Repairing of worn out metal parts in selected boundaries.</li> <li>d). Machine should be able to work in both additive and subtractive mode to establish a hybrid AM facility.</li> </ul>	Information to Vendor			
2.	<b>MATERIAL SUPPLY: All the required items including accessories along with installation &amp; commissioning as per details below. (Vendor to provide technical documents including catalogues, specifications, model etc.)</b>	Information to Vendor			
2.1	<b>Additive Manufacturing (AM) Head:</b> AM Head is to be mounted on the machine's Z axis structure beside the spindle in order to achieve the maximum build volume of additive component. The head should be activated only during the additive process and should not hinder the milling operation of the machine. The head should consist of the following:	Vendor to confirm			
2.1.1	Solid State Fiber Laser: Vendor to specify details including Laser OEM	Vendor to provide details			
2.1.2	Laser max. Power should be 3 KW (or more): Vendor to specify	Vendor to provide details			
2.1.3	Laser power should be infinitely variable for achieving different accuracy levels. Vendor to specify range.	Vendor to provide details			
2.1.4	Wavelength: Vendor to specify	Vendor to provide details			
2.1.5	Laser Operating Mode - Pulsed or Continuous Wave (CW): Vendor to specify	Vendor to provide details			
2.1.6	Vendor to specify that whether laser calibration is required for maintaining desired accuracy levels and if required whether it can be done on the machine site as an operational activity.	Vendor to provide details			
2.1.7	Head Deployment - Retractable or Fixed: Vendor to specify	Vendor to provide details			
2.1.8	Nozzle Diameter: Vendor to specify	Vendor to provide details			
2.1.9	Nozzle assemblies: Vendor to specify whether the nozzles are interchangeable for different diameters and worn out nozzles.	Vendor to provide details			



2.1.10	Minimum spot size: Vendor to specify	Vendor to provide details			
2.1.11	Surface finish: Vendor to specify the best achievable surface finish with the AM head.	Vendor to provide details			
2.1.12	Feed stock – Powder or Wire: Vendor to specify	Vendor to provide details			
2.1.13	Deposition rate: Vendor to specify the maximum deposition rate for best achievable surface finish at different laser power. Vendor shall provide a chart (if available) regarding the same along with details of material being deposited.	Vendor to provide details			
2.1.14	Minimum possible Layer Thickness: Vendor to specify	Vendor to provide details			
2.1.15	Maximum possible Layer Thickness: Vendor to specify	Vendor to provide details			
2.1.16	Minimum possible Wall thickness: Vendor to specify	Vendor to provide details			
2.1.17	Maximum possible Wall thickness: Vendor to specify	Vendor to provide details			
2.1.18	Cooling for head: Vendor to specify	Vendor to provide details			
2.1.19	Head & cables/ connections should have safety arrangement to prevent damage from dust, fluids, metal chips etc.	Vendor to provide details			
2.1.20	Head size (L x W x H) in mm: Vendor to specify	Vendor to provide details			
2.1.21	Head weight in Kg: Vendor to specify	Vendor to provide details			
2.1.22	Any other item required for proper functioning of the head	Vendor to provide details			
2.1.23	Repeatability of material deposition rate: Vendor to specify the repeatability (best possible) of deposition rate of the material for AM head.	Vendor to provide details			
2.1.24	Accuracy of material deposition rate: Vendor to specify the accuracy (best possible) of deposition rate of the material for AM head.	Vendor to provide details			
2.2	<b>AM Head Controller:</b> It should be possible to control the operations of AM head controller from the CNC system (Sinumerik 840D) to integrate the additive manufacturing facility in the machine along with subtractive manufacturing. The controller should activate the head only during the additive process.	Vendor to confirm			
2.2.1	Vendor should provide HMI/ display for the AM head controller to display and control the process parameters.	Vendor to provide details			
2.2.2	Vendor to specify all the parameters viz. Laser Power, Deposition rate, Gases flow rate etc. available on controller for achieving the desired surface finish. Vendor to also specify whether these parameters can be controlled through either CNC program on CNC Controller, HMI/ display of AM head controller or both.	Vendor to provide details			
2.2.3	Vendor to specify the communication protocols/ ports for programming, back-up and interfacing with existing CNC system.	Vendor to provide details			
2.2.4	Vendor to specify and include the hardware (if any) required to be installed in the machine for integration with the AM head controller. Vendor to also specify and include the software for the same to ensure proper functioning of AM process in machine.	Vendor to provide details			
2.2.5	Any other items required for proper functioning of the AM head controller to be included in the offer.	Vendor to provide details			

*Soubaraj Choudhary*

*Suman*

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<b>2.3</b>	<b><u>Optical Scanner:</u></b>				
2.3.1	Optical scanner system (with 0.01 mm accuracy or better): Vendor to specify details viz. software, accessories etc. Vendor to specify whether the scanned data can be read and edited by CAM software.	Vendor to provide details			
<b>2.4</b>	<b><u>Spares:</u></b>				
2.4.1	Vendor has to provide list of spares and all consumables viz. nozzles, build plate etc. required for 2 years (3-shifts) operation.	Vendor to provide details			
<b>2.5</b>	<b><u>Accessories:</u></b>				
2.5.1	Shielding Gas: Vendor to Specify details viz. type, operating pressure, purity in percentage, consumption for 24 hours operation etc.	Vendor to provide details			
2.5.2	Carrier Gas: Vendor to Specify details viz. type, operating pressure, purity in percentage, consumption for 24 hours operation etc.	Vendor to provide details			
2.5.3	Laser safety standards	Vendor to provide details			
2.5.4	Vendor may note that the machine work area is enclosed from three sides as visible from front and open from the top side. Front sliding doors (2 nos.) of the machine have transparent safety glasses. All the related arrangements to ensure proper functioning of AM process and safety from laser should be provided by the vendor.	Vendor to Confirm			
2.5.5	Fumes extraction system: Vendor to include	Vendor to provide details			
2.5.6	High definition Camera (for mounting in work area to monitor the AM process): Vendor to specify details viz. resolution, IP rating etc. Vendor should also specify whether the live HD video can be seen on CNC System display, HMI/ display of AM head controller or both.	Vendor to provide details			
2.5.7	CAM Software (for Windows Operating system): Vendor to specify with all the features of the software.	Vendor to provide details			
2.5.8	Laptop with Intel i7 Processor or better, 1TB SSD or higher, 8GB RAM or higher along with Preloaded OS Windows 10 or higher and should include CAM software, softwares required for AM process including optical scanner. Vendor to specify details of all the softwares required in establishing AM process.	Vendor to Confirm and provide details			
2.5.9	Vendor should include installable files of all the Softwares along with Licenses/ CDs/ DVDs. Vendor to specify whether any software needs regular updates for proper functioning of the AM process.	Vendor to Confirm and provide details			
2.5.10	All the pipelines, cables, conduits etc. of sufficient length from controller/ accessories to AM head shall be provided along with proper safety arrangements to prevent damage from dust, fluids, metal chips etc.	Vendor to Confirm			
2.5.11	Any other accessories required for establishing hybrid AM facility.	Vendor to provide details			
<b>2.6</b>	<b><u>Raw Material:</u></b> Following types of work piece materials are being used for subtractive	Information to Vendor			

Sachin Roy Chowdhury

JK

Forman

3/1/20

RAC

SK

Adin

3/1/20

	<p>manufacturing:</p> <ul style="list-style-type: none"> <li>i. Nickel and chromium based super alloys viz. Inconel 617 M, Nimonic 80A etc. having tensile strength up to 1300 N/mm<sup>2</sup>.</li> <li>ii. High alloy steels viz. X12CrMoWVNbN10-1-1, X13CrMoCoVNB9-2-1 (FB2), X19CrMoVNB11 1, X20Cr13, X22CrMoV12-1 having tensile strength up to 1050 N/mm<sup>2</sup>.</li> <li>iii. Stainless steel viz. EN18, EN24.</li> </ul>				
2.6.1	Raw material: Vendor to specify details viz. type, size etc. for commonly used material. Vendor to also specify the material required for manufacturing component of material grade as per point no. 2.6 above.	Vendor to provide details			
2.6.2	No. of raw material feeders: Vendor to specify	Vendor to provide details			
2.6.3	Feeders mounting location: Vendor to specify	Vendor to provide details			
2.6.5	Shelf life & Minimum order quantity (MOQ) of raw material: Vendor to specify.	Vendor to provide details			
2.6.6	Vendor must confirm that the raw material used should be from open source & commercially available. Vendor has to provide list of suppliers (preferably Indian) of raw material.	Vendor to provide details			
2.6.7	Vendor to confirm the availability of process parameters for each of the raw material.	Vendor to Confirm			
<b>2.7</b>	<b><u>Establishing AM Process:</u></b>				
2.7.1	<u>Qualification of material &amp; build quality:</u> Vendor should make samples with the offered AM head at their works. For this, 2 number of blocks of material X12CrMoWVNbN10-1-1 having cross section 80 mm x 50 mm and length 200 mm should be manufactured. Vendor should submit the test reports during technical scrutiny of the offer for evaluation of chemical & mechanical properties, microstructures, MPI, UT etc. as per attached Annexure 1.	Vendor to Confirm			
2.7.2	Vendor to specify any post processing like heat treatment etc. required to achieve required material properties.	Vendor to provide details			
2.7.3	<p>The supplied AM head and AM head controller should be capable of:</p> <ul style="list-style-type: none"> <li>i. Making metal parts with multiple layers of metals from scratch.</li> <li>ii. Repairing of worn out metal parts in selected boundaries.</li> </ul> <p>Vendor should provide the proposed method for achieving the above.</p>	Vendor to Confirm & provide details			
<b>2.8</b>	<b><u>Installation &amp; Commissioning:</u></b>				
2.8.1	Mounting of AM head in the machine with all the accessories along with alignment of the head should be done by the vendor. Tools and equipment along with calibration and alignment gauges required for the work should be brought and provided by the vendor.	Vendor to Confirm			
2.8.2	Installation of additional hardware (if any) along with required software for the CNC machine.	Vendor to Confirm			



2.8.3	Commissioning of the AM head controller along with integration with the CNC system.	Vendor to Confirm			
2.8.4	Installation, commissioning including integration of AM head, AM head controller and accessories has to be carried out by OEM Expert or under supervision of OEM expert.	Vendor to Confirm			
3.	<b>Final Acceptance:</b>				
3.1	Vendor shall undertake commissioning of all the supplied components at HEEP, BHEL, Haridwar. All material required for commissioning shall be arranged by the vendor free of cost and obligation for successful completion of the work.	Vendor to Confirm			
3.2	Building and prove out of components with supplied AM head & AM head controller as follows: i. Successful building of two different types of components (2 Qty. each). Drawings and other details will be shared at later stages. ii. Vendor to ensure that the components made through additive manufacturing should have required surface finish (as per point no. 2.1.11). In addition, vendor to make samples as mentioned in clause 2.7.1 at the time of prove out at HEEP, BHEL.	Vendor to Confirm			
3.3	Mechanical and chemical properties of the manufactured AM component shall be verified as per applicable standards.	Vendor to Confirm			
3.4	Vendor to specify whether any post processing will be required for prove out of components manufactured as per point no. 3.2	Vendor to provide details			
3.5	Final Acceptance shall be at HEEP, BHEL, Haridwar after: a) Upon completion of the scope of supply and scope of work at BHEL. b) Final acceptance shall include clearance of all pending issues. c) Demonstration of all features, various cycles and control functions as envisaged in the technical scope. Vendor shall demonstrate operation of all parts of the system supplied along with all the features as specified above. d) Successful completion of activities mentioned at clause no. 3.2 at BHEL, Haridwar. After settlement of all pending issues related to the purchase order, a certificate for Completion of works in all respect shall be released within 15 days by BHEL personnel which will be the referred document for Final Acceptance and final payment to the vendor.	Vendor to Confirm			
4.	<b>Pre-dispatch Inspection (PDI):</b>				
4.1	Pre-dispatch inspection of all the items covered under Scope of Supply at clause 2 and sub clauses shall be carried out by BHEL personnel at vendor's works/ video call as per discretion of BHEL.	Vendor to Confirm			
4.2	Vendor shall invite BHEL for carrying out pre-inspection.	Vendor to Confirm			
4.3	Deputed BHEL persons shall do pre acceptance of material under scope of supply and give dispatch clearance.	Vendor to Confirm			

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*3/11/20*



4.4	Expenses of Boarding and lodging of BHEL personnel during PDI shall be borne by BHEL.	Vendor to Confirm			
4.5	If in case PDI is not successful in first visit of BHEL personnel due to reasons attributed to vendor then expenses (boarding and lodging) for next visit of BHEL personnel at vendor's works regarding PDI shall be borne by the vendor.	Vendor to Confirm			
5.	<b><u>Delivery Schedule:</u></b>				
5.1	<u>Material:</u> No. of months from the date of purchase order.	Vendor to Specify			
5.2	<u>Work:</u> No. of days from date of release of machine for work.	Vendor to Specify			
6.	<b><u>General requirements:</u></b>				
6.1	Vendor to include warranty for a period of two years from the date of commissioning at BHEL Haridwar. Vendor should provide on-site service support during warranty period.	Vendor to Confirm			
6.2	Vendor should provide training to BHEL staff, for operation & maintenance of AM head, AM head controller & supplied accessories during installation & commissioning. Vendor to specify the duration of the required training.	Vendor to Confirm & provide details			
6.3	Vendor should arrange three visits of OEM experts for three days each during the warranty period for calibration, software updates & process optimization. The date of the visit of the expert will be intimated by BHEL.	Vendor to Confirm			
6.4	Vendor should provide safety interlocks to avoid damage to the machine, work piece and the operator during AM process.	Vendor to Confirm			
6.5	In addition of the above, any other item required shall be included & supplied by the vendor.	Vendor to Confirm			

*Sarban Roy Choudhury*  
 SARBAN Roy Choudhury  
 SDGM (WEX-INST, TELECOM & CRM)

*Kumar*  
 SANJIV KUMAR  
 Sr. mgr (TBM)

*Aditya Kumar*  
 (Aditya Kumar)  
 Manager (WEX/MM-NBS)

*Rishabh Gupta*  
 (Rishabh Gupta)  
 Manager  
 (WEX/CNC-NBS)

*Sandip Chakraborty*  
 SANDIP CHAKRABORTY  
 Sr Engr. (TBM)

*Sweet Kumar*  
 SWEET KUMAR  
 DM (MTE)

*Shri Ram Singla*  
 SHRI RAM SINGLA  
 SE, NCT

*Abhishek Kumar*  
 (Abhishek Kumar)  
 Sr. Engr. (WEX-CRNL & FM. SECT)

Technical Pre-Qualifying Requirements (PQR)

**REF: SUPPLY, INSTALLATION, COMMISSIONING & PROVE OUT OF DIRECTED ENERGY DEPOSITION (DED) BASED LASER AM HEAD, ACCESSORIES, SOFTWARE ETC. FOR ESTABLISHING HYBRID AM FACILITY IN EXISTING CNC VMC MACHINE**

Sl. No	Description		Accepted (Yes/No)	Vendor's comments
1.	<b><u>QUALIFYING CONDITIONS</u></b>			
1.1	<p>a) Vendor must have supplied, installed &amp; commissioned 2 nos. of similar AM head (Laser Power – 3 KW or more) &amp; AM head controller on CNC machines (with three or more axes) for metal applications during last seven years as on the date of tender opening.</p> <p>b) Vendor to submit P.O. copies, commissioning or performance certificates in support of the same. The AM head &amp; AM head controller must be working satisfactorily for a period of 6 months as on the date of tender opening. 6 months' period will be calculated on the basis of commissioning certificates/ performance certificates/ e-mail from vendor's customers provided/ received.</p> <p>c) Vendor to provide name, address &amp; contact details including e-mail IDs, telephone numbers of their customer*. In case commissioning/performance certificate is not provided, e-mail confirmation from customer of vendor will be considered as commissioning/performance certificate. E-mail IDs should preferably be based on the customer's domain name. *Customer would mean the eventual user who is using the referred machine.</p> <p>d) BHEL reserves the right to verify the information provided through suitable means viz. e-mail, telephonically or visit of BHEL team as per the discretion of BHEL.</p> <p>All the papers must be self-attested by the vendor along with company seal.</p> <p><b>Note:</b> Vendor may note that all documents regarding PQR required as per above clauses will need to be submitted during final tender. No documents to be submitted at this stage.</p>	Vendor to confirm		

*Sube-Raj Chaudhary* *Suman* *3/1/20* *RM* *Singh* *H.K.* *38/1/20*

Payment Terms

**REF: SUPPLY, INSTALLATION, COMMISSIONING & PROVE OUT OF DIRECTED ENERGY DEPOSITION (DED) BASED LASER AM HEAD, ACCESSORIES, SOFTWARE ETC. FOR ESTABLISHING HYBRID AM FACILITY IN EXISTING CNC VMC MACHINE**

Sl. No	Description		Accepted (Yes/No)	Vendor's comments
1.	<b><u>Payment Terms:</u> (Note : No advance payment shall be made to the vendor.)</b>			
1.1	Part payment will be made after completion of following milestones:	Vendor to confirm		
	a). Payment of 80% of material cost along with 100% of taxes (as applicable) shall be payable after inspection & acceptance of material at HEEP, BHEL, Haridwar.			
	b). Final payment of balance 20% of material cost, 100% of commissioning charges including taxes (as applicable) will be made after Final acceptance (As per Clause 3 of Annexure-A).			

*Sachin - Raj Chaudhary* *Suman* *3.12.20* *Rm:* *Saxena* *Adkin* *3.12.20*



## **ANNEXURE 1**

### **HEAT RESISTANT STEEL BARS FOR TURBINE BLADES,** **GRADE: X12CrMoWVNbN10-1-1**

#### **1.0 General:**

This specification governs the quality of Steel rectangular bars in steel grade X12CrMoWVNbN10-1-1, material no. 1.4906.

#### **2.0 Application:**

For machined/milled blades for Steam Turbine.

#### **3.0 Condition of Delivery:**

Rolled or Forged and Heat Treated.

#### **4.0 Dimension and Tolerances:**

Dimensional tolerance, straightness, twisting and bulging limits shall be as per HW0993008.

#### **5.0 Manufacture:**

Electro slag re-melted steel (ESR) shall be used.

**The manufacturing process must ensure a homogenous grain structure over the entire length of the bar and the bar cross section.**

#### **6.0 General Requirements:**

- Prerequisite requirement for approval of a new vendor is a successful Process qualification. Manufacturing process established during this shall be the basis for future manufacture.
- Manufacturing plan shall be prepared and submitted after successful process qualification. Manufacturing plan shall include specific information on manufacturing like rolling temperature, reduction ratio, heat treatment temperature, hardening method and soaking time, rate of heating and cooling etc. Test instructions for nondestructive and destructive testing are to be provided in the manufacturing and testing plan.
- Product and process qualification is mandatory for each of the suppliers manufacturing plants.
- For new supplier, process qualification shall be required for three purchase orders.
- If necessary, BHEL may ask for process qualification for verification of manufacturing reliability from regular suppliers also.
- Any change in the agreed manufacturing plan shall be informed to BHEL. BHEL will review the requirement of renewed process qualification.

## 7.0 Heat Treatment:

### Hardening:

1070 - 1100°C / air or liquid quenching, cooled down to a temperature <100°C in the center of the bar.

### Tempering:

A two-step tempering treatment must be performed as follows:

- The first tempering must be carried out at a temperature of 570°C and holding time of  $\geq 4$ h. Air has to be used for cooling.
- Temperature of second tempering step has to be  $\geq 700^\circ\text{C}$ .

A fully transformed and tempered martensitic microstructure must be present over the entire cross section.

**Hardening and tempering in bundles are not allowed. Suitable gaps between two bars are to be ensured during heat treatment for uniformity of properties.**

If bars need to be straightened after the heat treatment, a stress relieving heat treatment shall be performed after completion of entire straightening process. Stress relieving is to be carried out at 20 - 30°C below the tempering temperature with a subsequent slow cooling rate.

**The lowest possible residual stresses shall be targeted. Distortion of the finish machined part due to residual stresses from the manufacturing process or heat treatment process shall not occur.**

## 8.0 Properties and their verification:

### 8.1 Chemical Composition:

Heat analysis in weight %

C	Si	Mn	P	S	Cr	Mo
0.11 - 0.13	$\leq 0.12$	0.40 - 0.50	$\leq 0.010$	$\leq 0.005$	10.2 - 10.6	1.00 - 1.10
Ni	V	Nb	N	Al	W	
0.70 - 0.80	0.15 - 0.25	0.040 - 0.060	0.045 - 0.060	$\leq 0.010$	0.95 - 1.05	

Trace element content for Ti, Cu, As, Sb and Sn must be specified in the inspection certificate for information purposes.

### 8.2 Properties and Microstructure:

The specimens shall be taken in the longitudinal direction in accordance with Attachment 1. The properties described below shall be determined at room temperature in the delivery condition, i. e. after the last heat treatment including any stress relieving heat treatment.

The metallographic investigations shall be performed on the hardest and softest bar with an area of at least 320mm<sup>2</sup> each. The areas to be investigated must be in the longitudinal direction. The longitudinal direction must be indicated in the documentation.

#### 8.2.1 Mechanical Properties:

Hardness of the bars in a test unit shall be verified by Brinell hardness testing in accordance with ISO 6506 -1, HBW10/3000 or HBW 5/750 may be used.

The surface of the bar shall be prepared in the area of the hardness measurement so that the result is not affected by the surface condition.



Hardness testing shall be performed on 10% of each test unit but at least on 10 bars or on each bar if test unit is less than 10 bars. The greatest resulting difference in hardness shall not exceed 35HBW.

Mechanical properties shall be determined on the hardest and softest bar determined in a test unit.

Tensile testing shall be performed in accordance with ISO 6892 -1 or ASTM E8M (round specimen with  $L_0 = 50\text{mm}$  and  $d_0 = 10\text{mm}$ ) or ASTM E8M (standard specimen in accordance with Figure 8).

Standard specimens Charpy (V-notch) in accordance with ISO 148 -1 shall be used for determining the absorbed impact energy.

The following properties must be achieved at room temperature:

0.2 % Proof Stress (N/mm <sup>2</sup> )	Tensile Strength (N/mm <sup>2</sup> )	Elongation After Fracture (%)	Reduction in area %	Impact Energy (J) <sup>1</sup>	Hardness HBW
750 - 830	<b>890 - 990</b>	≥ 14	≥ 55	≥ 50	270 - 310

<sup>1</sup> Average of 3 specimens and minimum value for two specimens in accordance with EN10021, where the lowest value shall be at least 35 Joule.

Additionally, on the softest bar a tensile test in accordance with ISO 6892 - 2 has to be performed (in longitudinal direction) at 600°C. The following properties must be achieved:

0.2 % Proof Stress (N/mm <sup>2</sup> )	Tensile Strength (N/mm <sup>2</sup> )	Elongation After Fracture (%)	Reduction in area (%)
≥ 405	<b>≥ 440</b>	≥ 18	<b>≥ 80</b>

#### 8.2.2 Microstructure:

Microstructure must be uniform, without porosity, excessive segregation or other inhomogeneities.

##### 8.2.2.1 Cleanliness:

The cleanliness shall be determined as per DIN 50602 - K1. A minimum of 4 specimens per heat shall be used for determination of cleanliness.

##### Acceptance criteria:

Summary value K1: ≤ 2.0 (relating to 1000mm<sup>2</sup>)

##### 8.2.2.2 Delta Ferrite content and grain size:

- **Delta ferrite content shall be < 5%.** The determination of delta ferrite content shall be performed based on analysis methods in accordance with ASTM E45 Method A, "Worst field method" with V=100:1.
- **An average grain size of 3 or finer** has to be achieved. Grain size shall be determined on the martensitic secondary grain structure in accordance with ASTM E112 or ISO643. A deviation of more than 2 grain sizes in size of individual's grains from the average grain size is not allowable.

#### 8.3 Non-destructive Testing:

##### 8.3.1 Test Scope:

The following Non - destructive inspections shall be performed in the as delivered condition:

- Visual inspections of all bars
- Ultrasonic examination of all bars in accordance with TWP 1204. 100% of the volume must be tested in accordance with the recording level.



### 8.3.2 Recording level and acceptance criteria:

- Indications of surface defects such as rolled marks shall be ground out to investigate their depth at least at both ends, in the middle of the indication and at an interval of approx. 250mm.
- Surface defects with a depth extension of  $\geq 1\text{mm}$  are not allowable, and these areas shall be cut out of the bar.
- Ultrasonic examination and acceptance of all bars in accordance with TWP 1204.
- Defects above the recording level are not acceptable.
- It shall be confirmed in writing to the BHEL that bar sections containing defects above the recording level have been cut out of the bar.
- The acceptance of material at vendor's works does not relieve the supplier of his responsibility for defects discovered at later stages.

### 8.3.3 Material Identity Test:

An identity test must be conducted on 100% of bars in the as – delivered condition.

### 9.0 Process Qualification:

The following additional investigations shall be performed in process qualification (see Attachment 2):

#### - Tensile tests:

The strength values (0.2% Proof Stress and Tensile Strength) in the transverse direction (specimen orientation ZQ) shall not differ by more than 10% from the corresponding longitudinal values.

The smallest individual value for absorbed impact energy in transverse direction shall not be below 30J.

#### For case where standard specimens in transverse direction cannot be made: -

- For tensile test specimens, a round specimen with  $L_0 = 5 d_0$  or a flat specimen with a proportionality factor of  $k = 5.65$ . Proportional specimens in accordance with Fig 8 shall be used if ASTM E8 is applied.
- An undersized specimen in accordance with ISO 148 -1 for impact test specimen. Undersize dimension to be reported.
- If dimension do not allow testing in the transverse direction, even with special specimen, testing will be carried out in the longitudinal direction only.
- **FATT:** Determination of FATT (fracture appearance transition temperature) in accordance with ASTM A370. The FATT should be preferably evaluated based on SEP 1670 (software). The test scope must include at least 10 specimens.  $\text{FATT} < 25^\circ\text{C}$  is to be achieved.
- The fraction of Intergranular fracture shall be determined over the entire brittle fracture portion of the fracture surface of the impact test specimens tested at room temperature. The fraction of Intergranular fracture shall not exceed 10%. This test is not required for materials which indicate  $\geq 90\%$  ductile fracture at room temperature.
- Performance of MT testing by the magnetic flux leakage method, alternating current phase shifted and a field strength of 20 – 65A/cm. Distribution, type and size of grain structure in-homogeneities (e.g. segregation or delta ferrite) shall not result in MT indications.
- **All test results shall be submitted to BHEL for approval.**

#### **10.0 Identification Marking:**

All bars are to be marked with following information:

- Purchase Order Number
- Size
- Material Grade
- Supplier Identification

The details are to be clearly stamped and encircled by oil paint. Each bar shall be painted with a band of colour **orange - blue - orange** on both ends. All the bars shall be suitably packed to protect them against corrosion and damage during transportation.

Bars having maximum and minimum hardness (from which test samples are taken) shall be clearly marked by oil paint for easy identification. Their respective hardness values shall also be punched on these bars.

#### **11.0 Documentation:**

Prior to, but in no case later than the delivery of the material, an inspection certificate as per EN 10204 shall be provided to BHEL in duplicate; this certificate must contain the following data:

- (a) Material code no and P.O. number
- (b) Material designation
- (c) Heat no., heat analysis and melting methods
- (d) Complete information on all heat treatments performed
- (d) Mechanical test results including hardness range and the metallurgical examination.
- (e) Results of non-destructive tests, UT inspection report
- (f) Confirmation of the material identity check
- (g) Confirmation of the dimensions and visual inspection

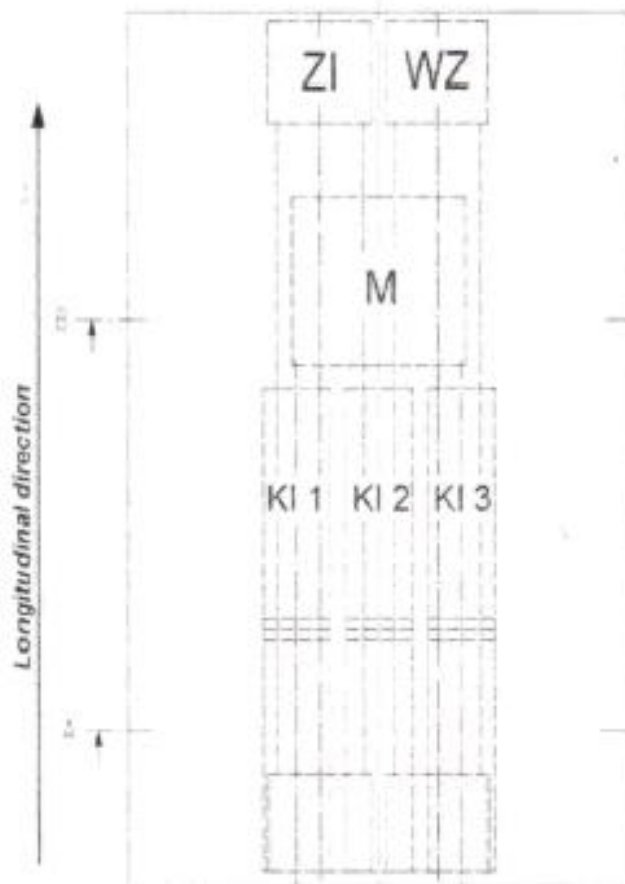
#### **12.0 Cross Referred Standard:**

HW0993008, ISO 6506 -1, ISO 6892 – 1, ISO 6892 – 2, ASTM E8M, ISO 148 – 1, EN10021, ASTM E45, ASTM E112, ISO 643, DIN50602, TWP 1204, ASTM A370, EN10204

#### **13.0 Modification with respect to last revision:**

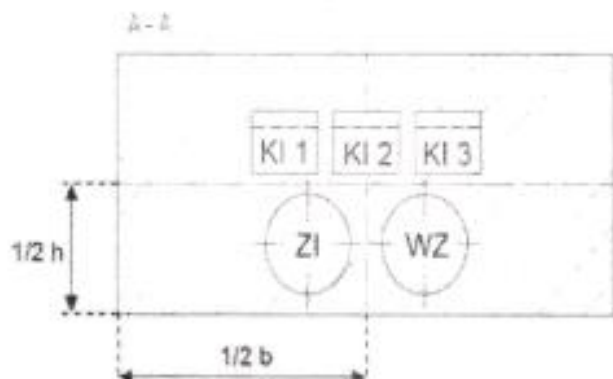
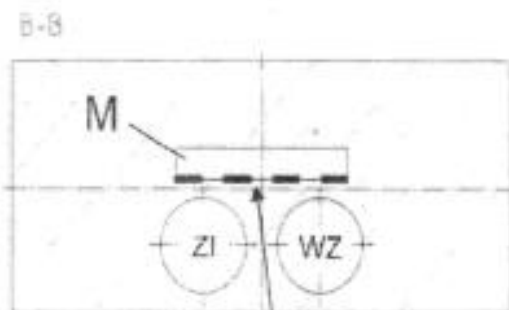
- Clause 4.0 modified.
- Clause 9.0 modified.
- Clause 12.0 modified.

## Standard Testing



Label	Specimen
ZI	Tensile Specimen Centre
WZ*	Hot Tensile Specimen
KI 1 - KI 3	Notched Impact Specimen Centre
M	Metallographic Specimen

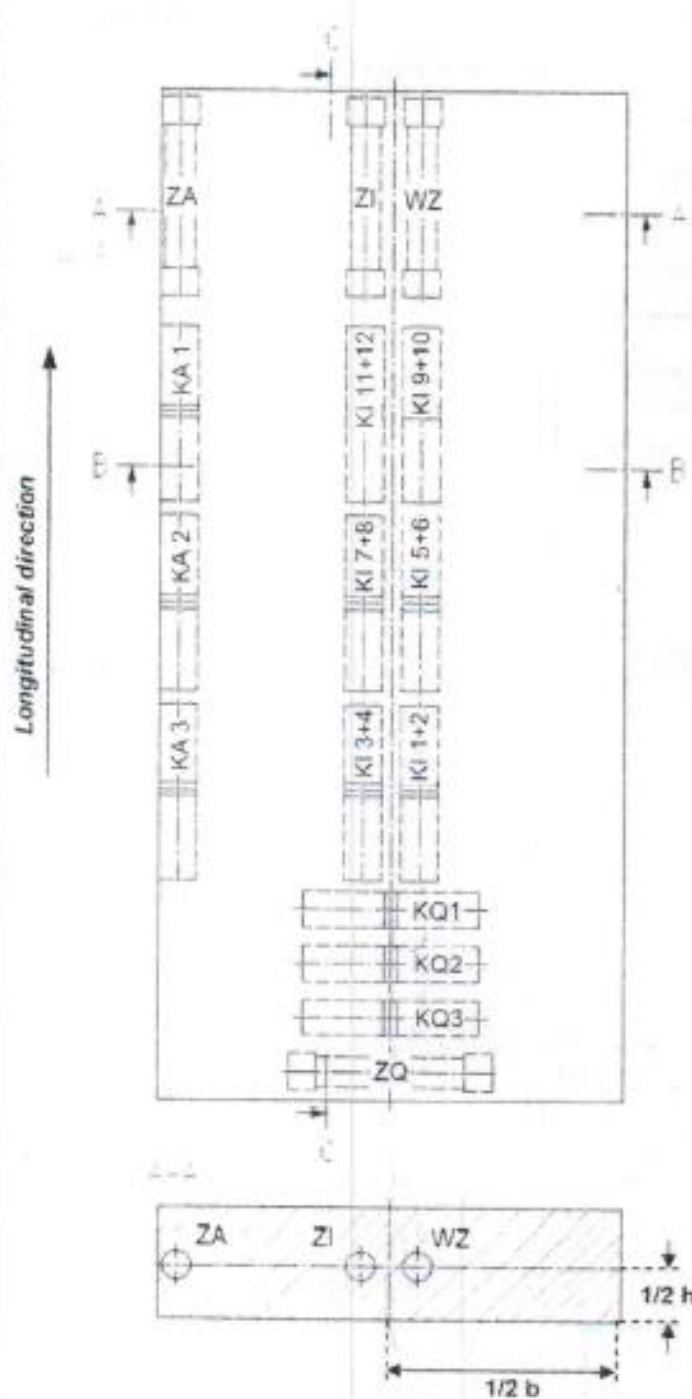
\* if required in material specification



**Lower Surface of the Metallographic Specimen has to be examined. Longitudinal direction must be indicated in the documentation.  $A \geq 320\ mm^2$**



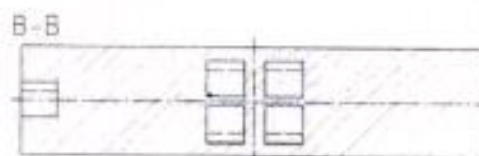
## Process Qualification



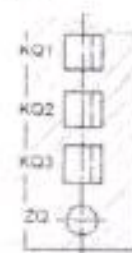
Label	Specimen
ZI	Tensile Specimen Centre
ZA	Tensile Specimen Rim
ZQ	Tensile Specimen Transverse
WZ*	Hot Tensile Specimen
KI 1 - KI 12	Notched Impact Specimen Centre (FATT)
KA 1 - KA 3	Notched Impact Specimen Rim
KQ 1 - KQ 3	Notched Impact Specimen Transverse

\* if required in material specification

Note the notch positions of the notch impact specimens (see B - B and C - C).

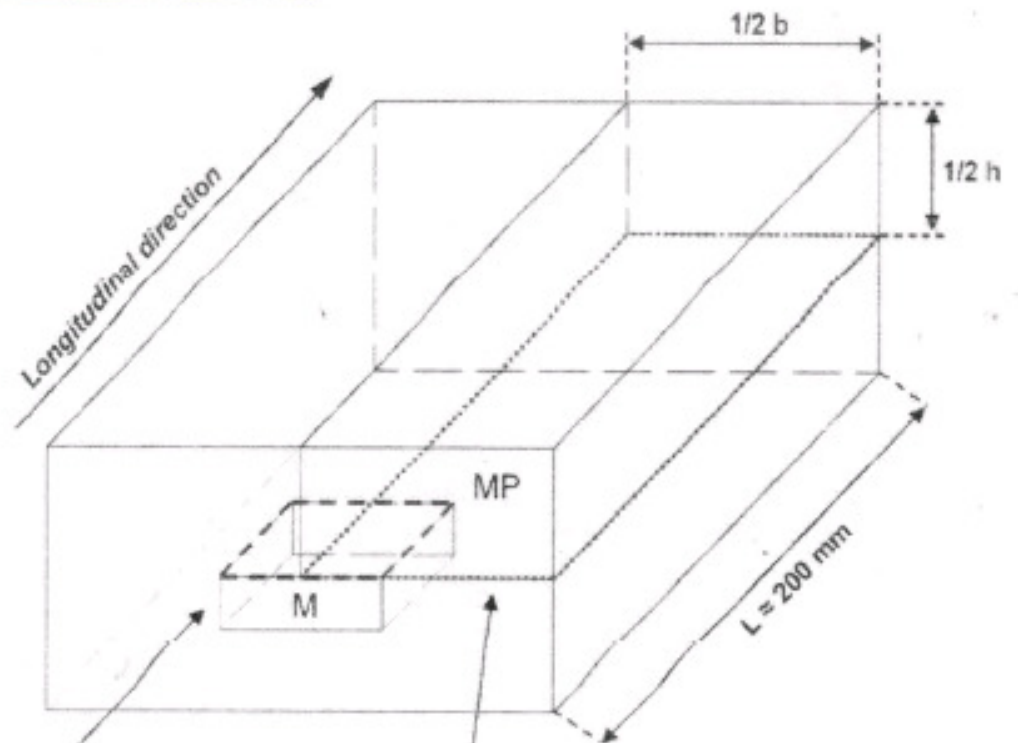


C-C



## Process Qualification

Label	Specimen
M	Metallographic Specimen
MP	Specimen for Magnetic Particle Test



**Upper Surface** of the Metallographic Specimen has to be examined. Longitudinal direction must be indicated in the documentation.  $A \geq 320 \text{ mm}^2$

**Lower Surface** of the specimen has to be examined in Magnetic Particle Test.