

Enquiry items along with quantities:

It. no	Size & Item description	Technical requirement	Quantity in kg
1	140 mm dia X 3000 mm – 6000 mm LG	1.5% Ni-Cr-Mo Hot Rolled / Forged, Hardened and Tempered Steel Round Bars to Spec. AA19358 Rev08 and product standard WTM 0001 Rev00, Straightness within 3 mm / meter. All other details as per product standard WTM 0001 Rev00, Spec. AA 19358 Rev08 and QAP No. QA/HT/1042 Rev00. Ultra Sonic Test to be carried out as per BHEL Spec. AA0850118 (Acceptance Category 2).	33000
TOTAL			33000 kg

Quantity variation as per below:

Item-1 Supplies quantity are to be restricted between 33000 kg & 27000 kg.

Pre-qualification criteria:

S. No.	Description of pre-qualification requirement	Vendor Response	
		Complied (YES/NO)	Supporting Documents required to accept compliance
1	Manufacture of steel round bar / their authorized representative.		Relevant certificate of being manufacturer (for manufacturer not registered with BHEL) / authorization letter with validity (for authorized representative). Firm name, address, email and contact no. from whom bars is intended to be supplied to be furnished.
2	Vendors should have experience of manufacturing, Material Testing & supplying Alloy steel forging round bar (1.5% Nickel – Chromium-Molybdenum steel forgings-Hardened & Tempered) as per Spec.AA19358 rev.08 or latest standards IS : 4367-1991 for up to 150mm dia only, GR:40Ni6Cr4Mo3 H&T / BS 4670-1971, Gr: 818M40, H&T or equivalent grade meeting our Requirement during last 7 years (ending last day of month previous to the one in which NIT is published)		Purchase order and Mill Test certificate. In case of authorized dealer experience documents of there OEM is also considered.
3	Company shall be certified with ISO 9001 or equivalent. In case of authorized representative, Valid ISO certificate of manufacturer is required.		Valid certificate to be submitted.

Note-

- BHEL has right to verify information / confirmation furnished, by asking additional documents, proofs etc.**

ALL THE ABOVE POINT WISE PRE-QUALIFICATION REQUIREMENT ARE TO BE NECESSARILY ACCEPTED BY THE BIDDERS FOR THEIR OFFERS TO BE CONSIDERED FAILING WHICH OFFERS SHALL BE REJECTED.

MAKE IN INDIA format (to be filled by OEMs of the participating bidders)

BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL

MATERIAL MANAGEMENT – STEEL DIVISION

For this Procurement, Government of India Public Procurement (Preference to Make in India), Order 2017 with its amendments and subsequent Orders issued by the respective nodal ministries shall be applicable even if issued after issue of this NIT but before finalization of contract/PO/WO against this NIT.

*As per the Provisions of this order, please submit **a self-certification complying with the conditions below on company letterhead duly signed by competent authority.***

I, hereby declare on behalf of M/s. that we are participating in the Enquiry No. floated by BHEL, Bhopal (MP), India and shall comply with following:

1. Public Procurement (Preference to Make in India), Order 2017 *with its amendments* and subsequent Orders issued by the respective nodal ministries shall be applicable even if issued after issue of this NIT but before finalization of contract/PO/WO against this NIT.

- (a) A supplier will be treated as **“Class-I Local Suppliers”**, if the items quoted by bidder have local content equal to or more than 50%.
 - (b) **‘Local Content’** means the amount of value added in India, which shall be total value of item quoted (excluding net domestic indirect taxes) minus the value of imported content in the item (including all custom duties) as a proportion of the total value, **in percent**.

2. I hereby declare that our firm qualifies as **“Class-I Local Suppliers”**.

a. The Local Content in the items quoted under this Enquiry is Percent

b. Details of location(s) in India where this value addition shall be done, is/are as follows:

- (a)
- (b)
- (c)

(.....)

For M/s.

(Seal & Sign)

BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL
QA-HYDRO
STANDARD QUALITY ASSURANCE PLAN FOR BAR MATERIAL

QAP NO. : QA/HT/1042 Rev. 00 Dated :- 16.05.2018
SPECIFICATION : AA 19358 Rev. 08 (1.5 % Nickel - Chromium - Molybdenum Steel Bars)
SUPPLY CONDITION : 110 - 200 mm - (Hot Rolled ; Hardened & Tempered, unmachined) OR (Forged ; Hardened & Tempered, machined)

1	2	3	4	5	6	7	8	9	10	11	12
SL. NO.	STAGE	CHARACTERSTIC	METHOD	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	P	V	W	REMARKS
1	Raw Material	Chemical	Chemical test	1 Sample / Heat	AA 19358 Rev. 08	AA 19358 Rev. 08	Mill Test Certificate	1	2	-	-
2	Heat Treatment	Hardened & Tempered	Hardened & Tempered	1 Sample / Heat & H.T. Batch	-do-	-do-	H.T. Chart	1	2	-	-
3	Final Stage	Stamping on test bar for mechanical Testing	Hard Stamp by TPIA	-do-	-do-	-do-	Stage Inspection Report	1	-	2	Test Piece duly stamped by TPIA
		i) Tensile Test	As Specified in AA 19358 Rev. 08	-do-	-do-	-do-	Supplier's Test Certificate	1	-	2	-
		ii) Charpy Impact Test (on 3 samples)	-do-	-do-	-do-	-do-	Supplier's Test Certificate	1	-	2	-
		iii) Yield strength	-do-	-do-	-do-	-do-	Supplier's Test Certificate	1	-	2	-
		iv) % Elongation	-do-	-do-	-do-	-do-	Supplier's Test Certificate	1	-	2	-
		Ultra Sonic Test	As Specified in AA 19358 Rev. 08	100%	AA0830118 Rev. 01	Category II	U.T. report	1	-	2	1) 100% UT to be done by vendor. 2) 15% UT to be witness by TPIA on sample basis
		Chemical Composition	Chemical test	1 sample / Heat	AA 19358 Rev. 08	AA 19358 Rev. 08	Supplier's Test Certificate	1	-	2	-
		Visual Examination	Visual	100%	-do-	Bars shall be free from surface defects, bends & twists	Supplier's Dimensional Report	1	-	2	-
		Dimension & Tolerance	Measurement	100%	WTM 0001 Rev. 00	WTM 0001 Rev. 00	-do-	1	-	2	-
		Identification Marking	Hard Stamping	100%	AA 19358 Rev. 08	AA 19358 Rev. 08	1. Heat No. 2. P.O. No. 3. Spec No. 4. Size 5. Supplier's Name	1	-	2	Identification & marking shall be done on face of each bar & TPIA hard stamp to be done on both face of each bar.
5	Document submission duly certified by TPIA	1) Mill test certificate (Mechanical & Chemical) 2) Supplier Test certificate (Mechanical & Chemical) 3) Dimensional Inspection report. 4) Heat Treatment chart 5) U.T. Report									


Note : Final Testing of Material will be done at BHEL Bhopal works before clearance of SRV.

1 = Manufacturer / Trader
2 = BHEL / BHEL's TPIA

Adhar
आधार शर्मा / ADHAR SHARMA
वरिष्ठ अभियंता (विद्युत) / Sr. Engineer (E.E.)
गुणता नियंत्रण-जल दरवाज़े / Quality Control-Water
बी.एच.ई.एल., भोपाल / BHEL, BHOPAL

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Shivendra
शिवेन्द्र कुमार / Shivendra Kumar
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एच.टी.ई. विभाग / H.T.E. DIVISION
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WTM
MAHENDRA SOMI
महेश सोमि / MAHENDRA SOMI
उप प्रबंधक (उत्पादन) ज.ट.वि. प्रभाग
Dy. Manager (Production) WTM Division
बी.एच.ई.एल., भोपाल / BHEL, BHOPAL

	<h1 style="margin: 0;">CORPORATE PURCHASING SPECIFICATION</h1>	<div style="border-bottom: 1px solid black; padding: 2px;">AA19358</div> <div style="border-bottom: 1px solid black; padding: 2px;">Rev No. 08</div> <div style="padding: 2px;">PAGE 1 of 6</div>
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1.5% NICKEL – CHROMIUM – MOLYBDENUM STEEL FORGINGS – HARDENED AND TEMPERED

1.0 GENERAL:

This specification governs the quality requirements of 1.5% Nickel – Chromium – Molybdenum Steel Forgings, Hardened and Tempered.

The raw material for these forgings is covered by AA10559

2.0 APPLICATION:

Suitable for general engineering purposes.

3.0 CONDITION OF DELIVERY:

Hardened and tempered.

Rough machining of the forgings shall be carried out, unless otherwise specified in BHEL order/drawing.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The material shall comply with the following National standards and also meet the requirements of this specification.

IS: 4367 – 1991 : Alloy steel forgings for general industrial purpose.
Gr: 40Ni6Cr4Mo3, H&T

5.0 DIMENSIONS AND TOLERANCES:

The dimensions and tolerances shall be as specified in BHEL order/drawing. Wherever these are not specified, the machining allowances and tolerances shall be as specified below.

For finish machined drawings	: 3 ± 1 mm
For rough machined drawings	: ± 1 mm

6.0 MANUFACTURE:

Forgings shall be manufactured from steel produced by the open electric, arc furnace, there after refined by vacuum degassing or other process as may be agreed to between BHEL and the manufacturer.

Revisions: Cl: 33.1.0, A.3 of MRC -FCF+HTM			APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(FCF+HTM)		
Rev No.08	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue
Dt:30-01-2008	Dt:	Year:2014	HEP, Bhopal	Corp.R&D	February, 1979

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Steel shall be fully killed.

Sufficient discard shall be made from each ingot to ensure freedom from pipe, segregation and other defects.

The amount of hot working and finishing temperature shall be such as to ensure complete soundness and adequate uniformity of structure and mechanical properties after heat treatment. The forgings shall not be over heated.

The minimum reduction ratio when forgings are made out of ingots shall be 4:1

For sizes above 250mm ruling section the minimum reduction ratio shall be 3.5:1

Note: Raw material like Ingots/Blooms/Billets required for forgings should be procured from BHEL approved sources along with test certificate.

7.0 HEAT TREATMENT:

Forgings shall be hardened and tempered to give the mechanical properties specified.

Stress relieving of the forgings shall be done so that minimum residual stresses are leftover.

8.0 FINISH:

As mentioned in the drawing.

9.0 FREEDOM FROM DEFECTS;

Forgings shall be free from defects such as cracks, flakes, seams, segregation, harmful non-metallic inclusions and other defects which may affect the utility of the forgings.

10.0 CHEMICAL COMPOSITION:

The melt analysis of steel and permissible variation in the composition of the forgings from the melt analysis shall be as specified below:

Element	<u>Melt analysis</u> <u>percent</u>		<u>Permissible variation percent</u>	
	Min.	Max.	Upto 250 mm	>250 upto 500 mm
Carbon	0.35	0.45	± 0.02	± 0.04
Silicon	0.10	0.35	± 0.03	± 0.04
Manganese	0.40	0.70	± 0.04	± 0.06
Nickel	1.25	1.75	± 0.05	± 0.05
Chromium	0.90	1.30	± 0.05	± 0.06
Molybdenum	0.20	0.35	± 0.03	± 0.04
Sulphur	---	0.035	+ 0.005	+ 0.010
Phosphorus	---	0.035	+ 0.005	+ 0.010



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Note:

- 1) Wherever necessary, more restricted ranges of chemical composition may be specified subject to mutual agreement between BHEL and the manufacturer.
- 2) Elements not quoted above shall not be added to the steel, other than for the purpose of finishing the heat and shall not exceed the following limits:

Element	Percent, max
Copper	0.25
Vanadium	0.05
Tin	0.05

11.0 TEST SAMELES:

- 11.1** Unless otherwise specified in the order/drawing, test samples shall be taken from each melt and each heat treatment batch. Test samples should be cut from the heat treated forgings by cold process only and shall receive no further heat treatment.

Test samples shall be taken from locations indicated on the drawing, leaving enough material, if required, for testing at BHEL's end, integral with the forging.

Test samples shall be cylindrical or rectangular in shape and cut at a distance of 12.5 mm below the heat treated surface.

- 11.2** When integral test pieces are not called for, a test sample equivalent to the ruling section or 65 mm diameter, whichever is less and 610 mm long, having similar reduction ratio and heat treatment, as the forgings it represents shall be provided per heat, per heat treatment batch for check testing at BHEL along with the forgings. The sample shall be properly identified and correlated with the heat/heat treatment Batch No/Test certificate No., Test samples shall be taken at a distance of 12.5 mm below the heat treated surface.
- 11.3** Test samples shall generally be taken in the longitudinal direction. However, for economic reasons or where the size/configuration does not permit the same. Test samples may be taken in the transverse or radial direction. The test sample orientation shall be mentioned in the test certificate.

12.0 MECHANICAL PROPERTIES:

The test pieces, after being heat treated as per clause 7.0 above, shall show the following properties upto a limiting section of 800mm. Properties for thicker sections shall be subject to agreement between BHEL and the manufacturer. Test methods are specified below:

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**12.1 Tensile test:**

IS: 1608

12.2 Hardness test (Brinell):

IS: 1500

12.3 Charpy Impact Value:

IS: 1499

This test applicable for forgings of sizes above 16mm only.

Property	Sample (See Cl: 11.3)	Limiting ruiing section, mm					
		Up to 30	>30 to 63	>63 to 100	>100 to 150	>150 to 250	>250 to 500
Tensile strength N/mm ²	Longitudinal/	1200	1100	1000	900	900	900
	Transverse/ Radial/Tangential	to 1350	to 1250	to 1150	to 1050	to 1050	to 1050
Yield strength min, N/mm ²	Longitudinal/ Transverse/ Radial/Tangential	1000	880	800	700	690	690
Elongation on 5.65√S ₀ gauge length percent, min	Longitudinal	10	11	13	13	13	13
	Transverse	5	6	7	7	7	7
	Radial	6	7	9	9	9	9
	Tangential	7	8	10	10	10	10
*Hardness Brinell,HB	----	355 to 399	325 to 370	295 to 341	266 to 311	262 to 311	262 to 311
Impact Value (ISO – U on 3 samples) min., Joules	Longitudinal	20	28	32	37	34	28
	Transverse	10	14	16	19	17	14
	Radial	12	17	19	22	20	17
	Tangential	15	21	24	28	26	21

* **Note:** Hardness test can be conducted only, when tensile test cannot be performed.**13.0 ULTRASONIC TEST:**

Each forging shall be tested ultrasonically in accordance with BHEL standard AA0850118 to ensure freedom from internal defects. The norms of acceptance shall be as per Category 2 of the above standard.



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14.0 ADDITIONAL TESTS:

If specified in the drawing/order, the following tests shall be conducted:

- i) Magnetic particle test.
- ii) Any other tests.

Norms and acceptance shall be as specified in the drawing/order.

15.0 TEST CERTIFICATES:

Three copies of test certificates shall be supplied unless otherwise stated in the order, preferably in the test certificate format annexed to this specification (Annexure-1).

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following Information.

Dimensional Inspection.

Details of heat treatment.

Reduction ratio.

Chemical composition including trace elements.

Results of mechanical tests.

Results of ultrasonic test.

Results of additional tests called for in the order/drawing.

16.0 PACKING AND MARKING:

Forgings shall be suitably packed to prevent corrosion and damage during transit. Machined surfaces shall be properly protected with anti-corrosive compounds. Each package or forging (when supplied separately) shall be legibly marked with the following Information:

AA19358:1.5% Nickel – Chromium – Molybdenum Steel Forgings –Hardened and Tempered
BHEL Order No.:

Consignment/Identification No.:

Weight:

Melt. No.:

Batch No.

Supplier/s name

17.0 REFERRED STANDARDS (Latest publications including amendments):

1. AA0850118 2. IS: 1500 3. IS: 1608 4. IS: 1757 5. IS: 4367

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ANNEXURE - 1

RECOMMENDED TEST CERTIFICATE FORMAT FOR FORGINGS

SUPPLIER'S NAME AND ADDRESS TEST CERTIFICATE FOR FORGINGS

- | | | |
|---|--|------------------------------------|
| 1. Customer: | 9. Reduction Ratio | } Ingot to Bloom
Bloom to Blank |
| 2. TC No. & Date: | 10. Batch No.: | |
| 3. PO No.: | 11. Heat/Melt No. | |
| 4. Process of Melting Ingot: | 12. Spec. No. | |
| 5. Deoxidisation Process: | 13. Test Bar Size & Nos. | |
| 6. Forging Method: | 14. Supplier of the ingot/billet/
Bloom and TC reference. | |
| 7. BHEL's Reference for Approval of Bloom | | |
| 8. Discard: Top _____%; Bottom _____% | | |

15. FORGINGS COVERED BY TEST CERTIFICATE

S.No.	Drawing No. & Item No.	Description	Quantity & Weight

16. CHEMICAL COMPOSITION (PERCENT)

Element	C	Si	Mn	S	P										
As Per Specn.	Min.														
	Max.														
Actual Values															

17. HEAT TREATMENT (To be accompanied by Recorder Chart, Whenever called for)

Condition	Heating Rate, °C/hr.	Temp. °C	Soaking Time, Hrs.	Cooling Rate, °C/hr	Cooling Medium

18. MECHANICAL PROPERTIES

	T.S. N/mm ²	Y.S. 0.5/0.2% Proof N/mm ²	% Elongation 5.65√S ₀ GL	% R.A. Min.	Hardness BHN (Min. 3 values)	Impact Value Joules	Bend Test		
							Angle of bend	Dia of mandrel	Result
As Per Specn.	Min.								
	Max.								
Actual Values									

19. SURFACE FINISH (When called for in the order/drg.)

20. DIMENSIONAL INSPECTION

21. NON-DESTRUCTIVE TESTS

Nature of Test	Acceptance level	Instrument used	Range	Results	Any other detail
Ultrasonic					
Radiographic					
Dye penetrant/ Magnetic Particle					

22. METALLOGRAPHIC EXAMINATION (To be conducted if called for and photo micrographs to be attached along with a report)

Location of Sample	Etchant used	Magnification	Constituent observed	Relative %	
Microstructure	Macroetch	Inclusion Rating			

23. OTHER TESTS IF ANY (MICROSCOPIC, SULPHUR PRINTS, ETC)

24. IDENTIFICATION OF FORGINGS AS PER PURCHASE SPEC.

We hereby certify that the items mentioned above have been tested and inspected in our presence and are found to be in accordance with drawings, specifications and purchase order.

SIGNATURE, NAME & SEAL OF THE
INSPECTING OFFICER
DATE:

SIGNATURE, NAME & SEAL OF THE
CHIEF OF QUALITY CONTROL/
CHIEF METALLURGIST OF THE SUPPLIER
DATE:

INSTRUCTIONS

- Details of all heat treatment processes carried out should be furnished sequentially in 17.
- Test certificates are to be furnished as per Purchase order and specification, in A4 size preferably in transparent paper.
- All the entries including signature should be in block colour ink.
- If testing is done by outside agencies, the original TCs shall be furnished.
- The actual TC may run into more than one A4 size paper, if needed, to facilitate filling up of details.



CORPORATE STANDARD

AA 085 01 18

REV.No. 01

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ULTRASONIC TESTING, CLASSIFICATION AND ACCEPTANCE STANDARDS FOR STEEL FORGINGS, BILLETS AND BLOOMS

1.0 SCOPE:

This standard deals with the ultrasonic testing of steel forgings, billets and blooms. The procedure covers pulse echo direct contact manual ultrasonic flaw detection technique. This standard does not apply to austenitic steel forgings.

2.0 PERSONNEL REQUIREMENT:

Personnel performing non-destructive examination and evaluation shall be qualified to the recommended practice SNT - TC - 1A or any other recognised practice.

3.0 EQUIPMENT CHARACTERISTICS:

3.1 Frequency range:

The ultrasonic equipment shall be suitable for operating at frequencies within the range of 0.5 to 6 MHz.

3.2 Sensitivity:

The sensitivity of the equipment shall be tested to ensure that the number of full screen back wall echo is not less than that given below, when the appropriate probe is placed on the metalised surface of plastic insert of the Indian Standard reference block (IS:4904)/IIW block.

Frequency range, MHz Min.No. of full screen back echoes

1	5
2	4
4 to 6	2

3.3 Resolution:

The resolution of the equipment and probe combined shall be such as to show separately indications of the three grooves in the IIW - VI block.

Revision:
C1.9.4 OF MOM OF WG(NDT)

Approved:
INTERPLANT STANDARDIZATION
COMMITTEE - (WG-NDT)

Rev.No. 01

Amd.No.

Reaffirmed

Prepared
CFFP
HARDWAR

Issued
CORP. R&D

Dt. of 1st issue
Jan '80

Dt. Jan '95

Dt.

Year:

**4.0 SURFACE CONDITION:**

The test surface shall be free from loose scales, rust and such other extraneous material that would interfere with the ultrasonic energy transmission. In case of machined surface, it is desirable to have a surface finish of 6.25 microns or better. A gramophone record type of finish and tear produced by machining tools shall be avoided since these give rise to spurious echoes and cause probe wear.

5.0 COUPLANT:

To ensure adequate transmission of ultrasonic energy between the probe and the test object, a suitable couplant having good wetting characteristics such as oil, grease, water, glycerine or cellulose paste shall be used.

6.0 TESTING TECHNIQUE:

6.1 Selection of testing technique shall be made after giving due consideration to the method of manufacture and shape of the object tested. Testing technique should be such that each and every part of the object volume is scanned at least once. Successive scans shall overlap a minimum of 15% of the probe width. Uniform contact shall be maintained between probe and object and scanning speed shall not exceed 100 mm/ second. The following techniques are considered to be minimum for providing adequate coverage.

6.2 Scanning Scheme (Solid And Hollow Forgings):

Complete length of the forging shall be scanned radially from sides / cylindrical surface through 360° using longitudinal wave probe. Whenever practicable the forging shall be scanned in axial direction also. Hollow forgings, and when necessary, solid forgings also shall be scanned using appropriate shear wave probes to detect axial and radial cracks. Hollow forgings are the forgings made hollow on the press by punching or ring rolling operation.

6.3 Solid Rectangular Forgings, Billets And Blooms:

Complete length of the object shall be scanned from two adjacent faces and whenever practicable one end face using longitudinal wave probe.

6.4 Radial cracks on round sections which can not be detected by normal testing method may be subjected to other crack detection methods such as MPI.

7.0 SCANNING:**7.1 Probes and Frequency:**

Overall scanning shall be done using 2 MHz nominal, 20-25 mm diameter probes except when large grain size and path length make it necessary to use a lower frequency. Smaller probes may be used when necessary. However, for forgings intended for backing material for white metal lined bearings, the examination shall be carried out by 4 MHz probes.



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7.2 Time Base Calibration:

The time base shall be calibrated using a calibration block or a known dimension of forging under examination.

7.3 Sensitivity:

7.3.1 When Calibrated Attenuator Is Not Available:

Reference sensitivity of equipment shall be set such that the maximum acceptable defect equivalent flat bottomed hole in the test block is equal to 75% of the full screen height. Testing shall be carried out at the highest sensitivity possible.

7.3.2 When Calibrated Attenuator Is Available:

The sensitivity of the equipment during scanning shall be set 6 dB more than the sensitivity required to give a full screen height echo from the maximum acceptable size of defect.

Note: The above sensitivity level adjustment is purely for scanning purposes. Once a defect is encountered, the sensitivity shall be brought down to estimate the size of defect for evaluation of the material under test.

8.0 ESTIMATION OF FLAW SIZE:

8.1 Large Size Flaws:

The size of large flaws can be estimated by moving the probe in all directions and plotting the midpoint of the probe when echo falls to 50 percent or 6 dB.

8.2 Small Size Flaws:

8.2.1 When Calibrated Attenuator Is Not Available:

8.2.1.1 The size of the flaw may be estimated by comparing with the echoes of the flat bottomed holes at appropriate depths in a test block of ultrasonically similar material.

8.2.1.2 The size of the flaw may also be estimated by moving probe successively in all the four directions at right angles to each other and plotting the mid point of the probe when echo height falls to 50% or 6 dB. Due allowance shall also be made for beam spread, depth and orientation of flaw and diameter of the forging if the scanning is done from the curved surface.

8.2.2 When Calibrated Attenuator Is Provided With The Equipment:

The size of the flaw (smaller than the beam spread) can be estimated accurately in millimetres of equivalent circular flaw with the help of Krautkramer's DGS (Distance - gain - size) diagram. Method of estimating flaw size using a DGS diagram is given in Annexure - A.



9.0 CLASSIFICATION OF FORGINGS, BILLETS AND BLOOMS:

9.1 Forgings, billets and blooms are classified into the following five categories depending upon the defect size admissibility for the purpose of ultrasonic testing:

Category

Unacceptable defects

- | | |
|---|--|
| 1 | <ul style="list-style-type: none"> (i) Cracks, flakes, seams & laps. (ii) Defects giving indication larger than that from a 2 mm diameter equivalent flaw. (iii) Groups of defects with maximum indication less than that from a 2 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 70%. (iv) Defects giving indications of 1 to 2 mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws. |
| 2 | <ul style="list-style-type: none"> (i) Cracks, flakes, seams & laps. (ii) Defects giving indication larger than that from a 4 mm diameter equivalent flaw. (iii) Groups of defects with maximum indication less than that from a 4 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 50%. (iv) Defects giving indications of 2 to 4 mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws. |
| 3 | <ul style="list-style-type: none"> (i) Cracks, flakes, seams & laps. (ii) Defects giving indication larger than that from a 6 mm diameter equivalent flaw. (iii) Groups of defects with maximum indication less than that from a 6 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 40%. (iv) Defects giving indications of 3 to 6 mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws. |
| 4 | <ul style="list-style-type: none"> (i) Cracks, flakes, seams & laps. (ii) Defects giving indication larger than that from a 10 mm diameter equivalent flaw. (iii) Groups of defects with maximum indication less than that from a 10 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 20%. |



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- (iv) Defects giving indications of 5 to 10 mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws.
- 5
- (i) Cracks, flakes, seams & laps.
- (ii) Defects giving indication larger than that from a 15 mm diameter equivalent flaw.
- (iii) Groups of defects with maximum indication less than that from a 15 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 10%.

Note: Loss of back wall echo not attributable to the presence of defects or geometry and exceeding the limits mentioned in item (iii) of each category of unacceptable defects shall be a cause for rejection.

ANNEXURE - A

The equivalent flaw size curves of the DGS diagram is prepared by plotting the amplitude in decibels from a series of circular reflectors with increasing distance from the probe in water and so the graph incorporates only the loss in water. When it is found that the attenuation in the material under test is more (this can be checked using back echo curve of DGS diagram), this shall be taken into account while calculating the flaw size. Corrections will not be required for majority of heat treated forgings when tested with 2-4 MHz probes.

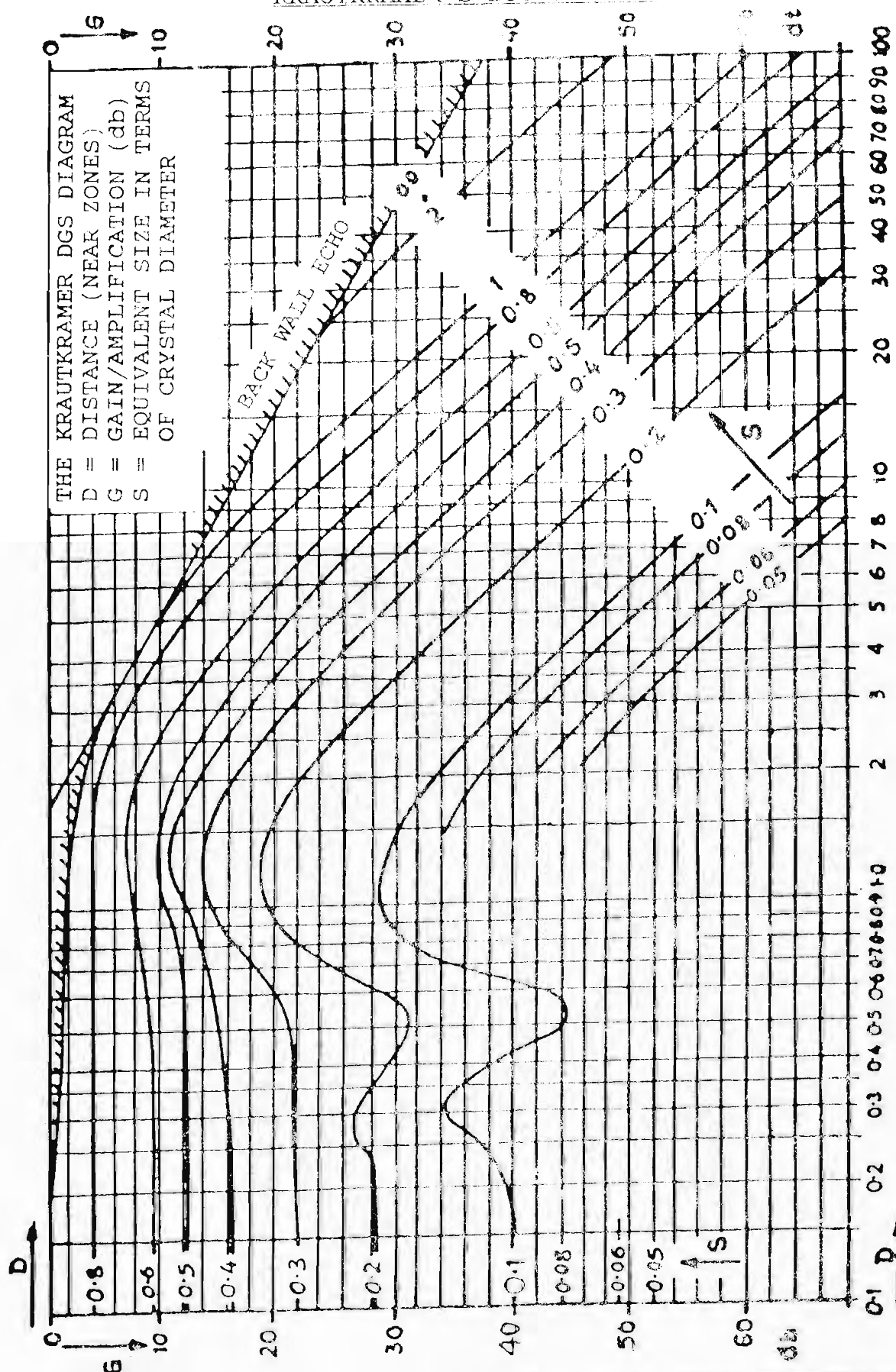
A step by step method of estimating flaw size using universal DGS diagram is given below:


- (a) Adjust the depth range of the equipment to the required depth.
- (b) Adjust the back echo to 70% of screen height from a defect free area parallel wall of the material under test or ultrasonically similar test block and note the dB value (A) on the calibrated gain control.
- (c) Mark on the back echo curve of the diagram, the back wall of the distance in terms of near field in millimetres in the case of universal DGS diagram.
- (d) Move the probe to the defective area and get the maximum defect echo. Read off the flaw depth. Increase the gain with the calibrated gain control until echo height reaches 70% of screen height. Note the attenuator reading in dB (B).
- (e) Calculate the gain (G) in dB by subtracting 'A' from 'B'. Count off the gain 'G' downwards from the marked point on the back echo curve, and then move horizontally to intersect the vertical line from the base line corresponding to the flaw depth 'D' in terms of near field in the case of universal diagram.

- (f) Note the equivalent flow size curve passing through the above point. Multiply the reduced flow dimension (S) of the curve by the probe diameter to give the equivalent flow size in millimetres.

ANNEXURE - A

KRAUTKRAMER'S DGS DIAGRAM



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GENERAL REQUIREMENTS OF 1.5 % NICKEL – CHROMIUM – MOLYBDENUM STEEL BARS HARDENED AND TEMPERED AS PER AA 19358 Rev. 08		Page 1 of 2

1.0 MATERIAL SPECIFICATION :

These requirements are in addition to those included in BHEL corporate purchase specification AA 19358 rev. 08 and are applicable for dia. ranging from 110 to 200 mm (both dia. inclusive)

2.0 CONDITION OF DELIVERY :

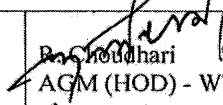
It is allowed to supply Hot rolled / Forged ; Hardened and tempered.


3.0 FOR HOT ROLLED BAR :

- 3.1 Bars to be supplied as Hot rolled, hardened & tempered condition. Rough machining is not required.
- 3.2 Rolled bars to be supplied in lengths of 3 – 6 meter.
- 3.3 Out of straightness allowed is 3 mm / meter.
- 3.4 Tolerance on diameter to be + 2.5 % & - 0.0 % of diameter required.
- 3.5 Each Rolled bar shall be tested ultrasonically in accordance with BHEL standard AA0850118 rev. 01 to ensure freedom from internal defects. The norms of acceptance shall be as per category 2 of the above standard.
- 3.6 All the mechanical properties, chemical composition and any other requirement not mentioned above shall be as per BHEL corporate specification AA 19358 rev. 08
- 3.7 Quantity variation ± 10 % acceptable.

4.0 FOR FORGED BAR :

- 4.1 Bars to be supplied as Forged, hardened & tempered condition. Rough machining is to be done.
- 4.2 Forged bars to be supplied in lengths of 3 – 6 meter.

Rev. No.	Date of Rev.	Remarks			
00	12.05.18	-	 Mahendra Soni Dy. Manager - WTM		
			Prepared Mahendra Soni Dy. Manager - WTM	Checked Jitendra Singh Manager - WTM	Date of issue (Rev 00) 12.05.18

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GENERAL REQUIREMENTS OF 1.5 % NICKEL – CHROMIUM – MOLYBDENUM STEEL BARS HARDENED AND TEMPERED AS PER AA 19358 Rev. 08		

4.3 Out of straightness allowed is 3 mm / meter.

4.4 Tolerance on diameter to be + 2.5 % & - 0.0 % of diameter required.

4.5 Each Forged bar shall be tested ultrasonically in accordance with BHEL standard AA0850118 rev. 01 to ensure freedom from internal defects. The norms of acceptance shall be as per category 2 of the above standard.

4.6 All the mechanical properties, chemical composition and any other requirement not mentioned above shall be as per BHEL corporate specification AA 19358 rev. 08

4.7 Quantity variation ± 10 % acceptable.

Note :

The requirement given in the document overrules the requirement given in BHEL specification AA19358 rev. 08

Rev. No.	Date of Rev.	Remarks			
00	12.05.18	-	R. Choudhari AGM (HOD) - WTM		
			Prepared	Checked	Date of issue
			Mahendra Soni	Jitendra Singh	(Rev 00)
			Dy. Manager - WTM	Manager - WTM	12.05.18