

Enquiry items along with quantities:

It. no	Size & Item description	Technical requirement	Quantity in MT
1	71 mm dia X 3000 mm – 6000 mm LG	1.5% Ni-Cr-Mo hot rolled, hardened and tempered steel round bars to spec. AA 10501 rev. 14. Ultra sonic testing as per spec AA0850118 (acceptance category – 2). Straightness within 3 mm / meter & tolerance on dia +2.5%/-0.0%)	14
2	100 mm dia X 3000 mm – 6000 mm LG		32
TOTAL			46

Above quantities are subject to variation per lot and on overall basis: +10% / -10%.

Pre-qualification criteria:

S. No.	Description of pre-qualification requirement	Vendor Response	
		Complied/ Not complied	Supporting Documents required to accept compliance
1	Manufacturer of structural steel bar / their authorized representative	YES / NO	Relevant certificate of being manufacturer (for manufacturer not registered with BHEL) / authorization letter with validity (for authorized representative). Firm name and address from whom bars is intended to be supplied to be furnished.
2	Vendor should have experience of manufacturing, material testing & supplying of Nickel – Chromium – Molybdenum hot rolled round steel bars – H&T as per latest standard IS: 5517 – 2004 Gr: 40Ni6Cr4Mo3, type J, hot rolled, H&T or equivalent grade fulfilling our requirement during last 7 years (ending last day of month previous to the one in which tender is published).	YES / NO	Purchase order, mill test certificate, invoice. In case of authorized dealers, relevant documents of their 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.	YES / NO	Valid certificate to be submitted.
4	Vendor should furnish any 3 years' audited balance sheet of last 7 financial years. FY ending 2019 – 20.	YES / NO	Audited profit and loss statement.

Note:

1. BHEL has right to verify information / confirmation furnished by asking additional documents, proof 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.

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/1041 Rev. 00 Dated :- 16.05.2018
SPECIFICATION : AA 10501 Rev. 14 (1.5 % Nickel - Chromium - Molybdenum Steel Bars)
SUPPLY CONDITION : upto 100 mm - Hot Rolled ; Hardened & Tempered

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 10501 Rev. 14	AA 10501 Rev. 14	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
		Mechanical Properties	i) Tensile Test	As Specified in AA 10501 Rev. 14	-do-	-do-	Supplier's Test Certificate	1	-	2	-
			ii) Charpy Impact Test (on 3 samples)	-do-	-do-	-do-	Supplier's Test Certificate	1	-	2	-
			iii) Yield strength	-do-	-do-	-do-	Supplier's Test Certificate	1	-	2	-
			iv) % Elongation	-do-	-do-	-do-	Supplier's Test Certificate	1	-	2	-
			v) Hardness Test	-do-	-do-	-do-	Supplier's Test Certificate	1	-	2	-
		Ultra Sonic Test (applicable for dia 40 mm and above)	As Specified in AA 10501 Rev. 14	100%	AA0850118 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 10501 Rev. 14	AA 10501 Rev. 14	Supplier's Test Certificate	1	-	2	-
		Visual Examination	Visual	100%	-do-	Bars shall be free fom surface defects, bends & twists	Supplier's Dimensional Report	1	-	2	-
		Dimension & Tolerance	Measurement	100%	-do-	AA 10501 Rev. 14	-DO-	1	-	2	-
4	Dispatch	Identification Marking	Hard Stamping	100%	-do-	-do-	1. Heat No. 2. P.O. No. 3. Spec No. 4. Size 5. Supplier 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

Aadhar Sharma
16/5/18
QA-HYDRO
आधार शर्मा (विशेषज्ञ) / Sr. E. Engineer (QA)
वरिष्ठ अभियंता (विशेषज्ञ) / Sr. E. Engineer (QA)
गणता नियंत्रण-जल उत्पादन / Quality Control-WTM
बी.एच.ई.एल., भोपाल / BHEL, BHOPAL

H.T.E. *Shivendra Kumar*
16/05/18
शिवेन्द्र कुमार / Shivendra Kumar
वरिष्ठ प्रबंधक / Sr. Manager
विभाग / H.T.E. DIVISION
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WTM *MAHENDRA SONI*
16/5/18
महेंद्र सोनी / MAHENDRA SONI
उप प्रबंधक (उत्पादन) ज.उ.वि. प्रभाग
Dy. Manager (Production) WTM Division
बी.एच.ई.एल., भोपाल / BHEL, BHOPAL

	CORPORATE PURCHASING SPECIFICATION	AA10501 Rev No.14 PREFACE SHEET			
1.5% NICKEL-CHROMIUM-MOLYBDENUM HOT ROLLED/FORGED STEEL BARS- H & T FOR INTERNAL USE ONLY REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS					
Comparable Standards: 1) INDIAN : IS: 5517 – 2004 Gr: 40Ni6Cr4Mo3, Type J, H&T					
Suggested/Probable Suppliers and Grades: Refer Plant Vendors list					
User Plants References: 1) HEP, BHOPAL : PS10559 2) HEEP, HARDWAR : --- 3) HPEP, HYDERABAD : HY0210299 4) HPBP, TRICHY : En 24					
Revisions: Revised as per email dt 18.12.08 from Shri Gopal Bhatt from Bhopal.		APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(S&GPS)			
Rev No.14	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue
Dt:18-12-2008	Dt:	Year:2020	HEP, Bhopal	Corp.R&D	April, 1977

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	CORPORATE PURCHASING SPECIFICATION	AA10501 Rev No. 14 PAGE 1 of 4																		
1.5% NICKEL-CHROMIUM-MOLYBDENUM HOT ROLLED/FORGED STEEL BARS- H & T																				
1.0 GENERAL: This specification governs the quality requirements of 1.5% Nickel-Chromium-Molybdenum Hot rolled/forged Steel Bars, Gr: 40Ni6Cr4Mo3 in Hardened and Tempered condition. 2.0 APPLICATION: For the manufacture of bolts, studs and various components of machines. 3.0 CONDITION OF DELIVERY: Hot Rolled / Forged; Hardened and tempered. Note: Sizes up to 100mm in hot rolled >100 to 180mm in hot rolled or forged above 180mm in forged The ends of bars shall be reasonably square and true. The bars shall be supplied in straight lengths without twists and bends. 4.0 COMPILANCE WITH NATIONAL STANDARDS: The material shall comply with the requirements of the following National standard and also meet the requirements of this specification. <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border-right: 1px solid black; padding: 5px;">IS: 5517 – 1993 Gr: 40Ni6Cr4Mo3, Type: J Hardened & Tempered</td> <td style="width: 50%; padding: 5px;">Steels for Hardening and Tempering - Specification</td> </tr> </table> 5.0 DIMENSIONS AND TOLERANCES: 5.1 Sizes: Bars shall be supplied to the dimensions specified on the order. 5.1.1 Length: Unless otherwise specified, hot rolled bars shall be supplied in 3 to 6 metres length or in multiples with maximum 10%, shorts down to 1 metre. Forged bars shall be supplied in lengths of 1.5 to 3.0 metres			IS: 5517 – 1993 Gr: 40Ni6Cr4Mo3, Type: J Hardened & Tempered	Steels for Hardening and Tempering - Specification																
IS: 5517 – 1993 Gr: 40Ni6Cr4Mo3, Type: J Hardened & Tempered	Steels for Hardening and Tempering - Specification																			
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="3" style="padding: 5px;"> Revisions: Revised as per email dt 18.12.08 from Shri Gopal Bhatt from Bhopal. </td> <td colspan="3" style="text-align: center; padding: 5px;"> APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(S&GPS) </td> </tr> <tr> <td style="width: 20%; padding: 5px;">Rev No.14</td> <td style="width: 20%; padding: 5px;">Amd No.</td> <td style="width: 20%; padding: 5px;">Reaffirmed</td> <td style="width: 20%; padding: 5px;">Prepared</td> <td style="width: 20%; padding: 5px;">Issued</td> <td style="width: 20%; padding: 5px;">Dt. of 1st Issue</td> </tr> <tr> <td style="padding: 5px;">Dt:18-12-2008</td> <td style="padding: 5px;">Dt:</td> <td style="padding: 5px;">Year:2020</td> <td style="padding: 5px;">HEP, Bhopal</td> <td style="padding: 5px;">Corp.R&D</td> <td style="padding: 5px;">April, 1977</td> </tr> </table>			Revisions: Revised as per email dt 18.12.08 from Shri Gopal Bhatt from Bhopal.			APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(S&GPS)			Rev No.14	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue	Dt:18-12-2008	Dt:	Year:2020	HEP, Bhopal	Corp.R&D	April, 1977
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Dt:18-12-2008	Dt:	Year:2020	HEP, Bhopal	Corp.R&D	April, 1977															

CORPORATE PURCHASING SPECIFICATION



5.2 Tolerance:

5.2.1 Hot rolled bars: The bars shall not vary from specified diameter or distance across flats by more than $\pm 2\frac{1}{2}$ %.

5.2.2 Forged bars: The tolerance on the forged bars shall be as follows.

<u>Diameter, mm</u>	<u>Tolerance, mm</u>
50 mm to 175 mm	+ 8.0 mm
Above 175 mm	+ 12.5 mm

Note: (Hot rolled & forged bars).

Insignificant surface defects in the form of dent and ripple marks are permissible provided their depth does not exceed half the tolerance on each size.

6.0 MANUFACTURE:

Material shall be manufactured from fully killed steel.

7.0 HEAT TREATMENT:

The recommended heat treatment is as follows:

Harden in oil / water from a temperature of 830 – 850°C.

Temper at a suitable temperature between 550 – 660°C.

8.0 FREEDOM FROM DEFECTS:

The bars shall be sound, straight and free from internal and surface defects, such as seams, laps, cracks or any other defects which may impair the end use.

9.0 CHEMICAL COMPOSITION:

The melt analysis of steel and the permissible variation in the composition of the finished product from the melt analysis shall be follows:

Element	Melt analysis percent		Permissible variation, percent, in product analysis
	Min.	Max.	
Carbon	0.35	0.45	± 0.02
Silicon	0.10	0.35	± 0.03
Manganese	0.40	0.70	± 0.04
Nickel	1.25	1.75	± 0.05
Chromium	0.90	1.30	± 0.05
Molybdenum	0.20	0.35	± 0.03
Sulphur	---	0.035	+ 0.005
Phosphorus	---	0.035	+ 0.005



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10.0 TEST SAMPLES:

10.1 One sample shall be taken from each melt for chemical analysis.

10.2 One sample shall be taken from each heat treatment batch for testing of mechanical properties. Test pieces for mechanical tests shall be taken in the longitudinal direction of the piece.

For ruling section up to & including 40mm, the test piece shall be machined coaxially from the test bars. For ruling section above 40mm the longitudinal axis shall be at least 12.5 mm from surface of the test bars.

Test methods for determining mechanical properties shall be as per IS: 1598 (For IZOD impact test)/IS: 1757 (For impact test in ISO-V Charpy) and IS: 1608 (For tensile test) or any other reputed International Standard.

10.3 For ruling section above 200mm, tensile test samples can be taken in tangential or transverse direction.

11.0 MECHANICAL PROPERTIES (In Hardened and Tempered Condition):

Ruling section, mm	Tensile strength, N/mm ²	0.2%/PS/YS N/mm ² min	%E $5.65\sqrt{S_0}$ min	* IZOD impact J, min	Hardness ** BHN
up to 30	1200, min	1000	10	30 (25)	360 – 420
> 30 to = 63	1100 – 1250	880	11	41 (35)	330 – 390
> 63 to = 100	1000 – 1150	800	13	48 (42)	300 – 350
>100 to = 150	900 – 1050	700	15	55 (50)	270 – 300
>150	800 – 950	600	16	55 (50)	240 – 285

* Average of 3 samples applicable for sizes above 16 mm ruling section only. Values in bracket are in ISO - V Charpy.

** Hardness shall be reported for information only.

12.0 ULTRASONIC TEST:

12.1 Each bar above 100 mm 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.

12.2 **Optional tests:** If specified on order, each bar > 40 to 100 mm shall be tested ultrasonically in accordance with BHEL standard AA0850118 to ensure freedom from internal defects and the norms of acceptance shall be as per category 2.

CORPORATE PURCHASING SPECIFICATION



13.0 TEST CERTIFICATES:

Three copies of test certificates shall be supplied, unless otherwise stated on the order. 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:

BHEL References:

AA10501, Rev.No.14: 1.5% Nickel-Chromium-Molybdenum Hot Rolled/Forged Steel Bars- H&T
BHEL order No,

Supplier's References:

Name:

Identification No:

Melt No:

Details of heat treatment:

Result of Tests:

Dimensional inspection.

Results of chemical analysis, mechanical and & Ultrasonic tests.

14.0 PACKING AND MARKING

The bars shall be suitably packed in bundles to prevent corrosion and damage during transit.

Each bar equal to or greater than 50 mm in diameter or of equivalent cross sectional area shall be stamped with 'AA10501' and melt number on the side near the end or on the face.

Bars below 50 mm shall be bundled together and tied with wire at 3 to 4 places along the length of the bars.

A metal label shall be securely attached to each bundle and shall bear the following information:

AA10501: 1.5% Nickel-Chromium-Molybdenum Hot Rolled/Forged Steel Bars- H & T.

BHEL Order No.:

Consignment/Identification No.:

Melt No.:

Size and Weight:

Supplier's Name:

15.0 REFERRED STANDARDS (Latest Publications Including Amendments):

1. IS: 1598

2. IS: 1608

3. IS: 1757

4. IS: 5517

5. AA0850118

		AMENDMENT - NOTIFICATION		AA 085 01 18 REV. No. 01	
				PAGE 1 OF 1	
AA 085 01 18: <u>ULTRASONIC TESTING CLASSIFICATION AND ACCEPTANCE STANDARDS FOR STEEL FORGINGS, BILLETS AND BLOOMS</u>					
1.0 PAGE 1 OF 6; <u>CL 1.0 SCOPE:</u> Last sentence of the para is modified as follows: "This standard does not apply to austenitic steel forgings for which AA 085 01 19 may be referred to."					
2.0 <u>CL 3.2 Sensitivity:</u> Title of the left hand column of the table is modified as "<u>Frequency, MHz</u>" in place of Frequency range, MHZ.					
3.0 PAGE 2 OF 6; <u>CL 5.0 COUPLANT:</u> Last line is modified as "<u>or water shall be used.</u>"					
4.0 <u>CL 6.1:</u> Eight line is modified as follows: "shall not exceed 150mm/second. The following techniques"					
Please see instructions on the reverse.					
Ref:	Amd. No.	Approved	Issued	Date	Cum. Sr. No.
CL:10.2.4 of MOM	01	WG-NDT	CORP. R&D	15.1.96	A 1822

INSTRUCTIONS

Changes to be incorporated in the controlled copies
for "AMENDMENT" -- NOTIFICATION".

- a) The "AMD. No." of this "Amendment Notification" shall be recorded against the sheet / clause, being amended, on the margin.
- b) This, "Amendment Notification" shall be filed over the concerned preface sheet of the Specification / or First sheet of the standard or over the previous Amendment, if any.



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:

<u>Category</u>	<u>Unacceptable defects</u>
1	(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	(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	(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	(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 flaw size curve passing through the above point. Multiply the reduced flaw dimension (S) of the curve by the probe diameter to give the equivalent flaw size in millimetres.

ANNEXURE - A

KRAUTKRAMER'S DGS DIAGRAM

