

COMPANY STANDARDS



QY1018-C

PAGE NO.2 OF 15

DATE :
1993-12-10

TITLE :
FERROUS CASTINGS -
CLASSIFICATION & ACCEPTANCE NORMS

3. METHOD OF INDICATION ON THE DOCUMENTS/DRAWINGS :

The following sentence shall be added in all documents/drawings under separate note :

'FOR ACCEPTANCE NORMS, CLASS----OF COMPANY STD. NO.QY1018-C SHALL BE REFERRED'.

4. PRODUCIBILITY CONSIDERATIONS :

The class assigned to the casting should represent a realistic assessment of its functional requirements. Do not assign A class of castings for class B function. Casting design coupled with foundry practice can make overly severe soundness requirements impractical for a manufacturer to satisfy. Caution should be exercised in specifying the location for radiographic test, and other nondestructive tests and, the maximum permissible discontinuity level and surface quality requirements to be met in a casting.

5. REFERRED DOCUMENTS :

5.1 ISSUE OF DOCUMENTS :

The following documents of the issue in effect on the date of the contract/purchase order for procurement of the castings form part of this standard to the extent specified herein.

COMPANY STANDARDS

DS1065-C - "Glossary of Terms relating to Ferrous Castings"

QY1024-C - "Surface Quality of Steel castings"

QY1025-C - "Surface Quality of S.G iron & Grey Iron castings"

OTHER PUBLICATIONS :

Indian Standards :

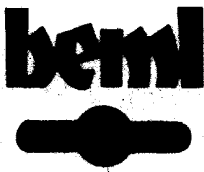
IS:2500 (Part 1&2) : Sampling Inspection Table

IS:2953 : Glossary of terms used in Radiographic Inspection of Castings

IS:2595 : Code of Practice for Radiographic Testing

IS:3703 : Code of Practice for Magnetic particle flaw detection

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IS:6907 : Method of Sampling Steel Castings
Visual, Dimensions and Properties

IS:7743 : Recommended practice for Magnetic
Particle Testing & Inspection of Steel
Forgings

IS:3658 : Code of Practice for Liquid Penetrant
flaw detection

ASTM Standards :

- ASTM E94 : Recommended practice for radiographic
Testing
- ASTM E125 : Reference photographs for magnetic
particle inspection - indications on
ferrous castings
- ASTM E142 : Method for controlling quality of
Radiographic testing
- ASTM E165 : Methods for liquid penetrant inspection
- ASTM E186 : Reference Radiographs for Heavy Walled
(51-114 mm) steel castings
- ASTM E242 : Appearance of radiographic flanges as
certain parameters are changed :
Reference radiographs for
- ASTM E280 : Reference Radiographs for Heavy walled
(114 to 305 mm) steel castings
- ASTM E433 : Penetrant inspection - Reference
Photographs for
- ASTM E446 : Reference Radiographs for steel
Castings upto 51 mm thickness
- ASTM A609 : Longitudinal beam Ultrasonic inspection
of carbon and low alloy steel castings.
- ASTM E709 : Standard recommended Practice for
Magnetic Particle Examination
- ASTM E802 : Recommended practice for Gray Iron
Castings upto 114mm Thickness

6. DEFINITIONS :

Refer Company Standard DS1065-C - "Glossary of
Terms relating to Ferrous castings".

7. GENERAL REQUIREMENTS :

7.1 INSPECTION :

7.1.1 Responsibility for Inspection :

The supplier of the castings is responsible for
supplying all supplies in conformance with the
contract/purchase order requirements and, unless
otherwise specified in the contract/purchase
order, the performance of all inspection require-
ments contained in this standard. The inspection



provisions contained herein shall become a part of the supplier's overall inspection system or quality programme.

BEML reserves the right to perform any of the inspections set forth herein or otherwise specified in the contract/purchase order, when such inspections are deemed necessary to assure the supplies conform to prescribed requirements.

7.1.2 Personnel Qualification :

Personnel making accept-reject decisions described in this standard shall be qualified to level III or level II of applicable ISNT/ASNT (Indian Society for Non-destructive Testing) standards.

Personnel qualified to level I as per ISNT/ASNT Standard shall be restricted to performance of the non-destructive testing methods described in this standard.

7.1.3 Final Inspection :

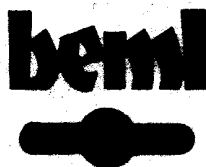
Castings shall be inspected as specified herein unless the Product Engg./Quality Engg. Department of BEML has informed substantiating the suitability of other inspection plans for specific cases of procurement.

7.1.4 Documentation for Final Inspection :

For all castings for which radiographic inspection is specified, the supplier shall prepare X-ray / GAMMA-Ray film, sketches indicating location of radiography and documents containing

- a) Part name and part number of casting radiographed
- b) Classification of casting
- c) Alloy and heat treatment condition
- d) Discontinuity levels applicable
- e) Discontinuity levels observed
- f) Type of radiography & source employed
- g) Deviations from this specification not covered by the contract/Purchase order
- h) Details of repairs and upgradation carried out

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8. SURFACE QUALITY :

Castings shall not contain cracks, cold shuts, hot tears, sand fusion or other defects in excess of that allowed for the applicable class of casting. Surface projections, such as those remaining after removal of gates and risers, shall not be higher than the limits specified in the drawings or other applicable documents.

Refer Company Standard QY1024-C/QY1025-C

9. SAMPLING :

9.1 Visual Inspection :

Every casting, of all classes, irrespective of lot size shall be examined visually.

9.2 NON-DESTRUCTIVE TESTING :

Refer Table-1.

9.2.1 Magnetic particle and Dye penetrant inspection :

Castings of Classes A, B and C shall be subjected either to magnetic particle or dye penetrant inspection as may be appropriate as per sampling plan in Table-1. Casting drawings shall specify areas designated for magnetic particle inspection/dye-penetrant inspection. In case of steel castings unless otherwise specified in the drawing, the following areas shall be inspected :

- a) Boss-fillets and junctions of varying X-sections susceptible to hot-tear and/or cold shut.
- b) Weld lands and zone of width 100mm adjacent to weld lands, as these may exhibit cracks in the castings when the castings are welded into fabricated structures,

9.2.2 Radiographic Inspection :

Unless otherwise specified, sampling inspection coverage shall be as indicated below :

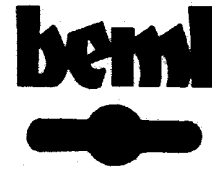
Class A, Class B, and Class C castings :

Casting shall be examined at zones indicated in the drawing, as per sampling plan in Table-1

Class D castings :

Radiography examination is not required unless otherwise specified in the drawing.

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9.2.3 Ultrasonic Flaw Detection k:

Ultrasonic inspection shall be in accordance with ASTM A609.as per table-1.

10. PROCESSING OPERATIONS :

When processing operations such as machining, grinding, welding or heat treatment are involved, inspection(s) shall be performed both before and after completion of such operations. For processing operations such as blast cleaning (shot/sand/grit blasting) and surface coating, inspection(s) shall be performed before such operations. Surface finish/roughness for certification shall be inspected after blast cleaning.

10.1 . Castings may be supplied with rust-preventive or primer coating as specified in the contract/purchase order.

If inspection is envisaged in BEML, the castings may be supplied with rust preventive oil coating after blast cleaning as indicated in the contract/purchase order or applicable document (See also Company Std. PR1006-C "Pretreatment and Painting Process for Vendor items/Beml-processed items).

11. TEST METHODS

11.1 VISUAL INSPECTION :

All castings shall be visually inspected for surface defects and irregularities, particularly in critical areas. Attention shall be given to the presence of discontinuities such as cracks, hot tear, sand fusion, evidence of shrinkage etc., (See also Clause 9.1).

When necessary, a magnifying glass (10x) shall be used to aid visual inspection. In case of dispute, castings shall be inspected by magnetic particle or Dye penetrant method as applicable and acceptance criteria shall be as indicated in clause 13.2.

11.2 MAGNETIC PARTICLE & PENETRANT INSPECTION :

Ferromagnetic Materials :

Class A, B & C castings and first off sample castings of class D (as per Table-1) of ferromagnetic materials shall be magnetic particle-inspected.

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Magnetic particle inspection shall be in accordance with ASTM E709 - with assistance from ASTM E125.

Dry powder magnetic particle inspection may be carried out where wet magnetic particle inspection is not feasible.

NONFERROMAGNETIC MATERIALS

Class A, B, C castings and first-off sample castings of Class D(as per Table-1) and nonferromagnetic material shall be penetrant-inspected in accordance with ASTM E165 with assistance from ASTM E433 as applicable using suitable postemulsified penetrant or water washable penetrant of requisite sensitivity.

11.3 RADIOGRAPHIC INSPECTION :

Radiographic inspection shall be in accordance with ASTM E94/E142.

Reference radiographs as per ASTM E186, E280, E446 and E802 as applicable shall be referred for test interpretations.

Assistance may be availed from ASTM E242, IS 2593 and IS:2595

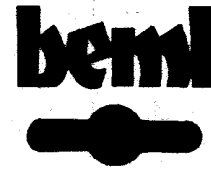
Non-film methods :

Castings of any class may be screened, using radiographic inspection by non-film methods.

Castings found acceptable by non-film methods shall be inspected by a film method in accordance with sampling requirements as applicable to the specific class for documentation (See clause 7.1.4).

11.4 ULTRASONIC TEST :

- a) It is proposed that ultrasonic flaw detection supplements radiographic examination. Ultrasonic flaw detection may be carried out in zones unsuitable for radiographic examination. Ultrasonic flaw detection is also expected to be carried out in zones of castings not indicated for radiographic examination in the casting drawing to ensure freedom from internal flaws which can not be permitted as per Table-7.
- b) Ultrasonic testing may be carried in place of radiography for established supplies when mutually



agreed to between BEML and the supplier of casting. However in case of doubt or dispute, the casting shall be radiographed to characterise and assess the defects.

NOTE : Ultrasonic examination and radiography are not directly comparable. Ultrasonic examination technique is intended to compliment radiography in detection of discontinuities.

12. EXAMINATION OF RE-SUBMITTED INSPECTION LOTS :

12.1 REJECTION :

On rejection of a lot after inspection as per single sample plan in Table-1, the lot shall be screened or upgraded as per approved procedure and shall be re-offered for inspection as per sampling plan in this standard.

12.2 DATA RECORDS :

Data records of all tests shall be kept on file in accordance with this standard/contractual obligations. For rejectable castings, the details of discontinuities/defects in the castings shall be recorded.

13. ACCEPTANCE NORMS :

13.1 Visual Inspection :

13.1.1 Castings shall be free from cracks, shrinkage cavities or other evidence of shrinkage, hot tears, swells, scab, blow holes and pinhole porosity that would impair the utility of the castings.

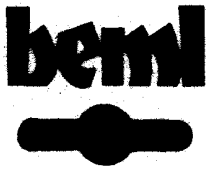
13.1.2 Castings shall be free from sand and scale on all surfaces to the extent that normal machining operations can be performed without the necessity for further cleaning operations.

13.1.3 Castings shall have gates and risers removed, maintaining casting design contour and dimensional requirements.

Refer Company Standard QY1024-C/QY1025-C

13.2 Magnetic Particle Inspection :

13.2.1 Magnetic Particle Inspection shall be in accordance with ASTM E 709.



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Test interpretations shall be based on ASTM E 125-reference photographs.

- 13.2.2 Table-2 establishes quality levels for test evaluation. All indications exceeding the specified degree shall be removed.
Removal of the surface defects should not impair the casting or necessitate weld (repair) build up by BEML.

13.3 DYE PENETRANT INSPECTION :

- 13.3.1 Dye Penetrant Inspection shall be in accordance with ASTM E165 with assistance from ASTM E433.
- 13.3.2 Test interpretations shall be based on ASTM E125 Reference photographs : Refer Table-2.
- All indications exceeding those specified shall be removed.

13.4 RADIOGRAPHIC INSPECTION :

- 13.4.1 Radiographic (X-ray or Gamma ray) inspection shall be in accordance with procedural and reliability requirements established in ASTM E94 and E142 respectively, with assistance from IS:2953, 2595 and other available Indian Standards.
- Test interpretations for steel, gray iron, ductile (spheroidal graphite) iron, malleable iron castings shall be based on ASTM E446/E186/E280 as applicable.
- 13.4.2 Maximum permissible severity levels for discontinuities are specified in Tables-3 to 6.
- Defects exceeding the permissible levels for the class of casting shall be cause for rejection of the casting.

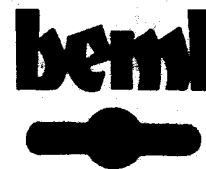
13.5 ULTRASONIC INSPECTION :

Ultrasonic test interpretations shall be based on ASTM A609 Quality levels 1 to 3 corresponding to Classes A, B and C of the standard.

Acceptance shall be based on no indications equal to or greater than that specified in Table-8. (For screening of castings when radiography is indicated, the permissible defect levels shall correspond to Table-3 to 6.

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13.6 HARDNESS MEASUREMENT :

Unless otherwise specified, hardness of the castings shall be measured by Brinell Hardness Test as per IS:1500. A portable hardness tester may be employed where necessary. Location of hardness testing shall be as indicated in the drawing. Sampling for hardness test shall be as per Table-1. Grinding performed for hardness test shall be smooth and blended so as not to create notches or stress risers.

13.7 HOMOGENISATION :

Castings shall be supplied to meet the mechanical properties as per the material standard specified. Steel castings shall be given homogenising annealing prior to heat treatment specified in the material standard or drawing, to ensure homogenous microstructure as applicable to the grade of material.

13.8 WELD REPAIR :

Some of the material grades for Steel Castings in BEML are classified as 'Difficult to Weld'. Weld repairs carried out on steel castings which require induction hardening or flame hardening or gas carburising on surfaces cause rejections of the castings in the surface hardening/ case hardening operations. It is therefore necessary that weld repairs, if any, on castings shall be strictly in consultation with Product Engg./ Quality Engg. Departments of BEML.

13.9 SPECIAL TESTS :

Some of the castings used in BEML have specific requirements such as pressure testing, kolene Process for Cleaning etc. These specific requirements and methods of inspection shall be agreed to at the time of ordering.

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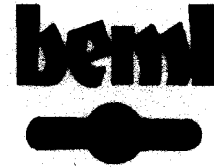
DATE :
1993-12-10

TABLE-1
SAMPLE SIZE BY INSPECTION LEVELS & SIZE OF LOTS

LOT SIZE	SAMPLE SIZE (ACCEPTANCE NO.)					
	CLASS 'A'		CLASS 'B'		CLASS 'C'	
	TIGHTENED	NORMAL	TIGHTENED	NORMAL	TIGHTENED	NORMAL
2 to 8	3(0)	2(0)	2(0)	2(0)	2(0)	2(0)
9 to 15	5(0)	3(0)	3(0)	2(0)	2(0)	2(0)
16 to 25	8(0)	5(0)	5(0)	3(0)	3(0)	3(0)
26 to 50	13(0)	8(0)	8(0)	5(0)	5(0)	3(0)
51 to 100	20(1)	13(0)	13(1)	5(0)	5(0)	5(0)
101 to 150	32(2)	20(1)	20(2)	8(0)	8(1)	5(0)
151 to 300	50(3)	32(2)	32(3)	13(1)	13(2)	8(1)
301 to 500	80(5)	50(3)	50(5)	20(2)	20(3)	13(2)
501 to 1000	125(7)	80(5)	80(7)	32(3)	32(5)	20(3)
1001 to 3000	200(10)	125(7)	125(10)	50(5)	50(7)	32(5)
3001 to 10000	315(14)	200(10)	200(14)	80(7)	80(10)	32(5)

Note : 1) REFERENCE : IS:2500 Part 1(1973) : INSPECTION BY ATTRIBUTES & BY COUNT DEFECTS
2) Acceptance numbers correspond to AQL = 2.5 For Cl.'A', 4 for Cl.'B', 6.5 for Cl.'C'

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TABLE-2
MAGNETIC PARTICLE INSPECTION ACCEPTANCE SPECIFICATIONS

CLASS OF CASTING	LINEAR DISCONTINUITIES	
	ASTM DEGREE	EQUIVALENT mm
A	1	3
B	2	6.3
C	3	12.7
D	4	25.4

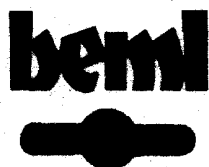
NOTE : Test interpretations shall be based on ASTM E125 reference paragraphs

This table establishes quality levels for test evaluation

All indications exceeding the specified degree shall be removed.

For non-linear surface defects, refer Company Standard QY1024-C & QY1025-C

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TABLE-3
MAXIMUM PERMISSIBLE RADIOGRAPHIC SEVERITY LEVELS FOR
DISCONTINUITIES IN STEEL CASTINGS UPTO 51 mm
IN THICKNESS, AS PER ASTM E 446

CODE/ CATEGORY AS PER ASTM	DISCONTINUITY	CLASS OF CASTING		
		A	B	C
A	GAS POROSITY.	2	3	4
B	SAND SPOTS & INCLUSIONS	2	3	4
CA	SHRINKAGE	2	3	4
CB	SHRINKAGE	2	3	4
CC	SHRINKAGE	2	3	4
CD	SHRINKAGE	2	3	4
D	CRACK	-----	NONE	-----
E	HOT TEAR	-----	NONE	-----
F	INSERT	NONE	2	3
G	MOTTILING*	-	-	-

* Note :1) Mottling not to exceed contract/drawing requirements

- 2) When two or more types of discontinuities are present to an extent equal to or not significantly better than the acceptance standard for rejective defective defects, the casting shall be rejected
- 3) When two or more type of discontinuities are present and the predominant discontinuity is not significantly better than the acceptance standard, the casting shall be considered border line.
- 4) Border line castings may be considered acceptable, upon review by cognizant engineering personnel.
- 5) Gas holes or hard spots and inclusions allowed by Table-3 to 6 shall cause of rejection when closer than twice their maximum dimension to an edge or extremity of casting.
- 6) Drawing tolerance is defined as minimum thickness of material after defects is removed by machining /grinding.
- 7) Numbers in the tables (3 to 6) are ASTM radiographic numbers for each particular type and severity of discontinuity. A low number indicates few small discontinuities while a higher number indicates more larger discontinuities.

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TABLE-4
 MAXIMUM PERMISSIBLE RADIOGRAPHIC SEVERITY LEVELS FOR
 DISCONTINUITIES IN THICK WALLED (51 TO 114 mm)
 STEEL CASTINGS AS PER ASTM E 186

CODE/ CATEGORY	DISCONTINUITY	CLASS OF CASTING		
		A	B	C
A	GAS POROSITY	1	2	3
B	SAND/SLAG INCLUSIONS	1	2	4
C	SHRINKAGE TYPE 1	2	3	5
C	SHRINKAGE TYPE 2	2	3	4
C	SHRINKAGE TYPE 3	2	3	4
F	INSERTS A	-- NONE ALLOWED --		
F	INSERTS B	-- NONE ALLOWED --		
D	CRACKS	-- NONE ALLOWED --		
E	HOT TEAR	-- NONE ALLOWED --		
	COLD SHUT	-- NONE ALLOWED --		

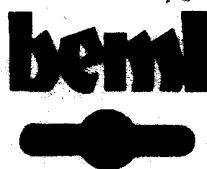
Note : See Table-3

TABLE-5
 MAXIMUM PERMISSIBLE RADIOGRAPHIC SEVERITY LEVELS FOR
 DISCONTINUITIES IN HEAVY WALLED (114 - 305 mm)
 STEEL CASTINGS, AS PER ASTM E 280

CODE/ CATEGORY	DISCONTINUITY	CLASS OF CASTING		
		A	B	C
A	GAS POROSITY	2	3	4
B	SAND & SLAG INCLUSIONS	2	3	4
C	SHRINKAGE TYPE 1	2	3	4
C	SHRINKAGE TYPE 2	2	3	4
C	SHRINKAGE TYPE 3	2	3	4
D	CRACK	NONE	NONE	NONE
E	HOT TEAR	NONE	NONE	NONE
F	INSERT	NONE	NONE	NONE

Note : See Table-3

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TABLE-6
MAXIMUM PERMISSIBLE RADIOGRAPHIC SEVERITY LEVELS FOR GRAY IRON
CASTINGS OF THICKNESS UPTO 114mm AS PER ASTM E802

DISCONTINUITY	CLASS OF CASTINGS		
	A	B	C.
FEATHERY SHRINKAGE	2	3	4

NOTE : For the other discontinuities such as porosity, sand and slag inclusions, other forms of shrinkages, cracks, hot tear, cold shut etc., the maximum levels specified in Tables 3 to 6 shall apply.

TABLE-7
ULTRASONIC INSPECTION - REJECTION LEVEL

CLASS OF CASTINGS	ASTM A609 QUALITY LEVEL	INDICATION AREA (Sq. Cm. MAX)	LENGTH (mm Max.)
A	1	5.16	3.8
B	2	9.67	5.6
C	3	19.35	7.6
D*	4	32.26	7.9

Note :

* For testing of first-off sample/pilot batch of production
Rejection level

- 1) The area in the Table refer to the surface area on the casting over which a continuous indication exceeded the amplitude reference line or a continuous loss of back reference of 75% or greater is maintained.
- 2) Area shall be measured from the centre of the search unit.
- 3) In certain castings, because of very long test distances or curvature of the test surface, area over which a given discontinuity is detected may be considerably larger or smaller than the actual area of the discontinuity in the casting. In such cases a graphic plot that incorporate a consideration of beam spread should be used for realistic evaluation of the discontinuity.

-X-X-



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FERROUS CASTINGS – CLASSIFICATION
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AMENDMENT NO. 03

DATE : 2004-03-16

STD NO.: QY1018-C

AMENDMENT SHEET – 1/1

ISSUE NO. : 01

- I. In page 11 of 15, Table-1 “Sample size by inspection levels and size of lots” shall be read as follows instead of the existing :

TABLE-1 - SAMPLE SIZE BY INSPECTION LEVELS & SIZE OF LOTS

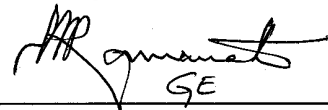
Lot size	Sample size (Acceptance number)								
	Class – ‘A’		Class – ‘B’			Class – ‘C’			
	Tightened	Normal	Tightened	Normal	Reduced	Tightened	Normal	Reduced	
2 ~ 9	2 (0)	2 (0)	2 (0)	2 (0)	2 (0)	2 (0)	2 (0)	2 (0)	
9 ~ 15	5 (0)	3 (0)	3 (0)	2 (0)	2 (0)	2 (0)	2 (0)	2 (0)	
16 ~ 25	8 (0)	5 (0)	5 (0)	3 (0)	2 (0)	3 (0)	3 (0)	2 (0)	
26 ~ 50	13 (1)	8 (0)	8 (1)	5 (0)	2 (0)	5 (1)	5 (1)	2 (0)	
51 ~ 90	20 (1)	13 (1)	13 (1)	5 (0)	2 (0)	5 (1)	5 (1)	2 (1)	
91 ~ 150	32 (1)	20 (1)	20 (1)	8 (1)	3 (1)	8 (1)	8 (1)	2 (1)	
151 ~ 280	50 (2)	32 (2)	32 (2)	13 (1)	5 (1)	13 (1)	13 (2)	3 (1)	
281 ~ 500	80 (3)	50 (3)	50 (3)	20 (2)	5 (1)	20 (2)	13 (2)	3 (1)	
501~1200	125 (5)	80 (5)	80 (5)	32 (3)	8 (1)	32 (3)	20 (3)	5 (1)	

NOTE : Sampling plan shall be as per IS: 2500 (part-1) – 2000 and acceptance quality level (AQL) shall be 2.5% for class – ‘A’, 4% for class – ‘B’ and 6.5% for class – ‘C’ castings.

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(Reason : Revision of Indian Standard).

APPROVED BY :


GE

411033



COMPANY STANDARDS

AMENDMENT NO. 01

TITLE :
FERROUS CASTINGS - CLASSIFICATION &
ACCEPTANCE NORMS
(QY1018-C)

DATE :
1996-12-30

AMENDMENT SHEET-01/01

Read Table-7 as follows, instead of the existing :

TABLE-7

ULTRASONIC INSPECTION - REJECTION LEVEL

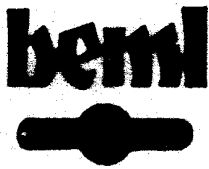
CLASS OF CASTINGS	ASTM A609 QUALITY LEVEL	INDICATION AREA (cm ² max.)	LENGTH (cm max.)
A	1	5.16	3.8
B	2	9.67	5.6
C	3	19.35	7.6
D*	4	32.26	9.9

-----*O*-----

Ref : EMF/ACC NIHON/51/5157 Dt 1996-12-24

APPROVED BY:

M. S. Sankaranarayanan
970115



COMPANY STANDARDS

TITLE :

FERROUS CASTINGS - CLASSIFICATION &
ACCEPTANCE NORMS

AMENDMENT NO02

DATE:

2001-07-19

STD.NO QY1018-C

AMENDMENT SHEET - 1 / 1

ISSUE NO: ONE

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In para 2 of clause 13.5 **ULTRASONIC INSPECTION:**
Read as follows instead of existing:

Acceptance shall be based on no indications equal to or greater than that specified in Table-7. (For screening of castings when radiography is indicated, the permissible defect levels shall correspond to Table -3 to 6)

—O—

Y90018TEAM

APPROVED BY:

M. S. Sankaran
010723

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