भारतीय मानक

Indian Standard

IS 9565 : 2023

इस्पात ढ़लाईयों के पराश्रव्य निरीक्षण के लिए स्वीकरण मानक — विशिष्टि

(तीसरा पुनरीक्षण)

Acceptance Standards for Ultrasonic Inspection of Steel Castings — Specification

(Third Revision)

ICS 77.140.80

77.040.10

भारतीय मानक ब्यूरो

BUREAU OF INDIAN STANDARDS

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August 2023 **Price Group 6**

Foundry and Steel Castings Sectional Committee, MTD 14

FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Foundry and Steel Castings Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1980 and subsequently revise on 1986 and 1995. This revision has been brought out to bring the standard in the latest style and format of the Indian Standards.

In addition, the following changes have been made:

a) Reference clause is modified; and
b) Clause **6.5** on surface finish is modified.

This standard contains **6.4**, **6.6**, **7.1** and **7.5** which call for an agreement between the purchaser and the supplier.

The composition of the Committee responsible for formulation of this standard is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be same as that of the specified value in this standard.

Indian Standard

ACCEPTANCE STANDARDS FOR ULTRASONIC INSPECTION OF STEEL CASTINGS — SPECIFICATION

(Third Revision)

1 SCOPE

This standard deals with the acceptance standards for ultrasonic testing for steel castings. The procedure covers the use of pulse echo ultrasonic flaw detection equipment, under surface contact conditions.

NOTE — Ultrasonic testing of austenitic steel castings may not ordinarily be feasible.

2 REFERENCE

The standards given below contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of these standards:

IS No.	*Title*
IS 2417 : 2003	Glossary of terms used in ultrasonic non-destructive testing (*second revision*)
IS 4904 : 2006	Calibration blocks for use in ultrasonic non-destructive testing — Specification (*fourth revision*)
IS 7666 : 1988	Ultrasonic examination of ferritic castings of carbon and low alloy steel — Recommended procedure (*first revision*)
IS 8780 : 2004	Non-destructive testing of steel castings — Code of practice (*first revision*)
IS 13805 : 2004	General standard for qualification and certification of non-destructive testing personnel — Specification (*first revision*)

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 2417 shall apply.

4 EQUIPMENT

4.1 Frequency Range

The equipment shall be capable of operating over a frequency range of at least 0.5 MHz to 5 MHz.

4.2 CRT Screen Presentation

An a scope (that is A-Scan) presentation shall be used. The trace shall be well defined, easy to read and associated with permanent graticule scale marking for both range and amplitude.

4.3 Linearity of Amplification

The amplifier shall be linear within ± 2 dB up to at least 75 percent of full screen height and any deviation above this should be known to the operator. Suppression over the full range shall be recorded.

4.4 Linearity of Time Base

The time base, shall as far as possible, be linear and for critical examination any deviation shall not exceed 1 percent of the full-scale graticule reading.

4.5 Resolution

The resolution of the equipment shall be checked employing the reference block and method given in IS 4904.

4.6 Sensitivity

The sensitivity of the equipment shall be checked with the longitudinal wave probe on the metallized surface of the plastic insert of test block as specified in IS 4904. The minimum number of multiple echoes from the plastic insert shall be as given below:

Sl No.	*Frequency Range* (MHz)	*No. of the Multiple Echoes*
(1)	(2)	(3)
i)	1	5
ii)	2	4
iii)	4 to 6	2

4.7 Probe

4.7.1 A probe consists of ultrasonic transducer (a piezoelectric material) with a sturdy cover to protect the device. Transducer diameters (or widths,

Type of probes

if rectangular) are determined by frequency, acceptable beam spread and by power requirements.

4.7.2 Three types of probes are recommended.

4.7.2.1 *Longitudinal probes*

These consists of one transducer which transmits as well as receives longitudinal waves. Probes fitted with a thin protective cover may be used for working on rough surfaces.

4.7.2.2 *Shear wave probes*

A transverse or angle or shear wave probe consists of transducer mounted on a wedge of perspex or similar material.

4.7.2.3 *Double probes*

These are combined double longitudinal or transverse wave probes which consist of two independent transducers, one transmitting and one receiving the ultrasonic wave. The transducers are mounted on perspex blocks and are acoustically separated. These may be usefully employed for investigating the surface layer and thin sections of the castings.

4.7.3 It is not advisable to place ultrasonic probes on hot castings above 45 °C, unless the probe is protected by a water-cooling device. The effect of heat, particularly on a transverse wave probe may both damage the probe and give rise to misleading results.

5 EQUIPMENT CALIBRATION

Prior to inspection, the apparatus shall be adjusted and calibrated with reference to specific test or reference blocks.

6 TESTING PROCEDURE

6.1 Code of Practice

General practice for ultrasonic testing shall be according to IS 8780 and IS 7666.

6.2 DGS (distance, gain, size of the defect) scales may be used for setting scanning sensitivity and evaluation of indications in relation to the acceptance standard.

NOTE — Because of the irregular shape and unknown orientation of most defects there is in general no direct relationship between the size of the defect and the amplitude of the echo it produces. Hence testing at high sensitivity with suitable shear wave probes also is desirable for evaluation.

6.3 Equivalent Flaw Size

The equivalent flaw size is the size of the flaw determined assuming a circular reflector, perpendicular to and concentric with the sound beam and having a 100 percent reflectivity, which would produce the same echo amplitude as the flaw at the same location. The diameter of the circular reflector is then a measure of the area of the reflecting surface and is termed 'as equivalent flaw size'.

6.4 Recording Limits

For ultrasonic testing of castings from heat-treated non-austenitic steels, the following shall be the applicable recording limits:

Sl No.	*Wall Thickness of Scanned Place,* mm	*Diameter of Circular Disc Shaped Reflector*		*Attenuation of Back Wall Echo (Using* 2 MHz *Probe)*
		Point type indication, mm	Indication with measurable extension, mm	
(1)	(2)	(3)	(4)	(5)
i)	Less than or equal to 150	4	3	12 dB
ii)	Over 150 up to 500	6	3	12 dB
iii)	In zone 4 and when quality level 1 is specified [*see* **7.1** (d) and Table 1]	3	3	6 dB

NOTES

1 Where the wall thickness exceeds 500 mm. the recording limits shall be subject to agreement between the supplier and the purchaser, in view of the likely severe problems of attenuation that may be encountered at such thickness.

2 For the purpose of this standard any indications falling below the above recording limits are to be treated as not significant and need not be recorded in the test documentation. However, for certain special applications like creep resisting castings, if so specified in the enquiry and order, indications with an equivalent flow size of 1.5 mm and above may also be recorded if their extent exceeds the parameters D, E and F shown in Table 1. Such a recording would be for the purpose of possible future failure analysis.

6.5 Surface Finish

The inspection of machined and casting surfaces using ultrasonic technology requires certain surface finish and conditions to ensure accurate results as follows:

a) *Machined Surfaces* — The surface finish for the purpose of testing under this standard shall be equal to or less than 12.5 µm. Additionally, the finish shall allow enough movement for the search units to travel along the surface;

b) *Casting Surfaces* — A qualified individual, as described in **6.6**, shall deem the casting surfaces acceptable for inspection;

c) *Surface Condition* — To ensure accurate inspection results, all surfaces should be reasonably free of any foreign matter, including scale, machining or grinding particles, excessive paint thickness, dirt, or any other material that may interfere with the inspection; and

d) *Position of Casting* — Finally, the inspector must position the casting in a way that provides free access to the back wall for the purpose of verifying changes in contour.

6.6 Operating Personnel

The testing shall be carried out by personnel qualified in accordance with IS 9346 or as may be mutually agreed to.

6.7 General

For best results, it is necessary that the castings are heat-treated before conducting the ultrasonic examination so that the as cast grain structure is broken up and refined. The ultrasonic examination of austenitic steel castings (like high manganese steel castings, certain grades of stainless steel and heat resistant steel castings, etc) is not ordinarily feasible in view of the exceptionally high attenuation of the beam encountered in such a material and may become possible only with special equipment and probes.

7 ACCEPTANCE STANDARD

7.1 The casting wall is divided into the following four zones as shown in Fig. 1 and Fig. 2.

a) Zone 1 — Middle one-third of the wall thickness, WT;

b) Zone 2 — Outer and inner one-third of wall thickness, WT, but not less than 12 mm;

c) Zone 3 — 12 mm from the surface of Zone 2; and

d) Zone 4 — Fabrication weld zone; the region representing weld preparation plus 25 mm adjoining length of the casting as shown in Fig. 2.

NOTES

1 Zone 4 is applicable to castings only when they are used for creep resisting applications that are exposure to high temperatures and fluid pressures. In other cases, the fabrication weld zone shall be treated as Zone 3.

2 In case of wall thickness less than 35 mm, the definition of different zones shall be as may be agreed to between the purchaser and the manufacturer. However, it there is no such prior agreement and if nothing has been specified in the enquiry and the order, the following shall apply, where the wall thickness is less than 35 mm:

a) The stipulation of the minimum of 12 mm for Zone 2 shall not apply; and

b) The Zone 3 shall be deemed to be equal to half the thickness of Zone 2, subject to the practical feasibility of separate evaluation of such a limited thickness.

7.2 Ultrasonic indications exceeding those given in **6.4** are deemed to be significant. Such indications are to be evaluated in terms of the different parameters and the permissible limits shown in Table 1.

7.3 The castings are categorized into 5 levels of quality according to the size, distribution, length and area of different indications, as per the parameters shown in Table 1.

7.4 Ultrasonic indications exceeding those shown in Table 1, as well as cracks, hot-tears and cold-shuts are unacceptable.

7.5 In the case of an isolated (point-like) indication, 100 percent loss of back echo within the flaw area will be permissible.

However, loss in back echo, more than that specified but without indication of flaw or with a flaw indication below recordable size should be investigated by either using shear wave probes or by scanning from the other side or by radiography or by any other mutually agreed method.

7.6 If a defect is spreading across two adjoining zones, then the requirements of the nearer to the surface shall apply. However, if the depth of encroachment of a defect from an inner zone into the outer zone is less than 10 percent of the wall thickness (subject to 12 mm, *Max*) then the foregoing stipulation shall not be applicable.

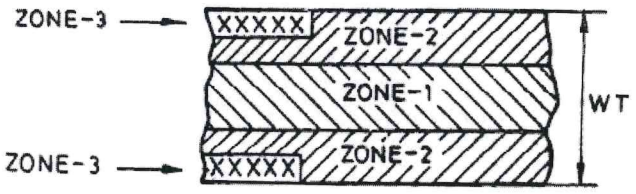

FIG. 1 ZONES OF CASTING WALL

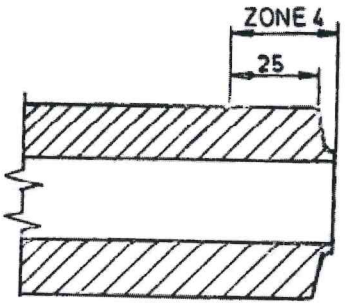

FIG. 2 FABRICATION WELD ZONE

8 RECORDS OF RESULTS

If so specified at the time of enquiry and order, the manufacturer shall, furnish to the purchaser the results of Ultrasonic Inspection carried out showing, for each casting or part thereof, the following:

a) Identification of the casting tested, reference drawing, metallurgical and surface condition of the casting;

b) Instrument make, model, frequency, size and type of probes used and control settings; c) Reference block used;

c) Record of other confirmatory tests, if any, made to more closely identify any indications, and the results thereof;

d) Operator's name and date of test; and

e) Any unusual occurrences encountered during test.

Table 1 Classification of Castings into Different Quality Levels

(*Clauses* 7.2, 7.3 *and* 7.4)

Sl No.	Ref	Description	Zone No.	Defects Parameter				
				Level 1	Level 2	Level 3	Level 4	Level 5
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	A	Maximum equivalent flaw size (*see* **6.3**)	1	1/5 WT & ≯ 10 mm	1/5 WT & ≯ 10 mm	1/4 WT & ≯ 12 mm	1/4 WT & ≯ 14 mm	1/4 WT & ≯ 16 mm
			2	1/8 WT & ≯ 6 mm	1/8 WT & ≯ 6mm	1/6 WT & ≯ 8mm	1/5 WT & ≯ 10 mm	1/5 WT & ≯ 12 mm
			3	3 mm	4 mm	4 mm	5 mm	5 mm
			4	3 mm	3 mm	3 mm	4 mm	4 mm
ii)	B	Maximum decrease of back echo	1	90 %	90 %	90 %	90 %	90 %
			2	75 %	75 %	75 %	75 %	75 %
			3	NA	NA	NA	NA	NA
			4	6 dB	6 dB	8 dB	10 dB	12 dB
iii)	C	Maximum thickness of defect	1	15 % of WT	15 % of WT	20 % of WT	25 % of WT	25 % of WT
			2	10 % of WT	10 % of WT	15 % of WT	20 % of WT	20 % of WT
			3	NA	NA	NA	NA	NA
			4	3 mm	3 mm	4 mm	5 mm	6 mm
iv)	D	Maximum length of defect, mm	1	100	120	150	200	250
			2	75	100	125	150	175
			3	12	50	75	100	125
			4	3	4	5	6	7
v)	E	Maximum individual area of defect, cm^2	1	120	150	200	250	300
			2	10	20	30	40	50
			3	0.25	0.5	10	15	20
			4	Nil	Nil	Nil	Nil	Nil
vi)	F	Maximum accumulated area of defect in cm^2 in a 1 000 cm^2 area	1	200	300	400	250	300
			2	10	40	60	40	50
			3	2.5	5	10	15	20
			4	NA	NA	NA	NA	NA

NOTES

1 WT – Wall thicknesses shown in Fig. 1.

2 NA – Not applicable.

3 Example for defect parameters E and F is given in Annex A.

ANNEX A

(*Table* 1)

EXPLANATION FOR DEFECT PARAMETER

A-1 Individual area of defect and accumulated area of defects is illustrated in Fig. 3.

A-2 An 'individual defect' is one which is separated from an adjoining defect by a distance not less than the maximum dimension of either of the defects. The 'individual area of defect' refers to the area of such an individual defect as delineated on the surface of the casting (*see* **A-4**).

A-3 In Fig. 3, F_1, F_2 and F_3 are the individual areas of defect and the accumulated area of defects would be the total of the individual areas of defect, that is, the sum of $F_1 + F_2 + F_3$, if the distance between the defects were $< L_1$, $< L_2$, and $< L_3$.

A-4 The dimensions L and B refer to the length and breadth of the defective area delineated on the surface of the casting. This is obtained by connecting the marks made during the scanning on locations where the reference level was exceeded. Marks are coincident with the mid-points of the transducers.

A-5 While testing large cross-sections, a realistic evaluation of the discontinuity shall be achieved by considering the beam spread and geometry.

A-6 In the case of an isolated (point-like) indication, the area of defect is taken as the area of the transducer. However, smaller diameter probes may be used for determining the actual size of the defect.

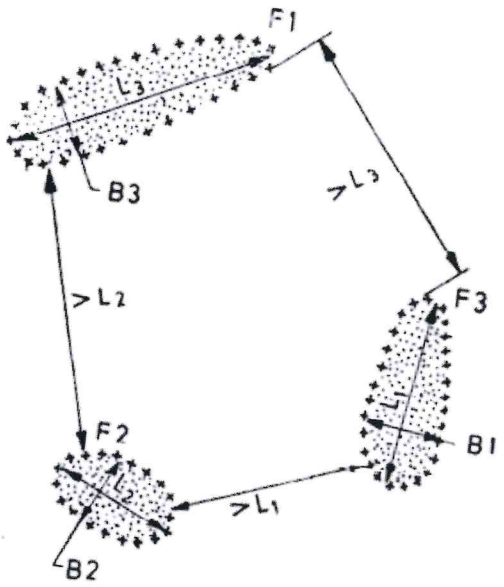

FIG. 3 AREAS OF DEFECTS

ANNEX B

(*Foreword*)

COMMITTEE COMPOSITION

Foundry and Steel Castings Sectional Committee, MTD 14

Organization	*Representative(s)*
BHEL (CFFP), Haridwar	SHRI V. K. RAIZADA (***Chairperson***)
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BEML Limited, Bengaluru	SHRI MAHENS KULKARNI SHRI A.S PHANEEDRA (*Alternate*)
Bharat Heavy Electrical Limited, New Delhi Haridwar	SHRI A. N. SUDHAKAR SHRI RANJITH LAKRA (*Alternate* I) SHRI ABHINAV AGRAWAL (*Alternate* II)
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CSIR - National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram	DR TPD RAJAN (*Alternate*)
CSIR - National Metallurgical Laboratory, Jamshedpur	DR D. N. PASWAN MS MINAL SAHA (*Alternate*)
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Indian Institute of Technology, Kharagpur	PROF SHIV BRAT SINGH PROF DEBALAY CHAKRABARTI (*Alternate*)
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Ministry of Science & Technology, New Delhi	MS TAMANNA ARORA SHRI K. S. P. RAO (*Alternate*)

ANNEX B

(*Foreword*)

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Ministry of Science & Technology, New Delhi	MS TAMANNA ARORA SHRI K. S. P. RAO (*Alternate*)

Organization	*Representative(s)*
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Member Secretary
SHRI KUNAL KUMAR
SCIENTIST 'D'/JOINT DIRECTOR
(METALLURGICAL ENGINEERING), BIS

Email **MTD MTD**

Re: Request to seek approval for publishing Draft document MTD 14 (20981)- IS 9139 and MTD 14 (21894)- IS 9565

From : raman sarita <raman.sarita@gmail.com> Sat, Aug 26, 2023 11:40 AM

Subject : Re: Request to seek approval for publishing Draft document MTD 14 (20981)- IS 9139 and MTD 14 (21894)- IS 9565

To : MTD MTD <mtd@bis.gov.in>

Approved.
Raman

On Fri, 25 Aug 2023, 11:40 MTD MTD, <mtd@bis.gov.in> wrote:

भारतीय मानक ब्यूरो
(धातुकर्म अभियांत्रिकी विभाग)

दिनांक: 25.08.2023

हमारा सन्दर्भ: MTD 14/T-19 & T-3

Respected Sir,

You are requested to kindly approve the following draft in accordance with sub-rule (5) of Rule 22 of Bureau of Indian Standards Rules, 2018. The drafts has been finalized by Foundry and Steel Castings Sectional Committee (MTD 14) and Chairman after giving due consideration to the comments received from important Producers, Consumers, Technologists, Members of Metallurgical Engineering Division Council:

1. MTD 14 (20981) - MALLEABLE IRON SHOTS AND GRITS FOR USE IN FOUNDRIES - SPECIFICATION
2. MTD 14 (21894) - ACCEPTANCE STANDARDS FOR ULTRASONIC INSPECTION OF STEEL CASTINGS-SPECIFICATION

Copy of the draft documents has been attached to this mail for kind information please.

Thanking You,

Yours Sincerely,
Sanjiv Maini,
Scientist-`F' & Head (MTD)


Azadi Ka
Amrit Mahotsav


G20
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