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**Ultrasonic examination of
stainless steel plates**

ICS 77.140.20

Descriptors : stainless steels, sheet materials, ultrasonic testing, flaw detection

Reference number : JIS G 0802 : 1998 (E)

Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of International Trade and Industry through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law.

This Standard has been established based on Japanese Industrial Standard **JIS G 0801** *Ultrasonic examination of steel plates for pressure vessels* as referring to various standards of Europe and America and modeling after the speciality of stainless steels. There are no similar International Standards (ISO) to consider the conformity.

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Ultrasonic examination of stainless steel plates

Introduction For the standard of ultrasonic examination of steel plates, **JIS G 0801** *Ultrasonic examination of steel plates for pressure vessels* has been widely applied and fixed as the standard method. Although stainless steel plates have been excluded from the scope in the said standard, a lot of instances applied to stainless steel plates have been found because of no standard to be applied at present time. However, in case of application to stainless steel plates, some inconvenient point such as the difference of attenuation characteristics has been experienced, therefore the standard of ultrasonic examination for the exclusive use of stainless steel plates has been prepared.

This Standard has been prepared so that the items in **JIS G 0801** applicable to stainless steel plates were specified as they were and the inconvenient points were confirmed by the experiments and the like and modeled on the speciality of stainless steel plates.

1 Scope This Japanese Industrial Standard specifies the ultrasonic examination of stainless steel plates of 6 mm or over up to and including 200 mm in thickness.

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. If the indication of the year of coming into effect (or the year of publication) is given to these referred standards, only the edition of indicated year constitutes the provision of this Standard but the revision and amendment made thereafter are not applied. The normative references without the indication of the year of coming into effect (or the year of publication) apply limiting only to the most recent edition (including amendments).

JIS B 0601 *Surface roughness—Definitions and designation*

JIS G 0587 *Methods of ultrasonic examination for carbon and low alloy steel forgings*

JIS G 3103 *Carbon steel and molybdenum alloy steel plates for boilers and other pressure vessels*

JIS G 3106 *Rolled steels for welded structure*

JIS G 4304 *Hot rolled stainless steel plates, sheets and strip*

JIS G 4305 *Cold rolled stainless steel plates, sheets and strip*

JIS Z 2300 *Glossary of terms used in nondestructive testing*

JIS Z 2344 *General rule of ultrasonic testing of metals by pulse echo technique*

JIS Z 2345 *Standard test blocks for ultrasonic testing*

JIS Z 2350 *Method for measurement of performance characteristics of ultrasonic probes*

JIS Z 2352 *Method for assessing the overall performance characteristics of ultrasonic pulse echo testing instrument*

3 General matters General matters other than those specified in this Standard shall be in accordance with **JIS Z 2344**.

4 Definitions For the main terms used in this Standard the definitions in **JIS Z 2300** apply, and the rest of the terms shall be as follows:

- a) **digital flaw detector** A flaw detector equipped with a function capable of mainly processing output signal digitally without observing that with a display.
- b) **specified sensitivity** An echo height-reference line in the digital flaw detector corresponding to 50 % on CRT (DM line) of an A-scan display type flaw detector in the case where sensitivity is set by combination of a digital flaw detector and a double transducer normal probe.

5 Flaw detection method The flaw detection method shall be a pulse echo method by a normal beam technique, and the probes as listed in Table 1 shall be used according to the thickness of steel plates.

Table 1 Probes used

Thickness of steel plate mm	Probe used
6 or over to and excl. 13	Double transducer normal probe
13 or over up to and incl. 60	Double transducer normal probe or normal probe
Over 60 up to and incl. 200	Normal probe (excluding double transducer normal probe)

6 Inspection engineer An engineer engaged in the ultrasonic examination of stainless steel plates shall acquire basic technique concerning the ultrasonic examination and shall have sufficient knowledge and experience concerning properties of the stainless steel plates being an object for inspection and its ultrasonic examination.

7 Apparatus for flaw detection

7.1 Performance of flaw detector

7.1.1 Digital flaw detector A flaw detector for automatic scanning housed in an air conditioned chamber shall be periodically checked once for three years, and other automatic flaw detectors shall be checked once a year, and shall have the following performance.

- a) **Amplitude linearity** The first back wall echo of a sensitivity correcting block (RB-S) in Annex 2 or an electric false signal is set to an appropriate level, the amplitude linearity is measured with respective lines of -6 dB, -12 dB and -18 dB from the set level. An ideal value is taken as a standard, and the sum of absolute values of the positive and negative maximum deviation of the ideal value and the measured value shall be at most 2.5 dB.

Further, the amplitude linearity of an automatic detector having an A-scan display shall be in accordance with **7.1.2 a)**.

- b) **Distance amplitude compensation performance** For an apparatus having the distance amplitude compensation performance, the back wall echo height after compensation for the maximum thickness used shall be within -6 dB from the maximum echo height in a distance amplitude characteristic curve.

7.1.2 A-scan display type flaw detector An A-scan display type flaw detector shall be periodically checked once a year in accordance with 5 of JIS Z 2352, and shall have the following performance.

- a) **Amplitude linearity** The amplitude linearity of a flaw detector shall be measured in accordance with 4.1 of JIS Z 2352 at a nominal frequency to be used, and the sum of the absolute values of the positive maximum deviation (+h) and the negative maximum deviation (-h) shall be at most 6 %.
- b) **Far surface resolution** The far surface resolution of a flaw detector shall be measured according to nominal frequency of Table 2 by using RB-RA in accordance with 4.4 of JIS Z 2352, and the measured value shall be as given in Table 2.

Table 2 Far surface resolution

Nominal frequency MHz	Far surface resolution mm
2 or over to and excl. 4	9 max.
4 or over up to and incl. 5	7 max.

- c) **Dead zone** The dead zone of a flaw detector shall be at most 10 mm for 4 MHz or over up to and including 5 MHz and at most 15 mm for 2 MHz or over to and excluding 4 MHz, and its measurement shall be carried out according to the following procedure.
- 1) Adjust the measuring range of the time base to 50 mm, detect flaws of STB-N1 of JIS Z 2345, and adjust an echo height of the reference hole to 20 % of the graticule.
 - 2) Then, raise the sensitivity by 14 dB, read a length from the zero point on the graticule to the point where the transmitted pulse finally becomes 20 % in terms of beam path length along the steel, and take this as the dead zone.

7.2 Scanning and indexing apparatus, manipulator, automatic alarm, and marker or recorder In the case where the scanning and indexing apparatus, manipulator, automatic alarm, and marker or recorder are used, they shall have enough performance on flaw detecting operation and on judging operation of the result.

7.3 Type of flaw detection The type of flaw detection shall be an immersion testing (a local immersion method or a gap scanning) or a direct contact method.

7.4 Couplant The couplant shall usually be water.

7.5 Test blocks

7.5.1 Reference block Reference block is a test block which checks the distance amplitude characteristic of a double transducer normal probe, and the reference block for double transducer normal probe (RB-E) of Annex 1 shall be used.

7.5.2 Sensitivity correcting block The sensitivity correcting block shall be the block used for measuring the sensitivity correcting value after adjusting the back wall echo height of specimen according to Table 3, and shall be in accordance with Annex 2.

7.5.3 Calibration block The calibration block shall be the block to measure the performance of double transducer normal probe, and STB-N1 of JIS Z 2345 shall be used.

7.6 Probe A double transducer normal probe shall have the performance as given in Annex 3.

8 Method for flaw detection

8.1 Flaw detecting time Flaw detection shall usually be executed at the final stage in the manufacturing process of steel plates.

8.2 Test surface A test surface shall usually be as it is after rolled or as it is after heat treated, and if necessary, shall be made a smooth surface by polishing or the like.

8.3 Flaw detecting condition

8.3.1 Working sensitivity, nominal frequency and dimensions of transducer
The working sensitivity of normal probe and double transducer normal probe, nominal frequency and dimensions of transducer shall be as shown in Table 3.

Table 3 Working sensitivity, nominal frequency and dimensions of transducer

Thickness of steel plate mm	Working sensitivity ⁽¹⁾			Nominal frequency MHz	Effective diameter of transducer mm
	Back wall echo height of specimen % on CRT	By sensitivity correcting block			
		+ Corrected value dB	Sensitivity correct test No.		
6 or over up to and incl. 13	50	F/B	1	2 to 5 ⁽²⁾	20 to 30 ⁽³⁾
Over 13 up to and incl. 20	50	F/B	2		
Over 20 up to and incl. 40	50	F/B	3		
Over 40 up to and incl. 60	50	F/B	4		
Over 60 up to and incl. 100	50	F/B	5		
Over 100 up to and incl. 160	50	F/B	6		
Over 160 up to and incl. 200	50	F/B	7		

Notes ⁽¹⁾ After adjusting the sensitivity so that the back wall echo height of specimen comes to 50 % on the CRT graticule of flaw detector, the sensitivity shall

be raised only by the corrected value, F/B (dB), previously measured by using the sensitivity-correcting test block (RB-S) in Annex 2.

When the thickness of steel plates exceeds 60 mm and the difference between the echo from hole of $\phi 5$ mm and the back wall echo is clearly readable from the DGS diagram of probe, the value of F/B obtained from DGS diagram may be used as the corrected value. The main DGS diagrams of probe are quoted from **JIS G 0587** and shown in Attached Figs. 1 to 16. The DGS diagrams prepared by the manufacturer of probe may be used.

- (2) When the attenuation based on the material of specimen is especially remarkable, other frequency than that may be applied according to the agreement between the parties concerned with delivery.
- (3) In case of using a rectangular transducer, the dimension of long side shall be within this specified range.

8.4 Setting of reference line When an A-scan display type flaw detector and a double transducer normal probe are combined to be used, a reference line is set to the graticule of the flaw detector. The height equal to 50 % of the graticule is taken as the reference DM line, the level 6 dB higher is taken as DH line, and the level 6 dB lower is taken as DL line. Further, DC line is determined as given in Table 4 according to the thickness (see Fig. 1).

Table 4 Thickness of steel plate and determination of DC line

Thickness of steel plate mm	Level of DC line
6 or over up to and incl. 20	Line 12 dB lower than DM line
Over 20 up to and incl. 60	Line 10 dB lower than DM line

When a digital flaw detector and a double transducer normal probe are combined to be used, a reference value corresponding to Fig. 1 shall be set.

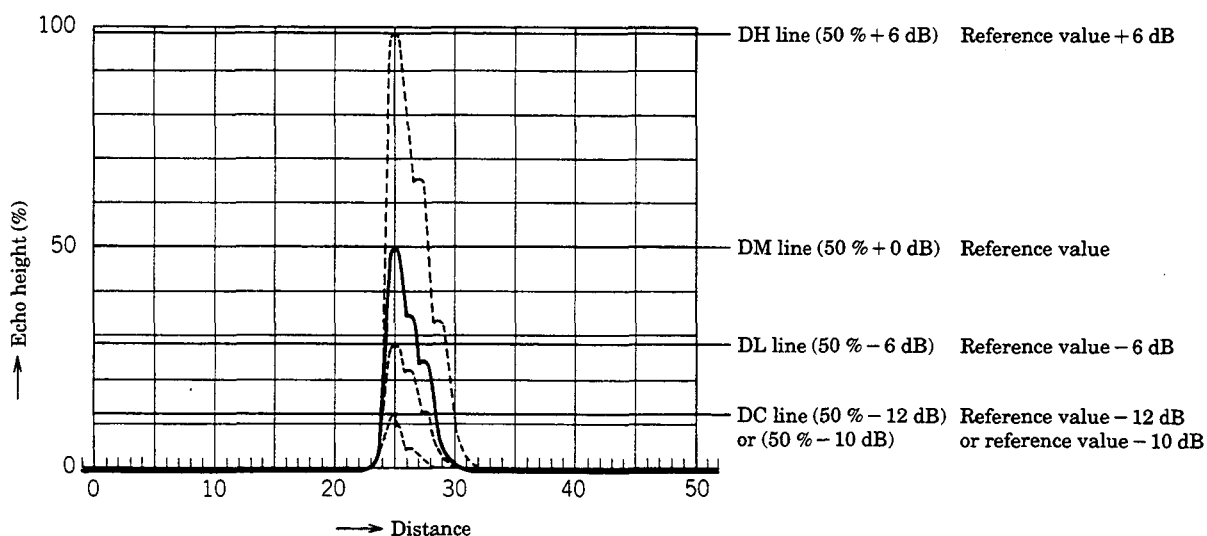


Fig. 1 Reference lines by A-scan display and double transducer normal probe

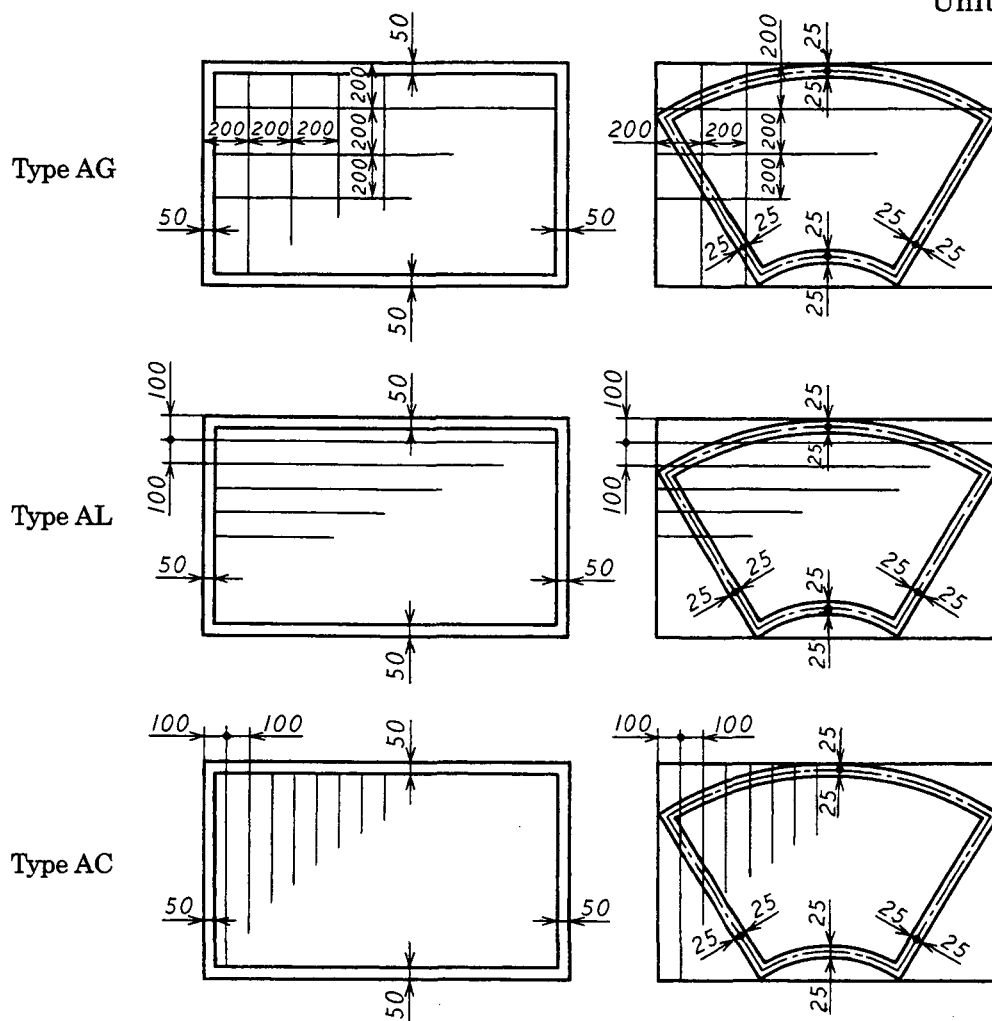
8.5 Flaw detecting area The flaw detecting area shall be, as a rule, as given in Table 5 according to the use of steel plates (see Fig. 2).

Table 5 Flaw detecting area

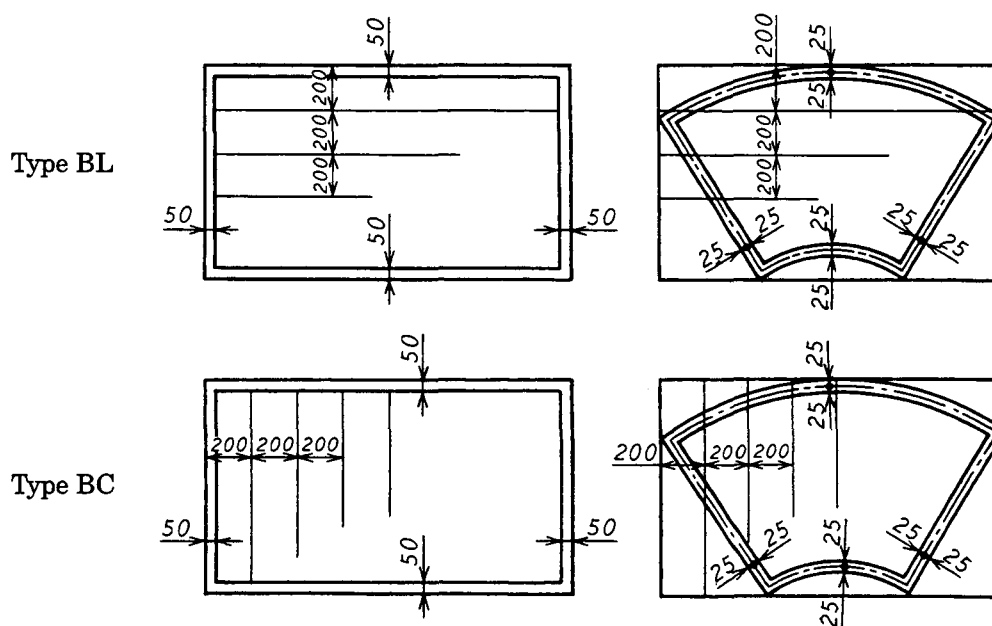
Inspection type	Flaw detecting area
Type A	Detect, as a rule, along vertical and horizontal lines of 200 mm pitch, or along vertical or horizontal of 100 mm pitch, and within 50 mm of the periphery or within 25 mm on both sides of the projected groove line as the center.
Type B	Detect along vertical or horizontal line of 200 mm pitch, and within 50 mm of the periphery or within 25 mm on both sides of the projected groove line as the center.
Type C	Detect within 50 mm of the periphery or within 25 mm on both sides of the projected groove line as the center.

- Remarks 1 The purchaser can specify the inspection type. Unless especially specified, the flaw detecting area within the same inspection type may be optionally selected by the manufacturer according to the function of the detector.
- 2 When there is a particular necessity, flaw detecting area other than those specified in Table 5 can be agreed upon between the purchaser and supplier.
- 3 When there is a necessity that either of vertical and horizontal directions is expressed by symbol in type A and type B, the vertical and horizontal directions of type A are expressed as AG, the parallel direction to the main rolling direction of steel plates is taken as AL for type A and as BL for type B, and the perpendicular direction thereto is taken as AC for type A and as BC for type B.

Unit : mm



a) Inspection type A



b) Inspection type B

Fig. 2 Flaw detection area