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pressure vessels**

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the results of proposal of revision of Japanese Industrial Standard submitted by The Japan Iron and Steel Federation (JISF) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS G 0801** : 1993 is replaced with this Standard.

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Ultrasonic testing of steel plates for pressure vessels

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of **ISO 17577** published in 2006 with some modifications of the technical contents.

The portions with continuous sidelines or dotted underlines are the matters in which the contents of the corresponding International Standard have been modified.

A list of modifications with explanations is given in Annex JD.

1 Scope

This Standard specifies the automated or manual ultrasonic examination of alloyed and carbon steel plates (excluding stainless steel) of thickness not less than 6 mm and not more than 300 mm used for principal parts of nuclear reactor, boilers, pressure vessels, etc.

Further, general matters other than those specified in this Standard shall be in accordance with **JIS Z 2344**.

NOTE : The International Standard corresponding to this Standard is as follows.

ISO 17577 : 2006 *Steel—Ultrasonic testing for steel flat products of thickness equal to or greater than 6 mm (MOD)*

The symbols which denote the degree of correspondence in the contents between **JIS** and the relevant International Standard are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 0601 *Geometrical Product Specifications (GPS)—Surface texture: Profile method—Terms, definitions and surface texture parameters*

JIS G 0431 *Qualification and certification of non-destructive testing (NDT) personnel for steel products*

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

JIS G 3106 *Rolled steels for welded structure*

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

JIS Z 2300 *Terms and definitions of nondestructive testing*

JIS Z 2305 *Non-destructive testing—Qualification and certification of personnel*

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

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS Z 2300** and the following apply.

3.1 internal discontinuity

any imperfection lying within the thickness of the steel plates, e.g. planar or laminar imperfection, single-plane or multi-plane inclusion bands or clusters

3.2 population density

number of individual internal discontinuities of a size greater than a specified minimum size and less than a specified maximum size per unit area or unit length of edge zone or the projected groove line of the steel plate

NOTE : In "internal discontinuities", the word "internal" refers to parts of the steel plate excluding the edge zone and the projected groove line.

3.3 manual testing

testing by an operator applying an ultrasonic probe to the steel-plate surface, manually executing the appropriate scanning pattern on the steel-plate surface and visually assessing ultrasonic signal indications on the electronic equipment screen either by direct viewing or by built-in signal amplitude alarm devices

3.4 automatic testing

testing using a mechanized means of applying the ultrasonic probe or probes to the steel-plate surface and executing the appropriate scanning pattern, together with ultrasonic signal evaluation by electronic means

3.5 type E reference block for double crystal probe (RB-E)

reference block for analyzing the distance amplitude characteristics of double crystal probe

It is also used for sensitivity setting.

4 Flaw detection method

The flaw detection method shall be a pulse echo method by a normal beam technique.

5 Inspection engineer

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

Upon agreed between the purchaser and the supplier, **JIS G 0431**, **JIS Z 2305** or any other standard(s) equivalent thereto may be applied.

6 Flaw detection apparatus

6.1 Composition of flaw detection apparatus

An automatic testing apparatus shall be composed of an automatic detector, a probe, a steel plate scanning and indexing device, a manipulator, an automatic alarm, a recorder, etc. A manual testing apparatus shall be mainly composed of a manual detector and a probe.

6.2 Flaw detector

6.2.1 General requirements

The general requirements for a flaw detector shall be as follows:

- The apparatus shall be equipped with time-base regulation and the working sensitivity shall be calibrated in decibels.
- The electronic equipment shall be appropriate for the ultrasonic probes and frequencies used.
- The transmitted pulse repetition frequency shall be appropriate for the applied scanning speed.
- The apparatus shall detect the ultrasonic signals of internal discontinuities by using a gate function. The output signal shall be provided for devices like display monitor or recording equipment.

6.2.2 Automatic flaw detector

The automatic flaw detector shall have the following amplitude linearity and distance amplitude compensation performance.

A flaw detector for automatic scanning housed in an air conditioned chamber shall be periodically checked at least once in three years, and other automatic flaw detectors shall be checked at least once a year.

- Amplitude linearity** The first back-wall echo of a type E reference block for double crystal probe in Annex JA or an electric false signal is set to an appropriate level, and the amplitude linearity is measured with respective lines of -6 dB, -12 dB, and -18 dB from that set level. An ideal value is taken as the standard, and the sum of absolute values of the positive and negative maximum deviation of the ideal value and the measured value shall not exceed 2.5 dB.

The amplitude linearity of an automatic detector having an A-scan display shall be in accordance with **6.2.3 a)**.

- 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.

6.2.3 Manual flaw detector

The A-scan display of a manual flaw detector shall be sharp in peak echo, capable of clear indication, and shall be periodically checked at least once a year according to clause 5 of **JIS Z 2352**. The amplitude linearity, far surface resolution and dead zone of the flaw detector shall be as described in the following.

- 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 value of the positive maximum deviation ($+h$) and the negative maximum deviation ($-h$) shall not exceed 6 %.
- b) **Far surface resolution** The far surface resolution of a flaw detector shall be measured according to nominal frequency of table 1 by using RB-RA in accordance with 4.4 of **JIS Z 2352**, and the measured value shall be as given in table 1.

Table 1 Far surface resolution

Nominal frequency MHz	Far surface resolution mm
2	9 max.
5	7 max.

- c) **Dead zone** The dead zone of a flaw detector shall be at most 10 mm for 5 MHz and at most 15 mm for 2 MHz, and its measurement shall be as follows.
- 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.

6.3 Probe

The probe shall be as follows.

- a) The types of probes, depending on the thickness of the steel plate product, shall be as given in table 2.

NOTE :A single crystal probe shall be simply referred to as "crystal probe".

- b) The probes shall have a nominal frequency in the range of 2 MHz to 5 MHz. Probes with a frequency outside the range of 2 MHz to 5 MHz can be used for the material that has high attenuation or special acoustic characteristics, if agreed between the purchaser and the supplier.
- c) The relevant dimension of transducers is less than or equal to 30 mm in diameter or in rectangularity.
- d) The double crystal probe shall satisfy the performance specified in Annex JB.
- e) The dead zone of crystal probes shall be indicated by the beam path length along the steel obtained with the specified working sensitivity when the zero point on the graticule to the point where the transmitted pulse or surface reflective echo finally becomes 20 % and shall be as small as possible, i.e. max. 15 % of the thickness of the steel plate or 15 mm, whichever is smaller.

Table 2 Type of ultrasonic probe

Thickness of steel plate mm	Type of probe
Under 13	Double crystal probe
13 or over up to and incl. 60	Double crystal probe or crystal probe
Over 60	Crystal probe

6.4 Steel plate scanning and indexing device, manipulator, data processing device, automatic alarm, marking device and recorder

When using a steel plate scanning and indexing device, a manipulator, a data processing device, an automatic alarm, marking device and a recorder, it shall be ensured that they are equipped with the following functions and have sufficient performance required for the flaw detection and judgment of the results.

- A suitable mechanical means for scanning the specified surface of steel plates
- Manipulator which is capable of following the surface contour of a steel plate to be tested, in order to maintain straight incidence
- A coupling medium which ensures an adequate contact between the probe and the surface of the steel plates and maintains sufficient coupling
- Electronics including, for example, transmitter, receivers, gates, appropriate for data collection
- Appropriate means for signal evaluation, recording (e.g. mapping) and storing
- Means for calibration of the equipment (i.e. sensitivity, time base and gate position), for example, by the use of reference blocks, input of artificial signals, input of distance-amplitude curves (DAC) or input of stored calibration files
- Means for controlling the pulse repetition frequency related to the scanning speed, so that the required pulse density can be obtained
- Means for coupling and function check (e.g. by surveillance of back-wall echo)
- Function to indicate the location of discontinuities from the edge of steel plates (recorder or display)

6.5 Reference block**6.5.1 Type E reference block for double crystal probe**

It is a reference block for analyzing the distance amplitude characteristics of double crystal probe. The type E reference block for double crystal probe (RB-E) specified in Annex JA shall be used.

6.5.2 Calibration block

It is a block which sets the working sensitivity of a crystal probe. STB-N1, STB-G V15-4 and STB-G V15-2.8 specified in **JIS Z 2345** shall be used.