

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS Z 3060 : 2015

(JSNDI/JSA)

**Method for ultrasonic testing for
welds of ferritic steel**

ICS 19.100;25.160.40;77.140.01

Reference number : **JIS Z 3060 : 2015 (E)**

 **Documents**
Document Sharing Hub

PROTECTED BY COPYRIGHT

63 S

Date of Establishment: 1975-09-01

Date of Revision: 2015-08-20

Date of Public Notice in Official Gazette: 2015-08-20

Investigated by: Japanese Industrial Standards Committee
Standards Board for ISO area
Technical Committee on Metal and Inorganic
Materials

JIS Z 3060:2015, First English edition published in 2016-06

Translated and published by: Japanese Standards Association
Mita MT Building, 3-13-12, Mita, Minato-ku, Tokyo, 108-0073 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

© JSA 2016

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

PROTECTED BY COPYRIGHT

Contents

	Page
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Examination personnel	2
5 Standard test blocks and reference blocks	2
5.1 Standard test blocks	2
5.2 Reference blocks	2
6 Ultrasonic test equipment	3
7 Couplant	4
8 Preparation of examination	4
8.1 Selection of examination method	4
8.2 Selection of reference block or standard test block	4
8.3 Selection of probe	4
8.4 Measurement of wave velocity ratio to STB	7
8.5 Measurement of refraction angle by the test object	8
8.6 Selection of disregard level	10
8.7 Stage of examination	10
8.8 Finishing of test surface	10
8.9 Examination of parent materials	10
9 Adjustment and check of ultrasonic test equipment	10
9.1 Angle beam examination	10
9.2 Normal beam examination	13
10 Examination	14
10.1 General	14
10.2 Angle beam examination	14
10.3 Normal beam examination	16
11 Record	17
Annex A (normative) Function and performance of test instrument and probe	19
Annex B (normative) Examination method for flat plate joint welds	24
Annex C (normative) Method for the angle beam examination of circumferential joint welds	42
Annex D (normative) Angle beam examination for longitudinal joint welds	55

Annex E (informative)	Angular beam examination method for steel pipe branch joint weld	81
Annex F (informative)	Examination method for nozzle joint welds	90
Annex G (normative)	Classification of discontinuities obtained as examination results	98
Annex H (informative)	Method for measurement of the indication height of discontinuities by end echo technique	99
Annex I (informative)	Method for measurement of the indication height of discontinuities by TOFD technique	109

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 result of proposal for revision of Japanese Industrial Standard submitted by The Japanese Society for Non-destructive Inspection (JSNDI)/Japanese Standards Association (JSA) 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 Z 3060:2002** is replaced with this Standard.

This **JIS** document is protected by the Copyright Law.

Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, applications for a patent after opening to the public or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, applications for a patent after opening to the public or utility model rights.

Method for ultrasonic testing for welds of ferritic steel

1 Scope

This Japanese Industrial Standard specifies the method for detecting discontinuities and for measuring their locations and dimensions on full penetration welds of ferritic steel with thickness of 6 mm or more by manual ultrasonic examination (hereafter referred to as “examination”) by means of an ultrasonic test instrument using ultrasonic pulse (hereafter referred to as “test instrument”) with a scope display. This Standard is not applicable to the examination of joint welds of steel pipes under production process.

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 Z 2300 *Terms and definitions of nondestructive testing*

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

JIS Z 2345 *Standard test blocks for ultrasonic testing*

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

JIS Z 2351 *Method for evaluating electronic characteristics of ultrasonic test instruments*

JIS Z 2352 *Method for evaluating performance characteristics of ultrasonic pulse-echo testing systems*

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 glycerol paste

a couplant made by adding a small amount of surfactant and thickener to glycerol

3.2 L direction

the principal rolling direction of rolled steel materials

3.3 C direction

the direction perpendicular to the principal rolling direction

3.4 Q direction

the direction at an angle of 45° to the principal rolling direction

3.5 wave velocity ratio to STB

ratio (V/V_{STB}) of the transverse wave velocity (V), measured with the vibration direction of the transverse waves agreeing with the direction of the ultrasonic beam at the time of an angle beam examination of a test object while the ultrasonic waves are being transmitted by means of a transverse wave normal probe, to the transverse wave velocity (V_{STB}) measured in a standard test block

3.6 transmission pulse

ultrasonic pulse which enters a receiving probe after penetrating a test object or its indication appearing on a test instrument indicator, in a double probe technique

3.7 transmission pulse height

height of a transmission pulse on an ultrasonic chart obtained by a V path method or a tandem probe technique

3.8 curve for dividing transmission pulse height

curve for dividing the transmission pulse height into regions for evaluation

4 Examination personnel

The engineers engaged in examination of steel welds shall be qualified for performing the ultrasonic testing (hereafter referred to as "examination") specified in **JIS Z 2305** or certified to have an equivalent qualification, and shall possess knowledge of principle of ultrasonic examinations and welds of ferritic steel, as well as sufficient knowledge and experience for performing specific examinations.

5 Standard test blocks and reference blocks

5.1 Standard test blocks

The standard test blocks (STB) to be used in this Standard are Type A1 standard test blocks, and Type A2 and A3 series standard test blocks which are specified in **JIS Z 2345**.

NOTE : Standard test blocks (STB) used for ultrasonic examination are specified in **JIS Z 2345**, and Type A1 standard test blocks include STB-A1, Type A2 series standard test blocks include STB-A2, STB-A21, and STB-A22, and Type A3 series standard test blocks include STB-A3, STB-A31, and STB-A32.

5.2 Reference blocks

Reference blocks used are RB-41, RB-42, RB-43, RB-A6 and RB-SDH, and shall be as follows.

a) RB-41 (horizontal hole reference block for testing flat plate joint welds)

RB-41 are reference blocks with horizontal holes, used for the examination of joint welds of flat plate and joint welds with a curvature radius of 250 mm or over. Their form and dimensions shall be as given in Table B.1 and Figure B.1, respectively. RB-41 shall be either of the followings.

- 1) RB-41A shall be of a steel material with equivalent acoustic characteristics to the test object, have a test surface condition equivalent to the test object and no curvature. The wave velocity and sensitivity correction quantity differences from the test object shall be within $\pm 2\%$ and ± 2 dB, respectively.
 - 2) RB-41B shall have a test surface finished by using homogeneous low-damping materials and have no curvature.
- b) **RB-42 (horizontal hole reference block for testing circumferential joint welds)**

RB-42 are reference blocks with horizontal holes, which shall be made of a steel material equivalent in acoustic characteristics to that of the test object and have a similar test surface condition to the test object, and have a curvature in the direction at right angles to the scanning direction. They are used for the examination of circumferential joint welds with a curvature radius of 50 mm or over. Their form and dimensions shall be as given in Figure C.2. The differences from the test object with respect to the wave velocity and quantity of sensitivity correction shall be within $\pm 2\%$ and ± 2 dB, respectively.

- c) **RB-43 (horizontal hole reference block for testing longitudinal joint welds)**

RB-43 are reference blocks with horizontal holes, which shall be made of a steel material equivalent in acoustic characteristics to that of the test object and have a similar test surface condition to the test object, and have a curvature in the direction parallel to the scanning direction. They are used for the examination of longitudinal joint welds with a curvature radius of 50 mm or over. Their form and dimensions shall be as given in Figure D.4. The difference from the test object with respect to the wave velocity shall be within $\pm 2\%$.

- d) **RB-A6 (vertical hole reference block for testing circumferential joint welds)**

RB-A6 are reference blocks with vertical holes, which shall be made of a steel material equivalent in acoustic characteristics to that of the test object and have a similar test surface condition to the test object, and have a curvature in the direction normal to the scanning direction. They are used for the examination of circumferential joint welds with a curvature radius of 50 mm or over using a maximum path length of 150 mm. Their form and dimensions shall be as given in Figure C.3. The difference from the test object with respect to the wave velocity shall be within $\pm 2\%$.

- e) **RB-SDH (horizontal hole reference block)**

RB-SDH are reference blocks with horizontal holes, as specified in Annex 1 of JIS Z 2350.

6 Ultrasonic test equipment

The function and performance of the test instrument and probe shall be in accordance with Annex A.

7 Couplant

The couplant used for examination shall be as follows.

In the case of using a transverse wave normal probe, the couplant used shall be that intended for transverse wave.

- a) Glycerol paste
- b) Glycerol water solution with a 75 % concentration (volume fraction 75 %) or more
- c) Water
- d) Oil
- e) Liquid with a known acoustic impedance

8 Preparation of examination

8.1 Selection of examination method

The examination of welds, unless otherwise specified, shall be performed by the single probe angle beam technique directing the ultrasonic beam perpendicularly to the direction of the weld line which uses the contact method. The tandem probe technique or the normal beam technique specified in Annex B may be used upon agreement between the interested parties. The angle beam parallel scanning technique by a slanted probe, longitudinal scanning technique of weld surface or straddle scanning technique may also be used upon agreement between the interested parties.

8.2 Selection of reference block or standard test block

8.2.1 Selection of test blocks for angle beam examination

For adjustment of working sensitivity, any of RB-41A, RB-41B, RB-42, RB-43, RB-A6 or one of Type A2 series reference blocks shall have been selected. However, where the thickness of the test object at the part which will be the test surface is 75 mm or over, or the refraction angle is selected in accordance with Table 5 based on the measurement result of wave velocity ratio to STB, the reference block to be used shall be selected from RB-41A, RB-41B, RB-42 and RB-43. Type A2 series reference blocks shall be selected when the maximum path length to be used is not more than 150 mm.

8.2.2 Selection of test blocks for normal beam examination

For adjustment of working sensitivity, either RB-41A or RB-41B shall be used.

8.3 Selection of probe

8.3.1 Frequency

The nominal frequency of the probe shall not be less than 2 MHz but not more than 5 MHz. However, when examining a test object with remarkable ultrasonic attenuation, a nominal frequency less than 2 MHz may be used keeping the frequency-dependent characteristics in mind.

Typical nominal frequencies used for angle beam examination are shown in Table 1, and those for normal beam examination, in Table 2.

Table 1 Typical nominal frequencies used for angle beam examination

Maximum path length to be used mm	Nominal frequency MHz
100 or under	3.5 to 5
Over 100 up to and incl. 150	2 to 5
Over 150 up to and incl. 250	2 to 3.5
Over 250	2

Table 2 Typical nominal frequencies used for normal beam examination

Maximum path length to be used mm	Nominal frequency MHz
40 or under	5
Over 40 up to and incl. 60	2 or 5
Over 60	2

8.3.2 Nominal size of transducer

The nominal size of transducer shall be as follows.

- The nominal size of the transducer of an angle probe shall be 5 mm × 5 mm or over up to and including 20 mm × 20 mm. The typical nominal sizes of transducer used are shown in Table 3. The nominal size of transducer of probe used for tandem probe technique are not specified.
- The transducer of a normal probe shall be circular in shape, and its nominal size shall be a diameter 10 mm or over up to and including 30 mm. The typical nominal sizes of transducer used are shown in Table 4.

Table 3 Typical nominal sizes of transducer used for angle probe

Nominal frequency MHz	Nominal size of transducer mm
2 to 2.5	14 × 14, 20 × 20
3 to 4	10 × 10, 14 × 14, 20 × 20
4.5 to 5	5 × 5, 10 × 10

Table 4 Typical nominal sizes of transducer used for normal probe

Nominal frequency MHz	Nominal size of transducer (diameter) mm
2	20, 28
5	10

8.3.3 Refraction angle

The refraction angle used for examination shall be as follows.

- a) The nominal refraction angle of a probe used for angle beam examination shall be 40°, 45°, 60°, 65° or 70°. The nominal refraction angle 40° is applicable only to the techniques specified in Annex D and Annex E.
- b) In examinations where a probe having a nominal refraction angle of 60°, 65° or 70° is used, the probe refraction angle shall be selected in accordance with Table 5, based on the measurement result in 8.4.
- c) In examinations where a probe having a nominal refraction angle of 45° is used, the STB refraction angle shall be $45 \pm 2^\circ$ or less for any wave velocity ratio to STB.
- d) Where the refraction angle of the probe to be used for examination becomes the STB refraction angle based on the wave velocity ratio to STB, it may be replaced by the refraction angle by the test object.
- e) Where the thickness of the test object exceeds 75 mm and the wave velocity ratio to STB (V/V_{STB}) is 0.995 or over up to and including 1.005, the STB refraction angle of 69° to 71° may be used.

Table 5 Selection of refraction angle based on wave velocity ratio to STB

Thickness of test object mm	Wave velocity ratio to STB	Refraction angle used for examination
6 or over up to and incl. 25	Under 0.990	Refraction angle by the test object 63° or over up to and incl. 72°
	0.990 or over up to and incl. 1.020	STB refraction angle 63° or over up to and incl. 72°
	Over 1.020	Refraction angle by the test object 63° or over up to and incl. 72°
Over 25 up to and incl. 75	Under 0.995	Refraction angle by the test object 58° or over up to and incl. 72°
	0.995 or over up to and incl. 1.015	STB refraction angle 58° or over up to and incl. 72°
	Over 1.015 up to and incl. 1.025	STB refraction angle 58° or over up to and incl. 67°
	Over 1.025	Refraction angle by the test object 58° or over up to and incl. 72°
Over 75	Under 0.995	Refraction angle by the test object 58° or over up to and incl. 67°
	0.995 or over up to and incl. 1.025	STB refraction angle 58° or over up to and incl. 67°
	Over 1.025	Refraction angle by the test object 58° or over up to and incl. 67°

8.3.4 SN ratio

In the test instrument to be used, the ratio (S-N dB) of the gain (S dB) of H line measured at the reference sensitivity to the gain (N dB) measured at the sensitivity enhanced to the level where the maximum noise echo height reaches H line in the range of the path length to be used shall be not more than -22 dB.

8.3.5 Dead zone of normal probe

The dead zone of a normal probe, at the working sensitivity to be used, is the distance (mm) from the point of rise of the transmitted pulse or surface echo to the point where the height of edge becomes 20 %, and shall be read off the time axis calibrated by a standard test block, etc. The dead zone value shall be 8 mm or under for nominal frequency of 5 MHz, and 15 mm or under for that of 2 MHz.

8.4 Measurement of wave velocity ratio to STB

8.4.1 Measuring condition of wave velocity ratio to STB

The measuring condition of the wave velocity ratio to STB shall be as follows.

- a) The measurement shall be made on the tested portion.
- b) The temperature of the test surface shall be equivalent to that at the time of examination.
- c) The measuring position for one tested portion shall be one, but may be more depending on the condition of the test object.

8.4.2 Measuring apparatus of wave velocity ratio to STB

The measuring apparatus of the wave velocity ratio to STB shall be as follows.

- a) For the measurement of wave velocity ratio to STB (V/V_{STB}), the ultrasonic wave apparatus (the ultrasonic thickness meter or test instrument capable of using a transverse wave normal probe) which is capable of measuring and displaying thickness or path length to three or more significant digits and the transverse wave normal probe capable of propagating transverse wave vertically through the test object shall be used.
- b) For the measurement of plate thickness, the ultrasonic thickness meter or dimension measuring instrument which uses a longitudinal wave probe (a longitudinal wave normal probe or a double transducer longitudinal wave normal probe) capable of measuring and displaying thickness to three or more significant digits shall be used.
- c) For the transverse wave normal probe, the vibrating direction shall be indicated.
- d) In the case of using a transverse wave normal probe, the couplant used shall be that intended for transverse wave.

8.4.3 Test block and test object

The measurement of the wave velocity ratio to STB shall be performed using any of Type A1 standard test block, Type A2 series standard test block or Type A3 series standard test block, the measurement of test body shall be conducted on the test surface of an applicable test object.

8.4.4 Confirmation of scanning direction of test object

Before the measurement of the wave velocity ratio to STB, the relation between the scanning direction and L, C and Q directions shall be confirmed by measuring the transverse wave velocity difference by sheet cutting in the rolling direction or the combination of the transverse wave normal probe and the ultrasonic thickness meter or test instrument.

8.4.5 Measurement of wave velocity ratio to STB

8.4.5.1 Method using ultrasonic thickness meter

The method using an ultrasonic thickness meter shall be as follows.

- The thicknesses of test object and standard test block measured by the ultrasonic thickness meter which uses the longitudinal wave probe or dimension measuring instrument shall be taken as t_M (mm) and t_{SM} (mm), respectively.
- The plate thickness obtained by making the vibrating direction of the transverse wave normal probe used for the ultrasonic thickness meter agree with the scanning direction of the test object and the plate thickness obtained from standard test block shall be taken as t_S (mm) and t_{STB} (mm), respectively.
- These ratios shall be calculated down to the third decimal place according to Formula (1), and the result shall be taken as the wave velocity ratio to STB (V/V_{STB}).

$$\frac{V}{V_{STB}} = \frac{t_M \times t_{STB}}{t_{SM} \times t_S} \dots\dots\dots (1)$$

8.4.5.2 Method using test instrument

The method using a test instrument shall be as follows.

- The thicknesses of test object and standard test block measured by the ultrasonic thickness meter which uses the longitudinal wave probe or dimension measuring instrument shall be taken as t_M (mm) and t_{SM} (mm), respectively.
- The path length of first back wall echo obtained by making the vibrating direction of transverse wave normal probe used for the test instrument agree with the scanning direction of the test object and the path length of first back wall echo obtained from standard test block shall be taken as W_S (mm) and W_{STB} (mm), respectively.
- These ratios shall be calculated down to the third decimal place according to Formula (2), and the result shall be taken as the wave velocity ratio to STB (V/V_{STB}).

$$\frac{V}{V_{STB}} = \frac{t_M \times W_{STB}}{t_{SM} \times W_S} \dots\dots\dots (2)$$

8.5 Measurement of refraction angle by the test object

8.5.1 Calculation of refraction angle by the test object

The refraction angle by the test object when the scanning direction agrees with L or C direction shall be calculated in accordance with 8.5.2 using the wave velocity ratio to STB obtained in 8.4.5, or obtained in accordance with 8.5.3 or 8.5.4. The refraction angle by the test object in the Q direction when there is no difference in the transverse wave velocity between L and C directions shall similarly be calculated in accordance with 8.5.2 using the wave velocity ratio to STB obtained in 8.4.5, or obtained in accordance with 8.5.3 or 8.5.4. When there is a difference in the transverse wave velocity between L and C directions, the refraction angle by the test object in the Q direction shall be obtained in accordance with 8.5.3 or 8.5.4.

8.5.2 Calculation by wave velocity ratio to STB

The refraction angle (θ) by test object, shall be calculated from the STB refraction angle (θ_{STB}) of a probe to be used and the wave velocity ratio to STB (V/V_{STB}) by Formula (3) and shall be rounded to the nearest 0.1° .

$$\theta = \sin^{-1} \left(\frac{V}{V_{\text{STB}}} \times \sin \theta_{\text{STB}} \right) \dots\dots\dots (3)$$

8.5.3 Method using V path method

The location of probe shall be adjusted so that the maximum transmission pulse height is obtained on the test surface of test object in accordance with the arrangement of V path method given in Figure 1 using the probe of the same type as that of angle probe to be used for examination. The refraction angle (θ) by test object shall be calculated from the distance (Y) between probe indices and the actually measured plate thickness (t) according to Formula (4), and shall be rounded to the nearest 0.1° .

$$\theta = \tan^{-1} \left(\frac{Y}{2t} \right) \dots\dots\dots (4)$$

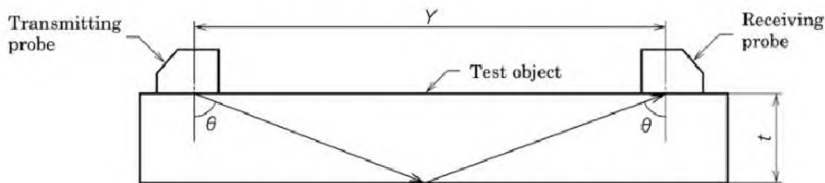


Figure 1 Probe position for V path method

8.5.4 Method using reference blocks

Using an angle probe to be used for the examination and a reference block, RB-41A, made of a steel material having acoustic characteristics equivalent to the test object, the probe position shall be adjusted so as to maximize the height of the echo from the standard hole as shown in Figure 2. The distance (y) between the standard hole and the probe index at this time and the standard hole depth (d) shall be used to calculate the refraction angle (θ) by the test object using Formula (5) and the result shall be rounded to the nearest 0.1° . Calculation of the refraction angle by the test object having a curvature shall be in accordance with Annex C or Annex D.

$$\theta = \tan^{-1} \left(\frac{y}{d} \right) \dots\dots\dots (5)$$

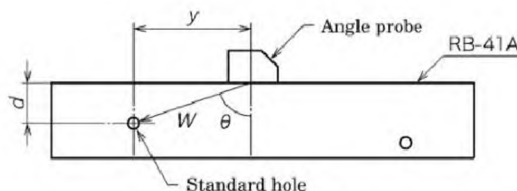


Figure 2 Measurement of refraction angle by the test object using RB-41A

8.6 Selection of disregard level

According to purpose of the examination, the disregard level shall be M disregard level for the object which exceeds M line in the curve for dividing echo height created according to 9.1.4 or L disregard level for the object which exceeds L line.

8.7 Stage of examination

The examination, where a heat treatment or other treatment after welding is specified in the order, shall be carried out after completion of the final heat treatment. When cold cracking is anticipated to occur on the material, the examination shall be performed after a sufficient time has elapsed after completion of welding.

8.8 Finishing of test surface

Spatter and/or floating scales, if present on the test surface, shall be removed. When the transfer loss exceeds 12 dB due to roughness, rust and painting film on the test surface, it shall be finished in the range not exceeding 12 dB.

8.9 Examination of parent materials

The parent materials of the part through which ultrasonic waves pass in angle beam examination shall be previously examined by normal beam examination as required. The nominal frequency and diameter of the probe to be used, in principle, shall be 5 MHz and $\phi 20$ mm, respectively, in the case of plate thickness of 60 mm or under, and 2 MHz and $\phi 30$ mm, respectively, in the case of plate thickness of over 60 mm. The working sensitivity shall be adjusted to obtain 80 % height of the first back wall echo of the ultrasonically sound area. The range of a discontinuity shall exceed 20 % in echo height. When a discontinuity is detected, it shall be recorded. A discontinuity of 100 mm² or over in range may interfere with the examination of the welds.

When such a discontinuity as may interfere with the examination of the welds has been detected, the examination shall be performed either by changing the test surface or the refraction angle so that the beam central axis passes through the whole weld avoiding the discontinuity on the parent material, or by using the normal beam technique or other examination method instead.

9 Adjustment and check of ultrasonic test equipment

9.1 Angle beam examination

9.1.1 Measurement of probe index

The probe index shall be measured by using a Type A1 standard test block or one of Type A3 series standard test blocks. The probe index shall be measured to the nearest 0.5 mm.

9.1.2 Adjustment of time base range

The time base range shall be adjusted by using Type A1 standard test block or one of Type A3 series standard test blocks.

9.1.3 Measurement of STB refraction angle and refraction angle by the test object

9.1.3.1 Measurement of STB refraction angle

The measurement of STB refraction angle shall be performed by using Type A1 standard test block or one of Type A3 series standard test blocks. The STB refraction angle shall be measured at the temperature of environment of the examination work and read to the nearest 0.1° .

9.1.3.2 Measurement of refraction angle by the test object

The measurement of refraction angle by the test object shall be performed in accordance with 8.5.

9.1.4 Preparation of curve for dividing echo height

The curves for dividing echo height shall be prepared in accordance with Annex B for flat plate joint welds, Annex C for circumferential joint welds and Annex D for longitudinal joint welds.

9.1.5 Determination of regional division

9.1.5.1 Determination of H line, M line and L line

Among the curves for dividing echo height prepared in 9.1.4, the third line or higher from the lowest shall be taken as H line, and used as a reference line for adjustment of working sensitivity. The curve lower than H line by 6 dB shall be taken as M line and the curve lower than H line by 12 dB shall be taken as L line. The L line shall be taken as the line of which the height becomes 10 % or more in the range of path length to be used for evaluating the discontinuity echo (see Figure 3).

9.1.5.2 Regional division

The regions divided by H line, M line and L line for regional division of echo height shall be designated as given in Table 6 (see Figure 3).

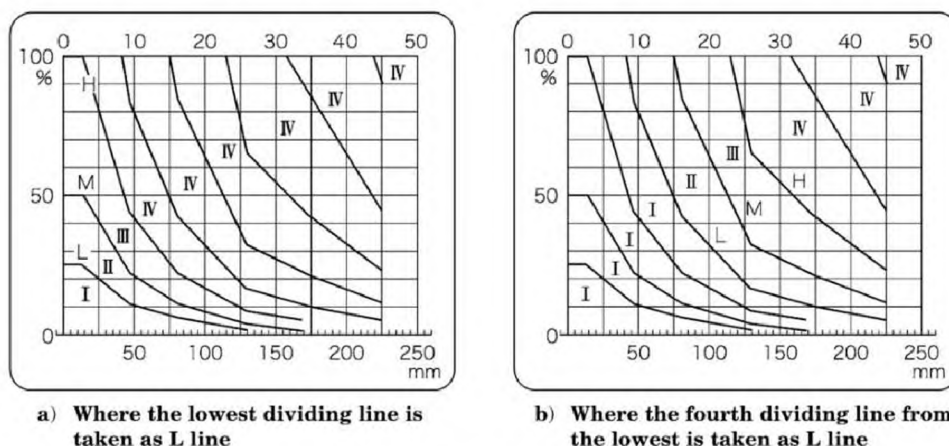


Figure 3 Example of selection of H line and regional division

Table 6 Regional division of echo height

Range of echo height	Region of echo height
Line L or under	I
Over L to M line incl.	II
Over M to H line incl.	III
Over H line	IV

9.1.6 Adjustment of working sensitivity

The working sensitivity shall be adjusted using the test block used for preparation of curve for dividing echo height according to the method specified in Annex B to Annex D. The working sensitivity for the parallel scanning by a slanted probe, straddle scanning, and longitudinal scanning of weld surface shall be determined by the agreement between the interested parties.

9.1.7 Measurement, adjustment and check of test equipment

The probe index, STB refraction angle, time base range and working sensitivity shall be measured and adjusted at the start of examination. These values shall be checked at intervals not exceeding 4 h after the start of the examination and at the end of the examination to check if any of the values have changed. If change is found, a suitable corrective action described in Tables 7 to 9 shall be taken.

Table 7 Corrective actions to be taken where the STB refraction angle is not maintained

Change	Corrective action
$\pm 2^\circ$ or under from the nominal refraction angle	Perform readjustment and continue examination
Over $\pm 2^\circ$ from the nominal refraction angle	Perform replacement or repair and redo the tests which were performed after the last adjustment or check.

Table 8 Corrective actions to be taken where the time base range is not maintained

Change	Corrective action
$\pm 2\%$ or under	Perform readjustment and continue examination
Over $\pm 2\%$	Perform readjustment and redo the tests which were performed after the last adjustment or check.

Table 9 Corrective action to be taken where the working sensitivity is not maintained

Change	Corrective action
± 4 dB or under	Perform readjustment and continue examination.
Decrease of over 4 dB	Perform readjustment and redo the tests which were performed after the last adjustment or check.
Increase of over 4 dB	Perform readjustment and redo the test on the indication of a discontinuity which was observed by the tests performed after the last adjustment or check.

9.2 Normal beam examination

9.2.1 Adjustment of time base range

The time base range shall be adjusted by using Type A1 standard test block, etc. to a distance that satisfies the required examination range.

9.2.2 Preparation of curve for dividing echo height

The curves for dividing echo height shall be prepared in accordance with the method specified in Annex B using RB-41A or RB-41B and the test instrument and the probe to be used for examination.

9.2.3 Determination of regional division

9.2.3.1 Determination of H line, M line and L line

Among the curves for dividing echo height prepared in **9.2.2**, the third line or higher from the lowest shall be taken as H line, and used as a reference line for adjustment of working sensitivity. The curve lower than H line by 6 dB shall be taken as M line and the curve lower than H line by 12 dB shall be taken as L line. The L line shall be taken as the line of which height becomes 10 % or more in the range of path length to be used for evaluating the discontinuity echo (see Figure 4).

9.2.3.2 Regional division

The regions divided by H line, M line and L line for regional division of echo height shall be designated as given in Table 6 (see Figure 4).

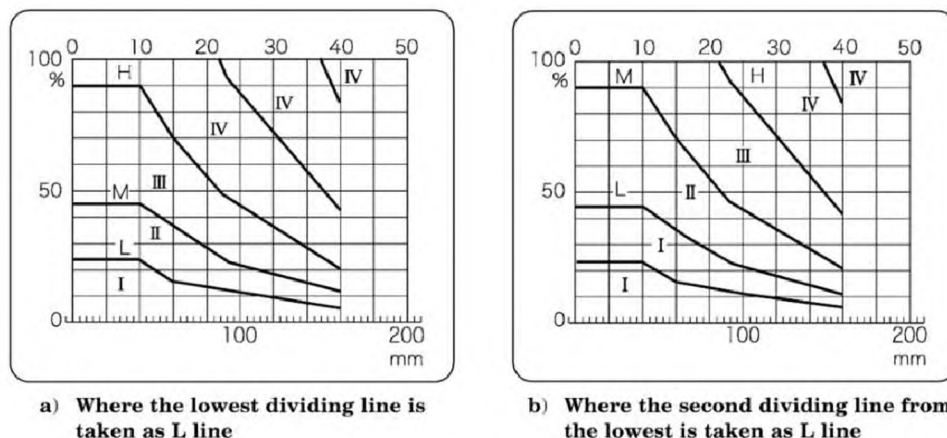


Figure 4 Example of regional division

9.2.4 Adjustment of working sensitivity

The working sensitivity shall be adjusted using the test block used for preparation of curve for dividing echo height according to the suitable method for the applicable test object specified in Annex B.

9.2.5 Adjustment and check of ultrasonic test equipment

The time base range and working sensitivity shall be measured and adjusted at the start of examination. These values shall be checked at intervals not exceeding 4 h after the start of the examination and at the end of the examination to check if any of the conditions have changed. If change is found in the conditions, a suitable corrective action described in Tables 8 and 9 shall be taken.

10 Examination

10.1 General

Examination method shall be performed in accordance with the method specified in Annex B for flat plate joint welds, that specified in Annex C for circumferential joint welds and that specified in Annex D for longitudinal joint welds.

NOTE : See Annex E for examination method for steel pipe branch joint welds, and Annex F for method for nozzle joint welds.

10.2 Angle beam examination

10.2.1 Scanning method

Typically the zig-zag scanning by probe shall be performed so as to ensure that no discontinuity is overlooked. For determination of the maximum echo height where a discontinuity has been found, the back and forth scanning, lateral scanning, swivel scanning and orbital scanning shall be used. In the case of applying the lateral square scanning or square scanning, or applying the parallel scanning by a slanted probe,

straddle scanning or longitudinal scanning of weld surface for detection of discontinuities that are apt to be overlooked by zig-zag scanning, a previous agreement between the interested parties shall be made.

The method for adjustment of the working sensitivity in the case where an examination is carried out applying straddle scanning shall be as agreed upon between the interested parties.

10.2.2 Evaluation of discontinuity

10.2.2.1 Discontinuity to be evaluated

The discontinuity to be evaluated, in the case of using M disregard level, shall be that in which the maximum echo height exceeds M line and in the case of using L disregard level, that in which the maximum echo height exceeds L line, with the working sensitivity adjusted to that specified in each Annex.

10.2.2.2 Region of echo height

The probe is placed at the location where the maximum echo height is indicated, and the region in which the peak of the echo exists shall be taken.

In the case of detecting one discontinuity at different refraction angles or on different test surfaces, the highest region of all shall be taken as the region of echo height.

NOTE : For measurement of indication height of discontinuity, see Annex H or Annex I.

10.2.2.3 Indication length of discontinuity

The indication length (l) of a discontinuity shall be measured to the nearest 1 mm by the lateral scanning over the probe-to-weld distance, and determining the transference distance of the probe in the range where the echo height exceeds L line. In this case, the back and forth scanning shall be used, but the swivel scanning shall not be used. In the case where the probe of nominal frequency of 2 MHz to 2.5 MHz is used, the transference distance of the probe in the range where the echo height exceeds one half (-6 dB) of the height of the maximum echo shall be taken as the indication length. When one discontinuity is detected by two or more probes with different refraction angles or by examining different test surfaces, the indication length shall be determined for each probe and test surface, and the longest among them shall be taken as the indication length of that discontinuity.

10.2.2.4 Classification of discontinuities

Classification of discontinuities shall be as specified in Annex G.

10.2.2.5 Presentation of location of discontinuity

As shown in Figure 5, the location of a discontinuity in the transverse section shall be presented by depth (d) of a discontinuity obtained at the probe location (X_P) indicating the maximum echo height, and the location in the direction parallel to the weld line shall be presented by the probe location (X_P) indicating the maximum echo height. The indication length of the discontinuity shall be presented by the start (X_S) and the end (X_E) of the maximum indication length.

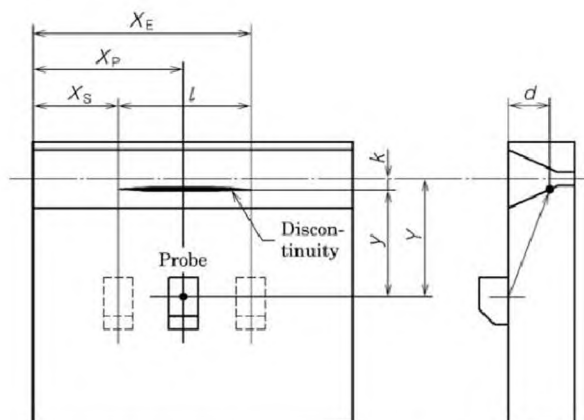


Figure 5 Presentation of discontinuity location for angle beam examination

10.3 Normal beam examination

10.3.1 Scanning method

Probe scanning shall be performed with care that no discontinuity is overlooked.

10.3.2 Evaluation of discontinuity

10.3.2.1 Discontinuity to be evaluated

The discontinuity to be evaluated, in the case of using M disregard level, shall be that in which the maximum echo height exceeds M line and in the case of using L disregard level, that in which the maximum echo height exceeds L line, with the working sensitivity adjusted to that specified in 9.2.4.

10.3.2.2 Region of echo height

The probe shall be placed at the location where the maximum echo height is indicated, and the region in the curve for dividing echo height in which the maximum echo height exists shall be read.

10.3.2.3 Indication length of discontinuity

The indication length of a discontinuity shall be obtained by scanning around the periphery of the position indicating the maximum echo height, and determining the transference distance of the probe (long diameter) in the range where the echo height exceeds L line. In the case where the plate thickness where the probe is to be placed is 75 mm or greater and the probe of frequency of 2 MHz is used, the transference distance of the probe in the range where the echo height exceeds one half (-6 dB) of the maximum shall be taken as the indication length of the discontinuity. The measurement shall be made to the nearest 1 mm.

10.3.2.4 Classification of discontinuities

Classification of discontinuities shall be as specified in Annex G.

10.3.2.5 Presentation of location of discontinuity

As shown in Figure 6, the location of a discontinuity in the transverse section shall be presented by depth (d) of a discontinuity obtained at the probe location (X_P) indicating the maximum echo height, and the location in the direction parallel to the weld line shall be presented by the probe location (X_P) indicating the maximum echo height and the start (X_S) and the end (X_E) of the indication length (l) of the discontinuity.

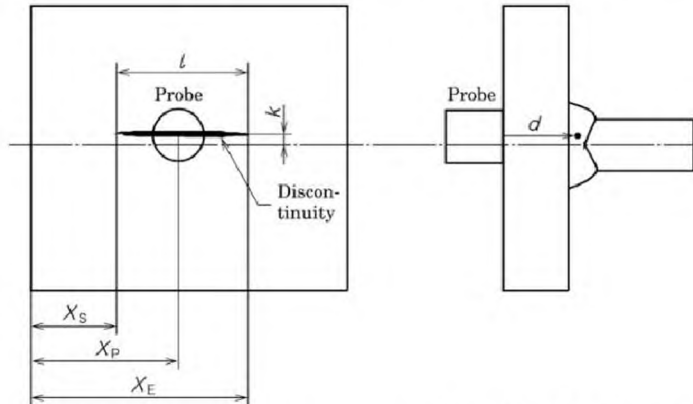


Figure 6 Presentation of discontinuity location for normal beam examination

11 Record

The record to be taken after examination shall include the necessary information among the following.

- a) Date of test
- b) Name of the constructor or the manufacturer
- c) Name of work or product
- d) Test number or symbol
- e) Signature and qualifications of the test engineer
- f) Material and dimensions
- g) Welding method and shape of groove face
- h) Model of the test instrument used, identification symbol, its performance characteristics and date of check
- i) Model, symbol and indication symbol of the probe used, its performance characteristics, date of check, and material of wedge
- j) Name of reference or standard test block used, and its identification symbol
- k) Thickness of reference block, curvature, condition of test surface and the wave velocity ratio to STB

- l) Condition of test surface of test object and method of finishing
- m) Temperature of test surface of test object
- n) Range of examination
- o) Kind and name of couplant
- p) Nominal frequency and test frequency
- q) Nominal refraction angle and STB refraction angle
- r) Wave velocity ratio to STB and the measurement method thereof
- s) Refraction angle by the test object and the calculation method thereof
- t) Time base range
- u) Whether a curve for dividing echo height was used
- v) Working sensitivity
- w) Quantity of sensitivity correction
- x) Disregard level
- y) Location of the probe along the direction of weld line indicating the maximum echo height, probe-to-weld distance, path length, the maximum echo height (region), indication length of discontinuity, depth of discontinuity, location of the probe along the direction perpendicular to weld line and the start and the end of indication length of discontinuity
- z) Acceptance or rejection and criteria applied
- aa) The following matters, when EDAC circuit has been used.
 - 1) Model of the test instrument and performance characteristics in the case of using EDAC
 - 2) That EDAC has been used
- ab) The following matters, in the case where tandem probe technique has been applied.
 - 1) Shadow zone
 - 2) Specification of the jig for tandem examination
 - 3) Position of tandem reference line
 - 4) Location of discontinuity in the direction of plate thickness (depth)
- ac) Other matters (specific requirements, matters of agreement, witnessing, sampling method, etc.)

Annex A (normative)

Function and performance of test instrument and probe

A.1 General

This Annex specifies the function and performance of test instrument and probe to be used in the examination as specified in this Standard.

A.2 Test instrument

A.2.1 Function required for the test instrument

The function required for the test instrument shall be as follows.

- a) The test instrument shall be applicable for use by both the single probe technique and the double probe technique.
- b) The adjusting quantity of the gain adjuster shall be 1 dB or less per step and 70 dB or over in total.
- c) For an analogue test instrument, its calibration scale plate shall have a space for indication of curves for dividing echo height, etc., allow easy attachment and detachment, and have a minimum measurement error due to parallax.
- d) Among the continuously adjusting knobs, those which are related to time axis and have a possibility of moving in use should be provided with lock mechanism.
- e) The test instrument used in combination with the broad band probe shall be capable of displaying or outputting RF waveform.

A.2.2 Performance required for test instrument

The performance required for the test instrument shall be as follows.

- a) The amplification linearity shall be measured in accordance with **6.2.2 of JIS Z 2352** and shall be within $\pm 3 \%$.
- b) The time axis linearity shall be measured in accordance with **6.1.1 of JIS Z 2352** and shall be within $\pm 1 \%$.
- c) The margin of sensitivity shall be measured in accordance with **6.5 of JIS Z 2352** and shall be not less than 40 dB.
- d) The stability against power supply variation shall be measured in accordance with clause **6 of JIS Z 2351**, and the sensitivity variation in the range of $\pm 10 \%$ of the rated voltage shall be within ± 1 dB, and the amount of transference of time axis shall be within $\pm 2 \%$ fs.

A.2.3 EDAC function

If the test instrument used is provided with the EDAC (electronic distance amplitude correction) function, this function may be used.

A.2.4 Inspection of performance of test instrument

The test instrument shall be inspected for the requirements specified in **a)** to **c)** of **A.2.2** in accordance with clause **7** of **JIS Z 2352** at the time of purchase of instrument and at intervals not exceeding 12 months (from the day following the previous inspection) to see if the instrument maintains the performance required in **A.2.2**.

A.3 Probe

A.3.1 Function required for the probe

The function required for the probe shall be as follows.

- a) The probe shall be compatible with the test instrument to be used.
- b) In order to make the measurement of probe index easy, both sides of the angle probe shall be marked with a guide scale of the intervals of 1 mm.
- c) The nominal size of the transducer of the angle probe shall be in accordance with **8.3.2 a)**.
- d) The transducer of the normal probe shall be circular, and its nominal diameter shall be in accordance with **8.3.2 b)**.

A.3.2 Test frequency

The test frequency shall be in the range of 90 % to 110 % of the nominal frequency. For probes with broad-band frequency characteristics, the test frequency shall be measured in accordance with **7.1** of **JIS Z 2350**, or be substituted by the frequency calculated based on the relation between time and the number of peaks measured in accordance with **7.2** of **JIS Z 2350**. The test frequency of probes with broad-band frequency characteristics shall be in the range of 80 % to 120 % of the nominal frequency.

A.3.3 Performance required for the angle probe

The performance required for the angle probe normally used shall be as follows.

When angle probes with other transducer size or frequency than specified in Tables A.1 to A.4 are used, the minimum distance between the probe index and the front end of the probe housing, resolution and dead zone shall be agreed upon between the interested parties.

- a) The distance between the probe index and the front end of the probe housing shall not exceed the value given in Table A.1. However, the minimum distance between probe indices of probe to be used for tandem probe examination shall be 20 mm or under in the case of probe of 5 MHz in nominal frequency and 45° in nominal refraction angle, 27 mm or under in the case of probe of 70°, and 25 mm or under in the case of probe of 2 MHz, 45°.

Table A.1 Minimum distance between the probe index and the front end of the probe housing

Nominal size of transducer mm	Minimum distance between the probe index and the front end of the probe housing mm
20 × 20	25
14 × 14	20
10 × 10	15
5 × 5	7

- b) The difference between the nominal refraction angle and the STB refraction angle shall be $\pm 2^\circ$ when the ambient temperature or the temperature of the standard test block is in the range of 10 °C to 30 °C. When the ambient temperature or the temperature of the standard test block is outside this range, the difference between the nominal refraction angle and the STB refraction angle, if specified, shall be subject to the agreement between the interested parties.
- c) The resolution shall be measured in accordance with **6.4** of **JIS Z 2352**, in combination with the test instrument to be used, and shall satisfy the values given in Table A.2.

The resolution of 2 MHz to 2.5 MHz shall be measured by means of reference block RB-RD or RB-HS specified in **JIS Z 2352**, and the resolution of 3 MHz to 4 MHz and 4.5 MHz to 5 MHz shall be measured by means of reference block RB-RD specified in **JIS Z 2352**.

Table A.2 Resolution of angle probe

Nominal frequency MHz	Resolution mm
2 to 2.5	9 max.
3 to 4	7 max.
4.5 to 5	5 max.

- d) The dead zone shall be measured in accordance with **8.3.7** of **JIS Z 2350**, in combination with the test instrument to be used, and shall not exceed the values given in Table A.3.

In the case where the nominal dimension of the transducer is 5 mm × 5 mm, it shall be measured with the working sensitivity to be used.

The dead zone of the probe to be used for tandem probe technique shall not be specified.

Table A.3 Dead zone of angle probe

Nominal frequency MHz	Nominal size of transducer mm	Dead zone mm
2 to 2.5	14 × 14	25
	20 × 20	15
3 to 4	10 × 10	25
	14 × 14	15
	20 × 20	10
4.5 to 5	5 × 5	8
	10 × 10	10

- e) The deviation of the beam central axis shall be measured in accordance with the measuring method in **8.3.4 2)** of **JIS Z 2350** and shall not exceed 2°.

A.3.4 Performance required for normal probe

The resolution of the normal probe shall be measured in accordance with **6.3.3** of **JIS Z 2352**, in combination with the test instrument to be used, and shall satisfy the values given in Table A.4.

Table A.4 Resolution of normal probe

Nominal frequency MHz	Resolution mm
2	9 max.
Over 2 to and excl. 5	7 max.
5	6 max.

A.3.5 Performance check of angle probe

The angle probe shall be inspected for requirements given in **A.3.2** and **A.3.3** at the timing specified in Table A.5, and it shall be confirmed that the required performance is maintained.

Table A.5 Timing of performance check of angle probe

Inspection item	Timing
Difference between the nominal refraction angle and the STB refraction angle Deviation of beam central axis Limit distance between the probe index and the front end of the probe housing Resolution Dead zone	At the time of purchase and at intervals not exceeding 12 months (counting from the first day of the month following the previous inspection) If repair has been performed, immediately after completion of repair.
Test frequency (narrow band) (wide band)	At the time of purchase At the time of purchase and at intervals not exceeding 12 months (counting from the first day of the month following the previous inspection)

A.3.6 Performance check of normal probe

The normal probe shall be inspected for requirements given in **A.3.2** and **A.3.4** at the timing specified in Table A.6 to see if the probe maintains the performance required in **A.3.2** and **A.3.4**.

Table A.6 Timing of performance check of normal probe

Inspection item	Timing
Resolution	At the time of purchase and at intervals not exceeding 12 months (counting from the first day of the month following the previous inspection) If repair has been performed, immediately after completion of repair.
Test frequency (narrow band) (wide band)	At the time of purchase At the time of purchase and at intervals not exceeding 12 months (counting from the first day of the month following the previous inspection)

Copyrighted material - Not for redistribution

Annex B (normative)

Examination method for flat plate joint welds

B.1 General

This Annex specifies methods of the ultrasonic angle beam examination, normal beam examination, and tandem probe examination for butt joint weld of flat plate, T joint weld, corner joint weld, circumferential joint weld with a test surface not less than 1 000 mm in curvature radius and longitudinal joint weld with a test surface not less than 1 500 mm in curvature radius.

B.2 Angle beam examination

B.2.1 Reference block and standard test block

The reference and standard test blocks to be used for adjustment of working sensitivity shall be RB-41A, RB-41B, or Type A2 series or Type A3 series standard test block shown in Table B.1 and Figure B.1. RB-41A shall be equivalent to test object in acoustic characteristics and in the state of the test surface, and with no curvature. The difference from the test object with respect to the wave velocity shall be within $\pm 2 \%$ and that with respect to the quantity of sensitivity correction shall be within ± 2 dB.

Table B.1 Dimensions of reference blocks RB-41A and RB-41B

Unit: mm

Test block No.	Thickness of test object t	Thickness of reference block T	Diameter of the standard hole d
No. 1	20 or under	19 or $t \pm 10 \%$	3.0
No. 2	Over 20 up to and incl. 40	38 or $t \pm 10 \%$	3.0
No. 3	Over 40 up to and incl. 80	75 or $t \pm 10 \%$	3.0
No. 4	Over 80 up to and incl. 140	125 or $t \pm 10 \%$	6.0
No. 5	Over 140 up to and incl. 200	175 or $t \pm 10 \%$	6.0
No. 6	Over 200 up to and incl. 250	225 or $t \pm 10 \%$	6.0
No. 7	Over 250	$t \pm 10 \%$	6.0

Unit: mm

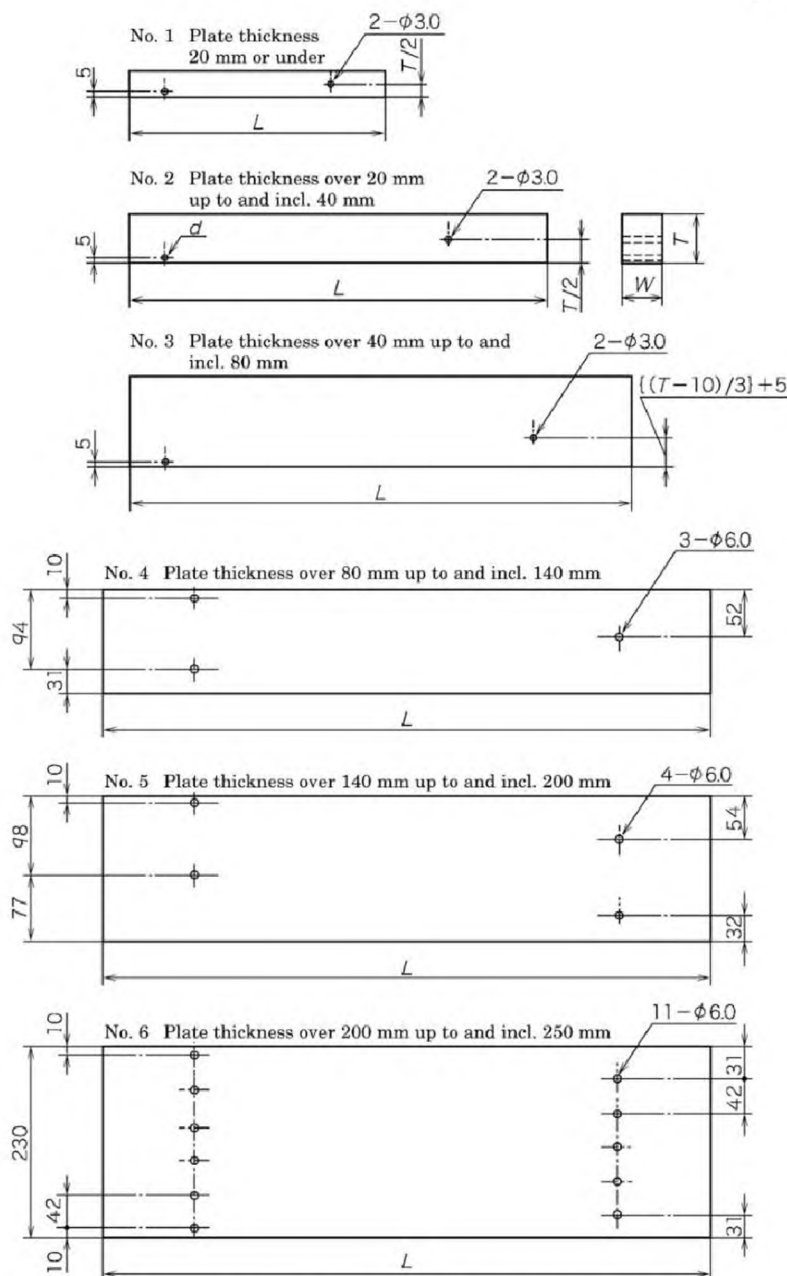


Figure B.1 Examples of dimensions of reference blocks RB-41A and RB-41B

L : length of reference block, depending on the path length used, equal to the length for V path method for sensitivity correction or twice that length.

T : thickness of reference block

d : diameter of the standard hole

W : width of test block

$W > 2 \times \lambda \times S/D$

λ : wavelength

S : maximum path length to be used

D : width of transducer

NOTE: No. 4 and No. 5 are reused by turning over and No. 6 is examined on one side.

Figure B.1 (concluded)

B.2.2 Probe

B.2.2.1 Selection of frequency

The nominal frequency of the angle probe used shall be in accordance with 8.3.1.

B.2.2.2 Selection of probe size

The nominal size of the transducer of the angle probe used shall be in accordance with 8.3.2.

B.2.2.3 Selection of refraction angle

The nominal refraction angle of the angle probe used shall be in accordance with 8.3.3 b).

When the plate thickness of the test object exceeds 75 mm, the nominal refraction angle of 45° in addition to the refraction angle selected in Table 5 shall be used.

B.2.3 Adjustment of test equipment

B.2.3.1 Probe index

The probe index shall be measured in accordance with 9.1.1.

B.2.3.2 Adjustment of time base range

The time base range shall be adjusted in accordance with 9.1.2 using the maximum path length which satisfies the range of examination given in Table B.2 or longer, but not excessively long.

Table B.2 Test surface, range of examination and frequency

Type of joint	Test surface	Range of examination	Maximum path length to be used mm	Frequency MHz
Butt joint	Single face/ both sides	Range of single and double traverse technique	100 or under	3.5 to 5
			Over 100 up to and incl. 150	2 to 5
			Over 150 up to and incl. 250	2 to 3.5
			Over 250	2
	Both faces/ both sides	Range of single traverse technique	100 or under	3.5 to 5
			Over 100 up to and incl. 150	2 to 5
			Over 150 up to and incl. 250	2 to 3.5
			Over 250	2
T-form joint	Single face/ single side	Range of single and double traverse technique	100 or under	3.5 to 5
			Over 100 up to and incl. 150	2 to 5
			Over 150 up to and incl. 250	2 to 3.5
			Over 250	2
	Both faces/ single side	Range of single traverse technique	100 or under	3.5 to 5
			Over 100 up to and incl. 150	2 to 5
			Over 150 up to and incl. 250	2 to 3.5
			Over 250	2
Corner joint (closed section)	Single face/ single side	Range of single and double traverse technique	100 or under	3.5 to 5
			Over 100 up to and incl. 150	2 to 5
			Over 150 up to and incl. 250	2 to 3.5
			Over 250	2

B.2.3.3 Measurement of STB refraction angle and refraction angle by the test object

The STB refraction angle and refraction angle by the test object shall be measured in accordance with 9.1.3. In the case of a test object having a wave velocity differing from that of the standard test block (a test object with a range of the wave velocity ratio to STB corresponding to the refraction angle by the test object in Table 5) the refraction angle by the test object shall be measured in the scanning direction using RB-41A or the test object.

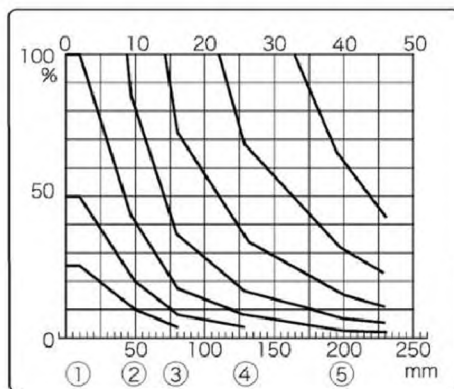
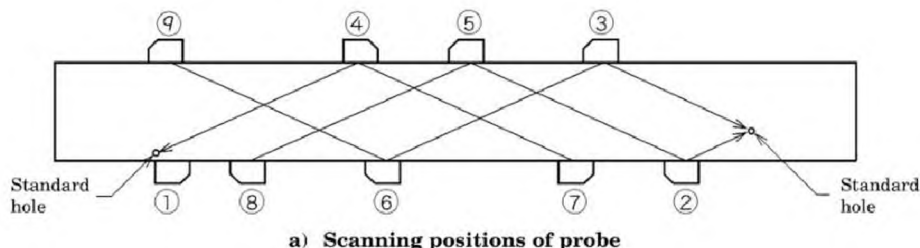
B.2.3.4 Preparation of curve for dividing echo height

The preparation of curve for dividing echo height shall be in accordance with the following.

- a) In the case of using RB-41A or RB-41B, the standard hole specified for the relevant test block shall be used, and in the case of using Type A2 series standard test block, a standard hole of size $\phi 4 \times 4$ mm shall be used.

If the difference between the echo height of the plotted point in the range of the path length used in the examination and the curve for dividing echo height previously prepared is within ± 2 dB, the latter may be used. The established curves shall be displayed on the indicator.

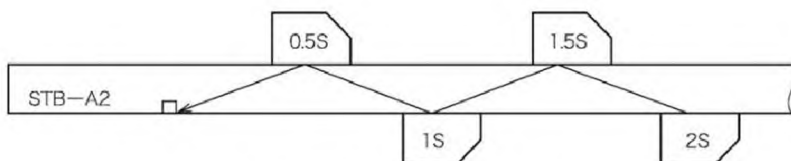
- b) The scanning shall be done by the probe set at the positions as shown in Figures B.2 a) and B.3 a), and each maximum echo height obtained shall be recorded on the indicator. The points shown in Figure B.2 b) and Figures B.3 b) and c) shall be connected to prepare curves for dividing echo height. Standard holes included in the dead zone shall not be recorded.
- c) The range of the curves for dividing echo height shall be larger than the path length to be used.
- d) The curves shall be made so as to include the range of 10 % to 100 % of the indicator.
- e) The range from the zero scale up to the plotted point which has the shortest path length shall be a horizontal line.
- f) Three or more curves each different by 6 dB shall be prepared.



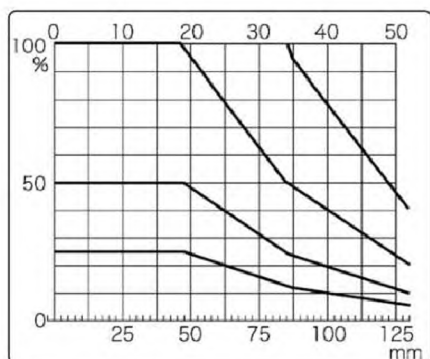
NOTE 1 The symbols ① to ⑤ show the scanning positions of probes.

NOTE 2 The probe symbol 2C20 x 20A65 is specified in clause 5 of JIS Z 2350, and represents the following: nominal frequency: 2 MHz, transducer material: porcelain other than lead zirconate titanate-based materials, transducer size: 20 mm x 20 mm, angle probe: (A) and nominal refraction angle: 65°.

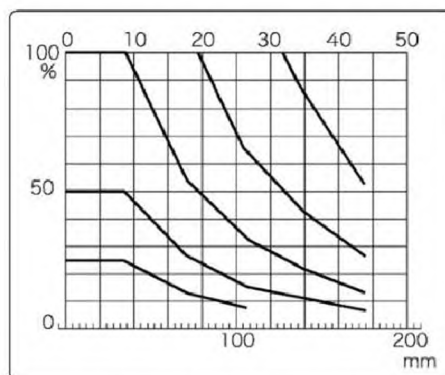
Figure B.2 Example of preparation of curves for dividing echo height by RB-41 No. 3



a) Scanning positions of probe



b) Example of 5C10 x 10A70



c) Example of 2C14 x 14A65

Figure B.3 Example of preparation of curves for dividing echo height by STB-A2

B.2.3.5 Determination of regional division

The determination of regional division shall be in accordance with 9.1.5.

B.2.3.6 Adjustment of working sensitivity

B.2.3.6.1 In the case of using RB-41

B.2.3.6.1.1 RB-41A

The gain of the instrument shall be adjusted so that the echo height of the standard hole agrees with H line and the adjusted gain shall be taken as the working sensitivity. When the standard holes of 6.0 mm in diameter in No. 4 to No. 7 of RB-41A specified in B.2.1 are used, the quantity of sensitivity correction, 3 dB, for the difference in the horizontal hole diameters, shall be added.

B.2.3.6.1.2 RB-41B

The gain of the instrument shall be adjusted so that the echo height of the standard hole agrees with H line. The quantity of sensitivity correction shall be added to it as required. The final adjustment condition shall be taken as working sensitivity. The method for obtaining the quantity of sensitivity correction shall be in accordance with B.2.3.7. When the sum of the quantity of sensitivity correction is over 2 dB, the sensitivity correction shall be performed. When the standard holes of 6.0 mm in diameter in No. 4 to No. 7 of RB-41B specified in B.2.1 are used, the quantity of sensitivity correction, 3 dB, for the difference in the horizontal hole diameters, shall be added.

B.2.3.6.2 In the case of using Type A2 series standard test block

The sensitivity adjustment shall be applied when the maximum path length used is 150 mm or less. In the case of using nominal refraction angle of 70° , the gain of the instrument shall be adjusted so that the echo height of the standard hole of $\phi 4 \times 4$ mm agrees with H line. The quantity of sensitivity correction shall be added to it as required. The final adjustment condition shall be taken as working sensitivity.

In the case of using nominal refraction angle of 65° , the gain of the instrument shall be adjusted so that the echo height of the standard hole of $\phi 4 \times 4$ mm agrees with M line. The quantity of sensitivity correction shall be added to it as required. The final adjustment condition shall be taken as working sensitivity.

In the case of using nominal refraction angle of 45° , after the gain of the instrument is adjusted so that the echo height of the standard hole of $\phi 4 \times 4$ mm agrees with H line, the gain shall be raised by 6 dB. The quantity of sensitivity correction shall be added to it as required. The final adjustment condition shall be taken as working sensitivity.

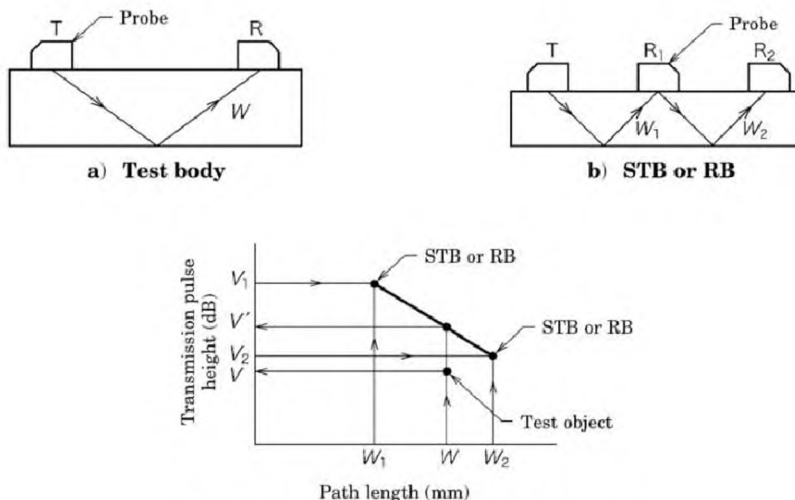
The method for obtaining the quantity of sensitivity correction shall be in accordance with **B.2.3.7**. When the sum of the quantity of sensitivity correction is over 2 dB, the sensitivity correction shall be performed.

For a nominal refraction angle of 60° , a Type A2 series standard test block shall be used without sensitivity adjustment.

B.2.3.7 Method for obtaining the quantity of sensitivity correction

The method for obtaining the quantity of sensitivity correction shall be as follows.

- a) After adjusted to the time base range to be used, the probe to be used for examination and the probe of the same model as that shall be used for the double probe technique.
- b) On the actual test object, the distance between the probes shall be adjusted so that the transmission pulse is highest at the position shown in Figure B.4 a). The height of this maximum transmission pulse shall be adjusted to 50 % and the value of gain, V (dB), shall be read.
- c) The probes shall be arranged at the positions as shown in Figure B.4 b) on reference block, a Type A1 standard test block or a Type A 2 series standard test block, and by the same procedure as described in **b)** above, the distance between the probes shall be adjusted so that the transmission pulse is highest when the receiving probe is at position R_1 . The value of gain, V_1 (dB), which makes the transmission pulse height 50 % and the value of gain, V_2 (dB), which makes the transmission pulse height 50 % at position R_2 shall be read.
- d) In the case where the two path lengths do not agree, as shown in Figure B.4 c), the value of V' on two path lengths which are longer and shorter than the path length in the test object shall be read.
- e) The value $|V' - V|$ shall be taken as the quantity of sensitivity correction.
- f) Correction for the transfer loss is not necessary where the material of the wedge of the angle probe is polystyrene, the couplant used is glycerine paste or glycerol water solution of 75 % (volume fraction 75 %) or more, and the maximum surface roughness of the test surface is 100 μmRz or less.



c) Quantity of sensitivity correction ($V' - V$)
Figure B.4 Method for obtaining the quantity of sensitivity correction

B.2.4 Examination method

B.2.4.1 Test surface

The test surface shall be in accordance with Table B.2. In the case of T joint and corner joint, the test surface, when applying the single probe angle beam technique, shall be on the side where a groove is formed. Examination on other surface may be added, as required.

The faces and sides shall be as shown in Figure B.5.

B.2.4.2 Scanning direction

The scanning shall be made with ultrasonic beams of not less than two directions as shown in Figures B.6 to B.8 so as to avoid overlooking of discontinuities due to their inclination.

B.2.4.3 Scanning method

The probe scanning method shall be as specified in 10.2.1.

B.2.4.4 Range of examination

The scanning range of the probe shall satisfy the range of examination specified in Table B.2.

B.2.4.5 Scanning speed

The scanning speed used shall be appropriate for a sound examination.

B.2.5 Estimation of discontinuity location

In the case where a discontinuity is detected, its location shall be estimated from the probe-to-weld distance, path length, and refraction angle measured according to 9.1.3.

B.2.6 Evaluation of discontinuity

The evaluation of discontinuity shall be as specified in 10.2.2.

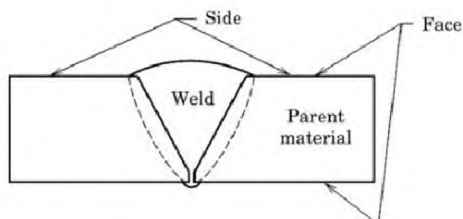
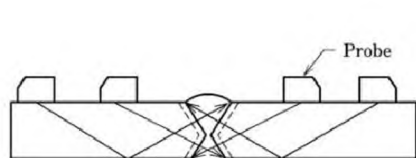
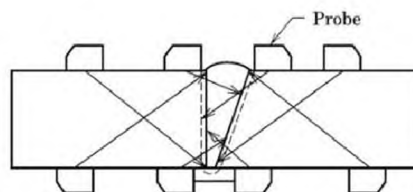


Figure B.5 Faces and sides

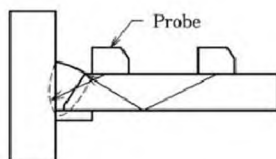


a) Examination of single face/both sides
(when the maximum path length used is
250 mm or less)

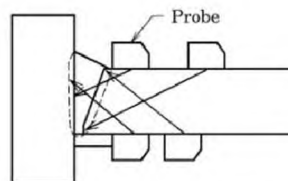


b) Examination of both faces/both sides
(when the maximum path length used is
over 250 mm)

Figure B.6 Example of examination method for butt joint weld



a) Examination of single face/single side
(when the maximum path length used is
250 mm or less)



b) Examination of single face/both sides
(when the maximum path length used is
over 250 mm)

Figure B.7 Example of examination method for T joint weld

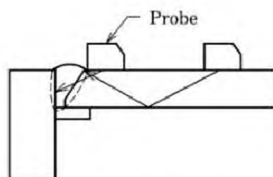


Figure B.8 Example of examination method for corner joint weld of closed section

B.3 Normal beam examination

B.3.1 Reference blocks

The reference test blocks to be used for adjustment of working sensitivity shall be RB-41A or RB-41B shown in Table B.1 and Figure B.1. When the sensitivity adjustment is carried out using an end face, the surface roughness of the end face shall be 25 μmRz or less.

B.3.2 Probe

B.3.2.1 Selection of frequency

The nominal frequencies of the normal probe used shall be in accordance with Table 2.

B.3.2.2 Selection of probe size

The nominal sizes of the transducer of the probe used shall be in accordance with Table 4.

B.3.3 Adjustment of test equipment

B.3.3.1 Adjustment of time base range

The time base range shall be adjusted in accordance with 9.2.1 using the maximum path length which satisfies the range of examination given in Table B.3 or longer, but not excessively long.

Table B.3 Test surface, range of examination and frequency

Type of joint	Test surface	Range of examination	Maximum path length to be used mm	Frequency MHz
T joint	Single face Parent material surface (Figure B.9)	From the test surface to the designed weld penetration area	40 or under	5
			Over 40 up to and incl. 60	2 or 5
			Over 60	2
Corner joint (closed section)	Single face Parent material surface (Figure B.10)	From the test surface to the designed weld penetration area	40 or under	5
			Over 40 up to and incl. 60	2 or 5
			Over 60	2