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**Method for ultrasonic examination for
carbon steel and low alloy steel
forgings**

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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 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 G 0587** : 1995 is replaced with this Standard.

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Method for ultrasonic examination for carbon steel and low alloy steel forgings

Introduction This Japanese Industrial Standard was established in 1987 and has been revised twice until now, the last one of which was done in 1995. Revision at this time is for the purpose of accommodating the improved accuracy of DGS diagram and adding the specifications for artificial flaw for sensibility calibration.

No International Standard corresponding to this Standard has been so far established.

1 Scope This Standard specifies the methods for ultrasonic examination for carbon steel and low alloy steel forgings (hereafter referred to as “steel forgings”) 20 mm or over in thickness and 50 mm or more in radius of outside curvature by means of an ultrasonic flaw detector with pulse echo type of A-scope presentation (hereafter referred to as “test”).

As for stainless steel forgings, this Standard may be applied when the purchaser and the manufacturer agree the test method considering the attenuation of ultrasonic wave.

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 K 2238 *Machine oils*

JIS Z 2300 *Terms and definitions of nondestructive testing*

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

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 in **JIS Z 2300** and the following apply.

3.1 Q-value the central frequency value, divided by the band width, obtained by the frequency analysis by means of the combination of a ultrasonic flaw detector and a ultrasonic probe

4 Examination engineer The engineer in charge of the examination for the steel forging shall be a person qualified by **JIS G 0431**, **JIS Z 2305** or a person having comparable sufficient knowledge, proficiency and experience, and also having adequate knowledge and experience concerning the manufacturing method of the steel forging to be examined, properties of produced flaws and examination thereon.

5 Ultrasonic testing instrument

5.1 Ultrasonic flaw detector The ultrasonic flaw detector used for the testing shall be in accordance with the following.

- a) The ultrasonic flaw detector shall be equipped with a display of A-scope presentation of the pulse echo type and fit for use at a frequency ranging from 1 MHz to 5 MHz.
- b) The vertical linearity shall be measured according to **4.1** of **JIS Z 2352** and the maximum deviation shall be within ± 3 %.
- c) The linearity of the time base shall be measured according to **4.2** of **JIS Z 2352** and the maximum error shall be with ± 1 %.
- d) The gain control shall be of 2 dB or less for each one knob step and not less than 70 dB in total adjustment amount.
- e) As to the display for indication, the indicated display shall be so distinct that it can be clearly identified in the light, and especially the rising and top portions of echo shall be clearly identifiable.
- f) The subsidiary graticule to be fitted to an ultrasonic detector shall be readily detachable with few parallax measurement error.

This rule does not apply to the digital detector without subsidiary graticule.

5.2 Normal incidence probe The normal incidence probe used for the testing shall be in accordance with the following.

- a) The shape of the transducer shall be circular, and its nominal diameter shall be as given in table 1 depending on the nominal frequency of the probe. However, the transducer having a nominal diameter within the range in the parentheses may be used.

Table 1 Nominal frequency of normal incidence probe and nominal diameter of transducer

Nominal frequency MHz	Nominal diameter mm
1	20, 24, 28, 30 (20 to 30)
2 or 2.25	20, 24, 28, 30 (10 to 30)
4 or 5	10, 14, 20, 24, (10 to 25)

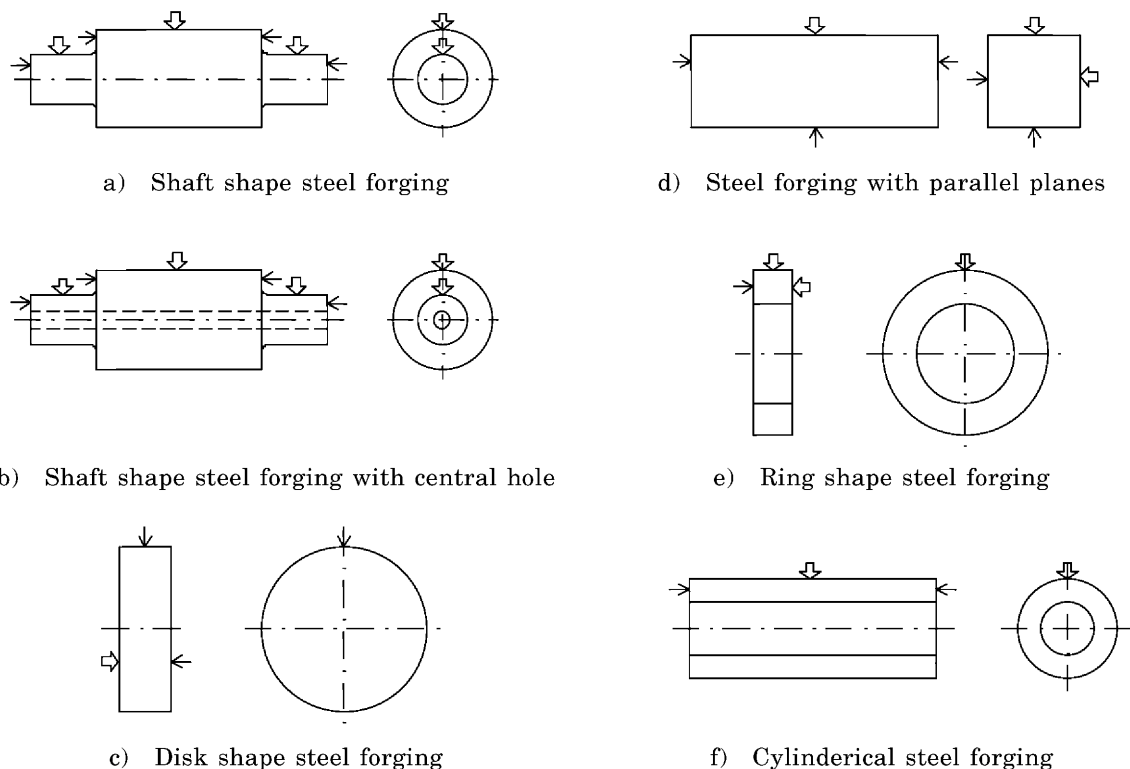
- b) The test frequency shall be in the range of 85 % to 115 % of the nominal frequency.
- c) Q-value of the probe shall be in the range of 1.8 to 3.3 according to the combination of the ultrasonic flaw detector and the probe to be used.
- d) The margin of sensitivity shall be measured according to **4.3** of **JIS Z 2352**, and not less than 30 dB.
- e) The far surface resolution shall be expressed by using RB-RA type test piece of normal detecting far surface resolution specified in **4.4** of **JIS Z 2352**, and 9 mm or less at a frequency not less than 2 MHz.
- f) The soft diaphragm shall be a suitable layer for the test frequency.

6 Method for testing and preparation The method for testing and preparation shall be in accordance with the following:

- a) The test shall be carried out by the straight beam technique of contact scanning. When designated, however, the ring-shaped or cylindrical steel forging of which the ratio of outside diameter to inside diameter is 1.4 or less and the length in axial direction exceeds 50 mm shall be examined by angle beam technique specified in Annex A.
- b) In the case where the evaluation of flaws is estimated by the flaw echo height, the testing shall be made by either the bottom echo method or reference block one. In the case where the evaluation of flaws is estimated by the decrement of the bottom echo, the bottom echo method shall be applied.
- c) The examination shall be carried out prior to cutting groove(s), taper(s), hole(s), or the like, following the heat treatment. In the case where the configuration of the steel forging is not suitable for the examination, however, it may be carried out before heat treatment. In this case, after heat treatment, the area as completely as possible shall be re-examined.
- d) The test surface shall be finished in the state of roughness of 25 μmRz or less specified in **JIS B 0601**, and free from burr, adherence of foreign matters, etc. which will interfere with the testing.
- e) The couplant to be used shall be the machine oil of **ISO VG 46** to 100 specified in **JIS K 2238** or that of equivalent quality. However, if agreed between the purchaser and the supplier, the glycerin paste or glycerin solution or any couplant equivalent to these may be used.

7 Testing environment The testing environment shall be in accordance with the following:

- a) The scanning shall be carried out along the basic scanning direction as shown in figure 1 corresponding to the manufacturing method of the steel forging. The examination in complementary scanning direction shall be carried out, as necessary.
- b) The flaw detection area shall be either whole area or specific area taking into consideration the kind, direction, size of flaws to be detected and also the degree of influence in practical use.



NOTE : $\longleftrightarrow$: basic scanning direction
 $\leftarrow$: complementary scanning direction

Figure 1 Scanning direction

- c) The scanning method with the probe shall be any one of the following concerning the designated flaw detection area.
 - 1) Full surface
 - 2) On some specific line
 - 3) Points at some specific spaces
- d) In the case where the full surface is detected, the scanning pitch of the probe shall be 85 % or less of the nominal diameter of the transducer.
- e) The scanning speed of the probe shall be 150 mm or less per second.
- f) The frequency used for testing shall be 1 MHz, 2 MHz, or 2.25 MHz. However, in the case where the test is carried out for the part 100 mm or less in thickness or the vicinity of the test surface, 4 MHz or 5 MHz may be used.

8 Measurement of attenuation coefficient Prior to the testing, the attenuation coefficient shall be measured at three representative places within the portion to be tested with a probe which will be actually used for the testing. The attenuation coefficient shall be computed from the formula (1).

$$\alpha = \frac{[-(B_1 - B_2)] - L}{2 \times T} \dots\dots\dots (1)$$

where,

- α : attenuation coefficient (dB/m)
- B_1 : first bottom echo height (dB)
- B_2 : second bottom echo height (dB)
- L : divergence loss of bottom echo (dB) The value obtained from DGS diagram shown in any one of figures 10 to 28 corresponding to the probe used. When B_1 is within the far field no less than 4 times the near field distance limit, it is 6 dB.
- T : thickness of the steel forging (m)

9 Adjustment of working sensitivity

9.1 General In the case where the evaluation of flaws is estimated by the flaw echo height, the adjustment of the working sensitivity shall be carried out in accordance with **9.2** or **9.3**. In the case where the evaluation of flaws is estimated by the decrement of the bottom echo, the first bottom echo height (B_G) of the sound area shall be set to 100 % on the graticule and take it as the working sensitivity.

9.2 Bottom echo method

9.2.1 Adjustment of working sensitivity

- a) The adjustment of the working sensitivity shall be carried out for each part of different diameter or thickness, and the first bottom echo height (B_G) of the sound area shall be set to 80 % on the graticule of the display for indication.
- b) The sensitivity shall be increased by the correction amount of sensitivity (dB) shown in figures 2 to 4 so that the echo height due to a disc type flaw 4 mm in diameter within the flaw detection area becomes at least 10 % of the screen height on the graticule of the display for indication. With this respect, in the case of examination of single surface, half-circumference of the shaft shaped steel forging and the shaft shaped steel forging with a central hole, the correction amount of sensitivity concerning the back wall shall be used. In these cases, the flaw detectable area shall be up to the diameter or thickness. In another case, the correction amount of sensitivity concerning the centre shall be used, and the flaw detectable area shall be up to half of the diameter or thickness.
- c) In the case of examination in diameter direction of the shaft shaped steel forging with central hole, the correction amount of sensitivity given by **b)** shall be desensitized by the compensation amount for curvature (dB) of the bottom echo due to the central hole as shown in figure 5.
- d) The sensitivity determined by the adjustment given in **a)** to **c)** shall be taken as the working sensitivity. In the case where the summation of the correction amount of sensitivity determined by **b)** and the compensation amount for curvature determined by **c)** becomes minus, however, the setting of sensitivity given by **b)** and **c)** shall not be performed.

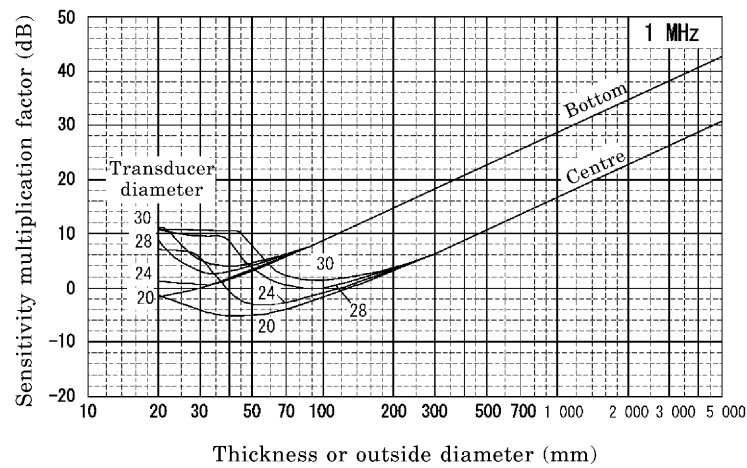


Figure 2 Sensitivity multiplication factor for 1 MHz in frequency and 20 mm, 24 mm, 28 mm in and 30 mm nominal diameter of transducer

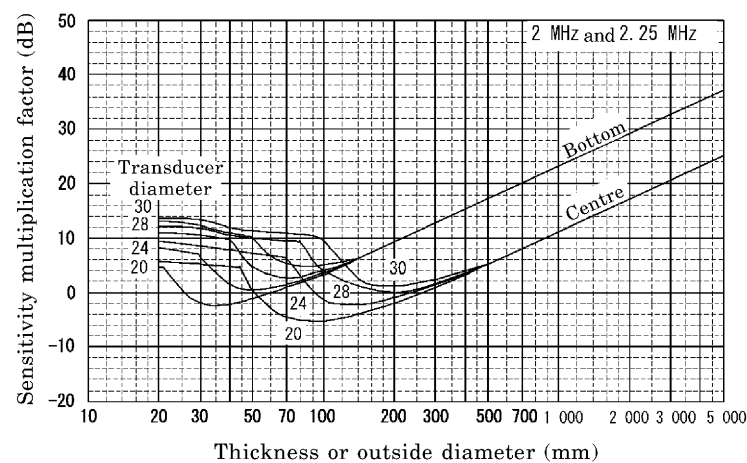


Figure 3 Sensitivity multiplication factor for 2 MHz in frequency and 20 mm, 24 mm, 28 mm and in 30 mm nominal diameter of transducer