RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

RULES

Part K Materials

2013 AMENDMENT NO.1

Rule No.38 30th May 2013

Resolved by Technical Committee on 4th February 2013

Approved by Board of Directors on 4th March 2013

Rule No.38 30th May 2013
AMENDMENT TO THE RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Rules for the survey and construction of steel ships" has been partly amended as follows:

Part K MATERIALS

Chapter 7 COPPER AND COPPER ALLOYS

7.2 Copper Alloy Casting

Table K7.4 has been amended as follows.

Table K7.4 Chemical Composition(%)

Grade	*Cu*	*Al*	*Mn*	*Zn*	*Fe*	*Ni*	*Sn*	*Pb*
*KHBsC*1	52～62	0.5～ 3.0	0.5～ 4.0	35～40	0.5～2.5	1.0 max.	~~0.1～~~1.5 max.	0.5 max.
*KHBsC*2	50～57	0.5～ 2.0	1.0～ 4.0	33～38	0.5～2.5	2.5～8.0	~~0.1～~~1.5 max.	0.5 max.
*KAℓBC*3	77～82	7.0～11.0	0.5～ 4.0	1.0 max.	2.0～6.0	3.0～6.0	0.1 max.	0.03 max.
*KAℓBC*4	70～80	6.5～ 9.0	8.0～20.0	6.0 max.	2.0～5.0	1.5～3.0	1.0 max.	0.05 max.

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 30 May 2013.

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE

Part K Materials

2013 AMENDMENT NO.1

Notice No.28 30th May 2013

Resolved by Technical Committee on 4th February 2013

Notice No.28 30th May 2013
AMENDMENT TO THE GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Guidance for the survey and construction of steel ships" has been partly amended as follows:

Part K MATERIALS

Annex K6.1.10(1) GUIDANCE FOR ULTRASONIC TESTS OF STEEL FORGINGS

Section 1.1 has been amended as follows.

1.1 Application

(1) This Guidance applies to the ultrasonic testing of steel forgings such as crankshafts, propeller shafts, intermediate shafts, turbine rotor shafts ~~and~~, rudder stocks and pintles specified in **6.1.10-1, Part K of the Rules** (hereinafter referred to as the "steel forgings").
(2) To steel forgings other than those concretely specified in this Guidance, the requirements in this Guidance are to apply correspondingly in consideration of their kind, shapes and stress conditions being subjected.

Section 1.2 has been amended as follows.

1.2 Timing of Ultrasonic Tests

The ultrasonic testing is to be carried out at such time when the whole area of steel forgings is ready for testing after the final heat treatment to obtain the specified mechanical properties. For turbine rotor shafts, positions where taper grinding is to be done are, in principal, to be step milled (to a rectangular shape) first and then flaw detected. When the ultrasonic testing is not available after the final heat treatment due to product shape processed by such as machining of grooves between disks, etc. before the final heat treatment, the testing is to be carried out before the process and also after completing the heat treatment on the whole area as far as practicable.

Section 1.3 has been amended as follows.

~~**1.3 Performance of Flaw Detector**~~

~~Ultrasonic flaw detector is to conform to a national standard or such standard considered appropriate by the Society and, in addition, to comply with the following requirements:~~

~~**1.3.1 Frequency**~~

~~The frequency range to have capability for examining is to be at least from 1 to 5*MHz*.~~

1.3.2　　Probe

The transducer is to be made of barium titanate, lead zirconate titanate or crystal, and its diameter is to be 24 to 28*mm* for 1 and 2 ~ 2.25*MHz* frequency band, and 20 to 25*mm* for 4 ~ 5*MHz*. As the transducer, soft protective membrane may be applied to the probe.

1.3.3　　Cable

The cable length is, in principle, to be 3 or 5*m* as the standard length of the attached cable of each detector. The permissible deviation of cable length is to be within 6 10%.

1.3.4　　Gain Controller or Attenuater

The ultrasonic flaw detector is to contain a gain controller or to be connected to an attenuater.

1.3.5　　Reserving Gain

The difference of the attenuation on the gain controller or the attenuator in the following states **(1)** and **(2)** is to be 30*dB* or more, under the measuring conditions that the pulse width is minimized at a frequency of 2 or 2.25*MHz* with rejection being set to "0" or "OFF."

(1) A state where the sensitivity is at its maximum. When electrical noise is significant, the sensitivity is to be lowered so that the noise assumes 10% or less.

(2) A state where the flaw echo height of the standard test block *SII* specified in **1.2.7** of the **Annex K5.1.9(1)** "GUIDANCE FOR ULTRASONIC TESTS AND SURFACE INSPECTION OF HULL STEEL CASTINGS" is calibrated to 50% on the graticule.

1.3.6　　Dead Zones

A length of the dead zone is to be 20*mm* or less as a estimated distance in steel at a total sensitivity calibrated to 50% or more for the flaw echo height of the standard test block *SI* at a frequency of 2 or 2.25*MHz*. In this case, the measurement of length of the dead zone is to be taken at a position of 20% on the graticule.

1.3.7　　Noise Level

The noise level is to be 5% or less on the graticule at a total sensitivity calibrated to 80% or more for the flaw echo height of the standard test block *SI* at a frequency of 2 or 2.25*MHz*.

1.3.8　　Amplitude Linearity

The linearity of the amplifier and of the output on CRT against input is to satisfy the following requirements in **(1)** and **(2)** when the echo from an reflection source is set near the centre on the graticule at a sensitivity calibrated to 100% for the echo height at a frequency of 2 or 2.25 *MHz* with rejection being set to "0" or "OFF".

(1) Measuring the echo height at every step of 2*dB* by increasing attenuation up to 26*dB*, the deviation between reference value (%) specified in the Table below and measured value (%) for each echo height is to comply with the following formula:

$d(+), d(-) \leqq 3$

where

$d(+)$ = 5 Absolute value (%) of the positive maximum deviation between the reference value (%) and measured value (%) within 2 ~ 26 *dB* (*See* **Table 1**) of attenuation

$d(-)$ = 5 Absolute value (%) of the negative maximum deviation between the reference value (%) and measured value (%) within 2 ~ 26*dB* (*See* **Table 1**) of attenuation

(2) Further, it is to be verified that the echo still exists at the attenuation of 30*dB*.

Table 1

Attenuation (*dB*)	0	2	4	6	8	10	12
Reference echo height(%)	100.0	79.4	63.1	50.1	39.8	31.6	25.1
Attenuation (*dB*)	14	16	18	20	22	24	26
Reference echo height(%)	20.0	15.8	12.5	10.0	7.9	6.3	5.0

1.3.9 Linearity of Time Base

The linearity of the time base is to be verified by the method specified in **(1)** through **(4).**

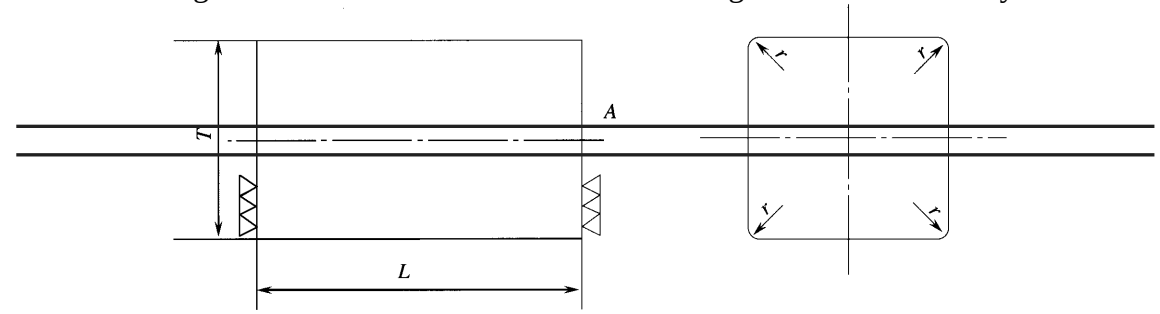
(1) The first6th base echoes (excluding transmission pulse) are to be displayed on the time base, putting a probe on surface *A* of the standard test block given in the following **(3)** with rejection being set at "0" or "OFF" at a frequency of 5*MHz*. These base echoes are to denote B_1 to B_6.

(2) The graticule is to be divided into five equal parts on the width used for ultrasonic detection and put graduations 0 and 50, and each of the five equal parts is to be further divided into ten equal parts. The time base is to be adjusted so that the left sides of B_1 and B_6 are located to the graduations of 0 and 50 respectively. The sensitivity is to be so calibrated that the height of B_6 echo is above 50% on the graticule.

(3) Tests are to be carried out for the standard test blocks LI, LII, LIII and LIV specified in **Fig. 1**, respectively. The material, surface treatment, etc. of the standard test blocks are to be equal to the standard test blocks specified in **1.2.7 of the Annex K5.1.9(1)** "GUIDANCE FOR ULTRASONIC TESTS AND SURFACE INSPECTION OF HULL STEEL CASTINGS".

(4) The maximum value of a_2 ~ a_5, which are the deviations between the left sides of the echoes of B_2 ~ B_5 and the graduations of 10 ~ 40 respectively (See **Fig. 2**), is to be a half graduation or less.

Fig. 1 Standard Test Blocks for Measuring Time Base Linearity

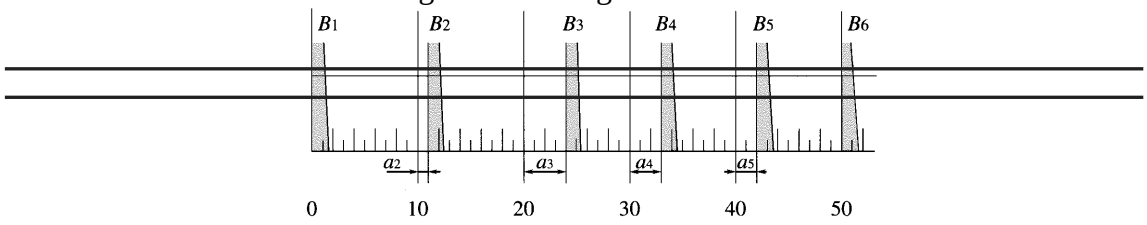


Unit (*mm*)

Kind	L	T	r
LI	15	60	< 12
LII	40		
LIII	100		
LIV	5 ℓ		

Note) ℓ : length of the inspected span

Fig. 2 — Reading of Deviations



1.3.10 — Long Distance Resolution

The value of h_2/h_1 obtained from the following procedures specified in **(1)** and **(2)** be 30*dB* or more.

(1) Putting a probe on the standard test block A1 specified in **Fig. 3** at the position shown in **Fig. 4**, to displace the three echoes, A, B and C on the CRT at a frequency of 2 ~ 2.25*MHz*.

(2) Then, moving the probe back and forth to adjust the echoes form B and C in a uniform height, and measuring the value of h_2/h_1 shown in **Fig. 5** and **Fig. 6** by the attenuator.

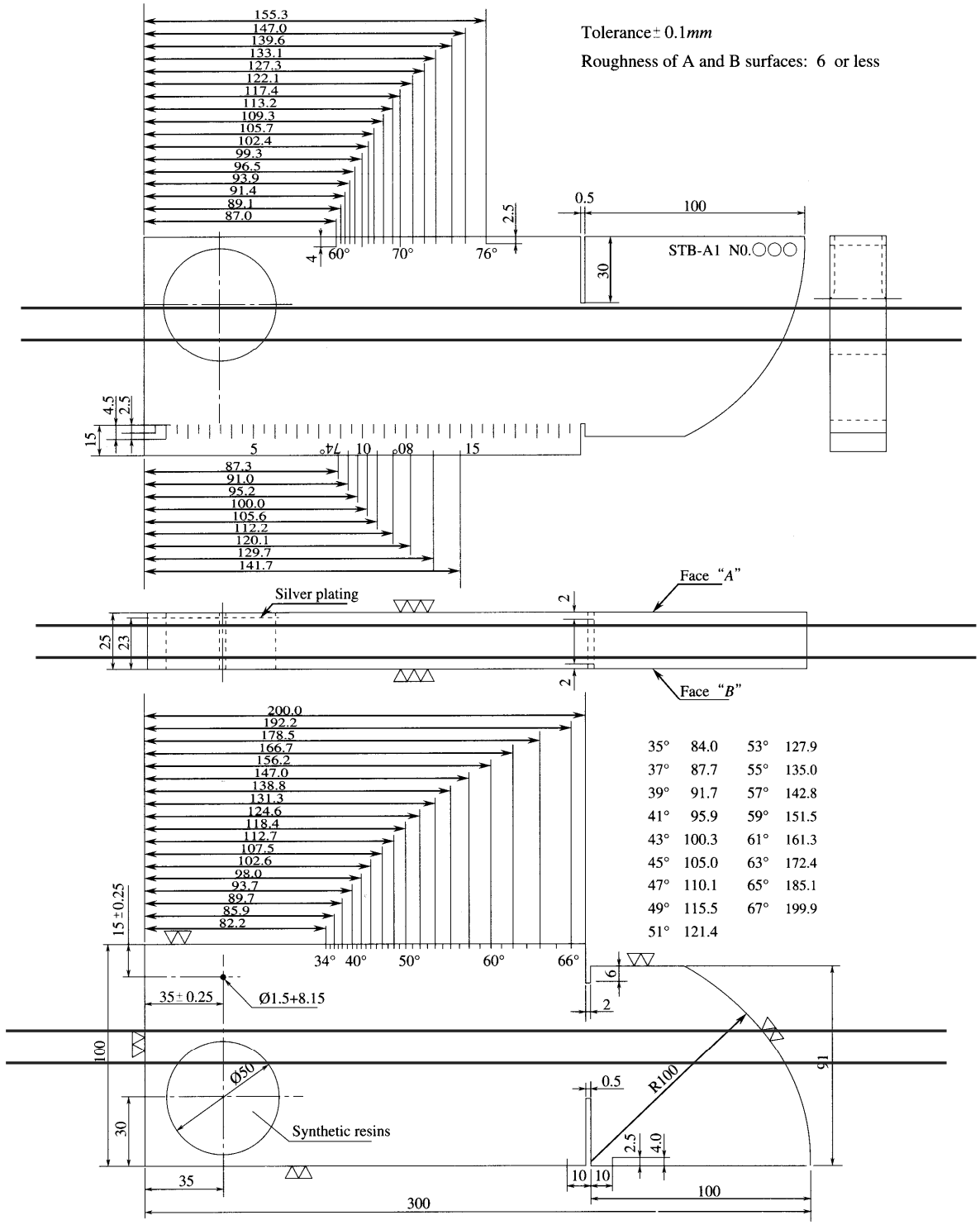
1.3.11 — Distance Amplitude Characteristics

The flaw detector is to have a distance amplitude characteristic such that the echo height from a standard artificial flaw is not to deviate over the allowance shown in **Table 2** at a frequency of 2 or 2.25*MHz* and at a test distance range between 50 and 500*mm*. The standard artificial flaws are provided in a test piece of which material is to be a normalized *KSF* 45 ~ *KSF* 55 without macro-segregation, with accoustic uniformity. One of examples of the test piece is shown in **Fig. 7**. When a material other than the above is used, the accoustic characteristics are to be considered. Diagrams of the distance amplitude characteristic are to be submitted at need.

1.3.12 — Maintenance

The performance of ultrasonic flaw detector is to be checked to verify if they meet these requirements at least once every year and where maintenance, repair or parts replacements, etc. which may affect its performance are made.

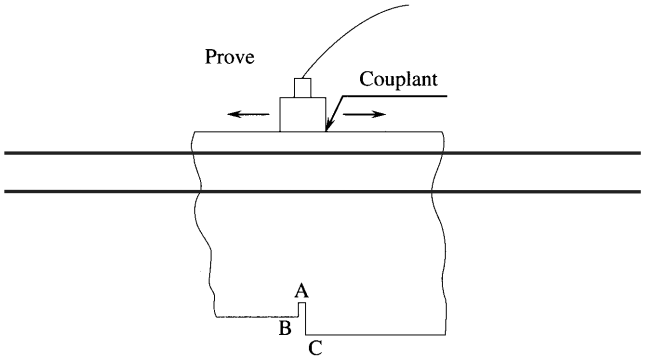
~~Fig. 3 Standard Test Block A-1 (unit: *mm*)~~



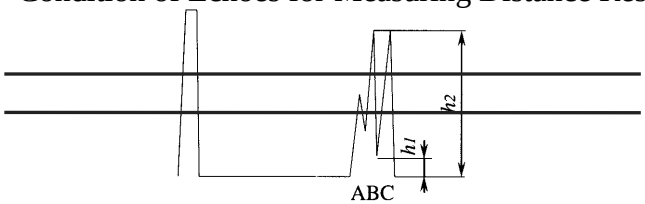
~~Materials:~~

~~The material of the test block is to be a normalized *KE* (restricted to fine-grained killed steels) specified in **3.1, Part K of the Rules**, of which number of austenite grains is 1024 or more per 1*mm*^{2}.~~

~~Fig. 4 Position of Probe~~



~~Fig. 5 Condition of Echoes for Measuring Distance Resolution~~



1.3 Flaw Detector Performance

Ultrasonic flaw detectors are to conform to national standards or such standards considered appropriate by the Society (e.g., *JIS Z* 2344(“General rule of ultrasonic testing of metals by pulse echo technique”)) and, in addition, are to comply with the following requirements:

1.3.1 Gain Controllers or Attenuators

Gain controllers or attenuators are to be built-in or connected to flaw detectors. The amount of adjustment for a single step is to be 2*dB* or less and the total amount of adjustment is to be 70*dB* or more.

1.3.2 Margin of Sensitivity

The margin of sensitivity is to be calibrated in accordance with *JIS Z* 2352 (“Method for evaluating performance characteristics of ultrasonic pulse-echo testing systems”) at a frequency of 2 or 2.25*MHz* and to be 30*dB* or more.

1.3.3 Amplitude Linearity

Amplitude linearity is to be calibrated in accordance with *JIS Z* 2352 (“Method for evaluating performance characteristics of ultrasonic pulse-echo testing systems”) at a frequency of 2 or 2.25 *MHz* and to be within ±3%.

1.3.4 Linearity of Time Base

Linearity of time base is to be calibrated in accordance with *JIS Z* 2352 (“Method for evaluating performance characteristics of ultrasonic pulse-echo testing systems”) and to be within ±1%.

1.3.5 Far Surface Resolution

Far surface resolution is to be within 9*mm* calibrated by a RB-RA type reference block in accordance with *JIS Z* 2352 (“Method for evaluating performance characteristics of ultrasonic

pulse-echo testing systems").

1.3.6 Distance Amplitude Characteristics

Flaw detectors are to have distance amplitude characteristics such that the echo heights from standard artificial flaws (drilled hole: diameter 3*mm*×length 30*mm*) do not deviate over the allowance shown in **Fig. 1** and **Table 1** at a frequency of 2 or 2.25*MHz* and at a test distance range from 50 to 500*mm*. Standard artificial flaws are to be provided in test pieces whose material is to be normalized *KSF* 45 ~ *KSF* 55 without macro-segregation with acoustic uniformity. An example of such a test piece is shown in **Fig. 2**. When materials other than those above are used, acoustic characteristics are to be considered. Diagrams of distance amplitude characteristics are to be prepared in advance and available to be submitted if necessary.

Fig. ~~6~~1 Distance Characteristic of Echo Height from Standard Artificial Flaw

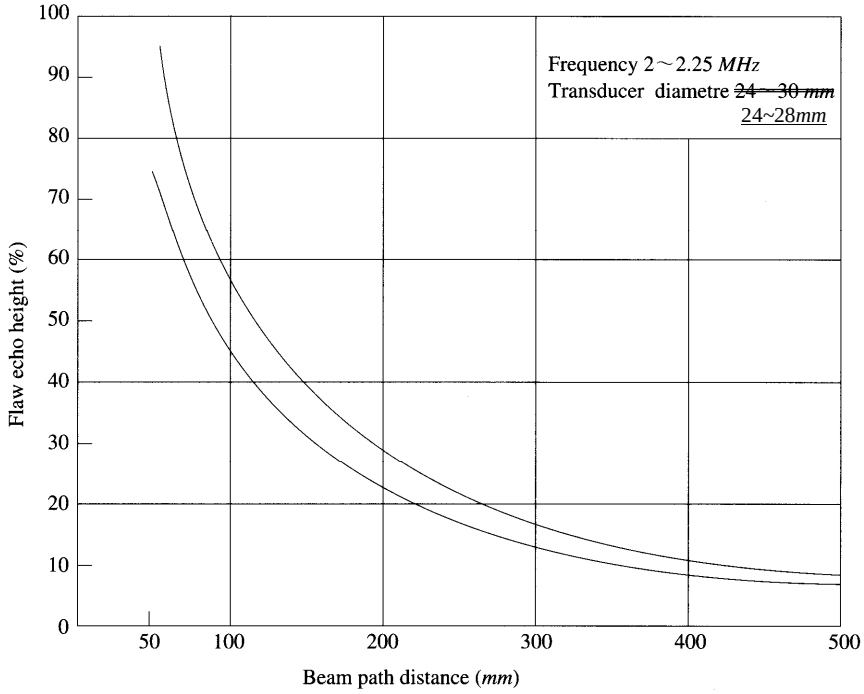
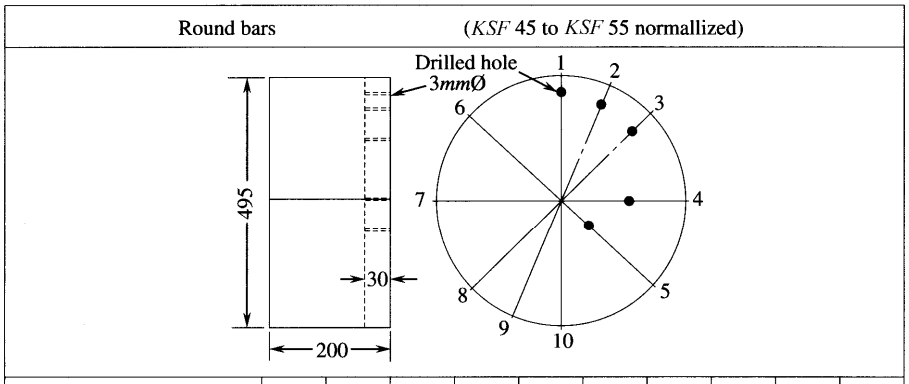


Table ~~2~~1 Distance Characteristic of Echo Height from Standard Artificial Flaw

Beam path distance(*mm*)	Flaw echo height	
	Allowable range	
	Upper limit(%)	Lower limit(%)
50	95	75
100	55	45
200	28	22
300	17	13
400	11	9
500	8	7

Fig. ~~7~~2 Test Piece for Measuring Distance Amplitude Characteristic (including artificial flaw)



Flaw No.	1	2	3	4	5	6	7	8	9	10
Beam path distance (*mm*)	25	50	100	150	200	295	345	395	445	470

Section 1.4 has been amended as follows.

1.4 Testing Procedure

The testing procedure is to be as given in **Table ~~3~~2**.

Table 3 has been amended as follows.

Table ~~3~~2 Ultrasonic Testing Procedures

Item	Scanning zone	Roughness of scanning surface(1)	~~Couplant~~ Contact medium	~~Frequency~~ Probe(2)	Scanning sensitivity	Evaluation sensitivity(3)(4)	Scanning method(5)
Crank shaft	Whole surface (*See* **Fig. ~~8~~3**)	Pin and journal parts: approx. ~~25~~6.3 *μmRa* or 25 *μmRz* (finished surface by spring-necked turning tool) Arm parts: approx. ~~35~~8.8 *μmRa* or 35 *μmRz*	Machine oil or ~~oily liquids with the compatible viscosity~~ oil medium which has the equivalent viscosity.(7)	Frequency: 2 ~ 2.25 *MHz* Transducer diameter: 20~28 *mm*	The scanning sensitivity is to be set by increased by 6 *dB*, after being calibrated the evaluation sensitivity.	The evaluation sensitivity is to be calibrated on each scanning section so that the first bottom echo height from an sound area is to be adjusted to 80% on the graticule.	Scanning speed is to be less than or equal to 150 *mm/s* by hand and scanning is to be over lapped more than or equal to 25% of the transducer diameter
Propeller shaft, ~~I~~intermediate shaft, ~~T~~thurst shaft	*See* **Fig. ~~9~~4**			~~Axialscanning:1 MHz Radical scanning~~ Frequency: 2 ~~to~~~2.25 *MHz* Transducer diameter: 20~28 *mm*			Scanning speed is to be less than or equal to150 *mm/s*
Connecting rod, ~~P~~piston rod ~~C~~crosshead	*See* **Fig. ~~10~~5**	Approx. ~~35~~12.5 *μmRa* or 50 *μmRz*					
Rudder stock, pintle	*See* **Fig. ~~11~~6**						

Turbine rotor shaft	Whole External Surface(6)	Approx.~~25~~6.3 *μmRa* or 25 *μmRz* (finished surface by spring-necked turning tool)		Frequency: 2 ~ 2.25 *MHz* Transducer diameter: 20~28 *mm*	The sensitivity is to be ~~caliblated~~calibrated on each scanning section so that the first bottom echo height from a sound area is to be adjusted to 100% of the graticule, and then increased by the gain controller or attenuator by a multiplier shown in **Fig.~~12~~7** according to the outside diameter and the centre bore diameter of each scanning section.	Scanning speed is to be less than or equal to 150 *mm/s* by hand and scanning is to be over lapped more than or equal to 25% of transducer diameter

Notes:

(1) Scanning surface is not to be covered with anything (gauges, chips, paints, etc.) that hinders proper flaw detection.

(2) Soft-faced probes may be to be used if necessary.

~~1~~(3) If the bottom echo with required height cannot be obtained due to configuration of the bottom surface, the evaluation sensitivity may be calibrated on a position having the similar dimension.

~~2~~(4) The pulse width is to be adjusted to the minimum at the required sensitivity, and rejection is to be set to "0" or "OFF".

(5) The proximity of steel forgings (except turbine rotor shafts) is to be detected again by evaluation sensitivity when abnormal echoes are detected during scanning evaluations by scanning sensitivity. Scanning techniques or conditions may be changed as needed in order to identify the causes of abnormal echoes and obtain information needed for final evaluation.

(6) Axial scanning may be conducted as needed.

(7) Contact mediums are to be equivalent to the *ISO VG* 46~100 specified in *JIS K* 2238.

1.5 Evaluation

Paragraph 1.5.1 has been amended as follows.

1.5.1 Divisions

The scanning zone is divided as given in **Table ~~4~~3** according to the item of products.

Table 4 has been amended as follows.

Table ~~4~~3 Divisions for Each Item

Item	Division
Crankshaft	Three divisions of zone I, II and III shown in **Fig. ~~8~~3**
Propeller shaft, intermediate shaft, thrust shaft	Two divisions of zone II and III shown in **Fig. ~~9~~4**
Connecting rod, piston rod, ~~C~~crosshead	Two divisions of zone II and III shown in **Fig. ~~10~~5**
Rudder stock, pintle	One division of zone III shown in **Fig. ~~11~~6**
Turbine rotor shaft	One division of I for the whole zone

Paragraph 1.5.2 has been amended as follows.

1.5.2 Acceptance Criteria

(1) Crankshafts or turbine rotor shafts, are to be rejected when indications equal to or exceeding the bottom echo height are detected in the zone I, or when the bottom echo height becomes 10% or less on the graticule due to other than geometric configurations in all zones.

(2) Other products than **(1)** are to be rejected when the bottom echo can not be obtained due to other than geometric configurations.
(3) In addition to the above requirements, when indications are detected, acceptance or rejection is to be decided according to **Table ~~5~~4**.
(4) When indications which do not comply with the acceptance criteria given in **Table ~~5~~4** are detected, the evaluation is to be made from overall ~~judgements~~ judgments through the results of detections by using different frequencies and probes, non-destructive testing, etc. and especially, for turbine rotor shafts, the following items:
   (a) Estimation of the size of flaws by taking into account the factors as attenuation and direction of flaws, etc.
   (b) Investigation on degree of cluster of flaws
   (c) Detections by other frequencies
   (d) Calculation of critical flaw size in relation to working stresses at the location of flaws and fracture toughness of the material, etc.

Table 5 has been amended as follows.

Table ~~5~~4 Acceptance Criteria

Item	Criteria diagram	Zone	Acceptance criteria
Crankshaft	**Fig. ~~13~~8**(1)	I Class *AA* and Class *A*(~~1~~2)	No indications
		I Others(2)	Reference line I-2 or less
		II	Reference line II-2 or less
		III	Reference line III-2 or less
Propeller shaft, intermediate shafts, thrust shaft~~, rudder stock~~	**Fig. ~~14~~9**(1)	II exterior part(3) ~~III exterior part(3)~~	Reference line II-1 or less ~~Reference line III-1 or less~~
		III exterior part(3)	Reference line III-1 or less
Rudder stock, pintle, ~~C~~connecting rod, piston rod, ~~C~~crosshead	**Fig. ~~14~~9**(1)	II	Reference line II-1 or less
		III	Reference line III-1 or less
Turbine rotor shaft	**Fig. ~~15~~10**	I	An isolated flaw indication(4): Reference line II-2 or less
			Clustered flaw indication(4): Reference line I-2 or less

Notes:
(1) The evaluation of indications detected in a range of not more than 50*mm* or not less than 500*mm* of beam path distance is to be made by examining the results of detections using different frequencies and/or probes, non-destructive test~~ings~~ of their surface, etc.
(2) Division of the Class is to be in accordance with the **Annex K5.1.9(2)** "GUIDANCE FOR SURFACE INSPECTION OF DIESEL ENGINGE CRANKSHAFTS".
(3) The exterior part means the part beyond one-third of the shaft radius from the centre of axis.
(4) ~~The~~ "~~c~~Clustered flaw indications" means flaw echoes which are above the dotted-line shown in **Fig.10** and those consisting ~~from~~ of more than five flaw indications within 50*mm* equivalent to a distance in steel on time base, and indications in number less than the above is termed the "isolated flaw indication".

1.6 Recording

Paragraph 1.6.1 has been amended as follows.

1.6.1 Indication of Examination Results

(1) Examination results on steel forgings except turbine rotor shafts are to be recorded in accordance with the following ~~**Fig. 16 ~ Fig. 19**~~ **Fig. 11 and Fig. 12** ~~**on**~~ for each section being

examined. Flaw indications ~~of which~~ whose height is equal to or ~~bellow~~ below 50% of each reference line ~~may~~ do not ~~be~~ require~~d~~ recording.
All flaw indications which ~~are~~ require~~d to describe~~ remarks(~~1~~), and scanning positions where the bottom echo height is equal to ~~bellow~~ 50% or below at the evaluation sensitivity on the graticule due to ~~other than~~ geometric configurations ~~at the evaluation sensitivity~~, are to ~~be recorded~~ have the~~ir~~ locations and extens~~ion~~ts of their defective areas recorded.
Where there are no flaw indications ~~to be recorded~~, only ~~the~~ scanning sensitivity results, ~~at the scanning sensitivity may be recorded~~ as ~~a typical figure according to~~ for the representative shape shown in **Fig. ~~16~~11** ~~below~~, are need to be recorded.
~~Note:~~
~~(1) "Indications which are required to describe remarks" means those of being clustered or continued, even when the height is within the allowable range.~~
(2) For turbine rotor shafts, ~~All~~ all isolated flaw indications exceeding the Reference line I-2 and clustered flaw indications exceeding the broken line in **Fig. ~~15~~12** are to be recorded ~~by~~ in accordance with the following ~~**Fig. 16 ~ Fig. 19**~~ **Fig. 13 and Fig. 14** In ~~this~~ such case~~s~~, flaw indications which ~~are~~ require~~d to describe~~ remarks are to ~~be clearly indicated for~~ have the~~ir~~ location~~s~~ and extens~~ion~~t of their defective areas clearly indicated. Any flaw indications exceeding 100% are to be indicated in % by using the gain controller or attenuator.

Note:
"Flaw indications which require remarks" means those clustered or continued, even when their height is within the allowable range.

Paragraph 1.6.2 has been amended as follows.

1.6.2 Report

The report~~s~~ are to include at least the following items.
(1) Hull number
(2) Drawing number
(3) Order number
(4) Heat number
(5) Manufacturing number
(6) Type of steel
(7) Product name and type
(8) Sketch showing the physical outline of the forging and scanning position (*T* and *B* of steel ingot are to be specified)
(9) Date of examination
(10) Timing of examination
(11) Name and type of flaw detector
(12) Frequencies
(13) Kind and size of probe
(14) Surface roughness
(15) Scanning sensitivity
(16) Pulse width (equivalent to a distance in steel)
(17) Couplant
(18) Flaw ~~I~~indication results (echo height, distribution and position)
(19) Name of the operator
(20) Comment and signature of the supervisor

Fig. 8 has been amended as follows.

Fig. ~~8~~3 Divisions of Crankshafts

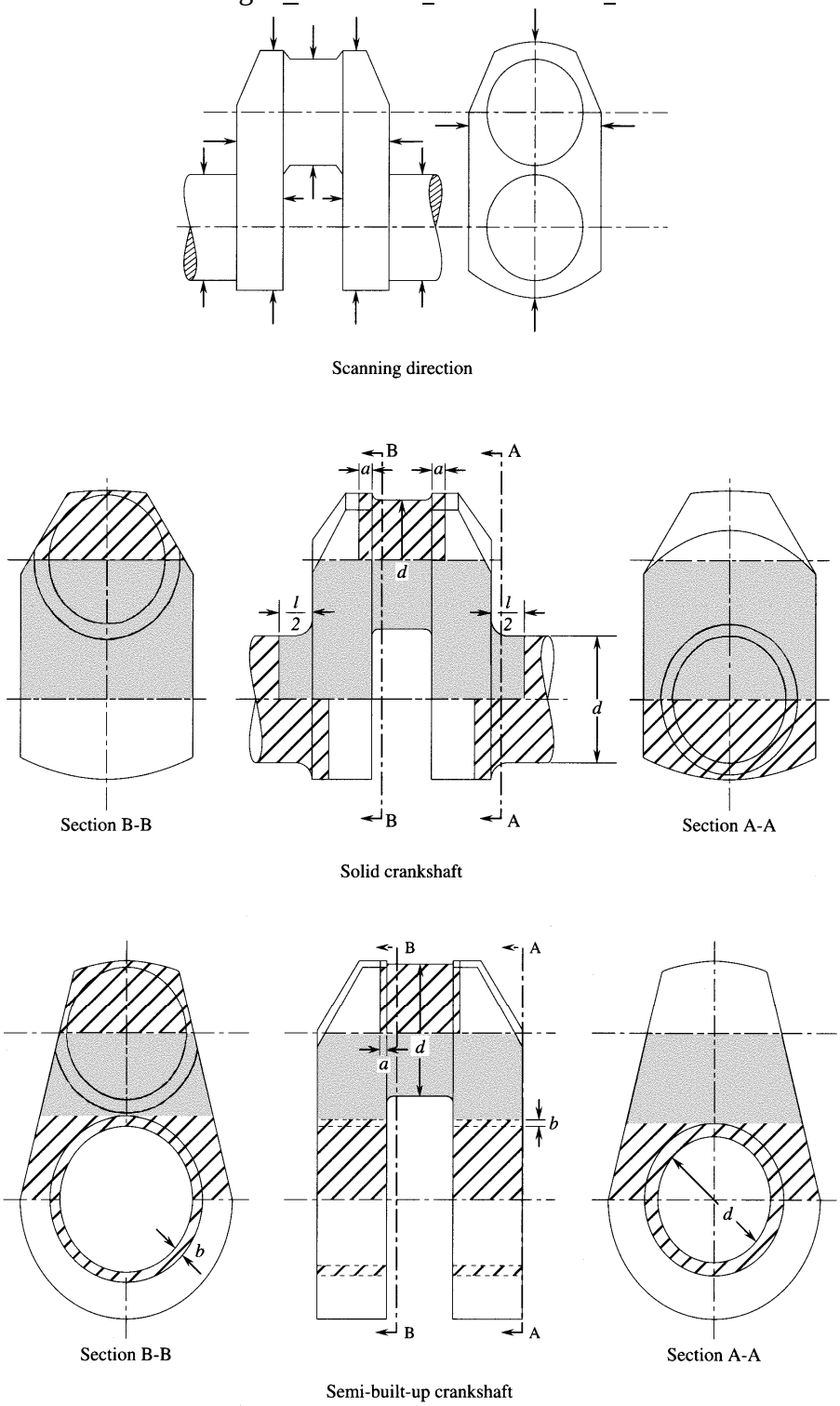
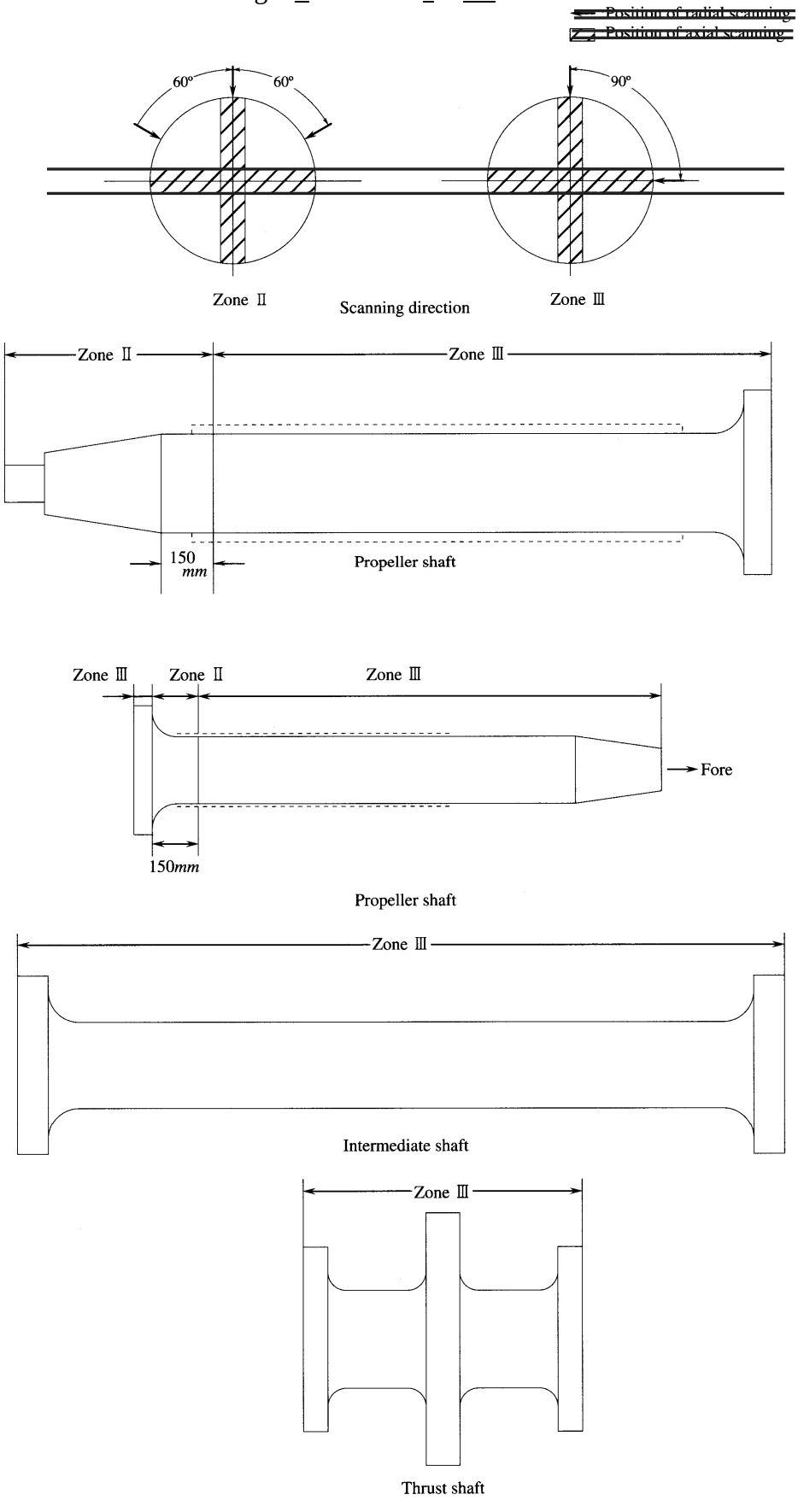
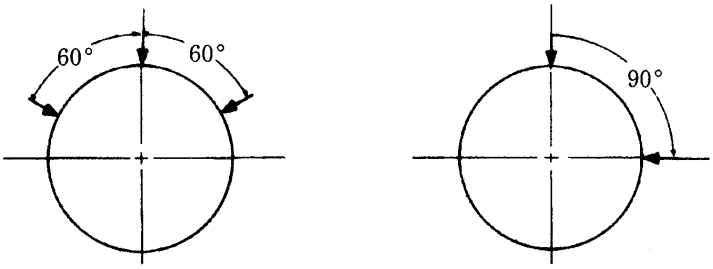
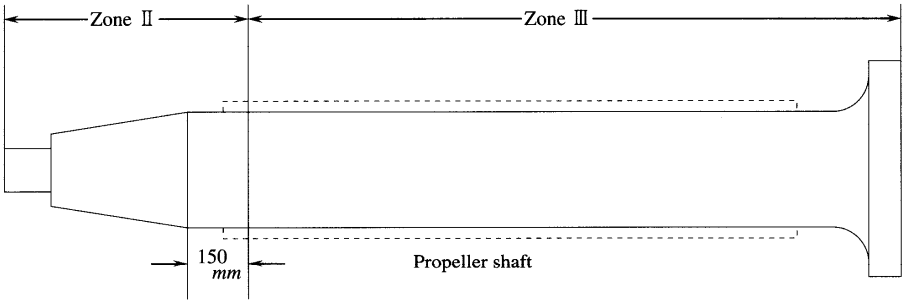


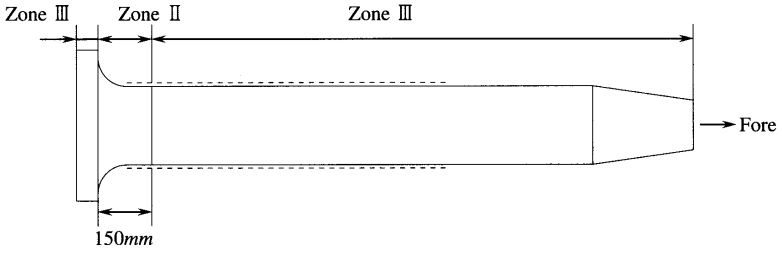
Fig. 9 has been amended as follows.

Fig. ~~9~~4 Divisions ~~of~~for Shafts

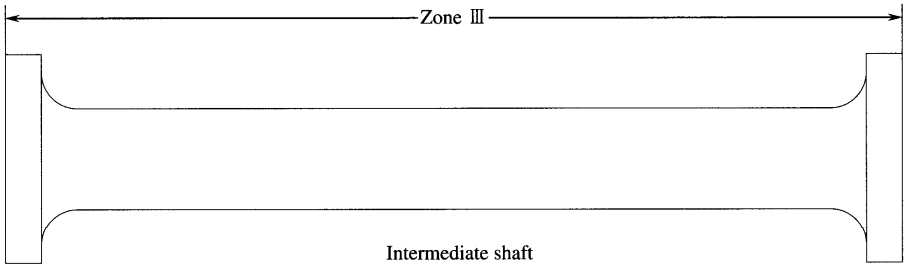




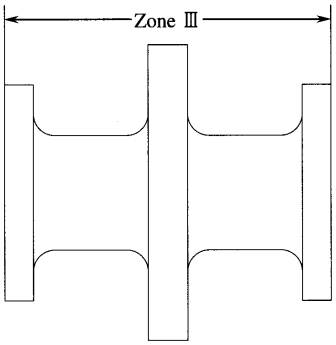




Propeller shaft



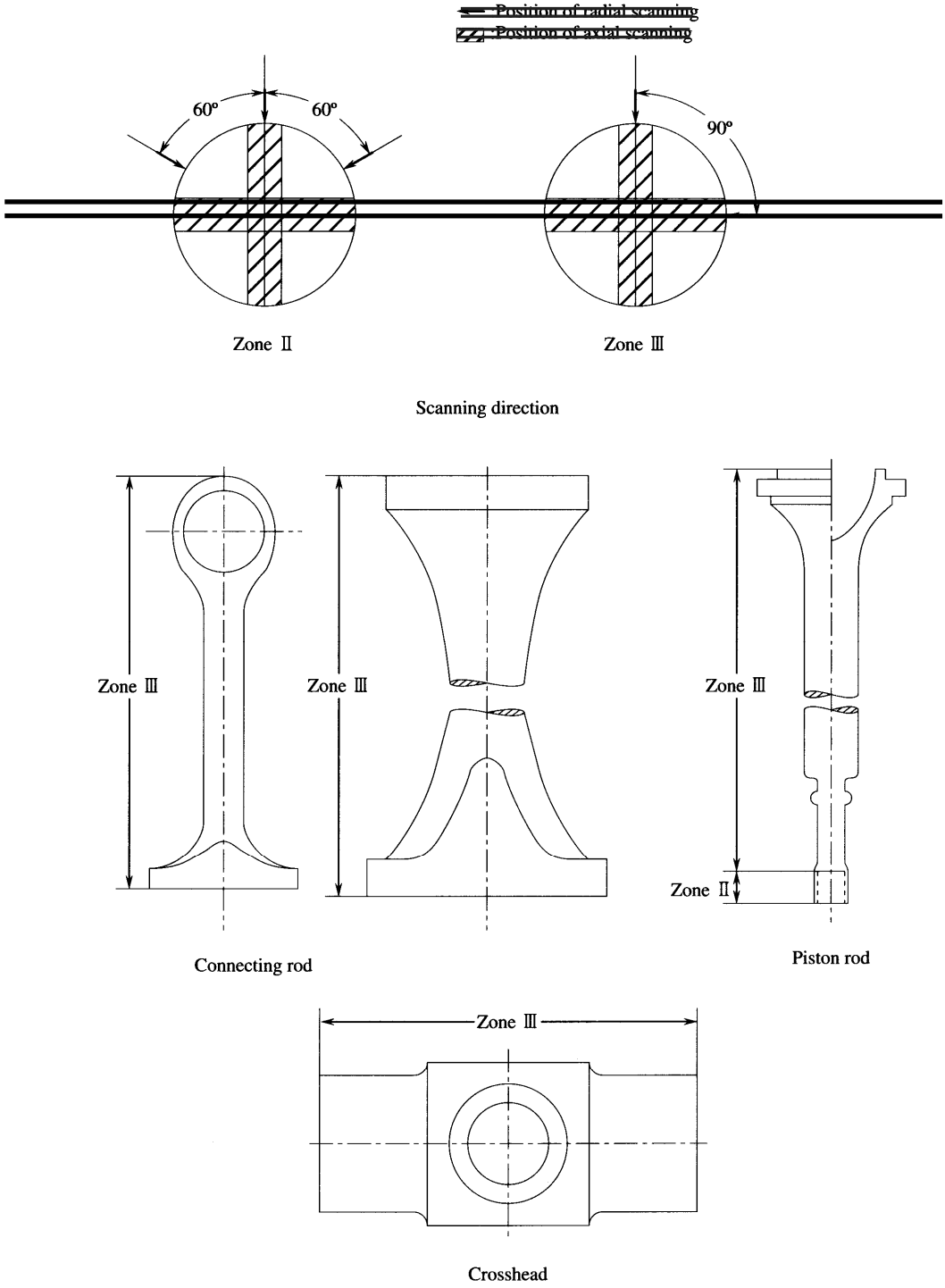
Intermediate shaft

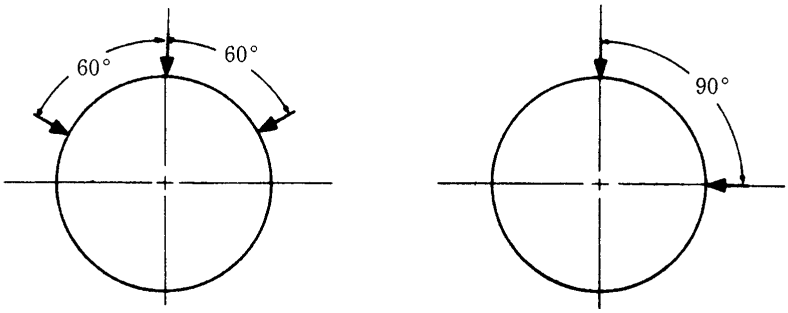


Thrust shaft

Fig. 10 has been amended as follows.

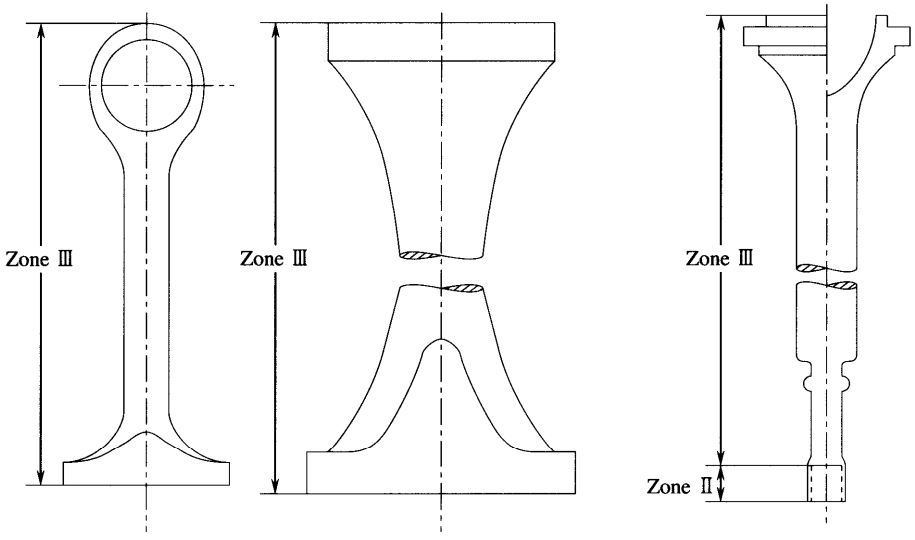
Fig. ~~10~~5 Divisions ~~of~~for Connecting Rods, Piston Rods and Crossheads



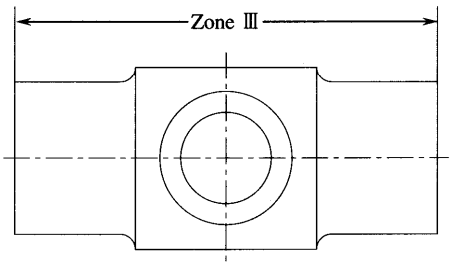


Zone Ⅱ　　Zone Ⅲ

Scanning direction



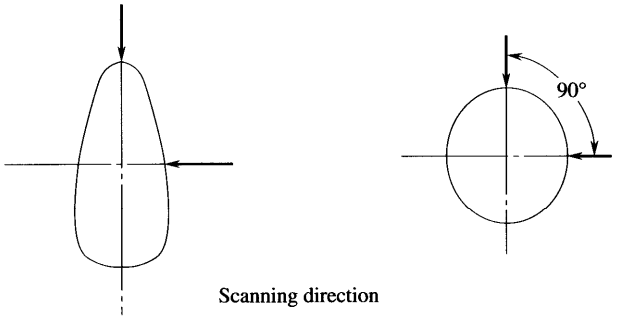
Connecting rod　　Piston rod

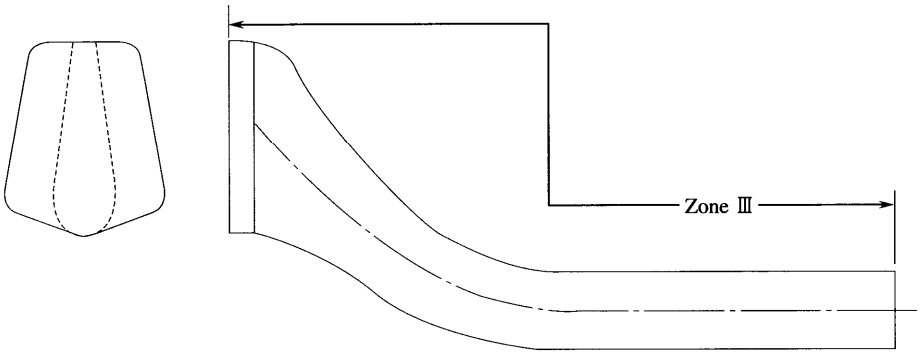


Crosshead

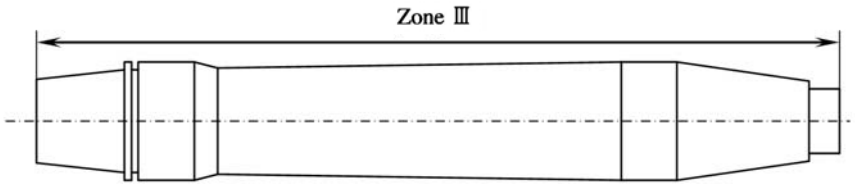
Fig. 11 has been amended as follows.

Fig. ~~11~~6 Divisions ~~of~~for Rudder Stocks and Pintles

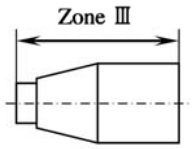




Curved rudder stock



Straight rudder stock



Pintle

Fig. 12 has been amended as follows.

Fig. ~~12~~7 Relation between Diameter of Rotor Shaft and Sensitivity Multiplier

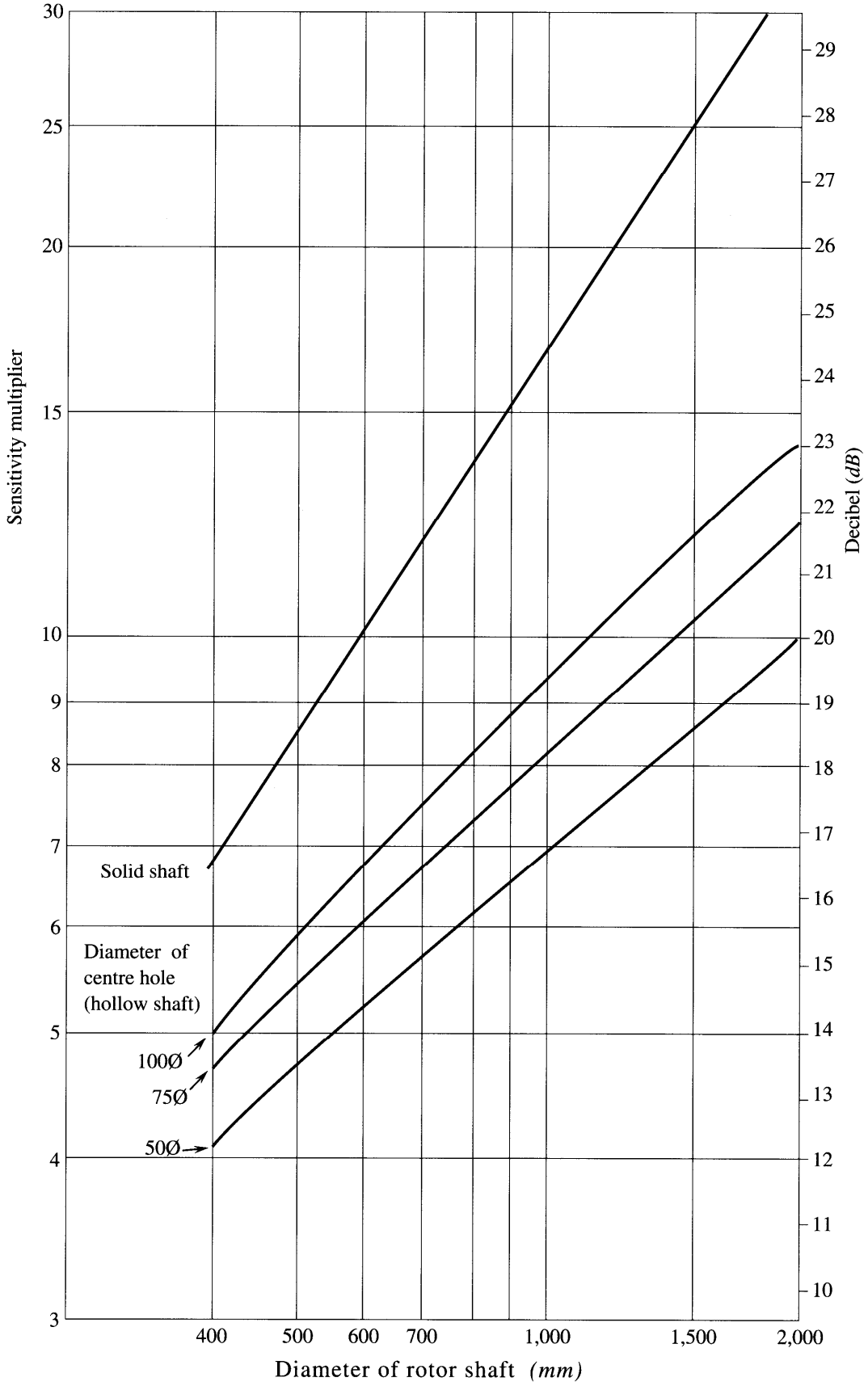


Fig. 13 has been amended as follows.

Fig. ~~13~~8 Acceptance Criteria Diagram for Crankshafts

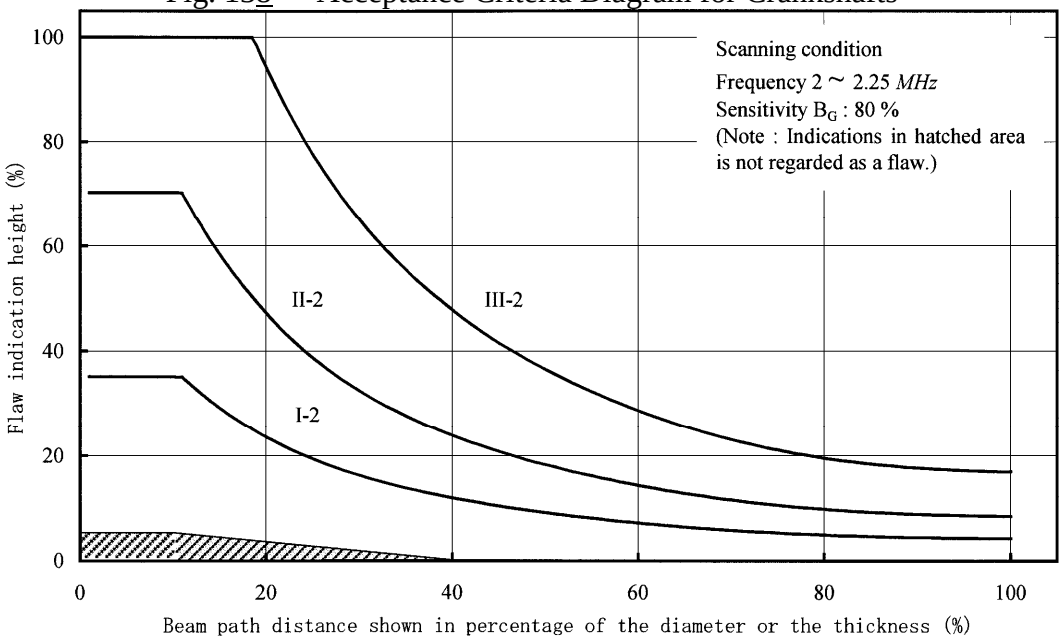


Fig. 14 has been amended as follows.

Fig. ~~14~~9 Acceptance Criteria Diagram for Shafts, Rods, ~~and~~ Rudder Stocks, and Pintles

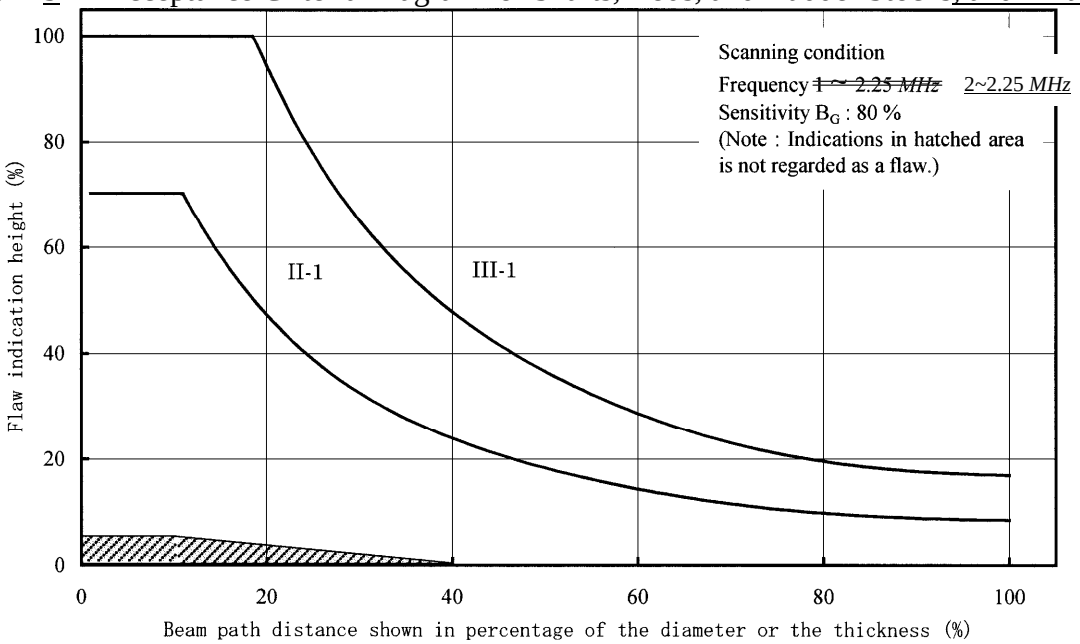
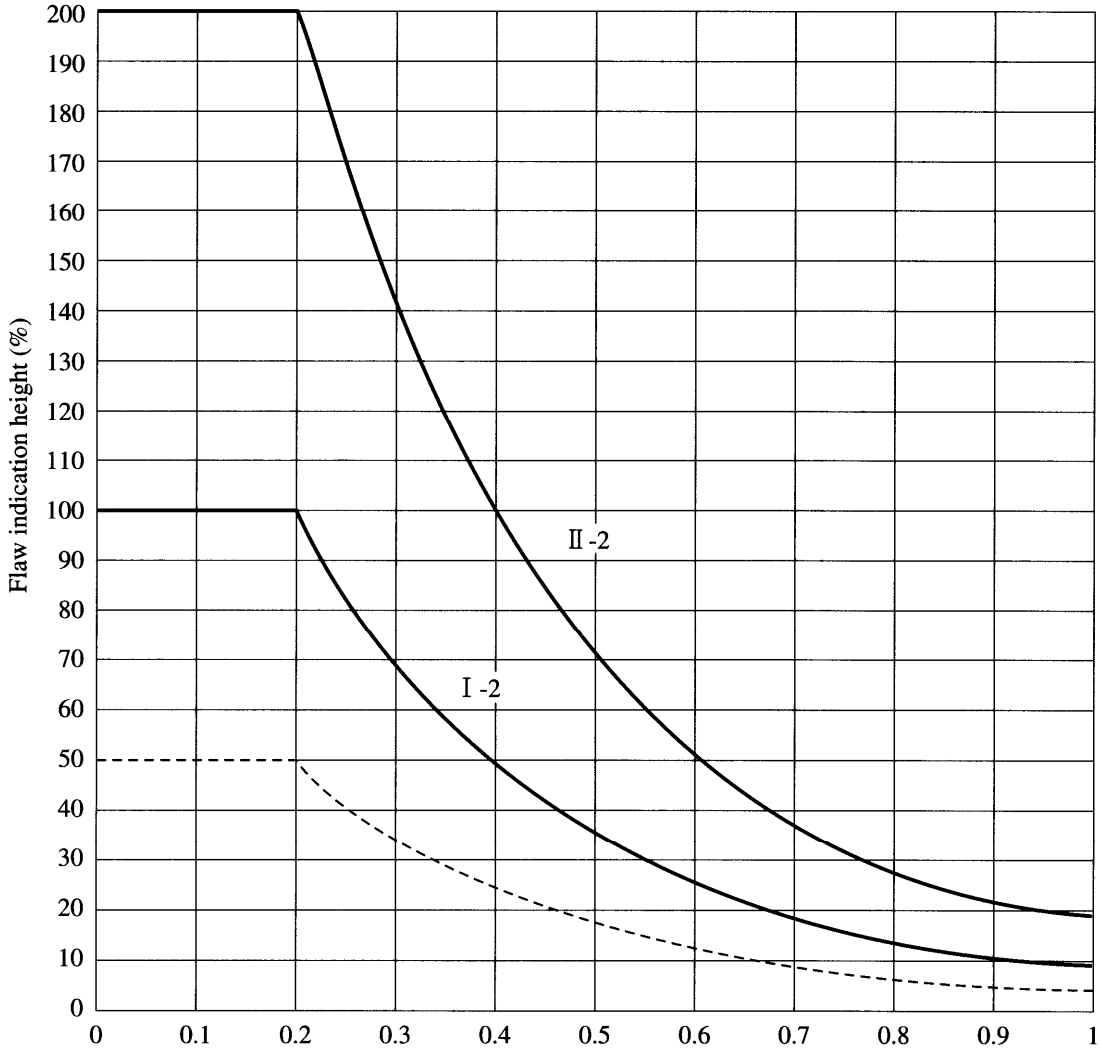


Fig. 15 has been amended as follows.

Fig. ~~15~~10 Acceptance Criteria Diagram for Turbine Rotor Shafts



Note:

Beam path distance shown by assuming the distance between the outer surface of the shaft and the inner surface of the central hole or the center of the shaft as 1.

Fig. 16 has been amended as follows.

Fig. ~~16~~11 Flow Indication (in the area free from defects)

Bottom echo height~~s~~ (%) of (B_1)~(B_3) = B100, 60, 30

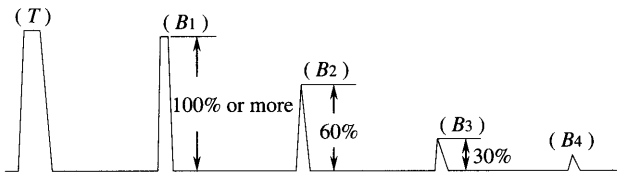
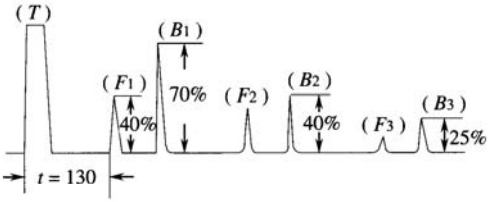


Fig. 17 has been amended as follows.

Fig. ~~17~~12 Flow Indication (in the area with defects)

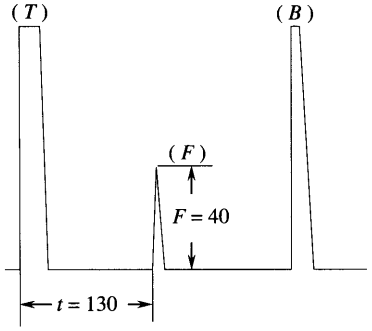


(F_1) Flaw indication height~~s~~ (%),

$$\frac{(t)\text{ distance from surface }(mm)}{\text{Bottom echo height~~s~~ (\%) of } (B_1)\sim(B_3)} = \frac{40\ (130)}{70,\ 40,\ 25}$$

Fig. 18 has been amended as follows.

Fig. ~~18~~13 Flaw Indication (isolated echo)

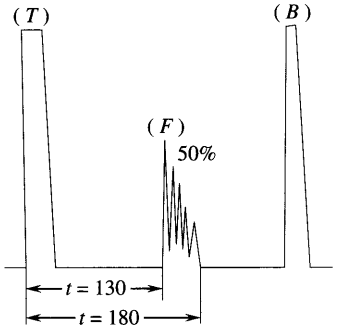


(*F*) Flaw indication height~~s~~ (%),

$$\frac{((t)\text{ distance from surface }(mm))}{(F/B)\ dB\text{~~s~~}} = \frac{40\ (130)}{26}$$

Fig. 19 has been amended as follows.

Fig. ~~19~~14 Flaw Indications (clustered echo)



(*F*) Flaw indication height~~(2)~~(%),

$$\frac{\text{(}t\text{) distance from surface (}mm\text{)}}{\text{(}F/B\text{) }dB^{(3)}} = \frac{50,\ 45,\ 35,\ 25,\ 20\ (130\sim180)}{16,\ 17,\ 19,\ 22,\ 24}$$

Notes of Fig.16 to Fig.19 have been deleted.

~~Notes:~~

~~(1) Percentage of the full screen height~~

~~(2) *(F/B) dB* is an abbreviation of $20\ Log_{10}(F/B)$ *dB* where *F* is the flaw indication height and *B* is the bottom echo height.~~

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 30 May 2013.

2. Notwithstanding the amendments to the Guidance, the current requirements may apply to steel forgings other than those for which the application for survey is submitted to the Society on or after the effective date.