Use of DGS Scale in Ultrasonic Testing Method, to Ensure Weld Soundness of Rotating Parts

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Abstract

Weldments in rotating parts of Power station fans are very critical and require stringent evaluation. One of the quick and reliable methods to ensure the soundness of the weld is use of DGS scales in Ultrasonic testing. This procedure presents the selection, step by step method of setting the UT equipment, selecting the flaw size, performing the test and evaluating the flaws by locating, sizing and its type using DGS scale for specific probe.

To meet this specific application requirement separate NDE procedures are required to be established to ensure specific examination sensitivity. This paper describes the application of ultrasonic testing method to establish the soundness of the butt weld.

1. Introduction

The DGS-Scale is an ‘attachment scale’ which is mounted in front of the CRT screen on an ULTRASONIC FLAW DETECTOR. It makes possible a reproducible setting of the instrument gain as well as a reproducible locating and evaluating of the discontinuities (echo amplitude evaluation).

Reference borings are not required and the time consuming transfer of measured values (as when working with the DGS diagram) is not required. The DGS- Scale then is particularly advantageous for weld testing where speed is a frequent requirement and where a conscientious echo amplitude evaluation is expected at the same.

2. Scale designation and design:

The essential features of DGS-Scales for angle-beam probes: (Fig 1)

Designation

The scale code is given at the left of the scales and the code for the respective probe is given at the top of the scales. The sound attenuation coefficient , which has to be taken into consideration when marking the curves , is given at the right of the scales for 2MHz transverse wave probes a sound attenuation influence of 8 dB/m was included.

The designation at the bottom of the indication field shows which reference block is to be used for adjusting the range (K1= reference block1; K2= reference block 2) and which respective quadrant to be beamed (R25=25mm radius; R50=50 mm radius). The adjusting marks denoted by the thick vertical lines indicate the positions to which the echo sequence has to be set for a correct adjustment.

NOTE: Independent from the range adjustment when setting the gain

For all probes MWB...N2 fundamentally the echo from the 100 mm quadrant of reference block1 is used; with probes MWB...N4 fundamentally the echo from 25mm quadrant of reference block 2 is used.

The circle marked R2 (with reference block 2) or R1(with reference block1) gives the height to which using the gain control, the reference echo from the respective reference block has to be brought.

The table in the top right hand corner of the attachment scale gives the gain by which the gain then has to be increased . If for example one wishes to correlate curve 1 to a 2 mm diameter disc reflector then the gain has to be increased by 18 dB . Curve II, for example, represents a disc diameter (an equivalent reflector size ) of 2 mm diameter, if one increases the gain by 30 dB.

If an uneven dB value has to be added (e.g. 23 dB ,in order to bring the 3mm diameter disc on to curve II) then one uses the lines over or, resp. under the R1 circle.
NOTE: The gain value given on the scales (table on the top right hand corner) contains the amplitude correction values of the respective probe, i.e. when setting the gain it does not have to be especially come in mind that the reference echoes from the reference block quadrants do not correspond to a back wall echo.

Lines K1 and TL or, resp. TL +12 dB are provided for determining the transfer losses. They have no connection with the other curves.

3. Operating

The choice of the scale depend on the Ultrasonic Flaw Detector used, the intended testing range and the probe chosen in accordance with the test assignment. The Ultrasonic Flaw Detector is adjusted to the range given on the DGS-Scale if the echo sequence from the prescribed quadrant of the specified reference block 1 (DIN54120) and 2 (DIN54122) or resp., the IIW calibration blocks 1 and 2 is positioned on the adjusting marks of the scales. (Fig. 2)

5. Setting the instrument gain

For setting the instrument gain for the 2MHz probes only use the 100mm quadrant of reference block 1. The instrument adjustment for “pulse strength” and “Resolution” must be the same as for the transfer measurement. (Fig. 3)

4. Calculating the transfer loss

The transfer losses are most easily determined using plate shaped test specimen and two angle beam probes of the same type in the through transmission. The distance dependent trend of the through transmission amplitude, taking into consideration the sound attenuation given in the following is marked, on each scale. According to experience the sound attenuation coefficient for structural steel is, on the average, 8 dB/m with 2 MHz and 60 dB/m with 4 MHz transverse waves. The sound coefficient of in the tempered steel of reference block 1 is, is on the average, 5 dB/m with 2 MHz and 40 dB/m with 4 MHz transverse waves. At 2 MHz there is hardly any difference in the sound attenuation values in the reference block and the test specimen, then the curves for both through transmission echoes are identical.

Calculating the distance

Measure the distance x from the sound exit point to the front of probe.

Calculate the skip distance p for the subject refraction angle and subject plate thickness:

\[ P = d \cdot 2 \tan \beta \]

\[ a_0 = p - x \]

\[ \beta \] = refraction angle

\[ a_0 \] = Shortened Projected Distance

6. How to test using DGS-Scale?

As a rule ultrasonic test involves 3 operations:
1. Detecting reflectors
2. Locating reflectors
3. Evaluating reflectors

Using the DGS-Scale these assignments are solved very easily.
Detecting reflectors

After having correctly adjusted the instrument gain, reflectors whose echoes lie in the range of the recording limits will be visible on the CRT screen and can purposefully examined.

Locating reflectors

The distance of the reflector from the front of the probe (on the surface). Maximize the echo from the detected reflector. Read the position of the echo on the horizontal graduation of the DGS-Scale (the read-off a point is the foot point of the rising flank of the echo) Y.

The value read-off gives the distance in mm between the front of the probe and that point below which the reflector lies.

Reflector depth

The depth of the flaw can now be calculated as follow

Depth \( d = \frac{(Y + x)}{\tan \beta} \)

\( Y \) - Shortened Projected Distance
\( x \) - Distance from the sound exit point to the front of probe
\( \beta \) - refraction angle

If \( d \) comes more than thickness of weld plate thickness \( t \) then

Depth \( d = 2t - \frac{(Y + x)}{\tan \beta} \)

Evaluating reflectors

If the indication has been maximized then its amplitude distance to the recording curve (exceeding or reaching it can be read off immediately in dB(reference curve II –2dB )

Adjusting to equivalent reflector sizes other than those given in the tables of the DGS-Scales:

If the curves of the DGS-Scales are to be identified with equivalent reflector sizes, which are not given in the tables of the scales then please proceed as follows:

Obtain the amplitude difference between the tabulated and desired disc diameter from the DGS diagram of the probe used, which accompanies each probe, and increase the tabulated value given by this difference (with smaller diameters) or, resp. , reduce the given table value by the difference (larger diameters).

7. Conclusion

With this procedure day to day testing of weld in Power plant fabrication can be carried out by any qualified person with out any difficulty

Reference

2. Operating Instructions for the DGS-Scales-A Branson Company