

Methods for

Ultrasonic Examination of Welds —

**Part 2: Automatic examination of fusion
welded butt joints in ferritic steels**

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Institute of Physics and the Physical Society	Society of Non-destructive Examination
Ministry of Defence, Army	United Kingdom Atomic Energy Authority
National Coal Board	Water-tube Boilermakers Association
	Individual firm

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Foreword

This British Standard forms part of a series dealing with methods for the non-destructive testing of welds. It does not state when this particular type of testing should be employed nor does it give standards of acceptance, as both of these aspects should be covered in the appropriate application standard or be agreed between the contracting parties.

This standard was first published in 1965 as a result of ultrasonic examination procedures being agreed between organizations interested in the manufacture and use of boilers and pressure vessels. Part 2 has now been revised to cover automatic examination of butt joints in a wide range of shapes and forms of ferritic steels.

The use of a D.G.S. (Distance, Gain, Size) diagram for obtaining the appropriate sensitivity setting only has been introduced although it is not the sole method. Guidance on this method is given in Appendix B.

The revised standard is not associated with any particular type of fabrication, but has been prepared to cover a wide range of products and as such lays down the broad principles of automatic ultrasonic examination. It is emphasized that a satisfactory technique can only be determined after taking into account all the relevant factors regarding the equipment to be used and the characteristics of the weld to be examined.

Prior to ultrasonic examination the weld should be visually inspected and any visible flaws recorded. Automatic ultrasonic examination is usually supplemented by manual examination and both are often used in conjunction with other testing methods in order to examine completely a welded article or structure. The use of any non-destructive testing method should always be considered in relationship to inspection and testing as a whole and the full benefits of this or any other method often can only be obtained by considering the results in conjunction with those from other methods.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 14, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of this British Standard deals with methods for the automatic scanning and recording of imperfections in fusion welded butt joints in ferritic steels¹⁾.

Whereas the procedures apply to all thicknesses of material, the limiting parameters are:

- 1) whether the material traversed by the ultrasonic beam is such that the beam can be propagated through it sufficiently to achieve the agreed sensitivity;
- 2) that with the angles of probe available, the ultrasonic beam will reflect from the under surface of the material in such a way as to cover the full cross section of the weld. For curved parts the ability of the beam to reflect from the under surface depends on the ratio of the outside diameter to the thickness (see Figure 1).

NOTE The titles of the British Standards referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the definitions given in BS 3683-4 apply.

3 Operators

If required, the operator shall demonstrate to the satisfaction of the contracting parties that he is able to meet the requirements of any particular technique adopted.

4 Equipment

4.1 Presentation. The examination shall be carried out by an agreed automatic or semi-automatic scan, using a pulse echo technique with either A or B-scope presentation, and a fully automatic recording or marking system shall be used.

4.2 Test frequency. The equipment shall be capable of working at a test frequency within the range 1 MHz to 6 MHz.

4.3 Probes²⁾

4.3.1 The area of each transmitting and/or receiving crystal shall not exceed 500 mm². No dimension of the crystal face shall exceed 25 mm unless otherwise agreed.

4.3.2 For parent metal examination, zero angle longitudinal wave probes shall be used.

4.3.3 For angle probes, the ultrasonic beam shall have an angle of refraction of between 35° and 70° within the material.

4.4 Coupling medium. The coupling shall be obtained by either contact, gap or immersion scanning using a liquid or paste medium suitable for this purpose.

4.5 Continuity of coupling. There shall be an indication of adequate acoustic coupling for example, by recording a compressional wave transmitted through the coupling or by a device which indicates any failure of the coupling.

4.6 Recording. The recording or marking system shall clearly indicate imperfections which require further investigation by manual scanning.

Any recorded imperfection shall be clearly located from a positional datum so that it can be accurately positioned along the weld. It is recommended that these positional data are located along welds at intervals of 250 mm.

5 Surface condition

The condition of the surface that will be in contact with the probe shall be such that a satisfactory coupling between the probe and the workpiece can be maintained. Spatter and loose scale shall be removed.

The surface condition of the weld and adjacent parent metal on each surface shall be such that it does not adversely influence the weld examination.

NOTE Depending on the profile and surface condition, dressing of the weld area may be necessary, even when contact is only to be made with the parent metal.

6 Parent metal examination

6.1 General. Whether or not the parent metal has been ultrasonically tested previously, manual ultrasonic examination shall be made after welding:

- 1) to locate any flaws, such as laminations, in the material through which the ultrasonic beam will pass during examination of the weld, and
- 2) to establish the material thickness to enable the actual beam paths to be determined.

If any flaws are found, their influence on the inspection of the weld shall be considered and if possible alternative techniques of scanning shall be used to ensure complete examination of the weld. If any section cannot be so tested, this fact shall be included in the report (see 6.6).

¹⁾ For the examination of welds used in the manufacture of pipes and tubes on a continuous basis see BS 3889-1A.

²⁾ Guidance on the determination of probe characteristics is given in Appendix A.

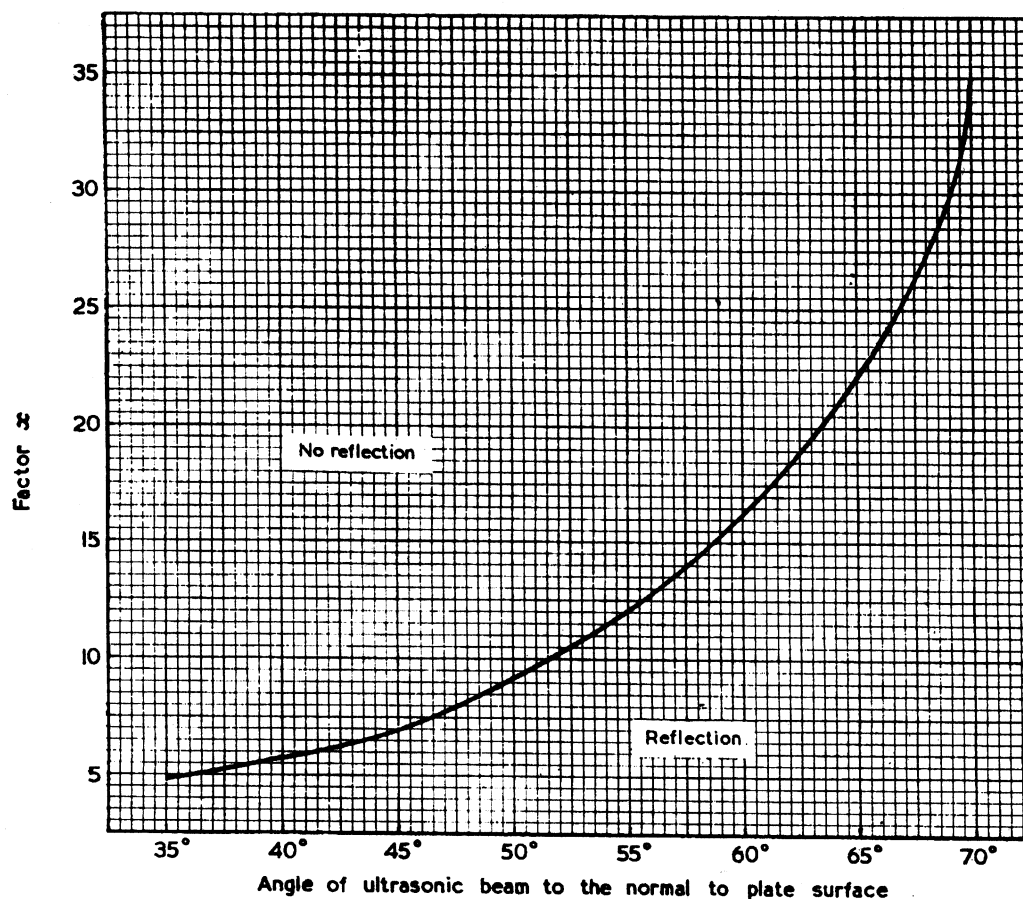


Figure 1 — Relationship between ratio of diameter to thickness and angle of ultrasonic beam

During the preliminary examination the operator shall assess the attenuation characteristics of the material and the influence that the surface condition will have on the coupling, in order to determine the practicability of performing an effective test (see also 6.5).

6.2 Method. The material shall be examined by the pulse echo technique using a longitudinal wave probe normal to the surface of the material. (See also BS 4336-1A.)

The parent metal shall be ultrasonically examined over the region covering the entire scanning zone for the subsequent weld examination.

6.3 Test frequency. The frequency shall be between one and two times the frequency to be used for the weld examination so that the attenuation characteristics assessed under 6.1 are related to the subsequent shear wave test.

NOTE On thin material it may be desirable to use a double crystal probe.

6.4 Time base calibration. The time base shall be calibrated using either the A2 or A3 block as specified in BS 2704.

6.5 Sensitivity. The method of setting the sensitivity shall be agreed between the contracting parties.

Methods of achieving the gain settings are described in Appendices B and C.

The sensitivity of the flaw detector/probe combination shall be such that a clear signal will be obtained from the smallest defect to be detected throughout the scanning distance.

The size, type and orientation of the smallest flaw to be detected shall be agreed between the contracting parties before testing is commenced.