

BS 9690-2:2011



BSI Standards Publication

Non-destructive testing – Guided wave testing

Part 2: Basic requirements for
guided wave testing of pipes,
pipelines and structural tubulars

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to ii, pages 1 to 16, an inside back cover and a back cover.

Foreword

Publishing information

This part of BS 9690 is published by BSI and came into effect on 31 October 2011. It was prepared by Technical Committee WEE/46, *Non-destructive testing*. A list of organizations represented on this committee can be obtained on request to its secretary.

Relationship with other publications

This document is part of a series which is intended to cover different applications of guided wave testing.

Currently, BS 9690, *Non-destructive testing – Guided wave testing*, comprises the following parts.

Part 1: *General guidance and principles*.

Part 2: *Basic requirements for guided wave testing of pipes, pipelines and structural tubulars*.

However, it is anticipated that further parts of the standard will be introduced to cover the interpretation of measurements; the testing of advanced cases of pipes, pipelines and structural tubulars; and the application of guided wave testing to other structures and components.

Use of this document

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Where optional recommendations are included, they are expressed in sentences in which the principal auxiliary verb is “should”. The word “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word “can” is used to express possibility, e.g. a consequence of an action or an event.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This part of BS 9690 specifies the basic requirements for screening pipes and similar tubular objects using the guided wave testing (GWT) method, including set-up, data collection and basic interpretation of the data. It is intended to be read in conjunction with BS 9690-1.

NOTE 1 Some background to the GWT method is given in Annex A.

This part is applicable to the testing of ferritic carbon and low-alloy steel pipes (tubes used for the transport of fluids) and structural tubulars (tubes used for load-bearing constructions) in the diameter range 1 inch (25 mm) to 60 inches (1.52 m), with maximum wall thickness of 2.2 inches (55 mm).

NOTE 2 The term “pipes” is used throughout this document to mean pipes, pipelines and structural tubulars within this scope of materials and dimensions.

This part of BS 9690 is applicable to the use of the GWT method using the pulse-echo technique with the transducer mounted on the outside of pipes for which the testing is straightforward. Advanced cases, in which the factors listed in Clause 4, items a) to i), are encountered so that the testing is not straightforward, fall outside the limitations of the scope as given above. For such cases, additional provisions are necessary.

For some of the advanced cases that are currently not covered by BS 9690 it might be possible to inspect using specific instructions provided by the GWT equipment manufacturers. These instructions are likely to differ between manufacturers according to the details of the equipment. Such instructions are referred to here as “supplementary instructions”. The intention is that some of these advanced cases will eventually be covered by other parts of BS 9690 as commonly accepted approaches emerge.

For those advanced cases that are not covered by other parts, it is necessary for supplementary procedures to be added to those specified in this part of BS 9690. It is necessary for any such supplementary procedures to be documented and agreed between the inspector and the clients [see 5.2, item a)].

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 9690-1:2011, *Non-destructive testing – Guided wave testing – Part 1: General guidance and principles*

BS EN 473, *Qualification and certification of NDT personnel – General principles*

BS EN 1330-2, *Non-destructive testing – Terminology – Part 2: Terms common to the non-destructive testing methods*

BS EN 1330-4, *Non-destructive testing – Terminology – Part 4: Terms used in ultrasonic testing*

BS EN 14127, *Non-destructive testing – Ultrasonic thickness measurement*

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions in BS 9690-1, BS EN 1330-2 and BS EN 1330-4 apply.

4 Factors influencing the performance of guided wave testing of pipes

The following factors can adversely affect the propagation of guided waves in pipes and/or the ability to interpret the resulting responses from features and imperfections (they are listed in approximate order of severity).

- a) Generally roughened surfaces, inside or outside.
- b) Short sections of pipe between major features, such as flanges or bends. The pipe needs to be sufficiently long that it can be tested, in consideration of axial resolution and dead zone.
- c) Bends, in particular sharp radius elbow fittings.
- d) Welded supports.
- e) Branches and other attachments.
- f) The presence of a viscous liquid in the pipe.
- g) The presence of external or internal coatings, particularly if they lead to rapid loss of sound energy and hence to high attenuation rates.
- h) The pipe being buried in the ground.
- i) A break in the continuous metal path for sound propagation, typically a flanged joint.

NOTE 1 Non-metallic paint and epoxy layers up to 1mm (0.04 in) thick do not normally affect the propagation of guided waves.

These factors affect the rate of loss of the ultrasonic energy, increasing the rate of attenuation, or the degree of scattering, resulting in coherent background signals (similar to grain noise in conventional ultrasonic testing). Their overall effect is to shorten the diagnostic range which may be achieved for a certain sensitivity level for detection of discontinuities.

The following limits shall therefore be applied for this part of BS 9690

NOTE 2 Testing beyond these limits might be permissible according to the requirements of other parts of BS 9690. If not, supplementary procedures may be used, if available.

- 1) The factors in items a), f), g) and h) cause losses from the transmitted pulse, which is observed as high attenuation and/or raised background levels of scatter. If severe, this can lead to signals which cannot readily be interpreted without special procedures. In tests where the attenuation rate exceeds 1 dB/m the requirements of this part of BS 9690 shall be deemed not to have been met. See 10.1 for a method of determining the attenuation rate.
- 2) Short sections of pipe [item b)]: The long wavelengths and tone burst excitation used for GWT produce pulse lengths which can be 0.5 m long or more. This limits the axial resolution possible. GWT is therefore not optimized for testing short lengths of pipe. See item i) regarding flanges. This factor also limits the proximity permitted between the transducer position and features (see 9.1.3) such that it might not be possible to test the whole length of the pipe section, even if more than one transducer position is used.
- 3) Bends [item c)]: Testing shall not be carried out beyond an elbow fitting. To

test the region beyond a fitting, the transducer has to be moved to a test position on the other side of the bend. This restriction does not apply to "pulled" bends where a straight length of pipe is formed into a curve.

- 4) Welded supports [item d)]: Testing shall not be carried out beyond a welded support if the amplitude of response from it is less than 6 dB lower than the weld DAC curve.

NOTE 3 Welded supports can generate reflections that are both large in amplitude and axial extent. The reflections are composed of direct reflections from the change in section at the front and back of the support with combinations of signals from internally within the support that are continuously radiated causing a large tail on the direct reflections. The internal signals from the support or structures rigidly attached to the support arrive at a distance beyond the support and can have amplitudes an order of magnitude larger than the supports direct reflections.

- 5) Branches and tees [item e)]: Testing can be carried out beyond a branch where the diameter of the branch is not greater than half the diameter of the pipe being tested. In such cases the interaction of the guided wave with the branch is such that the onward travelling pulse is not significantly distorted.
- 6) Flanged joints and other breaks [item i)]: Such breaks do not allow the passage of sound across them, so that testing beyond these is not possible.

5 Information and requirements to be agreed and documented

5.1 Information to be supplied by the client

5.1.1 The following information to be supplied by the client shall be fully documented. For compliance with the standard both the definitive requirements specified throughout the standard and the following documented items shall be satisfied.

- a) Pipe nominal diameter and wall thickness.
- b) Standard to which the pipe is manufactured.
- c) Actual pipe outer diameter if manufacturing standard is not known, or of non-standard size.
- d) Material (ferritic steel, austenitic stainless steel, etc.).
- e) Pipe type (spiral welded, seam welded or seamless).
- f) Geometry (straight lengths, bends, Ts, welded or flanged construction).
- g) Type and location of any supports (simple contact, welded, doubler plate, etc.).
- h) Whether pipe is above or below ground, or has an external sleeve or casing.
- i) Clearance between ground and adjacent pipework, or other obstructions.
- j) Coatings, if present (internal/external, type and thickness).
- k) Insulation, if present (type and ease of removal for transducer locations).
- l) Operating temperature and pressure at time of test.
- m) Pipe contents.
- n) Trace heating, if present (electrical/steam piping, number of traces, stand-off distance from pipe).