BS EN ISO 16440:2016

BSI Standards Publication

Petroleum and natural gas industries — Pipeline transportation systems — Design, construction and maintenance of steel cased pipelines (ISO 16440:2016)

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PSE/17/2, Transmission pipelines.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2016

ISBN 978 0 580 79260 1

ICS 75.200; 77.140.75

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2016.

Amendments/corrigenda issued since publication

Date	Text affected

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 16440

November 2016

ICS 75.200; 77.140.75

English Version

Petroleum and natural gas industries - Pipeline transportation systems - Design, construction and maintenance of steel cased pipelines (ISO 16440:2016)

Industries du pétrole et du gaz naturel - Systèmes de transport par conduites - Conception, construction et maintenance de conduites en fourreau en acier (ISO 16440:2016)

Erdöl- und Erdgasindustrien - Rohrleitungs-Transportsysteme - Auslegung, Konstruktion und Instandhaltung von stahlverkleideten Rohrleitungen (ISO 16440:2016)

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European foreword

This document (EN ISO 16440:2016) has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries" in collaboration with Technical Committee CEN/TC 12 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries” the secretariat of which is held by NEN.

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Full document details: BS EN ISO 16440:2016

Contents

Page

Foreword ..... **iv**

Introduction ..... **v**

1 Scope **1**

2 Normative references **1**

3 Terms and definitions **1**

4 Design **2**
- 4.1 General 2
- 4.2 Carrier pipe design 3
- 4.3 Casing design 3
- 4.4 Electrical isolation 4
- 4.5 Corrosion protection 4

5 Installation **4**
- 5.1 General 4
- 5.2 Handling and storage 4
- 5.3 New casing 4
  - 5.3.1 General 4
  - 5.3.2 Carrier pipe installation 5
  - 5.3.3 Casing end seals 6
  - 5.3.4 Test leads 6
  - 5.3.5 Backfilling 7
- 5.4 Split-sleeve type casing extensions and installations 7

6 Inspection and monitoring **8**
- 6.1 General 8
- 6.2 Integrity inspection of carrier pipe 8
- 6.3 Monitoring of carrier pipe and casing 9
- 6.4 Leakage survey 9
- 6.5 Corrosiveness of the annular space 9

7 Maintenance and repair **9**
- 7.1 General 9
- 7.2 Maintenance of vents and test leads 10
- 7.3 Clearing of shorted casings 10
- 7.4 Filling of casings 11
- 7.5 Removal of casings 11

Annex A (informative) **Casing filling procedures for Dielectric Filler Materials** **12**

Annex B (informative) **Examples of cathodic protection testing and monitoring techniques for carrier pipes and casings** **15**

Annex C (informative) **Inspection tools for cased carrier pipe** **30**

Annex D (informative) **Clearing a shorted casing** **35**

Annex E (informative) **Removing and cutting a casing** **37**

Bibliography **39**

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Document Sharing Hub
Full document details: BS EN ISO 16440:2016

Foreword

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The committee responsible for this document is ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 2, *Pipeline transportation systems*.

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Introduction

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INTERNATIONAL STANDARD ISO 16440:2016(E)

Petroleum and natural gas industries — Pipeline transportation systems — Design, construction and maintenance of steel cased pipelines

1 Scope

This document specifies requirements, including corrosion protection, for the design, fabrication, installation and maintenance of steel-cased pipelines for pipeline transportation systems in the petroleum and natural gas industries in accordance with ISO 13623.

NOTE 1 Steel casings can be used for mechanical protection of pipelines at crossings, such as at roads and railways and the installation of a casing at a highway, railway, or other crossing can be required by the permitting agency or pipeline operator.

NOTE 2 This document does not imply that utilization of casings is mandatory or necessary.

NOTE 3 This document does not imply that cased crossings, whether electrically isolated or electrically shorted, contribute to corrosion of a carrier pipe within a cased crossing. However, cased crossings can adversely affect the integrity of the carrier pipe by shielding cathodic protection (CP) current to the carrier pipe or reducing the CP effectiveness on the carrier pipe in the vicinity of the casing. Their use is not recommended unless required by load considerations, unstable soil conditions, or when their use is dictated by sound engineering practices.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 15589-1, *Petroleum, petrochemical and natural gas industries — Cathodic protection of pipeline systems — Part 1: On-land pipelines*

EN 12954, *Cathodic protection of buried or immersed metallic structures — General principles and application for pipelines*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
carrier pipe
pipe that conveys the fluid

Note 1 to entry: Note to entry: This applies to both transmission and distribution piping.

3.2
casing
steel pipe installed around a carrier pipe for mechanical protection

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3.3
electrolyte
medium in which electric current is transported by ions

3.4
electrolytic contact
ionic contact between the carrier pipe and the casing pipe through an electrolyte

3.5
end seal
device installed over or within the end of a casing to keep water, deleterious materials and debris out of the casing or provide a water tight seal between the casing and the carrier pipe

3.6
holiday
unintentional discontinuity in a protective coating that exposes the bare steel surface to the environment

3.7
isolator
spacer
dielectric device designed to electrically isolate a carrier pipe from a casing and provide support for the carrier pipe

3.8
metallic short
unintentional contact between two metallic structures

3.9
P/S potential
pipe-to-electrolyte potential
structure-to-electrolyte potential
potential difference between the surface of a buried or submerged metallic structure (pipe or casing) and the electrolyte that is measured with respect to a reference electrode in contact with the electrolyte

3.10
split sleeve
casing installed in situ by welding two halves of the casing together around the carrier pipe

3.11
tunnel liner plate
steel plate used when micro tunnelling, used to shore horizontal excavations in soft ground

3.12
C/S potential
casing–to–electrolyte potential
potential difference between the surface of a buried or submerged metallic casing and the electrolyte that is measured with respect to a reference electrode in contact with the electrolyte

4 Design

4.1 General

The purpose of a casing is to provide additional mechanical protection to the carrier pipe. A casing can also be required by a permitting authority to allow replacement of a carrier pipe without excavations at the location of a crossing.

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A carrier pipe within a casing is not designed to be cathodically protected. It is designed to be electrically isolated from the casing with non-conducting spacers, or isolated if the annulus of the casing is filled with a dielectric filler material. The carrier pipe is designed to be protected with a protective coating.

Steel casings shall not be cathodically protected by the pipeline's dedicated CP system.

4.2 Carrier pipe design

The carrier pipe shall be coated for corrosion protection. The application of an abrasion resistant coating over the corrosion coating should be considered.

NOTE 1 See NACE/SP 0169 for details of abrasion resistant coatings.

The carrier pipe shall be supported inside the casing with isolating spacers and outside the casing to prevent sagging. Sagging can lead to metallic contact between the casing and the carrier pipe and to carrier pipe stresses.

NOTE 2 See NACE/SP 0286 for details of isolation techniques.

4.3 Casing design

Casing design shall be in accordance with the local, national, or industry requirements/standards.

The casing should be kept as short in length as possible to minimize the risk of electrical shorting over time due to soil stress and pipe movement.

The casing internal diameter shall be selected based on the nominal diameter of the carrier pipe, the thickness of any abrasion resistant coating, such as concrete, duroplastic material, or epoxy polymer and the design of the isolators between carrier pipe and casing.

For individual carrier pipes with a nominal diameter of 200 mm (8.0 in) or greater, the outer diameter of the casing should be a minimum of 100 mm (4.0 in) larger than that of the carrier pipe or if installing parallel cable or conduits the casing should be a minimum of 300 mm larger than that of the carrier pipe.

For individual carrier pipes with a nominal diameter less than 200 mm (8.0 in), the diameter of the casing should be a minimum of 50 mm (2.0 in) larger than that of the carrier pipe.

Uncoated casing should be used. Coated or non-conductive casing may be used if the casing can be harmonized with the carrier pipe cathodic protection.

NOTE 1 The use of coated or nonconductive casing pipe is not recommended due to potential shielding problems when cathodic protection is applied. If coated casings (either internally coated or externally coated or both) are used, external cathodic protection will not provide protection to the carrier pipe in the event that the annulus is filled with a conductive electrolyte.

If vent pipes are required, then they should be installed on both ends of the casing. Vent pipes should be positioned so that they are not directly over any isolation spacer or end seal. If concrete coated pipe is used and no isolating spacers are used, then the vent pipes should only be installed on the top of the casing.

The casing vent hole should be at least one-half the diameter of the vent pipe, with a minimum of 25 mm (1,0 in). The vent pipe should be a minimum of 50 mm (2.0 in) in diameter.

Vent pipes shall be designed to prevent intrusion of water and debris.

Casing end seals shall be installed to prevent ingress of water, deleterious material and debris.

Vent pipes are used for venting, monitoring the casing for carrier pipe leaks, filling the casing and as line markers.

NOTE 2 NACE/SP 0200 gives guidance for design of end seals.

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4.4 Electrical isolation

Sufficient isolators shall be designed to prevent metallic contact between the carrier pipe and the casing, and to provide adequate support. Isolators shall be designed to minimize coating damage. The use of metallic components in isolation spacers should be avoided.

Isolators shall be selected to ensure they have the mechanical strength required to withstand the installation loads, considering all conditions including pipe weight, length of casing, conditions of weld beads, deflections in the casing and other field conditions. Selection should confirm the ability of the isolators to provide electrical isolation after installation and to position the carrier pipe properly for end seal application/installation.

Test leads should be located (connected to the carrier pipe) on the carrier pipe at each end of the casing to permit verification of metallic isolation. One test lead shall be required as a minimum. Test leads to be installed in accordance with 5.3.4. Test leads to be installed after the carrier pipe is inserted in the casing.

Metallic shorts between the vent pipe, test leads and carrier pipe shall be prevented.

4.5 Corrosion protection

Consideration may be given to applying cathodic protection to the casing as required by conditions or regulations. Cathodic protection design shall be in accordance with approved industry standards, such as ISO 15589-1.

Consideration may be given to placing a high dielectric filler or conductive grout in the annular space or injecting a vapour phase inhibitor. Annex A gives guidance on filling and the filling procedure.

Cathodically protected casings using the pipelines dedicated CP system may have a detrimental effect on the carrier pipe.

AC corrosion should be considered as a possible problem when the pipeline is located in an area of AC influence.

5 Installation

5.1 General

This Clause provides requirements for the installation of new cased pipeline crossings, casing extensions and new casing installation on existing pipelines.

5.2 Handling and storage

The carrier pipe and casing or tunnel liner plate shall be handled and stored in a manner that minimizes coating and pipe end damage. Lifting shall be accomplished utilizing slings, wide belts, or appropriate end hooks. If skids are utilized to support the carrier pipe or casing, padding material shall be used to prevent coating damage. Skids shall be removed upon completion of the installation.

5.3 New casing

5.3.1 General

Cased crossings are installed using various techniques including boring, directional drilling, tunnelling and open cutting.

NOTE 1 Filling of the annular space between the casing and excavation is sometimes required by the permitting agency when the borehole is unstable or fracked out.

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Welding of steel casings should be performed in accordance with the pipeline operator's line pipe welding specifications.

NOTE 2 ISO 13847 provides guidance on welding.

NOTE 3 Radiographic inspection of casing welds is normally not required.

Butt-weld alignment during casing fabrication shall be maintained to prevent casing, isolator, or spacer damage during push/pull operations.

Slag and any welding debris shall be removed from inside the casing to prevent damage to the carrier pipe, coating, isolator, or spacer.

Internal weld beads should be removed by grinding (when practical and allowed) to allow pulling or sliding of the carrier pipe without damage to the isolators and coating.

The casing vent pipe should be installed before the carrier pipe to avoid coating damage. If the carrier pipe is already in place when the vent hole is cut, measures shall be taken to prevent coating damage.

NOTE 4 The use of non-flammable insulating material to protect the carrier pipe coating is often required by the pipeline operator during installation of the vent pipes to prevent coating damage to the carrier pipe.

If two vent pipes are used, the one at the lower elevation should be installed on the bottom of the casing to facilitate possible filling of the casing at a later date. If the vent pipe is doglegged, adequate separation and non-metallic support between the vent pipe and carrier pipe shall be provided to keep the vent pipe from resting on the carrier pipe and possibly shorting between the casing and carrier pipe.

5.3.2 Carrier pipe installation

Before the installation of isolators, the carrier pipe coating shall be inspected for coating holidays using an electrical holiday detector.

NOTE 1 NACE/SP 0274 or NACE/SP 0490 provides guidance for holiday testing of the carrier pipe coating.

Isolators shall be installed according to the manufacturer's instructions and in a manner that does not damage the carrier pipe coating. Isolator runners (skids) shall be oriented to avoid a shorted condition. Bolts, if present, should not remain at the bottom (6 o'clock) position. Clearance between isolator extremities and casing should be a minimum of 25 mm (1.0 in) to allow adequate clearance during installation. The use of metallic components in isolation spacers should be avoided.

NOTE 2 Additional information is given in NACE/SP 0286.

End caps should be installed on the carrier pipe to keep debris and deleterious material from entering the carrier pipe and to aid in smooth push/pull operations.

The casing shall be visually inspected where possible and practical and, if necessary, cleaned immediately prior to installation of the carrier pipe to remove any debris or foreign material.

All coating damage on the carrier pipe shall be repaired prior to insertion into the casing in accordance with the applicable specifications and manufacturer's recommendations.

NOTE 3 The requirements on handling pipe are also applicable to the installation of uncoated carrier pipe.

The carrier pipe shall be installed by the boring sled, a crane, or side-boom tractor using slings or belts that do not interfere with the isolators or damage the coating. The push/pull operation shall continue in a smooth motion until the carrier pipe is properly positioned.

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The alignment of the carrier pipe and casing shall be ensured both prior to and during insertion of the carrier pipe into the casing. During the installation operation, it shall be ensured that there is no isolator or spacer displacement or damage to the carrier pipe coating.

NOTE 4 Isolators can slide along the carrier pipe during installation if not installed properly, if the casing is bent, or if the installation is out of line. Inadequate support of the carrier pipe allows the carrier pipe to sag and make metallic contact with the casing.

The cased crossing shall be inspected in accordance with Clause 6 to confirm that the casing and carrier pipe are electrically isolated.

The carrier pipe and casing or tunnel liner plate shall be cleaned as necessary for the installation of the end seals in accordance with design specifications and the manufacturer's recommendations.

NOTE 5 One procedure is to fill the annulus with water after carrier pipe has been pulled in temporarily for test purposes.

A CP drainage test is executed to verify the condition of the carrier pipe coating. Acceptance procedure is described in ISO 15589-1.

5.3.3 Casing end seals

Isolating end seals shall be installed on both ends of casing.

Particular attention should be paid to the selection process, application method and applicator skills when installing casing end seals.

Failure of end seals is a major cause of unwanted water and soil ingress into the annulus between the carrier pipe and the casing. This material ingress can give rise to accelerated corrosion of the carrier pipe if the ingress is coincidental with a coating breakdown. The end seal may be a pressure and water tight seal or a simple seal to prevent debris, deleterious material and water from entering the annular space between the casing and carrier pipe. The selection of the seal should consider:

— the position of the carrier pipe at the end of the casing;

— operating temperature;

— end seal materials;

— pressure rating of the seal.

NOTE 1 Annex A gives additional guidance on casing end seal selection.

NOTE 2 Most water tight seals, such as modular mechanical seals require that the carrier pipe be positioned in the centre of the casing (centralized), whereas most simple end seals allow for some amount of off-centred position.

5.3.4 Test leads

Test leads for cathodic protection testing shall be installed on the carrier pipe and should be installed at both ends of the casing. The leads shall be attached using pin brazing or thermite welding or other approved process.

Two test lead wires should be installed at each location in order to confirm the integrity of the leads and as a contingency in case of test lead damage.

The test lead connection to the carrier pipe shall be coated. The coating shall be compatible with the carrier pipe coating, the test lead insulation and conform to the shape of the test lead/carrier pipe connection. Damage to the carrier pipe or coating shall be repaired. The coating shall be made in such a way as to eliminate any voids that may permit the ingress of moisture. There shall be no strain on the test lead that might dislodge the protective coating. Any coating damage shall be repaired with a compatible repair coating to return the coating to a holiday free condition.

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To prevent electrical shorting, test leads shall not be wrapped around the vent pipe or the casing.

Test leads shall be installed on the casing when

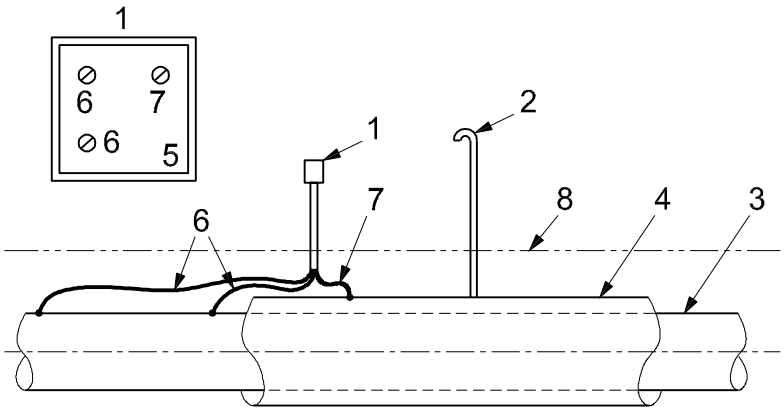
— required by the documents or specifications,

— no vent pipes are installed,

— non-metallic vent pipes are installed, or

— metallic vent pipes are installed using mechanical couplings/fittings.

Test leads shall be labelled or colour coded in accordance with the design and pipeline operator requirements.



Key

1 test station
2 vent pipe
3 carrier pipe
4 casing
5 insulated test panel inside test station
6 pipe test lead
7 casing test lead
8 ground level

Figure 1 — Typical Test Station at cased Crossing

5.3.5 Backfilling

The carrier pipe and casing shall be supported to prevent settlement during the backfilling operation. The method of support, for example, earth filled bags or compacted earth, shall be approved by the pipeline operator.

The backfill material shall be free of debris and deleterious material.

Caution shall be exercised to prevent test lead damage, which is a common cause of shorting.

Inspection as described in Clause 6 shall be performed upon completion of the backfilling operation.

5.4 Split-sleeve type casing extensions and installations

Extension of existing casings or construction of new casings on existing pipelines often involves installation by the split-sleeve method.

NOTE This method is used if the pipeline cannot be taken out of service and the subsequent blow down (gas), or drain-up (liquid), and cutting out of the crossing to allow a casing to be slipped over the pipeline is not feasible or cost-effective.

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