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BSI Standards Publication

# Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production

Part 2: Cracking-resistant carbon and low-alloy steels, and the use of cast irons

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# National foreword

This British Standard is the UK implementation of EN ISO 15156-2:2020. It is identical to ISO 15156-2:2020. It supersedes BS EN ISO 15156-2:2015, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PSE/17, Materials and equipment for petroleum, petrochemical and natural gas industries.

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

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# Petroleum and natural gas industries - Materials for use in H2S-containing environments in oil and gas production - Part 2: Cracking-resistant carbon and low-alloy steels, and the use of cast irons (ISO 15156-2:2020)

Industries du pétrole et du gaz naturel - Matériaux pour utilisation dans des environnements contenant de l'hydrogène sulfuré (H2S) dans la production de pétrole et de gaz - Partie 2: Aciers au carbone et aciers faiblement alliés résistants à la fissuration, et utilisation de fontes (ISO 15156-2:2020)

Erdöl- und Erdgasindustrie - Werkstoffe für den Einsatz in H2S-haltiger Umgebung bei der Öl- und Gasgewinnung - Teil 2: Gegen Rissbildung beständige unlegierte und niedriglegierte Stähle und Gusseisen (ISO 15156-2:2020)

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## European foreword

This document (EN ISO 15156-2:2020) 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.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2021, and conflicting national standards shall be withdrawn at the latest by May 2021.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 15156-2:2015.

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## Endorsement notice

The text of ISO 15156-2:2020 has been approved by CEN as EN ISO 15156-2:2020 without any modification.

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# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 12, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 15156-2:2015), which has been technically revised. The main changes compared to the previous edition are as follows:

— corrections of temperature conversion for welding (see A.2.1.4), vold deformation and stress relief (see A.2.1.6), identification stamping (see A.2.1.9), tubulars and tubular components (see A.2.2.3.4), compressor impellers (see A.2.3.3.2);

— title change from Shear rams to Rams in A.2.3.2.2;

— addition of C110 and changes the designation of C95 to R95 in Table A.3;

— reference change to NACE TM0316 in Table B.1;

— addition of reference to BS 8701 in B.4.3;

— changes and additions to Table B.3;

— modification of Annex C to include alternative parameters and expanded explanation for the use of chemical activity and fugacity, and to provide some general guidance for the use of thermodynamic modeling for the determination of environmental severity.

A list of all parts in the ISO 15156 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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# Introduction

The consequences of sudden failures of metallic oil and gas field components, associated with their exposure to $H_2S$-containing production fluids, led to the preparation of the first edition of NACE MR0175, which was published in 1975 by the National Association of Corrosion Engineers, now known as NACE International.

The original and subsequent editions of NACE MR0175 established limits of $H_2S$ partial pressure above which precautions against sulfide stress cracking (SSC) were always considered necessary. They also provided guidance for the selection and specification of SSC-resistant materials when the $H_2S$ thresholds were exceeded. In more recent editions, NACE MR0175 has also provided application limits for some corrosion-resistant alloys, in terms of environmental composition and pH, temperature and $H_2S$ partial pressures.

In separate developments, the European Federation of Corrosion issued EFC Publication 16 in 1995 and EFC Publication 17 in 1996. These documents are generally complementary to those of NACE though they differed in scope and detail.

In 2003, the publication of the ISO 15156-series and NACE MR0175/ISO 15156 was completed for the first time. These technically identical documents utilized the above sources to provide requirements and recommendations for materials qualification and selection for application in environments containing wet $H_2S$ in oil and gas production systems. They are complemented by NACE TM0177 and NACE TM0284 test methods.

The revision of this document, i.e. ISO 15156-2,involves a consolidation of all changes agreed and published in the Technical Circular 1, ISO 15156-2:2015/Cir.1:2017, the Technical Circular 2, ISO 15156-2:2015/Cir.2:2018 and the Technical Circular 3, ISO 15156-2:2015/Cir.3:2019, published by the ISO 15156 series Maintenance Agency secretariat at DIN.

The changes were developed by and approved by the ballot of, representative groups from within the oil and gas production industry. The great majority of these changes stem from issues raised by document users. A description of the process by which these changes were approved can be found at the ISO 15156 series maintenance website: www.iso.org/iso15156maintenance.

When found necessary by oil and gas production industry experts, future interim changes to this document will be processed in the same way and will lead to interim updates to this document in the form of Technical Corrigenda or Technical Circulars. Document users should be aware that such documents can exist and can impact the validity of the dated references in this document.

The ISO 15156 series Maintenance Agency at DIN was set up after approval by the ISO Technical Management Board given in document 34/2007. This document describes the make up of the agency, which includes experts from NACE, EFC and ISO/TC 67, and the process for approval of amendments. It is available from the ISO 15156 series maintenance website and from the ISO/TC 67 Secretariat. The website also provides access to related documents that provide more detail of the ISO 15156 series maintenance activities.

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**INTERNATIONAL STANDARD** **ISO 15156-2:2020(E)**

# Petroleum and natural gas industries — Materials for use in $H_2S$-containing environments in oil and gas production —

## Part 2: Cracking-resistant carbon and low-alloy steels, and the use of cast irons

**WARNING — Carbon and low-alloy steels and cast irons selected using this document are resistant to cracking in defined $H_2S$-containing environments in oil and gas production but not necessarily immune to cracking under all service conditions. It is the equipment user's responsibility to select the carbon and low alloy steels and cast irons suitable for the intended service.**

## 1 Scope

This document gives requirements and recommendations for the selection and qualification of carbon and low-alloy steels for service in equipment used in oil and natural gas production and natural gas treatment plants in $H_2S$-containing environments, whose failure can pose a risk to the health and safety of the public and personnel or to the environment. It can be applied to help to avoid costly corrosion damage to the equipment itself. It supplements, but does not replace, the materials requirements of the appropriate design codes, standards or regulations.

This document addresses the resistance of these steels to damage that can be caused by sulfide stress cracking (SSC) and the related phenomena of stress-oriented hydrogen-induced cracking (SOHIC) and soft-zone cracking (SZC).

This document also addresses the resistance of these steels to hydrogen-induced cracking (HIC) and its possible development into stepwise cracking (SWC).

This document is concerned only with cracking. Loss of material by general (mass loss) or localized corrosion is not addressed.

Table 1 provides a non-exhaustive list of equipment to which this document is applicable, including exclusions.

This document applies to the qualification and selection of materials for equipment designed and constructed using load controlled design methods. For design utilizing strain-based design methods, see ISO 15156-1:2020, Clause 5.

Annex A lists SSC-resistant carbon and low alloy steels, and A.2.4 includes requirements for the use of cast irons.

This document is not necessarily suitable for application to equipment used in refining or downstream processes and equipment.

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