INTERNATIONAL STANDARD

ANSI/NACE MR0175/ ISO 15156-1

Second edition
2009-10-15

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

Part 1: General principles for selection of cracking-resistant materials

Industries du pétrole et du gaz naturel — Matériaux pour utilisation dans des environnements contenant de l'hydrogène sulfuré (H_2S) dans la production de pétrole et de gaz —

Partie 1: Principes généraux pour le choix des matériaux résistant au craquage

An American National Standard
Approved December 2, 2010

Reference number
ANSI/NACE MR0175/ISO 15156-1:2009(E)

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Contents

Page

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.

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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.

ANSI/NACE MR0175/ISO 15156-1 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*.

This second edition cancels and replaces the first edition (ANSI/NACE/ISO 15156-1:2001), of which it constitutes a minor revision, specifically by the following:

— inclusion of changes to Table 1 in line with the version shown in ANSI/NACE MR0175/ISO 15156-2 and ANSI/NACE MR0175/ISO 15156-3;

— inclusion of changes to Clause 5 to make clearer the roles of those involved in the selection and supply and use of materials;

— replacement of the term “pre-qualified material”.

ANSI/NACE MR0175/ISO 15156 consists of the following parts, under the general title *Petroleum and natural gas industries — Materials for use in H_2S-containing environments in oil and gas production*:

— *Part 1: General principles for selection of cracking-resistant materials*

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

— *Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys*

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 three parts of ISO 15156 and ANSI/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 part of ANSI/NACE MR0175/ISO 15156 involves a consolidation of all changes agreed and published in the Technical Corrigendum 1, ANSI/NACE MR0175/ISO 15156-1:2001/Cor.1:2005 and by the Technical Circular 1, ANSI/NACE/ISO 15156-1:2001/Cir.1:2007(E), published by the ISO 15156 maintenance agency secretariat at DIN, Berlin.

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 maintenance Web site, www.iso.org/iso15156maintenance.

When found necessary by oil and gas production industry experts, future interim changes to this part of ANSI/NACE MR0175/ISO 15156 will be processed in the same way and will lead to interim updates to this part of ANSI/NACE MR0175/ISO 15156 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 part of ANSI/NACE MR0175/ISO 15156.

The ISO 15156 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/WG 7, and the process for approval of amendments. It is available from the ISO 15156 maintenance Web site and from the ISO/TC 67 Secretariat. The Web site also provides access to related documents that provide more detail of ISO 15156 maintenance activities.

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

Part 1:
General principles for selection of cracking-resistant materials

WARNING — Metallic materials selected using ANSI/NACE MR0175/ISO 15156 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 materials suitable for the intended service.

1 Scope

This part of ANSI/NACE MR0175/ISO 15156 describes general principles and gives requirements and recommendations for the selection and qualification of metallic materials for service in equipment used in oil and gas production and in natural-gas sweetening plants in H_2S-containing environments, where the failure of such equipment 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 given in the appropriate design codes, standards or regulations.

This part of ANSI/NACE MR0175/ISO 15156 addresses all mechanisms of cracking that can be caused by H_2S, including sulfide stress cracking, stress corrosion cracking, hydrogen-induced cracking and stepwise cracking, stress-oriented hydrogen-induced cracking, soft zone cracking and galvanically induced hydrogen stress cracking.

Table 1 provides a non-exhaustive list of equipment to which this part of ANSI/NACE MR0175/ISO 15156 is applicable, including permitted exclusions.

This part of ANSI/NACE MR0175/ISO 15156 applies to the qualification and selection of materials for equipment designed and constructed using conventional elastic design criteria.

This part of ANSI/NACE MR0175/ISO 15156 is not necessarily applicable to equipment used in refining or downstream processes and equipment.

INTERNATIONAL STANDARD

ANSI/NACE MR0175/ ISO 15156-2

Second edition
2009-10-15

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

Industries du pétrole et du gaz naturel — Matériaux pour utilisation dans des environnements contenant de l'hydrogène sulfuré (H_2S) 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

An American National Standard
Approved December 2, 2010

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Contents

Page

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.

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ANSI/NACE MR0175/ISO 15156-2 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*.

This second edition cancels and replaces the first edition (ANSI/NACE MR0175/ISO 15156-2:2003), of which it constitutes a minor revision, specifically by the following:

— inclusion of the requirements for welding-procedure qualification for overlay welding;

— inclusion of changes to the limitations that apply to Table A.1 on weld hardness;

— inclusion of the ISO equivalents of ASTM hardness standards;

— inclusion of a small number of other technical changes;

— inclusion of changes to make the intent of the text clearer and to correct editorial errors.

ANSI/NACE MR0175/ISO 15156 consists of the following parts, under the general title *Petroleum and natural gas industries — Materials for use in H_2S-containing environments in oil and gas production*:

— *Part 1: General principles for selection of cracking-resistant materials*

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

— *Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys*

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 three parts of ISO 15156 and ANSI/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 part of ANSI/NACE MR0175/ISO 15156 involves a consolidation of all changes agreed and published in the Technical Corrigendum 1, ANSI/NACE MR0175/ISO 15156-2:2003/Cor.1:2005 and by the Technical Circular 1, ANSI/NACE MR0175/ISO 15156-2:2001/Cir.1:2007(E), published by the ISO 15156 maintenance agency secretariat at DIN, Berlin.

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 maintenance Web site www.iso.org/iso15156maintenance.

When found necessary by oil and gas production industry experts, future interim changes to this part of ANSI/NACE MR0175/ISO 15156 will be processed in the same way and will lead to interim updates to this part of ANSI/NACE MR0175/ISO 15156 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 part of ANSI/NACE MR0175/ISO 15156.

The ISO 15156 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/WG 7, and the process for approval of amendments. It is available from the ISO 15156 maintenance Web site and from the ISO/TC 67 Secretariat. The Web site also provides access to related documents that provide more detail of ISO 15156 maintenance activities.

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 part of ANSI/NACE MR0175/ISO 15156 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 part of ANSI/NACE MR0175/ISO 15156 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 part of ANSI/NACE MR0175/ISO 15156 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 part of ANSI/NACE MR0175/ISO 15156 also addresses the resistance of these steels to hydrogen-induced cracking (HIC) and its possible development into stepwise cracking (SWC).

This part of ANSI/NACE MR0175/ISO 15156 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 part of ANSI/NACE MR0175/ISO 15156 is applicable, including permitted exclusions.

This part of ANSI/NACE MR0175/ISO 15156 applies to the qualification and selection of materials for equipment designed and constructed using conventional elastic design criteria. For designs utilizing plastic criteria (e.g. strain-based and limit-state designs), see ANSI/NACE MR0175/ISO 15156-1:2009, 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 part of ANSI/NACE MR0175/ISO 15156 is not necessarily suitable for application to equipment used in refining or downstream processes and equipment.

INTERNATIONAL STANDARD

ANSI/NACE MR0175/ ISO 15156-3

Second edition
2009-10-15

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

Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys

Industries du pétrole et du gaz naturel — Matériaux pour utilisation dans des environnements contenant de l'hydrogène sulfuré (H_2S) dans la production de pétrole et de gaz —

Partie 3: ARC (alliages résistants à la corrosion) et autres alliages résistants à la fissuration

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ANSI/NACE MR0175/
ISO 15156-3:2009(E)

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Contents

Page

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This second edition cancels and replaces the first edition (ANSI/NACE MR0175/ISO 15156-3:2003), of which it constitutes a minor revision, specifically by the following:

— inclusion of new materials, and revised limits for other materials, in the tables of Annex A;

— inclusion of ISO equivalent ASTM hardness standards;

— correction of the conversion from NaCl % mass fraction used in Annex E to Cl^- milligrams per liter as used in Annex A;

— inclusion of a small number of other technical changes;

— inclusion of changes to make the intent of the text clearer and to correct typographical errors.

ANSI/NACE MR0175/ISO 15156 consists of the following parts, under the general title *Petroleum and natural gas industries — Materials for use in H_2S-containing environments in oil and gas production*:

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

Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys

WARNING — CRAs (corrosion-resistant alloys) and other alloys selected using this part of ANSI/NACE MR0175/ISO 15156 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 CRAs and other alloys suitable for the intended service.

1 Scope

This part of ANSI/NACE MR0175/ISO 15156 gives requirements and recommendations for the selection and qualification of CRAs (corrosion-resistant alloys) and other alloys 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 part of ANSI/NACE MR0175/ISO 15156 addresses the resistance of these materials to damage that can be caused by sulfide stress cracking (SSC), stress corrosion cracking (SCC) and galvanically induced hydrogen stress cracking (GHSC).

This part of ANSI/NACE MR0175/ISO 15156 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 part of ANSI/NACE MR0175/ISO 15156 is applicable, including permitted exclusions.

This part of ANSI/NACE MR0175/ISO 15156 applies to the qualification and selection of materials for equipment designed and constructed using conventional elastic design criteria. For designs utilizing plastic criteria (e.g., strain-based and limit-state designs), see ANSI/NACE MR0175/ISO 15156-1:2009, Clause 5.

This part of ANSI/NACE MR0175/ISO 15156 is not necessarily suitable for application to equipment used in refining or downstream processes and equipment.