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Petroleum and natural gas industries — Procedures for testing casing and tubing connections

Industries du pétrole et du gaz naturel — Procédures de test des connexions pour tubes de cuvelage et de production

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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*, Subcommittee SC 5, *Casing, tubing and drill pipe*.

This second edition cancels and replaces the first edition (ISO 13679:2002), which has been technically revised.

This document supplements API RP 5C5:2017.

The technical requirements of this document and API Recommended Practice (RP) 5C5 used to be identical. In the meantime API RP 5C5 has been technically revised as API RP 5C5:2017. The purpose of this edition of ISO 13679 is to bring it up to date, by referencing the current edition of API RP 5C5 and including supplementary content.

The main changes compared to the previous edition of ISO 13679 are as follows:

— new specimen geometries, e.g. XH-XL have been added;

— all Connection Assessment Level(s) test requirements and sequences have been revised.

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.

Introduction

This document is part of a process to provide reliable tubing and casing connections for the oil and natural gas industry which are fit for purpose. It has been developed based on improvements to ISO 13679:2002 and proprietary test procedures, with input from leading users, manufacturers and testing consultants from around the world. This document represents the knowledge of many years of testing and qualification experiences, where many oil and gas industry manufacturers and operators have utilized the testing protocol to improve connection performance with objective evidence, i.e. physical testing.

The experimental validation of connection test load envelope and failure limit loads is relevant to design of tubing and casing for the oil and natural gas industries. Tubing and casing are subject to loads which include internal pressure, external pressure, axial tension, axial compression, bending torsion, transverse forces and temperature changes. The magnitude and combination of these loads result in various pipe body and connection failure modes. Although pipe body test and limit loads are well understood in general, the same cannot be stated for the connection. These failure modes and loads are generally different and often less than that of the pipe. Consequently, experimental validation is needed.

The validation of test and limit loads implies the testing of performance parameters to these defined loads at the extremes. Testing at the extremes of the performance parameters assures that the production population that falls within these limits meets or exceeds the performance of the test population. Thread connection performance parameters include dimensional tolerances, mechanical properties, surface treatment, make-up torque and the type and amount of thread compound. For typical proprietary connections, worst-case tolerances are known and defined in this document. For other connections designs, the worst-case tolerance combinations need to be determined.

Users of this document should be aware that different physical testing requirements might be needed for individual well applications. This document is not intended to inhibit a vendor from offering, or a purchaser from accepting, alternate equipment or engineering solutions for the individual application. This is particularly applicable when there is innovative or developing technology. Where an alternative is offered, it is the responsibility of the vendor to identify any variations from this document and provide details.

For specific applications that are not evaluated by the tests herein, supplementary tests can be appropriate.

Representatives of users and/or other third-party personnel are encouraged to monitor the tests.

This document includes various provisions. These are identified using certain verbal forms:

— "Shall" is used to indicate requirements that strictly need to be followed in order to conform to this document and from which no deviation is permitted.

— "Should" is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

— "May" is used to indicate a course of action permissible within the limits of the document.

— "Can" is used to indicate statements of possibility and capability, whether material, physical or causal.

Petroleum and natural gas industries — Procedures for testing casing and tubing connections

1 Scope

This document specifies tests to perform in order to determine the galling tendency, sealing performance and structural integrity of casing and tubing connections. “Casing” and “tubing” apply to the service application and not to the diameter of the pipe.

This document covers the testing of connections for the most commonly encountered well conditions. Not all possible service scenarios are included. For example, the presence of a corrosive fluid, which can influence the service performance of a connection, is not considered.

This document supplements API RP 5C5:2017, the requirements of which are applicable with the exceptions specified in this document.

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 3183, *Petroleum and natural gas industries — Steel pipe for pipeline transportation systems*

ISO 11960, *Petroleum and natural gas industries — Steel pipes for use as casing or tubing for wells*

API RP 5C5:2017, *Procedures for Testing Casing and Tubing Connections*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in API RP 5C5:2017 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
near-yield loading effects
cyclic growth of plastic strain range in a cyclically softening material at stresses below the material yield strength

3.2
nominal connection performance envelope
the manufacturer’s claimed connection performance envelope that is based on the pipe’s specified geometrical and material attributes

4 Supplements to API RP 5C5:2017

4.1 General requirements

The requirements specified in API RP 5C5:2017 shall apply, with the exceptions specified in 4.2 to 4.7.

4.2 Scope

Replace Clause 1 of API RP 5C5:2017 with Clause 1 of this document.

4.3 Normative references

Replace API Specification 5CT, *Specification for Casing and Tubing* with ISO 11960, *Petroleum and natural gas industries — Steel pipes for use as casing or tubing for wells*.

Replace API Specification 5L, *Specification for Line Pipe* with ISO 3183, *Petroleum and natural gas industries — Steel pipe for pipeline transportation system*.

4.4 Nominal connection performance envelope

Replace the first paragraph of 4.3 of API RP 5C5:2017 with the following paragraph.

Prior to beginning a test, the manufacturer shall provide a test plan. This test plan shall contain a connection specification sheet stating the intended testing assessment level and a connection datasheet with the nominal connection performance envelope. The manufacturer shall provide a representative drawing of the cross-sectional areas of the connection and documentation detailing the specifications, processes, and procedures required for complete manufacture and inspection of the connection. The manufacturer shall provide the connection make-up parameters and repair procedures. Additionally, the manufacturer shall identify any specific pipe body attributes, e.g. 90 % minimum specified wall, high collapse, or controlled yield, that are required for the connection being evaluated.

Replace A.1.5 of API RP 5C5:2017 with the following paragraph.

The connection manufacturer shall provide a nominal connection performance envelope with uni-axial ratings and specified parameters identified on the performance envelope.

4.5 Anisotropic reference curves

This document recognizes that isotropic material behaviour is not exhibited by all Oil Country Tubular Goods (OCTG) and that the nominal pipe body VME curve (see API RP 5C5:2017 Annex D, curve 1) and the test specimen pipe body actual VME curve (see API RP 5C5:2017 Annex D, curve 4) explicitly reflect the isotropic material assumption. To provide an appropriate context for connection testing with anisotropic materials, the manufacturer should develop and report the nominal pipe body yield curve and test specimen pipe body actual yield curves using anisotropic yield criterion, e.g. Hill's conventional anisotropic yield criterion or other criteria to account for observed (compression) yield properties, in place of the isotropic material curves. The connection manufacturer should document the methodology for the development of these anisotropic yield curves and report the methodology and results in API RP 5C5:2017, Clause C.2, Section 7, part (a) of the connection test report.

4.6 Near-yield loading effects

In tubular-connection systems, i.e. connection test specimens, cyclic loading to stress levels approaching the tubular material's yield strength can cause plastic deformation (plastic strain) that increases in magnitude with each load cycle. The resulting accumulation of plastic strain might affect the functionality of a tubular-connection system or lead to its structural failure, which has been observed in material property and full-scale tests conducted in support of casing/tubing-connection evaluations. These aspects of casing/tubing material behaviour, and their manifestations in tubular-connection systems, are referenced as near-yield loading effects[1].

The interactions among variables impacting the near-yield loading effects (tubular-connection architecture, material properties, and loading) are complex; in general, the near-yield loading effect severity depends on the following:

— uncertainty of the material yield estimates (ambient and elevated temperatures);

— strain rate;

— applied cyclic stress amplitude;

— multi-axial stress state in the tubular system;

— stress-strain response (yield and elastic limit envelopes);

— cyclic softening tendency;

— ratcheting tendency;

— thermomechanical load history of the tubular material.

The near-yield loading effects have been observed in executing test load envelopes for the connection tests prescribed by this document. The tubular-connection deformations (strains) should be monitored during pipe-connection tests to evaluate stability of the plastic strain, especially in cases where the connection test specimen is repeatedly loaded to stresses potentially exceeding the tubular material elastic limits. The locations for monitoring the stability of the plastic deformation as well as the acceptable levels of plastic strain should be recommended by the connection manufacturer.

4.7 Test report

Replace C.2.1.c of API RP 5C5:2017 with " c) reference to this document and the edition used;".

Replace C.2.1.f of API RP 5C5:2017 with "f) temperature and DLS used in the tests;".