Design and Manufacture of Surface Wellhead Running, Retrieving and Testing Tools, Clean-out Tools and Wear Bushings

API TECHNICAL REPORT 6RT
FIRST EDITION, XXXXX 2018
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# TABLE of CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>.................................................................</td>
<td>vi</td>
</tr>
<tr>
<td>1</td>
<td>Scope</td>
<td>.................................................................</td>
</tr>
<tr>
<td>2</td>
<td>Normative References</td>
<td>.................................................................</td>
</tr>
<tr>
<td>3</td>
<td>Terms, Definitions, Acronyms, Abbreviations, Symbols, and Units</td>
<td>.................................................................</td>
</tr>
<tr>
<td>3.1</td>
<td>Terms and Definitions</td>
<td>.................................................................</td>
</tr>
<tr>
<td>3.2</td>
<td>Acronyms and Abbreviations</td>
<td>.................................................................</td>
</tr>
<tr>
<td>4</td>
<td>Design</td>
<td>.................................................................</td>
</tr>
<tr>
<td>4.1</td>
<td>General</td>
<td>.................................................................</td>
</tr>
<tr>
<td>4.2</td>
<td>Loads</td>
<td>.................................................................</td>
</tr>
<tr>
<td>4.3</td>
<td>End Connections</td>
<td>.................................................................</td>
</tr>
<tr>
<td>4.4</td>
<td>Vertical Bore</td>
<td>.................................................................</td>
</tr>
<tr>
<td>4.5</td>
<td>Outside Profile</td>
<td>.................................................................</td>
</tr>
<tr>
<td>4.6</td>
<td>Pressure Rating</td>
<td>.................................................................</td>
</tr>
<tr>
<td>5</td>
<td>Materials</td>
<td>.................................................................</td>
</tr>
<tr>
<td>5.1</td>
<td>General</td>
<td>.................................................................</td>
</tr>
<tr>
<td>5.2</td>
<td>Additional Requirements</td>
<td>.................................................................</td>
</tr>
<tr>
<td>5.2.1</td>
<td>General</td>
<td>.................................................................</td>
</tr>
<tr>
<td>5.2.2</td>
<td>Heat Treatment</td>
<td>.................................................................</td>
</tr>
<tr>
<td>5.2.3</td>
<td>Chemical Composition</td>
<td>.................................................................</td>
</tr>
<tr>
<td>5.2.4</td>
<td>Material Qualification</td>
<td>.................................................................</td>
</tr>
<tr>
<td>5.2.4.1</td>
<td>Qualified Test Coupon</td>
<td>.................................................................</td>
</tr>
<tr>
<td>5.2.4.2</td>
<td>Qualification Lot</td>
<td>.................................................................</td>
</tr>
<tr>
<td>5.2.4.3</td>
<td>Mechanical Testing</td>
<td>.................................................................</td>
</tr>
<tr>
<td>5.3</td>
<td>Mechanical Property Requirements</td>
<td>.................................................................</td>
</tr>
<tr>
<td>5.4</td>
<td>Coatings</td>
<td>.................................................................</td>
</tr>
<tr>
<td>6</td>
<td>Testing</td>
<td>.................................................................</td>
</tr>
<tr>
<td>7</td>
<td>Marking</td>
<td>.................................................................</td>
</tr>
<tr>
<td>8</td>
<td>Quality Control Record Requirements</td>
<td>.................................................................</td>
</tr>
<tr>
<td>8.1</td>
<td>General</td>
<td>.................................................................</td>
</tr>
<tr>
<td>8.1.1</td>
<td>Purpose</td>
<td>.................................................................</td>
</tr>
<tr>
<td>8.1.2</td>
<td>ISO 15156 (all parts) (NACE MR0175; see Clause 2) Records Requirements</td>
<td>.................................................................</td>
</tr>
<tr>
<td>8.1.3</td>
<td>Records Control</td>
<td>.................................................................</td>
</tr>
<tr>
<td>8.1.4</td>
<td>Manufacturer Records</td>
<td>.................................................................</td>
</tr>
<tr>
<td>9</td>
<td>Storing and Shipping</td>
<td>.................................................................</td>
</tr>
<tr>
<td>9.1</td>
<td>Thread Protection</td>
<td>.................................................................</td>
</tr>
<tr>
<td>9.2</td>
<td>Draining After Testing</td>
<td>.................................................................</td>
</tr>
<tr>
<td>9.3</td>
<td>Rust Prevention</td>
<td>.................................................................</td>
</tr>
</tbody>
</table>
9.4 Sealing-surface Protection ........................................................................................................... 10
9.5 Assembly and Maintenance Instructions ....................................................................................... 10
9.6 Ring Gaskets ................................................................................................................................ 10
9.7 Age control of Non-metallic Materials .......................................................................................... 10
Bibliography ....................................................................................................................................... 11
Introduction

This technical report is derived from required previously found in API Specification 6A, 20th Edition. The International System of units (SI) and US Customary units are used in this technical report.

The fractions and their decimal equivalents are equal and interchangeable. Metric conversions and inch dimensions in this International Standard are based on the original fractional inch designs. Functional dimensions have been converted into the metric system to ensure interchangeability of products manufactured in metric or inch systems.

It is necessary that users of this technical report be aware that further or differing requirements can be needed for individual applications. This technical report is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This can be particularly applicable where there is innovative or developing technology. Where an alternative is offered, it is the responsibility of the vendor to identify any variations from this technical report and provide details.
Design and Manufacture of Surface Wellhead Running, Retrieving and Testing Tools, Clean-out Tools and Wear Bushings

1 Scope

This technical report addresses the design, materials selection, manufacture and testing of all tools and equipment for running, retrieving and testing of wellhead components, including wear bushings.

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, except that new editions may be used on issue and shall become mandatory upon the effective date specified by the publisher or 6 months from the date of the revision (where no effective date is specified).

API Specification 5B, Specification for Threading, Gauging and Thread Inspection of Casing, Tubing, and Line Pipe Thread

API Specification 5DP, Specification for Drill Pipe

API Specification 6A, Specification for Wellhead and Christmas Tree Equipment

API Specification 7-1, Specification for Rotary Drill Stem Elements

API Specification 7-2, Specification for Threading and Gauging of Rotary Shouldered Thread Connections

ASME¹ Boiler and Pressure Vessel Code:2004 with 2005 and 2006 addenda, Section IX, Welding and Brazing Qualifications

ASTM² A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products

ISO³ 148 (all parts), Metallic materials — Charpy pendulum impact test

ISO 15156 (all parts), Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production

NACE⁴ MR0175 (all parts), Petroleum and natural gas industries—Materials for use in H2S-containing environments in oil and gas production

¹ ASME International, 345 East 47th Street, New York, NY 10017-2392, USA
² American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohoken, PA 19428-2959, USA
³ International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland, www.iso.org
⁴ NACE International (formerly the National Association of Corrosion Engineers), 1440 South Creek Drive, Houston, Texas 77084-4906, www.nace.org
3 Terms, Definitions, Acronyms, Abbreviations, Symbols, and Units

3.1 Terms and Definitions

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

3.1.1 running tool
   retrieving tool
   tool used to run, retrieve, position or connect wellhead equipment remotely from the drill floor.
   NOTE Sometimes referred to as “fishing tools”.

3.1.2 wear bushing
   retrievable cylindrical device that protects the internal surfaces of wellhead equipment and the top of the last casing suspended

3.2 Acronyms and Abbreviations

For the purposes of this document, the following acronyms and abbreviations apply.

API American Petroleum Institute
HBW Brinell hardness value
ISO International Organization for Standardization
MPa megapascal
NACE National Association of Corrosion Engineers
NDE nondestructive examination
OD outer diameter
psi pounds per square inch
QTC qualified test coupon
°C degrees Celsius
°F degrees Fahrenheit
J joule
T heaviest cross-section prolongation
4 Design

4.1 General

The equipment manufactured in accordance with this technical report shall be designed to satisfy the manufacturer's documented performance characteristics and the service conditions specified in API 6A. The manufacturer shall specify methods for use in designs that are consistent with accepted engineering practices.

4.2 Loads

Design of running, retrieving, clean-out and testing tools shall include the following as a minimum:

- suspended loads, including overpull;
- bending loads;
- pressure;
- torsional loads, including the required make-up torque of shouldered connections;
- radial loads;
- environmental loads.

4.3 End Connections

Tool joints shall conform to the requirements of API 5DP. Rotary shouldered connections shall conform to the requirements of API 7-1. These elements shall be an integral part of the tool and shall not to be connected by welding. There shall be adequate space for elevator and rotary slips. The load capacity of the tool shall not be inferred by the choice of the end connection of the tool.

For attachments welded to tools, the following shall apply:

The following apply:

a) welding procedure/performance:

Welding procedures and performance qualifications shall be in accordance with ASME BPVC:2004, Section IX, Articles II and III with 2005 and 2006 addenda.

b) application:

Welding shall be performed in accordance with qualified procedures by qualified welding personnel. Non-pressure-containing weldments shall meet the manufacturer's design requirements.

c) quality control requirements:

Welding and completed welds shall meet the requirements of Table 1.
## Table A.1—Quality Control Requirements for Welding

<table>
<thead>
<tr>
<th>Weld type</th>
<th>Stages</th>
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<tbody>
<tr>
<td>Pressure-containing</td>
<td>Preparation</td>
</tr>
<tr>
<td>Non-pressure-containing</td>
<td>Preparation</td>
</tr>
<tr>
<td>Repair</td>
<td>Preparation</td>
</tr>
<tr>
<td>Weld metal overlay (ring grooves, stems, valve-bore sealing mechanisms and choke trim)</td>
<td>Preparation</td>
</tr>
<tr>
<td>Weld metal corrosion-resistant alloy overlay (bodies, bonnets and end and outlet connections)</td>
<td>Preparation</td>
</tr>
</tbody>
</table>

- **a**: Visual examination.
- **b**: Liquid-penetrant testing inspection for non-ferromagnetic materials and magnetic-particle testing or liquid-penetrant testing for ferromagnetic material.
- **c**: Radiation (radiography or imaging) examination.
- **d**: Ultrasonic examination.
- **e**: Hardness test (weld).
- **f**: Liquid-penetrant or magnetic-particle as applicable for material defects only.
- **g**: Ultrasonic examination only if weld thickness is greater than 25% of wall thickness, or 25 mm (1 in), whichever is less.
- **h**: Radiation (radiography or imaging) examination only if weld thickness is greater than 25% of wall thickness for PSL 2, or 20% of wall thickness for PSL 3, or 25 mm (1 in), whichever is less.

**NOTE**
- “Preparation” refers to surface preparation, joint preparation, fit-up and preheat.
- “Completion” refers to after all welding, post-weld heat treat and machining.

Threads shall be gauged in accordance with API 7-2.

Casing or tubing threads shall be conform to the requirements of API Spec 5B or, in case of proprietary connections, according to licensed drawings, including provision for tonging and elevator space.

Torque-operated tools should preferably be threaded left-hand for make-up and right-hand for release to prevent inadvertently backing off of casing/tubing/drillpipe connections during operation/disconnection. Left-hand threads shall be clearly marked and can be required for tubing running tools for backing out of a permanent production packer.

### 4.4 Vertical Bore

If tools have a vertical bore in order to make circulation possible, the drift diameter of the bore should, as a minimum, be equal to the drift size for the specified tool joint or, in case internal profiles are used, according to manufacturer’s written drift specifications.

The wear bushings shall have an ID in accordance with Table 2.
Table A.2—Minimum Vertical Full-opening Body Bores and Maximum Casing Sizes

<table>
<thead>
<tr>
<th>Nominal Connector&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Nominal Size and Bore of Connector</th>
<th>Rated Working Pressure</th>
<th>Label&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Casing Beneath Body</th>
<th>Specified Drift Diameter</th>
<th>Minimum Vertical Full-opening Wellhead Body Bore</th>
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<td>MPa</td>
<td>psi</td>
<td>OD</td>
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<td>139.89</td>
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<sup>a</sup> Upper-end connections of wellhead body.

<sup>b</sup> Maximum size and minimum mass of casing on which bore is based.

4.5 Outside Profile

The outside profile of the tools shall be in accordance with the manufacturer's written specification. When possible, the outside profile should be designed to ensure alignment, if needed, and to minimize the risk of hanging up in blowout preventer cavities. The OD and length of the connections shall be in accordance with 4.3.
4.6 Pressure Rating

The pressure rating of the tool shall, if applicable, be in accordance with the manufacturer's written specification.

5 Materials

5.1 General

All tools and parts thereof shall require a written material specification that shall define the following, along with accept/reject criteria:

— mechanical property requirements;
— material qualification;
— heat-treatment procedure, including cycle time and temperatures with tolerances;
— material composition with tolerances;
— NDE requirements;
— allowable melting practice(s);
— hot-working practice(s);
— cooling media when heat treating.

Running tools shall be fabricated from materials that meet the applicable property requirements as specified by the manufacturer.

5.2 Additional Requirements

5.2.1 General

Sections 5.2 to 5.4 shall apply only to major load-bearing tools, such as casing and tubing running tools, cup-type tester and seal assembly setting tools required to transmit torque that is higher than 50% of the make-up torque of the tool.

5.2.2 Heat Treatment

Heat treatment shall be performed in accordance with the manufacturer's written specification. This specification shall contain all necessary information to perform the heat treatment of each selected material or part in order to obtain the required mechanical properties.

5.2.3 Chemical Composition

Materials shall conform to the manufacturer's written specification.

The manufacturer shall specify the nominal chemical composition, including the composition tolerances, of the material.

The material composition shall be determined on a heat basis (or a remelt ingot basis for remelt grade materials) in accordance with an internationally recognized standard specified by the manufacturer.
5.2.4 Material Qualification

5.2.4.1 Qualified Test Coupon

The qualified test coupon (QTC) for a running tool shall be a full section prolongation.

NOTE  The prolongation may be heat-treated either attached or separated from the running tools it represents.

The prolongation shall be sufficiently long to ensure that mechanical test specimens (see 5.2.4.3) can be taken at least \( \frac{1}{4} T \) (where \( T \) is the heaviest cross-section of the prolongation) from the nearest heat-treated surface.

If a running tool is preheat-machined to different diameters, the prolongation shall be taken from the end having the largest diameter.

5.2.4.2 Qualification Lot

The QTC shall represent identical running tools that are from the same heat and heat-treated together in the same furnace at the same time (heat per heat-treat-lot testing). An attached prolongation, if used, shall remain attached to a production running tool throughout heat treatment, except for re-tempering or re-ageing cycles when required.

5.2.4.3 Mechanical Testing

A minimum of one tensile test and three Charpy V-notch tests shall be performed on each QTC. Full-size specimens shall be used. Testing shall be performed in accordance with ISO 148 (all parts) or ASTM A370. Impact test temperature shall be no higher than the lowest anticipated service temperature.

The following apply.

a) Test specimens shall be removed from the QTC such that the tensile specimen gauge length and the Charpy V-notch root are at least \( \frac{1}{4} T \) from the “as-heat-treated” ends of the QTC (\( T \) is the heaviest cross-section of the prolongation). The longitudinal axis of the tensile and Charpy specimens shall be taken within the centre \( \frac{1}{4} T \) envelope for solid QTCs or within 3 mm (\( \frac{1}{8} \) in) of the mid-wall for hollow QTCs.

b) Hardness testing shall be carried out as specified by the manufacturer.

5.3 Mechanical Property Requirements

In case the running tools are used to run casing or tubing, or are required to transmit high torque, or can be heavily loaded because of test pressures, the mechanical properties of the tool shall be as specified in Table 3.

<table>
<thead>
<tr>
<th>Minimum 0.2 % Offset Yield Strength (MPa (psi))</th>
<th>Minimum Elongation (%)</th>
<th>Brinell Hardness (HBW)</th>
<th>Charpy V-notch Minimum Impact Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>690 (100 000)</td>
<td>13</td>
<td>260 to 321</td>
<td>42 J at –20 °C (31 ft-lb at –4 °F)</td>
</tr>
</tbody>
</table>

Lower-yield-strength materials may be used if it can be demonstrated that the running tool is at least as strong as the hanger. The material requirements for wear bushings shall comply with the manufacturer's
written specification; however, the hardness should be between 241 HBW and 321 HBW. Impact testing is not required for wear bushing material. The ratio of yield strength to tensile strength shall not exceed 0.90.

5.4 Coatings

The rotary connections of the tools shall be coated with an anti-galling agent.

6 Testing

All tools shall, as far as reasonably possible, be functionally tested and dimensionally inspected or gauged to confirm their correct operation prior to shipment from the manufacturer’s facility. Tools with hydraulic operating systems shall have the hydraulic system tested in accordance with the manufacturer’s written specification. This hydrostatic test shall consist of three steps:

— a primary pressure-holding period;

— a reduction of the pressure to zero (atmospheric pressure);

— a secondary pressure-holding period.

Each holding period shall not be less than 15 min; the timing shall not start until the external surfaces of the body members have been thoroughly dried, the test pressure has been reached and the equipment and the pressure-monitoring gauge have been isolated from the pressure source.

7 Marking

All tools shall be marked “6RT” and also as indicated in API 5DP below the tool joint tong space, as a minimum. Wear bushings shall be marked “6RT” followed by the drift internal diameter, expressed in millimetres and inches. A unique serial number shall be die-fixed to each tool assembly, preferably in a milled recess.

8 Quality Control Record Requirements

8.1 General

8.1.1 Purpose

The quality control records required by this International Standard are necessary to substantiate that all materials and products made to meet this International Standard do conform to the specified requirements.

8.1.2 ISO 15156 (all parts) (NACE MR0175; see Clause 2) Records Requirements

Records required to substantiate conformance of equipment manufactured with sour service material classes (see ISO 15156 (all parts) (NACE MR0175; see Clause 2) requirements shall be in addition to those described in 8.1.4, unless the records required by this technical report also satisfy the ISO 15156 (all parts) (NACE MR0175; see Clause 2) requirements.
8.1.3 Records Control

The following apply.

c) Quality control records required by this International Standard shall be legible, identifiable, retrievable and protected from damage, deterioration or loss.

d) Quality control records required by this International Standard shall be retained by the manufacturer for a minimum of five years following the date of manufacture as marked on the equipment associated with the records.

e) All quality control records required by this International Standard shall be signed and dated.

8.1.4 Manufacturer Records

The following records shall be maintained by the manufacturer:

— material test records:
  — chemical analysis,
  — tensile test,
  — impact test (if required),
  — hardness test;

— welding process records:
  — weld procedure specification,
  — weld procedure qualification record,
  — welder qualification record;

— NDE personnel qualification records;

— hardness test (if applicable);

— NDE records:
  — surface NDE records,
  — weld volumetric NDE records,
  — repair weld NDE records;

— heat-treatment certificate of compliance
9 Storing and Shipping

9.1 Thread Protection

Threads shall be protected by a proper storage compound and a metal pressed thread protector or equivalent.

9.2 Draining After Testing

All equipment shall be drained and lubricated after testing and prior to storage or shipment.

9.3 Rust Prevention

Prior to shipment, parts and equipment shall have exposed metallic surfaces protected with a rust preventative that does not become fluid and run at a temperature of less than 50 °C (125 °F).

9.4 Sealing-surface Protection

Exposed sealing surfaces shall be protected from mechanical damage for shipping.

9.5 Assembly and Maintenance Instructions

The manufacturer shall furnish to the purchaser suitable drawings and instructions concerning field assembly and maintenance. This includes, if relevant, an operating manual for the equipment.

9.6 Ring Gaskets

Loose ring gaskets shall be boxed or wrapped during shipping and storage.

9.7 Age control of Non-metallic Materials

Age-control procedures and the protection of non-metallic seals shall be documented by the manufacturer.

The manufacturer shall define the provisions and requirements.