Casing Wear Tests

API STANDARD 7CW
FIRST EDITION, JUNE 2015

AMERICAN PETROLEUM INSTITUTE

Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilized. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

Users of this Standard should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein.

Foreword

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

Shall: As used in a standard, “shall” denotes a minimum requirement in order to conform to the specification.

Should: As used in a standard, “should” denotes a recommendation or that which is advised but not required in order to conform to the specification.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API standard. Questions concerning the interpretation of the content of this publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. Status of the publication can be ascertained from the API Standards Department, telephone (202) 682-8000. A catalog of API publications and materials is published annually by API, 1220 L Street, NW, Washington, DC 20005.

Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

Contents

Casing Wear Tests

1 Scope

It is the intent of this standard to provide a method by which results will be reproducible, under a specified set of conditions, for conducting tests that determine casing wear due to rotation of drill stem elements.

This standard is intended to be used in a laboratory environment and is not intended for use in the field during operations. The testing requirements in this standard are not represented at well conditions. This standard is divided into four major areas: machine apparatus, procedures, materials, and reporting.

This standard will not address the significance of specific data values. It is the responsibility of the user of this standard to establish the appropriate test data values that are acceptable based on their respective application, operational limitations, and safety practices.

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.

API Manual of Petroleum Measurement Standards Chapter 10.4, *Determination of Water and/or Sediment in Crude Oil by the Centrifuge Method (Field Procedure)*

API Recommended Practice 13B-1, *Recommended Practice for Field Testing Water-Based Drilling Fluids*

API Recommended Practice 19C, *Measurement of Properties of Proppants Used in Hydraulic Fracturing and Gravel-Packing Operations*

API Specification 5CT, *Specification for Casing and Tubing*

API Specification 5DP, *Specification for Drill Pipe*

3 Terms, Definitions, and Abbreviations

3.1 Terms and Definitions

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

3.1.1
asperity
Protuberance in the small-scale topographical irregularities of a solid surface.

3.1.2
axial friction factor
Ratio of frictional force and contact force between the test specimen and the casing while sliding (not rotating).

3.1.3
axial-load
Force imparted by the tool joint specimen against the inside casing wall.

3.1.4
coefficient of friction
Dimensionless ratio of the friction force between two bodies to the normal force pressing these bodies together.

3.1.5
contact pressure
Lateral-load applied by the test specimen to the casing divided by the area of contact.

NOTE Since the lateral-load is constant during a wear test, the contact pressure decreases as the wear groove deepens and widens during the wear test.

3.1.6
contact pressure threshold
Minimum pressure exerted by the test specimen on the inside casing wall that will produce wear; a more definitive predictor of wear than the "Wear Factor".

NOTE Factors that determine contact pressure threshold include wear groove width, wear groove depth, and the lateral-load of the test specimen on the casing.

3.1.7
critical wear groove depth
Wear groove depth when the wear grove width is equal to the test specimen diameter.

3.1.8
drill stem element test specimen
Tool joint test specimen.

3.1.9
field-ready
Test specimen looks like and has the same surface finish as an equivalent material would be received at the well site.

3.1.10
galling
Wear mechanism with the wear debris described as flakes.

3.1.11
grinding
Wear mechanism with the wear debris described as a powder.

3.1.12
lateral-load (side-load)
Contact force of the test specimen against the casing specimen divided by the net length of the hardband or material coating on the test specimen.

3.1.13
machining
Wear mechanism with the wear debris described as chips.

3.1.14
manufacturer
Principal agent in the design, fabrication, and furnishing of the test specimen who chooses to comply with this standard.

3.1.15
moment-load
Force imparted on casing specimen upon introduction of lateral-load and rotation of the tool joint specimen.

3.1.16
normalized
Test specimens with hardband material come from the manufacturer with varying OD dimensions.

NOTE Normalization is the mathematical process to equate those varying dimensions to 6.25 in. test specimen OD, $9^5/_8$ in., 58.4 lb/ft casing with 0.595 in. wall.

3.1.17
polishing
Wear mechanism with the wear debris described as a fine powder.

3.1.18
rotational friction factor
Ratio of frictional force and contact force between the test specimen and the casing while rotating.

3.1.19
side-load (lateral-load)
Contact force of the test specimen against the casing specimen divided by the net length of the hardband or material coating on the test specimen.

3.1.20
sliding distance
Distance traveled by a point on the periphery of the test specimen as it contacts the inner casing wall.

3.1.21
specific energy
Energy required to remove one cubic inch of material from one foot of the inner casing wall, lb_f-in. per cubic in.

3.1.22
surface finish
Final manufactured or machined exterior evaluated by a mean roughness index number, R_a.

3.1.23
surface roughness
Geometrical characteristics of the surface that may include macro-deviations, surface waviness, and micro-irregularities.

3.1.24
surface roughness number (R_a)
Represents the average departure of the surface from perfection measured along a line, running at a right angle to the general direction of tool marks on the surface.

NOTE Typically expressed in units of height; micro-inches (US customary units), microns (metric units), or N scale (ISO 1302:2002). In U.S. customary units, 1 R_a is typically expressed in “millionths” of an inch.

3.1.25
test agency
Party which provides a test facility and administers a test program that meets the requirements of this standard.

3.1.26
three-body abrasive wear
Form of abrasive wear in which wear is produced by loose particles introduced or generated between the contacting surfaces.

3.1.27
tool joint test specimen
Drill stem element test specimen.

3.1.28
torque arm
Length between center axis within casing cylinder ID and a specific pivot point.

3.1.29
translation
Reciprocation of the test specimen against the casing specimen.

3.1.30
water-base drilling fluid
Drilling fluid where gelled and special purpose solids are suspended in a water liquid base, often in combination with other water soluble special purpose chemicals.

3.1.31
wear factor
Determined mathematically based on actual casing wear over an 8-hour test period at 155 RPM normalized to standard dimensions.

3.1.32
wear groove depth
Wear groove created by a test specimen over a period of time.

3.1.33
wear rate
Rate of material removal or dimensional change per unit of time or distance.

3.2 Abbreviations

bbl	barrel (42 gallons)
g	gram(s)
ID	inside diameter
lb_f	pound-force
ml	milliliter(s)
MTR	material test report
OD	outside diameter
ppg	pounds per gallon
R_a	average roughness of a surface finish
revs	revolutions
RPM	revolutions per minute

4 Testing

4.1 General

While a surface finish of a solid may appear to be very smooth, microscopically small topographical irregularities cover the solid surface. These irregularities are called asperities. Surface roughness is a general geometric characteristic of asperities on a larger scale. A common measure of average surface roughness, R_a, is expressed in units of height. In U.S. customary units, 1 R_a is typically expressed in “millionths” of an inch or micro-inch.

As two solid surfaces meet and frictionally interface with one another, wear mechanisms such as galling, grinding, machining, or polishing may create wear debris of various shapes and sizes. The rate of material removed per unit of time or distance creates a dimensional change described as a wear rate.

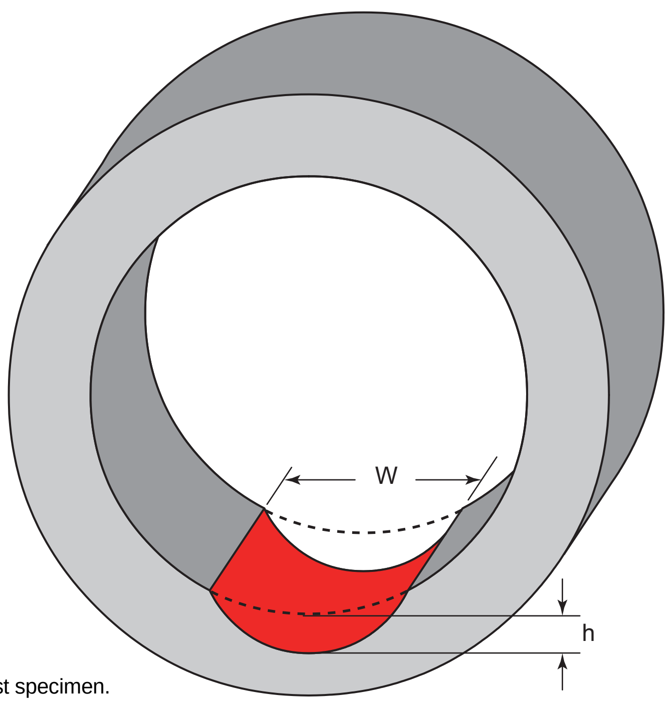
The term coefficient of friction describes the dimensionless ratio of the friction force between two bodies to the normal force pressing these bodies together. Axial friction factor is a related term that describes the ratio of frictional force and contact force between the test specimen and the casing while sliding (not rotating). Rotational friction factor describes the ratio of frictional force and contact force between the test specimen and the casing while rotating.

Three-body abrasive wear is a common occurrence when loose particles are introduced or generated between two contact surfaces.

Critical wear groove depth is demonstrated in cases of severe wear, where the entire tool joint specimen diameter may protrude through the casing wall.

4.2 Casing Wear Test

4.2.1 This test method describes laboratory procedures to create a measurable wear groove and classify the wear by determining the amount of material worn away from a casing specimen by means of abrasion. (See Figure 1.)



NOTE Also described as the test specimen.

Figure 1—Measurable Wear Groove Inside a Casing Tubular Created by Rotating Drill Stem Element, Typically a Tool Joint with Material Coating

4.2.2 The abrasion is created by rotating and reciprocating a drill stem element, test specimen (see Figure 2), against a stationary casing specimen (see Figure 1) at a prescribed side-load (see Figure 3). Additional abrasion is supplied by materials in the drilling fluid continuously circulated during the test procedure. The chief abrasive component within that drilling fluid is 100 mesh sand.

4.3 Open-hole Test Simulation

4.3.1 This test method describes laboratory procedures for determining the amount of material worn away from a rotating drill stem element test specimen, by means of abrasion from a counter rotating abrasive cylinder (see Figure 4).

4.3.2 The abrasion is imposed upon the drill stem element, typically a test specimen, by an abrasive element, typically in the shape of a cylinder (Figure 5); and at a prescribed side-load (Figure 6). Some additional abrasion is supplied by materials in the drilling fluid continuously circulated during the test procedure. The chief abrasive component within that drilling fluid is typically 100 mesh sand.

4.4 Manufacturer Requirements

4.4.1 Testing to qualify a hardband or material coating shall be performed by a test agency.

4.4.2 The manufacturer shall submit two field-ready specimens of most recent manufacture for testing.

Steel drill stem element test article substrate (base metal) shall conform to material qualification (see 5.3).

Supply traceability documentation with material shall conform to API 5DP.

The manufacturer shall permanently stamp the identification of the material being tested into the specimen wall.

Figure 2—Drill Stem Element Test Specimen with a Material Coating

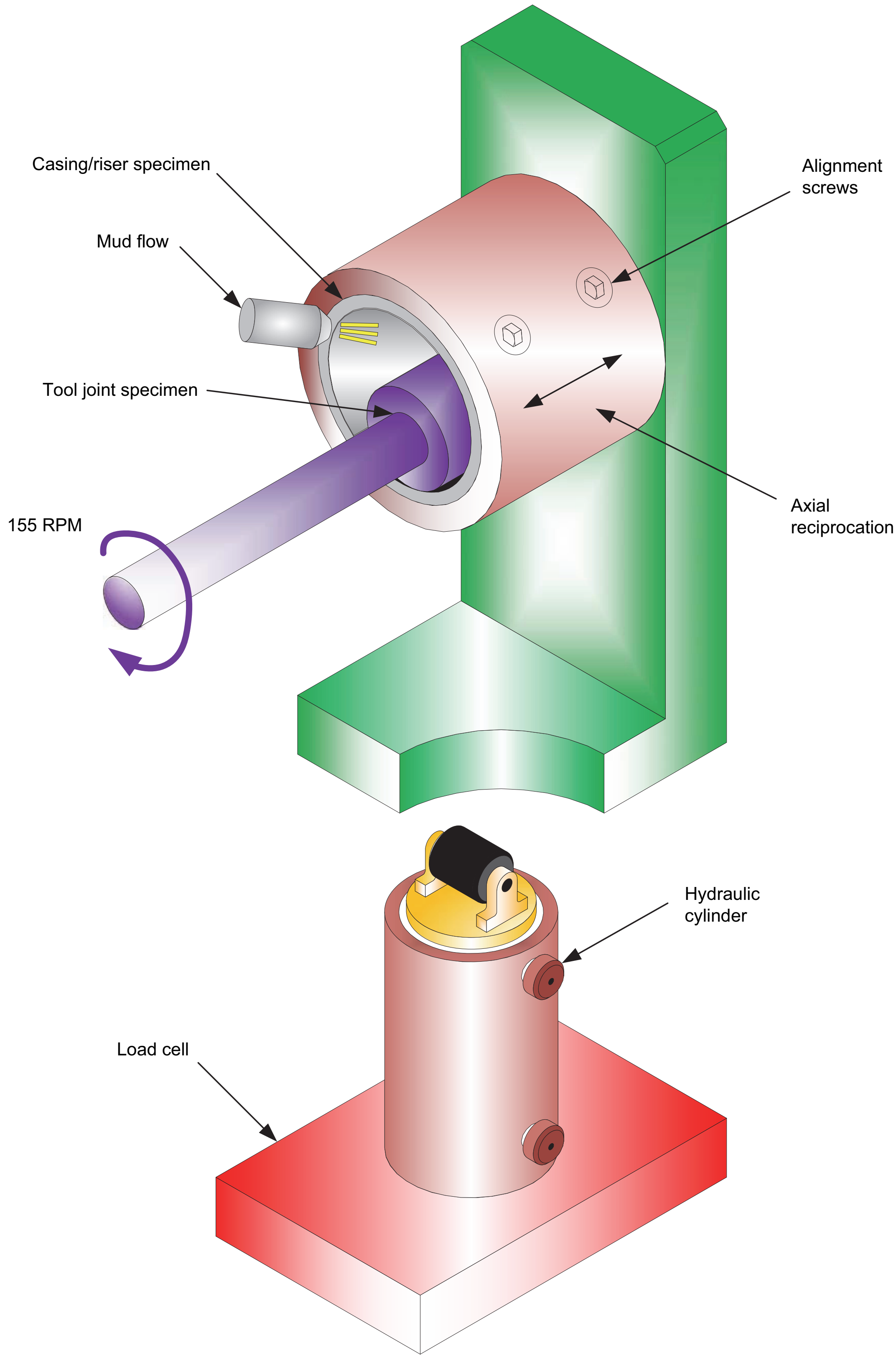


Figure 3—Casing Wear Test Apparatus for Cased-hole Test Configuration

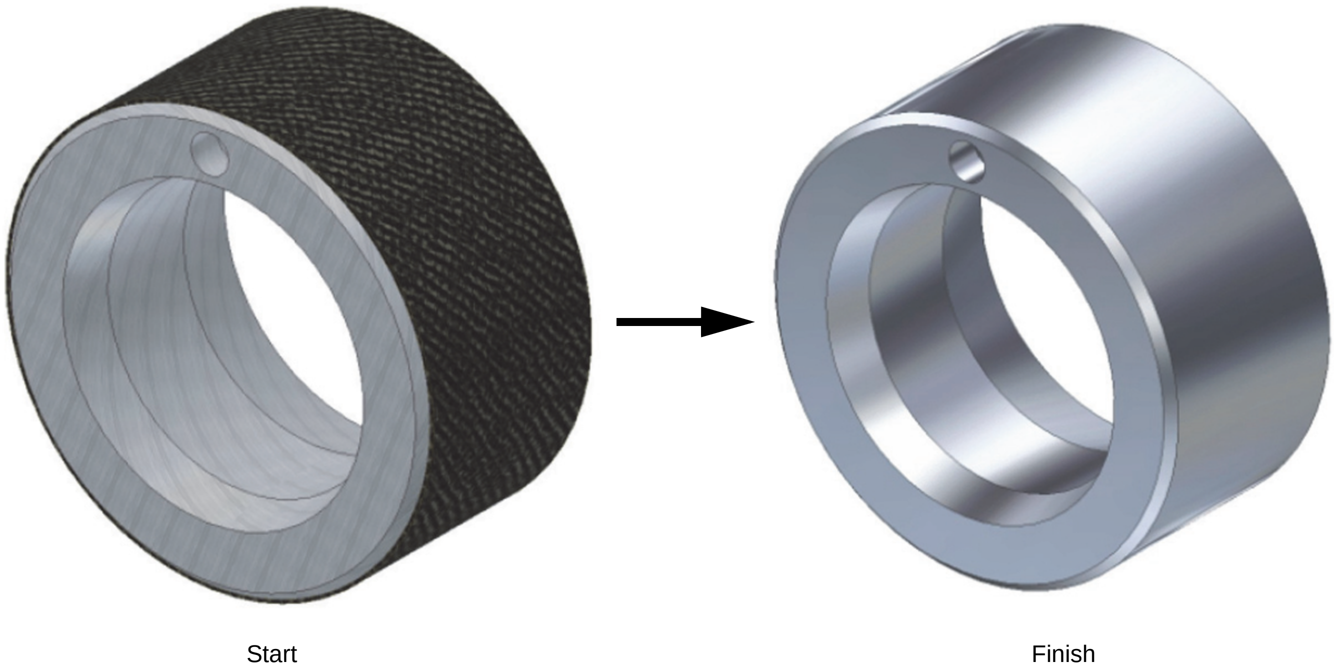


Figure 4—Material Coating Worn Away by Means of Abrasion

Figure 5—Aluminum Oxide Abrasive Cylinder Mounted in a Piece of Casing

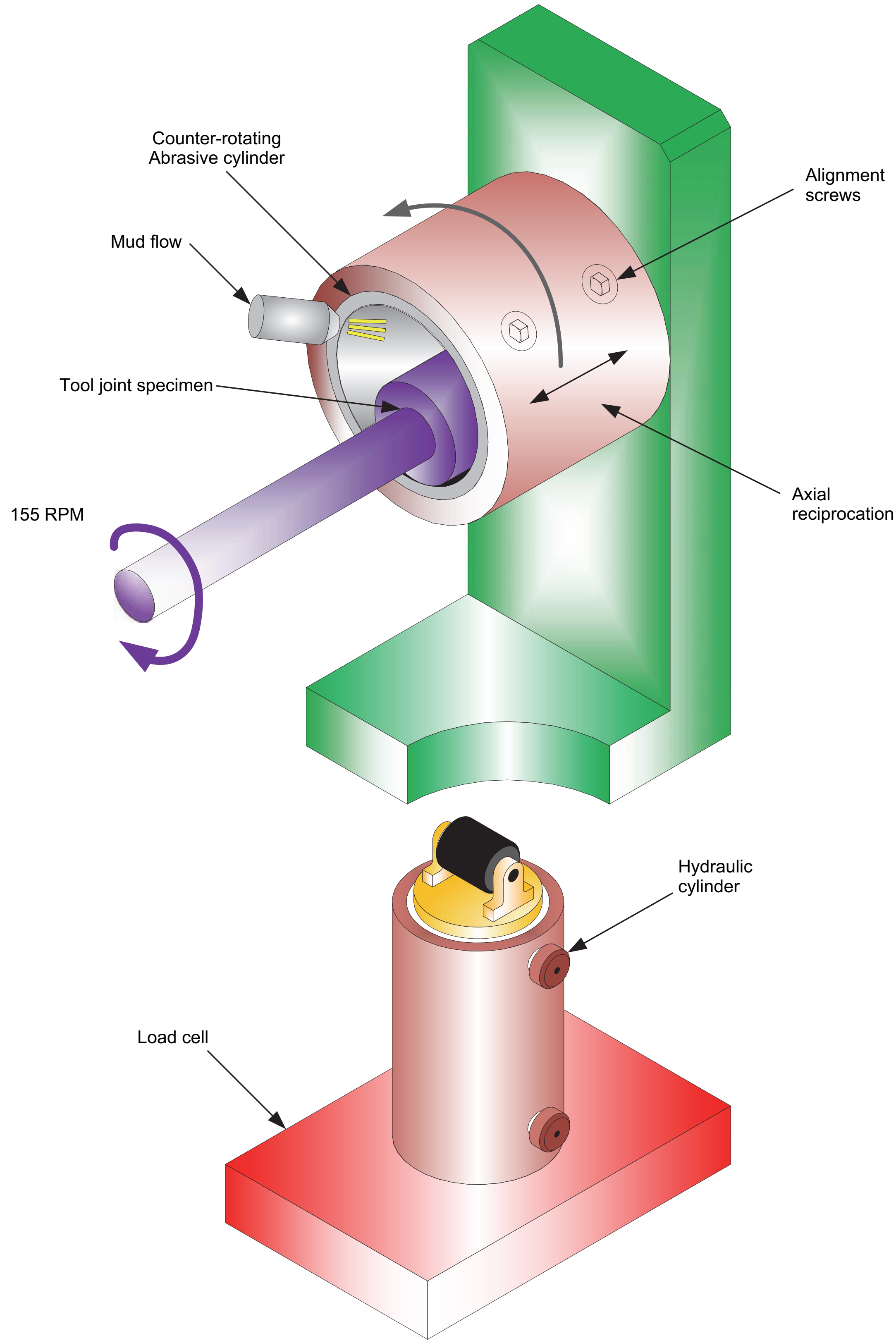


Figure 6—Test Specimen Wear Apparatus for Open-hole Test Configuration

4.4.3 Substantive changes to the material chemistry or application process shall require requalification of the material.

4.4.4 The test specimen length and diameter dimensions shall be defined by this standard.

4.5 Test Agency Requirements

4.5.1 The test agency shall conduct tests in accordance with this standard.

4.5.2 The test agency shall be responsible for assuring itself, the manufacturers and the operators that the test facility, procedures and forms comply with this standard.

4.5.3 The test agency shall provide or make available for review current documentation to manufacturers or operators on written request. This shall include, as a minimum, the following:

a) description of the facility, including any limitations on the diameter, length, temperature, load rating, and service of specimens may be tested;

b) test procedures and forms actually used at the test facility;

c) procedures for maintenance and calibration of measuring equipment;

d) procedures for making applications for tests, the delivery of specimens, pre- and post-test dimensional verification, and the initial installation and checkout in the test apparatus;

e) any limitations on the accessibility of the facility (such limitations shall not preclude access to the facility for inspection by manufacturers or operators for their testing); and

f) any limitations on the receipt of proprietary, competitive, or confidential information.

4.6 General Requirements for Qualification Testing Facility

4.6.1 The test facility shall be equipped with instrumentation to display and record information required by the test procedure with a time-based recorder.

The components of the test facility systems shall have a capacity to perform the tests according to this standard.

Unless otherwise stated, all load cells and pressure transducers shall be calibrated on an annual basis.

All pressures shall be defined as gauge unless otherwise specified and shall be recorded on time-based equipment.

All test conditions without a specified tolerance shall be considered minimum values. The maximum value shall not exceed the minimum value by more than 10 %.

Because of variations in surface coating materials, manufacturer fabrication processes and preferences, and the combined testing operations of rotation, translation, and application of compression loads; the test agency should strive to control the instantaneous measurement of side-load to within ±10 % of prescribed test parameter values.

4.6.2 Unless otherwise stated, all tests shall be performed at atmospheric conditions with the temperature of the surroundings within 45 °F to 120 °F.

4.6.3 The rotary subsystem shall, as a minimum, consist of the following:

a) primary rotational control subsystem for the drill stem element test specimen shall consist of a motor of sufficient horsepower achieving minimal rotational capabilities of 155 RPM ±5 RPM against impingement of a stationary casing specimen at a defined side-load; and

b) secondary rotational control subsystem allows the abrasive grindstone to turn at a minimal rate of 4 RPM ±1 RPM during the open-hole simulator test procedure while the test specimen is being rotated by the primary rotational control subsystem at 155 RPM ±5 RPM at a defined side-load.

4.6.4 The circulation fluid subsystem facility shall, as a minimum, consist of the following:

a) fluid density measuring instrument that shall be in accordance with API 13B-1;

b) Marsh funnel viscometer that shall be in accordance with API 13B-1 with required timer and graduated beaker; and recorded as a test parameter;

c) centrifuge with basic sediment and water (BS&W) sample test tubes that shall be in accordance with API *MPMS*, Chapter 10.4;

d) magnet(s) shall be in the circuit; and

e) drilling fluid circulation shall be maintained at a flow rate range of 1.5 gallons per minute to 3.0 gallons per minute.

4.6.5 The side-load control subsystem components shall consist of a pressure relief facility to protect the system and load cell.

4.6.6 The translation control subsystem components shall be capable of doing the test.

4.6.7 The tests shall be performed as prescribed in Section 6 with materials described in Section 5.

4.6.8 A written report shall be produced that is signed and dated by the test agency's designated approval authority or process.

5 Materials

5.1 General

The materials described in this section constitute the standard materials upon which the testing protocol is based. Deviation from these material test standards will lead to inconsistent test results over a wide ranging test population.

5.2 Water-base Drilling Fluid

A 9.9 pounds per gallon (ppg) to 10.1 ppg density water-base drilling fluid with a 50 second to 60 second Marsh funnel viscosity that shall be in accordance with the materials in Table 1.

Table 1—Material and Amount Requirements

Material	Amount
API Quality Wyoming Peptized Bentonite	21.0 lb/bbl
Barite (4.1 g/ml preferred)	33.0 lb/bbl
100 mesh frac sand as described in API 19C	7 % by volume

5.3 Steel Test Specimen (base metal)

The following criteria shall be used for the steel test specimen.

a) The test specimen shall be 4137M.

b) The chemical and mechanical properties of material shall conform to API 5DP.

c) A traceability report shall be submitted to test agency prior to testing.

d) The test specimen dimensions shall be in accordance Table 2 and verified by the test agency.

Table 2—Test Specimen and Dimensional Requirements

Test Specimen	Dimensions
Blank Steel Cylinder OD	6.25 in. ±0.0625 in.
Blank Steel Cylinder Length	4.00 in. ±0.0625 in.

The specimen identification shall be stenciled into the wall.

5.4 Surface Coated Material Test Specimen

The surface coating material on the test specimen shall be raised $^{3}/_{32}$ in. +$^{1}/_{32}$ in. –0 in.

5.5 Casing Specimen

The casing specimen shall be 9$^{5}/_{8}$ in. T–95 and shall be in accordance with API 5CT, and an MTR shall be submitted to the test agency.

5.6 Abrasive Cylinder for Open-hole Simulation

The following specifications shall be conformed to for the abrasive cylinder used for open-hole simulation:

a) aluminum oxide 57A,

b) grit size: medium 60,

c) grade: medium L,

d) grain density: 8,

e) Bond type: vitrified,

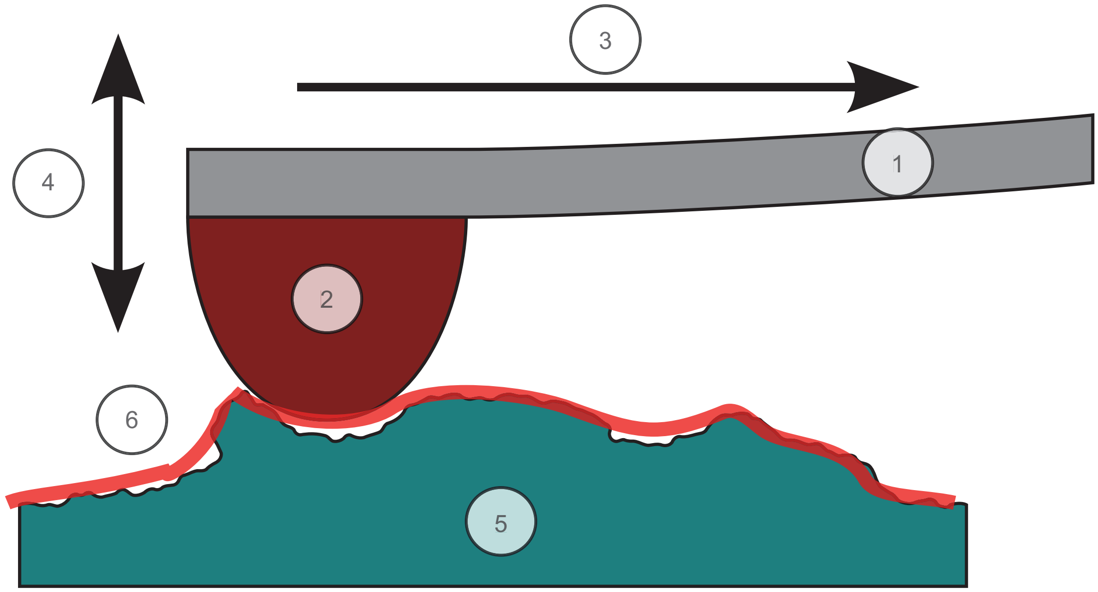
f) bond modification: BE.

6 Testing Procedure

6.1 Surface Finish Roughness Profile

By convention, every two-dimensional roughness parameter is a capital R (roughness) followed by additional characters in the subscript, where the subscript identifies the equation used.

The surface finish can be measured with a calibrated contacting stylus instrument called a profilometer (see Figure 7).



A cantilever (1) is holding a small tip (2) that is sliding along the horizontal direction (3) over the object's surface (5). Following the profile the cantilever is moving vertically (4). The vertical position is recorded as the measured profile (6) illustrated by the red line.

Figure 7—Tipped Cantilever Measuring Surface Profile

Equation 1 assumes that the roughness profile has been filtered from the raw profile data (Figure 8) and the mean line has been calculated. The roughness profile contains n ordered, equally spaced points along the trace, and h_i is the vertical distance from the mean line to the i^{th} data point. The height is assumed to be positive in the up direction, away from the bulk material.

$$R_a = \frac{1}{n}\sum_{i=1}^{n}|h_i| \quad (1)$$

NOTE ISO 1302:2002 provides an "N Scale" to describe surface finish texture and a reference for conversion between scale systems.

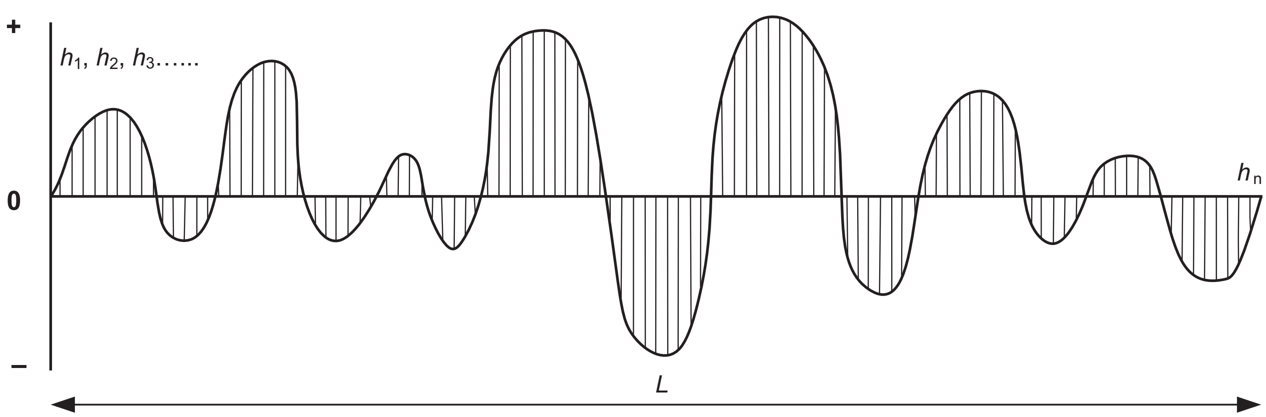


Figure 8—Raw Roughness Profile

6.2 Procedures

6.2.1 The drilling fluid properties shall be measured and recorded.

6.2.2 The testing procedure is divided into three distinct procedures and are as follows.

a) Procedure A (see Figure 9): Field-ready drill stem element test specimen is rotated (155 RPM) and impinged against the inner wall of a casing at a prescribed side-load and translation rate. A crescent shaped groove is worn into the inner wall of the casing specimen.

   1) During an 8-hour casing wear test, the depth of the wear groove is measured at elapsed time intervals of 15, 30, 60, 120, 240, 360, and 480 minutes at 155 RPM; and

   2) prescribed side-load is 3000 lbs/ft based on the length of the surface coating material on the test specimen.

b) Procedure B (see Figure 9): Field-ready test specimen is rotated (155 RPM) and impinged against the inner wall of a prescribed slowly counter rotating (4 RPM) abrasive stone cylinder at a prescribed side-load and translation rate for 15 minutes. This is also known as the open-hole simulation test.

   1) During the 15 minute open-hole simulation test, the outside diameter of the test specimen is measured at elapsed time intervals of 5, 10, and 15 minutes at 155 RPM ±4 RPM; and

   2) prescribed side-load is 2400 lbs/ft based on the length of the surface coating material on the test specimen.

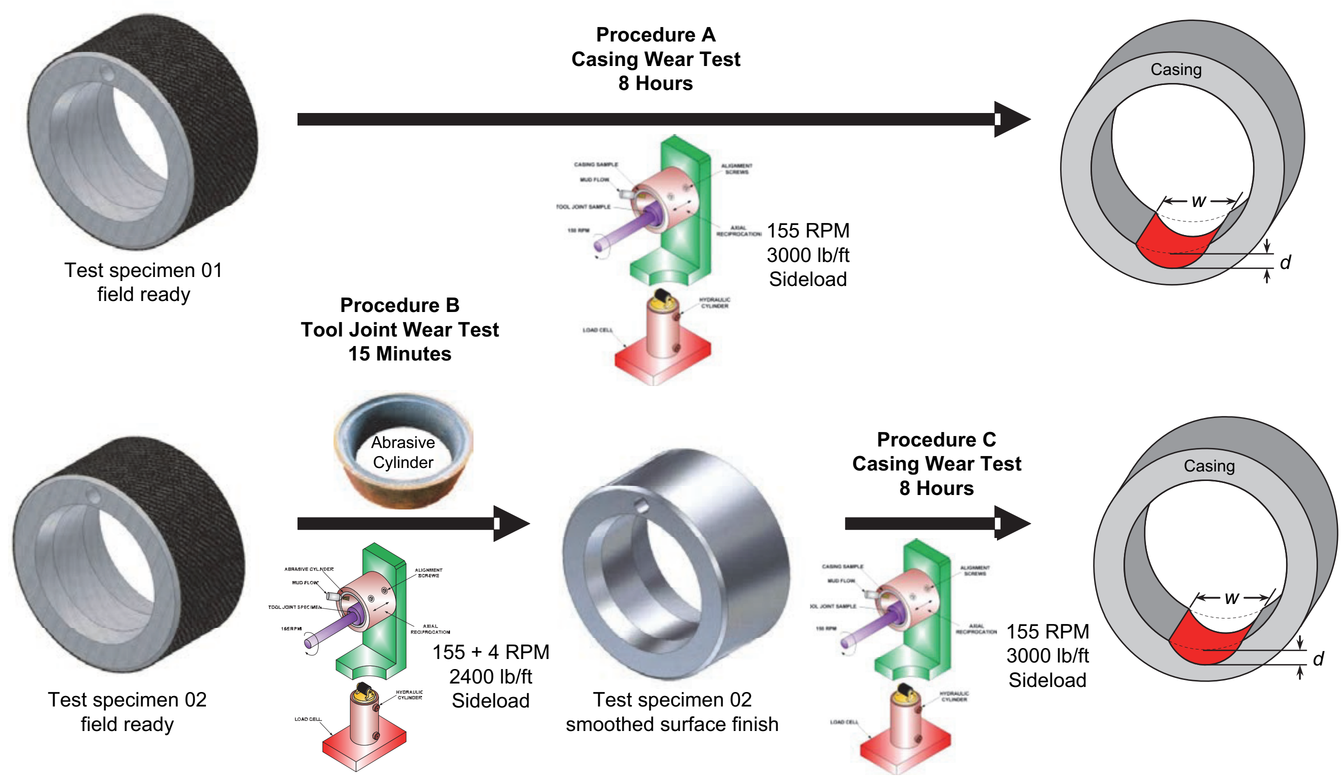


Figure 9—Casing Wear Test Procedures

c) Procedure C (see Figure 9): Post-procedure B test specimen is rotated (155 RPM) and impinged against the inner wall of a casing at a prescribed side-load and translation rate. A crescent shaped groove is worn into the inner wall of the casing specimen.

1) During an 8-hour casing wear test, the depth of the wear groove is measured at elapsed time intervals of 15, 30, 60, 120, 240, 360, and 480 minutes at 155 RPM; and

2) prescribed side-load is 3000 lbs/ft based on the length of the surface coating material on the test specimen.

7 Reporting

The rotating test specimen impinges against the inner wall of a casing at a prescribed side-load and translation rate where a crescent shaped groove is worn into the inner wall of the casing specimen.

A report shall be developed by the testing agency and contain the following.

a) The report shall include the test facility, testing supervisor, company sponsoring test, and test objective information.

b) The report shall include the drilling fluid properties for density (ppg) and Marsh funnel viscosity (sec).

c) The report shall include the follow test specimen identification and measurement information:

1) Test series sequence for Procedure A, B, and C:

a. procedures A, B, and C may be performed in any order;

b. the specimen tested in Procedure C shall be the same specimen tested in Procedure B in all cases:

i. Procedure A, then Procedure B, then Procedure C; or

ii. Procedure B, then Procedure C, then Procedure A; or

iii. Procedure B, then Procedure A, then Procedure C;

2) outside diameter (in.);

3) surface coating material;

4) surface coating material length (in.); and

5) condition of the surface finish.

d) The report shall contain the casing specimen identification information for outside diameter (in.), inside diameter (in.), and Brinell hardness.

e) The report shall contain the contact force information for contact force as calculated by Equation 2 and contact force per test specimen length.

$$\text{Axial-Load [lb]} - \text{Static Weight Specimen Fixture [lb]} \quad (2)$$

f) The report shall contain the following additional information:

1) elapsed time (mins);

2) elapsed revolutions (revs) as calculated by Equation 3;

$$\frac{\text{Revolutions}}{\text{Minute}} \times \text{Minutes} \tag{3}$$

3) torque (ft-lb) as calculated by Equation 4;

$$\text{Moment-Load [lb]} \times \text{Torque Arm [ft]} \tag{4}$$

4) side- or lateral-load (lb/ft) as calculated by Equation 5;

$$\frac{\text{Contact force [lb]}}{\text{Tool joint specimen material length [ft]}} \tag{5}$$

5) measured wear groove depth (in.);

6) measured wear groove width (in.);

7) depth loss per revolution (in./rev) as calculated by Equation 6;

$$\frac{\text{Wear groove depth [in.]}}{\text{Total test revs [revs]}} \tag{6}$$

8) rotary friction force (lb) as calculated by Equation 7;

$$\frac{\text{Torque [in-lbs]}}{\text{Casing ID radius [in.]}} \tag{7}$$

9) rotary friction factor (dimensionless) as calculated by Equation 8;

$$\frac{\text{Rotary friction force [lb]}}{\text{Contact force [lb]}} \tag{8}$$

10) sliding distance (in.) as calculated by Equation 9;

$$\pi \times \text{Tool joint specimen OD [in.]} \times \text{revs} \tag{9}$$

11) effective sliding distance (in.) as calculated by Equation 10;

$$\pi \times \text{Tool joint OD [in.]} \times \text{revs} \times \frac{\text{Tool joint specimen length [in.]}}{\text{Casing specimen length [in.]}} \tag{10}$$

12) casing wear factor (psi^{-1}) as calculated by Equation 11 and Equation 12;

$$\frac{\text{Wear volume}\left[\frac{\text{in.}^3}{\text{ft}}\right] \big/ \text{Lateral load}\left[\frac{\text{lb}}{\text{ft}}\right]}{\text{Effective sliding distance [in.]}} \tag{11}$$

$$\frac{\text{Rotary friction factor}}{\text{Specific energy}\left[\frac{\text{lb}}{\text{in.}^2}\right]} \tag{12}$$

13) modified casing wear factor (dimensionless) as calculated by Equation 13;

$$\text{Casing wear factor [psi}^{-1}] \times \text{Brinell Hardness [psi]} \tag{13}$$

14) specific energy (lb/in.^{2}) as calculated by Equation 14;

$$\frac{\text{Rotary friction factor}}{\text{Casing wear factor [psi}^{-1}]} \tag{14}$$

15) wear volume removed (in.^{3}/ft) as calculated by Equation 15;

$$\frac{\text{Rotary friction factor} \times \text{Lateral load}\left[\frac{\text{lb}}{\text{ft}}\right] \times \text{Sliding distance [in.]}}{\text{Specific energy}\left[\frac{\text{lb}}{\text{in.}^2}\right]} \tag{15}$$

16) contact pressure threshold (psi) as calculated by Equation 16;

$$\frac{\text{Lateral load}\left[\frac{\text{lb}}{\text{in.}}\right]}{\text{Wear groove width [in.]}} \tag{16}$$

17) estimated revs to 87.5 % nominal wall of casing;

18) test specimen OD (in.) wear; and

19) surface coating material durability.

Bibliography

[1] ISO 1302:2002 [1], *Geometrical Product Specifications (GPS)—Indication of Surface Texture in Technical Product Documentation*

1 International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, www.iso.org.

AMERICAN PETROLEUM INSTITUTE

1220 L Street, NW
Washington, DC 20005-4070
USA

202-682-8000

Additional copies are available online at www.api.org/pubs

Phone Orders:	1-800-854-7179	(Toll-free in the U.S. and Canada)
	303-397-7956	(Local and International)
Fax Orders:	303-397-2740	

Information about API publications, programs and services is available on the web at www.api.org.

Product No. G7CW01