**Work Item** | 3087 – 5A3 4th Edition Development  
---|---
**Ballot Type** | Re-ballot (partial) for Vote & Comment  
(Initial, Comment-only, Reballot, Recirculation)  
**Standard** | API 5A3 4th Edition (ballot draft), Annexes I and J (only)  
**Key** | Current in black text  
Deletions in stricken red text  
Additions in underlined blue text

**Work Item Charge:** This update is intended to include completed Work Items revising Annexes I, J, K and L, and the associated references of these throughout the document. Will also update the general verbiage of the document to be more aligned with current API documentation.

**Ballot Rationale:** Review revised Annexes and appropriate text in the body of API RP 5A3 with the new procedures prior to publication deadline.

**ATTENTION (some information to consider and aware of up front):**

- Due to the extensive updates to use “shall” terms in Annexes I and J – from the comment resolutions of the previous ballot with the entire document – this ballot is limited only to these annexes and their respective changes per the Key. Comments beyond this intent may be deferred for consideration in the next edition or used for an addendum, or included for resolution if there is sufficient reason determined.

- Subsequent to this ballot and its comment resolution, the annexes will be reinserted into the document which will then be recirculated.

**NOTE** See the ballot email notification for additional information regarding this ballot.

**Ballot Content Below**
Annex I
(informative

Frictional Properties Test for Thread Compounds

I.1 Full-scale Test for Casing, Tubing and Line Pipe

I.1.1 General

At least two test protocols utilizing multiple-connection test samples should be performed; one for tubing, preferably Label 1: 3½ inch, and one for casing, preferably Label 1: 9⅝ inch. Since the apparent coefficient of friction of the thread compound/connection system can vary with thread form, seal variation and material grade and finish, care should be exercised to ensure uniformity of connection test sample variables.

I.1.2 Background

The full-scale API test procedure referenced in these sections specifies a certain number of turns past a low "reference torque" for the make-up of 8-round test specimens. Full-scale test data from a combined API/joint industry research project (API 1997) demonstrated that if thread compounds have substantially different friction properties and/or compositions (e.g. solid component type or particle size, volume percent solids), there can be a significant difference (one full turn or greater) in the initial engaged position or stand-off to the test specimen connection members when using a standard reference torque. This difference in the initial stand-off results in a similar difference in the final engaged position. It is essential that any comparative testing of thread compounds, either for frictional properties or fluid sealing properties, be done to the same final engaged position within the allowable API tolerances. This is because the amount of engagement of the connection members determines both the pull-out strength and the leak-tightness of the connection. In the research project referenced above, an initial reference stand-off was established using the reference standard. The connection test specimen for all subsequent compounds tested was initially made-up to the reference stand-off, the torque recorded and then made-up to the specified number of turns to the final engaged position.

I.2 Small-Scale Test Background

This small-scale test procedure was developed and validated utilizing the metal-based rotary shouldered connections (RSC) compounds that were commonly used in field applications in the early 1990’s and with current non-metallic thread compounds. Industry test programs currently utilizing this method show a good correlation of small-scale test frictional properties with full-scale NC46 tool joint test results. Correlation to NC50 may have limits since the shoulders of these connections can reach contact pressures of more than 100,000 psi. Round-robin testing has not been evaluated at contact pressures at or above 100,000 psi.

The coefficient of friction of typical tubing and casing compounds determined using API 7A1 ranges from 0.067-0.08. However, when full-scale tests are performed on API 8-round connections, the same compounds can indicate frictional coefficients from as low as 0.02-0.04. This difference may possibly be caused by reduced surface contact pressure between the full-scale connection members as they “float” together on a thick layer of thread compound, as well as the significant difference in the connection variables described above. Thus, an apparent coefficient of friction is indicated. A test method should be selected to take into account such variables, including volume of compound applied.

NOTE API Recommended Practice 7A1 is superseded by API Recommended Practice 5A3.
I.3 Friction Properties Test

I.3.1 Purpose

Friction factor (not to be confused with coefficient of friction) is a multiplier applied to connection make-up torques (MUT) to correct for the frictional property differences of the thread compound used and a reference compound as represented by:

\[ \text{MUT} = \text{listed MUT} \times \text{average friction factor}. \]

This method currently outlines a procedure, as follows:

- For determining the friction factor of rotary shouldered connection thread compounds;
  
  *NOTE* Casing, tubing, and line pipe correlation have not yet been obtained.

- The calculation procedure for rotary shouldered connection make-up torque (MUT);

- For the recommended marking of the thread compound containers.

This method currently outlines a procedure for measuring thread compound frictional performance to contact pressures up to 90,000 psi, describes a statistical analysis method for evaluating the test results, and shows how to use the results of the tests. Using the results from this test does not guarantee failure-free rotary shouldered connection, or proprietary connection designs such as mechanical seal thread designs for tubing and casing service in the field. This information should assist the user in selecting the most appropriate make-up torque for the thread compound in use.

I.3.2 Summary of Test Procedure

The relative frictional performance of a thread compound is determined by using a specific cylindrical specimen set in conjunction with an assembly containing a compressive load cell, spacer(s) or spring disk washers depending on the test being run. The specimen sets are engaged using 7 or 8 pitch threaded bolts or studs through the assembly to measure and record torque and load versus turns data as shown in Figure I.1. One cycle is defined as a single make and break of the specimen set. A minimum of five cycles should constitute one test run for either the reference compound or the test compound for standard friction tests.

![Figure I.1 – Torque (ft-lb) and Load (psi) vs Turns Data](image)

A complete test consists of three test runs as follows:

- run performed using the bolt reference compound;
- run performed using the test thread compound;
- repeat run using the bolt reference compound.
The relative friction factor for the test thread compound can be determined by dividing the average test compound results into the average of the two results from the bolt reference compound formulation. The relative coefficients of friction can also be plotted from the data collected. That data can also be factored by a correction value based off the comparison of that test series data on the bolt reference compound to the standard data for the reference compound. Differences can occur based off different compressive load cells (or their calibration shunt values), surface conditions of the specimen set, pitch of the threaded stud or other factors.

NOTE Where the test thread compound components like lead, copper, zinc, and so forth, can result in plating or burnishing into the surfaces the bolt, the bolt reference compound second set of runs will not match within statistically significant values; ten additional runs with the bolt reference compound might be required to remove the residual product and bring the surface to the nominal readings.

Other properties of thread compounds such as resistance to downhole make-up are outside the scope of this current test procedure though possibly could be inferred through the data.

I.3.3 Bolt Reference Compound Formulation

This test method utilizes a reference formulation to simultaneously spot check the specimen set, the loading machine and the instrumentation. It is a simple mixture of common components that can be readily mixed and will yield consistent results when tested in the manner described in the following sections. In addition, the reference formula used on the surface of the test specimens is also applied to the threads of the stud for load tests. This reference formulation is not intended for use as a thread compound and is only a laboratory reference material. The bolt lube reference compound for the high contact pressures greater than 100,000 psi is based upon a blend of calcium fluoride and calcium salts, whose standard formulation is:

<table>
<thead>
<tr>
<th>Component</th>
<th>percent by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium Grease NLGI 1</td>
<td>55.0 ± 1.0</td>
</tr>
<tr>
<td>Calcium Fluoride Superfine</td>
<td>35.0 ± 1.0</td>
</tr>
<tr>
<td>Calcium Sulphate</td>
<td>8.0 ± 0.50</td>
</tr>
<tr>
<td>Antimony dialkyldithiocarbamate additive</td>
<td>2.0 ± 0.50</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The calcium fluoride powder shall conform to the following requirements:

— Particle size by mesh percent retention, with sieve designation in accordance with ASTM E11, as follows:

<table>
<thead>
<tr>
<th>Mesh Size</th>
<th>% through</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>140</td>
<td>0.3</td>
</tr>
<tr>
<td>150</td>
<td>0.3</td>
</tr>
<tr>
<td>200</td>
<td>2.5</td>
</tr>
<tr>
<td>325</td>
<td>17.9</td>
</tr>
<tr>
<td>&lt; 325</td>
<td>80</td>
</tr>
</tbody>
</table>

The calcium sulphate powder shall conform to the following requirements:

— Particle size by mesh retention, with sieve designation in accordance with ASTM E11, as follows:

<table>
<thead>
<tr>
<th>Mesh Size</th>
<th>% through</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0.05 max</td>
</tr>
<tr>
<td>325</td>
<td>7.0 max</td>
</tr>
<tr>
<td>&lt; 325</td>
<td>93 min</td>
</tr>
</tbody>
</table>

NOTE Laser diffraction particle size analysers may provide a more accurate analysis of the particle size distribution available in Mesh, microns and other measures.
Calcium Fluoride Statistical Data

<table>
<thead>
<tr>
<th></th>
<th>D10</th>
<th>D50</th>
<th>D90</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average</strong></td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>1.44</td>
<td>2.25</td>
<td>9.64</td>
</tr>
<tr>
<td><strong>Min</strong></td>
<td>9</td>
<td>26</td>
<td>42</td>
</tr>
<tr>
<td><strong>Max</strong></td>
<td>15</td>
<td>35</td>
<td>78</td>
</tr>
</tbody>
</table>

The grease base shall contain no additives such as extreme pressure, anti-wear, or any other additive that could affect the frictional properties of the bolt reference compound other than those added in the formula above. The grease base should conform to the following requirements:

- Consistency (in accordance with ASTM D217): worked penetration (60 strokes), 310-340; and
- Thickener (in accordance with ASTM D128): lithium 12-hydroxystearate.
- Base oil, petroleum/non-synthetic, viscosity (in accordance with ASTM D445):
  - @ 40 °C: 115 cSt min, 170 cSt max
  - @ 100 °C: 9.5 cSt min, 14.0 cSt max

The bolt reference compound formulation shall conform to the following requirement:

- Consistency (in accordance with ASTM D217): worked penetration (60 strokes), 290-320

### I.3.4 Friction Test Specimen Set

The friction test specimen set is shown in Figures I.2 and I.3. The material of the static specimen shall be AISI 4140 steel bar machined to the drawings shown in Figures I.2 and I.3, and a zinc or manganese phosphate surface treatment on the machined surfaces of the static specimen.
Figure I.2 – 4140 Static Specimens (inches)
Figure I.32 – P550 Dynamic and 4140 Static Specimens (inches)
The material of the dynamic specimen shall be P530, P550, or other material dissimilar to the static specimen. Different alloy types are used for friction tests to reduce any potential for galling.

The shoulder and the thread of each component should be single-point cut without removing the part from the chuck to ensure that the shoulder is perpendicular to the axis of the threads. The surface finish on mating surfaces shall be $1.6 \pm 0.4 \, \mu m \text{ Ra} (64.3 \pm 16 \, \mu in. \text{ RMS})$. There shall be no surface treatment on the machined surfaces of the test specimen set. See Table I.1 for converting surface finishes.

### Table I.1 – Surface Finish Conversion Chart

<table>
<thead>
<tr>
<th>ISO N</th>
<th>Rt</th>
<th>Ra</th>
<th>CLA</th>
<th>RMS</th>
<th>Cut-off (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>4</td>
<td>0.8</td>
<td>32</td>
<td>35.2</td>
<td>0.03</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>1.6</td>
<td>63</td>
<td>64.3</td>
<td>0.03</td>
</tr>
<tr>
<td>8</td>
<td>13</td>
<td>3.2</td>
<td>125</td>
<td>137.5</td>
<td>0.1</td>
</tr>
</tbody>
</table>

N=New ISO scale Numbers 
Rt=Roughness, total in microns 
Ra=Roughness, average in microns 
CLA=Center Line Average in micro inches 
RMS=Root Mean Square in micro inches

### I.3.5 Test Apparatus

The thread compound shall be tested in a machine capable of applying an increasing torque at a uniform rate to the specimen sets while recording the torque, load and rotation. The load on the specimen set for the standard test should typically be set at 55,000 lbs or and 90,000 lbs when the friction data is taken. The data acquisition instrumentation should be digital with a fast response rate. Care should be taken to ensure that the frequency response is adequate to acquire representative data. The signal for the rotation, load and torque transducers should be recorded in such a way that there is a one-to-one correspondence between data points for torque, load and rotation.

An example of a mechanical system is shown in Figure I.43. The test machine consists of four sections. The first section of the machine is the motor/gearbox that supplies the rotation and torque to the specimen set. The rotational frequency should be 1 to 5 rpm. The torque capability of the machine shall be at least 2750 ft-lb (3729 N-m) and shall be reversible and should have the capability to achieve 4000 ft-lb (5424 N-m) for other frictional applications. The second section of the machine is the torque transducer and resists rotation of the specimen set and produces an output signal that is proportional to the applied torque. This transducer should have a maximum capability well above 4000 ft-lb (5424 N-m). The third section of the machine is the rotation transducer that produces an output signal that is proportional to the angle through which the specimen set is rotated. The fourth part is the assembly consisting of a set of one dynamic and one static specimen, compressive (through hole) load cell, spacer (s) and/or spring disk washers where applicable for the test being performed. The load cell shall be capable of loads up to 150,000 psi stress in the current assembly.

**NOTE**  Spring disk washers allow for more rotation under load should one wish to model an advantage when modelling larger diameter connectors or running the galling test in Annex J.
I.3.6 Test Conditions

This test should be conducted with the apparatus, the reference compound and the test compound at a temperature between 15.6 °C and 37.8 °C (60 °F and 100 °F). The relative humidity should be between 20 % and 95 % and non-condensing. Results of tests performed at conditions outside of those listed above should be so noted.

Elevated temperature tests would not be recommended due to the use of the current load cell limitations.

I.4 Thread Compound Test Procedure

I.4.1 New Dynamic and Static Friction Specimen Set Break-in

Each newly manufactured dynamic and static friction specimen should be subjected to 10 make-and-break cycles using the bolt reference compound before actual tests are performed. The specimen set should then be cleaned using the recommended procedure.

I.4.2 Specimen Set Cleaning

The specimen set shall be cleaned with any appropriate solvent, lightly brushed or rotated on scouring pads to remove any burned, plated soft metal or other solid additive, then degreased. The specimen set shall then be dried before applying the next test compound.

CAUTION — Solvents and degreasers can contain hazardous materials. Refer to the safety data sheets and the precautions observed when handling products of this type.

I.4.3 Sample Submission and Storage

The sample of the thread compound to be tested shall be submitted in a clean, leak-proof container that can be sealed to prevent evaporation of any volatile materials or the possible contamination of the compound. The sample volume should be approximately 250 ml (8 fl oz). The sample shall be stored within the temperature range of 15.6 °C to 37.8 °C (60 °F to 100 °F). If the sample is submitted in a container of approximately 4 L (1 gal), a convenient portion for storage and testing may be transferred to a smaller container that meets the above requirements. It is extremely important that, before the transfer of the sample to an alternate container, or prior to the actual test procedure, the sample is stirred to ensure homogeneity. Care shall be taken when stirring the sample that material is not scraped or abraded from the container itself that could contaminate the sample and affect test results.
I.4.4 Friction Test

The threads of the stud for the assembly shall be coated with the bolt reference compound where the nut holding the dynamic specimen will run on the tests. The parallel mating surfaces of the dynamic and static cylindrical test specimen set of dissimilar alloys shall be coated with a liberal layer of the bolt reference compound or test thread compound. The specimen set shall then be made up hand-tight and placed in the testing machine. The initial or hand-tight torque shall not exceed approximately 14 N·m (10 ft·lb). The torque and the rotation shall then be recorded as the force is increased to 55,000 or 90,000 lbs depending on the test on the 1.25-inch bolt assembly. After these data are recorded, the specimen set shall be loosened by applying a torque in the opposite direction. The specimen set shall then be removed from the testing machine. The two parts of the specimen set shall be unscrewed to inspect the surfaces. If no galling or wear is noted on the specimen set, more thread compound shall be reapplied to the mating surfaces. The specimen set shall then be made up hand-tight and replaced in the test machine. The next set of data shall then be taken. This procedure shall be repeated a minimum of five cycles to a maximum of 10 cycles. A minimum of five cycles shall constitute one run and shall be used for the calculations in I.5.2 to calculate the performance factors from each run. If more than five cycles are performed, the operator may reject any cycle of the five to ten performed cycles that exhibit abnormal behaviour (outlier data sets) provided there is an assignable cause for the deviation and at least five data sets are maintained for the calculation.

I.4.5 Test Specimen Inspection

After a run has been completed, the specimen set should be cleaned as described in I.4.2. If there are any signs of non-repairable galling of the mating surfaces, the test is not valid for normal friction factor evaluation. To continue the test, a new specimen set should be used. Any further galling and occurs, the compound is rejected, and the test is complete. If excessive wear or galling is observed on the specimen set, the specimens shall be sent to a machine shop for re-facing to the proper surface roughness requirement. The shop may need to lightly grind the surface before machining, so the cutting dies do not break during machining due to hard spots where welds from the galling had occurred. A zinc phosphate coating shall be deposited on the 4140 static specimen.

I.5 Data Reduction

I.5.1 Analysis for Frictional Properties Using Torque and Load vs Turn Data

Coefficient of friction and torque at target force data can be extracted from the plot or the Data II worksheets of the generated data from each test. (Figure 1.54).

Data at the target contact pressure of the load cell such as 55,000 pounds for the test compound and the reference compound would be calculated into a friction factor much in the same way as the other methods (Figure 1.65). The average torque at target force of the test compound is multiplied by the assigned friction factor of the bolt reference compound and then divided by the average torque at target force of the bolt reference compound.
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Figure I.54 – Coefficient of Friction (sample) / Coefficient of Friction (reference)

Figure I.65 – Example Torque and Coefficient of Friction vs Turn Data
I.5.2 Friction Factor

The friction factor for the compound is:

$$FF = \frac{T_2 \cdot RCF}{T_1}$$  \hspace{1cm} (I.1)

where

- $T_1$ is the average torque at target force for the first and second bolt reference compound runs
- $T_2$ is the average torque at target force for test compound runs;
- $RCF$ is the assigned standard friction factor for the bolt reference compound (1.1 in round robin).

I.6 Application of Friction Factor

I.6.1 General

Recommended make-up torque for rotary shouldered connections were calculated using a coefficient of friction of 0.08 and are tabulated in API 7G. A thread compound with a friction factor other than 1.0 does not have a coefficient of friction of 0.08, and uncorrected tabulated torque values can result in improperly made-up connections.

The thread compound friction factor is used to correct the make-up torque for drill stem elements.

To be as generic as possible for drill and production connections, as well as bolting, the following may be appropriate, for example:

For drill pipe assembly – Label 1: 5-inch, 19.50 lb/ft, G-105 premium with 5-1/2” × 3-1/4 NC50 tool joints
- Make-up torque from API 7G = 29,715 N·m (21,914 ft·lb)
- With a thread compound friction factor of 0.9, the corrected make-up torque = 21,914 x 0.9
  = 19,723 ft·lb (26,744 N·m)
- With a thread compound friction factor of 1.2, the corrected make-up torque = 21,914 x 1.2
  = 26,297 ft·lb (35,658 N·m)

NOTE Thread compound performance is based on this test procedure and not a specific friction factor; drilling conditions exist where a friction factor of greater or less than 1.0 is beneficial.

I.6.2 Test Certification and Marking

I.6.2.1 Test Certification

Thread compound manufacturers wishing to comply with this standard can display the frictional performance data of their compound according to the guidelines in I.5.36.2.2. The thread compound manufacturer should provide, upon request, certified copies of the test results that were obtained using the methods and equipment described in this practice. The results should include the manufacturer’s name, product name, date of testing, and the name of the testing laboratory.

I.6.2.2 Marking

Thread compounds which have been tested in accordance with this standard may be so labelled. The label should contain a reference to “API 5A3” and “Friction Factor = X.X” or “FF (API 5A3) = Y.Y”. There should be no more or less than two digits with one digit to the right of the decimal.
Annex J

Extensive Surface-Contact Pressure (Galling) Properties

J.1 Background

This small-scale test procedure was developed and validated utilizing rotary shouldered connection (RSC) compounds that are commonly used in field applications. Currently industry test programs utilizing this method show a good correlation of small-scale test frictional properties with full-scale NC46 tool joint test results and have provided a good correlation for thread compound and coatings for galling resistance properties on several alloys.

J.2 Galling Resistance Property Test

J.2.1 General

Currently, the only reliable test methods are full-scale connection tests (repeated make-and-break of connection assemblies) such as described in ISO 13679 or API 5C5. These provide information on test methods for thread compound extreme surface-contact pressure (galling) properties and a full-scale connection test procedure, which includes the evaluation of compound galling-resistance properties for API connections.

J.2.2 Purpose

This method outlines a procedure for measuring thread compound frictional and galling resistance performance to contact forces up to 55,000 lbs, describes a statistical analysis method for evaluating the test results, and shows how to use the results of the tests. Using the results from this test does not guarantee failure-free performance on proprietary connection designs such as mechanical seal thread designs for tubing and casing in field use. The galling resistance test results have correlated well to field applications for thread compounds, types of plating and solid film lubricants. Therefore, this information should assist the user in selecting the most appropriate thread compound in use on specific alloys.

J.2.3 Summary of Test Procedure

The galling resistance procedure is based upon the method measuring the relative frictional performance of a thread compound using specific cylindrical specimens and in conjunction with an assembly containing a compressive load cell, spacer(s) or spring disk washers depending on the test being run. The specimen sets are engaged using 1-inch diameter 7 or 8 pitch threaded bolts or studs through the assembly to measure and record torque and load versus turns data, as shown in Figure J.1.
One cycle is defined as a single make and break of the specimen set. A set of up to ten cycles should constitute a test run for either the reference compound or the test compound. A complete test will consist of:

- a reference run performed using the bolt reference compound; and
- a run performed using the test thread compound.

NOTE See Annex I.3.3 for the bolt reference compound formulation.

J.2.3 Bolt Reference Compound Formulation (see I.3.3)

J.2.4 Galling Resistance Test Specimens

The galling test specimen sets are machined to the drawings shown in Figures J.2 and J.3. The material of the static and dynamic specimens should be matched alloy sets of a material susceptible to galling such as 12 % to 28 % chrome, Inconel, and so forth. The typical alloy used for galling resistance tests is Inconel 718. Matched alloy sets are used for galling tests to increase the potential for galling.
Figure J.2 – Inconel Static and Specimen
Figure J.3 – Inconel Dynamic Specimen Set
The surface finish on mating surfaces shall be 1.6 ± 0.4 μm Ra (64.3 ± 16 μin. RMS). The shoulder or test surface of the specimen of each component shall be single-point cut. The outside and inside edge of the dynamic specimens shall be beveled or rounded to eliminate potential edge effects. There shall be no surface treatment on the machined surfaces of the galling test specimen set unless coatings or other surface treatments are being evaluated for galling or wear resistance properties. See Table J.1 for converting surface finishes.

### Table J.1 – Surface Finish Conversion Chart

<table>
<thead>
<tr>
<th>ISO</th>
<th>Rt</th>
<th>Ra</th>
<th>CLA</th>
<th>RMS</th>
<th>Cut-off (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>4</td>
<td>0.8</td>
<td>32</td>
<td>35.2</td>
<td>0.03</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>1.6</td>
<td>63</td>
<td>64.3</td>
<td>0.03</td>
</tr>
<tr>
<td>8</td>
<td>13</td>
<td>3.2</td>
<td>125</td>
<td>137.5</td>
<td>0.1</td>
</tr>
</tbody>
</table>

N=New ISO scale Numbers  
Rt=Roughness, total in microns  
Ra=Roughness, average in microns  
CLA=Center Line Average in micro inches  
RMS=Root Mean Square in micro inches

**J.2.5 Test Apparatus (see I.3.5)**

**J.2.56 Test Conditions**

This test shall be conducted with the apparatus, the reference compound, and the test compound at a temperature between 60 °F and 100 °F (15.6 °C and 37.8 °C). The relative humidity should be between 20 % and 95 % and non-condensing. Results of tests performed at conditions outside of those listed above should be so noted.

*NOTE* See Annex I.3.5 for the test apparatus.

Elevated temperature tests would not be recommended due to the use of the current load cell limitations.

### J.3 Thread Compound Test Procedure

**J.3.1 New Dynamic and Static Friction Specimen Set**

Newly manufactured dynamic and static galling specimens should never be subjected to the 10 make and break cycles as galling is most likely to occur on the freshly machined surfaces. Any pre-burnishing/conditioning or “work-hardening” of the specimen sets would defeat the purpose of the galling resistance tests.

**J.3.2 Specimen Set Cleaning**

The specimen set should be cleaned with any appropriate solvent, lightly brushed or rotated on scouring pads to remove any burnished, plated soft metal or other solid additive, then solvent degreased. The clean specimen set should then be dried before applying the next test compound.

*CAUTION*—Solvents and degreasers may contain hazardous materials. Refer to the safety data sheets and the precautions observed when handling products of this type.

**J.3.3 Sample Submission and Storage**

The sample of the thread compound to be tested should be in a clean, leak proof container that can be sealed to prevent evaporation of any volatile materials or the possible contamination of the compound. The sample volume should be approximately 8 fl oz (250 ml). The sample should be stored within the temperature range of 60 °F to 100 °F (15.6 °C to 37.8 °C). If the sample is in a container of approximately 1 gal (4 L), a convenient portion for storage and testing may be transferred to a smaller container that meets the above requirements. It is extremely important that before the transfer of the sample to an alternate container, or prior to the actual test procedure, that the sample is stirred to ensure homogeneity. Care should be taken when stirring the sample that material is not scraped or abraded from the container itself that could contaminate the sample and affect test results.
J.3.4 Galling Test

Galling tests perform optimally using two Belleville spring-disk type washers in series within the assembly. The threads of the one-inch diameter stud as with the above should be coated with the bolt reference compound, also referred to as a “reference compound”. The parallel mating surfaces of the dynamic and static cylindrical test galling specimen set should be coated with a liberal layer of the thread compound. The specimen set should then be made-up as close to finger-tight as possible using the 1-inch diameter bolt allowing for insertion into the testing machine. The torque, load and the rotation should then be recorded as the load is increased to 55,000 lbs. After these data are recorded, the specimen set should be loosened by applying a torque in the opposite direction. The specimen set should then be removed from the testing machine. The two parts of the specimen set should be unscrewed to inspect the surfaces. If no galling (scoring and tearing) or wear is noted on the specimen set, more thread compound should be reapplied to the mating surfaces. Recoat the stud with the bolt reference compound. The specimen set should then be made-up finger-tight and replaced in the test machine. The next set of data should then be taken. This procedure should be repeated to a maximum of ten cycles. After a complete test the specimen set should be re-machined to a "fresh" surface. The appearance of each test cycle should be recorded (such as on the form using descriptions in Table J.4), and photos should be taken.

Table J.4 – Galling Level Description

<table>
<thead>
<tr>
<th>Galling Level</th>
<th>Galling Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>clear, little to no light scratches</td>
</tr>
<tr>
<td>2</td>
<td>nicks and scratches, signs of wear</td>
</tr>
<tr>
<td>3</td>
<td>light galling over less than 10 % on the circumference</td>
</tr>
<tr>
<td>4</td>
<td>repairable light galling over 10 % on the circumference</td>
</tr>
<tr>
<td>5</td>
<td>galling beyond reasonable repair efforts</td>
</tr>
</tbody>
</table>

J.3.5 Test Specimen Inspection

After a cycle (single make and break) has been completed, the specimen set shall be cleaned as described in J.3.2. If there are any signs of galling on the mating surfaces, the compound is rejected, and the test is complete. After every test run (5 to 10 cycles), regardless of whether or not galling occurred, the specimen set shall be sent to a machine shop for re-facing to the proper surface roughness requirement. The shop may need to lightly grind the surface before machining, so the cutting dies do not break during re-facing due to hard spots where welds from the galling had occurred. No specimen set can be re-used without re-facing.

J.3.6 Test Certification

Thread compound manufacturers wishing to comply with this standard should provide, upon request, certified copies of the test results that were obtained using the methods and equipment described in this practice. The results should include the manufacturer’s name, product name, date of testing, and the name of the testing laboratory. Report to include number of runs before irreparable galling occurs (taking more than scouring pads or fine sandpaper).

Table J.5 – Test Report Key

<table>
<thead>
<tr>
<th>Galling Test Runs</th>
<th>Galling Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/10</td>
<td>Fail</td>
</tr>
<tr>
<td>4/10</td>
<td>Fail</td>
</tr>
<tr>
<td>6/10</td>
<td>Pass</td>
</tr>
<tr>
<td>8/10</td>
<td>Pass</td>
</tr>
<tr>
<td>10/10</td>
<td>Pass</td>
</tr>
</tbody>
</table>