COMPLETE REVISION
September 2016

Machinery

PIP REEE003
Guidelines for General Purpose
Non-Lubricated Flexible Couplings
PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

This Practice is subject to revision at any time.
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1. **Scope**

This Practice describes guidelines for selecting non-lubricated flexible couplings for general purpose applications for most types of rotating equipment. General purpose coupling applications include loads with steady, non-fluctuating torque characteristics within the power and speed ranges defined in this Practice.

This Practice does not include guidelines for diaphragm couplings.

This Practice does not cover coupling applications for rotating equipment having any of the following characteristics:

- Rotational speeds greater than 3,600 rpm
- Driver-rated power greater than 2,000 horsepower
- Non-steady (fluctuating) torque characteristic
- Couplings covered by *API 671, Special Purpose Couplings for Petroleum, Chemical and Gas Industry Services*

2. **References**

Applicable parts of the following industry codes and standards shall be considered an integral part of this Practice. The latest edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles are used herein where appropriate.

2.1 **Industry Codes and Standards**

- American National Standards Institute (ANSI)
  - ANSI/AGMA 9000-C90 - *Flexible Couplings - Potential Unbalance Classification*
  - ANSI/AGMA 9002-A86 - *Bores and Keyways for Flexible Couplings (Inch Series)*
- American Petroleum Institute (API)
  - API 671 - *Special Purpose Couplings for Petroleum, Chemical, and Gas Industry Services*
- Occupation Safety and Health Administration (OSHA)
  - OSHA 1910.219 - *Mechanical power-transmission apparatus*

3. **Definitions**

*diaphragm coupling*: Type of flexible coupling consisting of one or more flexible elements that are attached to the outside diameter of one flange and that transfer torque through the diaphragm to its inside diameter attachment (i.e., a spacer or another flange). This type of coupling is considered a special purpose device and is not covered in this Practice.

*disc coupling*: Type of flexible coupling consisting of several flexible elements that are alternately attached with bolts to the opposite flanges. This type of coupling may be applied on either general purpose or special purpose machines.
elastomeric coupling: Type of flexible coupling that uses an elastomer, either in shear or compression, in the torque path

flexible coupling: Device that transmits torque while tolerating a limited amount of misalignment between connected shafts

hub: Part of the coupling that is installed on the shaft. Hubs receive or transmit torque from the shaft through keys, splines, or friction.

service factor: The continuous torque rating for a specific coupling divided by the torque transferred at the rated conditions for a specific application

spacer: A component inserted between two flexible elements (one connected to each coupling hub). Spacers permit couplings to span the distance between the connected shafts.

spacer coupling: Provides access for removal of equipment components for maintenance and increases the allowable tolerance for misalignment

4. **Type and Size Considerations**

4.1 **Data Requirements**

The following information is required for selection of coupling type and size:

a. Type of driver
b. Type of driven equipment
c. Rated speed of driver
d. Maximum speed of driver
e. Nameplate rated power of driver including service factor
f. Shaft power required by driven equipment
g. Shaft end dimensions and style for driver and driven equipment
h. Distance between driver and driven machine shaft ends
i. Environment
j. Coupling operating temperature
k. Space limitations
l. Anticipated shaft thermal growth
m. Maximum anticipated axial displacement

4.2 **Coupling Type**

4.2.1 For rotating equipment with rated speeds between 800 and 3,600 rpm, the coupling type should be selected in accordance with the following criteria:

a. For driver sizes less than or equal to 75 kW (100 horsepower), elastomeric couplings may be specified.

b. For driver sizes greater than 75 kW (100 horsepower) and less than or equal to 1,500 kW (2,000 horsepower), or for vital or unspared equipment of any
horsepower, non-elastomeric couplings are recommended. Additionally, the following should be considered:

(1) For equipment that operates at a continuous speed greater than 3,600 rpm, a special purpose coupling should be used.

(2) Rotating dynamic forces at speeds lower than 800 rpm are generally considered negligible. For equipment that operates at a speed less than 800 rpm, equipment manufacturer’s recommendation should be consulted.

4.2.2 Disc couplings should have greater than one flex plane.

4.2.3 Elastomeric couplings should not be used in hot services (e.g., steam turbine drivers, steam-jacketed pumps, etc.). Also, environmental conditions (e.g., humidity, sunlight, temperature, airborne chemicals, etc.) affect the reliability and shelf life of elastomeric couplings.

4.3 Coupling Sizing

4.3.1 For driven equipment having loads that are nonfluctuating, the following shall apply:

a. Coupling size should be based on transmitted torque.

b. The coupling and coupling-to-shaft juncture should have a maximum continuous torque rating greater than the driver-rated torque at driver-rated power including service factor and speed.

c. The coupling should have a minimum service factor of 1.0 at the maximum shaft power of the driver or driven equipment.

Comment: Fluctuating loads require larger service factors depending on the machine-specific characteristics. Consult the coupling manufacturer.

4.3.2 If required because of equipment shaft size, coupling size may be greater than that recommended in Section 4.3.1. The intent should be to minimize overhung weight and moment.

4.3.3 Oversized couplings can produce unanticipated bearing loads.

4.3.4 Rotordynamic effects can be affected if the coupling mass becomes significant relative to the mass of the rotating components.

5. Materials and Design

5.1 Disc Couplings

5.1.1 Coupling hubs and spacers should be steel.

5.1.2 Disc materials should be corrosion resistant steel. Operating area atmosphere should be considered when selecting disc and bolting materials.

5.1.3 Hubs and spacers should be designed so that the spacer is retained if a disc pack fails.

5.1.4 Puller holes, 1 cm (3/8 inch) National Course (NC) minimum, should be drilled and tapped in each coupling hub. The coupling manufacturer should provide
puller holes of sufficient size and depth to provide enough force to overcome the friction fit between the coupling and the shaft end without application of heat to the coupling hub.

5.2 Elastomeric Couplings

5.2.1 Operating area atmosphere should be considered when selecting hub and fastener materials.

5.2.2 Some elastomeric materials used in couplings lose strength and elastomeric properties under the following conditions:
   a. Elevated temperatures
   b. Hydrocarbon vapors
   c. Acid vapors
   d. Exposure to sunlight
   e. High humidity

5.2.3 Elastomeric couplings should not be used for equipment critical to the process or for unserved equipment. Disc or diaphragm couplings should be used for these equipment services regardless of the transmitted torque.

5.2.4 During operation, coupling surface temperatures can typically be 11°C (20°F) higher than ambient air temperature. Increased temperature is primarily because of internal heat generation from elastomer element flexing. Operating temperature rise can be much greater if the shaft is significantly misaligned or if the coupling guard restricts cooling air circulation.

5.2.5 Elastomer coupling misalignment tolerances are typically determined by heat dissipation capacity. Equipment alignment tolerances are typically tighter than coupling tolerances to maintain high equipment reliability.

5.2.6 All elastomers suffer loss of strength over time and should be replaced on a scheduled basis. The service life depends upon the type of elastomer used and the service conditions. Five years from the date of manufacture is considered the maximum life of an elastomeric coupling under ideal conditions.

5.2.7 Polyester-based urethane elastomer elements are susceptible to hydrolysis effects. These effects may cause failure if operated for extended periods in hot and humid environments.

5.2.8 High-torque elastomer elements/inserts should not be used unless provisions are made to prevent inadvertent replacement with standard torque capacity components.

5.2.9 Elastomeric couplings may not be able to achieve higher class balance criteria. 
   Comment: Fasteners should not be reused on elastomeric couplings.
6. Balance

6.1 Required coupling balance quality should be determined by considering the following:
   a. Type of coupling
   b. Shaft rotational speed
   c. Machine system sensitivity to imbalance

6.2 ANSI/AGMA 9000-C90 defines system sensitivity to imbalance in terms of the following:
   a. Shaft deflection
   b. Bearing load
   c. Equipment and foundation flexibility
   d. System natural frequencies
   e. Distance between shaft ends of the driver and driven equipment
   f. Shaft configuration

6.3 All couplings should be in accordance with the dynamic balance criteria shown in Table 1 which is in accordance with ANSI/AGMA 9000-C90.

<table>
<thead>
<tr>
<th>Coupling Type</th>
<th>Speed Range (RPM)</th>
<th>Minimum Balance Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastomeric</td>
<td>800 to 1,800</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>1,801 to 3,600</td>
<td>8</td>
</tr>
<tr>
<td>Disc</td>
<td>800 to 3,600</td>
<td>9</td>
</tr>
</tbody>
</table>

6.4 Assembly-balanced couplings should be clearly match-marked.

6.5 For coupling applications not covered in this Practice, see API 671.

7. Speed Rating

A coupling should have a speed rating that is greater than the speed expected in service, including the over-speed trip setting and the maximum speed of variable speed drives (i.e., maximum speed capability) if applicable.

8. Shaft Attachment

8.1 Key material should have the same strength and hardness as the shaft or the hub material.

8.2 The corners of all keys should be chamfered to eliminate corner interferences in the keyway.

8.3 For the following design information, see ANSI/AGMA 9002-A86:
   a. Dimensions for shafts with cylindrical bore (i.e., coupling hub bore, key, and keyways)
b. Class of recommended fits for cylindrical bore couplings and keys. See Table 2 in this Practice. ANSI/AGMA 9002-A86, Table 1, provides the tolerances for these fit classes.

c. Dimensions for coupling hub bore, key, keyway, and mounted hub overhang and fits for use with tapered, keyed shafts

8.4 Coupling hub bore, key, and keyway dimensions for use with cylindrical, keyed shafts should be in accordance with ANSI/AGMA 9002-A86.

8.5 Coupling hubs mounted on cylindrical, keyed shafts should have bore and key fits as shown in Table 2.

<table>
<thead>
<tr>
<th>kW (HP)</th>
<th>800–1,800 RPM</th>
<th>1,800–3,600 RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;40 (50)</td>
<td>Class I (Note 1)</td>
<td>Class I (Note 1)</td>
</tr>
<tr>
<td>40–75 (50–100)</td>
<td>Class I (Note 1)</td>
<td>Class I / Interference</td>
</tr>
<tr>
<td>&gt;75 (100)</td>
<td>Class I / Interference</td>
<td>Interference</td>
</tr>
</tbody>
</table>

NOTES:
1. Tapered bushings may be considered.
2. The benefit of an interference fit, compared with a Class I fit, is that the hub is kept axially positioned on the shaft. This prevents fretting and resists the forces and moments generated from imbalance and misalignment.

8.6 Allowable hub keyway offset should not be greater than 0.5 mm (0.002 inch), and allowable hub keyway lead should not be greater than 0.00025 mm/mm (0.00025 inch/inch) of keyway.

8.7 Coupling hub bore, key, keyway, and mounted hub overhang dimensions and fits for use with tapered, keyed shafts should be in accordance with ANSI/AGMA 9002-A86, Appendixes A and B.

9. Documentation

9.1 A coupling outline dimension drawing should be provided for all applications.

9.2 The coupling requirements should be shown on the driven equipment data sheet.