Special-purpose Couplings for Petroleum, Chemical, and Gas Industry Services

API STANDARD 671
FIFTH EDITION, AUGUST 2020

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Introduction

Users of this standard should be aware that further or differing requirements may be needed for individual applications. This standard is not intended to inhibit a vendor from offering, or the purchaser from accepting alternative equipment or engineering solutions for the individual application. This may be particularly appropriate where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this standard and provide details.

This standard requires the purchaser to specify certain details and features.

A bullet (●) at the beginning of a paragraph indicates that either a decision is required or further information is to be provided by the purchaser. This information should be indicated on the datasheet(s), typical examples of which are included as Annex A; otherwise it should be stated in the quotation request or in the order.

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1 Scope

This standard specifies the requirements for couplings for the transmission of power between the rotating shafts of two machines in special-purpose applications in the petroleum, petrochemical, and natural gas industries. Such applications are typically in large and/or high-speed machines, in services that can be required to operate continuously for extended periods, are often unspared and are critical to the continued operation of the installation. By agreement, it can be used for other applications or services.

Couplings covered by this standard are designed to accommodate parallel (or lateral) offset, angular misalignment, and axial displacement of the shafts without imposing unacceptable mechanical loading on the coupled machines. It is applicable to gear, metallic flexible element, quill-shaft and torsionally resilient type couplings. Torsional damping and resilient type couplings are detailed in Annex B, gear-type couplings are detailed in Annex C, and quill-shaft type couplings are detailed in Annex D.

This standard covers the design, materials of construction, manufacturing quality, inspection, and testing of special-purpose couplings.

This standard does not define criteria for the selection of coupling types for specific applications.

This standard is not applicable to other types of couplings, such as clutch, hydraulic, eddy-current, rigid, radial spline, chain, and bellows types.

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.

ANSI/AGMA 9000,[1] *Flexible Couplings—Potential Unbalance Classification*

ANSI/AGMA 9002-C14, *Bores and Keyways for Flexible Couplings (Inch Series)*

ANSI/AGMA 9003-B08, *Flexible Couplings—Keyless Fits (Inch Series)*

ANSI/AGMA 9004-B08, *Flexible Couplings—Mass Elastic Properties and other Characteristics (Inch Series)*

ANSI/AGMA 9103-B08, *Flexible Couplings—Keyless Fits (Metric Series)*

ANSI/AGMA 9104-A06, *Flexible Couplings—Mass Elastic Properties and other Characteristics (Metric Series*)

ANSI/AGMA 9112-B15, *Bores and Keyways for Flexible Couplings (Metric Series)*

ANSI/ASME B1.1,[2] *Unified inch screw threads, UN and UNR thread form*

ANSI B11.19-2010, *Performance Requirements for Safeguarding*

BS EN ISO 80079-36:2016, *Explosive atmospheres. Non-electrical equipment for explosive atmospheres. Basic method and requirements*

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[1] American Gear Manufacturers Association, 500 Montgomery Street, Suite 350, Alexandria, Virginia 22314-1560, www.agma.org.

[2] ASME International, Three Park Avenue, New York, New York 10016-5990, www.asme.org.

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ISO 262, *ISO general-purpose metric screw threads—Selected sizes for screws, bolts and nuts*

ISO 286-2, *Geometrical product specifications (GPS)—ISO code system for tolerances on linear sizes—Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

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

3.1.1
AFD
adjustable frequency drive
A device that allows speed adjustment accomplished by electrical frequency variation in an AC motor.

3.1.2
angular misalignment
(double-engagement couplings)
Two minor angles between the extension of each machine centerline and the centerline of the structure joining the two flexible elements.

3.1.3
angular misalignment
(single-engagement couplings)
Minor angle between the extensions of two machine-shaft centerlines.

NOTE If the shaft centerlines do not intersect, a single-engagement coupling is not appropriate.

3.1.4
assembly balance
Procedure in which a completely assembled coupling is balanced as a unit.

3.1.5
assembly balance check
Procedure in which an assembled coupling is placed on a balancing machine and the residual unbalance is measured.

NOTE An assembly balance check can be performed on a component balanced coupling, or on an assembly-balanced coupling.

3.1.6
axial displacement
Change in the relative axial position of the adjacent shaft ends of two coupled machines, usually caused by thermal expansion.

3.1.7
component balance
Procedure for achieving coupling balance in which the components or factory assembled subassemblies are balanced separately before assembly of the coupling.

3.1.8
continuous torque rating
Coupling manufacturer's declared maximum steady state torque that the coupling is capable of transmitting continuously for unlimited periods.

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3.1.9
coupling rated speed
Highest rotational speed at which the coupling is required to be capable of transmitting the continuous torque rating while simultaneously being subjected to the rated angular misalignment and the coupling rated axial displacement.

3.1.10
crown diameter
Major diameter of the external teeth of a gear-type coupling.

3.1.11
cyclic torque
Cyclic (fluctuating or oscillating) torques that occur from various sources, such as AFD (adjustable frequency drives) or synchronous motors.

3.1.12
cyclic torque rating
The cyclic torque value for a specified number of cycles (see 7.4.3 specified by purchaser) for the weakest component in the system.

3.1.13
diaphragm coupling
Coupling that transmits torque radially from the outside diameter of a driving flexible plate or plates to the inside diameter, across the spacer piece, and then from inside to outside diameter of a driven flexible plate or plates. Misalignment is accommodated by the flexing of the plate(s).

3.1.14
disc coupling
Coupling that transmits torque from a driving to a driven bolt tangentially on a common bolt circle. Torque is transmitted between the bolts through a series of thin discs. Misalignment is accommodated by the flexing of the discs.

3.1.15
distance between shaft ends
DBSE
Distance from the extreme end of one shaft (including any threaded end) to the extreme end of the next shaft or, in the case of integral flanges, the distance from the mating faces.

3.1.16
DN
diamétre nominal
Alphanumeric designation of size for components of a pipework system.

3.1.17
double engagement coupling
Coupling with two planes of flexure.

NOTE This arrangement enables couplings of certain types, notably gear and metallic flexible element types, that cannot normally accommodate parallel (or lateral) offset, to do so.

3.1.18
dummy hub
A hub that is used to simulate the moment of mass of a half coupling during rotating equipment testing without the use of the job hub.

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3.1.19
factor of safety
Factor that is used to cover uncertainties in a coupling design (e.g., analytical assumptions such as stress analysis, material properties, manufacturing tolerances).

NOTE Under given design conditions, the factor of safety is the material yield strength divided by the calculated stress, where the stress is a function of torque, speed, misalignment, and axial displacement.

3.1.20
fatigue factor of safety
Factor of safety at the published continuous rated conditions of torque, speed, misalignment, and axial displacement, used by coupling manufacturers to establish the coupling rating (see 7.2).

NOTE The fatigue factor of safety is further explained and defined in Annex E.

3.1.21
flex-hub coupling
Gear-type coupling with the external teeth on the hubs and the internal teeth in the sleeves.

3.1.22
gear coupling
Coupling of the mechanical contact type that transmits torque and accommodates angular misalignment, parallel offset, and axial displacement by relative rocking and sliding motion between mating, profiled gear teeth.

3.1.23
half coupling
Composite of all of the components of the coupling attached to, and supported from, one shaft, including an appropriate portion of the spacer assembly in the case of a double-engagement coupling or of the flexing elements of a single-engagement coupling.

3.1.24
idling adapter (solo plate)
Device designed to rigidly hold in alignment the floating parts of certain types of couplings to allow uncoupled operation of the driving machine without dismounting the coupling hub.

3.1.25
lateral offset
Lateral distance between the centerlines of two shafts that are not parallel, measured perpendicularly to the centerline and in the plane of the shaft end of the driving machine [See Annex F].

3.1.26
manufacturer
Agency responsible for the design and fabrication of the coupling

NOTE The manufacturer is not necessarily the vendor.

3.1.27
maximum allowable temperature
Maximum continuous temperature for which the manufacturer has designed the coupling at the continuous load condition.

3.1.28
maximum continuous angular misalignment
Maximum angular misalignment at each plane of flexure that the coupling is able to tolerate for unlimited periods.

NOTE Maximum continuous angular misalignment can be expressed as either:

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a) a single value if transmitting the coupling continuous torque rating at the coupling rated speed, and simultaneously subjected to the coupling maximum continuous axial displacement, or

b) a range of values expressed as an interrelated function of speed, torque, and axial displacement.

3.1.29
maximum continuous axial displacement
Maximum axial displacement the coupling is able to tolerate for unlimited periods.

NOTE Maximum continuous axial displacement can be expressed as either:

a) a single value if transmitting the coupling continuous torque rating at the coupling rated speed and simultaneously subjected to the coupling maximum continuous angular misalignment, or

b) a range of values expressed as an interrelated function of speed, torque, and angular misalignment.

3.1.30
maximum continuous speed
Highest rotational speed at which the machine, as made and tested, is capable of continuous operation.

3.1.31
maximum driver power
The maximum power the driver can provide (without hardware modifications) at rated (100 %) speed.

a) For an electric motor, it is the motor's nameplate rating plus any motor service factor.

b) For a gas turbine, it is when the gas turbine is operated at maximum allowable firing temperature, rated speed, ambient site conditions, or other conditions as defined by the manufacturer.

c) For a steam turbine, it is when the steam turbine is operated at rated operating conditions, rated speed, or under other conditions as defined by the manufacturer.

3.1.32
metallic flexible-element coupling
Coupling type that obtains its flexibility from the flexing of thin metallic discs, diaphragms, or links.

3.1.33
minimum allowable speed
Lowest speed (revolutions per minute) at which the machine, as made and tested, is capable of continuous operation.

3.1.34
moment simulator
Auxiliary device intended to simulate the moment of the mass of a half coupling.

3.1.35
momentary torque rating
Torque that corresponds to a factor of safety of 1.0 with respect to the most highly stressed component's material yield strength, allowing for a combination of speed, angular misalignment, and axial displacement.

3.1.36
NPS
nominal pipe size
Value approximately equal to a diameter in inches (e.g., NPS 3/4).

NOTE 1 Refer to ASME B 31.3

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NOTE 2 The letters NPS are followed by a value that is related to an approximate diameter of the bore, in inches, for piping up to and including 12 in. diameter. For piping over 12 in. (NPS 12), the NPS value is the nominal OD.

3.1.37
normal operating point
Point at which (normal) operation is expected with optimum efficiency. This is usually the operating point at which the vendor certifies that performance is within the tolerances stated in this standard.

3.1.38
owner
Final recipient of the equipment, who may delegate another agent as the purchaser of the equipment.

3.1.39
parallel offset
Distance between the centerlines of two coupled shafts that are parallel but not in the same straight line [See Annex F].

3.1.40
peak torque rating
Torque that corresponds to a factor of safety of 1.15 with respect to the most highly stressed component's yield strength, allowing for a combination of speed, angular misalignment, and axial displacement, considering all transient and momentary events.

3.1.41
pilot
rabbet
register
Surface that positions a coupling component, subassembly, or assembly radially with respect to another coupling component.

3.1.42
potential unbalance
Probable net unbalance of a complete coupling.

NOTE 1 Potential unbalance results from a combination of the residual unbalance of individual components and subassemblies and possible eccentricity of the components and subassemblies due to run-out and tolerances of the various surfaces and registers. Since it can be assumed that the actual values of the various contributory unbalances are random in both magnitude and direction, the numerical value of the potential unbalance is the square root of the sum of the squares of all the contributory unbalances. Typical contributory unbalances are:

a) the residual unbalance of each component or subassembly;

b) errors in the balance of each component or subassembly resulting from eccentricity in the fixture used to mount the component or subassembly in the balance machine;

c) the unbalance of each component or subassembly due to eccentricity resulting from clearance or run-out of the relevant registers or fits.

NOTE 2 The concept of potential unbalance is explained more fully, and a worked example is provided in Annex G.

3.1.43
purchaser
Agency that issues the order and purchase specification to the vendor.

NOTE The purchaser can be the owner of the plant in which the equipment is to be installed, the owner's appointed agent, or, frequently, the manufacturer of the driven equipment.

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3.1.44
quill-shaft coupling
Coupling that is both laterally and torsionally flexible, with angular misalignment, parallel offset, and torsional fluctuations being accommodated by elastic deformation of a relatively long, slender shaft.

NOTE Quill-shaft couplings, unless combined with another type, cannot accommodate axial displacement.

3.1.45
residual unbalance
Level of unbalance remaining in a component or assembly after it has been balanced, either to the limit of the capability of the balancing machine or in accordance with this standard (see Annex K).

3.1.46
roughness magnitude
Ra
Arithmetic average of the absolute value of the profile height deviations recorded within the evaluation length and measured from the mean line.

NOTE 1 Adapted from ASME B 46.1–2009, paragraphs 1–4.1.1.

NOTE 2 It is the average height of the entire surface, within the sampling length, from the mean line.

3.1.47
service factor
Factor applied to allow for such conditions as off-design conditions, cyclic and other variations, and equipment variations.

NOTE Service factor is not the same as the factor of safety (3.1.19) or the fatigue factor of safety (3.1.20).

3.1.48
single-engagement coupling
Coupling with only one plane of flexure.

NOTE This type of coupling can accommodate angular misalignment and axial displacement. Single-engagement couplings of some types, notably gear and metallic flexible element types, do not normally accommodate parallel (or lateral) offset. Certain types of single-engagement couplings (not covered by this standard) can accommodate offset misalignment to a limited extent.

3.1.49
spacer
Part of a coupling that is removable to give access for maintenance and/or removal of the coupling hubs.

NOTE The spacer can be a single component or an assembly.

3.1.50
spacer gap length
Distance between coupling hubs or sleeves in which the coupling spacer is installed.

NOTE Spacer gap length is not necessarily equal to the distance between the shaft ends.

3.1.51
spark resistant
Material that is not prone to generating impact sparks under conditions of use.

3.1.52
torsional damping
Absorption or dissipation of cyclic (oscillatory) rotary energy.

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NOTE Torsional damping is necessary in some cases to limit the buildup of steady-state torsional resonant cycles (oscillations) in a system.

3.1.53
torsional natural frequency
Frequency of the undamped, free-rotational vibration of a system composed of revolving mass inertias acting in combination with the restraining torsional rigidities of the connected shafts and couplings.

3.1.54
torsional stiffness
Ratio of the applied torque to the resulting torsional displacement of either a complete coupling or part of the coupling, such as a spacer.

NOTE With some types of couplings, the torsional stiffness is not constant, but is a function of the magnitude of the torque, axial positioning, and, with cyclic torques, also the frequency.

3.1.55
torsionally resilient coupling
Coupling with increased flexibility in a rotational direction, increased capability to recover from flexing, and hysteresis capability.

NOTE Resilience is the ability to recover from deformation under repeated flexing, taking account of energy storage and hysteresis effects. Some types of torsionally resilient couplings can also be designed to accommodate misalignment and/or axial displacement.

3.1.56
total indicator reading
total indicated runout
TIR
Difference between the maximum and minimum readings of a dial indicator or similar device, monitoring a face or cylindrical surface during one complete revolution of the monitored surface

NOTE For a cylindrical surface, the indicated run-out implies an eccentricity equal to half the reading. For a flat face, the indicated run-out implies an out-of-squareness equal to the reading. If the diameter in question is not cylindrical or flat, the interpretation of the meaning of TIR is more complex and may represent ovality or surface irregularities.

3.1.57
trip
Automated shutdown to ensure personnel safety (safety critical).

3.1.58
unit responsibility
Obligation for coordinating the documentation, delivery, and technical aspects of all the equipment and all auxiliary systems included in the scope of the order.

NOTE The technical aspects to be considered include, but are not limited to, such factors as the power requirements, speed, rotation, general arrangement, dynamics, noise, lubrication, sealing system, material test reports, instrumentation, piping, conformance to specifications, and testing of components.

3.1.59
vendor
Manufacturer or manufacturer's agent that supplies the equipment.

3.2 Acronyms and Abbreviations

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

ANF	axial natural frequency

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ATEX	atmosphere explosibles
CMM	coordinate measuring machine
CNC	coordinate measuring controlled
DBSE	distance between shaft ends
F_s	service factor
HRC	Rockwell hardness measured on the C scale
N_c	lateral natural frequency, rpm
N_x	speed as indicated by x, rpm
U	residual unbalance, g-mm (oz-in.)

4 Requirements

4.1 ● Units of Measure

The purchaser's use of an SI data sheet (see Annex A.1) indicates that the SI system of measurements shall be used for all data, drawings, and maintenance dimensions. The purchaser's use of a USC data sheet (see Annex A.2) indicates the USC system of measurements shall be used for all data, drawings, and maintenance dimensions.

4.2 Statutory Requirements

The purchaser and the vendor shall determine the measures to be taken to comply with any governmental codes, regulations, ordinances, directives, or rules that are applicable to the equipment, its packaging, and any preservations used.

5 Coupling Selection

5.1 ● The purchaser shall specify the type of coupling required. Unless otherwise specified, the coupling shall be a metallic flexible-element coupling. For torsional damping and resilient couplings, refer to Annex B; for gear couplings, refer to Annex C; and for quill-shaft couplings, refer to Annex D. Figure 1 provides guidance for the typical selection process for a coupling.

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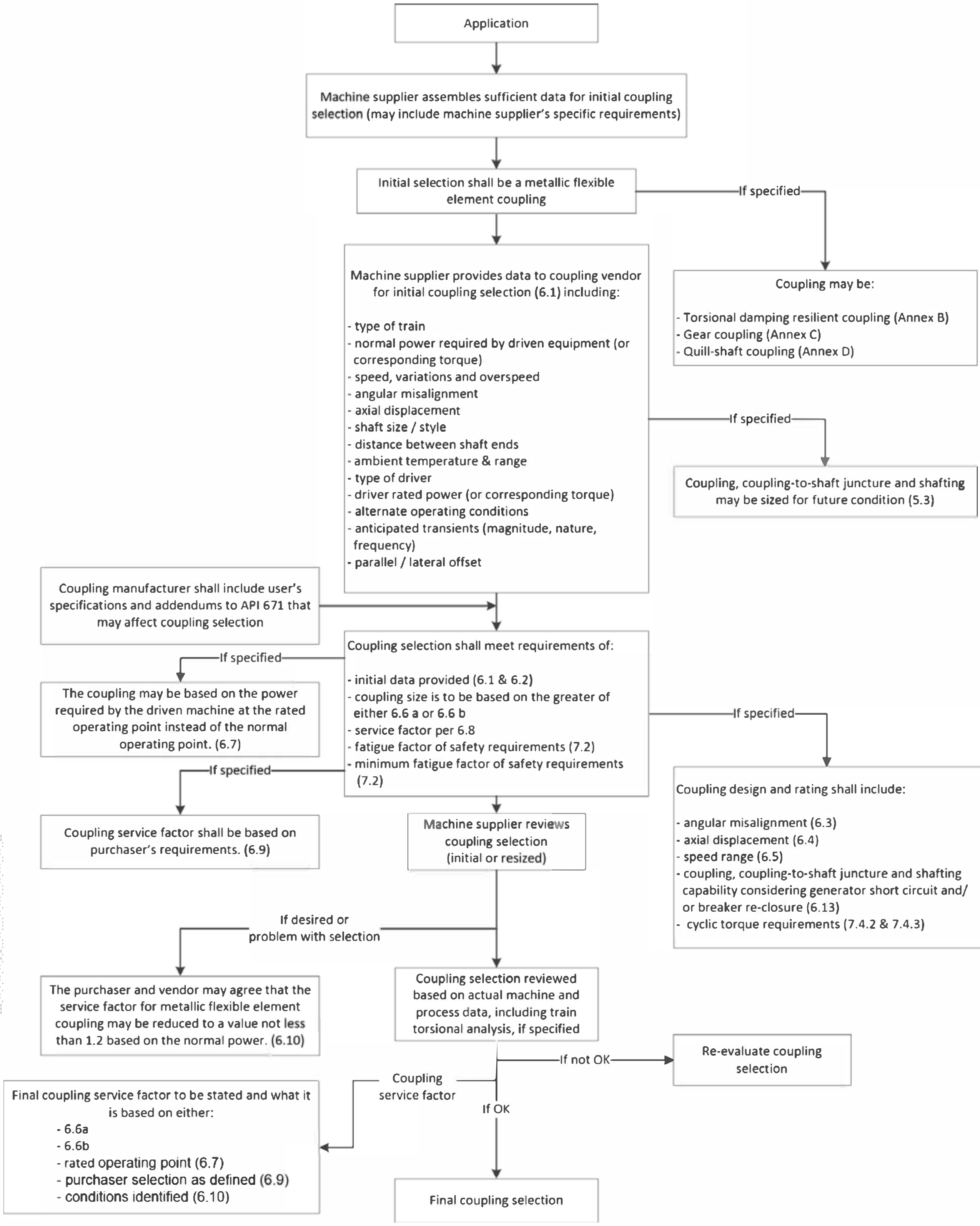

Figure 1—Typical Coupling Selection Process

5.2 The coupling shall be selected based on the equipment loading and shall be capable of simultaneously transmitting the steady-state torques, cyclic torques, and maximum transient torques under all conditions of

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angular misalignment, axial displacement, speed, and temperature, to which it will be subjected in service as identified in Section 6.

5.2.1 The purchaser shall specify the period of uninterrupted continuous operation. Shutting down the equipment to perform planned maintenance or inspection during the uninterrupted operation is not acceptable.

NOTE 1 It is recognized that there are some services where this objective is easily attainable and others where it is difficult.

NOTE 2 Auxiliary system design and design of the process in which the equipment is installed are very important in meeting this objective.

5.2.2 The vendor shall advise in the proposal any component or system designed for a finite life and identify any component or maintenance requirement that would result in the need to shut down the equipment within the uninterrupted operational period.

5.3 ● If specified, the coupling and coupling-to-shaft juncture may be sized for a future condition.

5.4 ● For trains with multiple couplings, the sizing of each coupling shall consider load profiles/sharing for different conditions, as specified.

6 Coupling Design

6.1 The coupling shall be designed based on the equipment loading and shall be capable of simultaneously transmitting the steady-state torque, cyclic torques, and the maximum transient torques under all conditions of angular misalignment, axial displacement, speed, and temperature, to which it will be subjected in service as identified in 6.2 through 6.16.

6.2 ● The purchaser shall specify the following requirements, where applicable:

a) type of train;

b) normal power;

c) normal speed;

d) rated speed of driver or driven equipment;

e) minimum operating speed;

f) maximum continuous speed;

g) any defined overspeed (including trip);

h) angular misalignment;

i) axial displacements;

j) shaft sizes and styles;

k) distance between shaft ends;

l) ambient temperature (maximum and minimum);

m) type of driver;

n) maximum driver power;

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o) driver power rating (list and driver service factor);

p) expected transient and cyclic torque conditions, including magnitude, nature, and number of occurrences of transients to which the coupling will be subjected in service;

NOTE This information is used to establish the required endurance strength or fatigue strength of the coupling components. The coupling design depends on the number of load cycles, allowing for a combination of speed, angular misalignment, and axial displacement considering all transient and momentary events that can lead to high torque-amplitudes, such as startup, short circuit, or auto reclosing, considering the related number of load cycles.

q) data for the coupling guard to allow windage calculations;

r) information for the torque measuring system identified in 11.3 (if a torque measuring system is provided);

s) oil properties available for gear coupling applications.

6.3 ● The purchaser shall specify the maximum angular misalignments the coupling is expected to experience during startup, normal operation, and shut-down of the coupled machines, normally expressed as parallel (or lateral) offset and/or angular misalignment between the coupled shafts. These values shall allow for all the known effects on the machines from thermal, pressure, and dynamic forces. Unless otherwise specified, the steady-state angular misalignment capability across each flexible element shall be not less than 0.2°.

6.4 ● The purchaser shall specify the maximum axial displacements the coupling is expected to experience, expressed as the amount and direction of the relative movement of the shaft ends toward or away from each other as the coupled machines go through their startup, normal operation, and shut-down cycle. These dimensions shall be given from the machine at ambient conditions and while it is in a non-operating position. Unless otherwise specified, the minimum steady-state axial deflection (plus/minus) capability shall be determined by the largest shaft diameter divided by 125.

6.5 ● The purchaser shall specify the speed range (minimum speed to maximum continuous speed) and trip speed for the fully assembled coupling, moment simulator, and solo plate for both continuous speed and any defined overspeed.

6.6 The steady-state selection torque, T_s, used to select the coupling shall be the greater of 6.6 a) or 6.6 b).

a) The steady-state selection torque, T_s, expressed in newton-meters (inch-pounds force), shall be determined based on the driven equipment demand using Equation (1). The coupling service factor, F_s, shall be based on the type of the coupling.

$$T_s = T_n * F_s \quad (1)$$

Where:

T_n is the steady-state torque expressed in newton-meters (inch-pounds force), and shall be determined using Equation (2);

F_S is the coupling service factor specified in 6.8.

$$T_n = (K_1 * P_{normal}) / N_{normal} \quad (2)$$

Where:

K_1 is a constant, equal to 9550 (63,000);

P_{normal} is the input power required by the driven machine, expressed in kilowatts (horsepower), at the specified normal operating point;

N_{normal} is the speed corresponding to the normal operating point's power, expressed in revolutions per minute.

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b) For metallic flexible-element couplings, the steady-state selection torque, T_s, expressed in newton-meters (inch-pounds force), shall be determined based on the maximum driver torque at maximum driver power using Equation (3). This coupling service factor, F_s, is considered to be a constant for this method.

The same methodology can be used for other types of couplings using an agreed-upon service factor.

NOTE 1 Adjustable frequency drive (AFD) motor drivers provide various torque curves; therefore, the maximum torque likely will not occur at the rated speed. This is also true with some gas turbine drivers with a flat torque curve.

NOTE 2 A coupling selection method is considered as some users install drivers much higher in capable power than the train requires, such as common drivers. This selection method results in couplings that are oversized for the application. This selection method proportionally splits the oversizing of the couplings for each of the driven machine(s).

$$T_s = T_d * F_s \tag{3}$$

Where:

T_d is the torque at maximum driver power, expressed in newton-meters (inch-pounds force), and shall be determined using Equation (4);

F_S is the coupling service factor, equal to 1.2.

$$T_d = (K_1 * P_{driver}) / N_{driver} \tag{4}$$

For adjustable frequency drivers, T_d is to be the maximum torque capability of the driver.

Where:

K_1 is a constant, equal to 9550 (63,000);

P_{driver} for a coupling connected directly to a driver (or gearbox and driver), P_{driver} is the maximum power of the driver as described in 3.1.31, expressed in kilowatts (horsepower); for couplings between multiple items of driven equipment, P_{driver} shall be the maximum power of the driver as described in 3.1.31, expressed in kilowatts (horsepower), minus the power of the driven equipment based on T_n (the additional power above each machine's T_n is to be proportionally split for each driven machine);

N_{driver} is the speed corresponding to the 100 % rotational speed, expressed in revolutions per minute.

6.7 ● If specified, the steady-state selection torque, T_s, expressed in newton-meters (inch-pounds force) shall be determined based on the torque required by the driven machine at the rated operating point and the corresponding speed rather than at the normal operating point (per 6.6a) using Equation (5). This can be appropriate if the power required by the driven machine at the rated operating point is significantly higher than that at the normal operating point.

$$T_s = T_r * F_s \tag{5}$$

Where:

T_r is the torque required by the driven machine at the rated operating point, expressed in newton-meters (inch-pounds force), and shall be determined using Equation (6);

F_S is the coupling service factor specified in 6.8.

$$T_r = (K_1 * P_{rated}) / N_{rated} \tag{6}$$

Where:

K_1 is a constant, equal to 9550 (63,000);

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P_{rated} is the power required by the driven machine, expressed in kilowatts (horsepower), at the rated operating point;

N_{rated} is the speed corresponding to the rated operating point's power, expressed in revolutions per minute.

NOTE 1 This situation can occur, for example, in the case of a centrifugal compressor with several different specified operating duties.

NOTE 2 Basing the coupling continuous torque rating on the driven-machine rated operating point rather than the normal operating point can result in a coupling that is undesirably large or heavy. This can be significant if one or both of the connected machines is sensitive to overhung mass.

6.8 Unless otherwise specified in 6.9 or 6.10, the minimum coupling service factor shall be 1.5 for a metallic flexible-element coupling; 3.0 for torsional damping and resilient couplings (see Annex B); 1.75 for gear couplings (see Annex C); and 1.5 for quill-shaft couplings (see Annex D).

NOTE At the proposal stage for new equipment, the final drive characteristics are often unknown. These factors are normally satisfactory to cover unknowns so that coupling sizes do not increase during engineering.

6.9 ● If specified, the purchaser may select a service factor value and state the basis of the service factor.

6.10 The coupling service factor, F_S, may be reduced by agreement between the purchaser and the vendor if:

a) the characteristics of the driver and driven machines and the operating process are well understood, or

b) all reasonable attempts to achieve the specified steady-state torque service factor fail to result in a coupling mass and subsequent overhung moment commensurate with the requirement for rotor dynamics of the connected machines.

In no case shall the service factor, F_S, for metallic flexible-element couplings be reduced to a value lower than 1.2 based on the input power required by the driven machine at the specified normal operating point.

6.11 If the machine train is driven by an induction motor, the coupling, coupling-to-shaft juncture, and machinery shafting shall be capable of transmitting 115 % of the expected transient torque encountered during a startup without damage.

6.12 If the machine train is driven by a synchronous motor, the coupling and coupling-to-shaft juncture shall be capable of withstanding the cyclic torque associated with startup for the expected number of starts specified by the purchaser. A limited life fatigue stress analysis shall be performed to verify this.

NOTE For initial coupling selection, a large cyclic torque requirement is typically assumed until all conditions are known so that the torsional response analysis can be completed.

6.13 ● If specified, the coupling and coupling-to-shaft juncture shall be capable of transmitting a specified transient torque associated with a generator short circuit and/or a motor breaker re-closure without damage.

NOTE During these situations, large torques can occur, which require that the total system be subsequently examined for possible damage.

6.14 The coupling-to-shaft juncture shall be capable of operating at a steady-state torque determined in accordance with 6.6a, substituting a service factor of 1.75. Torsional damped applications shall have a coupling-to-shaft juncture service factor of 3.0.

6.15 The torque capacity of a coupling-to-shaft juncture that is hydraulically fitted and keyless shall meet the following unless otherwise agreed:

a) methods and equations in ANSI/AGMA 9003-B08 or ANSI/AGMA 9103-B08. Other methods of calculation may be used with the approval of the purchaser;

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b) coefficient of friction of 0.15;

c) assumed length of hub engagement shall not include O-ring and oil-distribution grooves in the hub or the shaft.

6.16 Couplings may be designed to transmit torque through flange face friction. Unless otherwise agreed, a value of 0.15 shall be assumed for the coefficient of friction. However, the fasteners for coupling flanges, including integral flanges, shall not be less than that required to transmit the specified torques, as identified in 6.11 through 6.13 in shear.

6.17 Coupling shall provide drain passages in components, which could potentially trap and accumulate liquids. A minimum of two drain passages shall be provided in each affected component.

6.18 Spare parts shall meet all the criteria of this standard.

7 Coupling Ratings

7.1 The vendor shall state the continuous torque rating at the coupling rated speed while simultaneously subjected to the maximum continuous angular misalignment and the maximum continuous axial displacement.

7.2 The fatigue factor of safety at the continuous torque rating and any published combination of speed, angular misalignment, and axial displacement shall be determined using the proportional increase method with either the modified Goodman diagram or constant-life curves (see Annex E), together with the mean and cyclic stresses induced under the evaluated conditions. If the modified Goodman diagram is used, the fatigue factor of safety shall not be less than 1.25 for the flexible element and 1.5 for all other coupling components. If the constant-life curve is used, the fatigue factor of safety shall be not less than 1.35 for the flexible element and 1.5 for all other coupling components. Regardless of the method used, data for material strength shall be drawn from published industry standards or test data.

NOTE This subsection defines (for the coupling manufacturer) the minimum fatigue factors of safety and the methods for applying them to recognized material properties. This definition standardizes the basis for continuous coupling ratings. Details of the design, such as equations and analysis used to derive the stresses, are often considered proprietary and are not a point of documentation.

7.3 The vendor shall state the momentary and peak torque ratings of the coupling.

NOTE Typically, if the momentary or peak torque rating is exceeded, damage may occur to various components of the coupling, such as flex elements, fasteners, and shaft juncture.

7.4 For applications where cyclic torques can occur (such as from synchronous motor, generator, or reciprocating compressor), the coupling design shall be determined by completing a fatigue analysis and plotted on a fatigue diagram. (see Annex E).

7.4.1 The fatigue analysis shall take into account the normal operating conditions in conjunction with the transient conditions (see 6.1). Depending on whether the cyclic loads are considered for a limited number of occurrences or considered to be infinite, either a low-cycle fatigue analysis or high-cycle fatigue analysis shall be performed for the various torque-transmitting components in the coupling. For cyclic fatigue analysis, the resultant means and cyclic stresses plotted on a fatigue diagram shall fall under the applicable fatigue diagram based on a specific number of cycles, such as 10^4, 10^5, 10^6, or 10^7 cycles.

7.4.2 ● The fatigue diagram used shall be based on the purchaser specifying the number of occurrences of transients to which the coupling will be subjected in service. For high-cycle fatigue analysis, the analysis and safety factors shall be as specified in 7.2. Transient applications do not require the application of a service factor. The fatigue diagram should show the steady state (non-cyclic) stress plotted against the alternating stress generated at the coupling rated speed while simultaneously subjected to the maximum continuous angular misalignment and the maximum continuous axial displacement.

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7.4.3 ● If specified, the cyclic torque rating for the number of cycles specified (as a default 10^7 cycles), based on the combination of normal operating torque, maximum angular misalignments, maximum axial displacement, and maximum continuous speed, shall be provided on the coupling drawing.

7.4.4 In applications where potentially damaging, infrequent, maximum momentary or fault torques occur, the provision of an overload device may be considered to protect the coupling and equipment.

7.4.4.1 The overload device shall be designed to prevent the overload device from prematurely tripping due to low- or high-cycle fatigue of any sacrificial elements.

7.4.4.2 The overload device shall be designed to ensure that the device remains relatively intact after a trip until the connected equipment is brought to a stop.

8 Coupling Requirements

8.1 Metallic Flexible-element Couplings

8.1.1 The requirements of 8.1 apply only to metallic flexible-element couplings. For torsionally resilient couplings, gear couplings, and quill-shaft couplings, the requirements of Annex B, Annex C, or Annex D, respectively, shall apply.

8.1.2 Flexible elements shall be metallic.

8.1.3 If the flexible elements of a coupling are combined in a factory-assembled pack, the coupling spacer shall be removable without disturbance to the factory assembly of the elements.

8.1.4 If a tapered bore or integral flange is specified for one or both ends of the coupling, the vendor shall supply spacer shims to adjust the spacer gap. The shims shall provide a range of adjustment of ± 1.6 mm ($^1/_{16}$ in.), i.e., 3.2 mm ($^1/_8$ in.) total, for shafts with a nominal diameter less than 102 mm (4 in.). For shafts with a nominal diameter 102 mm (4 in.) or greater, the shims shall provide a range of ± 3.2 mm ($^1/_8$ in.), i.e., 6.4 mm ($^1/_4$ in.) total. For reduced moment style couplings for shafts with a nominal diameter less than 102 mm (4 in.), shims shall provide a range of adjustment of ± 0.8 mm ($^1/_{32}$ in.), i.e., 1.6 mm ($^1/_{16}$ in.) total.

8.1.5 The design of metallic flexible-element couplings shall be such that in the event of complete failure of the flexible element or elements in one plane of flexure, the spacer assembly is retained in approximately its normal position.

NOTE Once the coupling's flexible element(s) has failed, it is expected that the vibration will increase, and continual operation of the coupling is not possible.

8.1.6 ● If specified, couplings shall incorporate a feature that allows the transmission of load for a limited period in the event of a complete flexible element failure to allow safe shutdown of equipment.

NOTE For example, this feature can be considered for turbine main-drive couplings to provide an additional safety factor to prevent turbine overspeed in the event of coupling failure.

8.1.6.1 The purchaser should provide the torque load requirements, the time period for operation, and any other features or requirements.

8.1.6.2 The vendor shall provide the following information on this device:

a) type of feature;

b) how the feature functions;

c) risks associated with the operation of this feature;

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d) details of the system requirements if an oil spray system is required to provide cooling to accommodate operating with the backup system engaged.

8.2 Machining

All coupling parts, other than fasteners and flexible discs, shall be machined all over to minimize inherent unbalance. All exposed surfaces shall be finished to a surface roughness not exceeding 3.2 μm (125 microinches) arithmetic average (*Ra*). Chamfers shall be provided for interference fits. Fillet radius shall be applied to avoid high stress concentration.

8.3 Spacer

All couplings shall be of the spacer type. The spacer shall be of sufficient length to allow removal of coupling hubs and to allow for maintenance such as adjacent bearings and seals without removal of the shaft or disturbance of the equipment alignment. The minimum spacer length shall correspond to a distance between shaft ends of 460 mm (18 in.).

NOTE The spacer gap length is not necessarily the same as the spacer length.

8.4 Hub Type

● The purchaser shall specify whether the coupling shall be designed to fit to integral flange(s) or be provided with removable hub(s).

8.5 Integral Flanges

8.5.1 If the coupling is to fit to integrally flanged shaft end(s), the coupling vendor and the manufacturer with unit responsibility shall agree on the flange geometry. The holes shall be machined with computer numerical-controlled (CNC) equipment. A drill fixture (or template) shall be used only if CNC equipment is not available. In either case, inspection shall be performed to assure proper location of the mating coupling flanges. The coupling vendor shall supply the drill fixture (or template), if required.

8.5.2 The coupling shall mate directly to the integral flange without an adapter. If an adapter is necessary, it shall require purchaser approval.

NOTE Addition of an adapter between the coupling and the integral flange increases the overhung moment and adds another fit whose runout and clearance is necessary to control to maintain balance.

8.6 Hubs

8.6.1 Removable Hubs

8.6.1.1 Removable coupling hubs shall be fitted to the shaft using an interference fit to positively locate and center the hub, and therefore the rest of the coupling, on the shaft.

8.6.1.2 ● Hubs may have a parallel or tapered bore, with or without keyways, or may be splined with a major diameter fit, or splined with a side fit and fore and aft locating pilots, as specified by the purchaser.

8.6.1.3 ● The degree of interference shall be specified by the purchaser and is subject to approval by the vendor.

8.6.1.4 The following guidelines are recommended for hub-to-shaft fits:

a) The interference fit for straight-bore, keyed hubs should be from 0.00050 mm/mm (in./in.) to 0.00075 mm/mm (in./in.) of bore diameter.

b) The interference fit for tapered-bore, keyed hubs should be at least 0.001 mm/mm (in./in.) of bore diameter.

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c) The interference rate for taper-bore, hydraulically fitted hubs should be based upon the torque that is required to be transmitted. As a maximum, the interference rate should not exceed 0.003 mm/mm (in./in.) of bore diameter to avoid potential problems.

8.6.1.5 ● If specified for straight-bore, keyed hubs, the shaft sizes and coupling bores shall be in accordance with ANSI/AGMA 9002-C14, ANSI/AGMA 9112-B15, or ISO 286-2.

8.6.1.6 For tapered-bore, keyed hubs, the inspection procedures shall be in accordance with ANSI/AGMA 9002-C14 or ANSI/AGMA 9112-B15.

8.6.1.7 For tapered-bore, hydraulically fitted hubs, the inspection procedure shall be in accordance with ANSI/AGMA 9003-B08 or ANSI/AGMA 9103-B08.

8.6.1.8 The surface roughness, arithmetic average roughness (*Ra*), of hub bores shall not exceed:

a) 3.2 µm (125 microinches) for straight-bore, keyed hubs,

b) 1.6 µm (63 microinches) for tapered-bore, keyed hubs,

c) 0.8 µm (32 microinches) for keyless hubs.

8.6.1.9 The out-of-roundness of the hub bore, whether straight or tapered, shall not exceed 5.1 µm (0.0002 in.) total indicator reading (TIR) for bores less than or equal to 102 mm (4 in.) in diameter, and shall not exceed 12.7 µm (0.0005 in.) TIR for hub bores greater than 102 mm (4 in.) in diameter. Roundness measurements shall be made before any keyways are cut.

8.6.2 Tapered-bore Hubs

8.6.2.1 ● If a tapered-bore coupling is specified, the purchaser shall specify the taper (see Annex I).

8.6.2.2 Unless otherwise specified, keyless, hydraulically fitted hubs shall have a taper of 1:24 ($^1/2$ in./ft of diameter).

8.6.2.3 Unless otherwise specified, non-hydraulically fitted hubs shall have a taper of 1:16 ($^3/_4$ in./ft of diameter).

8.6.2.4 ● The taper of tapered-bore hubs shall be verified. The method of verification can either be using matched ring and plug gauges or by the coordinate measuring machine (CMM) technique. The verification method and acceptance criteria for the coupling hub-to-shaft end fit shall be determined by the purchaser.

8.6.2.4.1 The acceptance criteria for matched ring and plug gauge checking, using the matched ring and plug gauges specified in 11.2.5, is:

a) Tapered bores for keyless, hydraulically fitted hubs shall have at least an 85 % blued fit (surface contact) to the taper gauge. See API RP 687 for bluing check information.

b) Tapered bores for keyed hubs shall have at least a 70 % blued fit (surface contact) to the taper gauge before cutting keyways.

NOTE 1 ANSI/AGMA 9003-B08 or ANSI/AGMA 9103-B08 provides guidance for checking the contact.

NOTE 2 ANSI/AGMA 9002-C14 or ANSI/ASME 9112-B15 specifies the bore check before cutting keyways.

8.6.2.4.2 The acceptance criteria for the CMM checking is identified in 8.6.2.4.2.1 and 8.6.2.4.2.2. Annex J provides information for performing the checks.

NOTE This process is significantly easier with a programmable direct drive CMM and should only be performed on a CMM with the necessary level of accuracy and repeatability.

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8.6.2.4.2.1 If the profile of the bore's surface is inspected using a CMM technique, it shall be performed using a minimum of 32 points at a minimum of four different locations (minimum eight points per location) through the length of the bore. Two of the locations should be as close as possible to the large end bore and the small end bore.

8.6.2.4.2.2 If a scanning method is used, a minimum of 1440 degrees (four sweeps) from the large end bore to the small end bore through the length of the hub replaces the 32 points in 8.6.2.4.2.1. Unless otherwise specified for keyless hubs, the taper shall not exceed +/− 0.0001 mm/mm (0.0012 in./ft) taper on diameter, or an average included angular deviation of 20 seconds and the profile of the surface or cone shall not exceed 0.02 mm (0.0008 in.). Unless otherwise specified for tapered hubs with keyways, the taper shall not exceed +/− 0.00012 mm/mm (0.0014 in./ft) taper on diameter, or an average included angular deviation of 24 seconds and the profile of the surface or cone shall not exceed 0.024 mm (0.00096 in.) before cutting keyways.

8.6.2.5 The design of the tapered-bore hub shall provide for a shaft-end retaining nut or plate, including the necessary wrench clearance. The direction of the thread on the retaining nut shall be such that rotation of the coupling hub relative to the shaft (attributable to slippage under load) forces the hub more tightly on the taper.

8.6.3 Additional Requirements for Keyed Hubs

8.6.3.1 ● The purchaser shall specify the number and configuration of the keyways.

8.6.3.2 Keys, keyways, and inspection methods shall conform to ANSI/AGMA 9002-C14 or ANSI/AGMA 9112-B15.

8.6.3.3 The bottom corners of all keyways shall be radiused with a smooth transition from the keyway walls. Corner radii shall conform to ANSI/AGMA 9002-C14 or ANSI/AGMA 9112-B15.

8.6.3.4 Keyed coupling hubs shall have a sufficient number of threaded puller holes so that the hub can be removed if fitted with the proper interference or advancement. Puller holes for bores that are less than 64 mm ($2^1/_2$ in.) shall have a minimum nominal diameter of 6 mm ($^1/_4$ in). Puller holes for bores that are greater than or equal to 64 mm ($2^1/_2$ in.) shall have a minimum nominal diameter of 10 mm ($^3/_8$ in.). Puller holes shall have standard coarse threads.

8.6.3.5 The key(s) in the shaft for the keyed hub should completely fill the keyways of both the shaft and the coupling hub to avoid balancing errors or effects. The key(s) should not overhang the end of the shaft. Stepped, fully crowned keys should be used if the key extends past the end of the hub. Alternative key(s) should be approved by the purchaser.

NOTE Typically, service keys are supplied by the equipment vendor and not the coupling vendor.

8.6.4 Alternate Hub Design

Alternative coupling-to-shaft juncture methods (providing an interference fit) other than keyed or hydraulically fitted hubs may be proposed as an alternative, as determined by the purchaser, provided such methods comply with all the requirements of this document, including but not limited to torque transmission and balance requirements. Any exceptions shall be approved by the purchaser.

8.7 ● Idling Adapter (Solo Plate)

If uncoupled operation is specified and the coupling has floating components when the coupling spacer is removed, the vendor shall supply an idling adapter for drive end coupling. The idling adapter shall center and maintain the balance of the coupling.

NOTE An idling adapter (solo plate) does not fulfill the function of a moment simulator. An idling adapter (solo plate) can be designed to also serve as a moment simulator.

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8.8 Moment Simulator

8.8.1 ● If specified, a moment simulator shall be supplied. The purchaser shall provide the vendor with the measurement of the distance from the end of the shaft to the centerline of the adjacent bearing. This moment simulator shall not differ from the contract coupling overhung moment by more than +/− 10%.

NOTE A moment simulator can be designed to also serve as a solo plate.

8.8.2 If a moment simulator is specified in 8.8.1, with the purchaser's approval a "dummy hub" may be used to function as a moment simulator instead of using the job hub along with an additional component.

8.9 Component Fit Tolerances and Potential Unbalance Calculations

8.9.1 Except for nonmetallic insulating parts (see 8.11), components of couplings operating at speeds greater than 1800 rev/min shall be centered by means of piloted or rabbeted fits.

8.9.1.1 The eccentricity of these fits shall not exceed 0.00008 mm/mm (0.00008 in./in.) of diameter TIR or 0.013 mm (0.0005 in.) TIR, whichever is greater.

8.9.1.2 Fits that tighten under centrifugal loading are preferred.

8.9.1.3 The fit shall range from a loose fit of 0.025 mm (0.001 in.) to an interference fit, with the actual fit determined by balancing requirements.

8.9.1.4 For couplings operating at 1800 rev/min or less, fits are only required if needed to meet the balance tolerance.

8.9.2 The face runout of mating faces (except for flexible elements and nonmetallic insulating parts) shall not exceed 0.00008 mm/mm (0.00008 in./in.) of diameter TIR or 0.025 mm (0.001 in.) TIR, whichever is greater. For couplings operating at 1800 rev/min or less, face runout tolerances are only required if needed to meet the balance tolerance.

8.9.3 ● If specified, the coupling vendor shall perform calculations to verify the potential unbalance of the complete coupling, in the plane of the center of mass of each half coupling. The calculation shall be for the coupling specified.

NOTE An example of a potential unbalance calculation is given in Annex G.

8.9.3.1 The potential unbalance shall not exceed ANSI/AGMA 9000-C90, class 9, potential mass center displacement of 0.05 mm (0.002 in.), for couplings operating at speeds 1800 rev/min or less.

8.9.3.2 For couplings operating at speeds greater than 1800 rev/min up to 5000 rev/min, the potential unbalance shall not exceed ANSI/AGMA 9000-C90, class 10, potential mass center displacement of 0.027 mm (0.001 in.).

8.9.3.3 For couplings operating at speeds greater than 5000 rev/min, the potential unbalance shall not exceed ANSI/AGMA 9000-C90, class 11, potential mass center displacement of 0.013 mm (0.0005 in.).

8.9.3.4 The center of mass is the location at which the mass of the half coupling can be considered to be concentrated, and is normally referenced from the equipment shaft end, with a positive location being beyond the shaft end and a negative location being within the shaft.

8.9.4 If a potential unbalance calculation has been specified and performed in accordance with 8.9.3, the registers and the fits that locate components with respect to each other can require greater accuracy than the requirements of 8.9.1 or 8.9.2.

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8.10 Fasteners (Including Studs)

8.10.1 Fasteners for all piloted flanges, including integral flanges, and customer-interface flanges shall have a diametrical clearance of not greater than 0.13 mm (0.005 in.) in the holes of one flange. Where the bolts are threaded into one flange, this requirement does not apply. The hole location shall allow the balance requirements to be met.

8.10.2 For couplings that operate at 1800 rev/min or less, the location and the clearance between the bolt and the hole shall be such that the balance requirements can be satisfied.

8.10.3 Metallic, deformed-thread, self-locking fasteners shall be used. Castellated lock nuts are not acceptable. Lock washers shall not be used.

8.10.4 The coupling vendor shall recommend the interval of the replacement of fasteners.

8.10.5 The threads of the fasteners shall comply with ISO 262, class 1, or ANSI/ASME B1.1. The quality of the nuts shall be at least equal to that of the bolts or studs.

8.10.6 The coupling vendor shall specify the required bolt torque or tensile load and shall state whether this torque is for dry or lubricated torquing.

8.10.7 Fasteners shall be held within tolerances, on both dimensions and mass, sufficient to permit interchange within the same set of fastener or substitution of a spare set of fasteners without affecting the coupling integrity or resulting in the balance being outside the prescribed limits. See 9.3.4.

8.10.8 A minimum of 10 %, a minimum quantity of two spare coupling fasteners for installation shall be supplied with each coupling and each spare set of coupling fasteners.

NOTE 1 Couplings are weight sensitive and replacement of individual fasteners versus a matched set can cause a coupling balance issue.

NOTE 2 A complete set of spare nuts to maintain the required prevailing torque requirement can be considered.

NOTE 3 A complete set of matched fasteners to facilitate repeated assembly and disassembly can be considered.

8.11 ● Electrical Insulation

If specified, the coupling shall be electrically insulated to prevent the flow of electrical current from one shaft to the other through the coupling. Any nonmetallic insulating parts are exempt from the requirements of 8.9.1 and 8.9.2.

NOTE Electrical insulation is normally achieved by the insertion of insulating material between the flanges and around the flange bolts, including bolt head or nut faces.

8.12 Dynamics

8.12.1 The axial natural frequency (ANF) of a single element convoluted diaphragm coupling shall not occur within 10 % of the specified operating speed range. The vendor shall identify the ANF in the proposal.

NOTE Multi-disc, multi-diaphragm, and non-convoluted single-element flexible couplings do not exhibit a detrimental axial vibration response.

8.12.2 The lateral natural frequency (N_c) of that portion of the coupling between and including the flex elements, assuming infinitely stiff supports, shall be at least two times the highest specified operating speed for the uniform-tube-equation methodology as specified in ANSI/AGMA 9004-B08 or ANSI/AGMA 9104-A06, or at least 1.5 times using a more rigorous analysis based on actual geometry (for example, finite-element analysis). The purchaser and vendor shall agree who shall perform these calculations and the assumptions used.

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NOTE The actual lateral frequency of the coupling is affected by the stiffness of any flange adapter(s) and shaft extension(s). The calculation to achieve this actual number is complex. 8.12.2 establishes a default value to use if little else is known, such as in the proposal stages of a design.

8.12.3 The torsional stiffness shall be determined by taking into consideration the entire length of the coupling between the points where the shafts enter the coupling hub on each end, including a shaft penetration factor of 1/3 (or an alternative value based on the vendor's test data). The calculation used to determine torsional stiffness shall conform to ANSI/AGMA 9004-B08 or ANSI/ASME 9104-A06 methods unless a more rigorous method, such as finite-element analysis or actual testing, is used.

NOTE The shaft penetration factor is the portion of the shaft length within the confines of the coupling hub that is, for the purpose of calculating torsional rigidity, assumed to be free from restraint at the shaft-hub interface.

8.12.4 ● If specified, the torsional stiffness tolerance range (+/−) shall be indicated on the coupling drawing.

9 Balance

9.1 General

9.1.1 The overall objective of coupling balance is to provide a coupling that is designed, manufactured, assembled, and balanced such that it can be installed on the driving and driven machines and operated with machine vibrations within allowable limits. This requires that the machine shaft end eccentricity should be commensurate with the degree of balance required on the coupling.

9.1.2 The degree of balance required for a given coupling is a function of the unbalance responses of the coupled machines. Machines with a high degree of sensitivity to coupling unbalance require well-balanced couplings; machines with lower sensitivity require less-precisely balanced couplings. This standard provides three separate balancing methods. Certain specific applications can require tighter balancing criteria or methods to be specified by the purchaser.

9.1.3 ● Couplings shall be balanced by one of the following methods, as specified by the purchaser:

a) Method 1 is to separately balance each major component or factory-assembled subassembly. This method is the standard for couplings operating at 1800 rev/min or less.

b) Method 2 is as Method 1, but with the addition of a check balance performed on the completely assembled coupling. This method is the standard for couplings operating above 1800 rev/min, with options as specified.

c) Method 3 is an optional method for couplings operating above 1800 rev/min, with options as specified, and is based on the balancing of the completely assembled coupling as an entity.

Table 1 identifies the paragraphs pertinent to each balancing method.

Table 1—Summary of Balancing Methods

Operation	Reference Subsection	Method 1[a]	Method 2[a]	Method 3[a]
Component balance	9.3.5	R	R	R
Assembly check balance	9.3.6	N/A	R	N/A
Assembly balance	9.3.7	N/A	N/A	R
Residual unbalance verification	9.3.8	N/A	IS	IS
Repeatability check	9.3.9	N/A	IS	IS
Component interchangeability check	9.3.10	N/A	IS	N/A

[a] Meaning of abbreviations: R, required; N/A, not applicable; IS, if specified.

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9.2 Balancing Methods

9.2.1 Method 1—Component Balance

All components shall be individually balanced to the limits stated and the technique described in 9.3.5.

This method is illustrated in Figure 2.

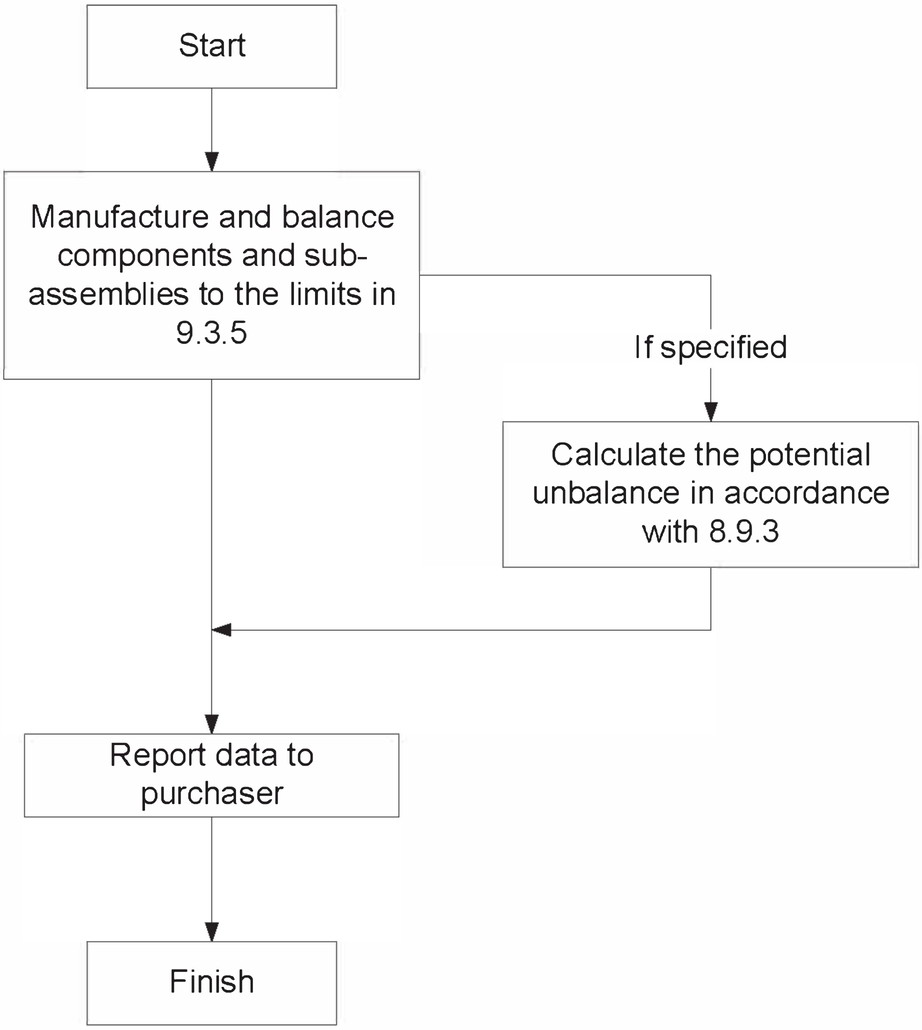

Figure 2—Component Balance Procedure

9.2.2 Method 2—Component Balance with Assembly Check Balance

9.2.2.1 ● All components shall be manufactured and balanced as for Method 1 to achieve the required level of potential unbalance. The coupling shall then be assembled, and the balance checked as an assembly with the limits stated and the technique described in 9.3.6. If specified, the coupling as mounted on the balance machine shall have the residual unbalance verified as described in 9.3.8.

9.2.2.2 ● If specified, the coupling shall be subjected to a repeatability check as described in 9.3.9.

The procedure for this method is illustrated in Figure 3.

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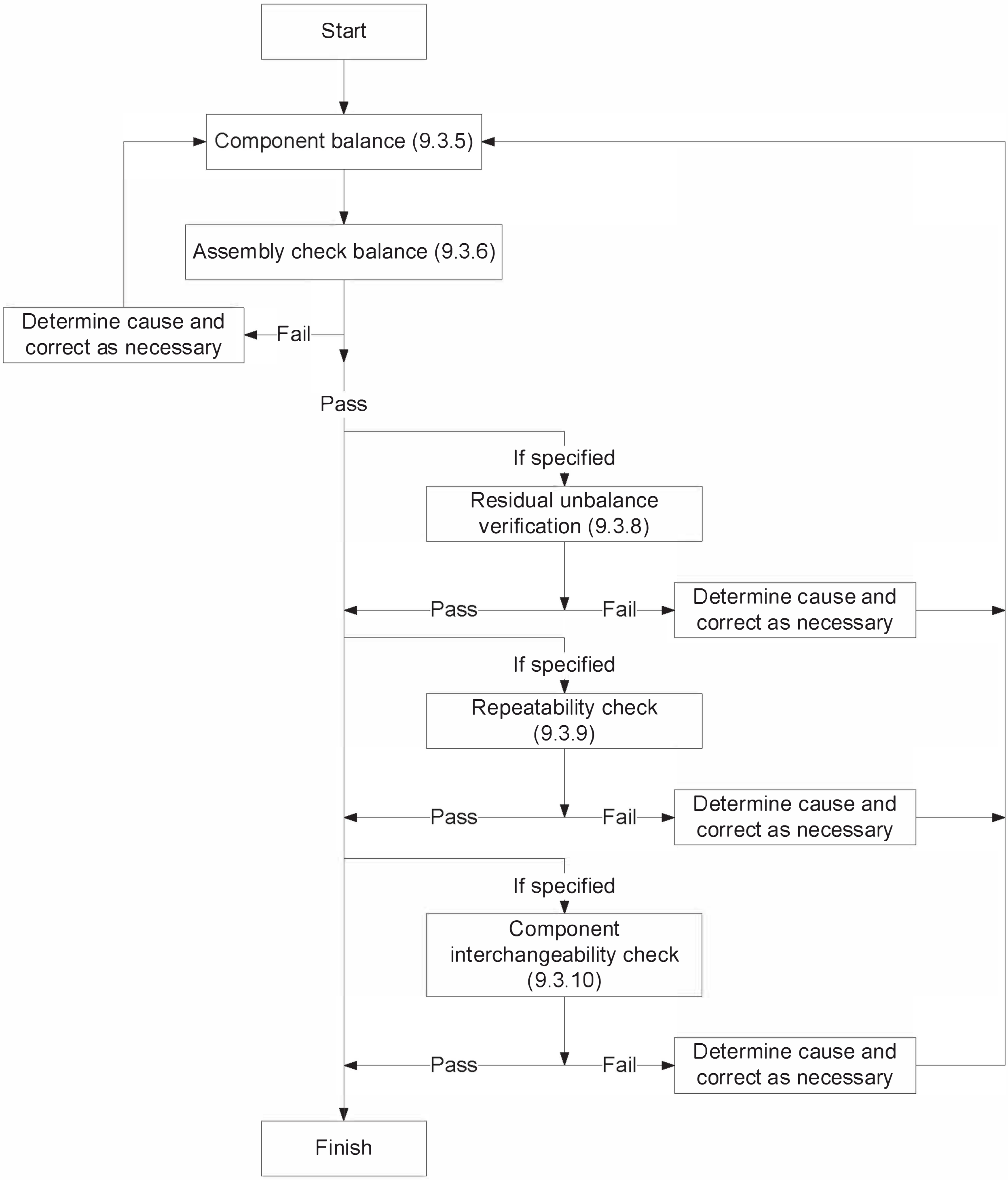

Figure 3—Procedure for Component Balance with Assembly Check Balance

9.2.3 Method 3—Component Balance with Assembly Balance

9.2.3.1 ● This balance method requires that all components be individually balanced to the limits stated using the technique described in 9.3.5, except for the component or subassembly that will have the assembly balance correction made to it. The coupling shall then be assembled and balanced in accordance with and to the limits stated in 9.3.7. If specified, the coupling as mounted on the balance machine shall have the residual unbalance verified as described in 9.3.8.

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9.2.3.2 ● If specified, the coupling shall be subjected to a repeatability check as described in 9.3.9.

The procedure for this balancing method is illustrated in Figure 4.

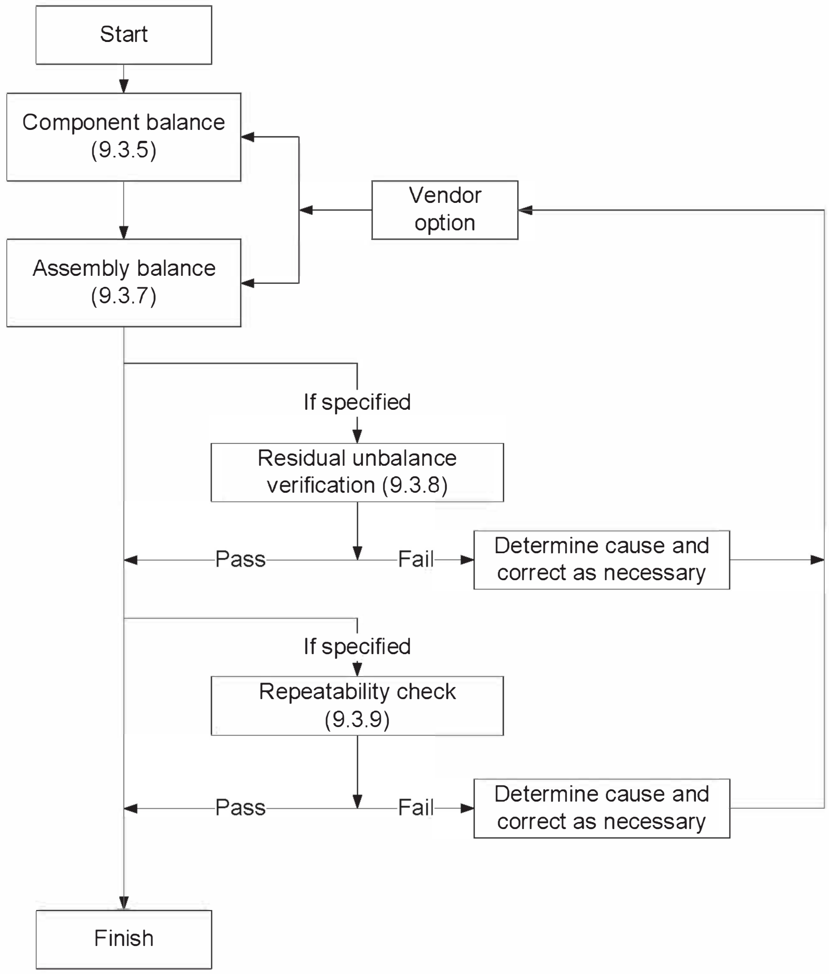

Figure 4—Procedure for Component Balance with Assembly Balance

9.3 Balance Criteria

9.3.1 Balancing Machines

Balancing shall be performed on balance machines that are capable of achieving the specified level of residual unbalance.

9.3.2 Material Removal

Material for the purpose of balancing shall be removed from low-stress areas of the components.

9.3.3 Concentricity

Before balancing is started, the mounting surfaces of the component (the hub bore, sleeve pilot, and so forth) shall be aligned so that the component's geometric center is concentric with the center of rotation for balancing within 0.00004 mm/mm of mounting diameter or 0.0064 mm (0.00025 in.), whichever is greater.

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NOTE Determination of the geometric center of rotation requires that the roundness of the component be identified. Once the roundness is identified, the geometric center is then determined. This procedure differs from a conventional TIR reading in that a TIR reading does not directly compensate for roundness variations (for example, roundness variation due to jaw squeeze).

9.3.4 Fasteners

Each bolt, each nut, and other similar components that require removal for normal field disassembly of the coupling shall be mass balanced individually to a total tolerance of 0.05 % of the component's mass or 0.1 g (0.0035 oz), whichever is greater.

9.3.5 Component Balance

9.3.5.1 Coupling components shall be balanced by rotation.

9.3.5.2 Each component, such as the hubs, sleeves, flexible elements, spacers, factory-assembled sub-assemblies, adapter plate(s), idling adapter (solo) plate(s), and moment simulators, shall be balanced individually (except for the component or subassembly that is corrected as described in 9.3.7).

9.3.5.3 Component balanced hub(s) shall not have additional corrections for any other balancing method.

9.3.5.4 All machining of components, except for keyway(s), shall be completed before balancing. The machining of keyway(s) prior to balancing is optional.

9.3.5.5 Two-plane balancing is required for components or sub-assemblies with a length/diameter ratio greater than or equal to 1.0. Where the length/diameter ratio is less than 1.0, two-plane balancing is preferred but single-plane balancing is acceptable.

9.3.5.6 ● Each component shall be balanced so that the level of residual unbalance, U, expressed in gram-millimeters (ounce-inches), for each balance plane does not exceed the greatest of the values determined by Equations (7) to (9) or does not exceed 10 % of the allowable shaft unbalance at the closest journal location provided by the purchaser.

$$U = \frac{K_2 \times m}{N} \tag{7}$$

$$U = K_3 \times m \tag{8}$$

$$U = K_4 \tag{9}$$

Where:

K_2 is a constant, equal to 6350 (4);

K_3 is a constant, equal to 1.27 (0.0008);

K_4 is a constant, equal to 7.2 (0.01);

m is the mass, expressed in kilograms (pounds), of the component apportioned to one or the other of the balance planes so that the sum of the masses apportioned to the two planes equals the total mass of the component;

N is the maximum continuous operating speed, expressed in revolutions per minute.

9.3.5.7 Components such as shaft end nuts or coupling hubs may be balanced on a vertical balancing machine.

9.3.6 ● Assembly Check Balance

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Couplings balanced in accordance with 9.2.2 (component balance with assembly check balance) shall be assembled, the balance verified, and the components shall be matchmarked. The residual unbalance, *U*, expressed in gram-millimeters (ounce-inches), for the randomly assembled coupling shall not exceed the greatest value determined by Equations (10) to (12) or does not exceed the allowable shaft unbalance at the closest journal location provided by the purchaser.

$$U = \frac{K_5 \times m}{N} \tag{10}$$

$$U = K_6 \times m \tag{11}$$

$$U = K_7 \tag{12}$$

Where:

K_5 is a constant, equal to 63,500 (40);

K_6 is a constant, equal to 12.7 (0.008);

K_7 is a constant, equal to 72 (0.1).

The remaining variables are the same as for Equations (7) to (9). Couplings that satisfy these criteria shall be matchmarked. Couplings that do not satisfy these criteria shall be inspected to determine the cause, which shall be corrected, and the test shall be repeated. Trim balancing the assembly is not allowed.

9.3.7 Assembly Balance

9.3.7.1 Couplings balanced in accordance with 9.2.3 (component balance with assembly balance) shall be assembly balanced.

9.3.7.2 For an assembly balance, coupling components or sub-assemblies shall be balanced in accordance with 9.3.5.

9.3.7.3 The assembled coupling shall then be matchmarked and two-plane balanced, with corrections being made only to the component or subassembly in each balance plane that was not previously balanced.

9.3.7.4 ● The final residual unbalance of the assembled coupling in each of the two correction planes shall not exceed the greatest value determined by Equations (7) to (9) or does not exceed the allowable shaft unbalance at the closest journal location provided by the purchaser.

NOTE Assembly balancing corrects for overall coupling unbalance caused by eccentricities of the pilot fits that are used to center components during assembly. However, assembly balancing can prohibit the subsequent interchange of duplicate coupling components and can require that the entire coupling be maintained as a unit, except for the bolts and nuts.

9.3.7.5 Coupling hubs that can be operated uncoupled should not be used for corrections during the assembly balance of the coupling.

9.3.8 Residual Unbalance Check

9.3.8.1 ● If specified, a residual unbalance check shall be performed on the assembled coupling.

9.3.8.2 The residual unbalance check shall be performed per Annex K after assembly balancing or assembly check balancing is complete and before the assembled coupling is removed from the balancing machine.

9.3.9 Repeatability Check

9.3.9.1 ● If specified, the coupling shall be checked after the assembly balance or assembly check balance to ensure that the assembly balance can be repeated.

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9.3.9.2 The coupling shall be disassembled to the same extent required for normal field disassembly and remounted on the balance fixture or fixtures.

9.3.9.3 The unbalance of the reassembled coupling shall then be measured on the balancing machine; the residual unbalance, *U*, expressed in gram-millimeters (ounce-inches), shall not exceed the greatest value determined by Equations (10) to (12).

9.3.10 Component Interchangeability Check

9.3.10.1 ● If specified, and where interchangeable spare parts are to be supplied with the original coupling, a component interchangeability test shall be performed.

9.3.10.2 After the coupling has been matchmarked following an assembly check balance, it shall be disassembled to the same extent required for normal field disassembly, and a major component, to be selected by the purchaser, shall be substituted and the coupling reassembled and remounted on the balance machine.

9.3.10.3 The unbalance of the coupling shall then be measured in the same manner and to the same criteria described in 9.3.9. The components shall be matchmarked to identify proper positioning as applicable.

9.3.10.4 A major component shall normally be a rigid adapter, a flexible element subassembly, a spacer, or a center section containing flexible elements.

9.3.11 Balance Mandrels

9.3.11.1 If balance mandrels are used, the mandrel shall have a surface roughness not exceeding 0.4 µm (16 microinches) arithmetic average (*Ra*), and shall exhibit no measurable eccentricity using an indicator graduated in 2.5 µm (0.0001 in.) increments.

9.3.11.2 Tapered spring mandrels shall not be used.

9.3.11.3 For components in which keyways have been machined prior to balance, inside crowned half keys or an equivalent compensating moment are required for proper balance, since mandrels are typically not keyed.

9.3.11.4 The mandrel mass should not exceed 25 % of the mass of the component or assembly being balanced.

9.3.11.5 The interference fit between a component and a mandrel shall not be less than 0.05 mm (0.002 in) or one quarter of the design fit between the component and the shaft, whichever is the lesser.

9.3.11.6 With the component mounted on the mandrel, the axial and radial phase related runout(s) (TIR) shall be recorded and shall not exceed 0.00017 mm/mm (0.002 in./ft) of component diameter.

The location of this runout measurement should be at the same place as measured during disassembly and reassembly.

9.4 Trim Balance Holes

9.4.1 ● If specified, threaded holes shall be provided in the coupling for trim balancing. The trim-balance holes should be capable of correcting for an unbalance, *U*, as given by Equation (13):

$$U = K_6 \times m \quad (13)$$

Where:

m is the mass, expressed in kilograms (pounds), of the component apportioned to one or the other of the balance planes so that the sum of the masses apportioned to the two planes equals the total mass of the component;

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K_6 is a constant, equal to 12.7 (0.008);

9.4.2 The number, size, depth, and location of such holes shall be agreed upon by the purchaser and the vendor. The optimum hole location for keyed hubs is generally on the outboard faces of the hubs, midway between the inside and outside diameters of the hub barrel. The optimum location for keyless (hydraulically fitted) hubs is generally on the coupling flanges, between the bolt holes of the flange.

NOTE 1 Because of eccentricity of the shaft end or incompletely filled keyways, trim balancing the rotor after the coupling hub has been mounted can be advisable. This practice normally precludes moving the hub to another rotor, unless balance is achieved by using balance holes as described in 9.4.1.

NOTE 2 If balance holes are used, the hub can always be returned to its original state of balance by removing the weights inserted into the holes.

10 Materials

10.1 Materials of construction shall be the manufacturer's standard for the specified operating conditions, except as required or prohibited by the purchaser or by this standard.

10.2 The materials of construction of all major components shall be clearly stated in the vendor's proposal. Materials shall be identified by reference to applicable standards, including the material grade. If no such designation is available, the vendor's material specification—giving physical properties, chemical composition, and test requirements—shall be included in the proposal.

10.3 ● The purchaser shall specify any corrosive agents present in the environment, including constituents that can cause stress corrosion cracking.

NOTE Experience shows that marine atmospheres are located within 25 miles (40 km) of the coastline. This limit can vary depending on topography, prevailing wind direction, and potential chloride exposure. Other sources of chlorides should be considered, such as de-icing salts and cooling tower vapor.

10.4 ● If a coupling operation in a corrosive environment is specified, either oil mist, a suitable coating, or an inert gas purge can be required. The vendor shall advise the purchaser if material limitations demand such protection for the coupling.

10.5 Flexible elements shall be of corrosion-resistant material. If approved by the purchaser, flexible elements may be suitably coated to resist corrosion. The type of coating and its method of application shall be described by the vendor.

10.6 ● If specified, all parts not covered by 10.5 shall be made from corrosion-resistant material or suitably coated.

10.7 All fasteners shall be of heat-treated steel, 510 MPa (74 KSI) proof strength (for example, SAE J 429:2013, Grade 5) or stronger. If plated fasteners are used, they shall be treated properly to avoid cracking caused by hydrogen embrittlement.

11 Accessories

11.1 Coupling Guards

Coupling guards shall comply with the requirements of Annex H.

11.2 Special Tools

11.2.1 ● The purchaser shall specify who is to supply the necessary pumps, hoses, fittings, pressure gauges, and other equipment required for the installation and removal of hydraulically fitted coupling hubs.

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11.2.2 The vendor shall supply all special tools (tools that are not commercially available catalog items) required for assembly and disassembly of the coupling, including jackscrews and other devices required to separate closely piloted parts. All special tooling (as practical) is to be identified with a unique number on a non-critical area of the tool (or with an austenitic stainless steel tag). A bill of material identifying each unique number for the special tooling shall be provided, including a picture or sketch of each tool.

11.2.3 ● If specified by the purchaser, a two-piece stop-ring or an alternative device shall be provided to locate the advance (draw) of the hydraulically fitted coupling hub during installation. The device shall be designed to be removable after the coupling is properly in place, whether installed in the shop or the field.

11.2.4 ● If specified by the purchaser, the vendor shall provide a puller for keyed coupling hubs.

11.2.5 ● If specified, the vendor shall supply a matched set of ring-and-plug gauges for each shaft-end taper and shall meet the following requirements.

a) hardness of the material of the gauge shall be greater than that of the shaft or coupling and not less than 45 HRC,

b) verified with the machinery vendor's master ring and master plug gauges,

c) roundness, surface finish and contact requirements of this standard for coupling tapers,

d) length of the ring-and-plug gauge shall at least be equal to the length of the coupling hub plus the advancement distance.

e) tools shall overlap the taper at each end,

f) equipment drawings shall be reviewed for possible interference,

g) gauges shall be marked “Gauge” in a non-critical location,

h) storage preservation of these gauges shall satisfy the requirements of 12.5.4,

i) “do not lap with this gauge” wording permanently stenciled in a non-critical location.

NOTE This gauge set is intended to become the master gauge set for the owner for use in inspection of both shaft and coupling taper.

11.2.6 ● If specified, the vendor shall supply a set of lapping tools in compliance with the following.

a) Be softer than the shaft and hub.

b) Overlap the taper at each end by a minimum of 12 mm (0.5 in.).

c) Equipment drawings shall be reviewed for possible interference.

d) Mark “Lapping Tool” in a non-critical location.

e) Storage preservation of these tools shall satisfy the requirements of 12.5.4.

11.3 Torque Measuring System(s)

11.3.1 ● If specified, a torque measuring system shall be included. Details of the torque measuring system are to be determined using Annex L.

11.3.2 ● The purchaser may specify the supplier for the specified torque measuring system(s).

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11.3.3 The purchaser and the torque measuring system vendor shall coordinate to integrate the torque measuring system with the machine interface or coupling guard.

11.3.4 The torque measuring system(s) shall meet the requirements identified in Annex L.

11.3.5 ● For trains with multiple couplings, the location of the coupling(s) for the torque measuring system(s) shall be specified.

11.3.6 ● If specified, the torque measuring system shall be capable of measuring the cyclic torque (torsional).

11.3.7 ● If specified, the torque measuring system shall be incorporated into the safety trip system.

NOTE Typically, torque measuring systems are condition-monitoring systems, and additional instrumentation and design may be required to meet the desired safety trip system requirements.

11.3.8 The purchaser and the torque measuring system vendor shall coordinate the torsional data, sample rate, and the accuracy required.

12 Manufacturing Quality, Inspection, Testing, and Preparation for Shipment

12.1 Manufacturing Quality

12.1.1 The purchaser's representative shall have access to the vendor's quality program for review. Vendor processes that ensure quality that may be reviewed may include:

a) receiving and inspections;

b) mechanical testing;

c) calibration of equipment and tools;

d) certification of operators;

e) corrective actions;

f) process for non-conforming parts.

12.1.2 Repair of defects by welding or plating in the torque-transmitting path shall not be undertaken without written authorization from the purchaser. Repair of other defects that do not affect the performance, reliability, or safety of the coupling may be made at the discretion of the vendor.

12.1.3 Parts of duplicate couplings, except for meshing gear components, shall be manufactured within tolerances that permit interchangeability or replacement of parts in the field with minimal fitting; however, the assembly can require rebalancing after interchange of component parts.

12.1.4 The vendor shall remove all sharp edges of parts and components, with the exception of the threads.

12.1.5 Manufacturer's markings, such as identification or matchmarking, shall be on a low-stress area that does not affect the performance or integrity of the coupling.

12.2 Inspection and Testing

12.2.1 ● The purchaser shall specify the extent of participation in the inspection and testing.

12.2.2 After advance notification to the vendor, the purchaser's representative shall have entry to all vendor and sub-vendor plants where manufacturing, testing, or inspection of the equipment is in progress.

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12.2.3 The vendor shall notify sub-vendors of the purchaser's inspection and testing requirements.

12.2.4 If shop inspection and testing have been specified, the purchaser and the vendor shall coordinate manufacturing hold points and inspector visits.

12.2.5 Unless otherwise specified, the vendor shall notify the purchaser not less than five working days before the date of any observed or witnessed testing.

12.2.5.1 For an observed inspection or test, the purchaser is notified of the timing of the inspection or test and the inspection or test is performed as scheduled if the purchaser or their representative is not present.

12.2.5.2 For a witnessed inspection or test, the purchaser is notified of the timing of the inspection or test and a hold is placed on the inspection or test until the purchaser or their representative is in attendance.

12.2.6 Equipment, materials, and utilities for the specified inspections and tests shall be provided by the vendor.

12.3 Inspection

12.3.1 It is the vendor's responsibility to determine what tests and inspection procedures, in addition to any specified in this standard or by the purchaser, are necessary to ensure that materials and finished components are satisfactory for the service. Since the specification for the actual component being inspected depends on metallurgy, component configuration, and method of manufacture, specific procedures and acceptance standards for the application should be covered by written documents, developed by the manufacturer for the specific application.

NOTE Standard tests and inspection techniques typically apply to a great variety of sizes, shapes, materials, and widely varying examination requirements.

12.3.2 The vendor shall keep the following data available for at least five years for examination or reproduction by the purchaser or their representative upon request:

a) certification of materials—at a minimum, mill test reports for all torque-transmitting components;

b) results of non-destructive tests;

c) results of documented tests and inspections, including fully identified records of all heat treatment (such as hardness verification) and radiography;

d) balance data in accordance with Section 9.

12.3.3 The vendor shall keep data sufficient to enable the reproduction of a functionally equivalent coupling available for at least 20 years. These data should include a general arrangement drawing, parts list, material specification list, and application data.

12.3.4 After final machining, all metallic torque-transmitting components, bolts, and other major parts, with the exception of multiple-membrane diaphragms and discs, manufactured from cold rolled strip shall be inspected by wet magnetic-particle, fluorescent, or dye-penetrant methods. Indications of cracks or other injurious defects shall be the basis for rejection of the affected part. Certification of conformance is required.

12.3.5 All welds shall receive 100 % surface and subsurface inspection after final treatment. Magnetic-particle or dye-penetrant methods shall be used for surface inspection. Ultrasonic or radiographic methods shall be used for subsurface inspection. All weld-inspection procedures shall be agreed by the purchaser and the vendor.

12.3.6 ● If specified, the purchaser's representative, the vendor's representative, or both, shall indicate compliance in accordance with an inspector's checklist such as that provided in Annex M by initialing, dating, and submitting the completed checklist to the purchaser before shipment.

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12.3.7 Periodic testing of the mechanical properties (such as ultimate tensile strength, yield strength, percentage elongation, and percentage area reduction) of sample materials after heat treatment shall be performed at least twice annually, and the results shall be documented. Unless otherwise specified, testing of these mechanical property requirements shall be per the vendor’s standard requirements based on international standards.

12.4 Testing

12.4.1 ● If specified, couplings identified in 8.12.1 shall be tested to verify the predicted axial natural frequency. The test technique shall be agreed by the purchaser and the vendor.

12.4.2 The purchaser's acceptance of shop tests does not constitute a waiver of the requirement to meet field-performance standards under specified operating conditions, and inspection by the purchaser does not relieve the vendor of responsibilities.

12.5 Preparation for Shipment

12.5.1 Before assembly and shipment, all surfaces of the coupling shall be cleaned and coated to prevent corrosion. Adequate instructions shall be provided for the removal of any temporary protective coating applied to the coupling components and any other preparation for operation. Any temporary protective coating that is applied to the bore of the hub shall have a tag indicating its existence and the recommended method of removal.

12.5.2 ● The purchaser shall specify the expected storage time and whether the storage location is to be indoors or outdoors.

12.5.3 ● The purchaser shall specify whether the packaging to be provided is for domestic or export shipping.

12.5.4 Packaging shall be adequate to prevent mechanical and corrosion damage during normal shipment and for the duration of the specified storage time.

12.5.5 ● Each coupling shall be properly identified by an item number and serial number stamped or etched on the coupling assembly (see 12.1.5). The container shall be marked with the information specified by the purchaser.

12.5.6 The vendor shall inscribe a serial number unique to the coupling on all of the coupling major separable parts.

12.5.7 The vendor shall inscribe the recommended bolt torques on each flange.

12.5.8 ● If specified, the purchaser may require the vendor to inscribe additional identifying markings; e.g., markings to indicate equipment train or location of the coupling within the train.

12.5.9 All special tooling provided in 11.2 shall be cleaned and coated to prevent corrosion. Adequate instructions shall be provided for the removal of any temporary protective coating applied to the coupling components and any other preparation for operation. Any temporary protective coating that is applied to the bore of the hub shall have a tag indicating its existence and the recommended method of removal.

13 Vendor’s Data

13.1 General

13.1.1 The purchaser may specify the content of proposals, meeting frequency, and vendor data content/format identified in Annex O. Annex O provides a general outline of information that potentially may be requested by the purchaser.

13.1.2 ● If specified, the information specified in Annex O shall be provided.

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Annex A
(informative)

Coupling Datasheets

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A.1 Datasheets in SI Units (3 Pages)

	Page 1 of 3
	Job No. ____ Item No. ____
	Purchase order No. ____ Date ____
COUPLING DATASHEET **API 671 5th Edition** **SI units**	Inquiry No. ____ By ____ Revision ____ Date ____

1 Note: Information to be completed ○ by Purchaser □ by Coupling manufacturer

2 Applicable to: ○ Proposal ○ Purchase ○ As built

3 ○ Owner: ____ No. required ____

4 Site: Service:

5 ○ Driver: Type ____ Manufacturer ____ Model ____

6 Nameplate power (kW) ____ Service factor ____ Serial No. ____ Tag. No. ____

7 ○ Driven unit: ____ Manufacturer ____ Model ____

8 Nameplate power (kW) ____ Serial No. ____ Tag. No. ____

9 Coupling type: ○ Flexible element ○ Gear ○ Quill shaft ○ Torsional Damp/Resilient ○ Other ____

10 □ Manufacturer: ____ Model ____ Size ____ Drawing Number ____

	○ CONDITIONS CONSIDERED FOR COUPLING SELECTION			□ RATINGS			
11–13	Conditions	Torque (N-m)	Speed r/min		Torque (N-m)	Speed r/min	Service Factor (using 7.1)
14	Steady state (normal) (6.6a)			Steady state (normal) (6.6a)			
15	Max driver power (3.1.30 & 6.6b)			Max driver pwr (3.1.30 & 6.6b)			
16	Rated (6.7)			Rated (6.7)			
17	Maximum transient (5.2 & 6.2p)			Peak (7.3)			X
18	Trip condition (6.2f)			Momentary (7.3)			X
19	Continuous cyclic (5.2 & 6.2p)			Shaft juncture driving (6.14)			X
20	Minimum operating speed (3.1.32 & 6.2e)	X		Shaft juncture driven (6.14)			X
21	Maximium continuous speed (3.1.29 & 6.2f)	X					
22	Other:						

23 ○ Frequency of transients (events/time) (6.2.p & 7.4.3) ____ ○ Non-synchronous exciting frequency (8.12.1) ____

24 ○ Number of starts (6.12) ____ ○ Period of Uninterrupted Operation (5.2.1) ____

25 ○ Minimum required coupling service factor (6.9) ____ Based on either: ○ Normal (6.6a) ○ Max Driver Power (6.6b) ○ Rated (6.7)

26 □ As designed coupling service factor (6.9) ____ (Based on purchaser's selection) ○ Other (6.10)

27 ○ Cyclic torque rating (7.4.3) ○ Coupling to shaft juncture (6.12)

28 ○ Allowable shaft unbalance (9.3.5.6, 9.3.6 or 9.3.7.4) ____ ○ Future Conditions (5.3) ____

29 ○ Ambient temperature (6.2k) (°F) Maximum ____ Minimum ____

30 Environment (10.3) (10.4) ○ Hydrogen chloride ○ Hydrogen sulfide ○ Other: ____

31 **LUBRICATION**

32 ○ Continuous (C.3.9 & C.3.10) ○ Batch (C.3.9) ○ Non-lubricated ○ Oil Spray (8.1.6)

33 ○ Viscocity (SSU) ____ @ ____ °C ○ Filtration (µm) ____

34 ○ Pressure (kPa) ____ ○ Temperature (°C) ____ □ Flow (l/s) ____

35 **COUPLING DATA**

36 ○ Shaft separation (including thermal growths), DBSE (mm):

37 @ Ambient temperature ____ In normal operation ____ @ maximum transient ____

38 ○ Motor float (mm.) ____ ○ Limited end float (mm.) (C.3.1) ____ ○ Spacer/non-spacer (B.2.11) ____

39 ○ Load transmission to contnue after flex-element failure (8.1.6) ○ Electrically insulated (8.11)

40 ○ Marine type required (C.3.3) ○ Flex-hub type required (C.3.3) ○ Torsional damping (B.2.6) ____ ○ Engagement (B.2.10) ____

41 ○ Required misalignment & displacement capability (6.2, 6.3, 6.4 & D.2.2) ○ Restrictions of elastomer in shear (B.2.7) ____

42 Steady state: Angular (DEG.) ____ Parallel offset (in.) ____ Axial (in.) ____ ○ Materials (B.4.1) ____

43 Transient: Angular (DEG.) ____ Parallel offset (in.) ____ Axial (in.) ____ ○ Life exp (B.5.3) ____

44 □ Maximium allowable misalignment (O.3.2.2.p)

45 Steady state: Angular (DEG.) ____ Parallel offset (mm) ____ Axial (mm) ____ Transient axial (mm) ____

46 Transient: Angular (DEG.) ____ Parallel offset (mm) ____ Axial (mm) ____ Transient axial (mm) ____

47 ○ Component balance (9.2.1) or ○ Component balance with assembly check balance (9.2.1 & 9.2.2)

48 or ○ Component balance with assembly balance (9.2.3 & 9.3.7) ○ Potential unbalance calc. Required

49 ○ Residual unbalance check of assembled coupling (9.3.8) ○ Balance repeatability check (9.3.9)

50 ○ Maximum allowable shaft unbalance (g·mm) (9.3.5.6, 9.3.6 & 9.3.7.4) Driver end ____ Driven end ____

51 □ Maximum allowable residual unbalance (g·mm) (9.3.6 & 9.3.7) Driver end ____ Driven end ____

52 □ Maximum actual residual unbalance (g·mm) (Annex G) Driver end ____ Driven end ____

53 □ Torsional stiffness (N·m/rad) (O.3.2.2.j) ____

54 □ Moment of inertia (kg·m^2) (O.3.2.2.i) Driver end ____ Driven end ____

55 □ Spacer lateral natural freq. (8.12.2 & O.3.2.2.k)

56 □ Torque capacity of hub/shaft interface for keyless fits (N·m) (O.3.2.2.s)

57 ○ List required of similar couplings (O.2.3.2.m)

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	Page 2 of 3
	Job No. ____ Item No. ____
COUPLING DATASHEET	Purchase order No. ____ Date ____
API 671 5th Edition	Inquiry No. ____ by ____
SI units	Revision Date

1 **COUPLING DATA (Continued)**

2 Flexible-element coupling :

3 ☐ Iinitial deflection (mm.) ____ ☐ Prestretch ☐ Compression ☐ Maximum axial deflection (mm) ____

4 ☐ Calculated axial natural freq., ANF (O.3.2.2.h) ____ ○ Test of ANF (12.4.1) ☐ Actual ANF ____

5 ☐ Maximum enclosure temperature at maximum continuous speed (°C) (O.3.2.3)

6 **MATERIALS (10.1)**

		Drive end materials	Driven end materials
7			
8	Hub/flange		
9	Spacer		
10	Sleeve		
11	Flexible element		
12	Flexible-element guard		
13	Bolts		
14	Nuts		

15 ○ Protective coating (10.6) ○ Vendor standard ○ Customer Specified ____

16 ☐ Internal teeth hardness (Rockwell C) (C.3.8) Driver end actual ____ Driven end actual ____

17 ☐ External teeth hardness (Rockwell C) (C.3.8) Driver end actual ____ Driven end actual ____

18 **COUPLING HUB MACHINING**

		Driver end	Driven end
19			
20	○ Type (integral, cylindrical, taper) (8.4 & 8.6.1.1)		
21	○ Keyed or hydraulically fitted (8.6.1.1 & 8.6.1.2)		
22	○ Taper (1 deg. Included angle, 1 : 24, 1 : 16.)		
23	(8.6.2.1, 8.6.2.2 & 8.6.2.3)		
24	☐ Keyway dimensions and number (8.6.3)		
25	☐ Nominal bore diameter (mm)		
26	☐ Interference fit (mm.) max/min. (8.6.1.3 & 8.6.1.4)		
27	☐ Alternative hub interference fit (mm) max/min (8.6.4)		
28	○ Puller holes (8.6.3.4)		
29	○ Trim balance holes (9.4)		

30 **COUPLING GUARD (Annex H)**

31	○ Coordinator (H.2.1) ____	○ Regulation (H.2.8) ____
32	○ Type (H.2.2 & H.2.6) ____	○ Internal Temp Calculation by (H.2.14) ____
33	○ Base mounted (H.3)	○ Purge gas ____ ○ Dry air purge (H.4.7)
34	○ Spark resistant (H.2.11) ○ Exp Atm (H.2.13)	☐ Purge connection size and type ____
35	○ Transparent window for each oil spray point (H.5.4)	☐ Purge rate required (m^3/h) ____
36	○ Vent connection (H.4.5)	○ Oil mist cooling ○ Gas Cooling
37	○ Dn 25 with filter/breather	○ Contract guard to be used during shop test (H.4.8)
38	○ Dn 25 flanged, rating and facing	○ Additional guard details ____

39 **ACCESSORIES**

40	○ One set of ring and plug gages by (11.2.5)	○ Hydraulic installation/removal tooling (to include hand pumps,
41	○ Coupling manufacturer ○ Purchaser	pressure gauge(s), fittings & hoses by: (11.2.1)
42	○ Drill template for integral flanged shaft ends by (8.5.1)	○ Coupling manufacturer ○ Purchaser
43	○ Coupling manufacturer ○ Purchaser	○ Puller by: (11.2.4)
44	○ Lapping tools by (11.2.6)	○ Coupling manufacturer ○ Purchaser
45	○ Coupling manufacturer ○ Purchaser	○ Idling adapter (Solo) plate by coupling manufacturer (8.7)
46	○ Two-piece stop rings by: (11.2.3)	○ Moment simulator by coupling manufacturer (8.8.1)
47	○ Coupling manufacturer ○ Purchaser	○ Torque Measuring System (11.3.1)
48		○ Supplier (11.3.2): ____

49	**APPLICABLE SPECIFICATIONS**	**PREPARATION FOR SHIPMENT**
50	○ API-671, Special purpose couplings	○ Outdoor storage for more than 3 months (12.5.2)
51	○ Keyless-fit design code ANSI/AGMA 9003 / DIN 7190	○ Expected storage time: ____
52		○ Shipping: ○ Domestic Storage: ○ Indoor
53	**MEETINGS / TESTING**	(12.5.3) ○ Export (12.5.2) ○ Outdoor
54	○ Information determined in (13.1.2)	○ Additional inscribed information (12.5.8) ____
55	○ Testing to be observed or witnessed (12.2.1)	○ See coupling purchase order for preservation, boxing,
56		and shipping instructions

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	Job No.	Item No.
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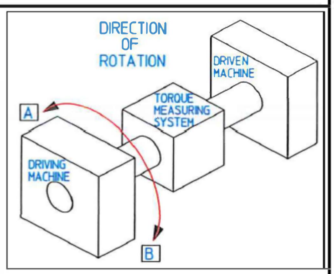
SI units		

Line	Group	Item	Torque Measuring System
1		TORQUE MEASURING SYSTEM	
2		☐ Manufacturer: ______ Model ______ Size ______ Assy. Dwg. No.	
3			
4		○ **CONDITIONS CONSIDERED FOR TORQUE MEASURING SYSTEM SELECTION(S) (11.3.1 & Annex L)**	
5			
6		Conditions to be Specified for Torque Measuring System	Torque Measuring System
7		Torque measuring system coupling location (between which machines?)	
8	L1	Normal Torque (Nm) to be measured (1% accuracy)	
9	L1	Maximum torque (Nm) to be measured	
10	L1	Maximum number of times maximum torque expected	
11	L1	Maximum torque components capability (Nm)	
12	L1	Minimum speed (RPM) at which torque measurement is required	
13	L1	Maximum speed (RPM) at which torque measurement is required	
14	L1	Which torque measurements are to be taken	
15	L2	System bandwdth minimum frequency system capable of resolving (Hz)	
16	L2	System bandwdth maximum frequency system capable of resolving (Hz)	
17	L2	Accuracy of torsional amplitude value (where different than stead state) (%)	
18	L2	Units of torsional amplitude value (where different than stead state)	
19	L2	Requirements for analog output	
20	L2	Visual display requirements	
21	L3	Machine movements from the cold installed postion to the hot running condition	
22	L3	Convention: State for each machine	
23	L3	Axial: (state direction and amount of movement)	
24	L3	Vertical: (state direction and amount of movement)	
25	L3	Horizontal: (state direction and amount of movement)	
26	L4	What is the requested accuracy for:	
27	L4	Maximum torque the system will display	
28	L4	Cyclic, maximum (or what) torque and frequencies	
29	L5	Advise if any rotordynamic restrictions apply such as torsional stiffness	
30	L6	Signal output	
31	L6	Requirements for analog output (if not 4 - 20 mA)	
32	L6	Requirements for visual display unit	
33	L6	Location of visual display unit	
34	L6	Ranges of output scaling for each parameter	
35	L6	Measurement requirement of negative torque (same direction of rotation)	
36	L6	Maximum allowable temperature for components within coupling guard (Deg C)	
37	L 7	Calibration temperature compensation range (Deg C)	
38	L9	Electro-magnetic interference (noise) specific requirements	
39	L10	Rotation and power flow - specify A or B from diagram below	
40	L10	Spare components, shafts or system desired	
41	L11	Advise if torque measuring system is incorporated into the safety trip loop	

Line	AREA CLASSIFICATION				POWER
43	○ ELEC. AREA CLASS.	○ NEC	○ IEC	○ ATEX	○ Available: Volts
44		○ FM	○ GOST	○ IECEx	Hertz
45		○ CEC	○ Other:		Cycles
46					
47	EQUIPMENT	INDOOR	OUTDOOR		
48	CLASS	GROUP	DIVISION		
49	ZONE	GROUP	TEMP CLASS		☐ Usage: Volts
50	VISUAL DISPLAY UNIT	INDOOR	OUTDOOR		Hertz
51	CLASS	GROUP	DIVISION		Cycles
52	ZONE	GROUP	TEMP CLASS		
53					☐ Power Consumption
54					Wattage -------------
55					Rotation:
56					☐ Other Requirements — "A" ○
57					"B" ○
58					



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A.2 Datasheets in U.S. Customary Units (3 Pages)

COUPLING DATASHEET API 671 5th Edition USC units	Page 1 of 3 Job No. ____ Item No. ____ Purchase order No. ____ Date ____ Inquiry No. ____ By ____ Revision ____ Date ____

1 Note: Information to be completed ○ by Purchaser ☐ by Coupling manufacturer

2 Applicable to: ○ Proposal ○ Purchase ○ As built

3 ○ Owner: ____ No. required ____

4 Site: Service:

5 ○ Driver: Type ____ Manufacturer ____ Model ____

6 Nameplate power (HP) ____ Service factor ____ Serial No. ____ Tag. No. ____

7 ○ Driven unit: ____ Manufacturer ____ Model ____

8 Nameplate power (HP) ____ Serial No. ____ Tag. No. ____

9 Coupling type: ○ Flexible element ○ Gear ○ Quill shaft ○ Torsional Damp/Resilient ○ Other ____

10 ☐ Manufacturer: ____ Model ____ Size ____ Drawing Number ____

	○ CONDITIONS CONSIDERED FOR COUPLING SELECTION			☐ RATINGS			
11–13	Conditions	Torque (in-lb)	Speed r/min		Torque (in-lb)	Speed r/min	Service Factor (using 7.1)
14	Steady state (normal) (6.6a)			Steady state (normal) (6.6a)			
15	Max driver power (3.1.30 & 6.6b)			Max driver pwr (3.1.30 & 6.6b)			
16	Rated (6.7)			Rated (6.7)			
17	Maximum transient (5.2 & 6.2p)			Peak (7.3)			X
18	Trip condition (6.2f)			Momentary (7.3)			X
19	Continuous cyclic (5.2 & 6.2p)			Shaft juncture driving (6.14)			X
20	Minimum operating speed (3.1.32 & 6.2e)	X		Shaft juncture driven (6.14)			X
21	Maximium continuous speed (3.1.29 & 6.2f)	X					
22	Other:						

23 ○ Frequency of transients (events/time) (6.2.p & 7.4.3) ____ ○ Non-synchronous exciting frequency (8.12.1) ____

24 ○ Number of starts (6.12) ____ ○ Period of Uninterrupted Operation (5.2.1) ____

25 ○ Minimum required coupling service factor (6.9) ____ Based on either: ○ Normal (6.6a) ○ Max Driver Power (6.6b) ○ Rated (6.7)

26 ☐ As designed coupling service factor (6.9) ____ (Based on purchaser's selection) ○ Other (6.10)

27 ○ Cyclic torque rating (7.4.3) ○ Coupling to shaft juncture (6.12)

28 ○ Allowable shaft unbalance (9.3.5.6, 9.3.6 or 9.3.7.4) ____ ○ Future Conditions (5.3) ____

29 ○ Ambient temperature (6.2k) (°F) Maximum ____ Minimum ____

30 Environment (10.3) (10.4) ○ Hydrogen chloride ○ Hydrogen sulfide ○ Other: ____

31 **LUBRICATION**

32 ○ Continuous (C.3.9 & C.3.10) ○ Batch (C.3.9) ○ Non-lubricated ○ Oil Spray (8.1.6)

33 ○ Viscocity (SSU) ____ @ ____ °F ○ Filtration (μm) ____

34 ○ Pressure (psi) ____ ○ Temperature (°F) ____ ☐ Flow (gpm) ____

35 **COUPLING DATA**

36 ○ Shaft separation (including thermal growths), DBSE (in):

37 @ Ambient temperature ____ In normal operation ____ @ maximum transient ____

38 ○ Motor float (in.) ____ ○ Limited end float (in.) (C.3.1) ____ ○ Spacer/non-spacer (B.2.11) ____

39 ○ Load transmission to contnue after flex-element failure (8.1.6) ○ Electrically insulated (8.11)

40 ○ Marine type required (C.3.3) ○ Flex-hub type required (C.3.3) ○ Torsional damping (B.2.6) ____ ○ Engagement (B.2.10) ____

41 ○ Required misalignment & displacement capability (6.2, 6.3, 6.4 & D.2.2) ○ Restrictions of elastomer in shear (B.2.7) ____

42 Steady state: Angular (DEG.) ____ Parallel offset (in.) ____ Axial (in.) ____ ○ Materials (B.4.1) ____

43 Transient: Angular (DEG.) ____ Parallel offset (in.) ____ Axial (in.) ____ ○ Life exp (B.5.3) ____

44 ☐ Maximium allowable misalignment (O.3.2.2.p)

45 Steady state: Angular (DEG.) ____ Parallel offset (in.) ____ Axial (in.) ____ Transient axial (in.) ____

46 Transient: Angular(DEG.) ____ Parallel offset (in.) ____ Axial (in.) ____ Transient axial (in.) ____

47 ○ Component balance (9.2.1) or ○ Component balance with assembly check balance (9.2.1 & 9.2.2)

48 or ○ Component balance with assembly balance (9.2.3 & 9.3.7) ○ Potential unbalance calc. Required

49 ○ Residual unbalance check of assembled coupling (9.3.8) ○ Balance repeatability check (9.3.9)

50 ○ Maximum allowable shaft unbalance (oz·in) (9.3.5.6, 9.3.6 & 9.3.7.4) Driver end ____ Driven end ____

51 ☐ Maximum allowable residual unbalance (oz·in) (9.3.6 & 9.3.7) Driver end ____ Driven end ____

52 ☐ Maximum actual residual unbalance (oz·in) (Annex G) Driver end ____ Driven end ____

53 ☐ Torsional stiffness (in·lb/rad) (O.3.2.2.j) ____

54 ☐ Moment of inertia (lb·in^2) (O.3.2.2.i) Driver end ____ Driven end ____

55 ☐ Spacer lateral natural freq. (8.12.2 & O.3.2.2.k) ____

56 ☐ Torque capacity of hub/shaft interface for keyless fits (in-lb) (O.3.2.2.s)

57 ○ List required of similar couplings (O.2.3.2.m)

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	Job No. ______ Item No. ______
COUPLING DATASHEET	Purchase order No. ______ Date ______
API 671 5th Edition	Inquiry No. ______ by ______
USC units	Revision ______ Date ______

1 **COUPLING DATA (Continued)**

2 Flexible-element coupling :

3 ☐ Iinitial deflection (in.) ______ ☐ Prestretch ☐ Compression ☐ Maximum axial deflection (in) ______

4 ☐ Calculated axial natural freq., ANF (O.3.2.2.h) ______ ○ Test of ANF (12.4.1) ☐ Actual ANF ______

5 ☐ Maximum enclosure temperature at maximum continuous speed (°F) (O.3.2.3)

6 **MATERIALS (10.1)**

7		Drive end materials	Driven end materials
8	Hub/flange		
9	Spacer		
10	Sleeve		
11	Flexible element		
12	Flexible-element guard		
13	Bolts		
14	Nuts		

15 ○ Protective coating (10.6) ○ Vendor standard ○ Customer Specified ______

16 ☐ Internal teeth hardness (Rockwell C) (C.3.8) Driver end actual ______ Driven end actual ______

17 ☐ External teeth hardness (Rockwell C) (C.3.8) Driver end actual ______ Driven end actual ______

18 **COUPLING HUB MACHINING**

19		Driver end	Driven end
20	○ Type (integral, cylindrical, taper) (8.4 & 8.6.1.1)		
21	○ Keyed or hydraulically fitted (8.6.1.1 & 8.6.1.2)		
22	○ Taper (1 deg. Included angle, 1 : 24, 1 : 16.)		
23	(8.6.2.1, 8.6.2.2 & 8.6.2.3)		
24	☐ Keyway dimensions and number (8.6.3)		
25	☐ Nominal bore diameter (in)		
26	☐ Interference fit (in) max/min. (8.6.1.3 & 8.6.1.4)		
27	☐ Alternative hub interference fit (in) max/min (8.6.4)		
28	○ Puller holes (8.6.3.4)		
29	○ Trim balance holes (9.4)		

30 **COUPLING GUARD (Annex H)**

31	○ Coordinator (H.2.1) ______	○ Regulation (H.2.8) ______
32	○ Type (H.2.2 & H.2.6) ______	○ Internal Temp Calculation by (H.2.14) ______
33	○ Base mounted (H.3)	○ Purge gas ______ ○ Dry air purge (H.4.7)
34	○ Spark resistant (H.2.11) ○ Exp Atm (H.2.13)	☐ Purge connection size and type ______
35	○ Transparent window for each oil spray point (H.5.4)	☐ Purge rate required (cfm) ______
36	○ Vent connection (H.4.5)	○ Oil mist cooling ○ Gas Cooling
37	○ 1 in. with filter/breather	○ Contract guard to be used during shop test (H.4.8)
38	○ 1 in. flanged, rating and facing	○ Additional guard details ______

39 **ACCESSORIES**

40	○ One set of ring and plug gages by (11.2.5)	○ Hydraulic installation/removal tooling (to include hand pumps,
41	○ Coupling manufacturer ○ Purchaser	pressure gauge(s), fittings & hoses by: (11.2.1)
42	○ Drill template for integral flanged shaft ends by (8.5.1)	○ Coupling manufacturer ○ Purchaser
43	○ Coupling manufacturer ○ Purchaser	○ Puller by: (11.2.4)
44	○ Lapping tools by (11.2.6)	○ Coupling manufacturer ○ Purchaser
45	○ Coupling manufacturer ○ Purchaser	○ Idling adapter (Solo) plate by coupling manufacturer (8.7)
46	○ Two-piece stop rings by: (11.2.3)	○ Moment simulator by coupling manufacturer (8.8.1)
47	○ Coupling manufacturer ○ Purchaser	○ Torque Measuring System (11.3.1)
48		○ Supplier (11.3.2): ______
49	**APPLICABLE SPECIFICATIONS**	**PREPARATION FOR SHIPMENT**
50	○ API-671, Special purpose couplings	○ Outdoor storage for more than 3 months (12.5.2)
51	○ Keyless-fit design code ANSI/AGMA 9003 / DIN 7190	○ Expected storage time: ______
52		○ Shipping: ○ Domestic Storage: ○ Indoor
53	**MEETINGS / TESTING**	(12.5.3) ○ Export (12.5.2) ○ Outdoor
54	○ Information determined in (13.1.2)	○ Additional inscribed information (12.5.8) ______
55	○ Testing to be observed or witnessed (12.2.1)	○ See coupling purchase order for preservation, boxing,
56		and shipping instructions

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COUPLING DATASHEET	Inquiry No. ____ By ____
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USC units	

TORQUE MEASURING SYSTEM

☐ Manufacturer: ____ Model ____ Size ____ Assy. Dwg. No.

○ CONDITIONS CONSIDERED FOR TORQUE MEASURING SYSTEM SELECTION(S) (11.3.1 & Annex L)

	Conditions to be Specified for Torque Measuring System	Torque Measuring System
	Torque measuring system coupling location (between which machines?)	
L1	Normal Torque (in lb) to be measured (1% accuracy)	
	Maximum torque (in lb) to be measured	
	Maximum number of times maximum torque expected	
	Maximum torque components capability (in lb)	
	Minimum speed (RPM) at which torque measurement is required	
	Maximum speed (RPM) at which torque measurement is required	
	Which torque measurements are to be taken	
L2	System bandwdth minimum frequency system capable of resolving (Hz)	
	System bandwdth maximum frequency system capable of resolving (Hz)	
	Accuracy of torsional amplitude value (where different than stead state) (%)	
	Units of torsional amplitude value (where different than stead state)	
	Requirements for analog output	
	Visual display requirements	
L3	Machine movements from the cold installed postion to the hot running condition	
	Convention:State for each machine	
	Axial: (state direction and amount of movement)	
	Vertical: (state direction and amount of movement)	
	Horizontal: (state direction and amount of movement)	
L4	What is the requested accuracy for:	
	Maximum torque the system will display	
	Cyclic, maximum (or what) torque and frequencies	
L5	Advise if any rotordynamic restrications apply such as torsional stiffness	
L6	Signal output	
	Requirements for analog output (if not 4 - 20 mA)	
	Requirements for visual display unit	
	Location of visual display unit	
	Ranges of output scaling for each parameter	
	Measurement requirement of negative torque (same direction of rotation)	
	Maximum allowable temperature for components within coupling guard (Deg F)	
L7	Calibration temperature compensation range (Deg F)	
L9	Electro-magnetic interference (noise) specific requirements	
L10	Rotation and power flow - specify A or B from diagram below	
	Spare components, shafts or system desired	
L11	Advise if torque measuring system is incorporated into the safety trip loop	

AREA CLASSIFICATION

○ ELEC. AREA CLASS. ○ NEC ○ IEC ○ ATEX ○ FM ○ GOST ○ IECEx ○ CEC ○ Other:

EQUIPMENT		INDOOR		OUTDOOR	
CLASS		GROUP		DIVISION	
ZONE		GROUP		TEMP CLASS	
VISUAL DISPLAY UNIT		INDOOR		OUTDOOR	
CLASS		GROUP		DIVISION	
ZONE		GROUP		TEMP CLASS	

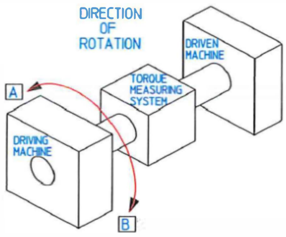
POWER

○ Available — Volts ____ Hertz ____ Cycles ____

☐ Usage — Volts ____ Hertz ____ Cycles ____

☐ Power Consumption
Wattage ____________

☐ Other Requirements



Rotation:
"A" ○
"B" ○

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Annex B
(normative)

Torsional Damping Couplings and Resilient Couplings

B.1 General

B.1.1 The requirements of this annex apply to torsional damping and resilient couplings, and replace the requirements in 8.1, except that the requirements of 8.1.4 shall apply.

B.1.2 Torsional damping and resilient couplings are used in equipment trains in which potentially harmful torsional excitations occur during transient or continuous operation. Because of the unique, specialized nature of these couplings and the applications for which they are suited, they are treated in a tutorial manner in this annex.

B.1.3 ● The purchaser shall specify if it is necessary to use a resilient coupling.

B.2 Basic Design

B.2.1 Torsional damping couplings and resilient couplings limit cyclic torque of coupled machinery by dissipating energy into one or more flexing elements. Generally, these couplings are applied to the lowest-speed shaft in an equipment train, and are, therefore, usually classified as low-speed. If some of the torsional natural frequencies of an equipment train fall below the running speed of the train (a normal occurrence), it is necessary that the train pass through these natural frequencies during startup and again during normal or emergency shutdown.

B.2.2 Torsional damping couplings and resilient couplings are available with either metallic or elastomeric flexing elements. Some couplings with spring steel as the flexing element can be filled with oil to provide a high degree of viscous damping by oil displacement. Generally, couplings with elastomeric flexing elements exhibit lower torsional stiffness and higher damping capability than do those with metallic flexing elements. Torsional damping couplings and resilient couplings are usually used on the low-speed side of a drive-train and are often used in combination with another type of coupling (gear, disc, or diaphragm). This combination may be used for several reasons, such as to accommodate axial movement and to reduce the mass (usually on the shaft-end of the driven equipment).

If a resilient coupling is used in conjunction with a metallic flexible element, (disc or diaphragm), or gear or quill-shaft coupling, those parts shall be in accordance with the appropriate section of this standard.

B.2.3 Unless otherwise agreed, initial sizing shall have a service factor of 3.0 based on the steady-state torque in 6.6 and comparing this to the peak capacity of the coupling. These couplings are usually sized based on transient/peak torques that are determined by doing a detailed system analysis. The peak capacity of the elastomeric flexible element of the coupling shall be greater than the calculated transient/peak torque by 1.15. The momentary torque rating of the elastomeric flexible element of the coupling shall be greater than the very infrequent high-transient torque. All other components (bolts, hubs, spacers) shall comply with the requirements of 7.3 and 7.4.

B.2.4 The coupling damping shall be sufficient to reduce torsional vibration stresses in the machinery train to a safe level.

B.2.5 ● The purchaser shall specify any material constraints regarding flexible elements.

B.2.6 ● The purchaser shall specify minimum requirements for torsional damping and the allowable range of torsional stiffness for the coupling.

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B.2.7 ● The purchaser shall specify any restrictions regarding the use of elastomers in shear.

B.2.8 Couplings that use elastomers in compression shall be designed to accommodate the resultant Poisson expansion in the axial direction.

B.2.9 Elastomeric elements shall be designed to dissipate the required vibrational energy without overheating.

B.2.10 ● The purchaser shall specify whether the coupling is a single or double engagement type, based on misalignment requirements.

B.2.11 ● The purchaser shall specify whether the coupling is a spacer or non-spacer type, taking the maintenance requirements of the coupled equipment into consideration.

B.2.12 ● If a spacer is used, the purchaser shall specify the length of spacer..

B.2.13 Fits shall be to the manufacturer's standard to meet the balance and interface connection requirements. The requirements of 8.9 do not apply.

B.2.14 The surface finish of the components of the couplings may be to the manufacturer's standard, provided that the coupling meets the design requirements and balance requirements of this standard.

B.2.15 The lateral natural frequency (N_c) of that portion of the coupling between and including the resilient elements (or combination of resilient and flexing elements, if appropriate), assuming infinitely stiff supports, shall be at least two times the highest specified operating speed for the uniform-tube-equation methodology as specified in ANSI/AGMA 9004-B08 or ANSI/AGMA 9104-A06, or at least 1.5 times the highest specified operating speed, using a more rigorous analysis based on actual geometry (i.e., finite-element analysis). The purchaser and vendor shall agree who shall perform these calculations and the assumptions used.

NOTE The actual lateral frequency of the coupling is affected by the stiffness of any flange adapter(s) and shaft extension(s). The calculation to determine this actual number is complex. B.2.14 establishes a default value to use if little else is known, such as during the proposal stages of a design.

B.2.16 Temperature, cyclic torque, and its frequency shall be included in the rating of the coupling as stated in 7.1.

B.3 Balance

B.3.1 Unless otherwise specified, the resilient coupling, including any part of a metallic flexible-element coupling or a gear coupling, shall be balanced by balancing the individual components to limits set in 9.3.5. Separate elastomeric, flexible elements shall be mass-balanced to a tolerance of 0.1 g (0.0035 oz).

B.3.2 ● If specified, the coupling shall be check-balanced and/or assembly balanced. Assembly-balance check limits and balance limits shall be agreed by the purchaser and the vendor.

B.4 Materials of Construction

B.4.1 ● The materials of construction, including elastomers, shall be agreed by the purchaser and the vendor. The purchaser shall specify pertinent operating conditions (including environmental conditions), such as temperature, corrosiveness of the atmosphere, and airborne abrasives.

B.4.2 Hubs, sleeves, and spacers shall preferably be forged. Welded spacers are acceptable. Ductile iron construction is permissible but gray cast iron is not acceptable.

B.4.3 The requirements of Section 10, except that of 10.5, shall apply.

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B.5 Vendor's Data

B.5.1 The vendor shall state the relationship between the coupling steady state torque, speed, the coupling maximum continuous angular misalignment, and the coupling maximum continuous axial displacement as a function of temperature, cyclic torque, and its frequency, if the rated maximum values of each cannot be accepted simultaneously.

B.5.2 For couplings with nonlinear torsional stiffness, the vendor shall supply a curve or tabulation of deflection versus torque and instantaneous values of equivalent viscous damping. Where applicable, the effects of temperature, speed, and frequency of vibration shall be taken into consideration.

B.5.3 ● If specified, the vendor shall state the life expectancy of the elastomeric elements if they are operating at the specified conditions (including environmental conditions).

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Annex C
(normative)

Gear Couplings

C.1 General

C.1.1 The requirements of this annex apply to gear couplings and replace the requirements of 8.1.

C.1.2 Gear couplings are not normally recommended for new applications. Possible exceptions are:

a) if large axial displacements are not practical to accommodate with metallic flexible-element couplings (disc or diaphragms);

b) where the diameter of the coupling is restricted and a gear coupling, because of its high power density, is the only type of coupling that fits into the system.

C.1.3 ● The purchaser shall specify if it is necessary to use a gear coupling.

C.2 Coupling Selection

C.2.1 The coupling shall be selected based on the equipment loading and shall be capable of transmitting the maximum steady-state torques, continuous cyclic torques, and maximum transient torques under all conditions of angular misalignment, axial displacement, speed, and temperature, simultaneously, to which it will be subjected in service.

C.2.2 Unless otherwise specified, the gear coupling shall be rated using a service factor of 1.75 based on the steady-state torque in 6.6.

NOTE This factor of 1.75 has been found by experience to be satisfactory for gear couplings in typical turbomachinery applications. It is different from the recommended service factor of 1.5 for metallic flexible-element couplings. The metallic flexible-element couplings are treated more precisely by having a coupling flexible-element factor of safety, for use in addition to the equipment service factor.

C.2.3 Where appropriate, a reduced service factor may be applied as outlined in 6.9.

C.3 Coupling Design

C.3.1 ● The purchaser shall specify the maximum axial displacements that the coupling is expected to experience, expressed as the amount and direction of the movement of the shaft ends toward or away from each other as the coupled machines go through their startup, normal operation, and shutdown cycle. These dimensions shall be given from the position of the machine under non-operating, ambient conditions. Unless otherwise specified, the total axial displacement the coupling shall be capable of accepting shall be not less than 6 mm (1/4 in.). The purchaser shall specify limited-end-float design, if required, by the equipment train.

A limited-end-float coupling is one in which the axial displacement is positively prevented from exceeding a specific value.

C.3.2 All gear couplings shall be the double-engagement type.

C.3.3 ● The purchaser shall specify whether the coupling shall have the external teeth on the hub (constituting a flex-hub coupling) or on the spacer (sometimes referred to as a marine-type coupling).

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C.3.4 The coupling design shall ensure that all components are positively centered.

C.3.4.1 The gear meshes shall be centered at the crown diameter of the external teeth and at the root diameter of the internal teeth.

C.3.4.2 The crown clearance of the tooth diameter shall be the maximum clearance possible that maintains the specified balance. On flex-hub couplings, the crown clearance shall allow for radial stretch resulting from the hub-to-shaft interference fit.

The root diameter is the diameter of the root circle of the internal teeth.

C.3.5 For hubs in couplings to operate at speeds greater than 1800 rev/min, pilot fits at gear-coupling teeth shall be concentric to the bore within 0.00008 mm/mm TIR (0.001 in./ft TIR) of diameter or 0.013 mm (0.0005 in.) TIR, whichever is greater. For couplings operating at 1800 rev/min or less, fits are required to meet only the balance tolerance.

C.3.6 For sleeves in couplings to operate at speeds greater than 1800 rev/min, pilot fits at gear coupling teeth shall be concentric to the rabbet within 0.00008 mm/mm TIR (0.001 in./ft TIR) of diameter or 0.025 mm (0.001 in.) TIR, whichever is greater. Pilot fits shall be round within 0.00016 mm/mm TIR (0.002 in./ft TIR) of diameter or 0.038 mm (0.0015 in.) TIR, whichever is greater. For couplings operating at 1800 rev/min or less, fits are required to meet only the balance tolerance.

C.3.7 The involute tooth form shall be used. External teeth shall be relieved or chamfered at the tips and edges to provide the required misalignment capability and torque capacity. The amount of backlash in the mesh—the gear tooth circumferential clearance—shall be held to the minimum value commensurate with the vendor's stated maximum permissible misalignment.

C.3.8 The hardness of the gear teeth shall be at least 45 on the Rockwell C (Rc) scale. The hardness of the teeth with the greater face width (generally the sleeve teeth) shall be greater than or equal to the hardness of the mating teeth.

C.3.9 ● If specified, couplings shall be designed for batch lubrication. Otherwise, couplings shall be designed for continuous lubrication.

C.3.10 ● To minimize the accumulation of foreign material and excessive temperature rise, continuously lubricated couplings shall be of flooded mesh design and designed to minimize the accumulation of sludge. Each gear mesh shall be fed separately with filtered oil. The purchaser shall specify the viscosity, pressure, temperature, and degree of filtration of the oil supply (to be provided by others). The vendor shall state the rate of oil flow that the coupling requires.

C.4 Vendor Data

The following data shall be supplied in addition to that required by Section 13:

a) lube-oil and cooling-system requirements for the coupling, if applicable;

b) axial force at steady-state torque at the assumed coefficient of friction;

c) bending moment at steady-state torque and rated misalignment at the assumed coefficient of friction;

c) type and quantity of lubricant, and size and orientation of lubricant spray nozzles, if supplied.

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Annex D
(normative)

Quill-shaft Couplings

D.1 General

D.1.1 The requirements of this annex apply to quill-shaft couplings and replace the requirements of 8.1.

D.1.2 ● The purchaser shall specify whether a quill-shaft coupling shall be supplied.

D.1.3 Quill-shaft couplings shall not be used between two shafts that are both constrained by thrust bearings. However, quill-shaft couplings may be combined with one of the other types of coupling to overcome the inherent inability to accommodate axial displacement.

D.2 Coupling Selection and Design

D.2.1 The coupling shall be selected based on the equipment loading and shall be capable of transmitting the maximum steady-state torques, continuous cyclic torques, and the maximum transient torques under all conditions of angular misalignment, speed, and temperature, simultaneously, to which it will be subjected in service.

D.2.2 ● The purchaser shall specify the maximum misalignments the coupling is expected to experience during startup, normal operation, and shutdown of the coupled machines, normally expressed as parallel (or lateral) offset and/or angular misalignment between the coupled shafts. These values shall allow for all the known effects on the machines from thermal, pressure, and dynamic forces.

D.2.3 The lateral natural frequency (N_c) of the coupling, assuming infinitely stiff supports, shall be at least two times the highest specified operating speed for the uniform tube equation methodology as specified in ANSI/AGMA 9004-B08 or ANSI/AGMA 9014-A06, or at least 1.5 times the highest specified operating speed using a more rigorous analysis based on actual geometry (i.e., finite-element analysis). The purchaser and vendor shall agree who shall perform these calculations and the assumptions used.

NOTE The actual lateral frequency of the coupling is affected by the stiffness of any flange adapter(s) and shaft extension(s). The calculation to achieve this actual number is complex. D.2.3 establishes a default value to use if little else is known, such as in the proposal stages of a design.

D.2.4 Unless otherwise specified, the quill-shaft coupling shall be rated using a service factor of 1.5 based on the steady-state torque in 6.6.

D.2.5 Unless otherwise specified, quill shafts shall have integral end flanges.

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Annex E
(informative)

Factors for Couplings

E.1 Service Factors

A service factor is the additional capability built into a component. The service factor of a coupling is a ratio of the coupling's continuous torque rating as compared to the required operating torque. This service factor allows for various modes of off-design operation of the equipment, such as torsional cycles, unequal load sharing, changes in the conditions of fluid or compressed gas, blade fouling, or driver output at maximum conditions. It is a factor to account for unknown or little-understood changes in load that a coupling can experience.

E.1.1 Coupling Service Factor

a) API 671 default service factors for the coupling are identified in 6.8.

   The default coupling design is per the greater of 6.6a or 6.6b. The service factors for both 6.6a and 6.6b are identified within 6.6. In addition to the requirements of 6.6, the coupling vendor will also ensure that the other torque requirements, such as those due to transients as identified in 5.2, are within the coupling's design.

b) If the purchaser decides to select a service factor per 6.9, the basis of this service factor has to be identified.

c) The purchaser may choose to base the coupling's rating on the torque required by the driven machine at a purchaser's operating point per 6.7. If the purchaser's specified operating point is selected, the coupling's service factor will be based of the purchaser's specified operating point instead of the normal operating point.

   NOTE The resulting service factor based on the purchaser's specified operating point can be less than the service factor based on the normal operating point.

d) The purchaser may determine that the conditions identified in 6.10 allow or require that the service factor be reduced for flexible metallic couplings, but not less than 1.2.

The service factor for the selected coupling from the coupling vendor is to be identified to the purchaser along with the basis of this service factor value.

E.1.2 Coupling to Shaft Juncture Service Factor

The service factor for the coupling to shaft juncture is identified in 6.14. In addition to the requirements of 6.14, the coupling vendor will also ensure that the other torque requirements, such as those identified in 6.11, 6.12, and 6.15, are within the coupling's design.

NOTE The shaft-end diameter has a great influence on this torque capacity.

E.2 Factors of Safety

The safety of the coupling design is covered by the coupling factors of safety.

The methods used by coupling manufacturers to rate a coupling for continuous operation are described in 7.1 and 7.2. This establishes the minimum fatigue factor of safety and the methods for applying them to recognized

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material properties (i.e., fatigue strength, yield strength, and ultimate tensile strength). This methodology standardizes the basis for published continuous ratings, so that different manufacturers' ratings can be compared on a more equivalent basis.

In 7.3, the minimum factor of safety with respect to the material yield strength for transient and momentary coupling limits is described.

This standard does not address the details of the design, such as equations or analysis used to derive the stresses or how these stresses are combined. This information is often considered proprietary and, as such, is not normally made available to the purchaser except by special agreement. As to how these stresses are derived and combined, a certain level of confidence is required in each coupling manufacturer based on experience with their product.

E.3 Typical Fatigue Diagram (metallic element couplings)

Figure E.1 is a typical fatigue diagram incorporating a modified Goodman diagram and a constant life curve.

The fatigue factor of safety can be defined as the length of the line from the origin to either the modified Goodman diagram or the constant life curve, divided by the length of the line from the origin to the combined stress point, i.e., the line segment 0 - 4 divided by the line segment 0 - 3 in Figure E.1.

The fatigue factor of safety is then compared to the minimum requirement outlined in 7.2 to determine whether it is acceptable.

NOTE This factor of safety is not related to a defined equipment operating point; it is for the combination of maximum ratings published in a catalog or stated on the coupling contract drawing. The actual factor of safety for an equipment operating point is typically much greater.

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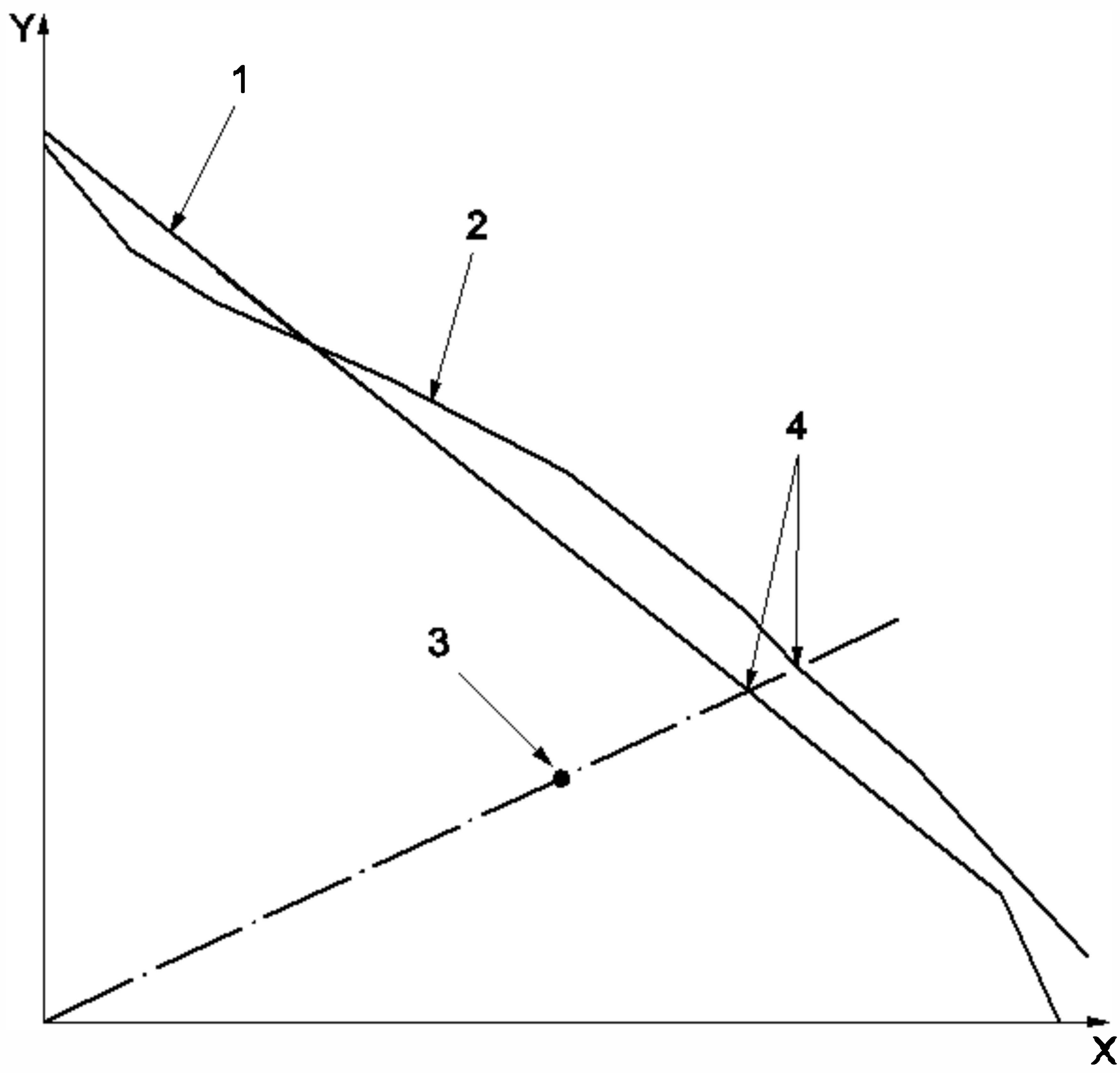

Key

X constant stress
Y alternating stress
1 typical modified Goodman diagram
2 typical constant life curve
3 combined stress point
4 intersection of line extending from the origin through the combined stress point to the modified Goodman diagram or the constant life curve

Figure E.1—Typical Fatigue Diagram

E.4 Example of T_s for 6.6, Methods a and b

See Figure E.2 for an example of T_S for Method b (6.5).

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Figure E.2—Example of Coupling Arrangement

Assumptions:

i) Metallic flexible coupling

ii) $N_{normal} = N_{rated}$ = 100 % speed = 4670 RPM

iii) Driver maximum power (per 3.1.31):

P_{driver} = 35,000 KW (46936 HP)

iv) Gearbox:

Assume no power consumption for this example

Assume ratio of 1.0

v) Compressor 1:

P_{normal} = 7000 KW (9387 HP)

vi) Compressor 2:

P_{normal} = 10,000 KW (13410 HP)

vii) Compressor 3:

P_{normal} = 9000 KW (12069 HP)

viii) Total absorbed P_{normal} (sum for compressors 1, 2, and 3) =

7000 + 10,000 + 9000 = 26,000 KW

(9387 + 13,410 + 12,069 = 34,866 HP)

ix) Therefore:

Compressor 1 (%) of total absorbed P_{normal} =

(7000 KW / 26,000 KW) × 100 = 26.9 %

(9387 HP / 34,866 HP) × 100 = 26.9 %

Compressor 2 (%) of total absorbed P_{normal} =

(10,000 KW / 26,000 KW) × 100 = 38.5%

(13,410 HP / 34,866 HP) × 100 = 38.5 %

Compressor 3 (%) of total absorbed P_{normal} =

(9000 KW / 26,000 KW) × 100 = 34.6 %

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(12,069 HP / 34,866 HP) × 100 = 34.6 %

For couplings A and B selection:

Method a:

$T_s = T_n$ x 1.5 = (9550 × (7000 + 10,000 + 9000) / 4670) x 1.5 = 53,169 x 1.5 = 79754 Nm

$T_s = T_n$ x 1.5 = (63,000 × (9387 + 13,410 + 12,069) / 4670) x 1.5 = 470,355 x 1.5 = 705,533 inch-pound force

Method b (proportioned):

$T_s = T_d$ x 1.2 = (9550 x 35,000 / 4670) x 1.2 = 71,574 x 1.2 = 85,889 Nm

$T_s = T_d$ x 1.2 = (63,000 x 46,936 / 4670) x 1.2 = 633,189 x 1.2 = 759820 inch-pound force

For coupling C selection:

Method a:

$T_s = T_n$ x 1.5 =(9550 x (10,000 + 9000) / 4670) x 1.5 = 38,854 x 1.5 = 58,282 Nm

$T_s = T_n$ x1.5 = (63,000 x (13,410 + 12,069) / 4670) x 1.5 = 343,720 x 1.5 = 515,581 inch-pound force

Method b (proportioned):

Compressor 2 (%) + Compressor 3 (%) = (38.5 + 34.6) = 73.1 % ® P_{driver} = 35,000 x 0.731 = 25,585 KW

= 46,936 x 0.731 = (34,310 HP)

$T_s = T_d$ x 1.2 = (9550 x 25,585 / 4670) x 1.2 = 52,320.5 x 1.2 = 62,785 Nm

$T_s = T_d$ x 1.2 = (63,000 x 34,310 / 4670) x 1.2 = 462,854 x 1.2 = 555,425 inch-pound force

For coupling D selection:

Method a:

$T_s = T_n$ x 1.5 = (9550 x 9000 / 4670) x 1.5 = 18,405 x 1.5 = 27,607 Nm

$T_s = T_n$ x 1.5 = (63,000 x 12,069 / 4670) x 1.5 = 162,815 x 1.5 = 244,223 inch-pound force

Method b (proportioned):

Compressor 3 (%) = 34.6 % ® P_{driver} = 35,000 x 0.346 = 12,110 KW

= 46,936 x 0.346 = 16,240 HP

$T_s = T_d$ x 1.2 = (9550 x 12,110 / 4670) x 1.2 = 24,764.5 x 1.2 = 29,717 Nm

$T_s = T_d$ x 1.2 = (63,000 x 16,240 / 4670) x 1.2 = 219,084 x 1.2 = 262,900 inch-pound force

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Annex F
(informative)

Examples of Misalignments

Various types of misalignment are illustrated in Figures F.1 through F.4.

Key
1 → driving machine
2 → parallel offset
3 → driven machine
4 → planes of flexure

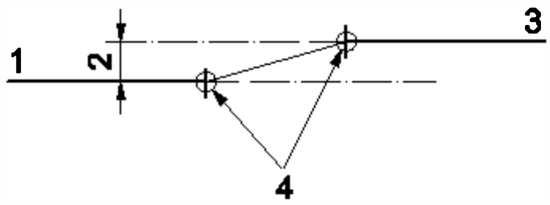

Figure F.1—Parallel Offset

Key
1 → driving machine
2 → driven machine
3 → planes of flexure

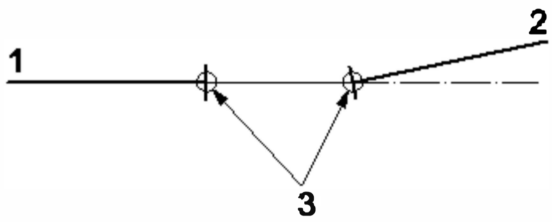

Figure F.2—Angular Misalignment

Key
1 → driving machine
2 → lateral offset
3 → driven machine
4 → planes of flexure
5 → driving machine shaft-end

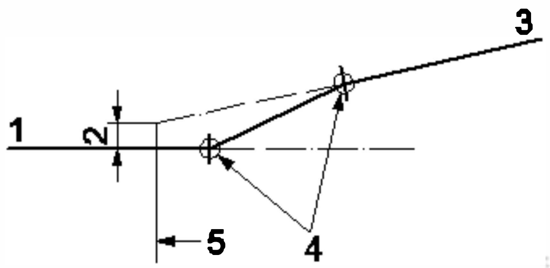

Figure F.3—Lateral Offset with Angular Misalignment in the Same Plane and in the Same Direction

Key
1 → driving machine
2 → lateral offset
3 → planes of flexure
4 → driven machine
5 → driving machine shaft-end

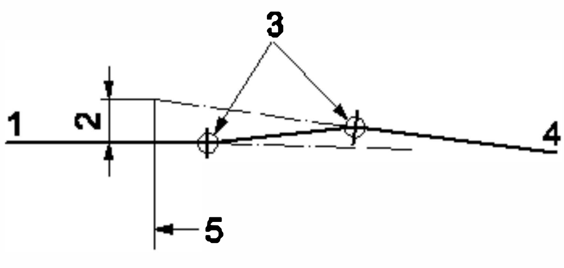

Figure F.4—Lateral Offset with Angular Misalignment in the Same Plane but in the Opposite Direction

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Annex G
(informative)

Example of the Determination of Potential Unbalance

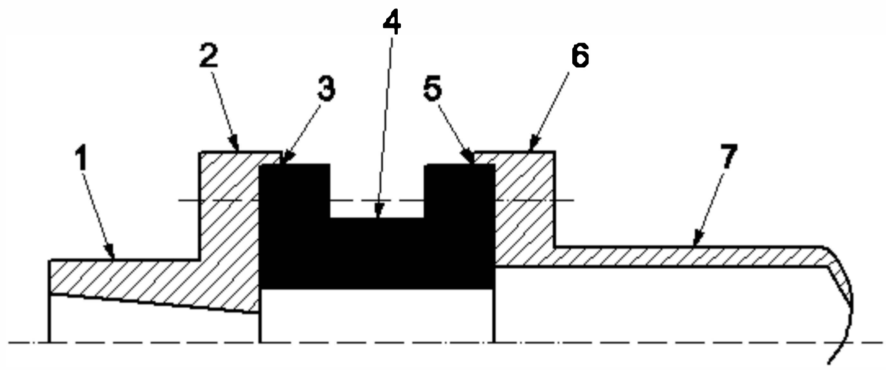
G.1 General

A typical flexible coupling consists of a number of components that are centered with respect to the axis of rotation by reference surfaces such as the hub bores and various pilots or registers (spigots or rabbets). The effective unbalance of such components is a combination of the residual unbalance of the component itself and the effect of the eccentricity of the mass of the component resulting from eccentricity and clearance in the various pilots or registers and other reference surfaces.

The net unbalance of the whole coupling is the summation of the effective unbalances of all the components. However, it is considered unreasonable to assume that all the contributory unbalances act in the same direction, and it is, therefore, not considered appropriate to add all these contributory unbalances arithmetically.

The actual magnitude and direction of each contributory unbalance is assumed to be random in nature and the magnitude is assumed to have a normal (Gaussian) distribution, such that the assumed maximum is a fixed multiple of the standard deviation. The magnitude of the net unbalance of the whole coupling, then, also has a normal distribution such that the maximum probable value (the potential unbalance) is the square root of the sum of the squares of all the contributory unbalances.

This is illustrated in Figure G.1, which shows a simplified representation of one-half of a flexible-element coupling, comprising three parts: the hub, the flexible-element pack or assembly, and one-half of the spacer.



Key

1 hub
2 flange 1
3 pilot 1
4 flexible element pack or assembly
5 pilot 2
6 flange 2
7 spacer

Figure G.1—Typical Flexible Element Coupling

G.2 Main Characteristics

Running speed: 5000 rev/min

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Masses: hub (m_h): 10 kg;

flexible-element assembly (m_f): 12 kg;

half-spacer (m_{sp}): 15 kg.

G.3 Balancing

The coupling is component-balanced as follows:

a) hub, balanced on a mandrel to ISO 1940-1:2003, grade 2.5:

1) maximum mandrel residual unbalance: 7 g·mm;

2) maximum eccentricity of mounting surface, e_h: 10 µm;

3) maximum eccentricity of pilot 1 to bore, e_i: 0 µm;

b) flexible-element assembly, locked and supported on a fixture at pilot 1 and balanced to ISO 1940-1:2003, grade 2.5:

1) maximum fixture residual unbalance: 7 g·mm;

2) maximum eccentricity of register (pilot 1) on fixture, e_f: 5 µm;

3) diametral clearance at register on fixture: 0;

4) diametral clearance at hub connection (pilot 1): 0;

5) maximum eccentricity, e_2, of pilot 1 to pilot 2: 10 µm;

c) spacer, balanced by rolling on outer surface of tube to ISO 1940-1:2003, grade 2.5:

1) maximum eccentricity, e_{sp}, of register to flexible assembly with respect to rolling surfaces: 5 µm;

2) clearance, c_{sp}, at register spacer-to-flexible element assembly (pilot 2): 10 µm;

d) bolting (both flanges): 12 (N) bolts on 200 mm pitch circle diameter (D_b):

1) maximum diametral bolt-hole clearance, c_b: 100 µm;

2) maximum variation in bolt-hole radius, $V_{r,bh}$: 100 µm;

3) mass, m_b of each bolt: 50 g; max. variation (heaviest to lightest), $V_{m,b}$: 0.1 g;

4) mass, m_{nut}, of each nut: 10 g; max. variation (heaviest to lightest): $V_{m,nut}$: 0.1 g.

NOTE ISO 1940–1:2003, grade 2.5, at 5000 rev/min represents a maximum unbalance of 5 g mm/kg.

G.4 Contributory Unbalance

The various contributory unbalances are listed in Table G.1.

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Table G.1—Contributory Unbalance

Element	Calculation	Unbalance U g·mm	U^2 (g·mm)^2
Residual unbalance of hub	$m_h \times 5$	50	2500
Unbalance of hub due to mandrel eccentricity	$m_h \times e_h$	100	10,000
Unbalance due to residual unbalance of hub mandrel	—	7	49
Residual unbalance of flexible-element assembly	$m_t \times 5$	60	3600
Unbalance of flex-element assembly due to fixture register eccentricity	$m_f \times e_f$	60	3600
Unbalance due to residual unbalance of flexible-element assembly fixture	—	7	49
Residual unbalance of half-spacer	$m_{sp} \times 5$	75	5625
Unbalance of half-spacer due to eccentricity of register	$m_{sp} \times e_{sp}$	75	5625
Unbalance of flex-element assembly plus half-spacer plus flange 2 fasteners due to pilot 1 eccentricity	$\left[m_f + m_{sp} + N\left(m_b + m_{nut}\right)\right] \times e_1$	277.2	76,839.84
Unbalance of half-spacer due to eccentricity of pilot 1 to pilot 2	$m_{sp} \times e_2$	150	22,500
Unbalance of half-spacer due to clearance at pilot 2	$m_{sp} \times c_{sp}/2$	75	5625
Flange 1 unbalance due to bolt and nut radial displacement	$N\left(m_b + m_{nut}\right) \times \left(c/2 + V_{r,bh}\right)/1000\sqrt{N}$	31.2	973.44
Flange 2 unbalance due to nut and bolt radial displacement	$N\left(m_b + m_{nut}\right) \times \left(c/2 + V_{t,bh}\right)/1000\sqrt{N}$	31.2	973.44
Flange 1 unbalance due to variation in mass of bolts	$V_{m,b} \times D/\pi \times \sqrt{N/2}$	15.6	243.36
Flange 1 unbalance due to variation in mass of nuts	$V_{m,b} \times D/\pi \times \sqrt{N/2}$	15.6	243.36
Flange 2 unbalance due to variation in mass of bolts	$V_{m,b} \times D/\pi \times \sqrt{N/2}$	15.6	243.36
Flange 2 unbalance due to variation in mass of nuts	$V_{m,b} \times D/\pi \times \sqrt{N/2}$	15.6	243.36
Total	—	1061.00	138,933.16

G.5 Potential Unbalance

The potential unbalance, U, equals the square root of the sum of the squares per half coupling:

$$U = \sqrt{138,933.16} = 373\,g\text{-}mm$$

Total mass of the half coupling is 37.36 kg for hub, flex element assembly, half of the hardware, and half of the spacer.

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The mass displacement, m_{dis}, of the principal inertia axis is then calculated as follows:

$$m_{dis} = 373 \times 10^6/(1000 \times 1000 \times 37.36) = 9.98 \mu m (393\, microinches)$$

In accordance with 8.9.3, a coupling operating at 5000 rev/min should not exceed ANSI/AGMA 9000-C90, Class 11; that is, a mass center displacement of 13 µm (500 microinches). Therefore, the example coupling satisfies the requirement.

NOTE Refer to ANSI/AGMA 9000 for the derivation of the equations used to calculate the various contributory unbalances and further information on the concept of potential unbalance.

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Annex H
(normative)

Coupling Guards

H.1 Scope

This annex covers the minimum requirements for guards used with special-purpose couplings. This information is added as a convenience to the owner or the contractor in specifying the total requirements for the driving and driven equipment system. Coupling guards are usually supplied by the machinery vendor rather than by the manufacturer of the coupling.

NOTE 1 It is recognized that coupling guards are typically not designed to retain any parts of the coupling that may come off during operation.

NOTE 2 It is recognized that since the coupling guards are typically supplied by the machinery vendor, there may be limitations to applying the information in this section.

H.2 General Requirements for All Guards

H.2.1 ● The purchaser shall designate who coordinates and who is responsible for the supply of all coupling guards in the equipment train.

H.2.2 ● The purchaser shall specify the types of guards that are required.

H.2.3 Each coupling shall have a coupling guard that sufficiently encloses the coupling and other rotating components to prevent personnel from contacting moving parts during operation of the equipment train. Allowable access dimensions shall comply with specified standards, such as ANSI B11.19, ISO 14120, or other applicable nationally recognized standard. The maximum size of the opening shall not exceed 10 mm (0.375 in.).

H.2.4 The guard shall be readily removable for inspection and maintenance of the coupling without disturbance of the coupled machines.

H.2.5 The guard shall be constructed with sufficient rigidity to withstand a 900 N (200 lb_f) concentrated static load in any direction without the guard contacting moving parts and with a deflection of not more than 0.0005 times the unsupported length of the guard.

H.2.6 ● With purchaser approval, guards fabricated from expanded metal or perforated sheets may be used. The requirements for the maximum size of the opening shall be per H.2.3.

H.2.7 Guards shall be constructed of steel, brass, aluminum, or nonmetallic (polymer) materials as agreed.

H.2.8 ● The guard shall comply with the requirements of any specified local codes or regulations; for example, OHSA Standard 1910.219-O, EN 953, ANSI B11.19, or ISO 14120.

H.2.9 The guard shall contain features that minimize drawing oil from the bearing housings.

NOTE Drawing air through the guard can be an effective way to reduce the guard surface temperature, but this benefit should be weighed against the possibility of drawing more oil from the bearing housings because of the reduced pressure in the guard.

H.2.10 ● If specified, guards shall be constructed of an agreed spark-resistant material. A description of the materials of construction shall be submitted to the purchaser for approval. Components such as fasteners, instrumentation, or other devices inside of the coupling guard around the coupling should also be considered.

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NOTE 1 Many users consider pure aluminum and aluminum alloys with less than 5 % iron and a maximum content of 2 % magnesium or 0.2 % copper to be spark-resistant. However, local regulations, such as BS EN ISO 80079–36:2016, sometimes prohibit aluminum or nonmetallic materials within potentially explosive atmospheres. Nickel-copper alloys (UNSN0440X or UNSN0550X) and copper-based alloys (e.g. brass, bronze, aluminum bronze, beryllium bronze) are generally considered to be spark-resistant. Nickel-based alloys, including alloy 600 (UNSN06600) and alloy 625 (UNSN06625), are considered spark-resistant.

NOTE 2 Materials that are not considered spark-resistant include stainless steels, iron, steel (all alloys), magnesium, and titanium.

H.2.11 ● If specified for guards used in potentially explosive atmospheres, an ignition hazard assessment (risk analysis) in accordance with BS EN 80079–36:2016 shall be conducted and documented.

NOTE This is a requirement for ATEX and may be required in other jurisdictions.

H.2.12 The maximum coupling guard surface temperature at the maximum continuous speed shall be calculated by the vendor supplying the coupling guard. Assumptions for ambient air and sun load shall be stated. The maximum surface temperature of the guard shall not exceed 60 °C (140 °F).

H.2.13 ● The maximum internal enclosure temperature at the maximum continuous speed shall be calculated based on the maximum ambient temperature and using the surface temperature calculated in H.2.13. It shall be agreed by the purchaser and the vendor who shall make these calculations.

H.2.14 The maximum internal temperature calculated in H.2.13 shall be reviewed for potential damages to items such as components, lubrication breakdown, or lubrication atomization. Computational modeling may be beneficial for optimizing the guard design. The coupling guard design shall consider other elements in the piping system and how they affect the air flow through the guard.

H.2.15 The guard shall include features to minimize the heat generated by the rotating components, such as:

a) internal baffles;

b) location, size, and orientation of inlets and/or outlets;

c) making the clearance between the coupling guard inside diameter and the maximum coupling outside diameter (typically the coupling flanges) as large as possible, with a minimum of 25 mm (1 in.) radial clearance;

   NOTE Increasing radial clearances may improve the air flow within the coupling guard, avoiding isolated high-temperature regions, to reduce heating caused by air shearing.

d) increasing the flow of air through the guard;

e) considering applying forced ventilation by creating a vacuum at the coupling guard fluid exits;

f) modeling bolt heads to accurately simulate the heat generation due to windage;

g) minimizing the number of rotating bolts (hardware) that can generate windage.

H.2.16 If the expected maximum surface temperature exceeds the value of H.2.12 after internal provisions have been considered, external provisions of the guard may be considered with the owner’s approval, such as:

a) incorporating cooling fins on the exterior surface of the coupling guard to promote convective heat loss;

b) adding panels or shields.

H.2.17 Injecting oil is not preferred to achieve the required coupling guard temperature.

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H.3 Base-mounted Guards

H.3.1 Guards that are fastened to the equipment foundation or baseplate shall be removable in one piece.

H.3.2 Base-mounted guards shall preferably be fabricated from a solid metal sheet or plate with no openings. Guards that are fabricated from expanded metal or perforated plate are acceptable, provided that the size of the opening meets the requirements of H.2.3. Guards of woven wire are unacceptable.

H.3.3 ● If specified, a base-mounted coupling guard shall be oil tight.

H.4 Fully Enclosed Guards

H 4.1 Fully enclosed guards shall at a minimum:

a) be cylindrical in shape;

b) be axially split with provision at each end for connection to the coupled equipment;

c) Coupling guard assembly shall be capable of allowing for axial growth while maintaining a seal. Typically, the sealing for the axial growth is provided through a slip joint at one end of the guard with two O-rings or by using a metallic bellows;

d) Coupling guard assembly shall accommodate both radial and axial movements between the stationary machines/components through articulation points or flexible bellows.

H.4.2 If adapting flanges are required to mate the guard to the associated components of the equipment train, the vendor designated in H.2.1 shall be responsible for their design and supply.

H.4.3 ● Fully enclosed guards shall be oil tight and provided with vent and drain connections. At a minimum, these vent and drain connections shall be DN 25 (NPS1) and, if specified, flanged.

H.4.4 If the guard is designed to be cooled using air flow, there should be adequate inlet air port(s), located in different planes from the exit air port(s). The oil drain may also serve as the air exit/inlet port so that air circulates throughout the enclosure. The exit air port area should be at least twice the inlet air port area. Exit air ports should be located as near as practical to the same axial positions as the bolt heads on the coupling flanges and oriented tangential to the enclosure outside diameter such that rotation tends to sling air directly out of the ports. This position and orientation maximizes the air flow from the pumping action induced by the bolt heads. Mixing of tangential and radial ports should be avoided.

H.4.5 A threaded filter breather shall be supplied for attachment to the vent(s) unless otherwise specified. In applications where the vent is piped or included as part of the vent system for the equipment train, this connection shall be flanged, in which case the breather is not required. Flanged drain connections, at a minimum, shall be DN 25 (NPS1) and capable of handling the oil carryover from the coupled equipment. It is recommended that the drain connection be tangential to the enclosure outside diameter and conform to the coupling direction of rotation.

H.4.6 A baffle should also be installed along the enclosure over the exit port to prevent the oil from rotating around more than one revolution before exiting. In guards 900 mm (36 in.) or longer, it can be necessary to have two drains, one at each end, in different planes than the inlet vents if air cooling is used.

H.4.7 ● If specified, the guard shall be fitted with a connection for purging with dry air or an inert gas.

NOTE This is necessary if unusually corrosive conditions exist.

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H.4.8 ● If specified, the contract guard shall be used when the contract coupling is factory tested with the driver and driven equipment.

H.5 Guards for Continuously Lubricated Couplings

H.5.1 In addition to the requirements listed in H.4, the following shall apply to coupling guards for continuously lubricated couplings.

H.5.2 Each oil-spray nozzle shall be positively fastened to the guard in the proper orientation, and the mounting shall ensure that this orientation is easily re-established if removal of the nozzle is required for maintenance. Friction clamping of nozzles or tubing in unacceptable.

H.5.3 Guards shall be designed to remain oil-tight for at least five years of operation. A flanged oil drain connection, DN 25 (NPS 1) or larger in size, shall be provided for each guard.

H.5.4 ● If specified, a transparent window shall be provided to permit safe inspection of each oil spray while the coupling is in service.

H.6 Guards for Instrumented Couplings

H.6.1 In addition to requirements in H.2 through H.5, guards containing instrumentation such as torque meters shall be designed so that the internal temperature does not exceed the maximum allowable temperature of the enclosed instrumentation.

H.6.2 If a torque measuring system is specified, the internal coupling guard temperature (H.2.14) shall not exceed the maximum allowable temperature for any torque measuring system component within the coupling guard.

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Annex I
(informative)

Coupling Tapers

This standard mandates shaft-ends with a taper of 1:24 ($^{1}/_{2}$ diametral in per foot length) for keyless, hydraulically fitted hubs and a taper of 1:16 ($^{3}/_{4}$ diametrical in per foot length) for non-hydraulically fitted hubs. It is recognized that other tapers exist; however, the 1:24 and 1:16 tapers are mandated as a default standard in order to standardize for tooling purposes.

The greater the taper, the greater the accuracy that is demanded to position the hub axially on the shaft in order to maintain stresses and contact pressures within given limits. Alternatively, the shallower the taper, the less latitude there is in varying stresses and contact pressures because of the relatively large accompanying change in the spacer-gap dimension.

Table I.1 illustrates the axial-hub advance required to achieve 0.025 mm (0.001 in.) of bore dilation for three standard shaft-end tapers.

As a further illustration, consider the case of a 125 mm (5 in.) diameter bore that has an interference of 0.002 mm (0.002 in.) per millimeter (inch) of bore diameter. This bore achieves a stress level of 4.14×10^{8} N/m^{2} (60,000 lb/in.^{2}). The total bore dilation is 0.25 mm (0.010 in.), requiring an axial advance 10 times the values shown in the chart—14.5 mm, 6.0 mm, and 4.0 mm (0.57 in., 0.24 in., and 0.16 in.), respectively, for the three tapers.

Table I.1—Axial Hub Advance Required to Achieve 25 µm (1 mil) of Bore Dilation

Taper	Axial Advance Required	
	mm	in.
1° (included angle)	1.4	0.057
1:20 (0.60 in. per foot)	0.5	0.020
1:24 ($^{1}/_{2}$ in. per foot)	0.6	0.024
1:16 ($^{3}/_{4}$ in. per foot)	0.4	0.016

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Annex J
(informative)

Inspection of Taper Bore Hubs with CMM Method

J.1 General

J.1.1 The purpose of this annex is to provide further definition and guidance for the inspection of taper bores for coupling hubs with coordinate measuring machines (CMM). 8.6.2.4.2 identifies the recommended acceptance standard.

J.2 Procedure (refer to Figure J.1 and Figure J.2)

J.2.1 Method 1—Discrete Points Methods

a) Thoroughly clean bore and ensure it is free of burrs and debris, and conforms to the minimum required surface finish.

b) Position the hub on the CMM to allow measurement of the entire length of the hub.

c) Measure and record at each of the four diameters over the length of the taper as shown in Figure J.1 (from A to D). Take measurements at a minimum of 12 equally spaced points at each diameter, as shown in Figure J.2.

d) Record the measurements.

e) Evaluate per acceptance criteria described in 8.6.2.4.2.

J.2.2 Method 2 Scanning Method

Thoroughly clean the bore and ensure it is free of burrs and debris, and conforms to the minimum required surface finish.

a) Position the hub on the CMM to allow measurement of the entire length of the hub.

b) Using a scanning CMM, scan from diameters A to D while traveling between the two locations and scanning through 1440 degrees (360 degrees four times through a spiral).

c) Record the measurements.

d) Evaluate per acceptance criteria described in 8.6.2.4.2.

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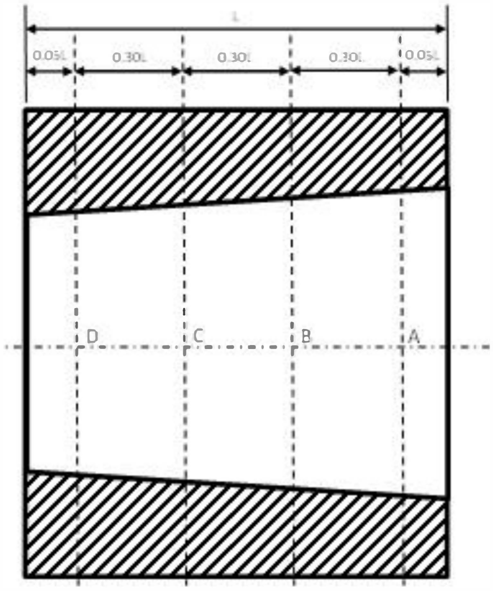

Figure J.1—Axial Probe Locations

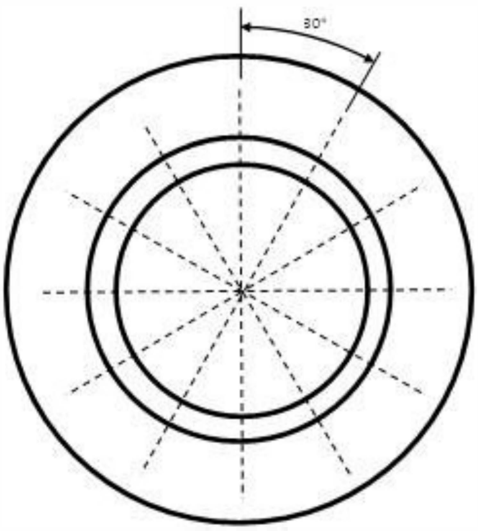

Figure J.2—Radial Probe Locations

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Annex K
(normative)

Procedure for Residual Unbalance Check

K.1 General

K.1.1 This annex describes a procedure to verify residual unbalance in couplings by determining the calibration accuracy of the balancing equipment. Balancing machines may be configured to display the amount of coupling unbalance; however, the calibration can be in error. To determine the actual residual unbalance, a known amount of unbalance should be added using an appropriate procedure.

K.1.2 Figures K.1, K.2, and K.3 are provided as examples. The worksheets for these figures can be completed for equations in 9.3.5.6 or 9.3.6.

K.1.3 The example sketches for the assembly for Figures K.1, K.2, and K.3 may have to be altered to best show the coupling's assembly.

K.2 Residual Unbalance

Residual unbalance is the amount of unbalance remaining in a coupling after balancing. Residual unbalance shall be expressed in g-mm (g-in.).

K.3 Maximum Allowable Residual Unbalance

K.3.1 The maximum allowable residual unbalance, per plane, shall be calculated in accordance with equations as appropriate in 9.3.5.6 or 9.3.6.

K.3.2 The mass apportioned to each balance plane shall be determined. It should not simply be assumed that the mass is equally divided between the two balance planes unless the coupling is truly symmetrical.

K.4 Residual Unbalance Check

K.4.1 General

K.4.1.1 When the balancing machine readings indicate that the coupling has been balanced within the specified tolerance, a residual unbalance check shall be performed before the coupling is removed from the balancing machine. Record and plot the indicated residual unbalance heavy spot of both planes on the Residual Unbalance Worksheet (one for each plane).

NOTE Due to the possibility of machine calibration errors, the residual unbalance check can be performed prior to final correction of the unbalance, typically after the placement of temporary weights.

K.4.1.2 To check the residual unbalance, a known trial weight, equal to the multiplier from Table K.1 times the maximum allowable unbalance from the appropriate equation in K.3.1, is attached to the coupling at the same angular location as the indicated heavy spot. The check is run at each balance machine readout plane, and the readings in each plane are tabulated. This run is then repeated with the weight placed 180° opposite of the heavy spot at the same radius. The check is run at each balance machine readout plane, and the readings in each plane are tabulated.

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Table K.1—Trial Weight Multiplier vs N_{mc}

Maximum Continuous Speed of Part/Assembly	Trial Weight Multiplier
N_{mc} ≤ 7500 rpm	1.5
7500 < N_{mc} ≤ 12,500 rpm	2.0
N_{mc} > 12,500 rpm	2.5

K.4.2 Procedure

K.4.2.1 Select a trial weight and radius that will be equivalent to the trial weight multiplier times the maximum allowable residual unbalance as defined by equations in 9.3.5.6 or 9.3.6. Equation K.1 shows the use of these equations:

NOTE If U_r is 488.4 g-mm (19.2 g-in.), for a coupling with MCS £ 7500 rpm, the trial weight magnitude should equal 732.6 g-mm (28.8 g-in.).

In g-mm units:

$$U_r = 6350\frac{W}{N_{mc}} \text{ (for } N_{mc} < 25{,}000 \text{ rpm)} \qquad \text{(K.1a)}$$

$$U_r = \frac{W}{3.937} \text{ (for } N_{mc} \geq 25{,}000 \text{ rpm)}$$

In g-in. units:

$$U_r = 113.4\frac{W}{N_{mc}} \text{ (for } N_{mc} < 25{,}000 \text{ rpm)} \qquad \text{(K.1b)}$$

$$U_r = \frac{W}{220.46} \text{ (for } N_{mc} \geq 25{,}000 \text{ rpm)}$$

K.4.2.2 At the heavy spot, add the first trial weight at the selected radius in K.4.2.1 to the first balance readout plane.

NOTE Trial weight magnitude is a linear function with radial location. Every effort should be made to place the weight accurately, both radially and circumferentially.

K.4.2.3 Verify that the balancing machine's readings are stable, without faulty sensors or displays.

NOTE When the trial weight is added to the last known heavy spot, the first meter reading should easily exceed the balance tolerance in that plane. Little or no meter reading generally indicates that the coupling was not balanced to the correct tolerance, the balancing machine was not sensitive enough, or that a balancing machine fault exists (i.e. a faulty pickup).

K.4.2.4 Remove the trial weight and rotate the trial weight to the second position (180° from the initial trial weight position). All verification shall be performed using only one sensitivity range on the balance machine.

K.4.2.5 Record and plot the balancing machine unbalance amplitude and phase readout (heavy spot) on the Residual Unbalance Worksheet for the readout plane in question. If the indicated unbalance phase angle for the residual unbalance (K.4.1.1) differs by more than 10° from the first trial weight phase angle or the second trial weight phase angle plus 180°, the angular location of the trial weight should be adjusted to lessen the difference. Once the phase angle difference is less than 10°, the actual amount of residual unbalance (refer to worksheets Figure K.2, and Figure K.3) can be calculated.

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K.4.2.5.1 The difference in magnitudes of each trial weight run relative to the indicated unbalance should be within 20 %.

K.4.2.5.2 If this is exceeded, weight placement and magnitude should be reviewed. A larger trial weight can be used with the value entered into the “User Selected Trial Weight” cell; otherwise, this value should be zero.

NOTE 1 Not meeting this tolerance will generate errors in the calculated residual unbalance or indicate a problem with the balance machine.

NOTE 2 In Figure K.3, a larger trial weight was needed to enable the second reading to be 180° different than the indicated reading (cross over the center of the plot). The larger trial weight (9 gr) was inputted into the “User Selected Trial Weight” cell. This value of the trial weight, TW, is then used to calculate the Actual Residual Unbalance. For this example, the machine was determined to be reading $^1/_2$ of the actual unbalance.

K.4.2.6 Repeat the steps described in K.4.2.1 through K.4.2.5 for each balance machine readout plane. If the specified maximum allowable residual unbalance has been exceeded in any balance machine readout plane when calculating the actual residual unbalance, the coupling shall be balanced more precisely and checked for compliance using the calibration factors determined above.

K.4.2.7 Where the coupling is balanced by mounting it on a mandrel, and the mass of the mandrel is greater than 20 % of the mass of the coupling, the residual unbalance of the mandrel alone should be determined first. The residual unbalance of the coupling is then determined by deducting the residual unbalance of the mandrel vectorially from the residual unbalance of the mandrel plus coupling.

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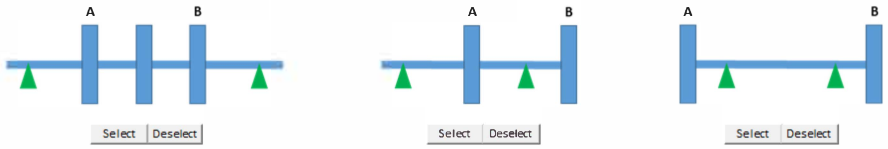
Customer:
Job / Project Number:
OEM Equipment S/N:
Rotor Identification Number:
Repair Purchase Order Number:
Vendor Job Number:
Correction Plane (A or B) - see sketch:

Balancing Speed:			rpm		
Maximum Continuous Operating Speed:	Nmcs		rpm		
Static Journal Weight Closest to This Plane:	W		kg		lbm
W obtained from:		Rotordynamics			Specify if Other
Correction Radius - radius at which the readings are taken and trial weight will be placed:	R		mm		in

Balance Plain Description: End A End B



Calculate the Maximum Allowable Residual Unbalance (Ur):

Nmcs ≤ 25000 rpm   Nmcs > 25000 rpm

SI Units:

$$U_r = \frac{6350 * W}{N_{mcs}} \quad \text{or} \quad U_r = \frac{W}{3.937}$$

Ur [ ] g-mm   Unbalance @ Balance Plane [ ] g

Customary Units: (USC expressed in grams)

$$U_r = \frac{113.4 * W}{N_{mcs}} \quad \text{or} \quad U_r = \frac{W}{220.46}$$

Ur [ ] g-in   Unbalance @ Balance Plane [ ] g

Trial Weight Calculation:

$$TW = \frac{Um * U_r}{R}$$

Trial Weight Multiplier (Um): [ ]

Recommended Trial Weight: [ ] g   User Selected Trial Weight: 0.00 g

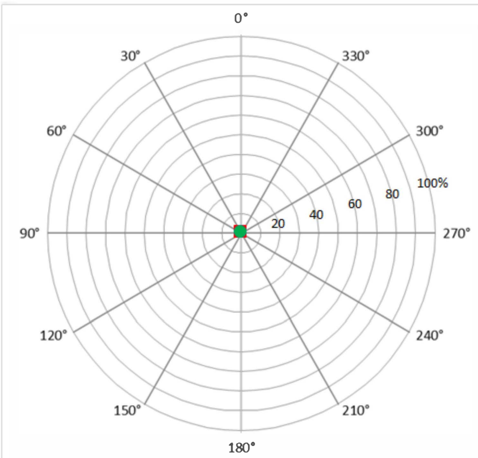
Record Indicated Residual Unbalance (K.4.1.1) and the Indicated Unbalance with Trial Weight (K.4.2.5)

Test Data

Unbalance Readings		Magnitude grams (g)		Phase Angle degrees (°)	
A: Residual Unbalance (IR)*					
B: Unbalance w/ 1st Trial Weight (Mx)*					
C: Unbalance w/ 2nd Trial Weight (Mn)*					
	Y = Mx - Mn	0.00	Angle Diff |B-A| <10		0.00
	Z = Mx + Mn	0.00	Angle Diff |C-A| <10		180.00
Trial Weight Effect	R1 = Mx - IR	0.00	R2 = Mn + IR		0.00
	R1/R2		R2/R1		
Uniformity Of Trial Weight Placement & Effect:		*Caution: Potential Inaccuracies*			
Anglediff<10 and Magnitude ratio [0.8<(R1/R2 & R2/R1)<1.2]		*If cautioned, increase weight or adjust weight placement angle*			
		Metric (g-mm)		Customary (g-in)	
Residual Unbalance Reading (IR*R)					
Actual Residual Unbalance (AR=R*TW*Y/Z)					
Within Specification (AR < Ur)					

** denotes indicated values*

Indicated Residual Unbalance
Indicated Unbalance w/ Trial Weight #1
Indicated Unbalance w/ Trial Weight #2
Indicates Input Required



100% = #NUM! g

Figure K.1—Residual Unbalance Worksheet Example

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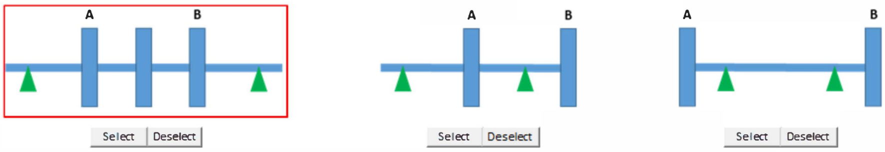
Customer:	International Oil Company
Job / Project Number:	JN 2398-IRG-48
OEM Equipment S/N:	345-687
Rotor Identification Number:	C4784XL
Repair Purchase Order Number:	
Vendor Job Number:	12484-45985
Correction Plane (A or B) - see sketch:	Plane A

Balancing Speed:		400	rpm		
Maximum Continuous Operating Speed:	Nmcs	11000	rpm		
Static Journal Weight Closest to This Plane:	W	1300	kg		lbm
W obtained from:		Rotordynamics			Specify if Other
Correction Radius - radius at which the readings are taken and trial weight will be placed:	R	200	mm		in

Balance Plain Description: Thrust End A Coupling End B



Calculate the Maximum Allowable Residual Unbalance (Ur):

Nmcs ≤ 25000 rpm Nmcs > 25000 rpm

SI Units:

$$U_r = \frac{6350 * W}{N_{mcs}} \quad \text{or} \quad U_r = \frac{W}{3.937}$$

Ur: 750.45 g-mm Unbalance @ Balance Plane: 3.75 g

Customary Units: (USC expressed in grams)

$$U_r = \frac{113.4 * W}{N_{mcs}} \quad \text{or} \quad U_r = \frac{W}{220.46}$$

Ur: g-in Unbalance @ Balance Plane: g

Trial Weight Calculation:

$$TW = \frac{Um * U_r}{R}$$

Trial Weight Multiplier (Um): 2

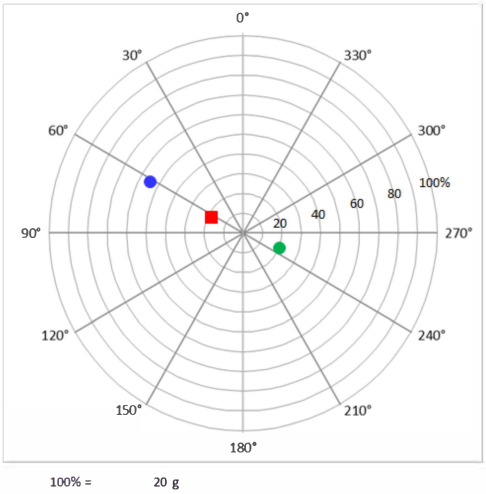
Recommended Trial Weight: 7.50 g User Selected Trial Weight: 0.00 g

Record Indicated Residual Unbalance (K.4.1.1) and the Indicated Unbalance with Trial Weight (K.4.2.5)

Test Data

Unbalance Readings		Magnitude grams (g)		Phase Angle degrees (°)	
A: Residual Unbalance (IR)*		3.5		65	
B: Unbalance w/ 1st Trial Weight (Mx)*		10.7		62	
C: Unbalance w/ 2nd Trial Weight (Mn)*		4.2		247	
	Y = Mx - Mn	6.50	Angle Diff |B-A| <10		3.00
	Z = Mx + Mn	14.90	Angle Diff |C-A| <10		2.00
Trial Weight Effect	R1 = Mx - IR	7.20	R2 = Mn + IR		7.70
	R1/R2	0.94	R2/R1		1.07
Uniformity Of Trial Weight Placement & Effect: *Angle diff<10 and Magnitude ratio [0.8 < {R1/R2 & R2/R1} < 1.2]*		Acceptable *If cautioned, increase weight or adjust weight placement angle*			
		Metric (g-mm)		Customary (g-in)	
Residual Unbalance Reading (IR*R)		700.00			
Actual Residual Unbalance (AR=R*TW*Y/Z)		654.76			
Within Specification (AR < Ur)		YES			

** denotes indicated values*



■ Indicated Residual Unbalance
● Indicated Unbalance w/ Trial Weight #1
● Indicated Unbalance w/ Trial Weight #2
Indicates Input Required

Figure K.2—Sample Residual Unbalance Worksheet for Left Plane (SI)

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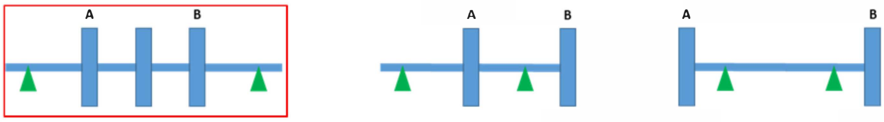
Customer:	US Oil Company
Job / Project Number:	JN 2398-IRG-48
OEM Equipment S/N:	345-687
Rotor Identification Number:	C4784XL
Repair Purchase Order Number:	
Vendor Job Number:	12484-45985
Correction Plane (A or B) - see sketch:	Plane B

Balancing Speed:		400	rpm			
Maximum Continuous Operating Speed:	Nmcs	11000	rpm			
Static Journal Weight Closest to This Plane:	W		kg		2866	lbm
W obtained from:		Rotordynamics				Specify if Other
Correction Radius - radius at which the readings are taken and trial weight will be placed:	R		mm		8	in

Balance Plain Description: Thrust End A Coupling End B



Select Deselect Select Deselect Select Deselect

Calculate the Maximum Allowable Residual Unbalance (Ur):

Nmcs ≤ 25000 rpm Nmcs > 25000 rpm

SI Units:

$$U_r = \frac{6350 * W}{N_{mcs}} \quad \text{or} \quad U_r = \frac{W}{3.937}$$

Ur: [ ] g-mm Unbalance @ Balance Plane: [ ] g

Customary Units: (USC expressed in grams)

$$U_r = \frac{113.4 * W}{N_{mcs}} \quad \text{or} \quad U_r = \frac{W}{220.46}$$

Ur: 29.55 g-in Unbalance @ Balance Plane: 3.69 g

Trial Weight Calculation:

$$TW = \frac{Um * U_r}{R}$$

Trial Weight Multiplier (Um): 2

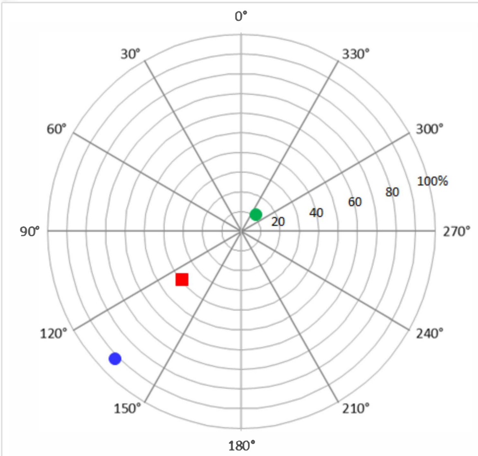
Recommended Trial Weight: 7.39 g

User Selected Trial Weight: 9.00 g

Record Indicated Residual Unbalance (K.4.1.1) and the Indicated Unbalance with Trial Weight (K.4.2.5)

Test Data

Unbalance Readings		Magnitude grams (g)		Phase Angle degrees (°)	
A: Residual Unbalance (IR)*		3.5		130	
B: Unbalance w/ 1st Trial Weight (Mx)*		8.2		135	
C: Unbalance w/ 2nd Trial Weight (Mn)*		1		312	
	Y = Mx - Mn	7.20	Angle Diff |B-A| <10	5.00	
	Z = Mx + Mn	9.20	Angle Diff |C-A| <10	2.00	
Trial Weight Effect	R1 = Mx - IR	4.70	R2 = Mn + IR	4.50	
	R1/R2	1.04	R2/R1	0.96	
Uniformity Of Trial Weight Placement & Effect:		Acceptable			
Anglediff<10 and Magnitude ratio [0.8<(R1/R2 & R2/R1)<1.2]		*If cautioned, increase weight or adjust weight placement angle*			
		Metric (g-mm)		Customary (g-in)	
Residual Unbalance Reading (IR*R)				28.00	
Actual Residual Unbalance (AR=R*TW*Y/Z)				56.35	
Within Specification (AR < Ur)				NO	



100% = 9 g

** denotes indicated values*

- Indicated Residual Unbalance
- Indicated Unbalance w/ Trial Weight #1
- Indicated Unbalance w/ Trial Weight #2

Indicates Input Required

Figure K.3—Sample Residual Unbalance Worksheet for Right Plane (USC)

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Annex L
(normative)

Torque Measuring System

L.1 ● Range of Torque (Including Steady State Torque, Speed, Temperature, and Overload Conditions of Interest)

The torque measuring system shall be capable of meeting the torque requirements of 5.2 and any speed identified without damage. The minimum speed for measurement should be specified by the purchaser.

Torque values will not necessarily match the coupling rating.

L.2 Cyclic Torque (Torsional) Monitoring Capability (If Specified)

The following shall be provided on the data sheet:

a) system bandwidth (minimum and maximum frequencies that the system is capable of resolving, typically in the 8 Hz to 25 Hz range);

b) accuracy of torsional amplitude value where different from that specified for steady-state torque measurement;

c) units of torsional amplitude value where different from that specified for steady-state torque measurement;

d) requirements for analog output, including any pre-processing of the output signal;

e) visual display requirements.

L.3 Torque Measuring System Alignment Requirements

The torque measuring system shall meet the requirements of alignment and axial positioning stated in 6.3 and 6.4.

L.4 Accuracy

The torque measuring system shall be designed to provide the highest accuracy at the steady state torque and the normal operating point. The measurement system's accuracy at the peak torque, cyclic torque. and frequencies and momentary torque shall be provided.

The measurement system's accuracy shall be (+/−) 1 % of the steady-state torque unless otherwise stated on the data sheets. The torque measuring system's accuracy will typically be different with higher torque values, such as transients as compared with steady state torque values.

Temperature compensation to improve accuracy of the measurement shall be included.

Accuracy of the torque measuring system may degrade over time. The supplier should discuss with the purchaser the expected degradation along with the time period.

NOTE 1 Some torque measuring systems include a self-test feature to assist with the self-verification to determine if the accuracy is degrading.

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NOTE 2 Depending on the level of accuracy desired, the torque measuring system may require additional components.

L.5 Effect of Rotordynamics

The system rotordynamics should include any physical change to the coupling resulting from the incorporation of the torque meter.

L.6 ● Signal Output Type and Signal Processing, Integration

a) The torque measuring system will provide 4–20 mA analog outputs.

b) The following should be specified by the purchaser:

   1) other than 4–20mA outputs;

   2) requirement for a visual display unit;

   3) location of the visual display unit;

   4) ranges of output scaling;

   5) measurement of negative torque;

   6) maximum allowable temperature of any torque measuring system component within the coupling guard.

L.7 Calibration and Effect on Temperature

The torque measuring system shall be supplied with the appropriate calibration documentation. Unless otherwise specified, the system shall be calibrated at factory temperature, and that temperature shall be stated with the documentation.

L.8 Service Duty

The torque measuring system shall be suitable for continuous duty.

L.9 Environmental Considerations

The torque measuring system shall be designed for typical inland industrial site applications. For non-inland applications, the specific requirements identified in 10.3 shall be met and any other requirements identified by the purchaser.

The torque measuring system should use good practices, such as overall shielded wiring to minimize external noise.

L.10 Additional Information

The purchaser should provide additional information required for the torque measuring system, such as:

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a) identification of electrical/instrumentation termination points of the system components, including any control panel;

b) electro-magnetic interference (noise): Any specific requirements, such as electro-magnetic interference or susceptibility, should be specified by the purchaser;

c) area classification and certification requirements: The torque measuring system shall meet the required area classifications and certifications as specified on the data sheet;

d) power:

   1) available power supply shall be provided on the data sheet;

   2) power consumption shall be provided to the purchaser;

e) direction of rotation and power flow: direction of normal rotation and power flow of the coupling;

f) spares identification and calibration requirements, such as:

   1) spare torque measuring coupling;

   2) spare set of electronic components.

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Annex M
(informative)

Inspector's Checklist

This inspection plan is an example and is intended to serve as a guideline only.

Inspections shall be per paragraphs 12.2 and 12.3.

Inspection levels are:

— Level 1: The default level; typically used for couplings in general service.

— Level 2: Comprises performance and material requirements and is more stringent than Level 1.

— Level 3: Items should be considered for couplings in the most critical services of initial vendor qualification.

The decision to review, observe, or witness the inspections should be indicated in the appropriate column in Table M.1.

Table M.1—Inspector's Checklist

Item	API 671 Paragraph	Level	To be	To be	To be			Status
Dimensional and Geometric Checks								
Bore(s) (if applicable)								
Size (bore diameter and fit length) and geometry	8.6.1.9	1						
Keyway (quantity, width, depth, bottom of bore to top of key, fit, radius, taper, etc)	8.6.1.5, 8.6.1.6, and 8.6.3	1						
Taper	8.6.2.4	2						
Hub/shaft fit (if applicable)	8.6							
Bore finish	8.6.1.8	2						
Ring and plug gauge records or CMM inspection records	8.6.2.4	2						
Integral flange(s) (if applicable)	8.5							
Hole size, quantity, and position	8.10.1	1						
Pilot diameter, length, and runout	8.9.1	1						
Flange face runout	8.9.2	2						

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Table M.1—Inspector's Checklist (Continued)

Item	API 671 Paragraph	Level	To be	To be	To be			Status
Overall dimensions per outline drawing (compliance with allowable coupling envelope)	Annex O.3.2.2.f	2						
Complete check of coupling dimensions and geometry	Various	3						
Balance								
Review of certification paperwork	9 and 12.3.2.d	1						Balance of accessories (bolts, nuts, rubber blocks, etc)
Balance method								
Balance of accessories (bolts, nuts, rubber blocks, etc)	9.3.4	2						
Component balance	9.3.5	3						
Assembly check balance	9.3.6	2						
Assembly balance	9.3.7	2						
Review of balance tooling (if applicable)	9.3.11	2						
Additional balance requirements (if applicable)								
Residual unbalance verification	9.3.8	2						
Repeatability check	9.3.9	2						
Component interchangeability check	9.3.10	2						
Trim balance holes	9.4	2						
Balance equipment capability and review	n/a	3						

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Table M.1—Inspector's Checklist (Continued)

Item	API 671 Paragraph	Level	To be	To be	To be			Status
Calibration, cleanliness, maintenance records	n/a	3						
Material								
Certification (minimum of all torque transmitting components)	12.3.2.a							
Fatigue (if constant-life curve is used)	7.2	3						
Chemical	12.3.2.a	2						
Documentation (mill certification, heat numbers, markings, etc)	12.3.2.a	2						
Mechanical	12.3.2.a	2						
Heat treat	12.3.2.c	3						
Gauss level	n/a	2						
Traceability (if specified)	n/a	3						
Verify material matches certification (if specified)	n/a	3						
Non-destructive testing	12.3.4							
Records	12.3.2.b	2						
Certification of inspectors/ operators	n/a	3						
Welding (if applicable)	12.3.5	2						
Certifications and procedures	12.3.5							
Non-destructive testing (surface and sub-surface)	12.3.5	2						
Welder certifications	12.3.5	3						
Results of periodic material testing	12.3.7	2						
Hardware and Accessories								
All hardware available and clearly labeled		1						

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Table M.1—Inspector's Checklist (Continued)

Item	API 671 Paragraph	Level	To be	To be	To be			Status
API 671 or customer required spares	8.10.8	1						
Certification as required								
Mechanical	10.7	2						
Non-destructive testing	12.3.4	2						
Hydrogen embrittlement (if applicable)	n/a	2						
Verify material matches certification	n/a	3						
Marking								
Match-marks	9.3.6 and 9.3.7	1						
Serial number and item numbers	12.5.6	1						
Customer identification numbers	12.5.6 and 12.5.8	1						
Tightening torques	8.10.5 and 12.5.7	1						
Special marking for shipping and assembly hardware and tools	11.2.2	1						
Packaging and Documentation								
Drawing includes required customer-specific data (customer blocks, ID numbers, labels, etc)	Annex O.1.2	1						
Drawing includes interface connections (clearly labeled for subsequent inspections and installation)	Annex O.3.2.2.f	1						
Drawing includes complete bill of materials (including quantities, part numbers, and materials)	11.2.2 and Annex O.3.4.1	1						

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Table M.1—Inspector's Checklist (Continued)

Item	API 671 Paragraph	Level	To be	To be	To be			Status
Preservation and packaging suitable for transport and storage	12.5.1, 12.5.4, and 12.5.9	1						
Shipping documentation and tags (as required)	12.5.3	1						
Packing list	Annex O.3.4.1	1						
Center of gravity location and lifting points	n/a	1						
Installation tooling (if applicable)	11.2	1						
Installation instructions	Annex O.3.5.1	1						
General arrangement drawing (reflecting the actual coupling shipped)	Annex O.3.2	1						
API 671 datasheets	Annex O.3.2.a	2						
Spare parts list	Annex O.3.2.g	2						
Quality								
Review vendor process(es) to ensure quality	12.1							
Receiving and inspections	12.1.1	3						
Mechanical testing	12.1.1	2						
Calibration of equipment and tools	12.1.1	2						
Certification of operators	12.1.1	3						
Corrective actions	12.1.1	3						
Process for non-conforming parts	12.1.1	2						
Special Feature (if applicable)								

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Table M.1—Inspector's Checklist (Continued)

Item	API 671 Paragraph	Level	To be	To be	To be			Status
Coating certification (including hydrogen embrittlement records if required)	n/a	2						
Continuity check for electrically insulated couplings	8.11	3						
Torque meters	11.3							
Calibration records	n/a	1						
Hazardous zone ratings clearly marked	n/a	2						
Overload protection devices (review of test results and/or certification)	7.4.4	2						
Ring and plug gauge	11.2.5	2						
Lapping tools	11.2.6	2						
Physical testing								
Axial natural frequency (ANF)	12.4.1	2						
Other (as specified and agreed upon by vendor and purchaser)	12.4.2	3						

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Annex N
(informative)

Purchaser's Checklist

This purchaser's checklist (Table N.1) may be used in conjunction with the data sheets (Annex A) to:

a) verify that the purchaser's specific requirements have been provided to the vendor for the items identified in the standard, with a bullet (•), that a decision or information is required from the purchaser;

b) ensure that the questions have been thoroughly addressed.

The purchaser should indicate in the appropriate column if the question has been sufficiently addressed or needs to be addressed by placing an "X" in the appropriate space. Comments can be added as required.

Table N.1—Purchaser's Checklist

Clause	Questions	Verified		Comments
		Yes?	No?	
4.1	Has the unit of measure been decided?			
5.1	Has the type of coupling required been specified by the purchaser and agreed upon by the driven-equipment manufacturer?			
5.2.1	Has the required period for uninterrupted continuous operation been defined?			
5.3	Has any future condition for the sizing of the coupling, coupling-to-shaft juncture, and shafting been specified?			
5.4	For trains with multiple couplings, have load profiles/ load sharing been considered?			
6.2	Have all operating requirements been provided to the coupling manufacturer by the purchaser?			
6.3	Have all requirements for angular misalignments and parallel offset been provided to the coupling manufacturer by the purchaser? Note the relationship between foundation stiffness, DBSE, equipment thermal growth, and required coupling flexibility.			
6.4	Have all requirements for axial displacements and shaft thermal growth/pre-stretch been provided to the coupling manufacturer by the purchaser? If "no," is the default standard requirement acceptable?			
6.5	Has the required operating speed range, minimum allowable speed to maximum continuous speed, and trip speed, been specified by the purchaser?			
6.6	Has method a) or method b) been selected for the coupling steady state selection torque?			
6.7	Has the required steady-state torque been defined at the driven-machine purchaser's specified operating point?			
6.9	Has a service factor been selected?			
6.10	Has the coupling been specified to be designed at 1.2 times the driver rating? If so, does this requirement result in an excessively conservative selection?			

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Table N.1—Purchaser's Checklist (Continued)

Clause	Questions	Verified		Comments
		Yes?	No?	
6.13	Have any transient torques associated with a generator short circuit and/or a motor breaker re-closure been specified by the purchaser?			
6.17	Has the requirement for drain passages in all components that could potentially trap liquids been defined? Has the coupling manufacturer defined the number, size, and location of all drain passages?			
7.4	Has the number of occurrences of transients been provided?			
8.1.4	Has the necessary amount of shim adjustment range been provided by the coupling manufacturer and agreed upon by the purchaser?			
8.1.5	Does the coupling design provide for spacer retention in case of a flexible element failure? Have the consequences of a failure and the potential impacts on operation of the equipment been considered?			
8.1.6	Has the requirement for any load transmission in the event of a complete flexible element failure been identified by the purchaser? If so, have the operating duration, load, time to stop, and speed been defined?			
8.3	Has the coupling spacer length been defined by the purchaser? If not, is the default standard requirement acceptable?			
8.4	Has the coupling hub type been defined by the purchaser for each shaft end?			
8.5.1	If integral flanges are to be provided, has the flange geometry been agreed upon by the coupling vendor and the manufacturer with unit responsibility? Will a drill template be needed for hole machining?			
8.5.2	Is an adaptor required for mounting the coupling to an integral flange? If so, is the adaptor provided by the coupling manufacturer or the machinery manufacturer?			
8.6.1.2	Has the type of bore, use of keys, and interference been provided?			
8.6.1.3	Has the degree of interference been determined?			
8.6.1.5	Has the straight bore reference document been specified?			
8.6.2.1	Has the taper been specified?			
8.6.2.2 8.6.2.3	If tapered bore hubs are used, has the shaft taper been agreed upon by the coupling manufacturer and the machine manufacturer?			
8.6.2.4	Have the method and acceptance criteria for checking the surface contact area of the hub to the shaft been defined?			
8.6.3.1	Have the number and configuration of the keyways been specified?			
8.7	Has an idling adapter (solo) plate been specified to allow uncoupled operation of the driver?			

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Table N.1—Purchaser's Checklist (Continued)

Clause	Questions	Verified		Comments
		Yes?	No?	
8.8	Has a moment simulator been specified to allow uncoupled operation of the driver? Have the design dimensions been provided to the coupling manufacturer? Will the moment simulator also be used as a solo plate? Will a dummy hub or adaptor plate style of simulator be required? Has the equipment supplier defined the distance from shaft end to closest bearing such that simulator design can be confirmed?			
8.9.3	Is the coupling vendor required to perform calculations to verify the potential imbalance of the complete coupling?			
8.10.8	Has the required quantity of spare fasteners and nuts been defined by the purchaser?			
8.11	Has the coupling been specified to be electrically insulated and confirmed with the motor/generator supplier as to whether they require an insulated coupling?			
8.12.2	Have the purchaser and vendor agreed on the acceptance criteria for the coupling lateral natural frequency, the calculation methodology, who will perform the calculations, and the assumptions used?			
8.12.4	Has the torsional stiffness tolerance range been indicated?			
9.1	Have the balancing criteria and methods been specified by the purchaser?			
9.2.2	Is the coupling to be subject to a repeatability check?			
9.2.3	Is the coupling to be subject to a repeatability check?			
9.3.5.6	Has the allowable shaft unbalance been provided by the purchaser?			
9.3.6	Has the allowable shaft unbalance been provided by the purchaser?			
9.3.7.4	Has the allowable shaft unbalance been provided by the purchaser?			
9.3.8	Has a residual unbalance check been specified by the purchaser?			
9.3.9	Has a repeatability check been specified by the purchaser?			
9.3.10	Are interchangeable spare parts being provided with the coupling, and do they require a component interchangeability test?			
9.4	Have threaded holes for trim balancing been specified? Details (number, size, depth, and location) are to be agreed upon by the purchaser and the vendor.			
10.3 10.4 10.6	Have any corrosive agents in the atmosphere been specified by the purchaser? The vendor and purchaser shall discuss the need for design measures to resist corrosion (oil mist, purging, corrosion-resistant materials, coatings).			

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Table N.1—Purchaser's Checklist (Continued)

Clause	Questions	Verified		Comments
		Yes?	No?	
11.2.1	Has the scope of supply for providing equipment required for the installation and removal of hydraulically fitted hubs been specified (pumps, hoses, fittings, gauges)?			
11.2.3	Is a stop-ring being provided for a hydraulically fitted coupling hub?			
11.2.4	Is a puller being provided for a keyed coupling hub?			
11.2.5	Are matching ring and plug gauges to be supplied by the coupling manufacturer? If not, and required, who will provide?			
11.2.6	Are lapping tools to be supplied by the coupling manufacturer?			
11.3.1	Is a torque measuring system to be included?			
11.3.2	Has the torque measuring system supplier been specified?			
11.3.5	Has the location for measuring for the torque measuring system been identified?			
11.3.6	Is the torque measuring system capable of measuring cyclic torque?			
11.3.7	Is the torque measuring system incorporated into the safety trip system?			
12.2.1	Has the extent of inspection participation been identified, considering Annex M?			
12.2.5	Has the advanced notice for witnessed or observed inspections or tests been identified?			
12.3.2	Has the request to have the data available for at least 5 years been made?			
12.3.6	Has the inspector's checklist been discussed?			
12.4.1	Has the requirement for axial natural frequency verification testing been specified by the purchaser? If required, the test technique shall be agreed upon by the purchaser and the vendor.			
12.5.2	Have the storage location and expected storage time been specified by the purchaser?			
12.5.3	Has the packaging been identified for domestic or export shipping?			
12.5.5	Has the information been provided for identification?			
12.5.8	Are additional identifying markings required on the coupling?			
13.1.2	Has the information in 13.1.2 been specified?			
Annex B.1.3	Has a resilient coupling been specified?			
Annex B.2.5	Have any material restraints been specified?			
Annex B.2.6	Have the minimum requirements for torsional damping and the allowable range of torsional stiffness been specified?			
Annex B.2.7	Have any restrictions regarding the use of elastomers in shear been specified?			
Annex B.2.10	Is the coupling to be a single or double engagement type?			

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Table N.1—Purchaser's Checklist (Continued)

Clause	Questions	Verified		Comments
		Yes?	No?	
Annex B.2.11	Is the coupling to be a spacer or non-spacer type coupling?			
Annex B.2.12	Has the length of the spacer been specified?			
Annex B.3.2	Is the coupling to be checked balanced and/or assembled balanced?			
Annex B.4.1	Has the operating environment conditions been specified so that the materials of construction can be agreed?			
Annex B.5.3	Has the life expectancy of the elastomeric elements been identified?			
Annex C.1.3	Has a gear coupling been specified?			
Annex C.3.1	Have the maximum axial displacements and direction been identified?			
Annex C.3.3	Is the coupling to have external or internal teeth?			
Annex C.3.9	Has the lubrication for the coupling been established?			
Annex C.3.10	Have the requirements for continuous lubrication for the coupling been determined?			
Annex D.1.2	Has a quill-shaft coupling been specified?			
Annex D.2.2	Have the maximum misalignments been established?			
Annex H.2.1	Has the coordination for who is to supply all coupling guards been established?			
Annex H.2.2	Has the type of coupling guard been selected?			
Annex H.2.6	Are expanded metal or perforated sheet coupling guards to be selected?			
Annex H.2.8	Have the requirements for the coupling guards been identified?			
Annex H.2.10	Is a spark-resistant material required?			
Annex H.2.11	Has a risk analysis been specified?			
Annex H.2.13	Has the responsibility for performing calculations to determine the maximum internal coupling guard temperature been agreed upon?			
Annex H.3.3	Is the coupling guard to be oil tight?			
Annex H.4.3	Are the vent and drains to be flanged?			
Annex H.4.7	Is the guard to be fitted with connection(s) for purging or inert air?			
Annex H.4.8	Is the contract coupling guard to be used for the factory testing of the driver and driven equipment?			
Annex H.5.4	Is a transparent window to be provided?			
Annex L.1	Has the range of torque—including steady state torque, speed, temperature, and overload conditions of interest—been identified?			
Annex L.6	Have the signal output and signal processing integration been identified?			
Annex O.2.1.6	Has a coordination meeting been considered?			
Annex O.2.3.2.L	Has a list of similar couplings been specified?			

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Table N.1—Purchaser's Checklist (Continued)

Clause	Questions	Verified		Comments
		Yes?	No?	
Annex O.2.4	Has a modified Goodman Diagram (S-N curve) for the coupling been specified?			
Annex O.3.1.2	Has the purchaser stated the number and type of drawings, along with the timetable?			
Annex O.3.2.3	Has the ambient temperature been provided?			
Annex O.3.4	Have all required spare parts to be supplied been identified?			
Annex O.3.5.1.2	Has the purchaser stated the number and type of manuals, along with the timetable?			

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Annex O
(informative)

Contract Documents and Engineering Design Data

O.1 Documents and Data

When specified by the purchaser in Section 13.1.2, the contract documents and engineering design data shall be supplied by the vendor, as listed in this annex.

O.1.1 The following data shall be identified with the following information on transmittal (cover) letters, title pages, and correspondence:

a) purchaser's/owner's corporate name;

b) job/project number;

c) equipment item number and service name;

d) inquiry or purchase order number;

e) any other identification specified in the inquiry or purchase order;

f) vendor's identifying proposal number, shop order number, serial number, or other reference required to completely identify return correspondence.

O.1.2 Each drawing shall have a title block in the lower right-hand corner with the date of certification, identification data specified in O.1.1, revision number, date, and title. Similar information shall be provided on all other documents, including sub-vendor items.

O.2 Proposals

O.2.1 General

O.2.1.1 The vendor shall forward the original proposal, with the specified number of copies, to the addressee specified in the inquiry documents.

O.2.1.2 The proposal shall include, at a minimum, the data specified in O.2.2 through O.2.5, and a specific statement that the equipment and all its components and auxiliaries are in strict accordance with this standard.

O.2.1.3 If the equipment or any of its components or auxiliaries is not in strict accordance, the vendor shall include a list that details and explains each deviation.

O.2.1.4 The vendor shall provide sufficient detail to enable the purchaser to evaluate any proposed alternative designs.

O.2.1.5 All correspondence shall be clearly identified in accordance with O.1.2.

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O.2.2 Drawings

O.2.2.1 The drawings indicated in this annex shall be included in the proposal. At a minimum, the following shall be included:

a) a general arrangement or outline drawing for each coupling or accessory, such as a coupling guard or torque monitoring system (when supplied) showing overall dimensions, maintenance clearance dimensions, overall weights, erection weights, and the largest maintenance weight for each item. The direction of rotation and the size and location of major purchaser connections shall also be indicated;

b) cross-sectional drawings showing the details of the proposed equipment;

c) schematics of all auxiliary systems, including air, lube oil, control, and electrical systems;

d) bills of material;

e) sketches that show methods of lifting major components and auxiliaries; this information may be included on the drawings specified in item a) above.

O.2.2.2 If “typical” drawings, schematics, and bills of material are used, they shall be marked up to show the weight and dimension data to reflect the actual equipment and scope proposed.

O.2.3 Technical Data for Proposal

O.2.3.1 All technical data shall be given in units of measurement according to the purchase order. If needed, the technical data in alternate units can be included in parentheses.

O.2.3.2 The following data shall be included in the proposal.

a) purchaser’s data sheets with complete vendor information entered and literature to fully describe details of the offering;

b) vendor drawing and data indicating the schedule according to which the vendor agrees to transmit all the data specified;

c) schedule for shipment of the equipment, in weeks after receipt of an order;

d) list of coupling’s major components, showing any interchangeability with the owner’s existing equipment;

e) list of special tool requirements;

f) list of spare parts recommended for startup and normal maintenance purposes;

g) list of the special tools furnished for maintenance;

h) description of any special weather protection and winterization required for startup, operation, and periods of idleness under the site conditions specified on the data sheets. This description shall clearly indicate the protection to be furnished by the purchaser, as well as that included in the vendor’s scope of supply;

i) complete tabulation of utility requirements, e.g. electricity, air, and lube oil (including the quantity and supply pressure of the oil required and the heat load to be removed by the oil). Approximate data shall be clearly indicated as such;

j) potential unbalance calculations, if specified; see 8.9.3;

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k) proposed inspection plan for vendor's review (Annex M);

l) ● if specified, a list of similar couplings installed and operating under analogous conditions;

m) any startup, shutdown, or operating restrictions required to protect the integrity of the equipment;

n) a list of any components that can be construed as being of alternative design, hence requiring purchaser's acceptance;

o) component designed for a finite life.

O.2.4 ● Curves

The vendor shall provide appropriate curves. If specified, a modified Goodman Diagram (S-N curve) for the coupling shall be provided.

O.2.5 Optional Tests

The vendor shall furnish an outline of the procedures to be used for each of the special or optional tests that have been specified by the purchaser or proposed by the vendor.

O.3 Engineering Design Data

O.3.1 General

O.3.1.1 Engineering data shall be furnished by the vendor as required within this specification, including:

a) data required by mandate or purchaser decision as specified in 12.3.2 and 12.3.3;

b) certified balance records;

c) relationships as described in B.5 as required.

O.3.1.2 The purchaser shall review the vendor's data upon receipt; however, this review shall not constitute permission to deviate from any requirements in the order unless specifically agreed in writing. After the data have been reviewed and accepted, the vendor shall furnish certified copies in the quantities specified.

O.3.1.3 A complete list of vendor data shall be included with the first issue of major drawings. This list shall contain titles, drawing numbers, and a schedule for transmittal of each item listed.

O.3.2 Drawings and Technical Data

O.3.2.1 The drawings and data furnished by the vendor shall contain sufficient information so that, together with the manuals specified in O.3.5, the purchaser can properly install, operate, and maintain the equipment covered by the purchase order. All contract drawings and data shall be clearly legible (8-point minimum font size, even if reduced from a larger-size drawing), shall cover the scope of the data requirements, and shall satisfy the applicable detailed descriptions in this annex. A typical purchaser's checklist is provided in Annex N, and can be used by the purchaser to ensure that items related to the coupling purchase have been addressed. This checklist is typically used in conjunction with the data sheets.

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O.3.2.2 The following information shall be provided on the coupling drawing(s). A copy of the finalized drawing shall be included with the shipment of the coupling. Typical (generic) drawings are not acceptable.

a) purchaser's order number (on every drawing);

b) purchaser's equipment item number (on every drawing);

c) make, type, and size of the coupling;

d) mass of each part of the coupling and mass of the entire assembled coupling;

e) mass and location of the center of mass of each half coupling (the effective center of mass of the half coupling is referenced from the equipment shaft end, with a positive location being beyond the shaft end and a negative location being within the shaft);

f) all principal overall outline, interface, and other critical dimensions, including interface pilot diameters, gear pitch diameter, lengths, hub-to-hub and shaft-end spacing, hub bore details (including keyways), hub-to-shaft interference fits, hub advances, and axial float;

g) distance from centerline to centerline of the flexing elements;

h) if applicable, axial natural frequencies of flexible element couplings;

i) polar mass moment of inertia for each coupling half (including half of the spacer). Polar moment of inertia and mass calculations are based on keyways being filled;

j) torsional stiffness and, if specified, range (8.12.4);

k) lateral natural frequency of the spacer, including assumptions that were used;

l) interval of the replacement of fasteners of all normally removable fasteners (8.10.4);

m) thread dimensions and trim-balancing hole dimensions;

n) materials of construction;

o) materials and outline dimensions of solo plate and/or moment simulator, if supplied;

p) maximum permissible values of axial displacement and angular misalignment for continuous and transient operation;

q) description of match-mark locations and nomenclature;

r) continuous, peak, and momentary torque ratings;

s) for all hubs:

   1) hub-to-shaft interference range;

   2) hub draw-up range (for taper-bored fits);

   3) torque capacity of hub-shaft interface (for keyless hubs only);

t) for flexible element couplings:

   1) flexible-element lateral stiffness—the ratio of the force to displacement while deflecting the coupling in a plane perpendicular to the coupling axis of rotation;

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2) maximum axial force at maximum deflection or axial stiffness;

3) maximum bending moment or bending stiffness—the force or bending moment required to angularly misalign a coupling to a specified angle while under torque load.

u) number of cycles specified for cyclic torque rating in 7.4.3.

O.3.2.3 Enclosure data and ambient-temperature data at the coupling location shall be supplied by the purchaser for the calculations in Annex H.2.13.

O.3.3 Progress Reports

The vendor shall submit progress reports to the purchaser at intervals specified. These reports shall, at a minimum, include the following:

a) overall progress summary;

b) status of engineering;

c) status of document submittals;

d) status of major suborders;

e) updated production schedule;

f) inspection/testing highlights for the month;

g) any pending issues.

O.3.4 Parts Lists and Recommended Spares

O.3.4.1 The vendor shall submit complete parts lists for all equipment and accessories supplied.

O.3.4.2 These lists shall include part names, manufacturers' unique part numbers, and materials of construction (identified by applicable international standards).

O.3.4.3 Each part shall be completely identified and shown on appropriate cross-sectional, assembly-type cutaway or exploded-view isometric drawings.

O.3.4.4 Interchangeable parts shall be identified as such.

O.3.4.5 Parts that have been modified from standard dimensions or finish to satisfy specific performance requirements shall be uniquely identified by part number.

O.3.4.6 The vendor shall indicate on each of these complete parts lists all those parts that are recommended as startup or maintenance spares, and the recommended stocking quantities of each. These shall include spare-parts recommendations of subvendors that were not available for inclusion in the vendor's original proposal.

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O.3.5 Installation, Operation, Maintenance, and Technical Data Manuals

O.3.5.1 General

The vendor shall provide sufficient written instructions and all necessary drawings to enable the purchaser to install, operate, and maintain all of the equipment covered by the purchase order. This information shall be compiled in a manual or manuals with a cover sheet showing the information listed in O.1.2, an index sheet, and a complete list of the enclosed drawings by title and drawing number. The manual pages and drawings shall be numbered. The manual or manuals shall be prepared specifically for the equipment covered by the purchase order. “Typical” manuals are unacceptable.

O.3.5.1.1 A draft manual(s) shall be issued to the purchaser 8 weeks prior to mechanical testing for review and comment.

O.3.5.1.2 The purchaser shall determine the number of copies needed. Hard copies and electronic copies shall be provided as described in the purchase order requirements.

O.3.5.2 Installation Manual

O.3.5.2.1 All information required for the proper installation of the equipment shall be compiled in a manual that shall be issued no later than the time of issue of final certified drawings. For this reason, it may be separate from the operating and maintenance instructions.

O.3.5.2.2 This manual shall contain information such as instructions covering installation, final tests and checks, startup, shutdown, operating limits, and operating and maintenance procedures. For flexible element couplings, the manuals shall include pre-stretch or pre-compression values, and instructions regarding the application of spacer shims. The manuals shall include instructions for mounting and use of any devices, such as solo plates or moment simulators.

O.3.5.2.3 All drawings and data specified in O.2.2 and O.2.3 that are pertinent to proper installation shall be included as part of this manual.

O.3.5.2.4 One extra manual, over and above the specified quantity, shall be included with the first equipment shipped.

O.3.5.2.5 All recommended receiving and storage procedures shall be included.

NOTE Refer to API 686 for data required for installation.

O.3.5.3 Operating and Maintenance Manual

A manual containing all required operating and maintenance instructions shall be supplied at shipment. In addition to covering operation at all specified process conditions, this manual shall also contain separate sections covering operation under any specified extreme environmental conditions.

O.3.5.4 Technical Data Manual

The vendor shall provide the purchaser with a technical data manual at shipment.

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