INTERNATIONAL STANDARD

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# Petroleum, petrochemical and natural gas industries — Flexible couplings for mechanical power transmission — Special-purpose applications

*Industries du pétrole, de la pétrochimie et du gaz naturel — Accouplements flexibles pour transmission de puissance mécanique — Applications spéciales*



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## Contents

Page

# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10441 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

This second edition cancels and replaces the first edition (ISO 10441:1999), which has been technically revised.

## Introduction

This International Standard was developed from the API Std 671, 3rd edition, 1998. It is intended that the 4th edition of API Std 671 will be identical to this International Standard.

Users of this International Standard should be aware that further or differing requirements may be needed for individual applications. This International 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 International Standard and provide details.

This International Standard requires the purchaser to specify certain details and features.

A bullet (●) at the beginning of a subclause or 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 J; otherwise it should be stated in the quotation request or in the order.



 

# Petroleum, petrochemical and natural gas industries — Flexible couplings for mechanical power transmission — Special-purpose applications

## 1 Scope

This International 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 International 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 A; gear-type couplings are detailed in Annex B and quill shaft style couplings are detailed in Annex C.

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



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



This International 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.

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

ISO 286-2, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

ISO 2491, *Thin parallel keys and their corresponding keyways (Dimensions in millimetres)*

ANSI Y14.2M[1)], *Line Conventions and Lettering*

ANSI/AGMA 9000[2)], *Flexible Couplings — Potential Unbalance Classification*

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

ANSI/AGMA 9003, *Flexible Couplings — Keyless Fits*

1) American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA.

2) American Gear Manufacturers Association, 500 Montgomery Street, Suite 350, Alexandria, VA 22314-1560, USA.

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

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

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

ANSI/ASME B1.1[3)], *Unified inch screw threads, UN and UNR thread form*

DIN 7190[4)], *Interference fits — Calculation and design rules*

## 3 Terms and definitions

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

**3.1**
**angular misalignment**
⟨double-engagement couplings⟩ two minor angles between the extension of each machine centreline and the centreline of the structure joining the two flexible elements

**3.2**
**angular misalignment**
⟨single-engagement couplings⟩ minor angle between the extensions of two machine-shaft centrelines

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



**3.3**
**assembly balance**
procedure in which a completely assembled coupling is balanced as a unit



**3.4**
**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 carried out on a component balanced coupling, or on an assembly-balanced coupling.

**3.5**
**axial displacement**
change in the relative axial position of the adjacent shaft ends of two coupled machines, usually caused by thermal expansion

**3.6**
**component balance**
procedure for achieving coupling balance in which the components or factory assembled sub-assemblies are balanced separately before assembly of the coupling

**3.7**
**continuous torque rating**
coupling manufacturer's declared maximum torque that the coupling is capable of transmitting continuously for unlimited periods

3) ASME International, Three Park Avenue, New York, NY 10016-5990, USA.

4) Deutsches Institut fur Normung, Burggrafenstrasse 6, Sresemannallee 15, Berlin, Germany D-10787.

 

**3.8**
**crown diameter**
major diameter of the external teeth of a gear-type coupling

**3.9**
**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

**3.10**
**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.

**3.11**
**factor of safety**
factor that is used to cover uncertainties in a coupling design

EXAMPLES Analytical assumptions in stress analysis, material properties, manufacturing tolerances, etc.

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.



**3.12**
**fatigue factor of safety**
factor of safety at the published continuous rated conditions of torque, speed, misalignment and axial displacement, used by the manufacturer to establish the coupling rating



See 7.1.

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

**3.13**
**flex-hub coupling**
gear-type coupling with the external teeth on the hubs and the internal teeth in the sleeves

**3.14**
**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

**3.15**
**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

**3.16**
**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 or driven machine without dismounting the coupling hub

**3.17**
**lateral offset**
lateral distance between the centrelines of two shafts, which are not parallel, measured perpendicularly to the centreline and in the plane of the shaft end of the driving machine

See Annex F.

**3.18**
**manufacturer**
agency responsible for the design and fabrication of the coupling

NOTE The manufacturer is not necessarily the vendor.

**3.19**
**maximum allowable temperature**
maximum continuous temperature for which the manufacturer has designed the coupling

**3.20**
**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

a) a single value when 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 inter-related function of speed, torque, and axial displacement.



**3.21**
**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 when 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 inter-related function of speed, torque, and angular misalignment.

**3.22**
**maximum continuous speed**
highest rotational speed at which the coupling, as made and tested, is capable of continuous operation

**3.23**
**metallic flexible-element coupling**
coupling type that obtains its flexibility from the flexing of thin metallic discs, diaphragms or links

**3.24**
**moment simulator**
auxiliary device intended to simulate the moment of the mass of a half coupling

NOTE A moment simulator can also be designed to serve as an idling adapter (solo plate).

**3.25**
**momentary torque limit**
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

 

**3.26**
**normal operating point**
point at which usual operation is expected

NOTE This point is usually the point at which the machine manufacturer(s) certify(ies) that performance is within the tolerances stated to the owner.

**3.27**
**owner**
final recipient of the equipment, who may delegate another agent as the purchaser of the equipment

**3.28**
**parallel offset**
distance between the centrelines of two coupled shafts that are parallel but not in the same straight line

See Annex F.

**3.29**
**peak torque rating**
maximum torque the coupling can tolerate for short periods

**3.30**
**pilot**
**rabbet**
**register**
surface that positions a coupling component, sub-assembly or assembly radially with respect to another coupling component



**3.31**
**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 sub-assemblies and possible eccentricity of the components and sub-assemblies 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 sub-assembly,

b) errors in the balance of each component or sub-assembly resulting from eccentricity in the fixture used to mount the component or sub-assembly in the balance machine,

c) the unbalance of each component or sub-assembly 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 E.

**3.32**
**purchaser**
agency that issues the order and the 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 machine.

**3.33**
**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.

**3.34**
**rated speed**
highest rotational speed at which the coupling is required to be capable of transmitting the continuous torque rating while simultaneously subjected to the rated angular misalignment and the coupling rated axial displacement

**3.35**
**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 the relevant standard

**3.36**
**service factor**
factor applied to the steady-state torque in order to allow for off-design conditions, cyclic and other variations as well as equipment variations resulting in higher torque than that at the equipment normal operating point

NOTE Service factor is not the same as the factor of safety, 3.11 or the fatigue factor of safety, 3.12.

**3.37**
**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 International Standard) can accommodate offset misalignment to a limited extent.



**3.38**
**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.



**3.39**
**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.

**3.40**
**torsional damping**
absorption or dissipation of oscillatory rotary energy

NOTE Torsional damping is necessary in some cases to limit the build-up of steady-state torsional resonant oscillations in a system.

**3.41**
**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

**3.42**
**torsionally resilient coupling**
coupling with increased flexibility in a rotational direction, increased capability to recover from flexing and with 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.

**3.43**
**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 and, with oscillating torques, also the frequency.

**3.44**
**total indicator reading**
**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 1 For a perfectly cylindrical surface, the total indicator reading implies an eccentricity equal to half the reading. For a perfectly flat face, the total indicator reading implies an out-of-squareness equal to the reading. If the surface in question is not perfectly cylindrical or flat, the interpretation of the meaning of total indicator reading is more complex and can represent ovality or lobing.

NOTE 2 Total indicator reading is also known as “full indicator movement”.

**3.45**
**unit responsibility**
responsibility for co-ordinating the delivery and technical aspects of 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.



**3.46**
**vendor**
**supplier**
agency that supplies the equipment

NOTE The vendor is the manufacturer of the equipment or the manufacturer’s agent and normally is responsible for service support.

## 4 Statutory requirements

The purchaser and the vendor shall mutually determine the measures to be taken to comply with any federal, state or local codes, regulations, ordinances or rules that are applicable to the equipment.

## 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 A; for gear couplings, refer to Annex B; and for quill-shaft couplings, refer to Annex C.

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

In general, a special-purpose coupling shall be designed and constructed for a minimum service life of five years for flexible element couplings and three years for gear and torsional damping and resilient couplings.

Figure 1 provides guidance for the typical selection process for a coupling.

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

 

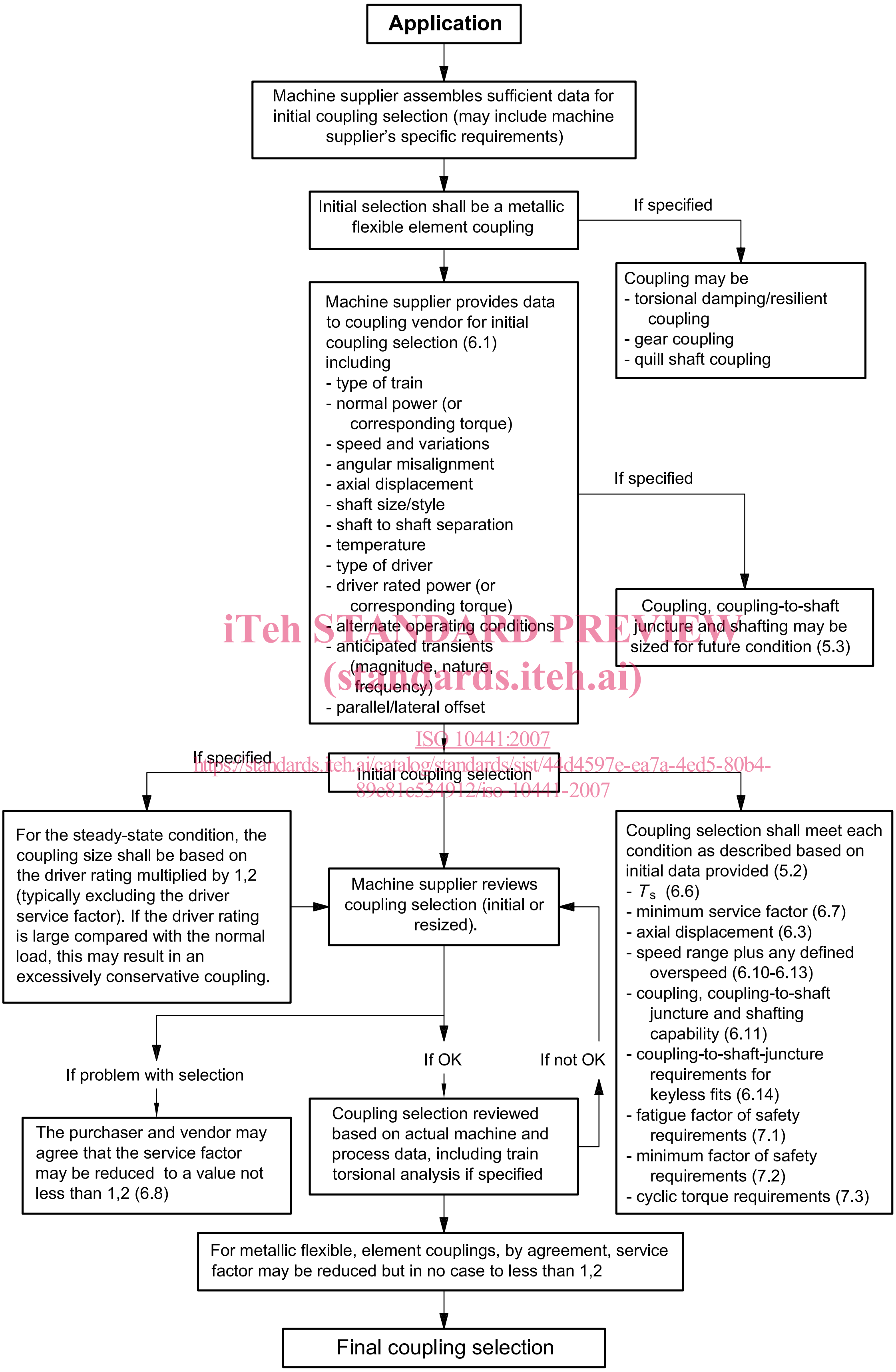




**Figure 1 — Typical coupling selection process**

## 6 Coupling design

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

a) type of train;

b) normal power;

c) normal speed and variations;

d) maximum continuous speed;

e) any defined overspeed;

f) angular misalignment;

g) axial displacements;

h) shaft sizes and styles;

i) distance between shaft-ends;

j) temperature;

k) type of driver;

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

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



● **6.2** The purchaser shall specify the maximum angular misalignments the coupling is expected to experience during start-up, 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°.

● **6.3** 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 start-up, normal operation and shut-down cycle. These dimensions shall be given from the machine at ambient conditions, 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.

● **6.4** The purchaser shall specify the speed range for the fully assembled coupling, moment simulator and solo plate for both continuous speed and any defined overspeed.

**6.5** The steady-state torque, $T_{\text{n}}$, expressed in newton-metres (inch-pounds force), shall be determined as given in Equation (1):

$$T_{\text{n}} = \frac{K_1 \times P_{\text{normal}}}{N_{\text{normal}}} \qquad (1)$$

where

$K_1$ is a constant, equal to 9 550 (63 000);

 