#### **DIN EN 1515-4**



ICS 21.060.10; 21.060.20; 23.040.60

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Flanges and their joints – Bolting – Part 4: Selection of bolting for equipment subject to the Pressure Equipment Directive 2014/68/EU; English version EN 1515-4:2021, English translation of DIN EN 1515-4:2021-06

Flansche und ihre Verbindungen – Schrauben und Muttern – Teil 4: Auswahl von Schrauben und Muttern zur Anwendung im Gültigkeitsbereich der Druckgeräterichtlinie 2014/68/EU; Englische Fassung EN 1515-4:2021, Englische Übersetzung von DIN EN 1515-4:2021-06

Brides et leurs assemblages -

Boulonnerie -

Partie 4: Sélection de la boulonnerie pour équipements relevant de la Directive Equipements sous pression 2014/68/EU;

Version anglaise EN 1515-4:2021,

Traduction anglaise de DIN EN 1515-4:2021-06

Document comprises 25 pages

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In case of doubt, the German-language original shall be considered authoritative.

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A comma is used as the decimal marker.

# National foreword

This document (EN 1515-4:2021) has been prepared by Technical Committee CEN/TC 74 "Flanges and their joints" (Secretariat: DIN, Germany).

The responsible German body involved in its preparation was *DIN-Normenausschuss Rohrleitungen und Dampfkesselanlagen* (DIN Standards Committee Piping and Boiler Plant), Working Committee NA 082-00-16 AA "Flanges and their joints; national mirror committee for CEN/TC 74".

The DIN documents corresponding to the documents referred to in this document are as follows:

ISO 261:1998	DIN ISO 261:1999-11
ISO 965-1	DIN ISO 965-1
ISO 965-2:1998	DIN ISO 965-2:1999-11
ISO 965-3	DIN ISO 965-3
ISO 965-4	DIN ISO 965-4
ISO 965-5	DIN ISO 965-5
ISO 8992	DIN ISO 8992

For current information on this document, please go to DIN's website (www.din.de) and search for the document number in question.

#### Amendments

This standard differs from DIN EN 1515-4:2010-04 as follows:

- a) requirements for starting material have been explained in accordance with EN 10269:2013;
- b) some temperature ranges and assignment of material groups have been amended in Table 3;
- c) an option for traceability by means of lot identification marking has been included instead of inspection documents;
- d) separate requirements have been given to bolting other than that in EN 10269:2013;
- e) requirements for prevention of brittle fracture have been updated.

#### **Previous editions**

DIN EN 1515-4: 2010-04

## National Annex NA (informative)

# Bibliography

DIN ISO 261:1999-11, ISO general purpose metric screw threads — General plan (ISO 261:1998)

DIN ISO 965-1, ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data

DIN ISO 965-2:1999-11, ISO general purpose metric screw threads — Tolerances — Part 2: Limits of sizes for general purpose external and internal screw threads — Medium quality (ISO 965-2:1998)

DIN ISO 965-3, *ISO general purpose metric screw threads* — *Tolerances* — *Part 3: Deviations for constructional threads* 

DIN ISO 965-4, ISO general purpose metric screw threads — Tolerances — Part 4: Limits of sizes for hot-dip galvanized external screw threads to mate with internal screw threads tapped with tolerance position H or G after galvanizing

DIN ISO 965-5, ISO general purpose metric screw threads — Tolerances — Part 5: Limits of sizes for internal screw threads to mate with hot-dip galvanized external screw threads with maximum size of tolerance position h before galvanizing

DIN ISO 8992, Fasteners — General requirements for bolts, screws, studs and nuts

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# EUROPEAN STANDARD NORME EUROPÉENNE EUROPÄISCHE NORM

# EN 1515-4

March 2021

ICS 21.060.10; 21.060.20; 23.040.60

Supersedes EN 1515-4:2009

**English Version** 

# Flanges and their joints -Bolting -Part 4: Selection of bolting for equipment subject to the Pressure Equipment Directive 2014/68/EU

Brides et leurs assemblages -Boulonnerie -Partie 4: Sélection de la boulonnerie pour équipments relevant de la Directive Equipments sous pression 2014/68/EU Flansche und ihre Verbindungen -Schrauben und Muttern -Teil 4: Auswahl von Schrauben und Muttern zur Anwendung im Gültigkeitsbereich der Druckgeräterichtlinie 2014/68/EU

This European Standard was approved by CEN on 1 February 2021.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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# **European foreword**

This document (EN 1515-4:2021) has been prepared by Technical Committee CEN/TC 74 "Flanges and their joints", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2021, and conflicting national standards shall be withdrawn at the latest by September 2021.

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

This document supersedes EN 1515-4:2009.

EN 1515, *Flanges and their joints* — *Bolting*, consists of the following parts:

- Part 1: Selection of bolting;
- Part 2: Classification of bolt materials for steel flanges, PN designated;
- Part 3: Classification of bolt materials for steel flanges, class designated;
- Part 4: Selection of bolting for equipment subject to the Pressure Equipment Directive 2014/68/EU.

Main changes compared to edition EN 1515-4:2009:

- explanation of requirements for starting material in accordance to EN 10269:2013;
- some temperature ranges and assignment of material groups are amended in Table 3;
- option for traceability by means of lot identification marking instead of inspection documents;
- separate requirements have been given to bolting other than those in EN 10269:2013;
- requirements for prevention of brittle fracture have been updated.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

#### 1 Scope

This document is applicable to the selection of bolting for flanged joints on equipment subject to the Pressure Equipment Directive 2014/68/EU.

It specifies standards and additional requirements for dimensions, material properties and technical conditions of delivery for bolting.

NOTE 1 Washers are not within the scope of this document.

The selection is based on commonly used bolting. It covers common temperature ranges of the general service of flanges.

When selecting bolting according to this document it is essential to take into account environmental conditions and other parameters including type of fluids, corrosion hazards, sour service, low temperature brittle failure and relaxation at elevated temperatures.

The purpose of this document is to provide a selection of most commonly used bolting types and bolting material combinations.

It is not the intention to specify all possible applications but to give guidance on the most common applications. For example, application limits for material in the creep range are not explicitly covered in this document. Where material standard provides mechanical properties for the creep range respective reference is made in Table 3.

NOTE 2 Special services and ambient conditions may require the application of coatings. It is the purchaser's option to decide on this. Depending on the coating used, a verification of the temperature ranges given in Table 3 and Table 4 may be required.

NOTE 3 In Annex B there are bolting types and bolting material combinations according to commonly used national standards other than those listed in Table 2, Table 3 and Table 4.

#### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN 764-5:2014, Pressure equipment - Part 5: Inspection documentation of metallic materials and compliance with the material specification

EN 1092-1:2018, Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 1: Steel flanges

EN 1759-1:2004, Flanges and their joint - Circular flanges for pipes, valves, fittings and accessories, Class designated - Part 1: Steel flanges, NPS 1/2 to 24

EN 10204:2004, Metallic products - Types of inspection documents

EN 10269:2013, Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties

EN 13445-3:2014,<sup>1</sup> Unfired pressure vessels - Part 3: Design

<sup>&</sup>lt;sup>1</sup> As impacted by EN 13445-3:2014/A1:2015, EN 13445-3:2014/A2:2016, EN 13445-3:2014/A3:2017, EN 13445-3:2014/A4:2018, EN 13445-3:2014/A5:2018, EN 13445-3:2014/A6:2019, EN 13445-3:2014/A7:2019 and EN 13445-3:2014/A8:2019.

EN 13480-3:2017,<sup>2</sup> Metallic industrial piping - Part 3: Design and calculation

EN ISO 898-1:2013, Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread (ISO 898-1:2013)

EN ISO 898-2:2012, Mechanical properties of fasteners made of carbon steel and alloy steel - Part 2: Nuts with specified property classes - Coarse thread and fine pitch thread (ISO 898-2:2012)

EN ISO 3269:2019, Fasteners - Acceptance inspection (ISO 3269:2019)

EN ISO 3506-1:2020, Fasteners - Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs with specified grades and property classes (ISO 3506-1:2020)

EN ISO 3506-2:2020, Fasteners - Mechanical properties of corrosion-resistant stainless steel fasteners - Part 2: Nuts with specified grades and property classes (ISO 3506-2:2020)

EN ISO 4014:2011, Hexagon head bolts - Product grades A and B (ISO 4014:2011)

EN ISO 4017:2014, Fasteners - Hexagon head screws - Product grades A and B (ISO 4017:2014)

EN ISO 4032:2012, Hexagon regular nuts (style 1) - Product grades A and B (ISO 4032:2012)

EN ISO 4033:2012, Hexagon high nuts (style 2) - Product grades A and B (ISO 4033:2012)

EN ISO 4042:2018, Fasteners - Electroplated coating systems (ISO 4042:2018)

EN ISO 6892-2:2018, Metallic materials - Tensile testing - Part 2: Method of test at elevated temperature (ISO 6892-2:2018)

EN ISO 16228:2018, Fasteners - Types of inspection documents (ISO 16228:2017)

EN ISO 16426:2002, Fasteners - Quality assurance system (ISO 16426:2002)

ISO 261:1998, ISO general purpose metric screw threads — General plan

ISO 965-2:1998, ISO general purpose metric screw threads — Tolerances — Part 2: Limits of sizes for general purpose external and internal screw threads — Medium quality

#### 3 Terms and definitions

#### 3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

#### 3.1.1 bolting

#### type of fastener such as a bolt, screw or stud with normal, reduced or waisted shank or nut

2

As impacted by EN 13480-3/A1:2021, EN 13480-3/A2:2020 and EN 13480-3/A3:2020.

#### 3.1.2

#### purchaser

person or organization that orders products in accordance with this European Standard

Note 1 to entry: Where a purchaser has responsibilities under the requirements of EU Directive listed in Annex ZA, the use of this European Standard, if its reference is published in the OJEU (Official Journal of European Union), will provide the presumption of conformity with the essential requirements of the Directive as identified in Annex ZA.

#### 3.1.3

#### bolting manufacturer

person or organization that is responsible for the compliance of the bolting with the requirements of this European Standard and the referenced standards given for bolting and starting materials agreed with the purchaser

#### 3.1.4

#### manufacturing lot

quantity of fasteners of a single designation including product grade, property class and sizes, manufactured from bar, wire, rod or flat product from a single cast, processed through the same or similar steps at the same time or over a continuous time period through the same heat treatment and/or coating, if any

Note 1 to entry: Same heat treatment or coating means:

- for a continuous process, the same treatment cycle without any setting modification;
- for a discontinuous process, the same treatment cycle for identical consecutive loads (batches).

Note 2 to entry: The manufacturing lot may be split into several manufacturing batches for processing purposes and then reassembled into the same manufacturing lot.

#### 3.1.5

#### manufacturing lot number

unique number assigned by the bolting manufacturer and which allows full traceability from the finished product back through all previous steps of the manufacturing operations to a given cast number of the starting material of manufacture

#### 3.1.6

#### starting material

material from which the bolt or nut is manufactured

#### 3.1.7

#### creep range

the temperature range at which a material has time dependent mechanical properties

#### 3.2 Symbols and units

The symbols and respective units used in this document are defined in Table 1.

Symbol	Designation	Unit
KV	Impact rupture energy	J
$T_{ m KV}$	Material impact test temperature	°C
$T_{M}$	Minimum metal temperature of the bolting	°C

#### Table 1 — Symbols and units

### 4 Selection of bolting types and materials

#### 4.1 General

The selection of bolting types and bolting material combinations for a certain application shall consider in addition to the requirements covered by this document, the range of application of the equipment for which the bolting is intended to be used. The selection shall consider all service conditions including maximum/minimum allowable temperature, required bolt load, tightening method and resultant stresses, type of fluids, corrosion hazards and if applicable type and material of gasket.

Furthermore, it shall be regarded that flanged joints shall remain tight under the expected operating conditions. Other properties like residual magnetism and relaxation properties shall be evaluated by the purchaser.

The minimum yield strength, tensile strength, and creep of the bolting shall be suitable for the required bolt load determined for the application and tightening method. Where there is a requirement concerning the strength category for bolting given in EN 1092-1:2018, Annex E, EN 1759-1:2004, Annex B, EN 13480-3:2017, Annex D<sup>2</sup>, or EN 13445-3:2014, Clause 11<sup>1</sup>, then this shall be observed by the user of this document.

### 4.2 Selection of bolting types

Selection of bolting types according to Table 2.

Table 2 —	· Types	of bolting
-----------	---------	------------

Dimension	nal standard	Remarks			
Bolts/Studs	Nuts				
EN ISO 4014:2011 EN ISO 4032:2012 EN ISO 4033:2012ª		Hexagon head bolt			
EN ISO 4017:2014	EN ISO 4032:2012 EN ISO 4033:2012ª	Hexagon head bolt, threaded full length			
Annex A	EN ISO 4032:2012 EN ISO 4033:2012ª	Stud bolt, threaded full length			
The user shall determine whether EN ISO 4033:2012 Nuts are required for the application. For sizes $\geq$ M39 nuts with <i>m</i> = <i>d</i> are recommended.					

#### 4.3 Selection of bolting material combinations

A selection of commonly used bolting material combinations and their suitable application ranges is shown in Table 3 and Table 4. Combination of bolting materials other than the combinations shown may reduce the given temperature limits.

All bolting materials shall conform to the requirements of the standard that specifies it and starting material shall fulfil all the requirements of EN 10269:2013. The heat treatment may be performed on the starting material or on the finished bolting.

Guidance on conditions to determine the permissible minimum temperature is defined in 6.2.

Line	PN Class	Suitable temperature range	Type of bolting a materia	nd description of l groups	Steel designation name Steel designation number Material standard		
No up to		°C	Bolts, screws, studs Nuts		Bolts, screws, studs	Nuts	
1	All	-10 to 400	0,25C-1Cr-Mo	),25C-1Cr-Mo elev. temp.		C35E 1.1181 EN 10269:2013	
2	All	-10 to 350	0,42C-1Cr-Mo	Unalloyed steel elev. temp.	42CrMo4 1.7225 EN 10269:2013	C45E 1.1191 EN 10269:2013	
3	All	-60 to 500	0,25C-1Cr-Mo	0,25C-1Cr-Mo	25CrMo4 <sup>e</sup> 1.7218 EN 10269:2013	25CrMo4 1.7218 EN 10269:2013	
4	All	-40 to 500	0,25C-1Cr-Mo	0,42C-1Cr-Mo	25CrMo4 <sup>e</sup> 1.7218 EN 10269:2013	42CrMo4 1.7225 EN 10269:2013	
5	All	-40 to 500	0,42C-1Cr-Mo	0,42C-1Cr-Mo	42CrMo4 1.7225 EN 10269:2013	42CrMo4 1.7225 EN 10269:2013	
6	All	-10 to 500	0,42C-1,3Cr-0,6Mo	0,42C-1Cr-Mo	42CrMo5-6° 1.7233 EN 10269:2013	42CrMo4 1.7225 EN 10269:2013	
7	All	-10 to 500	0,40C-1Cr-0,6Mo-V	0,42C-1Cr-Mo	40CrMoV4–6° 1.7711 EN 10269:2013	42CrMo4 1.7225 EN 10269:2013	
8	Allc	-10 to 500	0,21C-1,3Cr-0,7Mo- V	0,21C-1,3Cr-0,7Mo- V	21CrMoV5-7° 1.7709 EN 10269:2013	21CrMoV5-7 1.7709 EN 10269:2013	
9	All	-10 to 500	0,2C-1Cr-1Mo-V-Ti- B	0,2C-1Cr-1Mo-V-Ti- B	20CrMoVTiB4-10 <sup>e</sup> 1.7729 EN 10269:2013	20CrMoVTiB4-10 1.7729 EN 10269:2013	

Table 3 — Selection of bolting materials combinations acc. to EN 10269:2013 with suitable
application ranges

Line	Suitable temperature rangeType of bolting and description of material groups		Steel desigr Steel designa Material	nation name htion number standard		
NU	up to	°C	Bolts, screws, studs		Bolts, screws, studs	Nuts
10	All <sup>b</sup>	-60 <sup>f</sup> to 650	25Ni-15Cr-0,2Ti- Mo-V-B	25Ni-15Cr-0,2Ti- Mo-V-B	X6NiCrTiMoVB <sup>e</sup> 25–15–2 1.4980 EN 10269:2013	X6NiCrTiMoVB 25-15-2 1.4980 EN 10269:2013
11	All <sup>b</sup>	-10 to 500	12Cr-1Mo-V	12Cr-1Mo-V	X22CrMoV12-1 QT2° 1.4923 EN 10269:2013	X22CrMoV12–1 QT2 1.4923 EN 10269:2013
12	All	-10 to 650	16Cr-16Ni-Mo-B-Nb	16Cr-16Ni-Mo-B-Nb	X7CrNiMoBNb16– 16 <sup>e</sup> 1.4986 EN 10269:2013	X7CrNiMoBNb16- 16 1.4986 EN 10269:2013
13	PN 40° Cl. 300	-196 to 550	17Cr-12Ni-2Mo	17Cr-12Ni-2Mo	X5CrNiMo17-12-2 +AT 1.4401 EN 10269:2013	X5CrNiMo17-12-2 1.4401 EN 10269:2013
14	PN 100 Cl. 600	–196 to 200ª	17Cr-12Ni-2Mo +AT+C	17Cr-12Ni-2Mo	X5CrNiMo17-12-2 +AT+C700 1.4401 EN 10269:2013	X5CrNiMo17-12-2 1.4401 EN 10269:2013
15	PN 40° Cl. 300	-196 to 550	18Cr-10Ni	18Cr-10Ni	X5CrNi18–10 +AT 1.4301 EN 10269:2013	X5CrNi18-10 1.4301 EN 10269:2013
16	PN 100 Cl. 600	-60 <sup>d</sup> to 200 <sup>a</sup>	18Cr-10Ni AT+C	18Cr-10Ni	X5CrNi18–10 +AT+C700 1.4301 EN 10269:2013	X5CrNi18-10 1.4301 EN 10269:2013

Allowable stresses for elevated temperatures may be taken from the material in AT condition, as no stresses exist for the cold worked condition.

<sup>b</sup> Commonly used for PN 160 up to PN 400.

Is limited to be used for max. PN 40/Cl. 300 (low strength bolting).

-200 °C for studs or for bolts manufactured by machining from annealed rods or bars (AT) without work hardening except thread forming, if any.

<sup>e</sup> May be used in the creep range. For maximum suitable temperature see EN 10269:2013.

When intended to be used down to -273 °C, for additional requirements see Table 7.

# Table 4 — Selection of bolting materials combinations acc. to property classes, with suitable application ranges

Line	PN	Suitable temperature range	Type of bolting and description of material groups		Property class Material standard	
No	up to	°C	Bolts, screws, studs	Nuts	Bolts, screws, studs	Nuts
1	PN 40ª Cl. 300	-10 to 300f	Unalloyed Steel	Carbon Steel	5.6 — EN ISO 898-1:2013	5 <sup>b</sup> — EN ISO 898-2:2012
2	PN 40 <sup>a</sup> Cl. 300	-10 to 300 <sup>f</sup>	Alloyed Steel	Carbon Steel	8.8 — EN ISO 898-1:2013	8  EN ISO 898-2:2012
3	PN 40° Cl. 300	-200 to 400	18Cr-9Ni	18Cr- 9Ni	A2–50 — EN ISO 3506-1:2020	A2–50, A2–70 <sup>e</sup> — EN ISO 3506-2:2020
4	PN 100 Cl. 600	-200 to 400	18Cr-9Ni	18Cr- 9Ni	A2-70 — EN ISO 3506-1:2020	A2-70 — EN ISO 3506-2:2020
5	PN 40° Cl. 300	-200 to 400	18Cr-9Ni <sup>g</sup>	18Cr- 9Ni	A3-50 — EN ISO 3506-1:2020	A2-50, A2-70 — EN ISO 3506-2:2020
6	PN 100 Cl. 300	-200 to 400	18Cr-9Ni <sup>g</sup>	18Cr- 9Ni	A3-70 — EN ISO 3506-1:2020	A2-70 — EN ISO 3506-2:2020
7	PN 40 <sup>c</sup> Cl. 300	-60 <sup>d</sup> to 400	18Cr-9Ni- Mo	18Cr- 9Ni- Mo	A4–50 — EN ISO 3506-1:2020	A4–50 A4–70° — EN ISO 3506-2:2020
8	PN 100 Cl. 600	-60 <sup>d</sup> to 400	18Cr-9Ni- Mo	18Cr- 9Ni- Mo	A4–70 — EN ISO 3506-1:2020	A4-70 — EN ISO 3506-2:2020
9	PN 40° Cl. 300	-60 <sup>d</sup> to 400	18Cr-9Ni- Mo <sup>g</sup>	18Cr- 9Ni- Mo	A5–50 — EN ISO 3506-1:2020	A4–50, A4–70 — EN ISO 3506-2:2020
10	PN 100 Cl. 600	-60 <sup>d</sup> to 400	18Cr-9Ni- Mo <sup>g</sup>	18Cr- 9Ni- Mo	A5-70 — EN ISO 3506-1:2020	A4-70 — EN ISO 3506-2:2020

 $^{\rm a}$   $\,$   $\,$  Up to PN 63 for temperature up to 120 °C.

<sup>b</sup> The use of free-cutting steel is not permitted.

<sup>c</sup> Is limited to be used for max. PN 40/Cl. 300 (low strength bolting).

-200 °C for studs or for bolts manufactured by machining from annealed rods or bars (AT) without work hardening except thread forming, if any.

e Generally cold forged nuts will be used in strength class 70.

Line	PN	Suitable temperature range	Type of b and descri material	oolting ption of groups	Proper Material	ty class standard	
No	up to	°C	Bolts, screws, studs	Nuts	Bolts, screws, studs	Nuts	
f El	<sup>f</sup> EN ISO 898-1:2013 and EN ISO 898-2:2012 are not giving any values of mechanical properties in elevated temperatures. The use of these bolts as such is limited to max +50 °C. For use in temperatures above +50 °C, 4.4 applies.						
<sup>g</sup> St	Stabilized by other elements: $5C \le Ti \le 0.80$ and/or $10C \le Nb \le 1.00$ .						

#### 4.4 Requirements of bolting related to property classes

Bolts of property classes 5.6 and 8.8 shall be validated by regular tensile testing according to EN ISO 6892-2:2018 at a temperature of 300 °C on a machined test piece derived from full-size bolts, screws and studs. The minimum strength properties according to Table 5 apply.

For bolts of steel grade A2 to A5 the mechanical properties shall be guaranteed. The minimum values of strength properties for design and service purposes shall be ensured by appropriate method.

Nominal design stresses for design shall be determined acc. to applicable product standard and applied calculation method (e.g. EN 13480-3:2017<sup>2</sup>, EN 13445-3:2014<sup>1</sup>, etc.).

Property class	Size limitation	Tensile strength	M	Minimum proof strength <i>R</i> <sub>p0,2/t</sub> (MPa) at a temperature (°C) of:			
		R <sub>m</sub> (MPa)	20	100	200	300	400
5.6	≤ M 39	500	300	270	229	192	—
8.8	≤ M 39	800	640	590	540	480	_
A2-50 to A5- 50	≤ M 39	500	210	175	155	135	125
A2-70 to A5- 70	≤ M 24	700	450	380	360	335	315

Table 5 — Minimum strength properties of bolting to be secured

The above strength values for 5.6 and 8.8 bolts have been derived from EN ISO 898-1:2013 and its earlier versions. The values for austenitic bolts have been derived from EN 13445-2:2014<sup>3</sup> by multiplying the allowable stresses by safety factor 1,5.

## 5 Manufacturing

#### 5.1 General

Final heat treatment is not necessary for bolting which are machined from adequate pre-treated bars. The process of pre-treatment of bars is at the responsibility of the bolting manufacturer.

Generally cold forming (except rolling of external threads) requires a subsequent heat treatment. However cold working is necessary and therefore permitted for austenitic stainless steel bolting in accordance to property class 70 and for nuts in accordance to property classes 5 and 8, in order to achieve hardness specifications and therefore post heat treatment is not allowed. Nuts should be obtained, preferably, by forging. The internal thread of the nut will usually be machined.

3

As impacted by EN 13445-2:2014/A3:2018.

#### 5.2 Coating

The type of coating shall be specified in the purchase order (see Clause 8). The coating process is under the responsibility of the bolting manufacturer and shall take into consideration confirmation of achievement of the mechanical and dimensional properties of bolting, as appropriate.

The coating to be used for the bolting shall be appropriate for the foreseen service conditions.

NOTE 1 In general, bolting will be delivered:

- with a primary manufacture finish (slightly greased); or
- with an electrolytic coating in compliance with EN ISO 4042:2018; or
- hot galvanized in compliance with EN ISO 10684:2004;
- passivated according to EN ISO 16048:2003 (applicable for corrosion-resistant stainless-steel bolting only).
- Fasteners with different types of coating shall not be mixed within one flanged connection.

• The upper and lower temperature limits of coatings, including the influence on fastener material must be considered when specifying or using the coating.

NOTE 2 For additional requirements regarding hot dip galvanized carbon steel bolting see Annex C.

#### 6 Technical conditions of delivery

#### 6.1 General

The technical conditions of delivery and the marking requirements are included in the referenced standards given for bolting and materials.

Starting material shall comply with EN 10269:2013. The use of free-cutting steel is not permitted.

#### 6.2 Requirements for prevention of brittle fracture at low temperatures

Requirements are given in Table 6, Table 7 and Table 8.

For other bolting listed in Annex B, the following applies:

- a specified impact energy of minimum 40 J is required at  $T_{KV} = RT$  for  $T_M \ge -10$  °C.
- if  $T_{\rm M}$  is lower than -10 °C, specified impact energy of minimum 40 J is required at  $T_{\rm KV} \leq T_{\rm M}$ ;
- bolting material with a design temperature below -160 °C shall be impact tested at -196 °C.

Some bolting materials listed in Table 7 and Table 8 are not covered by Table 3 and Table 4, but  $T_{M}$  is given in addition.

NOTE The data in the tables corresponds to EN 13445-2:2014, Table B.2-8, Table B.2-9, Table B.2-10<sup>3</sup>.

European Standard	Type of material	Thickness limitation	<b>Impact test for</b> $T_{\rm M} \ge -10  {\rm ^{\circ}C}$	Test temperature/ value		
EN 10269:2013	All steels	According to EN 10269:2013	According to EN 10269:2013, Table 4	According to EN 10269:2013, Table 4		
EN ICO 000 1.2012	5.6	M ≤ 39	M ≥ 16	RT <sup>a</sup> /40 J		
EN ISO 898-1:2013	8.8	M ≤ 39	M ≥ 16	RTª/52 J		
EN ICO 000 2-2012	5	M ≤ 39	None	_		
EN 150 898-2:2012	8	M ≤ 39	None	—		
<sup>a</sup> Testing in accordance with EN 10269:2013. Additional testing is required to comply with $T_{\rm M}$ –20 °C in accordance with EN ISO 898-1:2013, 9.14.						

# Table 6 — General Requirements for prevention of brittle fracture for nuts and bolts for $T_{\rm M} \ge -10~{\rm ^{\circ}C}$

Table 7 — General Requirements for prevention of brittle fracture with reference thickness for
nuts and bolts with starting material according to EN 10269:2013

Type of material	Thickness limitation	Impact test (impact energy of minimum 40 J)	$T_{ m M}$
1.4307, 1.4301, 1.4303, 1.4404, 1.4401, 1.4948, 1.4919, 1.4941	According to EN 10269:2013, Table 10	According to EN 10269:2013, Table 4	−196 °C
1.4429, 1.4910, 1.4980	According to EN 10269:2013, Table 10	According to EN 10269:2013, Table 4	−273 °C
1.5525, 1.1133	According to EN 10269:2013, Table 10	According to EN 10269:2013, Table 10	–20 °C
1.7218	<i>d</i> ≤ 60 mm	According to EN 10269:2013,	−60 °C
	60 < <i>d</i> ≤ 100 mm	Table 10	−50 °C
1.6582, 1.6580, 1.7225	According to EN 10269:2013, Table 10	According to EN 10269:2013, Table 10	−40 °C
1.5680	<i>d</i> ≤ 40 mm	According to EN 10269:2013,	−120 °C
	40 < <i>d</i> ≤ 75 mm	Table 10	−90 °C
1.5662	According to EN 10269:2013, Table 10	According to EN 10269:2013, Table 10	–196 °C

Standard	Type of n	naterial	Thickness limitation	$T_{ m M}$	Impact test
EN ISO 3506-1:2020	A2, A3	50	M ≤ 39	–200 °C	None
		70	M ≤ 24		
	A4, A5	50	M ≤ 39	-60 °Cª	
		70	M ≤ 24		
EN ISO 3506-2:2020	A2, A3, A4, A5	50	M ≤ 39	–200 °C	
		70	M ≤ 24		
<sup>a</sup> −200 °C for studs or hot forged bolts with head in property class 50.					

# Table 8 — Requirements for prevention of brittle fracture with reference thickness for bolts<br/>according to EN ISO 3506-1:2020 and nuts according to EN ISO 3506-2:2020

#### 7 Traceability and inspection documents

#### 7.1 Traceability

Beside the requirements for traceability given in EN ISO 16426:2002, bolting made from alloy steels shall be subjected to a suitable test to ensure no mixing of materials has occurred. Appropriate procedures shall be applied to ensure traceability of material and respective documentation for the starting material used shall be possible to be provided.

NOTE Alloy steel as defined in EN 10269:2013.

Non-destructive testing: The acceptance test shall be according to EN ISO 3269:2019, acceptance number Ac = 0. The definition of the inspection lot shall be according to EN ISO 16426:2002.

#### 7.2 Inspection documents

Under consideration of EN 764-5:2014, an inspection certificate according to EN 10204:2004 shall be prepared, applicable for the respective category of the equipment for which the bolting is intended to be used referring to the following criteria. The content of test reports shall be in accordance with EN ISO 16228:2018.

EN 764-5:2014 defines the required type of inspection document as follows:

- a) for main pressure bearing part then a certificate of specific control is required, i.e. type 3.1 or type 3.2 (unless the item of equipment itself is in Category I);
- b) for other pressure bearing parts a test report is sufficient, i.e. type 2.2;
- c) for other than pressure bearing parts a certificate of compliance is sufficient, i.e. type 2.1.

Test reports according to EN ISO 16228:2018 issued by a distributor cannot replace certificates according to EN 10204:2004 issued by the manufacturer of the fastener mentioned.

For bolting materials in Table 4, the bolting manufacturer shall affirm that the product complies with this document.

#### 7.3 Alternative to inspection documents

Inspection documents according to EN 10204:2004, type 2.1 or 2.2 may be substituted by a traceable marking linked to the bolting manufacturer (definition in 3.1.3) of bolts, screws, studs or nuts. On basis of this relevant traceable marking, the manufacturer shall be prepared to reproduce the associated inspection document for each concerned product.

Inspection documents according to EN 10204:2004, type 3.1 may be substituted by a traceable marking linked to the manufacturing lot (definition in 3.1.5) of bolts, screws, studs or nuts. On basis of this relevant traceable marking, the manufacturer shall be prepared to reproduce the associated inspection document with the specific test data for each concerned manufacturing lot.

### 8 Ordering information

The following information shall be provided with the purchase order:

- a) order quantity;
- b) type of bolting: dimensional standard, nominal diameter and length;
- c) material:
  - steel grade according to EN 10269:2013,
  - property class according to EN ISO 898-1:2013 or EN ISO 898-2:2012 or,
  - type of material, i.e. steel grade and property class, according to EN ISO 3506-1:2020 or EN ISO 3506-2:2020;
- d)  $T_{\rm M}$ , if  $T_{\rm M}$  is below -10 °C;
- e) testing temperature for tensile test at elevated temperature for property classes 5.6 or 8.8, if other than 300 °C;
- f) type of inspection document;
- g) any other particular specification including type of coating and finishing (see 5.2) or other requirements presented in Clause 6.

## Annex A

(normative)

# **Studs threaded full length**

Studs shall be threaded full length. The points shall be chamfered or rounded at the bolting manufacturer's option. The height of point shall be a maximum one time the pitch of thread.

The length of studs shall be measured including points. The lengths are stepped by increments of 5 mm for length up to 80 mm, by increments of 10 mm for length above 80 mm and up to 200 mm, and by increments of 20 mm for length above 200 mm.

Thread shall be in accordance with ISO 261:1998, ISO 965-2:1998 tolerance class 6g. The type of thread shall be specified by the purchaser.

NOTE Type of thread is either coarse thread or above M39 fine thread with 4 mm pitch.

Fine thread above M39 is normally used for industrial plants, coarse thread up to and including M64 is normally used for water service.

# Annex B

## (informative)

# Additional bolting types and materials according to commonly used national standards

Additional bolting types and materials according to commonly used national standards which are not listed in Table 2 and Table 3 may be used.

A selection of commonly used national standards for bolting types and materials is listed in Table B.1.

**WARNING** — Materials used for equipment subject to the Pressure Equipment Directive 2014/68/EU in combination with non-harmonized standards require following procedures.

- European Approval of Material (EAM); or
- Particular Material Appraisal (PMA);

For pressure equipment that are not in the scope of Article 4 paragraphs 1 and 2 of the PED 2014/68/EU, paragraph 3 of Article 4 is applied.

Dimensional standard		De ser la	
Bolts, studs	Nuts	Kemarks	
BS 3692	_	ISO Metric Precision Hexagon head bolt	
BS 4190	—	ISO Metric Black Hexagon Bolts	
NF E29-043		Non Alloy and Alloy Steel Bolting	
DIN 976-1	—	Stud bolt, threaded full length, Type B	
DIN 2510-3	—	Reduced shank stud-bolts <sup>a</sup>	
	DIN 2510-5	Hexagon Nuts	
NF E 25–136		Fasteners – Threaded rods and threaded ends – Product grades A and B	
<sup>a</sup> Also denominated as necked-d	own bolts.	•	

#### Table B.1 — Selection of bolting types according to commonly used national standards

# Annex C

(informative)

# Additional requirements for hot dip galvanized carbon steel bolting

The following additional requirements may be subject of agreement between the purchaser and bolting manufacturer if carbon steel bolting shall be supplied in hot dip galvanized condition.

Hot dipped galvanizing should be performed according to EN ISO 10684:2004.

Thread tolerances should be according to ISO 965 and EN ISO 10684:2004, Clause 6.

As defined in EN ISO 10684:2004, 5.7, the threading of the nuts shall be performed after the hot dipped galvanization process. A threading before galvanization followed by a re-tapping step should be avoided due to the risk of "double-threads".

It is recommended that these kinds of bolts and nuts should be delivered as matching assemblies. Checking of the proper fitting of the threads while assembling the bolts and nuts is recommended.

NOTE It is the purchaser's option to require a supply in assembled condition.

# Annex ZA

# (informative)

# Relationship between this European Standard and the essential requirements of Directive 2014/68/EU aimed to be covered

This European Standard has been prepared under a Commission's standardization request M/071 "Mandate to CEN for standardization in the field of Pressure equipment" to provide one voluntary means of conforming to essential requirements of the Directive 2014/68/EU.

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

Essential Requirements of Directive 2014/68/EU	Clause(s)/sub- clause(s) of this EN	Remarks/Notes
3.1.4	5.1	Heat treatment
3.1.5	7.1	Traceability
41(a)	4	Material properties
4.1 (a)	6	Impact strength
4.3	7.2 Conformity to specification, Inspe documents	

Table ZA.1 — Correspondence between this European Standard and Annex I of Directive 2014/68/EU

**WARNING 1** — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

**WARNING 2** — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

### **Bibliography**

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- [2] EN 1092-3, Flanges and their joints Circular flanges for pipes, valves, fittings and accessories, PN designated Part 3: Copper alloy flanges
- [3] EN 1092-4, Flanges and their joints Circular flanges for pipes, valves, fittings and accessories, PN designated Part 4: Aluminium alloy flanges
- [4] EN 1515-1, Flanges and their joints Bolting Part 1: Selection of bolting
- [5] EN 1515-2, Flanges and their joints Bolting Part 2: Classification of bolt materials for steel flanges, PN designated
- [6] EN 1515-3, Flanges and their joints Bolting Part 3: Classification of bolt materials for steel flanges, class designated
- [7] EN 1759-3, Flanges and their joints Circular flanges for pipes, valves, fittings and accessories, Class designated - Part 3: Copper alloy flanges
- [8] EN 1759-4, Flanges and their joint Circular flanges for pipes, valves, fittings and accessories, class designated Part 4: Aluminium alloy flanges
- [9] EN 10045-1, Metallic materials Charpy impact test Part 1: Test method
- [10] EN 13445-2:2014, Unfired pressure vessels Part 2: Materials
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- [15] ISO 8992, Fasteners General requirements for bolts, screws, studs and nuts
- [16] BS 3692, ISO metric precision hexagon bolts, screws and nuts Specification
- [17] BS 4190, ISO metric black hexagon bolts, screws and nuts Specification
- [18] DIN 976-1, Stud bolts Part 1: Metric thread
- [19] DIN 2510-3, Bolted connections with reduced shank Stud-bolts

- [20] DIN 2510-5, Bolted connections with reduced shank Hexagon nuts
- [21] NF E29-043, Non alloy and alloy steel bolting for pressure equipment Specifications
- [22] Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment
- [23] EN ISO 7089:2000, Plain washers Normal series Product grade A (ISO 7089:2000)
- [24] EN ISO 4018:2011, Hexagon head screws Product grade C (ISO 4018:2011)
- [25] EN ISO 10684:2004, Fasteners Hot dip galvanized coatings (ISO 10684:2004)
- [26] EN ISO 16048:2003, Passivation of corrosion-resistant stainless-steel fasteners (ISO 16048:2003)