

Recommended Practice for Application of Subsea Fasteners

Revision history

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Acknowledgements

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Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly agreed specification, building on recognized industry and international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2020).

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Introduction

This recommended practice defines the fastener material and quality (bolting specification) levels for the subsea applications mapped to the general requirements based on ISO 13628-1 and API Recommended Practice 17A, and the key application requirements from the API 17 series of standards, specifications and recommended practices.

This JIP33 standardized specification follows a common document structure comprising the four document types as shown below, which together with the purchase order define the overall technical specification for procurement. It should be noted, however, that this specification for application of subsea fasteners does not include a data sheet, information requirements specification or quality requirements specification.



JIP33 Specification for Procurement Documents

This specification is to be applied in conjunction with the following specification documents for subsea fasteners.

IOGP S-724: Supplementary Specification to API Specification 20E Subsea Fasteners (Alloy and Carbon Steel Bolting)

This specification defines the technical requirements for the supply of alloy and carbon steel subsea fasteners and is written as an overlay to API Specification 20E.

IOGP S-725: Supplementary Specification to API Specification 20F Subsea Fasteners (Corrosion-resistant Bolting)

This specification defines the technical requirements for the supply of corrosion-resistant subsea fasteners and is written as an overlay to API Specification 20F.

IOGP S-724Q: Quality Requirements for Subsea Fasteners (Alloy and Carbon Steel Bolting)**IOGP S-725Q: Quality Requirements for Subsea Fasteners (Corrosion-resistant Bolting)**

The QRS defines quality management system requirements and the proposed extent of purchaser conformity assessment activities for the scope of supply. Purchaser conformity assessment activities are defined through the selection of one of two generic conformity assessment system (CAS) levels (A and D) on the basis of evaluation of the associated service and supply chain risks. CAS A is intended to support additional control activities for the qualification of new products, while CAS D specifies no physical intervention, allowing for off-the-shelf commodity items to be purchased. The applicable CAS level is specified by the purchaser in the purchase order.

IOGP S-724L: Information Requirements for Subsea Fasteners (Alloy and Carbon Steel Bolting)**IOGP S-725L: Information Requirements for Subsea Fasteners (Corrosion-resistant Bolting)**

The IRS defines the information requirements, including contents, format, timing and purpose to be provided by the supplier. It may also define specific conditions which invoke information requirements.

The terminology used within this specification and the supporting technical specifications, QRS and IRS follows that of API Specification 20E and API Specification 20F and is in accordance with ISO/IEC Directives, Part 2 as appropriate.

The IRS is published as editable document for the purchaser to specify application specific requirements. The recommended practice and QRS are fixed documents.

The order of precedence (highest authority listed first) of the documents shall be:

- a) regulatory requirements;
- b) contract documentation (e.g. purchase order);
- c) this specification;
- d) the referenced standards.

1 Scope

This recommended practice defines the fastener material and quality (bolting specification) levels for the subsea applications mapped to the general requirements based on ISO 13628-1 and API Recommended Practice 17A, and the key application requirements from the API 17 series of standards, specifications and recommended practices.

NOTE Refer to IOGP S-724 and IOGP S-725 for details of the fastener types (forms), processes and sizes applicable to this specification.

2 Normative References

API Standard 6ACRA, *Age-hardened Nickel-based Alloys for Oil and Gas Drilling and Production Equipment*

API 17, *Series of equipment standards, specifications and recommended practices*

API Specification 20E, *Alloy and Carbon Steel Bolting for Use in the Petroleum and Natural Gas Industries*

API Specification 20F, *Corrosion-resistant Bolting for Use in the Petroleum and Natural Gas Industries*

ASTM A193/A193M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications*

ASTM A194/A194M, *Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both*

ASTM A320/A320M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service*

ASTM A453/A453M, *Standard Specification for High-Temperature Bolting, with Expansion Coefficients Comparable to Austenitic Stainless Steels*

ASTM A540/A540M, *Standard Specification for Alloy-Steel Bolting for Special Applications*

ASTM A962/A962M, *Standard Specification for Common Requirements for Bolting Intended for Use at Any Temperature from Cryogenic to the Creep Range*

ASTM A1082/A1082M, *Standard Specification for High Strength Precipitation Hardening and Duplex Stainless Steel Bolting for Special Purpose Applications*

ASTM F467, *Standard Specification for Nonferrous Nuts for General Use*

ASTM F467M, *Standard Specification for Nonferrous Nuts for General Use (Metric)*

ASTM F468, *Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use*

ASTM F468M, *Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use (Metric)*

ASTM F593, *Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs*

ASTM F594, *Standard Specification for Stainless Steel Nuts*

IOGP S-724, *Supplementary Specification to API Specification 20E Subsea Fasteners (Alloy and Carbon Steel Bolting)*

IOGP S-725, *Supplementary Specification to API Specification 20F Subsea Fasteners (Corrosion-resistant Bolting)*

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

ISO 3506-2, *Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners — Part 2: Nuts with specified grades and property classes*

ISO 13628 (all parts), *Petroleum and natural gas industries — Design and operation of subsea production systems*

ISO 15156 (all parts), *Petroleum and natural gas industries — Materials for use in H₂S containing environments in oil and gas production*

3 Terms, Definitions and Abbreviations

3.1 Terms and Definitions

Refer to terms and definitions in API Recommended Practice 17D, API Specification 20E and API Specification 20F.

3.2 Abbreviations

BSL	bolting specification level
CP	cathodic protection
CRA	corrosion resistant alloy
LAS	low alloy steel
PTFE	polytetrafluoroethylene

4 Fastener Material Grades, Classes and Property Classes

4.1

Fastener material grades, classes and property classes shall be in accordance with Table 1.

NOTE 1 Table 1 represents the most common fastener material grades, classes and property classes used in a subsea application.

NOTE 2 Unlisted fastener material grades (and classes/property classes) are equally acceptable if agreed between the equipment manufacturer or supplier and the equipment end user.

4.2

Stainless steel 17/4 PH (UNS S17400) shall not be used.

Table 1—Fastener Material Grades, Classes and Property Classes

Fastener Material	Base Case Standard/Specification	Grade (and Class / Property Class)
Low alloy steel (LAS) (in conformance with API Specification 20E and IOGP S-724)	ASTM A194/A194M	7L, 7ML, 2H ^a , 2HM ^a
	ASTM A193/A193M	B7 ^a , B7M ^a
	ASTM A320/A320M	L7, L7M, L43
	ASTM A540/540M	B22 ^a Class 3, 4 and 5, B23 ^a Class 3, 4 and 5
	Manufacturer's specification	6ACRA (UNS N07716 (625+) 120K) ^b , 6ACRA (UNS N07725 (725)) ^b
Corrosion resistant alloy (CRA) (in conformance with API Specification 20F and IOGP S-725)	Manufacturer's specification	Alloy 718 in accordance with API Standard, 6ACRA (UNS N07718 120K)
	Manufacturer's specification	UNS R30035
	ASTM A453/A453M	Grade 660 Class D
Corrosion resistant alloy (CRA)	ASTM A193/A193M	B8M Class 2 (UNS S31600)
	ASTM A194/A194M	8M (UNS S31600)
	ASTM A1082/A1082M	25Cr Duplex (UNS S32750, UNS S32760) ^b
	ASTM F467/F467M/F468/F468M	Alloy 625, Alloy 276, Titanium 5 ^b , Titanium 23 ^b
	ASTM F593/F594	Strain Hardened 316 (316SH)
	ISO 3506-1 / ISO 3506-2	A4-80
^a Bolting specification level 1 (BSL-1) only.		
^b Only applicable if isolation from cathodic protection (CP) can be assured.		

5 Design

5.1 General

The design of connections shall reference applicable industry standards, specifications or guidance.

5.2 Pressure Retaining/Controlling Fasteners

Flange connections shall be made with stud and nut bolting designs.

5.3 Coating/Plating

LAS fasteners shall be protected from corrosion.

NOTE 1 Polytetrafluoroethylene (PTFE) and other thin-film organic coatings are not considered sufficient as a standalone long term corrosion resistant coating without supplemental CP that assumes 100 % coating breakdown factor for the coatings.

NOTE 2 PTFE and other thin-film organic coatings may be selected for fully submerged applications where only a low friction lubricant is required provided that electrical continuity of the CP system is verified after assembly.

6 Fastener Material Grade Selection

6.1

The fastener material selection shall consider:

- applicable design codes;
- design load cases;
- environmental conditions.

6.2

The fastener material grades, classes and property classes listed in Table 1 shall be applied in accordance with Table 2.

Table 2—Fastener Material Grade Selection

Environment		Stud, Bolt and Screw Material Grades
Seawater, submerged	CP is ensured, non-hydrocarbon containment service ^h	A4-80, Alloy 276, Alloy 625, Alloy 718-120K ^a , B22, B23, B7, B7M, B8M Class 2, L43, L7, L7M, R30035, 2H, 2HM, 316SH
	CP is ensured, hydrocarbon containment service	Alloy 276, Alloy 625, Alloy 718-120K ^a , Grade 660 Class D, L43 ^c , L7 ^c , L7M, R30035
	CP is ensured, hydrocarbon containment service, under thermal insulation	Alloy 276, Alloy 625, Alloy 718-120K ^e , L7M ^b , Grade 660 Class D ^d , R30035
	CP cannot be ensured or is intentionally isolated from CP by design	Alloy 276 ^f , Alloy 625 ^f , N07716-120K ^g , N07725-120K ^g , R30035, Titanium Grade 5 ^g , Titanium Grade 23 ^g , 25Cr Duplex ^g
Seawater, splash zone		Fasteners materials to be agreed with the equipment end user
^a Only if a greater Rp0,2/YS is necessary. ^b Refer to API Specification 6A for limitations. ^c L7 and L43 grade bolts are not suitable for sour service as per ISO 15156-2. ^d ≤65 °C. Refer to API Specification 6A and ISO 15156-3 for additional limitations. ^e >65 °C. Refer to API Specification 6A and ISO 15156-3 for additional limitations. ^f Refer to ISO 15156-3 requirements. ^g Only acceptable when isolated from CP. ^h Compatibility with specific fluids to be evaluated.		

6.3

Stud or bolt and nut material combinations shall be in accordance with Table 3.

Table 3—Stud/Bolt and Nut Material Grade Combinations

Stud/Bolt Material Grade	Nut Material Grade
A4-80	A4-80
Alloy 276	Alloy 276
Alloy 625	Alloy 625
Alloy 718-120K	Alloy 718-120K
B7	2H
B7M	2HM
B8M Class 2	8M
B22/B23 Class 3	B22/B23 Class 3
B22/B23 Class 4	B22/B23 Class 4
B22/B23 Class 5	B22/B23 Class 5
L43	7L
L7	7L
L7M	7ML
N07716-120K	N07716-120K
N07725-120K	N07725-120K
R30035	R30035
Titanium Grade 5	Titanium Grade 5
Titanium Grade 23	Titanium Grade 23
25Cr Duplex	25Cr Duplex
316SH	316SH
660 Class D	660 Class D

6.4

When dissimilar materials are used in the design of the connection, the following shall be evaluated:

- the possibility of galvanic corrosion during assembly, testing, transportation and storage pending subsea deployment;
- the consequences of different thermal coefficients;
- the consequences of different elastic moduli.

NOTE The application of a CP system may mitigate the galvanic corrosion of a dissimilar material connection once installed. This should be confirmed with a CP design.

6.5

Isolation from the CP system, when required by design, shall be demonstrated by testing upon completion of assembly.

NOTE Consideration should be given to isolating titanium grades of materials that have propensity to form hydrides when coupled to CP in seawater and duplex SS from the CP system.

7 Bolting Specification Level

7.1

BSL assignment based on application, loading and containment shall be in accordance with Table 4.

NOTE Table 4 is based on API Specification 17D.

Table 4—Fastener BSL Assignment

Bolting Classification	Material	Reference
Utility	Alloy and carbon steel	Manufacturer's specification
	Stainless steel and CRA	Manufacturer's specification
Pressure-controlling	Alloy and carbon steel	Manufacturer's specification
	Stainless steel and CRA	Manufacturer's specification
Closure	Alloy and carbon steel ^a	IOGP S-724, BSL-2
	Stainless steel and CRA	IOGP S-725, BSL-2 ^b
Lifting bolting	Alloy and carbon steel ^a	IOGP S-724, BSL-2 ^b
	Stainless steel and CRA	IOGP S-725, BSL-2 ^b
Critical	Alloy and carbon steel ^a	IOGP S-724, BSL-3
	Stainless steel and CRA	IOGP S-725, BSL-3
^a For 105 ksi (725 MPa) 0.2 % offset yield strength studs, bolts, or cap screws ≥ 2.5 in., the bolting material should be ASTM A320/A320M L43. ^b The use of unlisted fastener materials is acceptable if agreed between the equipment manufacturer or supplier and equipment end user and in accordance with specific requirements in API Specification 20F for BSL-2, excluding any specific grade/alloy requirements.		

7.2

If a more stringent BSL is assigned by another governing standard or specification, the more stringent BSL shall apply.

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