Specification for Application of Subsea Fasteners
Acknowledgements

This IOGP Specification was prepared by a Joint Industry Programme 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

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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 2014).
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Introduction

The purpose of this specification is to define a minimum common set requirements for subsea fasteners types and integrity levels for the primary subsea applications mapped to the general requirements based on ISO 13628 and API Recommended Practice 17 series of standards for the petroleum and natural gas industries.

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 specifications for subsea fasteners.

**IOGP S-724:** Specification for Subsea Fasteners (Alloy and Carbon Steel)

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:** Specification for Subsea Fasteners (Corrosion-resistant)

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

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

1.1 Purpose

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

This specification is applicable to all subsea fasteners including splash zone, used for:

— subsea trees and wellheads;
— structures and manifolds;
— umbilicals;
— bend stiffeners;
— flexible jumpers;
— flowlines and connector jumpers;
— control systems;
— drill-throughs;
— choke and kill;
— valves;
— drilling well control and well intervention/workover equipment/systems including any associated equipment (e.g. deployment, retrieval, tooling and test equipment).

NOTE 1 Refer to IOGP S-724 and IOGP S-725 for details of the fastener types (forms), processes and sizes applicable to this specification.

NOTE 2 Cold formed (forged), headed bolts, screws and nuts are not permitted for subsea applications and therefore are out with the scope of this specification.

This specification covers three quality levels (BSLs) based on API Specification 20E and API Specification 20F: BSL-1, BSL-2 and BSL-3, with BSL-1 representing the least stringent technical, quality and qualification requirements, and BSL-3 representing the most stringent technical, quality and qualification requirements.

NOTE 3 API Specification 20F does not include BSL-1. However, for the purpose of this specification BSL-1 is included for CRAs.

1.2 Applicability

This specification shall apply to fastener sizes M6 (0.250")≤ND≤M100 (4.00") in accordance with the fastener base case standard or specification as given in Table 1.

NOTE For fastener sizes ND<M6 (0.250") or ND>M100 (4.00"), the specified requirements should be agreed between the equipment manufacturer or supplier and equipment end user.

2 Normative References

API 6A, Specification for Wellhead and Tree Equipment
API 6ACRA, Age-hardened Nickel-based Alloys for Oil and Gas Drilling and Production Equipment
API Recommended Practice 17A, Design and Operation of Subsea Production Systems-General Requirements and Recommendations - Fifth Edition
API Recommended Practice 17D, Specification for Pipeline and Piping Valves
API Recommended Practice 17P, Recommended Practice for Subsea Structures and Manifolds
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
ASME B18.31.2, Continuous Thread Stud, Double-End Stud, and Flange Bolting Stud
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 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/F467M, Standard Specification for Nonferrous Nuts for General Use
ASTM F468/F468M, Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use
ASTM F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594, Standard Specification for Stainless Steel Nuts
EEMUA 194, Guidelines for materials selection and corrosion control for subsea oil and gas production equipment
ISO 888, Fasteners — Bolts, screws and studs — Nominal lengths and thread lengths
ISO 3506, Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners
ISO 13628, Petroleum and natural gas industries — Design and operation of subsea production systems
ISO 15156, Petroleum and natural gas industries — Materials for use in H2S containing environments in oil and gas production
ISO 21457, Materials selection and corrosion control for oil and gas production systems

3 Terms, Definitions and Abbreviations

3.1 Terms and Definitions

3.1.1 closure bolting
threaded fastener used to assemble well-bore pressure containing parts or join end or outlet connections

3.1.2 critical bolting
threaded fastener in the vertical load path from the subsea wellhead to the top connection of the subsea tree subjected to additional environmental loading resulting from the coupling of well control and well intervention equipment whose failure will result in the release of wellbore fluid to the environment
3.1.3 **fastener**
threaded stud, tap-end stud, double-ended stud, hexagon headed bolt or screw, hexagon socket head cap screw or nut

**NOTE TO ENTRY 1** Variants of hexagon socket head cap screws and nuts are also included (e.g. hexagon socket head shoulder screws and prevailing torque nuts respectively).

**NOTE TO ENTRY 2** Machine screwed components or clamps (e.g. lead screw or similar) are outside the scope of this specification.

3.1.4 **lifting bolting**
bolting in the direct lifting load path that is loaded in tension

3.1.5 **pressure-controlling bolting**
bolting (other than critical bolting or closure bolting) whose failure would result in the loss of wellbore pressure-controlling functionality

3.1.6 **utility bolting**
threaded fastener used to mount equipment and accessories to the production equipment

3.2 **Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSL</td>
<td>bolting specification level</td>
</tr>
<tr>
<td>CP</td>
<td>cathodic protection</td>
</tr>
<tr>
<td>CRA</td>
<td>corrosion resistant alloys</td>
</tr>
<tr>
<td>HPHT</td>
<td>high pressure high temperature</td>
</tr>
<tr>
<td>LAS</td>
<td>low alloy steel</td>
</tr>
<tr>
<td>PTFE</td>
<td>polytetrafluoroethylene</td>
</tr>
</tbody>
</table>

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 equipment end user.

<table>
<thead>
<tr>
<th>Fastener Material</th>
<th>Base Case Standard / Specification</th>
<th>Grade (and Class / Property Class)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAS (in conformance with API Specification 20E)</td>
<td>ASTM A194/A194M</td>
<td>7L, 7ML</td>
</tr>
<tr>
<td></td>
<td>ASTM A320/A320M</td>
<td>L7, L7M, L43</td>
</tr>
<tr>
<td>CRA (in conformance with API Specification 20F)</td>
<td>ASTM A962/A962M and IOGP S-725</td>
<td>Alloy 718 in accordance with API Standard 6ACRA (UNS N07718 120K)</td>
</tr>
<tr>
<td>Fastener Material</td>
<td>Base Case Standard / Specification</td>
<td>Grade (and Class / Property Class)</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td></td>
<td>ASTM A453/A453M</td>
<td>Grade 660 Class D</td>
</tr>
<tr>
<td>CRA (based on API Specification 20F)</td>
<td>ASTM A193/A193M</td>
<td>B8M Class 2 (UNS S31600)</td>
</tr>
<tr>
<td></td>
<td>ASTM A194/A194M</td>
<td>8M (UNS S31600)</td>
</tr>
<tr>
<td></td>
<td>ASTM A1082/A1082M</td>
<td>25Cr Duplex (UNS S32760)</td>
</tr>
<tr>
<td></td>
<td>ASTM F467/F467M/F468/F468M</td>
<td>Alloy 625</td>
</tr>
<tr>
<td></td>
<td>ASTM F467/F467M/F468/F468M</td>
<td>Titanium Gr 2 (UNS R50400)</td>
</tr>
<tr>
<td></td>
<td>ASTM F593/F594</td>
<td>Strain Hardened 316 (316SH)</td>
</tr>
<tr>
<td>ISO 3506-1/ISO 3506-2</td>
<td></td>
<td>A4-80</td>
</tr>
</tbody>
</table>

4.2

The following material grades (and classes/property classes) shall not be used:

a) Alloy 625+ (UNS N07716);
b) Alloy 725 (UNS N07725);
c) Stainless Steel 17/4 PH (UNS S17400).

5 Design

5.1 General

5.1.1

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

5.1.2

The design shall reference local regulatory requirements.

5.1.3

Fastener allowable stresses shall be in accordance with an industry recognized design standard, specification or guidance.

5.1.4

Connections shall achieve metal-to-metal contact.

5.1.5

Where cathodic protection (CP) is required, connection electrical continuity shall be verified during assembly.

5.1.6

Washers shall not be used for pressure-retaining, lifting, load bearing or assembly essential fastener applications.
5.1.7
Bolt, screw, stud and thread lengths shall be in accordance with ASME B18.2.1, ASME B18.3, ASME B18.31.2 or ISO 888 as applicable to the fastener and thread type.

5.1.8
The thread length of non-fully threaded UN studs shall be in accordance with ASME B18.31.2.

5.1.9
The thread engagement length of tap end studs shall be in accordance with ISO 13628-7, Annex G.

5.1.10
The fastener pre-tension or pre-loading protrusion length shall be ≥2.0x thread pitch.

5.1.11
The bearing surface shall be parallel to the bolt, screw or nut bearing face within 1°.

5.1.12
Surfaces underneath fasteners shall not be painted or coated.

5.1.13
Unpainted or uncoated areas around fasteners shall be locally protected.

5.1.14
Unpainted low alloy steel fasteners (LAS) shall be accounted for in the CP calculations.

5.2 Pressure Retaining / Controlling Fasteners

5.2.1
Studs in conjunction with hexagon high, heavy or thick type nuts shall be used for flanged connections.

5.3 Coating / Plating

5.3.1
LAS fasteners shall be protected from corrosion.

5.3.2
PTFE coating shall not be accounted for in the CP calculations unless a supplementary coating is applied (e.g. epoxy).

NOTE 1 Polytetrafluoroethylene (PTFE) coating is not considered sufficient as a corrosion resistant coating.

NOTE 2 PTFE coating may be selected for fully submerged applications where only a low friction lubricant is required provided that electrical continuity is verified after assembly.
5.3.3

Fasteners shall not be electrodeposited zinc (El-Zn) or cadmium (El-Cd) plated, hot dip galvanized (HDG) or coated with molybdenum disulphide (MoS₂).

5.3.4

Coating or plating selection shall consider influencing factors and be based on pre-tension/pre-load, CP, etc.

5.3.5

Electrodeposited plating on LAS fasteners shall be combined with a trivalent type chromium passivate.

5.3.6

PTFE coating on LAS fasteners shall be combined with a phosphate coating.

6 Fastener Material Grade Selection

6.1

The fastener material selection shall consider:

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

6.2

Equipment industry standards, specifications or guidance (e.g. API Specification 6A, API Specification 17D, API Recommended Practice 17P, EEMUA 194, ISO 13628-1, ISO 13628-4, ISO 13628-15 and ISO 21457) shall be referenced for fastener material selection.

6.3

The recommended fastener material grades, classes and property classes listed in Table 1 shall be selected as per Table 2.

Table 2—Fastener Material Grade Selection

<table>
<thead>
<tr>
<th>Environment</th>
<th>Stud, Bolt and Screw Material Grades</th>
<th>Alternative Fastener Material Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seawater (submerged or splash zone)</td>
<td>L43, L7, A4-80, 316SH, B8M Class 2</td>
<td>L7M, Alloy 718 °</td>
</tr>
<tr>
<td>CP is ensured, non-hydrocarbon service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP is ensured, hydrocarbon service, sweet</td>
<td>L43, L7</td>
<td>L7M, 660D, Alloy 718 °</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Environment

<table>
<thead>
<tr>
<th>Stud, Bolt and Screw Material Grades</th>
<th>Alternative Fastener Material Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP is ensured, hydrocarbon service, sour</td>
<td>L7</td>
</tr>
<tr>
<td>CP is ensured, hydrocarbon service, sweet, under thermal insulation</td>
<td>L7M&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>CP is ensured, hydrocarbon service, sour, under thermal insulation</td>
<td>L7M&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>CP cannot be ensured or is intentionally isolated from CP by design</td>
<td>Alloy 625&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>Seawater (submerged or splash zone) (continued)</td>
<td></td>
</tr>
<tr>
<td>Seawater, splash zone</td>
<td>Alloy 625</td>
</tr>
<tr>
<td>Controlled non-corrosive environment (e.g. nitrogen, dielectric fluids)</td>
<td>L7 A4-80 316SH</td>
</tr>
<tr>
<td>Produced fluid/gas (hydrocarbon)</td>
<td>Alloy 625&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
</tr>
</tbody>
</table>

<sup>a</sup> Only if a greater Rp0.2/YS is necessary.
<sup>b</sup> Refer to API Specification 6A for limitations.
<sup>c</sup> Only when acceptable to equipment end user.
<sup>d</sup> ≤65°C. Refer to API Specification 6A and ISO 15156-3 for additional limitations.
<sup>e</sup> >65°C. Refer to API Specification 6A and ISO 15156-3 for additional limitations.
<sup>f</sup> Refer to ISO 15156-3 requirements.
<sup>g</sup> Only acceptable when isolated from CP.
<sup>h</sup> Compatibility with specific fluids to be evaluated.

### 6.4

Nuts shall be of an equivalent or greater strength than that of the associated stud or bolt.

### 6.5

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

#### Table 3—Stud/Bolt and Nut Material Grade Combinations

<table>
<thead>
<tr>
<th>Stud/Bolt Material Grade</th>
<th>Nut Material Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>L43</td>
<td>7L</td>
</tr>
<tr>
<td>L7</td>
<td>7L</td>
</tr>
<tr>
<td>L7M</td>
<td>7ML</td>
</tr>
<tr>
<td>316SH</td>
<td>316SH</td>
</tr>
<tr>
<td>A4-80</td>
<td>A4-80</td>
</tr>
<tr>
<td>B8M Class 2</td>
<td>8M</td>
</tr>
<tr>
<td>660 Class D</td>
<td>660 Class D</td>
</tr>
<tr>
<td>25Cr Duplex</td>
<td>25Cr Duplex</td>
</tr>
<tr>
<td>Stud/Bolt Material Grade</td>
<td>Nut Material Grade</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Alloy 625</td>
<td>Alloy 625</td>
</tr>
<tr>
<td>Alloy 718</td>
<td>Alloy 718</td>
</tr>
<tr>
<td>Titanium Grade 2</td>
<td>Titanium Grade 2</td>
</tr>
</tbody>
</table>

6.6

Externally threaded fasteners designed to be fastened into an internal thread shall be of a compatible material (corrosion properties, thermal expansion and galling) to the internally threaded material.

6.7

Externally threaded fasteners not compatible with internally threaded material shall be protected from corrosion.

6.8

The material for the temporary externally threaded fasteners used for assembly or test purposes shall be compatible with the internally threaded material.

6.9

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.

6.10

For fasteners exposed to cyclic temperatures, variations in thermal expansion properties and low temperature creep resistance shall take precedence for the design of the connection.

6.11

25Cr austenitic-ferritic (duplex) stainless steel and titanium grade 2 fastener materials shall be isolated from the CP by design.

6.12

Isolation from the CP shall be demonstrated by testing upon completion of assembly.

6.13

The maximum allowable material grade operating temperatures when submerged shall be in accordance with ISO 21457 and ISO 15156 (all parts).

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

<table>
<thead>
<tr>
<th>Class</th>
<th>Application</th>
<th>Loading</th>
<th>Containment</th>
<th>BSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical</td>
<td>Lifting/load bearing</td>
<td>Cyclic (fatigue sensitive connection)</td>
<td>N/A unless combined with pressure retention</td>
<td>3</td>
</tr>
<tr>
<td>Closure</td>
<td>Pressure retention, HPHT</td>
<td>Pre-tension/ pre-load only</td>
<td>Produced fluid/gas (hydrocarbon) injected fluid/gas injected chemical</td>
<td>3</td>
</tr>
<tr>
<td>Lifting</td>
<td>Lifting/load bearing</td>
<td>Non-cyclic (non-fatigue sensitive connection)</td>
<td>N/A</td>
<td>2</td>
</tr>
<tr>
<td>Closure</td>
<td>Pressure retention, non-HPHT</td>
<td>Pre-tension/ pre-load only</td>
<td>Produced fluid/gas (hydrocarbon) injected fluid/gas injected chemical</td>
<td>2</td>
</tr>
<tr>
<td>Pressure controlling</td>
<td>Pressure retention</td>
<td>Pre-tension/ pre-load only</td>
<td>Hydraulic/control fluid</td>
<td>1</td>
</tr>
<tr>
<td>Utility</td>
<td>Assembly (structural), permanent installation</td>
<td>Pre-tension/ pre-load only</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td>Utility</td>
<td>Assembly, undemanding environment/ application</td>
<td>Pre-tension/ Pre-load only</td>
<td>N/A</td>
<td>b</td>
</tr>
</tbody>
</table>

* Refer to 3.1.

* b In accordance with the applicable fastener product standard.

#### 7.2

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