Supplementary Specification to API Specification 20E Subsea Fasteners (Alloy and Carbon Steel Bolting)
Revision history

<table>
<thead>
<tr>
<th>VERSION</th>
<th>DATE</th>
<th>PURPOSE</th>
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<tr>
<td>0.1</td>
<td>September 2020</td>
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</table>

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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These Terms and Conditions shall be governed by and construed in accordance with the laws of England and Wales. Disputes arising here from shall be exclusively subject to the jurisdiction of the courts of England and Wales.
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 of requirements for the procurement of subsea fasteners in accordance with API Specification 20E Alloy and Carbon Steel Bolting for Application in the Petroleum and Natural Gas Industries.

This JIP33 standardized procurement specification follows a common document structure comprising the four documents as described below, which together with the purchase order documentation, define the overall technical specification for procurement. It should be noted however, that this specification package for subsea fasteners does not include a data sheet.

JIP33 Specification for Procurement Documents
Supplementary Technical Specification

This specification is to be applied in conjunction with the supporting quality requirements specification (QRS) and information requirements specification (IRS) as follows.

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 the equipment and is written as an overlay to API Specification 20E, following the API Specification 20E clause structure. Clauses from API Specification 20E not amended by this specification apply as written to the extent applicable to the scope of supply.

Modifications to API Specification 20E defined in this specification are identified as Add (add to clause or add new clause), Replace (part of or entire clause) or Delete.

IOGP S-724Q: Quality Requirements for Subsea Fasteners (Alloy and Carbon Steel 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 four generic conformity assessment system (CAS) levels on the basis of evaluation of the associated service and supply chain risks. 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)

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 QRS and IRS follows that of API Specification 20E 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 supplementary specification 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) purchaser defined requirements (QRS, IRS);
d) this specification;
e) API Specification 20E.
1 Scope

1.4 Delete list item c)

1.5 Add before first sentence

BSL-1, BSL-2 or BSL-3 fasteners shall be manufactured at a facility licenced by API.

2 Normative References

ANSI/ASQ Z1.4, Sampling Procedures and Tables for Inspection by Attributes
ASTM A962, Standard Specification for Common Requirements for Bolting Intended for Use at Any Temperature from Cryogenic to the Creep Range
ISO 6892-1, Tensile Testing on Metals at Room Temperature
ISO 9712, Non-destructive testing - Qualification and certification of NDT personnel
ISO 16228, Fasteners — Types of inspection documents
ISO/IEC 17020, Conformity assessment - Requirements for the operation of various types of bodies performing inspection
ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories

3 Terms, Definitions and Abbreviations

Add new definition

3.1.14 accreditation or accredited [ISO/IEC 17020 and ISO/IEC 17025]
A formal recognition by an IAF or ILAC (e.g. an ISO/IEC 17011 conforming national) accreditation body that an organization is competent to perform specific processes, activities, or tasks as detailed in the scope of accreditation. The accreditation takes the form of an accreditation certificate with a definition of the scope of the certificate.

Add new definition

3.1.15 qualification or qualified [ISO/IEC 17025]
The test/examination method under consideration shall be qualified in accordance with ISO/IEC 17025. The qualification shall be performed by an independent and technically competent person or authority only. Records pertaining to both the qualification and the person attesting to the qualification shall be established and maintained.
4 Qualification Bolting

4.1 General

4.1.1 In first sentence replace "nine" with eight

In third sentence add after "bolting type"

and BSL

4.2 Qualification Testing

Replace Table 1 with

<table>
<thead>
<tr>
<th>BSL</th>
<th>Material</th>
<th>Forge/Heat Treat</th>
<th>Chemistry</th>
<th>Mechanical</th>
<th>Metallurgical</th>
<th>Hardness</th>
<th>NDE Surface</th>
<th>NDE Volumetric</th>
<th>Dimensional and Visual Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSL-1</td>
<td>5.5.1</td>
<td>5.4.5</td>
<td>5.6</td>
<td>5.7.1</td>
<td>5.8.2</td>
<td>5.9.2.3</td>
<td>5.10.1</td>
<td>5.10.2.2</td>
<td>5.11.2</td>
</tr>
<tr>
<td>BSL-2</td>
<td>5.5.2</td>
<td>5.4.6</td>
<td>5.6</td>
<td>5.7.2</td>
<td>5.8.3</td>
<td>5.9.2.4</td>
<td>5.10.1</td>
<td>5.10.2.2</td>
<td>5.11.3</td>
</tr>
<tr>
<td>BSL-3</td>
<td>5.5.3</td>
<td>5.4.7</td>
<td>5.6</td>
<td>5.7.2</td>
<td>5.8.4</td>
<td>5.9.2.4</td>
<td>5.10.3.1</td>
<td>5.10.3.2</td>
<td>5.11.4</td>
</tr>
</tbody>
</table>

4.2.2

Replace first sentence with

Testing, including that certified by the raw material supplier, shall be performed by a laboratory accredited for the full testing scope in accordance with ISO 17025.

Replace second sentence with

NOTE For ultrasonic examination and magnetic particle inspection, accreditation to ISO/IEC 17020 is an acceptable alternative to ISO/IEC 17025.

Delete third sentence

4.3 Materials and Dimensions

4.3.1

Replace section with

The following bolting material grades are covered by this specification:

— ASTM A194/A194M Grades 7 and 7M;
— ASTM A320/A320M Grades L7, L43 and L7M.
Add new section

4.3.5

The maximum permitted raw material (bar) diameter for machined only nuts and headed fasteners shall be as follows:

— ASTM A194/A194M Grades 7L and 7ML; 65 mm (2.5 in.);
— ASTM A320/A320M Grades L7 and L7M; 65 mm (2.5 in.);
— ASTM A320/A320M Grade L43; 100 mm (4.0 in.).

4.5 Records of Qualification

Replace list item b) with

b) heat number and production number, and where applicable, heat lot;

In list item o) replace "qualification" with

"accreditation;"

Add list item r)

r) the range of approval;

Add list item s)

s) the bolting manufacturer’s raw material specification reference.

4.6 Limits of Bolting Qualification

4.6.1 BSL-1

Replace section with

A change to the following limits of bolting qualification shall require re-qualification:

a) heat treat method (type of equipment, furnace control method and cooling methods);

b) heat treatment parameters as given in the MPS;

c) repeat heat treatment cycles—the number of repeat cycles is limited to one repeat cycle unless two repeat cycles were performed during qualification;

d) fastener material grade including class or property class;

e) qualified coating or plating process to an unqualified coating or plating process—qualification in this context is a process verification.

Add new section

4.6.1.1

A coating or plating qualification on one LAS material grade shall qualify application on all LAS material grades provided the substrate preparation is consistent.
4.6.2 BSL-2 and BSL-3

Replace list item a) with

a) raw material manufacturer not previously qualified in accordance with Section 5;

Add new list item

e) mechanical test method, e.g. a change from a fastener (or product based) tensile/tension test to a standard machined tensile/tension test specimen or vice versa;

Add new list item

f) raw material forming method.

5 Production of Qualified Bolting

5.1 Qualification of Procurement Sources for Raw Material

5.1.2

Replace section b) with

BSL-2 and BSL-3 - all of the methods listed in 5.1.2.a) shall be used.

Delete section c)

Add new section

5.1.2.1

Raw material sourced from stockists or distributors shall have the traceability maintained as applied by the raw material supplier (manufacturer).

5.2 Qualification of Suppliers for Subcontracted Operations

5.2.1 General

Replace section with

Subcontracted operation shall be qualified by the manufacturer in accordance with this section.

5.2.2 Qualification Requirements

5.2.2.2

Delete "an onsite"

Add new section

5.2.2.3

The following procedures for subcontracted operations shall be subject to document control and approval by the manufacturer prior to use by the subcontractor during qualification and production fastener manufacture:

— forging/forming;
— heat treatment;
— threading;
— plating/coating;
— NDE.

5.2.3 Technical Evaluation

In first paragraph replace "b) and c) below" with
and b) below:

Replace list item a) with

a) BSL-1 requirements.

1) A quality management system evaluation, ensuring that the subcontractor’s QMS is compliant with ISO 9001 or API Q1.

2) Accreditation in accordance with ISO/IEC 17020 or ISO/IEC 17025.

Replace list item b) with

b) BSL-2 and BSL-3 requirements.

1) Requirements specified for BSL-1 are required for BSL-2 and BSL-3.

2) Onsite process audit performed by a technical authority at an interval no greater than three years.

3) First article evaluation of each subcontracted process as per manufacturer’s documented procedure.

Delete list item c)

5.4 Manufacturing Process Specification

5.4.1 General

Replace first sentence with

The fastener manufacturer shall establish and maintain an MPS for each bolting type, material grade (class and property class where applicable) and size or size range.

Add new section

5.4.1.1

The MPS shall include allowable levels for all bolting manufacturing parameters and the general variables listed in 5.4.2, the forging and hot heading parameters listed in 5.4.3 and the heat treatment parameters listed in 5.4.4.

Add new section

5.4.1.2

The following information shall be included in the MPS in addition to items listed in 5.4.1:
a) this specification and revision;
b) BSL;
c) scope;
d) fastener material grade, class and property class (where applicable);
e) raw material hot work ratio (reduction), minimum;
f) mechanical testing (and metallurgical testing where applicable);
g) hardness testing and test location on the actual fastener;
h) NDE;
i) visual inspection;
j) dimensional inspection;
k) coating or plating (where applicable);
l) markings including the location on the fastener;
m) reference to:
  — API Q1 certificate number;
  — API Specification 20E licence number;
  — fastener manufacturer’s raw material specification;
  — fastener product standard;
  — fastener standard or specification;
  — ISO 17020 or 17025 test facility accreditation number;
  — supporting MPQ reference;
  — supporting production manufacturing related procedures, e.g. NDE, coating or plating.

5.4.2 General Variables

Replace list item h) with

h) subcontracted operation supplier (name and address).

5.4.4 Heat Treatment Parameters

Replace first sentence with

The following heat treat parameters shall apply to all forms of heat treatment as applicable:
5.4.5  BSL-1 Requirements

5.4.5.3

Add after third sentence

External and internal metric threads shall be in accordance with ISO 68-1.

5.4.5.4

Replace first sentence with

Furnace qualification shall be in accordance with API 6A Section 6.5, SAE AMS2750 or SAE AMSH6875.

Add new section

5.4.5.5

For induction heat treatment, qualification shall be in accordance with ASTM A1100.

Add new section

5.4.5.6

Forging furnace qualification shall be in accordance with the written procedure.

Add new section

5.4.5.7

Fasteners shall be within the working zone of the furnace during heat treatment.

Add new section

5.4.5.8

Fasteners shall not be in direct contact with each other during heat treatment.

Add new section

5.4.5.9

If used within the furnace, supporting mechanisms shall not affect heat treatment.

Add new section

5.4.5.10

Hot formed nuts ≥M42 (1,625 in.) shall be pierced or drilled through prior heat treatment.

Add new section

5.4.5.11

For grades L7 and L43, the maximum actual $R_{p0.2}$ (YS) shall be 930 MPa (135 ksi).
Add new section

5.4.5.12

$R_{p0.2} \text{(YS)}/R_m \text{(UTS)}$ ratio shall be 0.90 maximum.

5.4.6 BSL-2 Requirements

5.4.6.4

Replace section with

For rolled threads, parts shall be stress relieved at a temperature within 10 °C to 28 °C (18 °F to 50 °F) below the final tempering temperature intended to establish mechanical properties.

Add new section

5.4.6.8

One contact thermocouple attached to a part shall be used to verify heat treatment times and temperatures.

Add new section

5.4.6.9

The referenced thermocoupled part shall be placed in a location deemed to have the slowest heating rate or centrally in the furnace load.

Add new section

5.4.6.10

Continuous process heat treatment shall not be used.

Add new section

5.4.6.11

Induction and direct resistance heat treatments shall not be used for normalizing, austenitizing, tempering, and stress relieving operations.

5.4.7 BSL-3 Requirements

Delete section

5.4.7.2

Delete section

5.4.7.3

Delete section
5.4.7.4

Delete section

5.4.7.5

5.4.8  Plating and Coating

Add new section

5.4.8.1.1

Coating and plating application procedures shall be qualified.

Add new section

5.4.8.1.2

Qualified plating and coating application procedure qualifications shall have a validity of five years from the release/issue date after which re-qualification is required to extend the qualification for a further five years.

5.5  Raw Material

5.5.1  BSL-1

5.5.1.2

Replace section with

The raw material hot work ratio (reduction) shall be 10.0:1.

Add new section

5.5.1.2.1

The qualification of a hot work ratio ≥10.0:1 shall qualify production hot work ratios ≥10.0:1.

Add new section

5.5.1.6

Test specimens shall be located at the axis of the bar diameter or distance across flats i.e. D/2.

5.5.3  BSL-3

Add new section

5.5.3.6

The permissible variation for the product analysis of ASTM A194/A194M grades 7L and 7ML shall be in accordance with ASTM A320/A320M grades L7 and L7M respectively.
5.7 Mechanical Properties

5.7.1 General

Add new section

5.7.1.1

Retesting shall be recorded in the final documentation.

Add new section

5.7.1.2

Nut CVN impact testing shall be performed in accordance with ASTM A194/A194M Supplementary Requirement S3.

Add new section

5.7.1.3

Nut proof load testing shall be performed in accordance with ASTM A194/A194M Supplementary Requirement S4.

Add new section

5.7.1.4

If the minimum proof load specified in ASTM A194/A194M Tables S4.1 and S4.2 cannot be applied, maximum available proof load shall be applied.

Add new section

5.7.1.5

If the specified proof load in ASTM A194/A194M Tables S4.1 and S4.2 cannot be applied, a cross section hardness test in accordance with ASTM A194/A194M 8.2 shall be performed.

Add new section

5.7.1.6

Testing shall be performed by an ISO 17025 accredited test laboratory or facility.

Add new section

5.7.1.7

For hot formed and heat treated 7L and 7ML nuts which cannot be proof load tested or the specified proof test load cannot be applied due to test equipment limitations, the tension/tensile test shall meet the tensile properties based on ASTM A320/A320M L7 and L7M respectively.
Add new section

5.7.1.8

If product is formed by hot forming and subsequently heat treated and its size does not permit the removal of the required mechanical test specimen types and quantity, test bar from the same raw material heat and representative of the product ruling section thickness shall be used for mechanical testing.

Add new section

5.7.1.9

If the product is formed by hot forming and subsequently heat treated and its size does not permit the removal of the required mechanical test specimen types and quantity, test bar from the same raw material heat and representative of the product ruling section thickness shall be heat treated in the same heat treatment lot as the product.

Add new section

5.7.1.10

A representative test bar shall only be used for the specific test specimens that cannot be obtained from the product.

5.8 Metallurgical Requirements

5.8.1 General

Add new section

5.8.1.1

Metallurgical requirements shall apply after the final quality heat treatment.

Add new section

5.8.1.2

For the purpose of decarburization testing, "heat treatment" in ASTM A962/A962M shall include stress relieving if the holding temperature is greater than 675 °C (1247 °F).

Add new section

5.8.1.3

Decarburization and carburization testing shall be performed on studs if the raw material (bar) OD is within 1.5 mm of the finished thread diameter.

Add new section

5.8.1.4

Testing shall be performed by an ISO/IEC 17025 accredited test laboratory or facility.
5.8.3 BSL-2

5.8.3.1 Microstructure Testing

5.8.3.1.1 General

Add new section

5.8.3.1.1.1

The examination shall be performed at 1d from the end of the threaded section for bolts, screws and studs.

Add new section

5.8.3.1.1.2

Bolts, screws and studs examination shall encompass the thread root.

Add new section

5.8.3.1.1.3

The examination shall be performed at mid thickness and mid height for nuts.

5.8.3.1.5 Bending

In first sentence of first paragraph replace "ASTM E1268" with

ASTM E1268-01 (2016)

Table 2—Microstructure and Macrostructure Requirements for BSL-2 and BSL-3

In Table 2, replace "ASTM E1268" with

ASTM E1268-01 (2016)

5.9 Examination and Test Requirements

5.9.1 General

In first sentence replace "inspecting or testing" with

performing hardness testing, surface NDE, and dimensional and visual inspection on

Add new section

5.9.1.1

If sampling examination is specified for hardness testing, surface NDE, and dimensional and visual inspection on production lots, the sample selection shall be random unless the sample size is specified as 100 %.
5.9.2 Hardness Test Requirements

5.9.2.1 General

*Replace "ASTM A370, including Annex A3" with ASTM F606/F606M*

5.9.2.2 BSL-1

5.9.2.2.1 Hardness Testing of Bars and Fasteners

*Replace first sentence with*

The hardness test results shall conform to the requirements of ASTM A194/A194M and ASTM A320/A320M.

*Add new sentence*

The maximum hardness for Grades L7, L43 and 7L shall not exceed 34.0 HRC.

*Add new sentence*

The maximum hardness for Grade 7ML shall be within the range 93-99.0 HRB.

5.9.2.2.1.1 For the manufactured lot, the hardness range (from lowest to highest recorded) shall be maximum 6 HRC.

5.9.2.2.1.2 The hardness test results shall not be converted.

5.9.2.2.1.3 Hardness readings shall be taken on the end of the threaded section of a bolt, screw or stud or the arbitration test location in accordance with ASTM F606/F606M.

5.9.2.2.1.4 For grade 7L nuts subjected to cross sectional hardness testing, the difference between the core and surface hardness shall be three HRC.
5.9.2.2.2  
*Delete section*

5.9.2.2.3  
*Delete section*

5.9.2.3  
**BSL-2**

5.9.2.3.1  **Hardness Testing of Bars and Fasteners**

*Delete text after "BSL-2"

5.9.2.3.3  
**Nuts Not Subject to Mandatory Proof Load**

*Add after "Tables 3 and 4"*

S4.1 and S4.2  
*Add new section*

5.9.2.3.3.1  
For nuts not subjected to proof load testing, the difference between the core or cross section and surface hardness shall be 3HRC.

5.10  **Nondestructive Examination Requirements**

5.10.1  **BSL-1 NDE**

*Delete section*

*Add new section*

5.10.1.1  
Surface NDE (magnetic particle examination) shall be performed on the final product prior to coating or plating.  
*Add new section*

5.10.1.2  
Surface NDE (magnetic particle examination) shall be performed by an ISO/IEC 17025 (or alternatively an ISO/IEC 17020) accredited test laboratory or facility.  
*Add new section*

5.10.1.3  
Surface NDE (magnetic particle examination) personnel shall be certified by an organisation accredited to ISO/IEC 17024 for the certification of personnel in accordance with ISO 9712.
Add new section

5.10.1.4
Personnel performing surface NDE (magnetic particle examination) shall be certified to ISO 9712 Level 2.

Add new section

5.10.1.5
Personnel approving surface NDE (magnetic particle examination) procedures shall be certified to ISO 9712 Level 3.

Add new section

5.10.1.6
Surface NDE (magnetic particle examination) shall be in accordance with API Standard 20D.

Add new section

5.10.1.7
The surface NDE (magnetic particle examination) procedure shall include a technique sheet unless the procedure is specific to fastener surface NDE.

Add new section

5.10.1.8
Surface NDE (magnetic particle examination) shall be performed on fasteners in accordance with the requirements of API Specification 20E BSL-2 with a sample size based on ASTM F1470 Table 3 sample size A.

Add new section

5.10.1.9
Where hot forming is performed, the surface NDE (magnetic particle examination) sample size shall be increased to 100% of the manufactured lot.

Add new section

5.10.1.10
The AC electromagnetic yoke or similar for the surface NDE (magnetic particle examination) shall not be used.

Add new section

5.10.1.11
Surface breaking or sub-surface indications shall not be allowed.
5.10.2 BSL-2

5.10.2.1 BSL-2 Surface NDE

Delete second sentence
Delete "*, including personnel qualification" from third sentence
Delete fourth sentence
Delete fifth sentence
Add to end of sixth sentence

Sample size shall be in accordance with Table 3.

Add new section

5.10.2.1.1

Surface NDE (magnetic particle examination) requirements specified for BSL-1 shall be used for BSL-2.

5.10.2.2 BSL-2 Volumetric NDE

Replace first sentence with

Volumetric NDE (ultrasonic testing) shall be performed on raw material (bar) diameter ≥25.4 mm (1.0 in.) after heat treatment and fasteners which have been hot formed from raw material (bar) diameter ≥25.4 mm (1.0 in.) after heat treatment.

Delete *, including personnel qualification" from second sentence

Add new section

5.10.2.2.1

Volumetric NDE (ultrasonic examination) shall be performed by an ISO/IEC 17025 (or alternatively an ISO/IEC 17020) accredited test laboratory/facility.

Add new section

5.10.2.2.2

Volumetric NDE (ultrasonic examination) personnel shall be certified by an organisation accredited to ISO/IEC 17024 for the certification of personnel in accordance with ISO 9712.

Add new section

5.10.2.2.3

Personnel performing volumetric NDE (ultrasonic examination) shall be certified to ISO 9712 Level 2.
Add new section

5.10.2.2.4

Personnel approving volumetric NDE (ultrasonic examination) procedures shall be certified to ISO 9712 Level 3.

Add new section

5.10.2.2.5

Volumetric NDE (ultrasonic examination) shall be in accordance with API Standard 20D.

Add new section

5.10.2.2.6

The volumetric NDE (ultrasonic examination) procedure shall include a scanning plan or technique sheet unless the procedure is specific to raw material or fastener NDE.

Add new section

5.10.2.2.7

The reference reflector for angled beam probes shall be 60° V-notch of a depth of 3% of the raw material (bar) OD, headed bolt, headed screw, stud or nut ND or 6.35 mm, whichever is the lesser.

Add new section

5.10.2.2.8

For a bar OD or distance across flats >50 mm (2.0 in.), headed bolt/screw d>50 mm (2.0 in.) or nut m>50 mm (2.0 in.), a single crystal probe shall be used for 360° circumferential scanning.

Add new section

5.10.2.2.9

For a bar OD or distance across flats ≤50 mm (2.0 in.), either a twin crystal probe shall be used with minimum 180° circumferential scanning or a single crystal probe with minimum 360° circumferential scanning.

Add new section

5.10.2.2.10

Single crystal probes shall be used for the scanning of flat faces (e.g. bar or stud ends, bolt or screw heads, ends, nut faces or flats).

Add new section

5.10.2.2.11

Angle beam probes shall be used for axial scanning with the probe contoured to the OD of the bar or headed bolt/screw or stud.
Add new section

5.10.2.2.12

Special probes, e.g. creep wave/compression wave angle beam probe, miniature probes (e.g. size 3 mm, 5 mm and 6 mm) and frequencies other than specified above, etc., shall be used.

Add new section

5.10.2.2.13

Raw material (bar) shall be scanned longitudinally and circumferentially using a combination of normal and angle beam probes as per Figure 1.

Add new figure

![Figure 1—Scanning of Raw Material Bars](image)

Add new section

5.10.2.2.14

The scanning of LAS BSL-2 fasteners after hot forming and quality heat treatment shall be detailed on the scanning plan or technique sheet.

Add new section

5.10.2.2.15

The acceptance criteria for volumetric NDE (ultrasonic examination) shall be in accordance with Table 4.

Add new table

Table 4—Volumetric NDE Acceptance Criteria

<table>
<thead>
<tr>
<th>Volumetric NDE Acceptance Criteria</th>
<th>BSL-2</th>
<th>BSL-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>No single indication exceeding the PRL(^1)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>An indication between 50-80 % of the PRL(^1) and with length (\geq 3x) the reference reflector size shall be cause for rejection.</td>
<td>–</td>
<td>X</td>
</tr>
<tr>
<td>An indication (&gt;80\ %) of the PRL(^1) is not permitted and requires rejection regardless of length and/or depth.</td>
<td>–</td>
<td>X</td>
</tr>
<tr>
<td>No multiple indications (&gt;50\ %) of the PRL(^1)</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Add new section

5.10.2.2.16

For raw material (bar) examination, 10 mm length on either side of an indication shall be discarded from examined material which does not meet the acceptance criteria in Table 4.

5.10.3 BSL-3

5.10.3.2 BSL-3 Volumetric NDE

Replace section with

Volumetric NDE requirements specified for BSL-2 are required for BSL-3.

5.11 Dimensional and Visual Inspection

5.11.1 General

Replace first sentence with

The dimensions shall meet the requirements of the applicable product dimensional standard (e.g. ASME, ISO).

In fourth sentence replace "bolts threads" with

bolt, screw or stud threads

Add new section

5.11.1.1

Visual inspection shall be performed prior to dimensional inspection.

Add new section

5.11.1.2

Fasteners shall be free from cracks, bursts, seams, folds, thread laps and voids.

Add new section

5.11.1.3

Surface discontinuities other that those listed in 5.11.1.3 shall be evaluated in accordance with ASTM F788, ASTM F812, ISO 6157-2 or ISO 6157-3.
Add new section

5.11.1.4

Markings on coated or plated fasteners shall be verified as part of the visual examination.

Add new section

5.11.1.5

For coated and plated fasteners, thread dimensions shall be verified again after coating or plating based on a sample size in accordance with ASTM F1470 Table 3 sample A.

Add new section

5.11.1.6

Thread dimensions of bolts, screws and studs d<\(M48\) (1.875 in.) shall be verified using a thread caliper go/no go gauge.

Add new section

5.11.1.7

Thread dimensions of bolts, screws and studs d\(\geq M48\) (1.875 in.) shall be verified using a thread ring go/no go gauge.

Add new section

5.11.1.8

External threads of coated or plated fasteners shall accept a 6H or 3A gauge.

Add new section

5.11.1.9

Internal threads of coated or plated fasteners shall accept a 6H or 3B go gauge.

Add new section

5.11.1.10

The same no go gauge size shall be used before and after application of the coating or plating.

5.11.2  BSL-1 Sample Size

Replace section with

Sample size shall be in accordance with ASTM F1470 Table 3 sample A.
5.11.4 BSL-3 Sample Size

*Replace Table 3 title with*

**Table 3—Sampling for Dimensional and Visual Inspection and Surface NDE**

6 Calibration Systems

*Add after "ANSI/NCSL Z540.3"*

"or IEC/ISO 17025"

7 Test Report

7.1 BSL-1, BSL-2 and BSL-3

*Replace first sentence with*

The fastener test report shall be in accordance with the base case product standard or specification, API Specification 20E and ISO 16228 Type F3.1.

*Add new section*

7.1.1

The following shall be included in the fastener test report in addition to that which is specified in the base case product standard/specification, API Specification 20E and ISO 16228 F3.1:

a) reference to S-724;
b) fastener BSL;
c) MPS reference;
d) raw material manufacturer;
e) manufactured lot quantity;
f) head or nut forming method;
g) thread forming method;
h) chemistry check analysis (heat);
i) chemistry check analysis (product, BSL-3 only);
j) coating or plating report;
k) macroetch and microstructure examination photographs;
l) decarburization test report;
m) comments on the test or inspection results.
Add new section

7.1.2
When data is transferred, the original certification or test report shall accompany the fastener test report.

7.2 BSL-1

Delete section

7.3 BSL-2 and BSL-3

Delete section

8 Marking

8.2 Marking Required by This Specification

Add new section

8.2.1
Markings on fasteners shall include:

a) the fastener manufacturer's identification mark;

b) the fastener material grade (and class/property class where applicable); and

c) the manufacturing lot number.

NOTE Refer to the FDS for specific details of marking 'b'.

Add new section

8.2.2
The manufacturing lot number shall be unique.

Add new section

8.2.3
A raw material "cast" or "heat" number (or any part thereof) shall not be used as the unique manufacturing lot number.

Add new section

8.2.4
Markings on nuts shall not protrude beyond the bearing surfaces.

Add new section

8.2.5
Hexagon headed bolts and screws shall be marked on the head but not on the wrench flat.
Add new section

8.2.6

SHCSs shall be marked on the top of the head.

Add note

NOTE Where space limitations prevent all or some of the markings being applied, it is allowed to apply marking to the side of the head. - Refer to Figure 2.

Add new figure 2

![Example Fastener Marking Locations]

Figure 2—Example Fastener Marking Locations

Add new section

8.2.7

Studs shall be marked on one end only unless the other end is required to apply all required markings.

Add new section

8.2.8

For tap end (TE) type studs, the marking shall be applied to the ‘nut’ end only.

Add new section

8.2.9

Nuts shall not be marked on the wrench flat.

Add new section

8.2.10

Markings shall not be applied to unthreaded shank or body section of bolts, screws, SHCSs, SHSSs and studs.

Add new section

8.2.11

Where fasteners are specified to be coated or plated, the required markings shall be applied prior to coating or plating.
Add new section

8.2.12

Markings on coated or plated fasteners shall be legible after coating or plating.
Annex B  
(Informative)  
Fastener Data Sheets

Add NOTE

NOTE In terms of units, this specification is expressed in both SI (MPa, kN, J) and inch-pound (ksi, lbf, ft-lbf) units where applicable (e.g. MPa (ksi)) however mechanical property values have to be regarded separately. The values specified may not be exact equivalents therefore each unit system should be used independently of the other. Combining or manually converting values from or between the two unit systems may result in non-conformance with the specified requirements, and therefore is not permitted.

Add new Table B.1

Table B.1—Fastener Data Sheet - Grade 7L and 7ML

<table>
<thead>
<tr>
<th>Fastener type</th>
<th>Nut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>ASTM A194/A194M</td>
</tr>
<tr>
<td>Grade or alloy</td>
<td>7L, 7ML</td>
</tr>
<tr>
<td>Class and property class</td>
<td>N/A</td>
</tr>
<tr>
<td>Fastener material condition</td>
<td>Quenched and tempered</td>
</tr>
<tr>
<td>Raw material manufacture</td>
<td>BSL-1</td>
</tr>
<tr>
<td></td>
<td>Refer to IOGP S-724, 5.5</td>
</tr>
<tr>
<td></td>
<td>BSL-2</td>
</tr>
<tr>
<td></td>
<td>BSL-3</td>
</tr>
<tr>
<td>Threading method</td>
<td>BSL-1</td>
</tr>
<tr>
<td></td>
<td>Machined</td>
</tr>
<tr>
<td></td>
<td>BSL-2</td>
</tr>
<tr>
<td></td>
<td>BSL-3</td>
</tr>
<tr>
<td>Forming method</td>
<td>BSL-1</td>
</tr>
<tr>
<td></td>
<td>Hot forming only if D&gt;M42 (1.625 in.)</td>
</tr>
<tr>
<td></td>
<td>BSL-2</td>
</tr>
<tr>
<td></td>
<td>BSL-3</td>
</tr>
<tr>
<td>Volumetric NDE (UT) - raw material</td>
<td>BSL-1</td>
</tr>
<tr>
<td></td>
<td>100 % of raw material (bar) OD or distance across flats ≥25 mm (1,0 in.)</td>
</tr>
<tr>
<td></td>
<td>BSL-2</td>
</tr>
<tr>
<td></td>
<td>BSL-3</td>
</tr>
<tr>
<td>Volumetric NDE (UT) - fasteners</td>
<td>BSL-1</td>
</tr>
<tr>
<td></td>
<td>D≥M24 (1,0 in.) only if hot formed</td>
</tr>
<tr>
<td></td>
<td>BSL-2</td>
</tr>
<tr>
<td></td>
<td>BSL-3</td>
</tr>
<tr>
<td>Surface NDE (MT)</td>
<td>BSL-1</td>
</tr>
</tbody>
</table>
| | Sample size ASTM F1470 Table 3 Sample ‘A’ 
 | Refer to S-724 section 5.10.1 |
| | BSL-2 |
| | Sample size API Specification 20E Table 3 
 | Refer to S-724 section 5.10.1 |
| | BSL-3 |
| | Sample size 100 % of manufactured lot |
| Hardness testing | L7/L43 |
| | BSL-1 |
| | Sample size ASTM F1470 Table 3 Sample ‘A’ |
| | L7M |
| | BSL-2 |
| | Sample size 100 % of manufactured lot |
| | BSL-3 |
| Visual inspection | BSL-1 |
| | Sample size ASTM F1470 ‘A’ |
| | BSL-2 |
| | Table 3 |
| | BSL-3 |
| | Sample size 100 % of manufactured lot |
### Supplementary Specification to API Specification 20E Subsea Fasteners

**Alloy and Carbon Steel Bolting**

<table>
<thead>
<tr>
<th>Dimensional inspection</th>
<th>BSL-1</th>
<th>Sample size ASTM F1470 Table 3 Sample ‘A’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BSL-2</td>
<td>Sample size API Specification 20E Table 3</td>
</tr>
<tr>
<td></td>
<td>BSL-3</td>
<td>Sample Size 100 % of manufactured lot</td>
</tr>
<tr>
<td>Tensile/tension test, machined specimen</td>
<td>Refer to IOGP S-724, 5.7.1</td>
<td></td>
</tr>
<tr>
<td>Tensile/tension test, full size product, axial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile/tension test, full size product, wedge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proof load test, full size product</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>CVN impact test</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Decarburization/carburization test</td>
<td>Yes. Refer to IOGP S-724, 5.8.1</td>
<td></td>
</tr>
<tr>
<td>Metallurgical examination - raw material</td>
<td>BSL-1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BSL-2</td>
<td>Yes, after final heat treatment. Refer to IOGP, S-724, 5.8.3</td>
</tr>
<tr>
<td></td>
<td>BSL-3</td>
<td></td>
</tr>
<tr>
<td>Metallurgical examination - fasteners</td>
<td>BSL-1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BSL-2</td>
<td>Yes, if heat treated. Refer to IOGP S-724, 5.8.3</td>
</tr>
<tr>
<td></td>
<td>BSL-3</td>
<td></td>
</tr>
<tr>
<td>Chemical composition / chemistry</td>
<td>BSL-1</td>
<td>ASTM A194/A194M 7L/7ML</td>
</tr>
<tr>
<td></td>
<td>BSL-2</td>
<td>ASTM A194/A194M 7L/7ML P and S 0.025 % maximum</td>
</tr>
<tr>
<td></td>
<td>BSL-3</td>
<td>ASTM A194/A194M 7L/7ML P and S 0.015 % maximum</td>
</tr>
<tr>
<td>Product (chemical) analysis</td>
<td>BSL-1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BSL-2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BSL-3</td>
<td>Yes</td>
</tr>
<tr>
<td>Yield strength/Rp0,2 (YS), MPa (ksi)</td>
<td>7L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7ML</td>
<td></td>
</tr>
<tr>
<td>Tensile strength/Rm (UTS), MPa (ksi)</td>
<td>7L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7ML</td>
<td></td>
</tr>
<tr>
<td>Elongation, 50 mm / in., %, min.</td>
<td>7L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7ML</td>
<td></td>
</tr>
<tr>
<td>Reduction in area, %, min.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rp0,2 (YS)/Rm (UTS) Ratio, max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torsional strength, Nm (in./lbs), min.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proof load, kN (lbf), min., regular or full nut</td>
<td>Metric</td>
<td>Table 4 2 and S4.2</td>
</tr>
<tr>
<td></td>
<td>UN</td>
<td>Table 3 and S4.1</td>
</tr>
<tr>
<td>Proof load, kN (lbf), min., thin, half or jam nut</td>
<td>0,46xHex (regular/full) nut proof load</td>
<td></td>
</tr>
<tr>
<td>Proof load, kN (lbf), min., regular or full nut</td>
<td>Metric</td>
<td>Table 4 2 and S4.2</td>
</tr>
<tr>
<td></td>
<td>UN</td>
<td>Table 3 and S4.1</td>
</tr>
<tr>
<td>Impact toughness, CVN, J (ft-lbf), min.</td>
<td>7L</td>
<td>Average 27 (20), individual 20 (15) at -101 °C (-150 °F)</td>
</tr>
<tr>
<td></td>
<td>7ML</td>
<td>Average 27 (20), individual 20 (15) at -73 °C (-100 °F)</td>
</tr>
<tr>
<td>Hardness</td>
<td>7L</td>
<td>34.0 HRC maximum</td>
</tr>
<tr>
<td></td>
<td>7ML</td>
<td>93-99.0 HRB</td>
</tr>
<tr>
<td>Markings M6sd&lt;M24 (0,25 in.sd&lt;1,0 in.)</td>
<td>Manufacturer, 7L or 7ML 3 and manufacturing lot number</td>
<td></td>
</tr>
</tbody>
</table>
Markings M24≤d≤M100 (1.0 in.≤d≤4.0 in.)

Manufacturer, 7L or 7ML, manufacturing lot number and heat lot number

Fastener test report

ASTM A194/A194M, API Specification 20E, ISO 16228 Type F3.1 and IOGP S-724, 7.

Raw material certification

EN 10204/ISO 10474 Type 3.1

1 Note the additional hardness testing specified in ASTM A194/A194M unless the product is zinc (Zn) or Zn alloy electroplated.
2 For product sizes M6≤d<M12, refer to ASTM A194/A194M-18 Table 4.
3 Product machined from bar requires marking with '7BL' or '7MLB'.

Add new Table B.2

Table B.2—Fastener Data Sheet - Grade L7, L43 and L7M

<table>
<thead>
<tr>
<th>Fastener type</th>
<th>Bolt, screw</th>
<th>Stud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>ASTM A320/A320M</td>
<td>ASTM A320/A320M</td>
</tr>
<tr>
<td>Grade or alloy</td>
<td>L7, L43, L7M</td>
<td></td>
</tr>
<tr>
<td>Class and property class</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fastener material condition</th>
<th>BSL-1</th>
<th>BSL-2</th>
<th>BSL-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer to IOGP S-724, 5.5</td>
<td></td>
<td></td>
<td>Refer to IOGP S-724, 5.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Threading method</th>
<th>BSL-1</th>
<th>BSL-2</th>
<th>BSL-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted</td>
<td></td>
<td></td>
<td>Unrestricted</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Forming method</th>
<th>BSL-1</th>
<th>BSL-2</th>
<th>BSL-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot forming only if d&gt;M42 (1.625 in.)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Head or nut forming method</th>
<th>BSL-1</th>
<th>BSL-2</th>
<th>BSL-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machined or hot formed</td>
<td></td>
<td></td>
<td>Hot formed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Volumetric NDE (UT) - raw material</th>
<th>BSL-1</th>
<th>BSL-2</th>
<th>BSL-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 % of raw material (bar) OD or distance across flats ≥25 mm (1.0 in.)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Volumetric NDE (UT) - fasteners</th>
<th>BSL-1</th>
<th>BSL-2</th>
<th>BSL-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>d≥M24 (1.0 in.) if hot formed</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surface NDE (MT)</th>
<th>BSL-1</th>
<th>BSL-2</th>
<th>BSL-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size ASTM F1470 Table 3 Sample 'A'.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refer to IOGP S-724, 5.10.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample size API Specification 20E Table 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refer to IOGP S-724, 5.10.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample size 100 % of manufactured lot</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hardness testing</th>
<th>L7/L43</th>
<th>L7M</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSL-1</td>
<td>Sample size ASTM F1470 Table 3 Sample 'A'</td>
<td></td>
</tr>
<tr>
<td>BSL-2</td>
<td>Sample size 100 % of manufactured lot</td>
<td></td>
</tr>
<tr>
<td>BSL-3</td>
<td>Sample size API Specification 20E Table 3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Visual inspection</th>
<th>BSL-1</th>
<th>BSL-2</th>
<th>BSL-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size ASTM F1470 Table 3 Sample 'A'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample size API Specification 20E Table 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Supplementary Specification to API Specification 20E Subsea Fasteners
(Alloy and Carbon Steel Bolting)

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensional inspection</strong></td>
<td>BSL-1: Sample size ASTM F1470 Table 3 Sample ‘A’</td>
</tr>
<tr>
<td></td>
<td>BSL-2: Sample size API Specification 20E Table 3</td>
</tr>
<tr>
<td></td>
<td>BSL-3: Sample size 100 % of manufactured lot</td>
</tr>
<tr>
<td><strong>Tensile/tension test, machined specimen</strong></td>
<td>Yes, if hot formed</td>
</tr>
<tr>
<td><strong>Tensile/tension test, full size product, axial</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Tensile/tension test, full size product, wedge</strong></td>
<td>M6≤d&lt;M24 (0,25 in.≤d≤1,5 in.) only if hot formed</td>
</tr>
<tr>
<td><strong>Proof load test, full size product</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CVN impact test</strong></td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Decarburization/carburization test</strong></td>
<td>Yes. Refer to IOGP S-724, 5.8.1</td>
</tr>
<tr>
<td><strong>Metallurgical examination - raw material</strong></td>
<td>BSL-1: Yes, after final heat treatment. Refer to IOGP S-724, 5.8.3</td>
</tr>
<tr>
<td></td>
<td>BSL-2: Yes, after final heat treatment. Refer to IOGP S-724, 5.8.3</td>
</tr>
<tr>
<td></td>
<td>BSL-3: Yes, after final heat treatment. Refer to IOGP S-724, 5.8.3</td>
</tr>
<tr>
<td><strong>Metallurgical examination - fasteners</strong></td>
<td>BSL-1: L7/L43/L7M</td>
</tr>
<tr>
<td></td>
<td>BSL-2: L7/L43/L7M. P and S 0.025 % max.</td>
</tr>
<tr>
<td></td>
<td>BSL-3: L7/L43/L7M. P and S 0.015 % max.</td>
</tr>
<tr>
<td><strong>Chemical composition / chemistry</strong></td>
<td>BSL-1: L7/L43/L7M</td>
</tr>
<tr>
<td></td>
<td>BSL-2: L7/L43/L7M. P and S 0.025 % max.</td>
</tr>
<tr>
<td></td>
<td>BSL-3: L7/L43/L7M. P and S 0.015 % max.</td>
</tr>
<tr>
<td><strong>Product (chemical) analysis</strong></td>
<td>BSL-1:</td>
</tr>
<tr>
<td></td>
<td>BSL-2:</td>
</tr>
<tr>
<td></td>
<td>BSL-3:</td>
</tr>
<tr>
<td><strong>Yield strength/(R_{p0.2}) (YS), MPa (ksi)</strong></td>
<td>BSL-1: L7, L43: 725-930 (105-135)</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tensile strength/(R_m) (UTS), MPa (ksi)</strong></td>
<td>BSL-1: L7, L43: 860-1033 (125-150)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Elongation, 50mm / 2 in., %, min.</strong></td>
<td>BSL-1: L7, L43: 16</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reduction in area, %, min.</strong></td>
<td>BSL-1: 50</td>
</tr>
<tr>
<td><strong>(R_{p0.2}) (YS)/(R_m) (UTS) ratio, max.</strong></td>
<td>BSL-1: 0.90</td>
</tr>
<tr>
<td><strong>Proof load, kN (lbf), min., regular or full nut</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Proof Load, kN (lbf), min., thin, half or jam nut</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Proof Load, kN (lbf), min., high, heavy or thick nut</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Impact toughness, CVN, J (ft-lbf), min.</strong></td>
<td>BSL-1: L7, L43: Average 27 (20), Individual 20 (15) at -101 °C (-150 °F)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hardness</strong></td>
<td>BSL-1: L7, L43: 34.0 HRC maximum</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Markings M6≤d&lt;M24 (0,25 in. ≤d≤1,0 in.)</strong></td>
<td>BSL-1: Manufacturer, L7, L43 or L7M and manufacturing lot number</td>
</tr>
<tr>
<td><strong>Markings M24≤d≤M100 (1,0 in. ≤d≤4,0 in.)</strong></td>
<td>BSL-1: Manufacturer, L7, L43 or L7M and manufacturing lot number and heat lot number</td>
</tr>
<tr>
<td><strong>Fastener test report</strong></td>
<td>BSL-1: ASTM A320/A320M, API Specification 20E, ISO 16228 Type F3.1 and IOGP S-724, 7</td>
</tr>
<tr>
<td><strong>Raw material (bar) inspection certificate/test report</strong></td>
<td>BSL-1: EN 10204/ISO 10474 Type 3.1</td>
</tr>
</tbody>
</table>
### Annex C
(Informative)
Test/Examination/NDE Method

#### Add new Table C.1

**Table C.1—Mechanical/Metallurgical Test/Examination Method**

<table>
<thead>
<tr>
<th>Fastener Standard/Specification</th>
<th>Grade/Property Class</th>
<th>Test/Examination Method</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
<th>T7</th>
<th>T8</th>
<th>T9</th>
<th>T10</th>
<th>T11</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM A194</td>
<td>7L, 7ML</td>
<td>D or Q</td>
<td>A</td>
<td>G</td>
<td>S</td>
<td>L</td>
<td>J</td>
<td>K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASTM A194M</td>
<td>7L, 7ML</td>
<td>E or R</td>
<td>H</td>
<td>G</td>
<td>T</td>
<td>L</td>
<td>J</td>
<td>K</td>
<td></td>
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</tr>
<tr>
<td>ASTM A320</td>
<td>L7, L43, L7M</td>
<td>A* or Q</td>
<td>A</td>
<td>G</td>
<td>M</td>
<td>S</td>
<td>L</td>
<td>J</td>
<td>K</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASTM A320M</td>
<td>L7, L43, L7M</td>
<td>R</td>
<td>H</td>
<td>G</td>
<td>M</td>
<td>T</td>
<td>L</td>
<td>J</td>
<td>K</td>
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</tr>
</tbody>
</table>

**Key**

<table>
<thead>
<tr>
<th>Test/Examination Method</th>
<th>Test/Examination Method Standard/Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 Tensile/Tension</td>
<td>A ASTM A370</td>
</tr>
<tr>
<td>T2 Torsional Strength</td>
<td>A* ASTM A370 (Annex 3)</td>
</tr>
<tr>
<td>T3 Proof Load</td>
<td>B ASTM A604</td>
</tr>
<tr>
<td>T4 CVN Impact</td>
<td>C ASTM A923</td>
</tr>
<tr>
<td>T5 Hardness</td>
<td>D ASTM A962</td>
</tr>
<tr>
<td>T6 Decarburization/Carburization</td>
<td>E ASTM A962M</td>
</tr>
<tr>
<td>T7 Macro Examination</td>
<td>F ASTM E10</td>
</tr>
<tr>
<td>T8 Micro Examination</td>
<td>G ASTM E18</td>
</tr>
<tr>
<td>T9 Grain Size Determination</td>
<td>H ASTM E23</td>
</tr>
<tr>
<td>T10 Corrosion Test</td>
<td>J ASTM E45</td>
</tr>
<tr>
<td>T11 Ferrite Count</td>
<td>K ASTM E112</td>
</tr>
<tr>
<td></td>
<td>L ASTM E381</td>
</tr>
<tr>
<td></td>
<td>M ASTM E384</td>
</tr>
<tr>
<td></td>
<td>N 'Documented In-House Method' in accordance with API Standard</td>
</tr>
</tbody>
</table>

**NOTE** A ‘Documented In-House Method’ is a test/examination method that is listed on the IEC/ISO 17025 ‘Schedule of Accreditation’.

#### Add new Table C.2

**Table C.2—NDE Method**

<table>
<thead>
<tr>
<th>NDE Method</th>
<th>NDE Method Standard/Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumetric (Ultrasonic Examination)</td>
<td>ASTM A388/A388M ^a</td>
</tr>
<tr>
<td>Surface, Ferromagnetic (Magnetic Particle Examination)</td>
<td>ASTM E1444/E1444M ^b,c</td>
</tr>
</tbody>
</table>

^a Ref. API Specification 6A PSL3 (Stems).
^b Ref. ASTM A962/A962M S55.
^c Wet fluorescent method.