

API Specification

# 20B

First Edition, April 2013

Open Die Shaped Forgings for Use in the  
Petroleum and Natural Gas Industry

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## 5 Production Forgings

### 5.1 Qualification of Procurement Sources for Starting Material

**5.1.1** Only melt source facilities that are approved by the forging supplier shall be used to supply starting material such as billet or ingot material. The forging supplier shall have a documented procedure, fully implemented, for qualifying starting material suppliers for each specific size and grade of starting material. The approval process shall be based on both a quality assurance and a technical evaluation. The approval process shall establish the methodology by which the starting material supplier will be evaluated on an ongoing basis to maintain their status as an approved supplier.

**5.1.2** The maintenance of an acceptable quality program, such as an ISO registration, is not sufficient by itself to satisfy the requirements of 5.1.1. Documented evidence that a starting material supplier has a historical and ongoing technical capability of producing materials meeting this standard and who has proven, implemented procedures and capabilities in place to consistently produce acceptable product is a minimum requirement. Options for the technical approval of a starting material supplier include one or more of the following.

a) Supplier experience over an extended period of time. Demonstration of acceptable experience shall include tests/inspections, quantity of material received, nonconformance analysis, etc.

b) On-site technical audit at scheduled 3 year intervals. A new supplier shall be subject to an onsite technical audit, which includes the controls addressed in 5.1.3.

**5.1.3** The forging supplier is responsible for ensuring that a starting material supplier has implemented controls addressing the following for each size and grade of starting material ordered:

- chemistry controls;
- hydrogen controls;
- melting practice controls;
- teeming practice and ingot mold controls;
- hot work practice controls (method of forging, amount of reduction, forging temperature, etc.);
- cooling rate and method controls;
- ingot/billet cropping controls;
- starting material inspection and acceptance criteria (cleanliness requirements, limitations on porosity or inclusions, grain size, secondary phases, microstructure, macrostructure, etc.) as applicable;
- material contamination controls (e.g. mercury, radioactivity).

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## 5.2 Material Specifications

**5.2.1** Starting material requirements shall be documented in the form of material specifications. Material specifications shall be developed by the forging supplier or the purchaser. Material specifications shall include as a minimum:

- material grade, including element chemistry ranges;
- melting practices and ladle refinements;
- acceptable forging reduction range, if applicable;
- acceptable cleanliness level range, as required by applicable FSL;
- acceptable inspection practices and criteria.

**5.2.2** The forging supplier shall document acceptance of incoming starting material to the requirements of the material specification prior to use for production of forgings.

## 5.3 Manufacturing Procedure Specification (MPS)

The forging supplier shall prepare a manufacturing procedure specification (MPS) to include, as a minimum, the material specification and the general variables listed in 5.4.1 and the heat treat parameters listed in 5.4.2. As part of the MPS, the forging steps shall be shown detailing initial and final dimensions during forging for each step of the forging process. This will also include documentation of the heat or reheat temperature ranges required for each hot work reduction step in a drawing and written documents.

## 5.4 Process Control Variables

### 5.4.1 General Variables

The following are general process control variables for the production of qualified forgings:

- size of starting material, cut weight and tolerances;
- evaluation process used for incoming material and for determining cropped length of starting material;
- hydrogen flake-control method (bake-out, slow cool, etc.), if applicable;
- hot-working temperature range;
- overall hot work ratio from starting material;
- description of each forging operation, including general product configuration at the beginning and end of each different type of hot work or forging operation and hot-work ratio for each step;
- acceptable forging equipment for production;
- inspection requirements;
- NDE, if applicable.

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## 5.4.2 Heat Treat Parameters

The following are heat treat parameters, as applicable:

- furnace loading diagram, orientation and spacing of production parts;
- heat treat times and temperatures for each processing cycle;
- forging configuration and dimensions at time of heat treatment;
- quenching medium and type of agitation (water/polymer, forced, horizontal; or vertical quench, ID/OD, etc.);
- quench medium start and finish temperature and transfer time to quench.

## 5.5 Forging Production

### 5.5.1 General

Forgings shall be produced by the open die or ring rolled forging process in accordance with the MPS specified in 5.3. The overall hot work ratio, as defined in 3.1.9, shall be sufficient to produce a wrought material structure throughout all sections of the forging. The overall hot-work ratio from starting stock to product shall be greater than or equal to that specified below for the applicable FSL.

- a) FSL-1: 3.0:1
- b) FSL-2: 3.0:1
- c) FSL-3: 4.0:1
- d) FSL-4: 4.0:1

### 5.5.2 Mechanical and Material Testing

The forging supplier shall perform mechanical or material testing of the production forgings as specified in the purchasing document.

## 5.6 Inspection, Quality Control, Marking, and Documentation

### 5.6.1 Calibrations Systems

Inspection, measuring, and testing equipment used for acceptance shall be identified, inspected, calibrated, and adjusted at specific intervals in accordance with ANSI/NCSS Z540.3 and this standard. Calibration standards shall be traceable to the applicable national or international standards agency and shall be no less stringent than the requirements included herein. Inspection, measuring, and testing equipment shall be used only within the calibrated range. Calibration intervals shall be established based on repeatability and degree of usage.

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## 5.6.2 Furnace Calibration

**5.6.2.1** Forging furnaces shall be calibrated in accordance with the forging suppliers written procedures.

**5.6.2.2** Heat treatment furnaces shall be calibrated in accordance with recognized international standards such as API 6A, Annex M, or AMS 2750. Records of furnace calibration shall be maintained.

## 5.6.3 Visual Inspection

**5.6.3.1** Visual inspection of the production forging shall be performed in accordance with the forging supplier's procedures for cracks, laps, seams and other anomalies.

**5.6.3.2** Results shall be documented and the material shall be dispositioned.

**5.6.3.3** Any discontinuities discovered shall be evaluated and the disposition documented.

## 5.6.4 Nondestructive Examination (NDE)

**5.6.4.1** Production forgings shall be capable of meeting the NDE requirements of the applicable API product specification.

**5.6.4.2** NDE shall be performed as specified in the purchasing documents.

## 5.6.5 Dimensional Inspection

Dimensional inspection shall be performed on forgings produced to this standard. Each forging shall be inspected. The purchaser shall specify dimensions to be inspected. Acceptance criteria for dimensions shall be as required by the purchaser's written specification.

## 5.7 Repair Welding

Repair welding is not permitted on forgings produced to this specification.

## 5.8 Traceability

**5.8.1** Full traceability of forgings shall be maintained with respect to material heat, MPS with revision level and heat treatment loads.

**5.8.2** Forging qualification records shall be traceable to the MPS with revision level.

**5.8.3** Forgings produced to this specification shall be traceable to the applicable forging qualification record.

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## 5.9 Record Retention

The forging supplier shall establish and maintain documented procedures to control all documents and data required by this standard. Records required by this standard shall be maintained for 10 years. Documents and data may be in any type of media (hard copy or electronic) and shall be:

- a) maintained to demonstrate conformance to specified requirements;
- b) legible;
- c) retained and readily retrievable;
- d) stored in an environment to prevent damage, deterioration, or loss;
- e) available and auditable by the user/purchaser.

## 5.10 Marking

**5.10.1** Each forging shall be marked with the following:

- a) forging supplier's name or mark;
- b) part number;
- c) material grade;
- d) "API Spec 20B" and FSL;
- e) date of manufacture (month and year);
- f) heat and heat treat lot number;
- g) traceability number;
- h) material sub-group;
- i) weight range class;
- j) qualification record number;

**5.10.2** Procurement drawings shall identify where stamping is appropriate. The above marking listed in 5.10.1 shall be applied using low-stress (dot, vibration, or rounded V) stamps. Conventional sharp V-stamping is acceptable in low-stress areas, such as the outside diameter of flanges, except as limited in the following.

- a) For material group 1 and 2, sharp V-stamping is not permitted in high stress areas unless subsequently stress-relieved at 1100 °F (590 °C) minimum.
- b) For material groups 3, 4, and 5, conventional sharp V-stamping in high-stress areas shall not be permitted unless agreed with the purchaser.

## 5.11 Handling, Storage, and Shipping

Forgings shall be packaged for storage or transit in accordance with the written specifications of the forging supplier.