BS EN ISO 17782:2018

BSI Standards Publication

Petroleum, petrochemical and natural gas industries – Scheme for conformity assessment of manufacturers of special materials (ISO 17782:2018)

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National foreword

This British Standard is the UK implementation of EN ISO 17782:2018.

The UK participation in its preparation was entrusted to Technical Committee PSE/17, Materials and equipment for petroleum, petrochemical and natural gas industries.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Petroleum, petrochemical and natural gas industries - Scheme for conformity assessment of manufacturers of special materials (ISO 17782:2018)

Industries du pétrole, de la pétrochimie et du gaz naturel - Système d'évaluation de la conformité des fabricants de matériaux spéciaux (ISO 17782:2018)

Erdöl-, petrochemische und Erdgasindustrie - Herstellerqualifizierung von Sonderwerkstoffen (ISO 17782:2018)

This European Standard was approved by CEN on 27 September 2018.

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European foreword

This document (EN ISO 17782:2018) has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries" in collaboration with Technical Committee CEN/TC 12 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries” the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2019, and conflicting national standards shall be withdrawn at the latest by May 2019.

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Endorsement notice

The text of ISO 17782:2018 has been approved by CEN as EN ISO 17782:2018 without any modification.

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*.

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Introduction

This document is based on NORSOK M-650, 4th edition, which was developed by the Norwegian petroleum industry to ensure adequate safety, value added and cost effectiveness for petroleum industry developments and operations.

The conformity assessment requirements provide a Scheme for manufacturers to demonstrate their competence and experience to manufacture the relevant material grades and product forms. The intention is that a manufacturing procedure conformity record (MPCR) accepted by one customer should also be acceptable for other customers, within the essential variables of this document.

This document includes the following annexes that are either normative or informative:

— Annex A provides the Manufacturing Procedure Summary front page and examples (informative);

— Annex B contains the Temperature Uniformity Survey with additional requirements to Annex M of ISO 10423:2009 and ASTM A991-10 (normative);

— Annex C provides an example of verification of the heat treatment procedure (informative);

— Annex D contains requirements related to fasteners (normative);

— Annex E contains requirements related to induction bending in the case of testing for qualification of bends without post-bend heat treatment (normative);

— Annex F contains requirements for the assessment of testing laboratories (normative);

— Annex G provides the Manufacturing Procedure Conformity Record front page (normative).

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Petroleum, petrochemical and natural gas industries — Scheme for conformity assessment of manufacturers of special materials

1 Scope

This document establishes a procedure for verifying that the manufacturer of special materials for the petroleum, petrochemical and natural gas industries has sufficient competence and experience of the relevant material grades of metal, and the necessary facilities and equipment, to manufacture these materials in the required shapes and sizes with acceptable properties according to the applicable standard, material specification and/or material data sheet specified by the purchaser.

This document is applicable to manufacturers of various materials, product forms and manufacturing processes when specified by the purchaser. This document has been established considering especially, but not exclusively:

a) duplex stainless steel;

b) high alloyed austenitic stainless steel;

c) nickel-based alloys;

d) titanium and its alloys.

This document is also applicable to the processes of induction bending and strain-hardened products.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3834-2, *Quality requirements for fusion welding of metallic materials — Part 2: Comprehensive quality requirements*

ISO 9000, *Quality management systems — Fundamentals and vocabulary*

ISO 10423:2009, *Petroleum and natural gas industries — Drilling and production equipment — Wellhead and christmas tree equipment*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 14343, *Welding consumables — Wire electrodes, strip electrodes, wires and rods for arc welding of stainless and heat resisting steels — Classification*

ISO 15590-1, *Petroleum and natural gas industries — Induction bends, fittings and flanges for pipeline transportation systems — Part 1: Induction bends*

ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

ISO/IEC 17000:2004, *Conformity assessment — Vocabulary and general principles*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

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ASME Boiler and Pressure Vessel Code, Section II, Materials, Part C, *Specifications for welding rods, electrodes, and filler metals* (also referred to ASME II Part C)

ASME Boiler and Pressure Vessel Code, Section IX: *Welding and Brazing Qualifications* (also referred to ASME IX)

ASTM A370-14, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A991-10, *Standard Test Method for Conducting Temperature Uniformity Surveys of Furnaces Used to Heat Treat Steel Products*

ASTM E407, *Standard Practice for Microetching Metals and Alloys*

EN 10204, *Metallic products — Types of inspection documents*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO 9000, ISO/IEC 17000 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 Terms and definitions

3.1.1
conformity assessment
demonstration that specified requirements relating to a product, process, system, person or body are fulfilled

[SOURCE: ISO/IEC 17000:2004, 2.1]

3.1.2
continuous furnace
furnace in which the item/product to be heat treated is loaded and heat treated in a continuous cycle

3.1.3
company
owner or organization that is responsible for development of and/or operation of an installation/facility

Note 1 to entry: For the purposes of this document, the company is normally an oil company.

3.1.4
equalization time
time used to ensure a uniform pre-set temperature throughout a heat treatment load and/or throughout all section thicknesses of a component

3.1.5
heat sink
separate block used to monitor temperature during heat treatment and made from the same generic type of material as the parts being heat treated

3.1.6
high alloyed austenitic stainless steel (SS)
austenitic stainless steel typically having PREN ≥ 40 or [%Ni + 2(%Mo)] > 30 where %Mo > 2, all mass fractions expressed as percent

EXAMPLE UNS S31254, UNS N08367, UNS N08926, UNS S31266, UNS S32654, UNS S34565, J93254.

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3.1.7
holding time
time from when the controlling thermocouple(s) [normally the furnace thermocouple(s)] has reached set temperature until the specified soaking time is completed

Note 1 to entry: See also Annex C.

Note 2 to entry: Holding time consists of equalization time + soaking time. Holding time is not applicable to continuous and semi-continuous furnaces.

3.1.8
main contractor
party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility, on a contract awarded by the company

3.1.9
manufacturer
party, including subcontractors, which carries out operations that affect the material properties of the finished product

Note 1 to entry: A manufacturer should have minimum one operation, which affects material properties in-house.

Note 2 to entry: These operations can include forming, heat treatment, etc.

3.1.10
pitting resistance equivalent number
PREN
number indicating the resistance of stainless steel to pitting corrosion and related to chemical composition

Note 1 to entry: PREN is calculated from one of the following equations:

a) PREN = %Cr + 3,3 %Mo + 16 %N

b) PREN = %Cr + 3,3 %(Mo + 0,5 W) + 16 %N

where all mass fractions are expressed as a percentage.

Note 2 to entry: The requirement for the minimum PREN value applies to the applicable material specification, MDS and/or material standard as specified by purchaser.

3.1.11
purchaser
party which purchases a product from a manufacturer

Note 1 to entry: Company (end user), main contractor and buyer are purchasers in the context used in this document.

3.1.12
Qualifying Company
body or person that performs *conformity assessment activity* (3.1.13)

3.1.13
second-party conformity assessment activity
conformity assessment activity that is performed by a person or organization that has a user interest in the object

Note 1 to entry: Persons or organizations performing second-party conformity assessment activities include, for example, purchasers or users of products, or potential customers seeking to rely on a supplier's management system, or organizations representing those interests.

[SOURCE: ISO/IEC 17000:2004, 2.3]

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3.1.14
semi–continuous furnace
furnace for which the load to be heat treated is prepared as a batch in front of the furnace and then passed in a continuous way through the furnace

3.1.15
soaking time
time that the entire part/section being heat treated (throughout its cross-sections) remains within the specified soaking (material) temperature range

Note 1 to entry: See also Annex C.

3.1.16
soaking zone
zone in a continuous/semi-continuous heat treatment furnace where the material is maintained within the specified soaking temperature range

3.1.17
SS type 22Cr duplex
ferritic/austenitic stainless steel alloys with 30,0 < PREN < 40,0 and Cr ≥ 19 % (mass fraction)

EXAMPLE UNS S31803 and UNS S32205.

3.1.18
SS type 25Cr duplex
ferritic/austenitic stainless steel alloys with 40,0 ≤ PREN < 48,0 (mass fraction)

Note 1 to entry: This alloy is often referred to as “super duplex”.

EXAMPLE UNS S S32505, UNS S32550, UNS S32750, UNS S32760 and UNS S39274.

3.1.19
test direction
direction in which testing is carried out as defined relative to the geometry of the component to be tested

Note 1 to entry: For the purposes of this document, the definitions given in ASTM A370-14, section 5, apply, with axial defined as the longitudinal axis of the test specimen located parallel to the main axis of the component.

3.1.20
third-party conformity assessment activity
conformity assessment activity that is performed by a person or organization that is independent of the person or organization that provides the object, and of user interest in that object

Note 1 to entry: Criteria for the independence of the conformity assessment bodies and accreditation bodies are provided in the International Standards and Guides applicable to their activities [see Bibliography (in ISO/IEC 17000)].

[SOURCE: ISO/IEC 17000:2004, 2.4]

3.2 Abbreviated terms

AOD argon oxygen decarburization

API American Petroleum Institute

ASTM American Society for Testing and Materials

EN European Standard

HIP hot isostatic pressed

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HV	Vickers hardness
MDS	material data sheet
MOM	minutes of meeting
MPCR	manufacturing procedure conformity record
MPS	manufacturing procedure summary
NDE	non-destructive examination
NORSOK	Industry Standards for the Competitive Standing of the Norwegian Offshore Sector
PED	Pressure Equipment Directive
PREN	pitting resistance equivalent number
PWHT	post-weld heat treatment
SS	stainless steel
UNS	unified numbering system
VOD	vacuum oxygen decarburization
WPQR	welding procedure qualification record
WPS	welding procedure specification

4 Responsibilities

4.1 Purchaser's responsibilities

The purchaser is responsible for ensuring that the manufacturers engaged for a project are qualified within the essential variables of this document. Existing manufacturer's procedure conformity records (MPCRs) shall be reviewed for conformance with this document. Manufacturers unknown to the purchaser should in addition be visited.

Acceptance of an MPCR and the manufacturer chosen are at the discretion and determination of the purchaser.

The purchaser is not exempted from his responsibility for quality surveillance of his subcontractors, even if these fulfil the requirements of this document.

4.2 Manufacturer's responsibilities

The manufacturer is responsible for establishing and maintaining required documentation and carrying out verification and testing in accordance with this document.

A manufacturer conforming to this document assumes the obligation to carry out manufacturing and establish material/test certificates of products in accordance with the qualified Manufacturing Procedure Summary (MPS), including all referenced procedures. If an order requiring conformance with this document is outside the qualified range as defined in 10.2.15, the purchaser shall be informed.

4.3 Qualifying Company's responsibilities

The Qualifying Company shall monitor the conformity assessment activities, review and finally approve the resulting MPCR by signing and stamping the MPCR front page (see Annex G).

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The Qualifying Company person signing the MPQR shall have the following,

a) a relevant education on bachelor level from a university college or equal;

b) good knowledge of metallurgical aspects of the applicable alloys, which shall be evaluated, including phase and transformation diagrams, effects of hot forming, welding, heat treatment, testing, etc.;

c) relevant knowledge of the manufacturing process(es) to be evaluated;

d) in-depth knowledge and understanding of this document;

e) previous experience with this document or received guidance/supervision from a person with previous qualification experience with this document.

The Qualifying Company shall be independent of the manufacturer.

NOTE Qualification (conformity assessment) experience with NORSOK M-650 Ed. 4 is considered equal to conformity assessment experience with this document.

5 Conformity assessment of manufacturers

5.1 Conformity assessment

The conformity assessment shall be carried out in cooperation with and verified by the Qualifying Company. The conformity assessment shall be carried out as either

a) a second-party conformity assessment activity (see definition in 3.1.13), or

b) a third party conformity assessment activity (see definition in 3.1.20), but only where the third party is accepted as a competent Qualifying Company by Company, Main Contractor or Purchaser.

A Qualifying Company can be engaged:

a) through projects for which the manufacturer has specific orders; that is, through contact between the manufacturer and the Companies, Main Contractors or Purchasers;

b) through a third party in cases where manufacturer wants to be evaluated without having any specific orders. In such cases the acceptance of the Qualifying Company and of the MPCR shall be by future customers prior to purchase order placement. Acceptance may be indicated by counter signature of the MPCR front page as specified in 5.5.

5.2 Basis for assessment of manufacturers

The manufacturer, including any nominated subcontractors, shall have:

a) knowledge and relevant manufacturing experience with the type of material to be qualified (see Clause 7);

b) acceptable manufacturing facilities and equipment (see Clauses 7 and 9);

c) an established MPS (procedure) covering all manufacturing steps from melting or start material, as defined in Table 1, column “Type of start material”, to finished product (see Clause 8);

d) an established heat treatment procedure (see Clause 9);

e) a management system that conforms with the requirements of ISO 9001 or equivalent;

f) satisfactory verification test results in conformance with this document (see Clause 10).

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5.3 Evaluation for conformity

The Qualifying Company shall carry out a review and inspection of the manufacturing facilities, equipment, implementation of procedures and documentation, as required by this document, on the premises of the manufacturer and his subcontractors.

The results of the evaluation shall be documented in an evaluation report or minutes of meeting (MOM).

5.4 Review of manufacturing procedure conformity record (MPCR)

A complete MPCR with content in accordance with Clause 11 shall be established for review.

The only way to qualify a manufacturing procedure is to fulfil all the requirements of this document. It is not possible to deviate from this document with respect to being qualified. When all requirements in this document are fulfilled, the MPCR front page (see Annex G) shall be signed off and stamped by the Qualifying Company.

5.5 Statement of conformity

The original MPCR front page (see Annex G), completed with all data indicated in Annex G and signed by the Qualifying Company, is the only valid proof of conformity in accordance with this document.

Where a party authorized by the Company, Main Contractor or Purchaser is used as the Qualifying Company, the Company, Main Contractor or Purchaser who has given the authorization shall co-sign the MPCR front page to confirm their acceptance of the MPCR.

NOTE ISO does not keep any listing of qualified manufacturers who are accepted in accordance with this document.

6 Validity of the manufacturer procedure conformity record (MPCR)

6.1 Term of validity

The manufacturer's MPCR is valid for a maximum of five years starting from the date of signing and stamping of the MPCR front page. For new manufacturers, see 7.1.2.

For renewal of an existing MPCR according to 6.2, the renewal is valid for a maximum of five years starting from the expiry date of the original conformity assessment.

The conformity assessment is valid within the parameters specified in 10.2.

6.2 Renewal of the MPCR

The MPCR from a manufacturer with regular production of the originally conformity assessed products and alloys to a valid MPS is considered renewed without additional testing provided that production testing records are retained that demonstrate continued conformance to the specifications employed for the original conformity assessment. It is a prerequisite that applicable requirements of this document are complied with.

A renewal shall be initiated prior to the expiry date of the existing MPCR. If this is not the case, a complete new conformity assessment shall be carried out.

The following actions shall be executed for a renewal of the conformity assessment:

a) evaluating and reviewing the manufacturer's and subcontractors' premises according to 5.3 by the Qualifying Company;

b) reviewing and updating the MPS and referred procedures and making a decision whether retesting is required;

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c) reviewing the heat treatment procedure and its corresponding verification (see 9.3) and making a decision whether a new verification is required;

d) the renewed MPCR shall contain a MOM, which describes the actual parts of the MPCR, which shall be updated, and the conditions for the renewal of the conformity assessment;

e) establishing and properly signing a new MPCR front page with new revision number.

6.3 Transitional requirements

A valid NORSOK M-650 Ed. 4 QTR, which complies with the essential variables of this document, is considered equivalent to this document provided the original material specification, e.g. NORSOK M-630 MDS, remains applicable.

Renewal of a NORSOK M-650 QTR to an ISO 17782 MPCR shall be in accordance with 6.2.

7 General requirements

7.1 Knowledge and relevant experience

7.1.1 Knowledge

The manufacturer shall have in-house knowledge of the relevant metallurgical aspects of the alloys to be qualified, including phase transformation diagrams, effects of hot forming, welding, and heat treatment parameters, etc. as applicable to the manufacturing processes employed.

7.1.2 Relevant experience

The manufacturer shall have relevant experience with manufacture of the type of material to be qualified.

Relevant experience shall be demonstrated by statistical data presented in the form of a histogram for key properties, e.g. tensile strength, impact toughness, corrosion resistance, etc. In addition, a relevant reference list from the last two years' production for the products, materials and the range of sizes to be qualified shall be included.

New manufacturers with less than two years of documented production for actual product and material may be qualified to this Scheme, but with a validity period limited to two years, after which a renewal according to 6.2 shall be carried out. The reason for the limited validity period shall be included on the MPCR front page.

7.2 Manufacturing facilities and equipment

Facilities and equipment shall be fit for purpose, regularly maintained and calibrated in conformance with pertinent International Standards and other requirements specific to the processes employed or the material grade being manufactured as specified in this document.

Requirements for heat treatment facilities and equipment are further described in 9.1.

7.3 Subcontractors and suppliers

The manufacturer is responsible for ensuring that subcontracted services shall meet the requirements of this document for all manufacturing steps performed by the subcontractor.

The manufacturer shall demonstrate adequate and consistent control of supply chain regarding purchase of start materials as defined in Table 1, column “Type of start material”.

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7.4 Quality requirements for test laboratories and manufacturers of welded products

7.4.1 Test laboratories

Test laboratories shall operate in accordance with ISO/IEC 17025 for the applicable test methods.

Conformance to ISO/IEC 17025 shall be documented by,

a) a national accreditation certificate with definition of the scope of the certificate, issued by an ISO/IEC 17011 conforming national accreditation body or;

b) the test laboratory shall complete and sign the form in Annex F. The form shall be presented to the Qualifying Company for evaluation. In such cases,

   1) the Qualifying Company shall carry out an assessment of the laboratory to review listed procedures and how they are implemented.

   2) In addition, microstructure examination, as applicable, shall be demonstrated to the Qualifying Company's satisfaction.

   3) The results of the assessment shall be documented by a statement of conformity, which shall be signed by the laboratory and the Qualifying Company. The statement of conformity shall be attached to the filled in form in Annex F.

7.4.2 Manufacturers of welded products

Manufacturers of welded products shall conform to ISO 3834-2 or equivalent, as accepted by the Qualifying Company.

8 Manufacturing procedure summary (MPS)

8.1 General

The manufacturer shall have an MPS for each production route, type of product, grade of material and size range.

NOTE Sometimes it can be convenient to combine several production routes, types of product and/or grades of material into one MPS, e.g. as shown in the flow chart in Annex A.

The MPS shall describe, step by step in a logical and correct sequence, all important manufacturing activities with reference to detailed procedures. A short description and the main parameters for each activity shall be included. Each production route shall be illustrated with a flow chart.

If the manufacturer has different plants or different production routes for a product, separate documentation is required for each of these. If essential parts of the work, e.g. forming, heat treatment, pickling, etc., are subcontracted, this shall be identified in the documentation. The documentation shall then include the name and address of each subcontractor and the relevant documentation from the subcontractor's equipment and procedures.

The MPS is the property of the manufacturer. Distribution is at the manufacturer's discretion.

8.2 Content of the manufacturing procedure summary (MPS)

8.2.1 Scope of the manufacturing procedure summary

The scope of the MPS shall be clearly defined, stating:

a) name and address of the manufacturer;

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b) grade of material, UNS number, with reference to standard and material specifications;

c) type and size range of products for which the MPS is applicable (in conformance with 10.2.);

d) identification of the manufacturing process(es).

8.2.2 Manufacturing procedure summary requirements

The MPS shall as a minimum include applicable requirements for the following.

a) Start material:

   1) type of start material;

      NOTE For the definition of start material see Table 1, column "Type of start material".

   2) manufacturer's start material purchasing specification;

   3) name of start material manufacturer(s).

b) Manufacturer's inspection of start material on reception.

c) Melting shop practices, including:

   1) melting and refining processes;

   2) casting methods, e.g. ingot, continuous cast, etc..

d) Foundry practices, including:

   1) melting and refining processes;

   2) handling of and maximum percentage of internal returns (gates, sprues, risers, and rejected castings) in the melt;

      With respect to 1) and 2) remelting of AOD or VOD refined raw material in induction furnaces is acceptable. Raw material composed from virgin materials such as ferro-alloys is regarded to be equivalent to AOD or VOD refined materials. Internal revert after remelting of AOD or VOD treated steels should not be used.

   3) casting processes, e.g. investment, centrifugal, sand castings, etc.;

   4) moulding method, type of sand, binding agent and method of casting.

e) Hot forming, including:

   1) all hot-forming processes, such as forging, pressing, rolling and induction bending, with details regarding size and thickness range of each hot-forming process;

   2) maximum and minimum hot-forming temperatures and how these temperatures are monitored and controlled;

   3) possible reheating cycle;

   4) method of cooling after completion of the hot-forming process;

   5) minimum reduction ratio, including how the reduction ratio is calculated;

   6) a sketch illustrating each step in the forming process (see Annex A);

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7) for induction bending, an MPS shall be established in accordance with ISO 15590-1 or equivalent, as accepted by the Qualifying Company.

f) Fasteners, including:

1) manufacturing method, e.g. forged or machined from bar;

2) method of threading, e.g. rolled or machined.

g) Heat treatment, including:

1) for batch furnaces, description of heat treatment cycle, e.g. loading temperature, heating rate, furnace set temperature, soaking (material) temperature with tolerances and holding and soaking times;

2) for continuous, semi-continuous and induction furnaces and for seamless pipes and tubes directly quenched from hot forming, the soaking (material) temperature range, and minimum soaking time as a function of size (e.g. thickness, diameter, cross-section) of products to be heat treated according to 9.2.4;

3) cooling details, e.g. cooling medium (water, air or combination thereof, etc.), type of cooling (quenching, spraying, etc.), relevant parameters (temperatures of cooling medium; for spraying medium-velocity, the type and size of nozzles, quantity, etc. as applicable.);

4) reference to the specific heat treatment procedure according to 9.2.

h) Blasting/cleaning equipment, including the type of grit.

i) Pickling.

j) Welding (including weld repair), where the WPS and WPQR applicable for the conformity assessment shall be listed.

k) PWHT (if applicable).

l) Type of NDE and inspection methods.

m) Strain hardening, including:

1) description of the strain hardening process with information about dimensional range of each process;

2) strain hardening parameters to be used for each dimension;

3) sketch illustrating each step in the forming process (see Annex A).

n) Production testing, including:

1) extent of production testing;

2) type of tests to be carried out, together with acceptance criteria for each test;

3) test sampling, which shall be identified as a separate activity and described in the correct sequence in the MPS;

4) sketches showing typical samples with dimensions for production tests, including location and orientation of test specimens;

5) procedure for microstructure examination, if applicable, that shall include as a minimum:

i) test sampling if not specified in the test sampling sketch(es) included in the MPS;

ii) preparation of specimens;

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