PRE-L-02

Assessment of Safety Equivalency

EN 13480 – ASME B31.3

Process Piping

-

8/12/2024

George Antaki, PE, Fellow ASME

Pressure Equipment Engineering LLC

gaa1951@outlook.com

Contents

1 Purpose

To assess whether the European piping construction Code EN 13480 (2017, the latest edition at the time of this writing) provides an equivalent level of safety as the ASME B31.3 Process Piping Code (2022, the latest edition at the time of this writing).

2 Assessment Method

EN 13480 is compared to ASME B31.3 for a series of key attributes that covers all aspects of pressure safety for newly constructed piping and tubing systems:

1. Materials.
2. Code design.
3. Fabrication.
4. Examination.
5. Testing.
6. Over-pressure protection.
7. Inspections and certifications.

Note: In this report, piping systems refer to piping and tubing systems.

3 Conclusions on Safety Equivalency

The comparative review of attributes in ASME B31.3 (2022) and EN 13480 (2017), which are grouped into seven categories ((1) materials, (2) Code design, (3) fabrication, (4) examination, (5) testing, (6) over-pressure protection, and (7) inspections and certifications), indicates that the European Code EN 13480 together with the European Pressure Equipment Directive (PED) 2014/68/EU provides an equivalent level of safety, or in some cases is more restrictive than B31.3, with the following exceptions:

3.1 Unlisted Joints and Fittings Qualification

Attribute 6.7: The qualification of unlisted joints and fittings (i.e. specialty joints or fittings) for internal pressure by burst testing is an alternative to qualification of the fitting for internal pressure by analysis. Regarding qualification by burst test, ASME B31.3 and EN 13480 (based on PED 2014-68 Para.2.2.4) are not equivalent. When qualifying a fitting by burst test, ASME B31.3 requires a minimum design margin (burst pressure / design pressure) of 3, while PED 2014-68 does not specify a design margin.

Suggestion: This is particularly important for specialty (catalog) fittings and joints which are often qualified by burst test rather than analysis. Therefore, the user must either 1) request, from the manufacturer, the documented burst test of specialty (catalog) fittings and joints to confirm the burst test pressure was greater than 3x the design pressure or 2) perform their own burst test on the fitting or joint sample to establish its design margin as required by B31.3 Para.304.7.2.

If the user requests the documented burst test of specialty (catalog) fittings and joints and the burst test pressure was less than 3× the design margin the user must perform their own burst test on the fitting or joint sample to establish its design margin as required by B31.3 Para.304.7.2.

3.2 Bolted Flange

Attribute 6.19: B31.3 provides the following restrictions on the type of bolted joints for the various categories of fluid service

- Slip-on flanges if used with toxic or flammable materials and in cryogenic service shall be double-welded (outer and inner pipe-to-flange weld).

- In a service subject to severe cyclic conditions flanges shall be weld neck, unless safeguarded (encapsulated).
- Low yield strength bolting (ambient yield strength below 30 ksi) shall not be used for flanged joints under severe cyclic conditions.

Note: severe cyclic conditions: conditions applying to specific piping components or joints for which the owner or the designer determines that design and construction to better resist fatigue loading is warranted. See [B31.3] Appendix F, para. F301.10.3 for guidance on designating piping as being under severe cyclic conditions.

These B31.3 restrictions are not mentioned in EN 1340.

Suggestion: The user must impose the B31.3 restrictions on bolted joints either to the fabricator or as an alteration after the piping system has been received.

If a user encounters an EN 13480 piping or tubing system with types of bolted flanged joints that would not be permitted in B31.3, they should provide protection against the potential leakage of the bolted flanged joints.

3.3 Brazing and Soldering

Attribute 7.13: Brazing and soldering are not addressed in EN 13480-4.

Suggestion: Where EN 13480 piping or tubing is joined by brazing, the brazing program should be qualified and certified to braze in accordance to ISO 22688. Since ISO 22688 is not referenced in EN 13480, the owner-user should verify the compliance of brazed joints to ISO 22688.

3.4 Testing of Externally Pressured Piping

Attribute 9.4: ASME B31.3 addresses pressure testing of newly constructed piping systems operating at negative pressure. EN 13480 does not.

Suggestion: For systems operating at negative pressure, down to full vacuum, the user must verify that the system has been pressure tested in accordance with the provisions of ASME B31.3 for external pressured piping Para.345.2.4.

3.5 Testing of Double-Wall Piping

Attribute 9.8: ASME B31.3 has explicit pressure test requirements for double-wall piping while EN 13480-5 does not address pressure testing of jacketed (double wall) piping.

Suggestion: For double-wall piping (jacketed piping), the user should verify that the inner pipe (the carrier or core pipe) and the outer pipe (the containment or jacket pipe) have been pressure tested in accordance with ASME B31.3 Para.345.2.5.

3.6 Over-Pressure Protection

Attribute 10.1: Over-pressure is to be addressed in B31.3 and EN 13480, but neither Code specifies what constitute credible over-pressure scenarios. ASME B31.3 301.2.2(a) is explicit to permit over-pressure protection by system design (see Over-Pressure Protection, below). The user should be knowledgeable of the transients considered and means provided to limit over-pressure.

Suggestion: The user must request an over-pressure protection report from the supplier, which specifies the method to evaluate over-pressure, and the pressure transient events considered. In addition, the user must verify equivalency of EN to ASME VIII/XIII EN in sizing and set pressure tolerance of rupture discs.

3.7 Leak Test at Startup

The construction codes focus on pressure or leak testing of the final assembled piping system upon completion of fabrication and assembly. However, the piping system may not be operated for a long period of time after the construction pressure or leak test was completed. It is even possible that mechanical joints (bolted flanges, groove couplings, swaged joints, etc.) may have been assembled and re-assembled during transport, storage, or pre-operational checks.

Suggestion: For newly received piping systems, ASME B31.3 or EN 13480, in toxic, flammable, explosive, or otherwise dangerous service, it is a good practice for the user to perform a low-pressure leak test of the system to assure that the joints (welded or mechanical) are tight and do not leak. This pre-operational leak test is not addressed in either B31.3 or EN 13480, because these Codes rely on the manufacturer Code pressure test (hydrostatic, pneumatic, or leak test) conducted at end of fabrication.

4 Scope of the Construction Codes

4.1 ASME B31.3 Process Piping Code

The ASME B31.3 Process Piping Code is the commonly used Code in DOE facilities. It is a construction Code which addresses:

1) Materials
2) Code Design
3) Fabrication
4) Examination
5) Testing
6) Over-pressure protection
7) Inspections and Certifications

ASME B31.3 does not address post-construction activities, which are typically:

1) Periodic inspections and tests of operating piping systems.
2) Fitness-for-service assessment (remaining life assessment, run-or-repair decisions) based on the results of the inspections and tests.
3) Repairs, replacements, alterations based on the outcome of the fitness-for-service assessment.

300.1.3 Exclusions. This Code excludes the following: (a) piping systems designed for internal gage pressures at or above zero but less than 105 kPa (15 psi), provided the fluid handled is nonflammable, nontoxic, and not damaging to human tissues as defined in 300.2, and its design temperature is from −29° C (−20°F) through 186°C (366°F).

4.2 EN 13480 Metallic Industrial Piping Code

4.2.1 The European Pressure Equipment Directive (PED)

PED 2014/68/EU Close (6) and EN 13480 throughout states that the PED applies to pressure equipment with a maximum allowable pressure greater than 0.5 bar (7.25 psi) which is ~ half the B31.3 pressure limit. The scope of the PED is:

- Pressure vessels
- Boilers
- Piping systems
- Pressure accessories (valves)

An EU Directive is a legislation that sets out requirements that products must meet in order to be sold throughout the EU. A manufacturer of pressure equipment or related components wishing to enter the European market must certify their pressure equipment according to the European PED.

The European Community (CE) PED was first published in 1997 (97/23/CE) and updated in 2014 (2014/68/EU).

(a) The PED is mandatory throughout the EU, for pressure vessels, piping systems, and boilers. It supersedes national regulations of member states.
(b) The PED covers a large range of equipment (from pressure cookers to chemical reactors). The PED does not apply to nuclear power plants and waterworks which have their own regulations.
(c) The PED provides high level Essential Safety Requirements (ESRs).
(d) The European Norm (EN) standards such as EN 13445 for pressure vessels and EN-13480 for piping systems, provide detailed implementation requirements to meet the PED. The EN

standards are not mandatory. But, compliance to the EN standards is presumed to comply with the ESR of the PED, without further justification.

(e) National standards (such as PD5500 in the UK, CODAP in France, AD 2000 in Germany) can be used if it is established that they meet the ESRs of the PED.

(f) The ESRs take a hazard-based approach, based on the consequence of failure in terms of (1) the size of the vessel or piping system, (2) its contents (gas or liquid), (3) its pressure, and (4) its contents (Group 1 toxic, flammable, explosive, etc.) and Group 2 (not Group 1). Hazard Categories range from 0 (not subject to the ESRs) up to IV.

(g) Each PED equipment, if it is to receive the CE mark, is subject to a Conformity Assessment Procedure, performed by a Notified Body or by applying an approved Quality Assurance procedure, the extent of which depends on the Hazard Category. Pressure equipment that complies with the PED bears the CE marking.

4.2.2 EN 13480 Outline

The European piping construction Code EN 13480 “Metallic Industrial Piping Code” consists of the following parts:

1) Part 1 General (2017) with addendum A1.
2) Part 2 Materials (2017) with addenda A1, A2, A3, A7, A8.
3) Part 3 Design and calculation (2017) with addenda A1 through A5.
4) Part 4 Fabrication and installation (2017).
5) Part 5 Inspection and testing (2017) with addenda A1 and A2.
6) Part 6 Additional requirements for buried piping (not reviewed).
7) Part 7 Use of conformity assessment procedures (2017).
8) Part 8 Additional requirements for aluminum and aluminum alloy piping (not reviewed).

As is the case for ASME B31.3, EN 13480 does not address post-construction activities.

The hazard consideration in 300.1.3 are addressed in PED 2014/68/EU regulation, clause (8) by the statement that PED addresses “risk due to pressure” while other risks are addressed in other directives.

5 Key Attributes for Materials

The key attributes for materials are:

5.1 Listed materials (base metals, weldments, bolts)

5.1.1 B31.3

323.1.1 permits Code-listed materials.

The listed materials and their allowable stresses are listed in B31.3 Appendix A.

5.1.2 EN 13480

EN 13480-2 Para.4.1.2 materials must be certified per EN 10204.

"A study was conducted under the ASME Standards Technology, LLC (ASME ST-LLC) to compare ASME and European specifications for mechanical testing of steels for pressure equipment. The study has concluded that there are no technical differences between the two systems, the ASTM/ASME requirements and the EN requirements for material testing, that would support a position that one or the other system of requirements is more or less conservative than the other" per "Comparison of ASME Specifications and European Standards for Mechanical Testing of Steels for Pressure Equipment", Elmar Upitis, Michael Gold, December 16, 2005, published by ASME Standards Technology LLC.

Unlike B31.3, the approved materials and their allowable stresses are not compiled in EN 13480. The designer must retrieve the allowable stresses in multiple material specifications.

5.1.3 Conclusion

Material testing is equivalent in B31.3 (ASTM materials) and EN 13480. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

The ease of finding listed materials and their allowable stresses is different, with B31.3 being much simpler.

5.2 Allowances for unlisted materials.

5.2.1 B31.3

323.1.2 Unlisted materials may be used provided they conform to a published specification covering chemistry, physical and mechanical properties, method and process of manufacture, heat treatment, and quality control, and otherwise meet the requirements of this Code. See also ASME BPVC, Section II, Part D, Appendix 5. Allowable stresses shall be determined in accordance with the applicable allowable stress basis of this Code or a more conservative basis.

5.2.2 EN 13480

EN 13480-2 Para.4.3.3 permits "particular materials" other than EN, provided they have been accepted by a Particular Material Appraisal (PMA). The PMA procedure is one of three ways to approve a material for the specific requirements of the pressure equipment:

- Material which complies with an EN standard.
- Material covered by a European Approval of Material (EAM).
- Material covered by a Particular Material Appraisal (PMA). That means, if a material has not been referenced by an EN standard or approved by the EAM procedure (i.e., an unlisted material) a manufacturer can provide a description of the solutions adopted to meet the "Essential Safety Requirements – ESR" within a PMA. This will allow the material to be used for pressure equipment. The PMA describes the material properties for the foreseen application. It comprises qualitative and quantitative data providing evidence that the relevant Essential Safety Requirements (ESR) of PED Annex I are met.

5.2.3 Conclusion
B31.3 and EN 13480 permit unlisted materials (non-ASTM for B31.3 and non-EN or EAM for EN 13480). Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

5.3 Responsibility for material selection and corrosion allowances.
5.3.1 B31.3
The selection of materials (base metal, welds, non-metallic) based on compatibility for the service (the fluid), the environment (outside the pipe), and the design life are not in the scope of B31.3.

323.5 Deterioration of Materials in Service Selection of material to resist deterioration in service is not within the scope of this Code …

Appendix F - F300 GENERAL - This Appendix provides guidance and precautionary considerations relating to particular fluid services and piping applications. These are not Code requirements but should be taken into account as applicable in the engineering design. Further information on these subjects can be found in the literature.

5.3.2 EN 13480
EN 13480-2 Para.4.1.1 material must be compatible with the service. Selection is not in the scope of EN 13480.

5.3.3 Conclusion
In B31.3 and EN 13480 the designer and user are responsible for material selection because the selection is not within the scope of either Codes. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

5.4 Material used within the lower temperature limits.
5.4.1 B31.3
323.2.2 Lower Temperature Limits, Listed Materials provides minimum temperatures for ferritic steels, based on their thickness and stress ratio.

323.2.3 *Temperature Limits, Unlisted Materials … shall be qualified for service at all temperatures within a stated range, from design minimum temperature to design maximum temperature …*

5.4.2 EN 13480
EN 13480-2 Para.4.1.6 and Annex B provide toughness requirements, including stress ratio adjustment.

5.4.3 Conclusion
B31.3 and EN 13480-2 both require toughness testing of ferritic steels depending on the minimum temperature, the thickness, and the stress ratio, they are therefore equivalent.

5.5 Material used within the maximum temperature limits.
5.5.1 B31.3
323.2.1 Upper Temperature Limits, Listed Materials refers to Appendix A for upper temperature limits.

323.2.3 Temperature Limits, Unlisted Materials … *shall be qualified for service at all temperatures within a stated range, from design minimum temperature to design maximum temperature …*

5.5.2 EN 13480
EN 13480-2 Para.4.2.2.1 the material properties required by EN 13480-3 (design) are defined in the technical (material) specification for the material.

5.5.3 Conclusion
EN 13480 is equivalent to B31.3 for upper temperature limits. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

5.6 Unknown or reclaimed materials used within allowances.
5.6.1 B31.3
323.1.4 Reclaimed Materials. Reclaimed pipe and other piping components may be used, provided they are properly identified as conforming to a listed or published specification (para. 323.1.1 or para. 323.1.2) and otherwise meet the requirements of this Code.

5.6.2 EN 13480
EN 13480-2 Para.4.3 requires the materials to comply with the European standard, and exceptions to be accepted by a "particular material appraisal" (PMA).

5.6.3 Conclusion
EN 13480 is stricter than B31.3 requiring a material appraisal for non-European standard materials.

5.7 Toughness requirements.
5.7.1 B31.3
323.2.2 Lower Temperature Limits, Listed Materials provides minium temperatures for ferritic steels, based on their thickness.

323.2.3 Temperature Limits, Unlisted Materials … *shall be qualified for service at all temperatures within a stated range, from design minimum temperature to design maximum temperature …*

323.3 Impact Testing Methods and Acceptance Criteria - 323.3.1 General. When impact testing is required by Table 323.2.2 … minimum energy ranges from 14 J (10 ft.lb) to 20 J (15 ft.lb).

5.7.2 EN 13480
EN 13480-2 Para.4.1.6 requires minimum Charpy of 27J and 40J depending on the material. Para.B.2 addresses toughness requirements at a minimum temperature.

5.7.3 Conclusion
EN 13480 and B31.3 require Charpy test of ferritic steels as a function of the material, the thickness, and the stress. EN 13480 is more restrictive regarding the required minimum impact energy.

5.8 Elevated temperature material testing.
5.8.1 B31.3
323.2.4 Verification of Serviceability (a) When an unlisted material is to be used, or when a listed material is to be used above the highest temperature for which stress values appear in Appendix A, the designer is responsible for demonstrating the validity …

5.8.2 EN 13480
EN 13480-2 Para.4.3 requires the materials to comply with the European standard, and exceptions to be accepted by a PMA.

PED 27.6.2014 Article 15 "European approval for materials" provides the protocol to approve materials used as a pressure boundary:

"1. European approval for materials shall be issued at the request of one or more manufacturers of materials or equipment, by one of the notified bodies referred to in Article 20 specifically designated for that task. The Notified Body shall determine and perform, or arrange for the performance of, the appropriate inspections and tests to certify the conformity of the types of material with the corresponding requirements of this Directive. In the case of materials recognised as being safe to use

before 29 November 1999, the Notified Body shall take account of the existing data when certifying such conformity …"

5.8.3 Conclusion

EN 13480 is stricter than B31.3 requiring a material appraisal for non-European standard materials.

5.9 Allowance for brittle materials.

5.9.1 B31.3

323.4.2 Specific Requirements (b) Other Cast Irons. The following shall not be used under severe cyclic conditions. If safeguarding is provided against excessive heat and thermal shock and mechanical shock and abuse, they may be used in other services subject to the following requirements: …

M323.4.2 Specific Requirements. [for Cat.M toxic, flammable] Paragraph 323.4.2 applies, except that cast irons other than ductile iron shall not be used for pressure-containing parts …

K323.4.2 Specific Requirements (a) Ductile iron and other cast irons are not permitted. [for high pressure, above 6000 psi].

5.9.2 EN 13480

EN 13480-2 Para.4.1.4 imposes a minimum elongation at rupture of 14%, which would exclude cast iron.

5.9.3 Conclusion

By limiting pressure piping to ductile materials EN 13480 is stricter than B31.3.

5.10 Suitability of non-metallic materials.

5.10.1 B31.3

Chapter VII Nonmetallic Piping and Piping Lined with Nonmetals permits non-metallic under certain conditions.

5.10.2 EN 13480

EN 13480 applies to metallic piping systems only. Non-metallic piping is addressed in the following EN standards:

- EN 1401: PVC-U piping systems for non-pressure underground drainage
- EN 1329: PVC-U piping systems for wastewater discharge within buildings
- EN 1453: PVC-U piping systems with structured-wall pipes for water discharge inside buildings
- EN 13476: PVC-U, PP, and PE structured-wall pipe systems for non-pressure underground drainage and buried sewerage
- EN 17176: PVC-O piping systems for water supply, pressurized drainage, sewerage, treated wastewater, and irrigation systems, either underground or overground

5.10.3 Conclusion

Non-metallic pipe is not addressed in EN 13480.

5.11 Qualification of material suppliers.

5.11.1 B31.3

No explicit requirement for material suppliers.

APPENDIX Q Quality System Program. (This Appendix is a Code requirement only when specified by the owner in accordance with para. 300(b)(1).) Design and construction of piping in accordance with this Code shall be performed under a Quality System Program following the principles of an appropriate standard such as the ISO 9000 series. The details describing the quality system shall be documented and shall be available upon request. A determination of the need for registration and/or certification of the quality system program shall be the responsibility of the owner.

5.11.2 EN 13480

EN 13480-7 requires a graded quality assurance (QA) system:

The manufacturer is responsible for ensuring that the requirements of this Technical Report, including inspection and testing activities, are fully applied. If a CE marking is sought, it is a requirement of the PED that (in many cases) there is a supplementary involvement of a Responsible Authority (e.g. Notified Body) to ensure the requirements of the PED are met.

The kind and extent of Responsible Authority involvement in inspection and testing activities will depend upon the conformity assessment procedure chosen by the manufacturer. For each appropriate conformity assessment procedure, the participation is indicated in Table B.1 of EN 13480-7.

5.11.3 Conclusion

B31.3 and EN 13480 have graded QA requirements. For the higher PED Category of piping the Notified Body would be involved in quality assurance. For the higher PED category, EN 13480 is therefore stricter than the B31.3 fabricator QA. For high consequence applications (such as flammable or toxic fluids) the B31.3 owner will often implement their own oversight in accordance with ISO 9000 plus the owner's corporate QA.

5.12 Quality control of materials.

5.12.1 B31.3

No explicit requirement for the quality control (QC) of materials.

APPENDIX Q Quality System Program. (This Appendix is a Code requirement only when specified by the owner in accordance with para. 300(b)(1).) Design and construction of piping in accordance with this Code shall be performed under a Quality System Program following the principles of an appropriate standard such as the ISO 9000 series. The details describing the quality system shall be documented and shall be available upon request. A determination of the need for registration and/or certification of the quality system program shall be the responsibility of the owner.

5.12.2 EN 13480

EN 13480-7 requires a graded QC system that depends on the assigned piping Group. The piping Groups are dependent on the pressure energy contained (pressure-volume), and the toxicity or flammability of the contents.

The pressure-volume gradation for piping systems is in accordance with PED Article 4:

"(i) gases, liquefied gases, gases dissolved under pressure, vapours and also those liquids whose vapour pressure at the maximum allowable temperature is greater than 0,5 bar above normal atmospheric pressure (1 013 mbar) within the following limits:

- *for fluids in Group 1 with a volume greater than 1 L and a product of PS and V greater than 25 bar·L, or with a pressure PS greater than 200 bar (Annex II, table 1),*
- *for fluids in Group 2, with a volume greater than 1 L and a product of PS and V is greater than 50 bar·L, or with a pressure PS greater than 1 000 bar, and all portable extinguishers and bottles for breathing apparatus (Annex II, table 2);*

(ii) liquids having a vapour pressure at the maximum allowable temperature of not more than 0,5 bar above normal atmospheric pressure (1 013 mbar) within the following limits:

- *for fluids in Group 1 with a volume greater than 1 L and a product of PS and V greater than 200 bar.L, or with a pressure PS greater than 500 bar (Annex II, table 3),*

- *for fluids in Group 2 with a pressure PS greater than 10 bar and a product of PS and V greater than 10 000 bar.L, or with a pressure PS greater than 1 000 bar (Annex II, table 4);"*

5.12.3 Conclusion
EN 13480 graded approach is more prescriptive than B31.3.

5.13 Material traceability.
5.13.1 B31.3
No explicit requirement for material traceability.

APPENDIX Q Quality System Program. (This Appendix is a Code requirement only when specified by the owner in accordance with para. 300(b)(1).) Design and construction of piping in accordance with this Code shall be performed under a Quality System Program following the principles of an appropriate standard such as the ISO 9000 series. The details describing the quality system shall be documented and shall be available upon request. A determination of the need for registration and/or certification of the quality system program shall be the responsibility of the owner.

5.13.2 EN 13480
EN 13480-2 Para.4.4 requires traceability through markings.

5.13.3 Conclusion
Material traceability is more explicit in EN 13480.

5.14 Material test reports.
5.14.1 B31.3
No explicit requirement for material test reports.

APPENDIX Q Quality System Program. (This Appendix is a Code requirement only when specified by the owner in accordance with para. 300(b)(1).) Design and construction of piping in accordance with this Code shall be performed under a Quality System Program following the principles of an appropriate standard such as the ISO 9000 series. The details describing the quality system shall be documented and shall be available upon request. A determination of the need for registration and/or certification of the quality system program shall be the responsibility of the owner.

5.14.2 EN 13480
Requirements for the documentation of material properties in EN 13480-2 Para.4.1.2 is by reference to EN-10204 and EN-764-5.

5.14.3 Conclusion
EN 13480 is more explicit than B31.3.

6 Key Attributes for Code design

The layout of the vessel and piping systems are the responsibility of the owner-operator or its contractor.

The conformance to permitted and prohibited design features, the designation of the design loads, and the qualification of stresses/strains/loads/movements are specified in the construction Code and the owner-operator supplementary requirements.

The key attributes for Code design are:

6.1 Scope exclusions and boundaries of the vessel or piping.

6.1.1 B31.3

300.2 Definitions pipe: a pressure-tight cylinder used to convey a fluid or to transmit a fluid pressure, ordinarily designated "pipe" in applicable material specifications. Materials designated "tube" or "tubing" in the specifications are treated as pipe when intended for pressure service.

323.4.2 restricts the use of brittle materials (such as cast iron) on the basis of several considerations such as the type of service, the type of loads applied in service, the pressure and temperature.

For gray iron, 302.3.2 limits the allowable stress in tension to 1/10 of the ultimate strength (as opposed to 1/3 for ductile materials). In practice this is one of the reasons why, today, gray cast iron is avoided in the construction of pressure piping systems.

6.1.2 EN 13480

Covers metallic piping materials and fittings. Per EN 13480-2 Para.4.1.4 the design rules apply to ductile materials, with an elongation at rupture exceeding 14%.

6.1.3 Conclusion

The scope of the two Codes is piping and tubing systems. EN 13480 is restricted to ductile materials.

6.2 Selection of the design pressure and temperature.

6.2.1 B31.3

301.2 Design Pressure
301.2.1 General

(a) The design pressure of each component in a piping system shall be not less than the pressure at the most severe condition of coincident internal or external pressure and temperature (minimum or maximum) expected during service, except as provided in para. 302.2.4.

301.3 Design Temperature

The design temperature of each component in a piping system is the temperature at which, under the coincident pressure, the greatest thickness or highest component rating is required in accordance with para. 301.2. (To satisfy the requirements of para. 301.2, different components in the same piping system may have different design temperatures.)

6.2.2 EN 13480

EN 13480-3 Para.4.2.3.3 calls for the most severe sets (pressure, temperature) to be considered.

6.2.3 Conclusion

The definition of design pressure is nearly identical in the B31.3 and EN 13480. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

Note: Neither B31.3 nor EN 13480-3 specifies what are the credible scenarios to be considered in developing the most severe sets (pressure, temperature).

6.3 Allowances for over-pressure and over-temperature.

6.3.1 B31.3

302.2.4 Allowances for Pressure and Temperature Variations.

(f) Occasional variations above design conditions shall remain within one of the following limits for pressure design.

(1) Subject to the owner's approval, it is permissible to exceed the pressure rating or the allowable stress for pressure design at the temperature of the increased condition by not more than

(-a) 33% for no more than 10 h at any one time and no more than 100 h/y, or

(-b) 20% for no more than 50 h at any one time and no more than 500 h/y

The effects of such variations shall be determined by the designer to be safe over the service life of the piping system by methods acceptable to the owner. (See Appendix V.)

6.3.2 EN 13480

Per EN 13480-3 Para.4.2.3.3, the stress cannot exceed the allowable stress by more than 10% for longer than 10% of any 24-hour period. Since the pressure stress is proportional to the pressure, this corresponds to permitting a 10% over-pressure for 10% of any 24 hour period.

6.3.3 Conclusion

The +10% over-pressure allowance in EN 13480 is more conservative than B31.3 which permits up to +33% over-pressure.

6.4 Loads to be considered in the design.

6.4.1 B31.3

Loads are not mandatory in B31.3, but listed for consideration of applicability:

301.2 Design Pressure; 301.3 Design Temperature; 301.4 Ambient Effects; 301.5 Dynamic Effects; 301.6 Weight Effects; 301.7 Thermal Expansion and Contraction Effects; 301.8 Effects of Support, Anchor, and Terminal Movements; 301.9 Reduced Ductility Effects; 301.10 Cyclic Effects; 301.11 Air Condensation Effects.

6.4.2 EN 13480

EN 13480-3 Para.4.2 lists the loads to be considered.

6.4.3 Conclusion

B31.3 and EN 13480 list loads to be considered but the loads that a piping system must be designed for is in all cases a decision of the designer-user. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

6.5 Margins of basic allowable stress against ultimate and yield.

6.5.1 B31.3

302.3.2 Bases for Design Stresses

(d) Other Materials [other than bolts and cast iron]*. Basic allowable stress values at temperature for materials other than bolting materials, gray iron, and malleable iron shall not exceed the lowest of the following:*

(1) the lower of one-third of S_T and one-third of tensile strength at temperature.

(2) except as provided in (3) below, the lower of two thirds of S_Y and two-thirds of yield strength at temperature.

(3) for austenitic stainless steels and nickel alloys having similar stress–strain behavior, the lower of two-thirds of SY and 90% of yield strength at temperature [see (e)].

(4) 100% of the average stress for a creep rate of 0.01% per 1 000 h.

(5) for temperatures up to and including 815°C (1,500°F), 67% of the average stress for rupture at the end of 100 000 h.

(6) for temperatures higher than 815°C (1,500°F), (100 × Favg)% times the average stress for rupture at the end of 100 000 h. Favg is determined from the slope, n, of the log time-to-rupture versus log stress plot at 100 000 h such that log Favg = 1/n. Favg shall not exceed 0.67.

(7) 80% of the minimum stress for rupture at the end of 100 000 h.

For structural grade materials, the basic allowable stress shall be 0.92 times the lowest value determined in (1) through (7).

In summary, below the creep temperature, the allowable stress is:

For ferritic and austenitic steels:

$$S_h = \min \{1/3\ S_{ult(T)};\ 2/3\ S_{yield(T)}\}$$

Where S = allowable stress at hot temperature; $S_{ult(T)}$ = tensile strength at temperature; $S_{yield(T)}$ = yield strength at temperature.

An allowance for austenitic steels, base metal and welds:

$$S_h = \min \{1/3\ S_{ult(T)};\ 90\%\ S_{yield(T)}\}$$

For castings a casting factor E_c is added, which varies from 0.85 to 1.0 based on surface finish and extent of surface or volumetric NDE of the casting.

For gray iron

$$S = 1/10\ S_{ult(T)} \text{ where gray cast iron is permitted}$$

6.5.2 EN 13480

From EN 13480-3 Para.5.2, and PED 2014/68/EU Annex I Para.7.1 “Allowable stresses”, below the creep temperature, the general membrane stress allowable is:

Per 5.2.1.1 for ferritic and austenitic steels:

$$S_h = \min \{1/2.4\ S_{ult(T)};\ 2/3\ S_{yield(T)}\}$$

Per 5.2.2.1 there is an allowance for austenitic steels base metal and welds:

$$S_h = \min \{1/2.4\ S_{ult(T)};\ 1/1.2\ S_{yield(T)}\} \text{ if elongation at rupture} \geq 35\%$$

Para.5.2.4.1 allowable for steel castings is

$$S_h = \min \{1/3\ S_{ult(T)};\ 1/1.9\ S_{yield(T)}\} \text{ if elongation at rupture} < 30\%$$

Per EN 13480 Para.5.3, at creep temperatures (i.e., above 700°F approximately) the allowable stress is a fraction of the mean value of creep rupture strength at 200,000 hrs (22 years), divided by a safety factor of 1.25 or 1.50.

EN 13480-2 Para.4.1.4 requires the pressure boundary materials to be ductile, with an elongation at rupture larger than 14% in the transverse direction and 16% in the longitudinal direction. Gray cast iron, permitted in B31.3, would not be permitted in EN 13480.

6.5.3 Conclusion

For ductile wrought materials (not cast) the allowable stress in B31.3 is more conservative by 3/2.4 = 1.25 when the allowable stress is controlled by the ultimate strength. This means that the minimum required thickness for a B31.3 pipe or tubing will be ~ 25% thicker than a EN 13480 pipe or tubing if controlled by ultimate strength. In practice this difference of 25% in thickness is overcome because the calculated thickness is rounded up to the next available commercial size, such as schedule 40, results in an installed pipe wall much thicker than the Code required minimum wall thickness. For this reason, this difference in allowable stresses is not significant in practice. Therefore, in practice ASME B31.3 and EN 13480 are equivalent for this attribute.

6.6 Burst prevention design.

6.6.1 B31.3

304.1.2 Straight Pipe Under Internal Pressure

Minimum required thickness for internal pressure:

$$t = P D_o / [2 (S E W + 0.4 P)] \quad \text{Eq.(3a)}$$

The factor W in B31.3 (Table 302.3.5) varies from 0.50 (stainless steel above 1500°F) to 1.0 (carbon steel below 1100°F and 300 series stainless steel below 950°F).

6.6.2 EN 13480

EN 13480-3 Para.6.1 for thin wall piping when $D_o/D_i \leq 1.7$ (covers most practical sizes), the minimum thickness equation is

$$t = P D_o / [2 ((f = S) (z = E) + P)] \quad \text{Eq.(6.1.1)}$$

EN 13480 Para.5.3.1 requires a penalty factor of 20% for welds in the creep regime.

6.6.3 Conclusion

The B31.3 and EN 13480 minimum thickness equations are similar, and provide in both cases a minimum thickness that is adequate. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

6.7 Unlisted joints and fittings qualification.

6.7.1 B31.3

304.7.2 Unlisted Components

Pressure design of unlisted components to which the rules elsewhere in para. 304 do not apply … The designer shall ensure that the pressure design has been substantiated through one or more of the means stated in (a) through (d).

(a) extensive, successful service ...

(b) experimental stress analysis …

(c) proof test in accordance with ASME B16.9, MSS SP- 97, or ASME BPVC, Section VIII, Division 1, UG-101.

(d) detailed stress analysis (e.g., finite element method) with results evaluated as described in ASME BPVC, Section VIII, Division 2, Part 5.

(e) For any of the above, the designer may interpolate between sizes, wall thicknesses, and pressure class …

The proof test (burst test) of B16.9 is to be performed at a minimum pressure hoop stress (PD/2t) of 105% the material actual ultimate strength, i.e. a minimum design factor of 105% × 3 against the allowable stress $S_{\text{allowable ambient T}}$. The burst test pressure iofASME VIII Div.1 Para.UG-101 has a minimum design factor of 4 (with additional corrections) against the burst pressure.

6.7.2 EN 13480

PED 2014-68 Para.2.2.4 *Experimental design method* states:

"The design of the equipment may be validated, in all or in part, by an appropriate test programme carried out on a sample representative of the equipment or the category of equipment.

The test programme shall be clearly defined prior to testing and accepted by the Notified Body responsible for the design conformity assessment module, where it exists.

This programme shall define test conditions and criteria for acceptance or refusal. The actual values of the essential dimensions and characteristics of the materials which constitute the equipment tested shall be measured before the test.

Where appropriate, during tests, it shall be possible to observe the critical zones of the pressure equipment with adequate instrumentation capable of registering strains and stresses with sufficient precision.

The test programme shall include:

(a) A pressure strength test, the purpose of which is to check that, at a pressure with a defined safety margin in relation to the maximum allowable pressure, the equipment does not exhibit significant leaks or deformation exceeding a determined threshold."

Therefore, PED 2014/68/EU Annex I Para.2.2.4, permits verification of design by testing, but does not specify a test pressure.

6.7.3 Conclusion

The qualification of unlisted joints and fittings (i.e. specialty joints or fittings) for internal pressure by burst testing is an alternative to qualification of the fitting for internal pressure by analysis. Regarding qualification by burst test, ASME B31.3 and EN 13480 (based on PED 2014-68 Para.2.2.4) are not equivalent. When qualifying a fitting by burst test, ASME B31.3 requires a minimum design margin (burst pressure / design pressure) of 3, while PED 2014-68 does not specify a design margin.

Suggestion: This is particularly important for specialty (catalog) fittings and joints which are often qualified by burst test rather than analysis. Therefore, the user must either 1) request, from the manufacturer, the documented burst test of specialty (catalog) fittings and joints to confirm the burst test pressure was greater than 3x the design pressure or 2) perform their own burst test on the fitting or joint sample to establish its design margin as required by B31.3 Para.304.7.2.

If the user requests the documented burst test of specialty (catalog) fittings and joints and the burst test pressure was less than 3× the design margin the user must perform their own burst test on the fitting or joint sample to establish its design margin as required by B31.3 Para.304.7.2.

6.8 Plastic instability prevention design.

6.8.1 B31.3

320 Analysis of Sustained Loads

$$S_L = \sqrt{[(S_a+S_b)^2+(2S_t)^2]} \leq S \quad \text{Eq.(23a)}$$

$$S_b = \sqrt{[(I_iM_i)^2+(I_oM_o)^2]} / Z \quad \text{Eq.(23b)}$$

$$S_t = I_t M_t / (2 Z) \quad \text{Eq.(23c)}$$

$$S_a = I_a F_a / A_p \quad \text{Eq.(23d)}$$

302.3.6 Limits of Calculated Stresses Due to Occasional Loads

(1) Subject to the limits of para. 302.2.4, the sum of the stresses due to sustained loads, such as pressure and weight, SL, and of the stresses produced by occasional loads, such as wind and earthquake, shall not exceed 1.33 times the basic allowable stress …

6.8.2 EN 13480

EN 13480 Para.11.6 longitudinal stress formulas for sustained loads (pressure + weight) and occasional loads (seismic, wind, waterhammer, etc.) are the same as B31.3. The allowable stress is 1.8S for sustained plus occasional loads; and 2.7S for "exceptional" loads. This is higher than B31.3 allowable stress of 1.33S, but is similar to ASME III Div.1 NCD-3600 (nuclear power plant piping) which permitted 2.4S with 0.75i.

6.8.3 Conclusion

The allowable stress in B31.3 for occasional loads is 1.33S, while in EN 13480 it can be as large as 2.7S. Therefore, B31.3 is more conservative. There has not been a need in B31.3 for higher allowable stresses because the "exceptional" (large) design loads such as seismic loads in B31.3 (process piping) are based on the International Building Code and ASCE-7, which once the ductility factor Rp is applied are much lower than the site-specific seismic input in nuclear power plants.

ASME B31E-2010 Section 3.4 the seismic allowable stress was increased to 2.4S, approximately the same as 2.7S of EN 13480.

However, the Code that best reflects the state-of-the-art regarding occasional and "exceptional" (large) loads is the nuclear component design Code ASME III Div.1, which is consistent with the higher allowable stresses of EN 13480. These higher EN 13480 allowable stresses are therefore appropriate.

6.9 Fatigue cracking prevention design.

6.9.1 B31.3

319.4.4 Flexibility Stresses

$$S_E = \sqrt{[(S_a+S_b)^2+(2S_t)^2]} \leq S_A = f\,(= 20\,N^{-0.33})(1.25\,S_c + 0.25\,S_h) \quad \text{Eq.(1a) and Eq.(17)}$$

$$S_b = \sqrt{[(i_iM_i)^2+(i_oM_o)^2]} / Z \quad \text{Eq.(18)}$$

$$S_t = i_t M_t / (2 Z)$$

$$S_a = i_a F_a / A_p$$

6.9.2 EN 13480

EN 13480-3 Para.11.6 longitudinal stress formulas for thermal expansion are identical to B31.3 Para.319.4.4.

6.9.3 Conclusion

The longitudinal stress formulas for thermal expansion are identical in B31.3 and EN 13480-3 they are therefore equivalent for this attribute.

6.10 Buckling prevention design.

6.10.1 B31.3

302.5 Mechanical Strength

(a) Designs shall be checked for adequacy of mechanical strength under applicable loadings. When necessary, the wall thickness shall be increased to prevent overstress, damage, collapse, or buckling due to superimposed loads from supports, ice formation, backfill, transportation, handling, or other loads enumerated in para. 301.

321.2.3 Resilient Supports

(a) Spring supports … shall be provided with means to prevent misalignment, buckling

6.10.2 EN 13480

EN 13480 Para.9.3 addresses buckling under external pressure. Para.7.1.3 addresses buckling of heads.

EN 13480 Annex C addresses buckling of piping systems with expansion joints.

EN 13480 Annexes L and J address buckling of pipe supports.

6.10.3 Conclusion

B31.3 and EN 13480 address prevention from buckling with sound design formulas, there is therefore an equivalent level of safety for this attribute.

6.11 Bearing stress failure prevention.

6.11.1 B31.3

302.3 Allowable Stresses and Other Stress Limits

(b) Shear and Bearing. Allowable stresses in shear shall be 0.80 times the basic allowable stress in tension tabulated in Appendix A. Allowable stress in bearing shall be 1.60 times that value.

In practice, for B31.3 piping systems with D/t < 50, bearing stresses are not critical and seldom checked.

6.11.2 EN 13480

EN 13480 Addendum 5 Para.16 provides a 1.5S limit for the von-Mises equivalent stress.

6.11.3 Conclusion

B31.3 and EN 13480 limits on bearing stresses are similar (1.60x0.80S = 1.3S and 1.5S), they are therefore equivalent for this attribute.

6.12 Margins on stress limits for load combinations.

6.12.1 B31.3

See plastic instability and fatigue cracking.

6.12.2 EN 13480

See plastic instability and fatigue cracking.

6.12.3 Conclusion

Per conclusion on plastic instability and fatigue cracking, B31.3 and EN 13480 are equivalent for this attribute.

6.13 Weld joint efficiency factors.

6.13.1 B31.3

Table 302.3.4 Longitudinal Weld Joint Quality Factor, Ej

The weld joint quality factor varies from 1.0 (butt welded with 100% radiography) to 0.60 (furnace butt welded with NDE per material specification).

6.13.2 EN 13480

EN13480-3 Para.13.11.5.2, and PED 2014/68/EU Annex I Para.7.2, provide weld joint efficiency factors that vary from 0.7 (visual examination) to 1.0 (100% NDT).

6.13.3 Conclusion

The weld joint efficiency factors, an approximate parameter, are similar, B31.3 and EN 13480 are therefore equivalent for this attribute.

6.14 External pressure design.

6.14.1 B31.3

304.1.3 Straight Pipe Under External Pressure.

… the procedure outlined in ASME BPVC, Section VIII, Division 1, UG-28 through UG-30 shall be followed, … As an exception, for pipe with Do/t < 10, the value of S to be used in determining Pa shall be the lesser of the following values…

6.14.2 EN 13480

EN 13480 Para.9 explicitly addresses the design of piping under external pressure (such as vacuum service), including sizing the stiffeners.

6.14.3 Conclusion

B31.3 and EN 13480 address external pressure design in a similar manner. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

6.15 Nozzle reinforcement design.

6.15.1 B31.3

304.3 Branch Connections

(a) the branch connection is made with a listed branch type fitting such as an ASME B16.9 or ASME B16.11 tee, or MSS SP-97 …

(b) the branch connection is made by welding a listed threaded or socket welding coupling or listed half coupling directly to the run …

(c) the branch connection utilizes an unlisted branch connection fitting …

304.3.3 Reinforcement of Welded Branch Connections.

$$A_{2(header)} + A_{3(branch)} + A_{4(weld+reinforcement)} \geq A_{1(header\ cut-out\ disk)} \quad Eq.(6a)$$

6.15.2 EN 13480

EN 13480 Clause 8 and Annex O apply for the design of openings, including branch reinforcements, for several component shapes, and the corresponding design restrictions.

6.15.3 Conclusion

EN 13480 is more restrictive than B31.3 because the branch reinforcement rules cover the same approach as B31.3 (area reinforcement) and include additional restrictions.

6.16 Permitted and prohibited weld details.

6.16.1 B31.3

328.5.4 Welded Branch Connections … are full penetration welds. B31.3 avoids partial penetration welded branch connections because of concerns with crevice corrosion (in the crevice under the partial

penetration) and vibration cracking. B31.1 permits partial penetrated bosses, which are common in instrument taps to the main pipe.

328.7 Attachment Welds

The welding of structural and other non-pressure retaining attachments may be made by complete penetration, partial penetration, fillet, or stud welding.

6.16.2 EN 13480

EN 13480 Table 10.3.2-4 requires welded branch connections to be full penetration welds; except for set-on nozzles (bosses).

EN 13480-3 permits partial penetration welds in the following cases: Para.7.2.4 for flat end welded to pipe; Para.11.4.4 and 11.5.4 for welded attachments; Para.13.11.5.4 for pipe supports; Table 10.3.2-4 No.2.5 for set-on nozzles (bosses with socket joint).

6.16.3 Conclusion

EN 13480 Table 10.3.2-4 permits partial penetration welds for set-on nozzles for socket-like welded branch pipe (typically NPS 2 and smaller), while B31.3 does not. Partial penetration welds for set-on bosses are permitted in the Power Piping Code B31.1 Figure 127.4.8-7 for branch and instrument connections NPS 2 and smaller.

While not explicitly addressed in B31.3, set-on bosses with fillet welds are accepted in the Power Piping Code B31.1; and therefore, technically sound.

6.17 Allowances and prohibitions for types of mechanical (non-welded) joints.

6.17.1 B31.3

Threaded joints

> Fluid Service Category M (toxic, flammable):
>
> *M307.2 Specific Requirements … b) Valves having threaded bonnet joints (other than union joints) shall not be used.*
>
> *M308.2 Specific Requirements for Metallic Flanges The following shall not be used: … (d) threaded metallic flanges, except those employing …*
>
> M314.2 Specific Requirements M314.2.1 Taper-Threaded Joints. Paragraph 314.2.1 applies except that only components suitable for Normal Fluid Service in sizes 8 ≤ DN ≤ 25 (1⁄4 ≤ NPS ≤ 1) are permitted.
>
> *(b)* The nominal wall thickness of piping components with external taper threads shall be at least as thick as that specified for Schedule 160 in ASME B36.10M.
>
> High Pressure Piping (above ~ 6000 psi)
>
> *K314.2 Taper-Threaded Pipe Joints … (a) Taper-threaded pipe joints shall be used only for instrumentation, vents, drains, and similar purposes, and shall be not larger than DN 15 (NPS 1⁄2).*

Lapped joints

> *306.4.4 Laps for Severe Cyclic Conditions … (c) A flared lap is not permitted under severe cyclic conditions.*
>
> *Normal fluid conditions*

306.4.1 Fabricated Laps. A fabricated lap is suitable for use in Normal Fluid Service, provided that all of the following requirements are met: …

6.17.2 EN 13480

EN 13480 Para.8.3.11 "Screwed-in branches" permits threaded branches if T < 400°C (752°F), P < 40 barg (580 psig), branch DN < 50 (NPS 2), with additional limitations.

Para.D.5.6 addresses the use of lap joints provided limits on the flange and bolts are met, which indirectly limits the service pressure and temperature.

6.17.3 Conclusion

B31.3 and EN 13480 have limitations on the use of non-welded joints in certain applications, which would limit the use of threaded joints and lap joints to low pressures and temperatures. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

6.18 Design of flanges and bolted joints.

6.18.1 B31.3

304.5 Pressure Design of Flanges and Blanks

(a) Flanges not in accordance with para. 303 or (b) or (d) [standard B16.5 flange] *shall be qualified as required by para. 304.7.2.*

(b) A flange may be designed in accordance with ASME BPVC, Section VIII, Division 1, Mandatory Appendix 2 (Rules for Bolted Flange Connections with Ring Type Gaskets) or ASME BPVC, Section VIII, Division 2, 4.16 (Design Rules for Flanged Joints), using the allowable stresses and temperature limits of this Code.

… (e) See Section VIII, Division 1, Appendix S, for considerations applicable to bolted joint assembly.

6.18.2 EN 13480

EN 13480-3 Para.6.6.3 addresses standard flanges, including pipe load limits in the form of P_{eq} which is equivalent to ASME III Div.1 NCD-3600 but is not yet addressed in B31.3.

EN 13480-3 Para.6.6.4 addresses non-standard flange design in Annex D based on Taylor-Forge method.

A design method similar to EN 13480 Annex D is provided in EN-1591.

6.18.3 Conclusion

EN 13480 is stricter in applying a load limit on bolted joints that is included for example in the nuclear piping design Code (ASME III NCD-3600) but is not yet introduced in B31.3.

EN 13480 and B31.3 have different design formulas for non-standard pipe flanges. The EN 13480 formulas are conservative when compared to ASME VIII which is referred to in B31.3

6.19 Bolted flange.

6.19.1 B31.3

308.2.1 Slip-On Flanges

(a) A slip-on flange shall be double-welded as shown in Figure 328.5.2B when the service is

(1) subject to severe erosion, crevice corrosion, or cyclic loading

(2) flammable, toxic, or damaging to human tissue

(3) under severe cyclic conditions

(4) at temperatures below −101°C (−150°F)

(b) The use of slip-on flanges should be avoided where many large temperature cycles are expected, particularly if the flanges are not insulated.

308.2.4 Flanges for Severe Cyclic Conditions. Unless it is safeguarded, a flange to be used under severe cyclic conditions shall be welding neck conforming to ASME B16.5 or ASME B16.47, or a similarly proportioned flange designed in accordance with para. 304.5.1.

309.1 General

309.1.1 Listed Bolting. Listed bolting is suitable for use in Normal Fluid Service, except as stated elsewhere in para. 309.

309.1.2 Unlisted Bolting. Unlisted bolting may be used only in accordance with para. 302.2.3.

309.2.1 Low Yield Strength Bolting. Bolting having not more than 207 MPa (30 ksi) specified minimum yield strength shall not be used for flanged joints rated ASME B16.5 Class 400 and higher, nor for flanged joints using metallic gaskets, unless calculations have been made showing adequate strength to maintain joint tightness.

309.2.4

Bolting for Severe Cyclic Conditions. Low yield strength bolting (see para. 309.2.1) shall not be used for flanged joints under severe cyclic conditions.

6.19.2 EN 13480

Bolting selection and design is addressed in EN 13480-3 Para.6.6.1 incorporating by reference EN 1515. EN 13480 does not include guidance on the selection of the type of flange for the various types of service.

6.19.3 Conclusion

B31.3 provides the following restrictions on the type of bolted joints for the various categories of fluid service

- Slip-on flanges if used with toxic or flammable materials and in cryogenic service shall be double-welded (outer and inner pipe-to-flange weld).
- In a service subject to severe cyclic conditions flanges shall be weld neck, unless safeguarded (encapsulated).
- Low yield strength bolting (ambient yield strength below 30 ksi) shall not be used for flanged joints under severe cyclic conditions.

Note: severe cyclic conditions: conditions applying to specific piping components or joints for which the owner or the designer determines that design and construction to better resist fatigue loading is warranted. See [B31.3] Appendix F, para. F301.10.3 for guidance on designating piping as being under severe cyclic conditions.

These B31.3 restrictions are not mentioned in EN 1340.

Suggestion: The user must impose the B31.3 restrictions on bolted joints either to the fabricator or as an alteration after the piping system has been received.

If a user encounters an EN 13480 piping or tubing system with types of bolted flanged joints that would not be permitted in B31.3, they should provide protection against the potential leakage of the bolted flanged joints.

6.20 Design of cladding and weld overlays.

6.20.1 B31.3

323.4.3 Cladding and Lining Materials

Then pressure design in accordance with rules in para. 304 may be based upon the total thickness of base metal and cladding after any allowance for corrosion has been deducted …

No weld overlay requirements.

6.20.2 EN 13480

Cladding is addressed in the Materials Section EN 13480-2 Para.4.3.4 and Annex C, but does not address whether to credit the cladding for strength.

6.20.3 Conclusion

B31.3 permits cladding to be credited to resist internal pressure. EN 13480 is silent, so it may be credited (as in B31.3) or not (which would be conservative).

6.21 Design of blanks and flat heads.

6.21.1 B31.3

304.5.3 Blanks provides the minimum thickness formula for blanks

$$t_m = d_g \sqrt{[3\ P / (16\ S\ E\ W)]} + x$$

6.21.2 EN 13480

EN 13480-3 Para.7.2 addresses circular flat heads, with a √P-dependent formula for thickness similar to B31.3.

6.21.3 Conclusion

Flat heads are addressed in B31.3 and EN 13480 with the same dependency of the thickness of the flat head with √P. The two codes are therefore equivalent for this attribute.

6.22 Design of support structures.

6.22.1 B31.3

321 PIPING SUPPORT

302.3 Allowable Stresses and Other Stress Limits

302.3.1 General. The allowable stresses defined in (a), (b), and (c) shall be used in design calculations unless modified by other provisions of this Code.

(a) Tension …

(b) Shear and Bearing. Allowable stresses in shear shall be 0.80 times the basic allowable stress in tension tabulated in Appendix A. Allowable stress in bearing shall be 1.60 times that value.

(c) Compression. Allowable stresses in compression shall be no greater than the basic allowable stresses in tension as tabulated in Appendix A. Consideration shall be given to structural stability.

6.22.2 EN 13480

EN 13480 Clause 13 and Annexes I through N provide explicit rules for the design of pipe supports.

6.22.3 Conclusion

EN 13480 exceeds the requirements of B31.3 because it includes explicit and more comprehensive rules than B31.3. EN 13480 is more comprehensive than B31.3 regarding the design of pipe supports.

6.23 Allowance for design by finite element analysis, and stress or strain limits.

6.23.1 B31.3

300 General Statements

(c)(3) The Code generally specifies a simplified approach for many of its requirements. A designer may choose to use a more rigorous analysis to develop design, materials, fabrication, assembly, erection, examination, and testing requirements. When the designer decides to take this approach, the designer shall provide to the owner details and calculations demonstrating that the proposed design, materials, fabrication, assembly, erection, examination, and testing requirements are consistent with the criteria of this Code, including the design criteria described in para. 302. These details shall be adequate for the owner to verify the validity of the approach. The approach may be implemented following approval by the owner. The details and calculations shall be documented in the engineering design.

6.23.2 EN 13480

EN 13480-3 Para.4.6 permits design by analysis, by reference to the vessel design Code 13445-3.

6.23.3 Conclusion

B31.3 and EN 13480 permit design by finite element analysis as an alternative to design by closed-form formulas. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

6.24 Graded approach to design based on consequence of failure.

6.24.1 B31.3

Fluid Service Categories D (low consequence), M (toxic, flammable, high consequence), K (high pressure above 6000 psi), severe cyclic (significant fatigue) and Normal (none of the above) have a graded approach to design and fabrication requirements. Separate Chapters address Fluid Service Categories M and K.

6.24.2 EN 13480

PED article 13, EN 13480-7 Annex A, and EN 13480-1 Table 5.1-1 classifies piping systems by the type of fluid (gases, liquids), pipe size, and system pressure-volume (energy-based).

6.24.3 Conclusion

EN 13480 and B31.3 classify piping systems by pressure (contained energy) and toxicity-flammability of the contents. The energy-based limits are different but both sets of limits (B31.3 and EN 13480) are adequate. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

6.25 Design of attachment to the support structure.

6.25.1 B31.3

321.3.2 Integral Attachments.

Consideration shall be given to the localized stresses induced in the piping component by welding the integral attachment, as well as differential thermal displacement strains between the attachment and the component to which it is attached … Welds shall be proportioned so that the shear stresses meet the requirements of para. 302.3.1(b).

6.25.2 EN 13480

EN 13480-3 Clause 11 covers the design of welded attachments in detail, using formulas that are based on ASME III Div.1 Appendix Y.

6.25.3 Conclusion

EN 13480-3 is more explicit and more complete than B31.3.

7 Key Attributes for Fabrication

Machining, welding, and heat treatment are specified in the construction Codes and supplemented by the owner-operator.

The key attributes for fabrication are:

7.1 Welding program.

7.1.1 B31.3

328.2 Welding and Brazing Qualification

Welding and brazing procedure specifications (WPSs and BPSs) to be followed in production welding shall be prepared and qualified, and welders, brazers, and operators shall be qualified as required by ASME BPVC, Section IX ...

7.1.2 EN 13480

The welding program is referenced to:

- EN 418 Welding personnel
- EN 9606 Qualification testing of welders
- EN 9692 Welding and allied processes
- EN 1011 Part 1 Welding. Recommendations for welding of metallic materials. General guidance for arc welding
- EN 1011 Part 2 Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels
- EN 1011 Part 3 Welding. Recommendations for welding of metallic materials. Arc welding of stainless steels
- EN 1011 Part 4 Welding. Recommendations for welding of metallic materials. Arc welding of aluminum and aluminum alloys
- EN 1011 Part 5 Welding. Recommendations for welding of metallic materials. Welding of clad steel
- EN 1011 Part 6 Welding. Recommendations for welding of metallic materials. Laser beam welding
- EN 1011 Part 7 Welding. Recommendations for welding of metallic materials. Electron beam welding
- EN 1011 Part 8 Welding. Recommendations for welding of metallic materials. Welding of cast irons
- EN 13480 Metallic industrial piping
- EN 14732 Welding personnel
- EN 5817 Welding
- EN 15610 Weld roughness measurements
- EN 15612 Specification and qualification of welding procedures for metallic materials — Qualification by adoption of a standard welding procedure specification
- EN 15613 Specification and qualification of welding procedures for metallic materials - Qualification based on pre-production welding test

7.1.3 Conclusion

ASME B31.3 and EN 13480 are explicit and detailed regarding welding programs (welding procedures, procedure qualifications, and welder qualifications). ASME B31.3 is more succinct by reference to ASME IX while EN 13480 references multiple EN welding standards. Together the EN standards form a total equivalent to ASME IX. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

7.2 Welding procedure.

7.2.1 ASME B31.3

ASME B31.3 Para.328.2 refers to ASME IX. The welding procedure specification (WPS) refers to ASME Section IX, which in Article V provides standard welding procedure specifications (SWPSs) which are generated by the American Welding Society (AWS).

There is a SWPS for each arc welding technique which captures the following variables, TIG welding used here as example, listing essential and non-essential variables:

- WPS No.
- Type of joint (groove design, root spacing, etc.)
- Base metal
- Filler metal
- Position
- Pre-heat
- Post-weld heat treatment
- Shielding gas
- Electrical characteristics (heat input, current and polarity)
- Tungsten electrode
- Welding technique (string or weaving, method cleaning, method back gouging, single or multiple passes, oscillation, etc.)

7.2.2 EN 13480

The WPS is provided in Annex A to EN ISO 15609-1. This document specifies requirements for the content of WPSs for arc welding processes. The EN 13480 WPS captures the following variables, applicable to all the arc welding processes:

- WPS No.
- WPQR No.
- Method of preparation and cleaning
- Manufacturer
- Parent material designation
- Mode of metal transfer
- Material thickness
- Joint type and weld type
- Outside diameter
- Throat thickness
- Degree of mechanization
- Deposited weld metal
- Weld preparation sketch
- Welding position
- Joint design
- Welding sequence
- Size of filler metal
- Type of current and polarity
- Current
- Voltage
- Wire feed speed
- Runout length

- Travel speed
- Arc energy / heat input
- Filler designation and make
- Special baking and drying
- Designation of shielding gas/flux
- Backing
- Weaving width
- Gas flow rate
- Tungsten electrode type and size
- Distance to work piece
- Preheating temperature
- Torch angle
- Inter-pass temperature
- Post-weld heat treatment, time, temperature, method, heating and cooling rates
- Manufacturer name and signature/date

Unlike ASME IX, in this list the variables are not denoted essential or non-essential. The statement is made that “The variables listed in this document are those influencing the quality of the welded joint.”

7.2.3 Conclusion

In ASME B31.3 and EN 13480 the welding variables in the WPS are nearly identical. Therefore, ASME VIII and EN 13445 are equivalent for this attribute.

7.3 Welding procedure qualification including coupon testing.

7.3.1 ASME B31.3

The welding procedure qualification record (WPQR) is a record of variables recorded during the welding of the test coupons. It also contains the test results of the tested specimens. Welding procedure qualification is in accordance with ASME IX QW-200.2. The type of tests to be performed to qualify a WPS depends on the material and thickness of the weld, and includes:

- Tensile testing
- Guided bend test
- Toughness test

7.3.2 EN 13480

The WPQR for EN 13480 WPS is addressed in 13480-4 Para.9.3 in accordance with EN ISO 15609-1; 15611 (based on previous experience); 15612 (standard WPS); 15613 (pre-production welding test); the mechanical tests are similar to ASME IX:

- Tensile tests
- Bend tests
- Toughness tests, with supplementary toughness requirements of EN 13445 Para.8.3.

7.3.3 Conclusion

The requirement for a WPQR is identical in ASME B31.3 and EN 13480, with reference to ASME IX and EN ISO 15614 respectively. The weld qualification tests are equivalent in both Codes and therefore ASME B31.3 and EN 13480 are equivalent for this attribute.

7.4 Welder or weld operator qualification.

7.4.1 ASME B31.3

ASME IX requires that welders be qualified for the WPS.

The duration of the welder qualification is addressed in ASME IX QW-322.1 Expiration. The qualification of a welder or welding operator for a process remains valid provided no more than 6 months have passed since the welder or welding operator last used that process.

7.4.2 EN 13480

EN 13480 Para.9.1 requires that each welder be qualified for the WPS, in accordance with EN ISO 9606 (welders) and ISO 14732 (welding operators).

The duration of the welder qualification is addressed in EN ISO 9606-1. The welder may be

- Retested every 3 years
- Retested every 2 years, if two welds made during the last 6 months of the validity period were satisfactorily tested by radiographic or ultrasonic testing or destructive testing.

7.4.3 Conclusion

While the duration of the welder qualifications varies, both ASME B31.3 and EN 13480 require the welder to be qualified and re-tested periodically. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

7.5 End preparation.

7.5.1 ASME VIII B31.3

Para.328.4.2 provide acceptable weld bevel details, but also permits other bevel details provided they are qualified in the WPS: *"(2) End preparation for groove welds specified in ASME B16.25, or any other that meets the WPS, is acceptable."*

7.5.2 EN 13480

EN 13480-4 Para.6.1 and EN ISO 15609 Para.4.4.2 address joint preparation but do not specify the shape of the weld bevel which is in accordance with the WPS.

7.5.3 Conclusion

Neither ASME B31.3 nor EN 13480 impose a weld joint profile, and both refer to the weld joint specified in the WPS. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

7.6 Permitted and prohibited weld details.

7.6.1 B31.3

328.5.4 Welded Branch Connections

Branch connections are full penetration welds.

328.5.2 Fillet and Socket Welds

The size of the leg of the fillet weld for a pipe-flange must be the lesser of $1.4T_{pipe}$ *or* T_{hub}*.*

The size of the leg of the fillet weld for a socket weld must be larger than $1.09T_{pipe}$*.*

7.6.2 EN 13480

EN 13480-3 Section 11 contains the formulas for analyzing the stress in fillet welds, compared to the standard minimum fillet weld sizes in B31.3.

EN 13480-3 Table 10.3.2-4 detail 3.3 fillet weld throat of 5 mm (0.2 in.) minimum. This may be less than the B31.3 fillet weld leg that is linked to the matching pipe wall thickness.

7.6.3 Conclusion
B31.3 provides a simplified minimum fillet weld formula, whereas in EN 13480 the size of the fillet weld is based on calculations. The EN 13480 approach is more precise.

7.7 Pre-heating.
7.7.1 B31.3
330 Preheating

330.1 General

330.1.1 Requirements. Unless specified otherwise in the engineering design, the minimum preheat temperatures for materials of various P-Numbers are given in Table 330.1.1.

7.7.2 EN 13480
EN 13480-4 Para.9.11.1 addresses preheating by reference to EN 1011, and refers to the WPS as mandatory for pre-heating.

7.7.3 Conclusion
B31.3 and EN 13480 provide pre-heat requirements that are equivalent. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

7.8 Post-Weld Heat treatment.
7.8.1 B31.3
331 HEAT TREATMENT

331.1 General

331.1.1 Post-weld Heat Treatment Requirements (PWHT)

(a) PWHT shall be in accordance with the material groupings (P-Nos. and Group Nos.) and ranges in Table 331.1.1 except as provided in Table 331.1.2 and Table 331.1.3.

For example:

P-No. 1, Group Nos. 1–3, 595 °C to 650 °C (1,100 °F to 1,200 °F) 1 h/25 mm (1 hr/in.); 15 min min.; 2 hr plus 15 min for each additional 25 mm (in.) over 50 mm (2 in.).

7.8.2 EN 13480
EN 13480 Tables 9.14.1-1 and 9.14.1-2 provide the PWHT temperatures and durations.

7.8.3 Conclusion
For ferritic steels ASME B31.3 and EN 13480 provide PWHT requirements in the form of tempering, with limitations on wall thickness.

The temperatures (for example 1022°F to 1112°F tempering), the hold time, the exemption for austenitic stainless steel, and the exemptions for carbon steel based on thickness, are consistent with B31.3. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

7.9 Temper bead welding.
7.9.1 B31.3
Not addressed.

7.9.2 EN 13480
Not addressed.

7.9.3 Conclusion

Neither B31.3 nor EN 13480 address temper bead welding as an alternative to PWHT. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

7.10 Backing rings.

7.10.1 B31.3

328.3.2 Weld Backing Material. When backing rings are used, they shall conform to the following:

(a) Ferrous Metal Backing Rings. These shall be of weldable quality. Sulfur content shall not exceed 0.05%.

(b) If two abutting surfaces are to be welded to a third member used as a backing ring and one or two of the three members are ferritic and the other member or members are austenitic, the satisfactory use of such materials shall be demonstrated by welding procedure qualified as required by para. 328.2. Backing rings may be of the continuous machined or split-band type. Some commonly used types are shown in Figure 328.3.2.

(c) Nonferrous and Nonmetallic Backing Rings. Backing rings of nonferrous or nonmetallic material may be used, provided the designer approves their use and the welding procedure using them is qualified as required by para. 328.2.

7.10.2 EN 13480

Backing rings are addressed in EN 13480-4 Para.9.12. They are disallowed for Category III piping, and caution is provided regarding the gap backing ring-pipe misalignment. Backing rings are referred back to the WPS.

7.10.3 Conclusion

B31.3 and EN 13480 have limitations on the use of backing rings, referring to the WPS. EN 13480 is more explicit regarding the guidance on the use of backing rings. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

7.11 Strength of welds.

7.11.1 B31.3

328.3 Welding Materials

328.3.1 Electrodes and Filler Metal

(a) The nominal tensile strength of the weld metal shall equal or exceed the minimum specified tensile strength of the base metals being joined, or the weaker of the two if base metals of two different strengths are being joined.

7.11.2 EN 13480

EN 13480-4 Para.9.2 requires compliance to ISO 15609 for qualification of the welding procedure.

7.11.3 Conclusion

B31.3 and EN 13480 (through ISO 15609) provide similar strength requirement through the welding procedure qualification. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

7.12 Toughness of welds.

323.3 Impact Testing Methods and Acceptance Criteria

7.12.1 B31.3

Toughness testing is required for ferritic materials on the basis of thickness and minimum operating temperature.

The minimum toughness depends on the strength of the metal and whether it is deoxidized, and varies from 7 ft.lb (10 J) to 20 ft.lb (27 J).

7.12.2 EN 13480
EN 13480 refers to ISO 15609 for qualification of the welding procedure, which provides toughness testing similar to B31.3.

7.12.3 Conclusion
B31.3 and EN 13480 (through ISO 15609) provide similar toughness requirement, with negligible differences, through the welding procedure qualification, where applicable.

7.13 Brazing and soldering.
7.13.1 B31.3
333 Brazing and Soldering. Qualification per ASME IX except for Fluid Service Category D.

M317. Brazing or soldering not allowed for Cat.M systems (toxic, flammable).

M317.2 Brazing or soldering not allowed for high pressure piping systems (above 6000 psi (41 MPa)).

7.13.2 EN 13480
Brazing and soldering are not addressed in EN 13480-4.

ISO 22688 "Quality requirements for brazing of metallic materials" is a guide providing complete sets of quality requirements, both in workshops and installation sites, of any sort of brazed construction or product. The fabricator typically implements ISO 22688 for brazing, as would be verified by the Notified Body.

7.13.3 Conclusion
Brazing and soldering are not addressed in EN 13480-4.

Suggestion: Where EN 13480 piping or tubing is joined by brazing, the brazing program should be qualified and certified to braze in accordance to ISO 22688 or equivalent. Since ISO 22688 is not referenced in EN 13480, the owner-user should verify the compliance of brazed joints to ISO 22688 or equivalent.

7.14 Allowances for weld repairs.
7.14.1 B31.3
328.6 Weld Repair

A weld defect to be repaired shall be removed to sound metal. Repair welds shall be made using a welding procedure qualified in accordance with para. 328.2, recognizing that the cavity to be repaired may differ in contour and dimensions from the original joint. Repair welds shall be made by welders or welding operators qualified in accordance with para. 328.2. Preheating and heat treatment shall be as required for the original welding. See also para. 341.3.3.

7.14.2 EN 13480
Per EN 13480-4 Para.7.5, the surface finish of bends is not permitted to be repaired by welding.

Per EN 13480-4 Para.10.3 permits grinding-out a weld flaw and weld repairing, using qualified procedures and welders, and NDE examined per EN 13480-5.

7.14.3 Conclusion
ASME B31.3 and EN 13480 permit welds to be ground-out and repaired. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

7.15 Attachment welds.

7.15.1 B31.3

328.7 Attachment Welds

The welding of structural and other non-pressure retaining attachments may be made by complete penetration, partial penetration, fillet, or stud welding.

For temporary attachments on pressure-retaining components, the surfaces where attachments have been removed shall be finished by grinding or other acceptable means. Surfaces shall be blended smoothly into the surrounding base metal without encroaching on the minimum required thickness, tm, and examined. See para. 341.4 for the extent of required examinations.

Low energy capacitor discharge welding may be used for welding thermocouples or strain gages …

7.15.2 EN 13480

EN 13480-4 Para.9.13 addresses temporary and permanent attachments with cautions regarding surface preparation, minimum required thickness, and heat treatment.

7.15.3 Conclusion

ASME B31.3 and EN 13480 permit welded attachments to the pipe surface, with similar cautions. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

7.16 Bending and forming.

7.16.1 B31.3

332 Bending and Forming

332.1 General

Pipe may be bent and components may be formed by any hot or cold method that is suitable for the material, the fluid service, and the severity of the bending or forming process. The finished surface shall be free of cracks and substantially free from buckling. Thickness after bending or forming shall be not less than that required by the design.

332.2 Bending

332.2.1 Bend Flattening. Flattening of a bend, the difference between maximum and minimum diameters at any cross section, shall not exceed 8% of nominal outside diameter for internal pressure and 3% for external pressure. Removal of metal shall not be used to achieve these requirements.

332.2.2 Bending Temperature

(a) Cold bending of ferritic materials shall be done at a temperature below the transformation range.

(b) Hot bending shall be done at a temperature above the transformation range and in any case within a temperature range consistent with the material and the intended service.

332.4 Required Heat Treatment

332.4.1 Hot Bending and Forming. After hot bending and forming, heat treatment is required for P-Nos. 3, 4, 5, 6, and 10A materials in all thicknesses …

332.4.2 Cold Bending and Forming. After cold bending and forming, heat treatment is required (for all thicknesses, and with temperature and duration as given in Table 331.1.1) when any of the following conditions exist:

(a) for P-Nos. 1 through 6 materials, where the maximum calculated fiber elongation after bending or forming exceeds 50% of specified basic minimum elongation (in the direction of severest forming) for the applicable specification, grade, and thickness. This requirement may be waived if it can be demonstrated that the selection of pipe and the choice of bending or forming process provide assurance that, in the finished condition, the most severely strained material retains at least 10% elongation.

(b) for any material requiring impact testing, where the maximum calculated fiber elongation after bending or forming will exceed 5%.

(c) when specified in the engineering design.

7.16.2 EN 13480

EN 13480-4 Para.7 addresses hot and cold forming. Post-bending heat treatment is required for ferritic steels if the bending strain exceeds 5%. For austenitic stainless steels heat treatment is not required as long as elongation after fracture remains above 15% after forming.

7.16.3 Conclusion

ASME B31.3 and EN 13480 permit hot or cold bending of piping and tubing. Post-bending heat treatment uses the same threshold bending strain of 5%. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

7.17 Fabrication tolerances.

7.17.1 B31.3

Not addressed.

7.17.2 EN 13480

Tolerances are addressed by reference to ISO 13920 and Annex B for dimensional length tolerances of pipe spools (fabricated subassemblies).

7.17.3 Conclusion

EN 13480 is more restrictive.

7.18 Bolted flange.

7.18.1 B31.3

335 Assembly and Erection

(c) Flanged Joints. Unless otherwise specified in the engineering design, flanged joints shall be aligned as described in (1) or (2), and (3) …

335.2 Flanged Joints

335.2.1 Preparation for Assembly. Any damage to the gasket seating surface that would prevent gasket seating shall be repaired, or the flange shall be replaced.

335.2.2 Bolting Torque

(a) In assembling flanged joints, the gasket shall be uniformly compressed to the proper design loading.

(b) Special care shall be used in assembling flanged joints in which the flanges have widely differing mechanical properties. Tightening to a predetermined torque is recommended.

335.2.3 Bolt Length. Bolts shall extend through their nuts such that there is complete thread engagement for the full depth of the nut.

335.2.4 Gaskets. No more than one gasket shall be used between contact faces in assembling a flanged joint.

335.2.5 Flanged Joint Assembly. Assembly requirements for bolted flanged joints and flanged joint assembler qualifications shall be considered in the engineering design. For guidance, see ASME PCC-1, Guidelines for Pressure Boundary Bolted Flange Joint Assembly, and ASME BPVC, Section VIII, Division 1, Nonmandatory Appendix S.

7.18.2 EN 13480

EN 13480-4 Para.8.3 addresses cleanliness, flush and square alignment, aligned bolt holes, protruding bolt threads, engaged thread length. Advice on personnel training is provided by reference to CEN/TS 1591-4.

7.18.3 Conclusion

ASME B31.3 and EN 13480 address rules of good practice for bolted flange joints. Neither imposes special qualifications for the personnel performing the bolting. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

7.19 Material segregation.

7.19.1 B31.3

Not addressed.

7.19.2 EN 13480

EN 13480-4 Annex A (informative, i.e., guidance) addresses “Contamination and surface quality of stainless steel” including segregation.

7.19.3 Conclusion

EN 13480 provides guidance on material segregation. It is not a requirement but it is more explicit than ASME B31.3. Therefore, EN 13480 is more explicit than ASME B31.3 for this attribute.

7.20 Cleaning.

7.20.1 B31.3

335.9 Cleaning of Piping

This Code does not prescribe mandatory procedures for flushing and cleaning. However, for potential hazards that may result from performing such procedures refer to Appendix F, para. F335.9 for precautionary considerations.

F335.9 Cleaning of Piping

The following are some general considerations that may be evaluated in determining the need for cleaning of piping: …

7.20.2 EN 13480

EN 13480-4 para.9.6 addresses cleaning before welding; Para.12.1 addresses cleaning in general (standard for cleaning is to be specified); and Annex A addresses cleaning of stainless steel.

7.20.3 Conclusion

ASME B31.3 and EN 13480 do not provide explicit requirements for cleanliness, which is typically a requirement imposed by the user to the fabricator. Therefore B31.3 and EN 13480 are equivalent for this attribute.

8 Key Attributes for Examination

Quality controls in the form of non-destructive examination (NDE) are specified in the construction Codes and supplemented by the owner-operator's equipment-specific requirements.

The key attributes for examination are:

8.1 Qualifications of NDE personnel.

8.1.1 B31.3

342 EXAMINATION PERSONNEL

342.1 Personnel Qualification and Certification Personnel performing nondestructive examination to the requirements of this Code shall be qualified and certified for the method to be used in accordance with their employer's written practice. The written practice shall be based on the training, examination, and experience requirements of one of the following: (a) ASME BPVC, Section V, Article 1; (b) ASNT CP-189; (c) ASNT SNT-TC-1A; (d) other national or international central certification programs or standards

8.1.2 EN 13480

EN 13480-5 Para.8.4.3 addresses personnel qualifications by reference to EN ISO 9712. Individuals are certified to three Levels 1, 2, and 3, as in the US.

8.1.3 Conclusion

Personnel performing NDE must be certified in ASME B31.3 and EN 13480. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

8.2 Extent and percent of examinations of welds.

8.2.1 B31.3

ASME B31.3 takes a graded approach to NDE of new welds:

- Normal fluid service piping calls for visual examination and 5% radiography.
- Category M fluid service (toxic, flammable), cyclic service, and high pressure piping calls for visual and 100% radiography.
- Category D piping calls for visual examinations but does not require surface or volumetric examination.
- B31.3 permits in-process examination in place of radiography in some cases.

8.2.2 EN 13480

EN 13480-5 Table 8.2-1 provides the method of NDE, the % welds to be examined, as a function of the material group and the piping category I (lowest) though III (highest). Visual examination is always required. For the lowest Catgory (Cat.I) no other examination is required. Volumetric examination ranges from 5% to 100%, the latter for creep service and when pneumatically tested. Surface examination varies from 5% to 100%.

8.2.3 Conclusion

ASME B31.3 and EN 13480 take a graded approach to NDE of welds in new construction, the graded approach is similar in B31.3 and EN 13480 (visual for lowest category, and a % of surface and volumetric examination depending on the B31.3 Fluid service and the PED Category. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

8.3 Method of examination of welds and acceptance criteria.

8.3.1 B31.3

PT or MT fillet welds.

UT or RT butt welds.

Flaws rejected (Table 341.3.2): cracks, lack of fusion, surface porosities.

Accepted within limits: Incomplete penetration, rounded indications, linear indications, undercutting, concave surface. Acceptance criteria depends on Fluid Service.

8.3.2 EN 13480

EN 13480-5 Table 8.4.2-1 provides graded acceptance criteria based on ISO 5817 (and ISO 17635 per Para.8.4.5) and service conditions as standard level, fatigue, and creep. Butt welds are volumetrically examined, fillet welds are surface examined.

8.3.3 Conclusion

Where NDE is required, ASME B31.3 and EN 13480 require volumetric NDE on butt welds and surface NDE on fillet welds. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

8.4 Allowance for spot examination.

8.4.1 B31.3

341.5 Supplementary Examination

Any of the methods of examination described in para. 344 may be specified by the engineering design to supplement the examination required by para.341.4 [mandatory NDE] …

341.5.1 Spot Radiography

(a) Longitudinal Welds. Spot radiography for longitudinal groove welds required to have a weld joint factor Ej of 0.90 requires examination by radiography in accordance with para. 344.5 of at least 300 mm (1 ft) in each 30 m (100 ft) of weld for each welder or welding operator. Acceptance criteria are those stated in Table 341.3.2 for radiography under Normal Fluid Service.

(b) Circumferential Butt Welds and Other Welds. It is recommended that the extent of examination be not less than one shot on one in each 20 welds for each welder or welding operator. Unless otherwise specified, acceptance criteria are as stated in Table 341.3.2 for radiography under Normal Fluid Service for the type of joint examined.

8.4.2 EN 13480

EN 13480-5 requires random examinations when 100% is not required.

8.4.3 Conclusion

Spot examination (random examination within a weld lot) is permitted in ASME B31.3 and EN 13480 based on the piping systems. EN 13480 mandates random examinations where “NDT is less than 100%”. Therefore, EN 13480 is stricter than B31.3 for this attribute.

8.5 Allowance for in-process examination.

8.5.1 B31.3

341.4.1 Examination — Normal Fluid Service

In-process examination in accordance with para. 344.7 may be substituted for all or part of the radiographic or ultrasonic examination on a weld-for-weld basis if specified in the engineering design or specifically authorized by the Inspector.

341.4.2 Examination — Category D Fluid Service.

(c) In-process examination in accordance with para. 344.7, supplemented by appropriate nondestructive examination, may be substituted for the examination required in (b) above on a weld-for-weld basis if specified in the engineering design or specifically authorized by the Inspector.

Not permitted for high pressure service.

342.2 Specific Requirement

For in-process examination, the examinations shall be performed by personnel other than those performing the production work.

8.5.2 EN 13480

EN 13480-5 Para.7.3.3 requires testing and inspection during welding in all cases.

8.5.3 Conclusion

EN 13480 is more exacting.

8.6 Allowances for weld non-conformance, progressive sampling, and weld repairs.

8.6.1 B31.3

341.3.4 Progressive Sampling for Examination. When required spot examination or random examination of a designated lot reveals a defect, additional joints shall be examined using any method and applicable acceptance criteria that meet the requirements for the original examination. These joints shall be from the same designated lot, and shall be the work of the same welder, brazer, bonder, or operator.

Two additional joints, twice, then all welds from the lot to be examined.

8.6.2 EN 13480

Para.8.1.3 addresses additional weld inspections where imperfections are identified. They are identical to B31.3, i.e., taking two additional welds for every failed weld, and allowing this to be repeated twice.

8.6.3 Conclusion

ASME B31.3 and EN 13480 require identical progressive NDE sampling where flaws are discovered. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

8.7 Extent and percent of examinations of mechanical joints

8.7.1 B31.3

Paragraph 341.4.1 applies with the following exceptions:

(a) Visual Examination

(1) All fabrication shall be examined.

(2) All threaded, bolted, and other mechanical joints shall be examined.

8.7.2 EN 13480

EN 1348 Para.8.4.4.1 addresses visual inspection and includes “other methods of joining”, i.e., other than welding.

8.7.3 Conclusion

ASME B31.3 and EN 13480 require visual examination of mechanical joints. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

8.8 Method of examination of mechanical joints and acceptance criteria.

8.8.1 B31.3

Acceptance criteria for mechanical joints is not addressed.

8.8.2 EN 13480

Acceptance criteria for mechanical joints is not addressed.

8.8.3 Conclusion

Neither ASME B31.3 nor EN 13480 address acceptance criteria for the visual inspection of mechanical joints. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

9 Key Attributes for Testing

Quality controls in the form of pressure or leak testing are specified in the construction Codes and supplemented by the owner-operator's equipment-specific requirements.

Functional testing (testing of flow rates, pressure drops, temperatures, chemical reactions, etc.) is specified by the owner-operator.

The key attributes for testing are:

9.1 Pressure testing requirements.

9.1.1 B31.3

345.1 Required Leak Test

Prior to initial operation, and after completion of the applicable examinations required by para. 341, each piping system shall be tested to ensure tightness. The test shall be a hydrostatic leak test in accordance with para. 345.4 except as provided herein.

Hydrotest or pneumatic test for all piping except Cat. D.

Sensitive leak test permitted in certain cases.

9.1.2 EN 13480

EN 13480-5 requires "proof test" in the form of hydrostatic or pneumatic test, in all cases, without the B31.3 exception for Cat. D fluid service. Para.9.3.4 permits substitution of NDE for proof testing on an individual weld basis.

9.1.3 Conclusion

EN 13480 is more restrictive.

9.2 Test method, duration, pressure, procedure.

9.2.1 B31.3

Hydrotest at 1.5 P (S_{test}/S_{hot}) or pneumatic test at 1.10 P.

345.2.1 Limitations on Pressure

(a) Reduced Test Pressure. If the test pressure would produce a circumferential or longitudinal stress (based on minimum pipe wall thickness) in excess of yield strength at test temperature or is greater than 1.5 times the component rating at test temperature, the test pressure may be reduced to the maximum pressure that will not exceed the lesser of the yield strength or 1.5 times a component rating at test temperature.

345.2.2 Other Test Requirements

(a) Examination for Leaks. The leak test pressure shall be maintained for at least 10 min and then all joints and connections shall be examined for leaks. The test pressure may be reduced to not less than the design pressure while performing this examination.

9.2.2 EN 13480

The EN 13480-5 hydrotest pressure is the greater of 1.25 P (S_{test}/S_{hot}) or 1.43 P; and the pneumatic test at 1.1 P or P (S_{test}/S_{hot}).

9.2.3 Conclusion

Depending on the ratio S_{test}/S_{hot} the hydrotest pressure in EN 13480 may be lower by 1.5/1.25 or 1.5/1.43 than that of B31.3. Note that the ASME VIII Div.1 UG-99 hydrotest pressure is 1.3 × MAWP ×

(S_{amb}/S_{hot}) which is similar to EN 13480 1.25 P (S_{test}/S_{hot}) and may be less than EN 13480 1.43 P. Both pressure tests will achieve the same objective of detecting leaking joints.

9.3 Acceptance criteria for pressure test.

9.3.1 B31.3

345.2.2 Other Test Requirements

(a) Examination for Leaks. The leak test pressure shall be maintained for at least 10 min and then all joints and connections shall be examined for leaks. The test pressure may be reduced to not less than the design pressure while performing this examination.

No mention of how to detect leak in a pneumatic test (e.g., bubble solution at each joint).

9.3.2 EN 13480

Para.9.3.2.2.3 refers to lack of leakage and no visible plastic deformation as acceptance criteria for the hydrotest. No criteria for pneumatic testing.

The hold time is 30 minutes per Para.9.3.2.22.

9.3.3 Conclusion

EN 13480 requires a longer holding time during the hydrotest. In ASME B31.3 and EN 13480 the acceptance criterion is lack of leakage. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

9.4 Testing of externally pressured piping.

9.4.1 B31.3

345.2.4 Externally Pressured Piping

(a) Except as provided in (b) below, piping systems subject to external pressure shall be tested at an internal gage pressure 1.5 times the external differential pressure, but not less than 105 kPa (15 psi).

(b) As an alternative to leak testing under internal pressure, piping systems designed for vacuum service only may be subjected to a vacuum leak test method …

9.4.2 EN 13480

Pressure testing of externally pressured components is not addressed.

9.4.3 Conclusion

ASME B31.3 addresses pressure testing of newly constructed piping systems operating at negative pressure. EN 13480 does not.

Suggestion: For systems operating at negative pressure, down to full vacuum, the user must verify that the system has been pressure tested in accordance with the provisions of ASME B31.3 for external pressured piping Para.345.2.4.

9.5 Sensitive leak testing allowance.

9.5.1 B31.3

345.1 Required Leak Test

(c) Where the owner considers both hydrostatic and pneumatic leak testing impracticable, the alternative specified in para. 345.9 may be used [sensitive leak test] …

9.5.2 EN 13480

No allowance for a sensitive leak test option.

9.5.3 Conclusion

EN 13480 stricter in requiring a pressure test (hydro or pneumatic) and not permitting a sensitive leak test option.

9.6 Allowance to repair leaks.

9.6.1 B31.3

345.2.6 Repairs or Additions After Leak Testing. If repairs or additions are made following the leak test, the affected piping shall be retested, except that for minor repairs or additions the owner may waive retest requirements when precautionary measures are taken to assure sound construction.

9.6.2 EN 13480

EN 13480 Para.9.3.2.1.10 requires re-hydro after a repair "… unless otherwise agreed.".

9.6.3 Conclusion

Equivalent. Both codes are vague, B31.3 refers to "minor repairs" and EN 13480 refers to "unless otherwise agreed". Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

9.7 In-shop testing, subassembly testing, and installed testing.

9.7.1 B31.3

345.1 Required Leak Test

Prior to initial operation, and after completion of the applicable examinations required by para. 341, each piping system shall be tested to ensure tightness … Test can be in the shop or in the field.

9.7.2 EN 13480

EN 13480-5 Para.9.3 does not specify the timing of the test.

9.7.3 Conclusion

ASME B31.3 permits testing either in the field or in the shop, while EN 13480 is not explicit but it can only be in the field or in the shop. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

9.8 Testing of double-wall piping.

9.8.1 B31.3

345.2.5 Jacketed Piping

(a) The internal line shall be leak tested on the basis of the internal or external design pressure, whichever results in a higher test pressure. This test must be performed before the jacket is completed if it is necessary to provide visual access to joints of the internal line as required by para. 345.3.1.

(b) The jacket shall be leak tested in accordance with para. 345.1 based on the jacket design conditions. The test pressure is permitted to be lower when so specified in the engineering design.

9.8.2 EN 13480

EN 13480-5 does not address testing of jacketed (double wall) piping.

9.8.3 Conclusion

B31.3 is more explicit. In practice, the manufacturer develops a leak test for the inner pipe and the annular space between the inner and outer pipe.

Suggestion: For double-wall piping (jacketed piping), the user should verify that the inner pipe (the carrier or core pipe) and the outer pipe (the containment or jacket pipe) have been pressure tested in accordance with ASME B31.3 Para.345.2.5.

9.9 Responsibility for functional testing.

9.9.1 B31.3

Not addressed.

9.9.2 EN 13480

EN 13480-5 Table 9.4-1 lists the documentation to be assembled “for the purchaser”, the Table lists “pressure test or equivalent test documents” but does not list functional testing.

9.9.3 Conclusion

Functional testing is not addressed in B31.3 nor EN 13480, which is consistent with the fact that these Codes are pressure boundary integrity codes, not functional codes. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

9.10 Cleaning, drying, isolating, storing after testing.

9.10.1 B31.3

335.9 Cleaning of Piping

This Code does not prescribe mandatory procedures for flushing and cleaning. However, for potential hazards that may result from performing such procedures refer to Appendix F, para. F335.9 for precautionary considerations.

9.10.2 EN 13480

EN 13480-4 para.9.6 addresses cleaning before welding; Para.12.1 addresses cleaning in general (standard for cleaning is to be specified); and Annex A for stainless steel.

9.10.3 Conclusion

ASME B31.3 and EN 13480 mention cleaning without providing much guidance. Cleaning is generally a requirement from the user to the manufacturer. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

10 Key Attributes for Over-Pressure Protection

Over-pressure protection consists of the engineering analyses of the potential causes of over-pressure in the vessel or piping system, and the means to prevent the over-pressure, either by the selection, sizing, and installation of pressure relieving devices, or by system design, i.e., the use of instruments, controls, or alarms.

The key attributes of over-pressure protection are:

10.1 Over-pressure protection.

10.1.1 B31.3

301.2.2 Required Pressure Containment or Relief
"(a) Provision shall be made to safely contain or relieve (see para. 322.6.3) any expected pressure to which the piping may be subjected. Piping not protected by a pressure-relieving device, or that can be isolated from a pressure-relieving device, shall be designed for at least the highest expected pressure. 301.2.2 (b) Sources of pressure to be considered include ambient influences, pressure oscillations and surges, improper operation, decomposition of unstable fluids, static head, and failure of control devices."

10.1.2 EN 13480

Sources of over-pressure are addressed in EN 13480 Para.4.2.3. While not addressed in EN 13480, the PED directive permits over-pressure protection by system design. In accordance with the PED: *"Where, under reasonably foreseeable conditions, the allowable limits could be exceeded, the pressure equipment shall be fitted with, or provision made for the fitting of, suitable protective devices, unless the equipment is intended to be protected by other protective devices within an assembly.*

The suitable device or combination of such devices shall be determined on the basis of the particular characteristics of the equipment or assembly. Suitable protective devices and combinations thereof comprise:

(a) safety accessories as defined in point 4 of Article 2,

(b) where appropriate, adequate monitoring devices such as indicators and/or alarms which enable adequate action to be taken either automatically or manually to keep the pressure equipment within the allowable limits."

10.1.3 Conclusion

Over-pressure is to be addressed in B31.3 and EN 13480, but neither Code specifies what constitute credible over-pressure scenarios. ASME B31.3 301.2.2(a) is explicit to permit over-pressure protection by system design (see Over-Pressure Protection, below). The user should be knowledgeable of the transients considered and means provided to limit over-pressure.

Suggestion: The user must request an over-pressure protection report from the supplier, which specifies the method to evaluate over-pressure, and the pressure transient events considered. In addition, the user must verify equivalency of EN to ASME VIII/XIII EN in sizing and set pressure tolerance of rupture discs.

10.2 Permitted amount of over-pressure prior and during relief.

10.2.1 B31.3

301.2.2 Required Pressure Containment or Relief
301.2.2 (c) The allowances of para. 302.2.4(f) are permitted, provided that the other requirements of para. 302.2.4 are also met.

322.6.3 (b) Relief set pressure shall be in accordance with Section VIII, Division 1, with the exceptions stated in alternatives (1) and (2), below.
(1) With the owner's approval, the set pressure may exceed the limits in Section VIII, Division 1, provided that the limit on maximum relieving pressure stated in (c) below will not be exceeded.
(2) For a liquid thermal expansion relief device that protects only a blocked-in portion of a piping system, the set pressure shall not exceed the lesser of the system test pressure or 120% of design pressure.
(c) The maximum relieving pressure shall be in accordance with Section VIII, Division 1, with the exception that the allowances in para. 302.2.4(f) are permitted [*(-a)* 33% for no more than 10 h at any one time and no more than 100 h/y, or *(-b)* 20% for no more than 50 h at any one time and no more than 500 h/y*, provided that all other requirements of para. 302.2.4 are also met.*]

10.2.2 EN 13480

EN 13480-3 Para.4.2.3.3 permits a 10% over-pressure allowance for less than 10% of any 24 hour operating period.

10.2.3 Conclusion

EN 13480 is more restrictive because it only permits a 10% over-pressure allowance, while B31.3 permits larger over-pressure allowances.

11 Key Attributes for Inspections and Certifications

Inspections refer to the quality control and quality assurance activities by a third party, an Authorized Inspector, to verify that the construction and its documentation meet the construction Code.

Certification refers to the application of the construction Code mark (stamp), such as “U” for ASME VIII Div.1 vessels, or “CE” for EN-13480 piping and EN-13445 for vessels. For piping systems, ASME B31.3 does not have a certification mark (no stamping), while the European Code will require the CE certification depending on the piping system category.

The key attributes of inspection and certification are:

11.1 Requirement for formal Quality Control and Quality Assurance programs.

11.1.1 B31.3

APPENDIX Q
QUALITY SYSTEM PROGRAM
[This Appendix is a Code requirement only when specified by the owner in accordance with para. 300(b)(1).]
Design and construction of piping in accordance with this Code shall be performed under a Quality System Program following the principles of an appropriate standard such as the ISO 9000 series.1 The details describing the quality system shall be documented and shall be available upon request. A determination of the need for registration and/or certification of the quality system program shall be the responsibility of the owner.

11.1.2 EN 13480

EN 13480-7 addresses the quality program for piping systems and pipelines. The quality program is graded into various *conformity assessment modules* on the basis of the *Piping Category*, from I (lowest) to III (highest), per EN 13480-7 Tables A.1, B.1, and B.2; and PED/2014/68/EU Annex II.

The *conformity assessment procedure* is the responsibility of:

- “M” i.e., actions performed by the manufacturer/installer without monitoring and approval by a responsible authority (a European “Notified Body”; or a “user inspectorate”), for Category I.
- “M/RA” i.e., actions performed by the fabricator/installer with monitoring by the responsible authority (a European “Notified Body”; or a “user inspectorate”) to “ensure the requirements of the PED [Pressure Equipment Directive] are met” (EN 13480-7 Para.4.2.3) for Category III and in part Category II.

- Assignment of Notified Bodies are addressed in PED 2014/68/EU Chapter 4 Article 24: Independent from the organization it assesses.

- Assignment of User Inspectorates are addressed in PED 2014/68/EU Chapter 4 Article 25: Organizationally identifiable as being impartial.

Note: The Notified Body and the user inspectorate are contracted by the manufacturer.

The CE marking cannot be affixed if the conformity assessment body is a user inspectorate rather than a Notified Body (PED 2014/68/EU Article 16 close (2)).

The conformity assessment procedure is applied “*with a view to affixing the CE marking*”. Conformity is in the form of:

- A declaration of conformity by “M” pr “M/RA”.

- A certificate of conformity by “M” or “M/RA”.
- Marking.

However, conformity to the PED only applies to “piping systems which are to be *installed in an EU Member State*” (EN 13480-7 Para.4.2). It may not apply to piping systems shipped to and installed in the US.

11.1.3 Conclusion

EN 13480 exceeds B31.3 regarding quality assurance, for piping systems installed in an EU Member State. B31.3 has no requirement for monitoring and approval by a third party “responsible organization” (an authorized third party), while EN 13480-7 does for category III (highest) and in part for Category II.

11.2 Requirement for an independent inspector, and exceptions if any.

11.2.1 B31.3

Unlike ASME VIII for pressure vessels, ASME B31.3 for process piping does not require a third-party authorized inspection agency. Instead, the Owner assigns an Owner Inspector to verify that B31.3 is implemented correctly.

300 GENERAL STATEMENTS (4) Owner’s Inspector. The owner’s Inspector (see para. 340) is responsible to the owner for ensuring that the requirements of this Code for inspection, examination, and testing are met. If a Quality System is specified by the owner to be employed, the owner’s Inspector is responsible for verifying that it is implemented.

340.4 Qualifications of the Owner’s Inspector
(a) The owner’s Inspector shall be designated by the owner and shall be the owner, an employee of the owner, an employee of an engineering or scientific organization, or the employee of a recognized insurance or inspection company acting as the owner’s agent. The owner’s Inspector shall not represent nor be an employee of the piping manufacturer, fabricator, or erector unless the owner is also the manufacturer, fabricator, or erector.

11.2.2 EN 13480

A Notified Body is an organization designated by an EU Member State (or by other countries under specific agreements) to assess the conformity of certain products before being placed on the market.

These bodies are entitled to carry out tasks related to conformity assessment procedures set out in the applicable legislation when the intervention of a third party is required.

The Commission publishes a list of such notified bodies in the NANDO information system.

11.2.3 Conclusion

EN 13480-7 exceeds B31.3 since it requires an organization designated by the EU Member State to verify Code compliance rather than B31.3’s Owner inspector selected by the owner.

11.3 Responsibilities of the Third-Party Inspector

11.3.1 B31.3

300 GENERAL STATEMENTS (4) Owner’s Inspector. The owner’s Inspector (see para. 340) is responsible to the owner for ensuring that the requirements of this Code for inspection, examination, and testing are met. If a Quality System is specified by the owner to be employed, the owner’s Inspector is responsible for verifying that it is implemented.

340.2 Responsibility for Inspection
It is the owner’s responsibility, exercised through the owner’s Inspector, to verify that all required examinations and testing have been completed and to inspect the piping to the extent necessary to be

satisfied that it conforms to all applicable examination requirements of the Code and of the engineering design.

11.3.2 EN 13480

The extent of Third-Party review by an inspector is specified in the PED and in EN 13480-7 “Metallic industrial piping – Part 7: Guidance on the use of conformity assessment procedures”. The conformity assessment procedures to be applied to an item or pressure equipment with a view to affixing the CE marking shall be determined by the category in which the equipment is classified. The conformity assessment procedure is explained in tabular form in EN 13480-7.

Notified bodies are nationally accredited bodies that are designated by EU countries (in accordance with ISO/IEC 17021 “Conformity assessment - Requirements for bodies providing audit and certification of management systems” and 17065 “Conformity assessment - Requirements for bodies certifying products, processes and services”) to carry out conformity assessment procedures when a third party is required.

Notified Bodies are independent bodies that manufacturers must apply to for assessment to verify compliance with pressure equipment directive (PED). The assessments consider factors such as the technical complexity of the equipment and production volume. The Notified Body's final assessment is the basis for the manufacturer's CE marking and declaration of conformity.

11.3.3 Conclusion

The responsibilities of the Notified Body apply to all aspects of materials, design, and fabrication; which is broader than the scope of the B31.3 Owner’s Inspector (as written in Para.340.2 and applied in practice) which is focused on fabrication.

11.4 Qualifications and independence of the Third-Party Inspector.

11.4.1 B31.3

340.4 Qualifications of the Owner’s Inspector
… (b) The owner’s Inspector shall meet one of the following requirements:
(1) have at least 10 yr of experience in the design, fabrication, or examination of industrial pressure piping. Each 20% of satisfactorily completed work toward an accredited engineering degree shall be considered equivalent to 1 yr of experience, up to 5 yr total.
(2) have a professional engineering registration or nationally recognized equivalent with at least 5 yr of experience in the design, fabrication, or examination of industrial pressure piping.
(3) be a certified welding inspector or a senior certified welding inspector as defined in AWS QC1, Specification for AWS Certification of Welding Inspectors, or nationally recognized equivalent with at least 5 yr of experience in the design, fabrication, or examination of industrial pressure piping.
(4) be an authorized piping inspector as defined in API 570, Piping Inspection Code: In-service Inspection, Rating, Repair, and Alteration of Piping Systems, with at least 5 yr of experience in the design, fabrication, or examination of industrial pressure piping.
(c) In delegating performance of inspection, the owner’s Inspector is responsible for determining that a person to whom an inspection function is delegated is qualified to perform that function.

The Owner inspector is assigned by the owner and can be an employee of the owner.

11.4.2 EN 13480

Conformity assessment notified bodies, are notified by the Member States to the Commission (PED 2014/68/EY Close (40)), with an accreditation system per PED 2014/68/EU complemented by Regulation (EC) No. 765/2008 (PED Close (43)). They are not employed by the owner.

The qualifications of personnel responsible for carrying out assessment tasks are listed in PED 2014/68/EU Articles 24 and 25, Para.7.

PED 2014/68/EU Article 33 provides for the Commission to investigate cases regarding the "competence of a Notified Body", and an appeals process (Article 35).

11.4.3 Conclusion

EN 13480 through PED 2914/68/EU exceeds the B31.3 provisions on third party qualifications and independence.

11.5 Allowance for self-certification of inspections.

11.5.1 B31.3

340.4 Qualifications of the Owner's Inspector

(a) The owner's Inspector shall be designated by the owner and shall be the owner, an employee of the owner, an employee of an engineering or scientific organization, or the employee of a recognized insurance or inspection company acting as the owner's agent. The owner's Inspector shall not represent nor be an employee of the piping manufacturer, fabricator, or erector unless the owner is also the manufacturer, fabricator, or erector.

11.5.2 EN 13480

PED 2014/68/EU does not permit self-certification by the owner or the manufacturer.

11.5.3 Conclusion

PED 2014/68/EU is stricter than B31.3.

11.6 Qualifications and audits of material supplier.

11.6.1 B31.3

Not explicitly required.

See Quality Assurance Appendix Q described in Section 5.

11.6.2 EN 13480

EN 13480-7 Para.4 requires that conformity assessment be performed on piping systems by a Responsible Authority (e.g. Notified Body) with a view to affixing the CE marking.

11.6.3 Conclusion

EN 13480 is stricter than B31.3 which does not require conformity assessment or stamping for piping systems.

11.7 Qualifications and audits of designer.

11.7.1 B31.3

301.1 Qualifications of the Designer

The Designer is the person(s) in charge of the engineering design of a piping system and shall be experienced in the use of this Code. The qualifications and experience required of the Designer will depend on the complexity and criticality of the system and the nature of the individual's experience. The owner's approval is required if the individual does not meet at least one of the following criteria:

(a) Completion of a degree, accredited by an independent agency [such as ABET (U.S. and international), NBA (India), CTI (France), and CNAP (Chile)], in engineering, science, or technology, requiring the equivalent of at least 4 yr of full-time study that provides exposure to fundamental subject matter relevant to the design of piping systems, plus a minimum of 5 yr of experience in the design of related pressure piping.

(b) Professional Engineering registration, recognized by the local jurisdiction, and experience in the design of related pressure piping.
(c) Completion of an accredited engineering technician or associates degree, requiring the equivalent of at least 2 yr of study, plus a minimum of 10 yr of experience in the design of related pressure piping.
(d) Fifteen yr of experience in the design of related pressure piping.
Experience in the design of related pressure piping is satisfied by piping design experience that includes design calculations for pressure, sustained and occasional loads, and piping flexibility.

11.7.2 EN 13480
EN 13480 does not contain minimum educational or experience requirements of the designer.

11.7.3 Conclusion
The technical quality of the design calculations, analyses, and layout are controlled by the design company's quality assurance program. While education and experience are not specified in EN 13480, the independent third party review by the Notified Body palliates this shortcoming.

11.8 Qualifications and audits of fabricator.
11.8.1 B31.3
Not explicitly required, except for welding.

328.1 Responsibility

Each employer is responsible for

(a) the welding and brazing performed by personnel of its organization

(b) conducting the qualification tests required to qualify the welding or brazing procedure specifications used by personnel in its organization, except as provided in paras. 328.2.1 and 328.2.2

(c) conducting the qualification tests required to qualify the welders, brazers, and operators, except as provided in para. 328.2.3

11.8.2 EN 13480
EN 13480-4 Para.9 outlines the qualification requirements for WPSs and welders. The welders are qualified by the organization employing the welder.

11.8.3 Conclusion
EN 13480 and B31.3 are equivalent as they place the responsibility on the organization that employs the welder.

11.9 Responsibilities of the Owner, the designer, the fabricator.
11.9.1 B31.3
300 GENERAL STATEMENTS

(b) Responsibilities

(1) Owner …

(2) Designer …

(3) Manufacturer, Fabricator, and Erector …

(4) Owner's Inspector …

11.9.2 EN 13480

EN 13480-1 Para.3.1.4 makes the manufacturer responsible for the design and fabrication of the piping system; and conformance to the PED (Para.3.1.5).

11.9.3 Conclusion

In ASME B31.3 and EN 13480, the final responsibility for compliance with the Code rests with the manufacturer. In the case of EN 13480, the manufacturer will affix the CE mark after approval by the Notified Body. In the case of ASME B31.3 there is no ASME mark to affix to the piping system, and no formal review by an Authorized Inspector, os it is up to the owner to verify compliance with the Code and the engineering design. EN 13480, because it requires stamping and Notified Body review is stricter.

11.10 Authorized Inspectors and Notified Body responsibilities and independence.

11.10.1 B31.3

No third-party Authorized Inspector is required in B31.3. Only the Owner Inspector.

11.10.2 EN 13480

EN 13480-7 Para.4 requires that conformity assessment be performed on piping systems by a Responsible Authority (e.g. Notified Body) with a view to affixing the CE marking.

11.10.3 Conclusion

EN 13480 is stricter than B31.3 which does not require conformity assessment or stamping for piping systems.

11.11 Materials records.

11.11.1 B31.3

346.2 Responsibility

It is the responsibility of the piping designer, the manufacturer, the fabricator, and the erector, as applicable, to prepare the records required by this Code and by the engineering design.

11.11.2 EN 13480

EN 13480-1 Para.3.1.4 makes the manufacturer responsible for the fabrication (and therefore records) of the piping system; and conformance to the PED (Para.3.1.5).

11.11.3 Conclusion

ASME B31.3 and EN 13480 place the responsibility for material records with the contracted fabricator/erector. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

11.12 Design records, including drawings.

11.12.1 B31.3

346.2 Responsibility

It is the responsibility of the piping designer, the manufacturer, the fabricator, and the erector, as applicable, to prepare the records required by this Code and by the engineering design.

11.12.2 EN 13480

EN 13480-1 Para.3.1.4 makes the manufacturer responsible for the fabrication (and therefore records) of the piping system; and conformance to the PED (Para.3.1.5).

11.12.3 Conclusion

ASME B31.3 and EN 13480 place the responsibility for design records with the contracted designer and fabricator/erector. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

11.13 Fabrication records.

11.13.1 B31.3

328.2.4 Qualification Records. The employer shall maintain copies of the procedure and performance qualification records specified by ASME BPVC, Section IX that shall be available to the Inspector at the location where welding is being done.

340.3 Rights of the Owner's Inspector

The owner's Inspector … shall have the right … to review all certifications and records necessary to satisfy the owner's responsibility stated in para. 340.2.

346.2 Responsibility

It is the responsibility of the piping designer, the manufacturer, the fabricator, and the erector, as applicable, to prepare the records required by this Code and by the engineering design.

11.13.2 EN 13480

PED 2014/68/EU Annex III sets the manufacturer's documentation responsibilities, and the Notified Body review responsibilities for design, examination, testing, declaration of conformity, and marking.

11.13.3 Conclusion

ASME B31.3 and EN 13480 place the responsibility for fabrication records with the contracted fabricator/erector. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

11.14 Examination records.

11.14.1 B31.3

341.2 Responsibility for Examination

Inspection does not relieve the manufacturer, the fabricator, or the erector of the responsibility for … (c) preparing suitable records of examinations and tests for the Inspector's use.

341.4.1 Examination — Normal Fluid Service

(c) Certifications and Records. The examiner shall be assured, by examination of certifications, records, and other evidence, that the materials and components are of the specified grades and that they have received required heat treatment, examination, and testing. The examiner shall provide the Inspector with a certification that all the quality control requirements of the Code and of the engineering design have been carried out.

11.14.2 EN 13480

See fabrication records in attribute 11.13.

11.14.3 Conclusion

ASME B31.3 and EN 13480 place the responsibility for examination records with the contracted fabricator/erector. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

11.15 Test records.

11.15.1 B31.3

345.2.7 Test Records. Records shall be made of each piping system during the testing, including (a) date of test; (b) identification of piping system tested; (c) test fluid; (d) test pressure; (e) certification of results by examiner.

These records need not be retained after completion of the test if a certification by the Inspector that the piping has satisfactorily passed pressure testing as required by this Code is retained.

346.2 Responsibility

It is the responsibility of the piping designer, the manufacturer, the fabricator, and the erector, as applicable, to prepare the records required by this Code and by the engineering design.

11.15.2 EN 13480
See fabrication records in attribute 11.13.

11.15.3 Conclusion
ASME B31.3 and EN 13480 place the responsibility for test records with the contracted fabricator/erector. Therefore, ASME B31.3 and EN 13480 are equivalent for this attribute.

11.16 Over-pressure protection report.
11.16.1 B31.3
Not explicitly required.

11.16.2 EN 13480
Not explicitly required.

11.16.3 Conclusion
B31.3 and EN 13480 do not require over-pressure protection reports therefore they are equivalent for this attribute.

11.17 Approval and certification of records.
11.17.1 B31.3
No third-party Authorized Inspector. The Owner is responsible for approving the records.

See B31.3 Appendix Q for QA program described in Section 5.

11.17.2 EN 13480
In PED 2014/68/EU, the Notified Body or user inspectorate must approve records and authorize the CE stamping.

11.17.3 Conclusion
PED 2014/68/EU is more stringent than B31.3.

11.18 Retention of records.
11.18.1 B31.3
346 RECORDS

346.2 Responsibility

It is the responsibility of the piping designer, the manufacturer, the fabricator, and the erector, as applicable, to prepare the records required by this Code and by the engineering design.

346.3 Retention of Records

Unless otherwise specified by the engineering design, the following records shall be retained for at least 5 yr after the record is generated for the project:

(a) examination procedures

(b) examination personnel qualifications

(c) examination reports

11.18.2 EN 13480
See fabrication records in attribute 11.13.

PED 2014/68/EU Chapter 2 Article 6 Para.3 requires retention of records for 10 years.

11.18.3 Conclusion
PED 2014/68/EU is more stringent than B31.3.

11.19 Stamping or other physical evidence of compliance.
11.19.1 B31.3
No stamping is required in B31.3.

11.19.2 EN 13480
CE marking is required for the higher PED Categories of piping systems (Categories II and III), PED 2014/68/EU Article 6 Para.2.

11.19.3 Conclusion
PED 2014/68/EU is more stringent than B31.3.

12 Record or Revisions

Rev.	Date	Description
8/8/2024	8/8/2024	Initial issue.
8/12/2024	8/12/2024	Introduction edited to align with PRE-L-03 comparing the pressure vessel Codes ASME VIII and EN 13445.