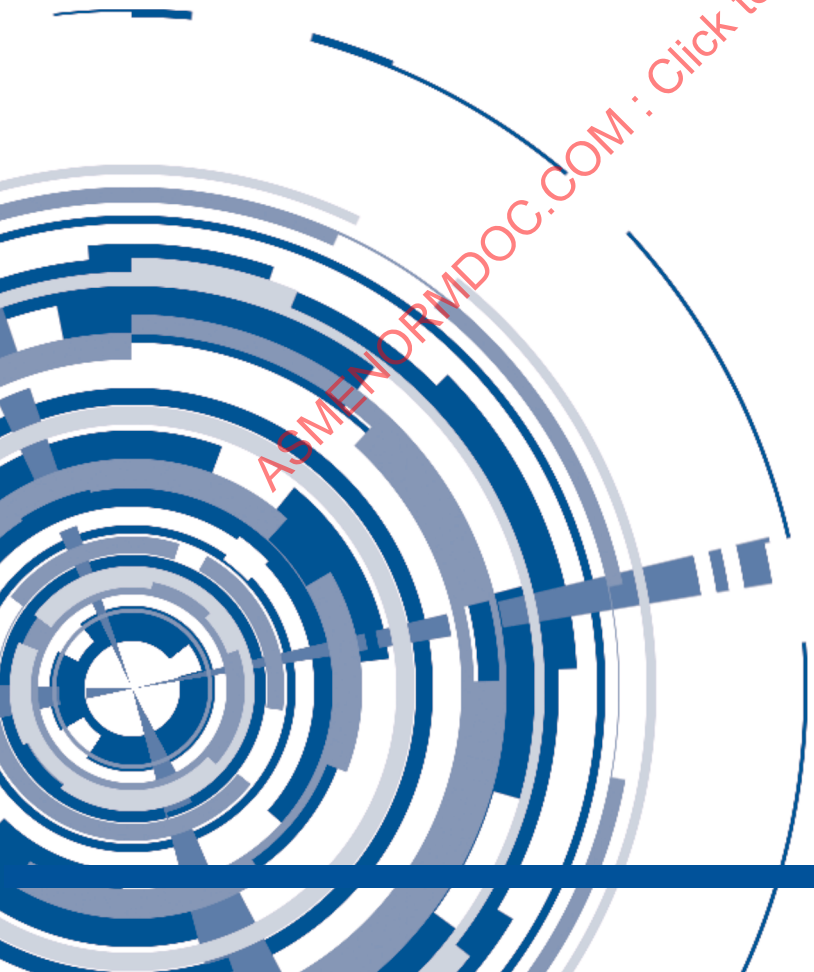
ASME PTB-11-2017

Guide for ASME BPVC Section I Stamp Holders



ASME
SETTING THE STANDARD

PTB-11-2017

GUIDE FOR ASME BPVC SECTION I STAMP HOLDERS

USE OF ASME SECTION I TO MEET THE EC PRESSURE EQUIPMENT DIRECTIVE (2014/68/EU)

Prepared by:

Elmar Upitis
Ambitech Engineering Corporation

ASME
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The American Society of Mechanical Engineers
Two Park Avenue, New York, NY 10016-5990

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FOREWORD

This Guide is a comprehensive review of the Pressure Equipment Directive (PED) and ASME Boiler and Pressure Vessel Code (BPVC), Section I. ASME has received requests from all over the world to provide guidance to manufacturers who have been or will be impacted by the European PED. This document provides that guidance. Manufacturers of ASME BPVC, Section I Power Boilers will find this document to be a useful tool when working with a notified body toward compliance with the PED and applying the Conformité Européene (CE) mark to their products.

This document begins with an explanation of the European New Approach and continues with the goals of the PED and a description of its scope of coverage. Then, the document offers an in-depth analysis of the PED concept of hazard categories and the various combinations of Conformity Assessment (CA) modules that can be used for each hazard category. Each of the PED Essential Safety Requirements (ESR) are then covered, including materials, use of Notified Bodies, and requirements for CE marking.

The reader is presented next with a detailed comparison of the PED with ASME Section I, followed by a modified version of Annex Z for ASME Section I. This Annex Z provides instructions regarding what additional tasks must be completed to meet the administrative requirements of the PED.

The author and ASME ST-LLC acknowledges, with deep appreciation, the contributions of Stuart Cameron, Alan Nywening, Anne Chaudouet of CETIM, France, the comments provided by Peter Hanmore, Consultant in the United Kingdom, Matteo Convento, the PED Notified Body in the UK, the ASME Pressure Technology Book (PTB) peer review group, and Luis Pulgarin of the ASME ST-LLC staff in preparing this PED Guide.

Established in 1880, ASME is a professional not-for-profit organization with more than 135,000 members and volunteers promoting the art, science, and practice of mechanical and multidisciplinary engineering and allied sciences. ASME develops codes and standards that enhance public safety, and provides lifelong learning and technical exchange opportunities benefiting the engineering and technology community. Visit www.asme.org for more information.

1 INTRODUCTION

When the European Commission (EC) PED 97/23/CE was adopted in May 1997, it became clear that pressure equipment designed and built to standards other than European standards could carry the "CE" marking. This was made possible by the European approach, in which Essential Safety Requirements (ESR) are established in the Directives, and standards are used to support them. The PED 97/23/CE has now been aligned with the new legislative framework and replaced by Directive 2014/68/EU, issued 15 May 2014. The new PED shall be applied no later than July 19, 2016, except that Article 13 shall be applied from June 1, 2015.

The purpose of this ASME PED Guide is to provide analysis of the PED and compare its ESR with the design, construction, and administrative requirements of ASME BPVC Section I. The first portion of the PED Guide consists of Chapters I through XI, which gives an overview of the PED, provides important basic information on the entire Directive, and identifies specific issues of higher importance. The next major portion is Chapters XII and XIII, which provide a comparison of the PED and ASME BPVC Section I requirements, including commentary on both the PED ESRs (Annex I) and ASME BPVC Section I. Chapter XIII provides ASME BPVC Section I Code users with additional considerations on how to augment their current practices to meet all ESRs of the PED.

It is the intent that this Guide will form the basis for an understanding between manufacturers and Notified Bodies (NB) regarding the use of ASME BPVC Section I as the basis for compliance with the PED. Having such a uniform approach will benefit not only manufacturers and NBs, but also users of pressure equipment.

Several PED Information Resource Center websites provide the latest information on the status of European approval of materials, names, contact information for all NBs, and other valuable news and developments. These are:

- http://ec.europa.eu/enterprise/sectors/pressure-and-gas/documents/ped/index_en.htm
- http://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/pressure-equipment/index_en.htm
- http://ec.europa.eu/enterprise/newapproach/nando/index.cfm?fuseaction=directive.notifiedbody&dir_id=19

2 THE EUROPEAN CONTEXT

2.1 Main Concepts of New Directives

(a) Before 1985, there were very few European Directives. They had to contain all technical requirements and had to be applied unanimously.

(b) In 1985, a *New Approach to Technical Harmonization and Standards* was established. The main objectives were to:

(1) Remove technical barriers to trade to permit free movement of goods throughout the European Union (EU).

(2) Implement common regulations and common standards throughout the EU.

(c) The fundamental principles of the *New Directives* are as follows.

(1) Directives are fully mandatory throughout the EU and supersede national regulations.

(2) Directives contain only ESR BPVC, which are defined in terms of general safety objectives to enforce a common high level of protection in the EU regarding the hazards inherent to the product. Only harmonized standards provide the presumption of conformity. There are numerous European standards that do not.

(3) EN-Standards will be explicit and quantify ESR to achieve these safety objectives. Use of these EN-Standards is not mandatory, but products complying with these standards are presumed to comply with the ESR of the Directive.

(4) Each Directive sets out CA Procedures to ensure that the product complies with all the requirements of the Directive. These procedures are selected from the European Council Decision No. 768/2008/EC of July 9, 2008 and are adapted to the products covered by each Directive.

(5) Each product covered by a Directive must be in full conformity with its specifications and must be CE marked, which will ensure free movement throughout the EU.

(6) A product may be subject to several Directives. The placing on the market and putting into service can only take place when the product complies with the provisions of all applicable directives. Additional comments on Simultaneous Application of European Directives are provided in Appendix I of this Guide.

2.2 Terms Used in European Directives

Appendix A in this Guide gives a definition of the main terms used in the Directives, and especially in the PED. These terms are identified in this Guide by an initial capital letter (Notified Body, Marking, etc.).

3 PED OVERVIEW

3.1 Introduction

3.1.1 General

Pressure components present inherent hazards due to the potential energy of their content, especially for gas. As a consequence, most industrial countries have regulated these products for many decades.

This is the case with the European countries that have developed national regulations, which often vary significantly. Some are very detailed (as in France), others contain only very general requirements (as in the UK), and some others have developed very detailed CA Procedures for Pressure Equipment (as in Germany). This profusion of different regulations leads to technical barriers to trade. In 1989 the EU decided to establish a PED to eliminate these problems.

3.1.2 Intent

The PED has three intents:

(a) Adopt a common regulation for Pressure Equipment throughout EU.
(b) Eliminate the technical barriers to trade for this industrial sector and permit free movement of products throughout the EU.
(c) Ensure a high level of safety for Pressure Equipment throughout the EU.

The third intent is the most important in that the PED has been built on this concept of safety level with the implementation of four Hazard Categories. Therefore, the PED is more a hazard-oriented than a product-oriented Directive. As a consequence, **the PED covers only the pressure hazard. Other Directives may be applicable to cover other hazards.**

Manufacturers must not forget that when they affix the CE Marking they implicitly declare that their equipment fully complies with all the Directives that apply to it.

3.1.3 Manufacturers

The liberal principles of the *New Approach* applied to the PED will lead to more freedom than before. The Manufacturers will be free to select:

(a) Their Notified Body: anywhere in the EU.
(b) The CA Procedure, adapted to their fabrication.
(c) How they will comply with the ESR: use of the European Harmonized Standard or a National Code.

3.1.4 Requirements

PED, like any European Directive, includes three types of requirements, which are:

(a) Legislative, as contained in Articles 1 to 52 of the PED.
(b) Devoted to CA Procedures (detailed in Annex III of the PED), which concern the responsibilities of Manufacturers and Notified Bodies.
(c) Devoted to the equipment itself and are called ESR (detailed in Annex I of the PED).

3.2 General Concepts

The *PED* was adopted on May 29, 1997 and published in the Official Journal of the European Union (OJEU) on July 9, 1997 under the reference 97/23/CE. This Directive came into force in November 1999 and became fully mandatory in May 2002. The PED 97/23/CE has now been substantially amended and replaced by Directive 2014/68/EU, issued 15 May 2014.

The two main purposes of the PED are as follows:

(a) Set up in all countries of the EU a common regulation for all Pressure Equipment to ensure a high level of safety throughout the EU.

(b) Allow the free movement of Equipment in the EU to remove the technical barriers to trade.

The purpose of this ASME Guide is to make the users familiar with the key elements of the PED.

3.2.1 Scope

The PED applies to all Equipment (pressure vessels, piping, and boilers) subject to a pressure greater than 0.5 bar.

(a) The application of the PED is fully mandatory in all countries of EU and has superseded the National Regulations.

(b) Any Pressure Equipment within the scope of the PED has to comply with it and bear the CE Marking.

(c) The PED applies only to new Equipment going into service in the EU for the first time. Equipment already in service is not subject to the PED, but will continue to meet the National Regulations.

Despite several exclusions, such as the nuclear field, this scope is very wide as it covers small products (such as pressure-cookers) as well as large industrial Equipment (such as chemical reactors or liquefied gas vessels). The PED applies only to new Equipment.

3.2.2 Hazard Categories

Equipment that is above the thresholds specified by the PED is classified in four categories (I, II, III, and IV) according to their hazards, based on the:

(a) Nature of the fluid contained (more or less hazardous). The fluid is gas or liquid. They are classified as more dangerous or less dangerous.

(b) Internal pressure (higher or lower).

(c) Internal volume (larger or smaller).

Equipment below these thresholds is not subject to the requirements in paragraphs 3.2.3 through 3.2.6, below.

3.2.3 Conformity Assessment (CA) Procedures

Each pressure equipment must be subject to a CA Procedure to verify that it complies with the specifications of the Directive. For each Hazard Category, one or several procedures are proposed to the Manufacturer. These procedures are more stringent for the higher categories. A reduction of stringency is provided for the Manufacturers who operate a Quality Assurance (QA) system. The QA route does not reduce the stringency. It is just an alternative.

3.2.4 Notified Body

The CA is performed by an independent inspection organization, notified by each of the Member States to the EC, who publishes the list in the OJEU. The Manufacturer may select any of the NB from this list for the CA of the Equipment. The inspecting criteria of each Notified Body will differ and although that these guidelines are not mandatory, they serve as the recommended best practice.

3.2.5 Conformité Européene (CE) Marking

The CE Marking must be affixed on each piece of pressure equipment, which complies with the specifications of the PED, ensuring the equipment the benefit of free movement in the EU.

3.2.6 Essential Safety Requirements (ESR)

Each piece of equipment classified in one of the four Hazard Categories must fulfill all the ESR specified in Annex I of the PED that apply to it. These technical requirements cover the design, material, fabrication, testing, and inspection aspects for the equipment.

3.2.7 Material Specifications

In May 2002, ASME was committed to working with manufacturers submitting proposals for European Approval of Materials (EAM) to the EC to gain approval of ASME material specifications for repeated use under the PED. Other notified bodies also submitted proposed EAMs covering ASME materials. However, the EC determined that Article 11, paragraph 5 of the PED 97/23/EC (the previous edition of the PED) prohibits the issuance of EAMs for grades of materials for which there exist an equivalent European harmonized standard. All of the submittals for EAMs for ASME materials were subsequently rejected. This means that the only method for using ASME materials under the PED is the Particular Material Appraisal (PMA) route. ASME has spent the last two years working with notified bodies to bring some uniformity to the PMA process, which is not clearly defined in the PED. The result has reduced the amount of redundancy of the process because it has been clarified that PMAs can be used repeatedly (by the same manufacturer using the same NB) for similar applications.

3.2.8 Use of Non-Harmonized Standards

When using a non-harmonized standard, many of the criteria for demonstrating compliance with the ESR of the PED revolve around the concept of equivalent overall level of safety (EOLS). The EOLS is applicable to using values other than those specified in Annex I. For that reason, it is valuable to select an NB that is familiar with the requirements and design/fabrication philosophies of the ASME BPVC. There are several ASME accredited Authorized Inspection Agencies that have established affiliations with European inspection bodies that are notified under the PED. These organizations bring knowledge of the ASME BPVC and the PED and can advise manufacturers as to what needs to be done in addition to ASME requirements to meet the PED. Section 12, Figure 12-1, and Section 13, Annex Z, of this document provides manufacturers additional information on compliance with the PED.

3.3 Structure of the PED

The PED has 52 Articles, which are listed in Appendix B of this Guide.

The following articles form the cornerstone of the PED.

Article 1: Scope.

Article 2: Definitions of the terms used in the PED.

Article 4: Technical Requirements. It defines the thresholds (pressure and volume) for the Pressure Equipment (vessels, piping, safety accessories, and assemblies) above which the Pressure Equipment will have to be classified in Hazard Categories in Annex II and will be subject to ESR, listed in Annex I of the PED.

Article 6: defines the obligations of the manufacturers. The manufacturers shall assure that they have designed and manufactured the pressure equipment or assemblies in accordance with the ESR in Annex I.

Article 12: The pressure equipment or assemblies which are in conformity with the harmonized standards and materials used for the manufacture of pressure equipment which are in conformity with EAM shall be presumed to be in conformity with the ESR in Annex 1.

Article 13: Pressure equipment referred to in Article 4(1) shall be classified by category in accordance with Annex II, according to level of hazard. Article 13 groups fluids into two groups.

Group 1 includes substances and mixtures listed for that group. Group 2 includes those substances and mixtures not specifically assigned to Group 1.

Article 14: defines the four Hazard Categories (I, II, III, and IV) that are obtained from graphs given in Annex II of the PED and lists the various CA Procedures to be applied to the four Hazards Categories detailed in Annex III of the PED. Article 15 lists the procedures for obtaining EAM.

Article 15: lists the procedures for EAM.

Article 19: lists the rules and conditions for affixing the CE marking.

Article 24: defines requirements relating to the NBs and Recognized Third-Party Organizations (RTPO).

The remaining Articles are devoted to Member States (Article 2), Free Movement (Article 5), Importers and Distributors (Articles 8, 9, and 10), User Inspectorates (Article 16), Notification of Conformity and NBs Articles 20–38), Market Surveillance, Control of Pressure Equipment and Assemblies Entering the EU, and Safeguard Procedures (Articles 39–43), and Articles of Administrative Nature (Articles 44–52).

These Articles are complemented by four Annexes of technical nature (Annexes I, II, III, and IV) or administrative nature (Annex V); the last Annex (Annex VI) lists the correlation between the articles in Directives 97/23/EC and 2014/68/EU.

The listing of all Articles and Annexes in PED 2014/68/EU is provided in Appendix B of this Guide.

Appendix C presents a flowchart of the PED.

4 SCOPE (ARTICLES 1, 2, AND 4 OF THE PED)

4.1 Scope (Article 1-§1 of the PED)

The PED embraces all Pressure Equipment subject to an internal pressure of gas or liquid above 0.5 bar. It applies to new Equipment fabricated in the EU (and to new or used Equipment imported from countries outside the EU).

In-service inspection of operating equipment is covered in the national regulations of each EU country. (It is not intended to develop an EU Directive covering in-service inspection.)

All materials, metallic and nonmetallic, are considered.

This scope is very wide as it covers any pressure containment above 0.5 bar from simple pressure- cookers to large water-tube boilers.

4.2 Types of Equipment Covered (Article 2 and Article 4 of the PED)

In the PED, the term *Pressure Equipment* covers the four following types:

Vessel: a component intended to contain a fluid (gas or liquid) above 0.5 bar. This covers what was formerly called pressure vessels (unfired or fired).

Piping: a component intended for the transport of fluids.

Safety accessories: devices designed to protect the Equipment.

Pressure accessories: devices with an operational function and subject to pressure (such as valves, pressure regulators, pressure gauges, filters, expansion joints, etc.).

Components (such as covers, collars, gaskets, flanges, bolts, and nozzles) are not considered as pressure accessories and cannot bear the CE Marking.

PED covers also Assemblies made of several parts of Pressure Equipment, assembled by the Manufacturer to constitute an integrated and functional whole, such as boilers.

These Assemblies are mentioned several times throughout the PED and are covered in Appendix H of this Guide.

Only the above four types of Pressure Equipment (plus Assemblies) can bear the CE Marking and have the free movement throughout EU.

Equipment subject to 0.5 bar or less are not regulated by the PED, as they do not present a significant hazard.

4.3 PED Exclusions (Article 1-§2 of the PED)

Because the scope is very wide, many exclusions are listed in the PED. They are of three types:

(a) Specific Equipment (e.g., pipelines, water networks, and nuclear sector), which are too difficult to regulate and is more properly addressed by the member State concerned.

(b) Equipment already covered by other Directives (e.g., Simple Pressure Vessels, Aerosol Dispensers, and Transportation of Dangerous Goods)

(c) Equipment that does not present significant hazards due to pressure (e.g., motor vehicles, tires, and gaseous bottles). These are covered by Type approval directives.

A list of these exclusions is provided in Appendix D of this Guide.

5 CLASSIFICATION OF PRESSURE EQUIPMENT (ARTICLE 4, ARTICLE 13, ANNEX 1, AND ANNEX II OF THE PED)

5.1 Level of Hazards in Pressure Equipment

The primary goal of the Directive is to prevent potential hazards due to internal pressure in pressure equipment. The pressure equipment referred to in Article 4 of the PED is classified by Category in accordance with Annex II, according to an ascending level of hazard.

Several levels of hazards are considered in the PED, which have practical consequences for the Equipment both for the stringency of the ESR and CA Procedures to be carried out. "Levels" are not used in the PED, but are used in the Guide to help explain the various Categories and those areas outside the numbered Categories.

Level 1 The pressure is 0.5 bar or lower: There is no significant hazard, and the equipment is outside the scope of the PED.
Level 2 The pressure is above 0.5 bar, which does not require a CA. This is generally referred to as "Sound Engineering Practice (SEP) of the Member State," which defines the threshold above which the Equipment is classified in Hazard Categories I, II, III, or IV.
Level 3 The pressure hazard level is low: The equipment is classified in Hazard Category I. There is no intervention of the NB.
Level 4 The pressure hazard level is moderate: The equipment is classified in Hazard Category II. The NB will check the Fabrication.
Level 5 The pressure hazard level is high: The equipment is classified in Hazard Category III. The NB will check the Design and the Fabrication.
Level 6 The pressure hazard level is very high: The equipment is classified in Hazard Category IV. The NB will perform increased checks of the Design and Fabrication.

Therefore, there are two main cases for Pressure Equipment:

(a) Equipment categorized as Levels 1 and 2.
(b) Equipment categorized as Levels 3 to 6.

5.2 Sound Engineering Practice (SEP) (Article 4-§3 of the PED)

This concerns all the equipment that is at or below the thresholds defined in Article 4-§3 of the PED (see Fig. 5-1 in this Guide). These thresholds depend on the type of the Equipment, the dangerousness of the fluid, and the pressure (PS) and volume (V) of the Equipment. Pressure equipment and assemblies below or equal to the limits set out in Article 4, paragraph 3 shall be designed and manufactured in accordance with SEP of a Member State in order to ensure a safe life.

Such equipment:

(a) Is not subject to the ESR: it must be constructed in accordance with SEP.
(b) Is not subject to the CA Procedures.
(c) Is not subject to the Declaration of Conformity: it must only bear the identification of the manufacturer and be accompanied by instructions for use.
(d) Must not bear the CE Marking; however, it has the benefit of the free movement throughout the EU.

5.3 Equipment in Categories I to IV (Article 4-§1 of the PED)

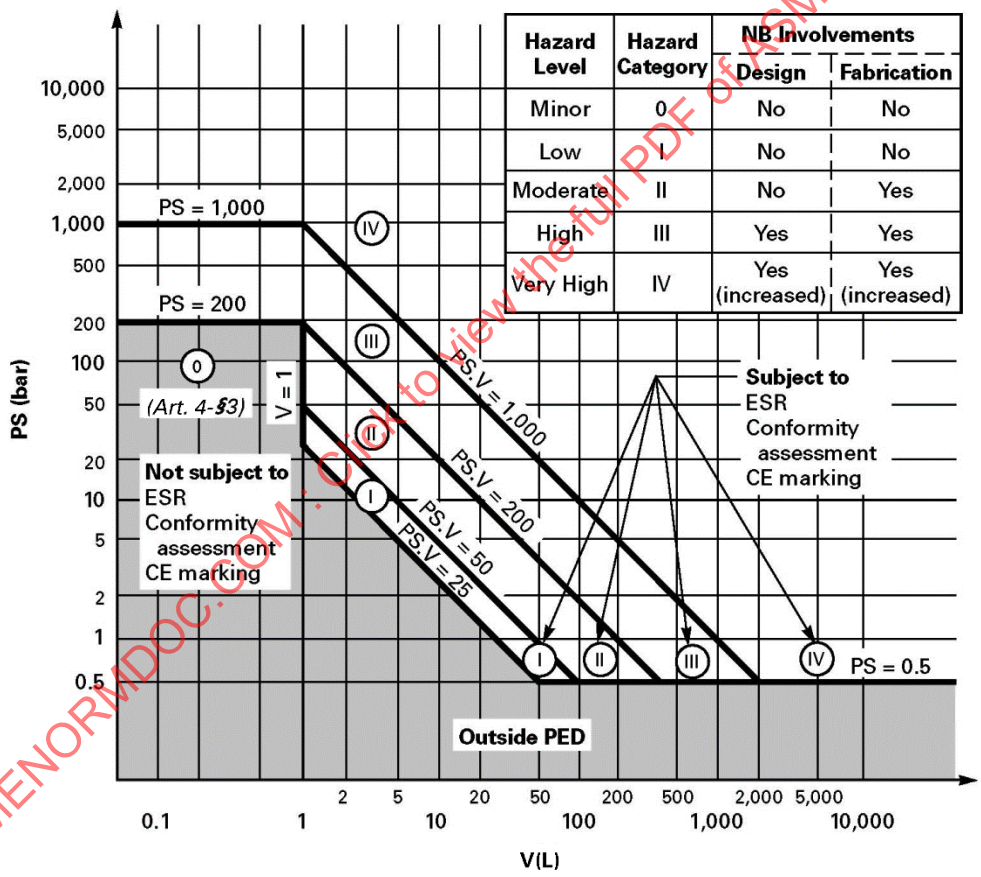
Equipment that is above the thresholds defined in Article 4-§3 of the PED is classified in Category I to IV, depending on their level of hazard. This Equipment:

(a) is subject to ESR
(b) is subject to the CA Procedure
(c) is subject to the Declaration of Conformity
(d) must bear the CE Marking
(e) has free movement throughout the EU

Hazard categories depend on the following factors.

(a) Type of Equipment: Vessel (fired on unfired), Piping, Safety Accessory, Pressure Accessory.
(b) Nature of Fluid:
(1) Gas in the sense of the PED (Article 4-§l.l(a) of the PED): gas (vapor pressure greater than 0.5 bar), liquefied gas (vapor pressure equal to or less than 0.5 bar), gas dissolved under pressure, vapors, etc.
(2) Liquid in the sense of the PED (Article 4-§l.l(b) of the PED): liquids having a vapor pressure 0.5 bar.

Figure 5-1: Category for Vessel Containing a Dangerous Gas



Note: Refer To Table 1 of the PED

(c) Dangerousness of the fluid, which is classified into two groups (Article 13-§1(a) of the PED):
(1) Group 1: Most dangerous fluids (explosives, flammable, toxic, oxidizing, pyrophoric).
(2) Group 2: Less dangerous fluids (all others).
(d) Operations conditions characterized by the maximum allowable pressure, PS, and the internal volume, V (for Vessels), or the nominal diameter, DN (for Piping).

The hazard categories are defined in the PED by graphs (Tables 1 through 9 of Annex II of the PED). How to determine the hazard category is explained as follows for each type of Equipment.

5.4 Vessels Not Subject to Fire or Heat (Article 4-§1(a) of the PED)

Figure 4-1 enables the determination of the Hazard Category of a vessel "not fired, nor heated with a risk of overheating" containing a dangerous (Group 1) gas, as a function of internal volume, V, and maximum allowable pressure, PS.

NOTE: If the vessel is composed of several chambers, the determination of the Hazard Category must be performed for each chamber and the higher hazard category is to be used.

The volume, V, to be used is the total internal volume of the vessel or the chamber (not the volume occupied by the fluid).

Each demarcation line pertains to the lower hazard category.
Three additional graphs, given by Tables 2, 3, and 4 of the PED (Annex II), cover vessels containing a

(a) Non-dangerous (Group 2) gas (Table 2)
(b) Dangerous (Group 1) liquid (Table 3)
(c) Non-dangerous (Group 2) liquid (Table 4).

5.5 Vessels Subject to Fire or Heat (Article 4-§1(b) of the PED)

This covers vessels subject to fire (e.g., boilers) and vessels subject to heat with the risk of overheating (e.g., pressure-cookers) intended for generation of steam or superheated water (at T <110°C, or 230°F).

This is a non-dangerous liquid (Group 2), and only one graph (Table 5 of the PED) is sufficient to determine the Category.

5.6 Piping (Article 4-§1(c))

As for unfired vessels, four graphs are also necessary to determine the Category of piping given by Tables 6, 7, 8, and 9 of the PED.

5.7 Safety Accessories (Article 4-§1(d), Annex II-§2 of the PED)

According to the Category of the Equipment on which the safety accessory is fitted, the following two cases are possible.

(a) The pressure equipment and assemblies are below or equal to the limits in paragraphs 1(a), 1(b), or 1(c) and in paragraph 2. (Article 4-§3 of the PED). The safety accessories shall be designed and manufactured in accordance with SEP instead of ESR. No CA and no CE Marking is required.
(b) The Equipment is in Category I, II, III, or IV (Annex II-§2 of the PED). Two cases are possible:
  (1) The accessory is fabricated specifically for the Pressure Equipment: The safety accessory is in the same Category as the Equipment,
  (2) The accessory is not fabricated specifically for the Pressure Equipment: The accessory is classified in Category IV.

5.8 Pressure Accessories (Article 4-§1(d), Annex II-§3 of the PED)

According to the Hazard Category of the Pressure Equipment on which the Pressure Accessory is fitted, the following two cases are possible.

(a) SEP (Article 4-§3 of the PED). The pressure accessories on equipment and assemblies that are below or equal to the limits in paragraphs 1(a), 1(b), or 1(c) and in paragraph 2. The accessories

shall be designed and manufactured in accordance with SEP instead of ESR. No CA and no CE Marking is required. SEP equipment must not bear CE marking.

(b) The Equipment is in Hazard Category I, II, III, or IV. The Accessory is classified using its pressure, PS, and its volume, V (using Table 1, 2, 3, 4, or 5 of the PED, as appropriate), or its nominal diameter, DN, (using Table 6, 7, 8, or 9 of the PED, as appropriate).

NOTE: If both V and DN are considered appropriate to define the Accessory, it is classified in the higher Hazard Category.

5.9 Summary

The Hazard Category system forms the cornerstone of the PED both on technical and legal aspects. The Hazard Category has a significant impact on:

(a) The severity level of the ESR applicable to the Equipment.

(b) The stringency level of the CA Procedure to be performed by the NB and the Manufacturer.

(c) Tables 1–9 of the PED are provided in Appendix E of this Guide.

6 CONFORMITY ASSESSMENT (CA) PROCEDURES (ARTICLE 14, ANNEX III OF THE PED)

6.1 Introduction

(a) Any product regulated by a European Directive is subject to a CA to ensure that it complies with all the requirements of the PED, generally under the responsibility of a NB (Article 14 of the PED).

(b) Thirteen CA Procedures that are proposed conform to the following principles (see Figure 5-1 of this Guide).

Figure 6-1: Relation of CA Procedures to Categories

CATEGORY	CA PROCEDURES
I	Module A
II	Modules A2, D1, E1
III	Modules B (design type) + D, B (design type) + F, B (production type) + E, B (production type) + C2, H
IV	Module B (production type) + D, B (production type) + F, G, H1

(1) The procedures are divided into a design phase and a production phase.

(2) In each phase, the roles and responsibilities of the Manufacturer and the NB are detailed.

(3) Some procedures are better adapted to single production (procedures G, H). Others are better adapted to production type (procedures B+C, B+E, B+F, B+D). In this case the procedure is divided in two modules covering separately the design phase and the production phase.

(4) The Manufacturer always has the choice between

(i) CA Procedure without a QA system: the NB will check the product itself.

(ii) CA Procedure requiring a QA system: the NB will check the QA system more than the product itself.

(5) The seven CA Procedures of Figure 5-1 of this Guide imply an increasing involvement of the NB from procedure A to procedure H, depending on the level of hazard presented by the Equipment covered by the Directive.

(6) Each Manufacturer must select a CA Procedure among these seven procedures. Their application is mandatory for affixing the CE Marking (Article 14 of the PED).

6.2 General Concept

(a) The PED uses these seven CA procedures (A to H) plus six additional ones (which are identified in Figure 5-3 of this Guide), making a total of 13 procedures. The multiplicity of these procedures results from the consensus between 15 countries and is justified by:

(1) diversity of types of Pressure Equipment,

(2) diversity of means of production (unit production, series production, with or without QA system),

(3) diversity of hazard levels presented by these Equipment, which has led to four Hazard Categories in the PED.

Figure 5-3 of this Guide shows a general overview of these CA Procedures.

(b) In each Hazard Category one or several CA Procedures, of equivalent stringency, are proposed to the Manufacturer, depending on production (single or series) and if there is a QA system (see Figure 5-2).

When the Hazard Category increases, the requirements of the procedures become more severe and there is more involvement of the NB:

Category I No intervention by the NB (Module A).

Category II No intervention by the NB at Design phase, but surveillance by the NB during production phase (A2), or surveillance by the NB of QA system (D1, E1).

Category III Design examination by the NB and final assessment of the equipment: B (production type) + C2, B (design type) + F.
Surveillance of the QA system: B (production type) + E, B (design type) + D, H.

Category IV Increased intervention of the NB: B (production type) + D, B (production type) +F, G, H1.

The Manufacturer may always use a CA Procedure of a higher category level.

Figure 6-2: CA Modules

	A. (Internal Control of Production)	**B. (Type Examination)**				**G. (Unit Verification)**	**H. (Full Quality Assurance (QA))**
DESIGN	Manufacturer: Keeps technical documentation at the disposal of national authorities	Manufacturer Submits to NB: (a) Technical documentation (b) Type NB: (a) Ascertains conformity with essential requirements (b) Carries out tests, if necessary (c) Issues EU type-examination certificate				Manufacturer: Submits technical documentation	Manufacturer: Operates an approved quality system (QS) for design Notified body: (a) Carries out surveillance of the QS (b) Verifies conformity of the design (H1) (c) Issues EC design examination certificate (H1)
PRODUCTION	A. Manufacturer: (a) Declares conformity with essential requirements (b) Affixes the CE mark	**C2 (Conformity to Type)** Manufacturer: (a) Declares conformity with approved type (b) Affixes the CE mark	**E. (Product QA)** Manufacturer: (a) Operates an approved QS for inspection and testing (b)Declares conformity with approved type, or to essential requirements (c)Affixes the CE mark	**F. (Product Verification)** Manufacturer: (a)Declares conformity with approved type, or with essential requirements (b)Affixes the CE marking	**D. (Production QA)** Manufacturer: (a)Operates an approved QS for production and testing (b)Declares conformity with approved type (c)Affixes the CE mark	Manufacturer: (a)Submits product (b)Declares conformity (c)Affixes the CE mark	Manufacturer: (a)Operates an approved QS for production and testing (b)Declares conformity (c)Affixes the CE mark
	A2. NB: (a)Tests on specific aspects of the product (b)Product checks at random intervals	NB: (a)Tests on specific aspects of the product (b)Product checks at random intervals	NB: (a)Approves the QS (b)Carries out surveillance of the QS	NB: (a)Verifies conformity (b)Issues certificate at conformity	NB: (a)Approves the QS (b)Carries out surveillance of the QS	NB: (a)Verifies conformity with essential requirements (b)Issues certificate of conformity	NB: Carries out surveillance of the QS
	1	2		3		4	

Figure 6-3: CA Procedures in the PED

Module	Category	Design	Production
A	I	Technical documentation	Internal production control
A2	II	Technical documentation	Internal production control with surveillance of the final assessment
B – Production Type	III	Type examination	without QA: C2 or F with QA: E or D
B – Design Type	IV	Design examination	without QA: F with QA: D
C2	III	(Module B – Production Type)	Conformity of the production to the type
D	III & IV	(Module B – Production Type or B- Design Type)	QA for production
D1	II	Technical documentation	QA for production
E	III	(Module B – Production Type)	QA for final testing on products
E1	II	Technical documentation	QA for final testing on products
F	III & IV	(Module B – Production Type or B- Design Type)	Product verification
G	IV	Unit verification	Unit verification
H	III	QA for design	QA for production
H1	IV	QA for design, with design examination	QA for production with specific surveillance of final assessment

Figure 6-4: CA Procedure to Be Applied In Each Category

	Without QA		With QA	
Category	**Series**	**Unit**	**Series**	**Unit**
I	A	A	A	A
II	A2	A2	D1 or E1	D1 or E1
III	B + C2 B1 B-Design Type + F	B1 B-Design Type + F	B + E B1 B-Design Type + D	H B1 B-Design Type + D
IV	B-Production Type + F	G	B -Production Type + D	H1

NOTE: See Table 5 for Categories applicable to boilers. Power boilers typically are Category IV pressure equipment.

6.3 Structure of the Procedures

(a) Each CA Procedure is described in detail in Annex III of the PED and specifies the respective tasks and responsibilities of the Manufacturer and of the NB for the Design and Production phases. For all Equipment:

(1) The Manufacturer must

(i) draw up the Technical Documentation

(ii) ensure conformity to the ESR by drawing up a Declaration of Conformity (Annex IV of the PED)

(iii) affix the CE Marking,

(iv) affix the identification number of the NB.

(2) The NB must check the conformity of the Equipment with the ESR by applying the specifications of the Procedure. This check will differ according to whether the manufacturer uses a QA procedure.

(b) For the six CA Procedures without QA (A, A2, B-Production Type +C, B-Production Type +F, B2-Design Type+F, G), the NB must examine the Design and the Fabrication of each Equipment, and perform appropriate tests, so as to check its conformity to the ESR, except for the following procedures.

(1) Procedure A. Self-certification by the Manufacturer.

(2) Procedure A2. Self-certification by the Manufacturer and surveillance by an NB that takes the form of unexpected visits.

(c) For the seven CA Procedures with QA (D1, E1, B-Production Type +E, B-Production Type +D, B1 B-Design Type+D, H, H1), the involvement of the NB on the Equipment itself is reduced, and the NB concentrates on the QA system. The NB:

(1) assesses the adequacy of the QA system to the production

(2) carries out periodic audits to ensure that the Manufacturer applies the QA system

(3) applies the surveillance by unexpected visits to check that the QA systems works correctly.

(d) Six procedures are devoted to unit production (A, A2, D1, E1, G, H, H1).

(e) Seven procedures are devoted to series production (B-Production Type +C2, B-Production Type +D, B-Production Type +E, B-Production Type +F, B-Production Type +D, B-Production Type +F). They consist of a design module covering the design phase (modules B) and a production module covering the production phase (modules C2, D, E, and F).

6.4 Review of CA Modules

6.4.1 CA Modules

Module A	Internal Production Control
Module A2	Internal Production Control Plus Supervised Pressure Equipment Checks at Random Intervals
Module B	EC type examination - Production Type
Module B	EU type examinations, B - Production Type, and B -Design Type
Module C2	Conformity to Type Based on Internal Production Control plus Supervised Pressure Equipment Checks at Random Intervals
Module D	Conformity to Type Based on Quality Assurance of the Production Process
Module D1	Quality Assurance of the Production Process
Module E	Conformity to Type Based on Pressure Equipment Quality Assurance
Module E1	Quality Assurance of Final Pressure Equipment Inspection and Testing
Module F	Conformity to Type Based on Pressure Equipment
Module G	Conformity Based on Unit Verification
Module H	Conformity Based on Full Quality Assurance
Module H1	Conformity Based on Full Quality Assurance Plus Design Examination
Appendix F	Declaration of Conformity
Appendix G	Activities of Manufacturers and Notified Bodies in Accordance with CA Procedures

6.4.2 Module A: Internal Production Control

This module describes procedures by which Manufacturers, or their authorized representatives established in the European Community, ensure and declare that pressure equipment satisfy the requirements of the PED to which they apply. This module is applicable for Category I, for a production by series or unit, with or without a QA system.

6.4.2.1 Characteristics of the Module

(a) Internal Production Control by the Manufacturer
(b) No intervention of the NB

6.4.2.2 Role of the Manufacturer

(a) The Manufacturer must draw up the technical documentation (see Module A2) and must keep it at the disposal of the relevant national authorities for inspection purposes for 10 years after the last of the pressure equipment has been manufactured.
(b) The Manufacturer must affix the CE marking to each item of pressure equipment.
(c) The Manufacturer must draw up a written declaration of conformity.
(d) The Manufacturer must keep a copy of the declaration of conformity with the technical documentation.

6.4.3 Module A2: Internal Production Control plus Supervised Pressure Equipment Checks at Random Intervals

This module describes procedure by which the Manufacturer, or its authorized representative established in the Community, ensures and declares that pressure equipment of Category II satisfies the requirements of the PED.

This module is applied for a production in series or by unit, without a QA system.

6.4.3.1 Tasks of the Manufacturer

(a) The Manufacturer chooses an NB.
(b) The Manufacturer draws up technical documentation, as far as is relevant to such assessment, and covers the design, manufacture, and operation of the pressure equipment. The basic document is the general design drawing of the equipment completed if necessary by more detailed manufacturing drawings or diagrams of the subassemblies or circuits and commented if necessary by a written description. The technical documentation will contain:
  (1) name of the Manufacturer and site of production
  (2) conceptual design and manufacturing drawings
  (3) a list of harmonized standards applied and description of the solutions adopted
  (4) results of design calculation made and/or test reports
(c) The Manufacturer ensures that the manufacturing process complies with technical documentation.
(d) The Manufacturer affixes the CE marking and NB identification number to each item.
(e) The Manufacturer draws up written declaration of conformity.
(f) Retain declaration of conformity and technical documentation for ten years.

6.4.3.2 Tasks of the Notified Body

(a) Monitoring of final assessment by unexpected visits. The final assessment must include
  (1) visual examination of the equipment
  (2) hydrostatic pressure test
  (3) examination of safety devices.
(b) Take samples of pressure equipment at manufacturing or storage premises to conduct checks.
(c) Take appropriate action if items do not conform.
(d) Monitor the state of art and revert to the manufacturer if type of approval does not keep up.

6.4.4 Module B: EU Type Examination – Production Type

This module describes the part of the procedure by which an NB ascertains and attests that a representative example of the production meets the provisions of the PED to which they apply. This module is applied for risk category III and IV, for a production in series, with or without QA.

6.4.4.1 Characteristics of the Module

This module is only applicable for the design examination. It is always associated with another module concerning the manufacturing of the pressure equipment (C2, E, F, or D).

6.4.4.2 Tasks of the Manufacturer

(a) The Manufacturer draws up the technical documentation that covers the design, manufacture, and operation of the pressure equipment. The documents to be given to the NB for a design examination are:
  (1) general description of the pressure equipment
  (2) list of codes or harmonized standards applied and solution adopted where harmonized standards are not used
  (3) design drawings, manufacturing drawings, diagram of components
  (4) identification marking drawings (identity plate)
  (5) list of materials used
  (6) results of design calculation made and/or test reports
  (7) forming procedures
  (8) heat treatment procedures
  (9) Non Destructive Testing (NDT) procedures
  (10) certification of Non Destructive Examination (NDE) personnel

(11) qualification of permanent assembly procedures: welding, braze-welding, brazing, expanding, and gluing
(12) operating instructions

For calculation design, the results of the design calculation shall be given; for experimental design, the test reports shall be given; and, for calculation design completed by experimental design, the results of the calculation shall be supplemented by the test reports.

These documents shall be given to the NB for this module, but also for EU Type examination - Design Type (modules B and H1). They shall also be available in complement of the documents for the final assessment in modules A, A2, D1, E1, and H.

(a) The Manufacturer provides representative example of production (a "type") to the NB.
(b) The Manufacturer retains documentation and copies of EU type-examination during ten years.

6.4.4.3 Tasks of the NB

(a) Examines the technical documentation
(b) Verify that the "type" is manufactured in conformity with the technical documentation
(c) Assess materials when they are not in conformity with harmonized standard or EAM, and check material certificates
(d) Approve procedures for permanent joining or check they have been previously approved
(e) Verify staff are qualified or approved for permanent joining and NDE
(f) Issues EU type-examination certificate with a validity of ten years
(g) Retain copy of documentation and EU type - examination certificate

6.4.5 Module B: EU Type Examination – Design Type

This module describes the part of the procedure where an NB ascertains and attests that the design of an item of pressure equipment meets the provisions of the PED to which they apply. This module is applied for risk category III, for production in series or by unit, with or without QA.

6.4.5.1 Characteristics of the Module

This module is only applicable for design examination (e.g., Module D); it is always associated with another module concerning the manufacturing of a pressure equipment (F or D).

6.4.5.2 Tasks of the Manufacturer

The Manufacturer draws up the technical documentation as described in module B.

6.4.5.3 Tasks of the Notified Body

See module B (para. 4.4).

(a) Examine the technical documentation
(b) Issue EC design-examination certificate

6.4.6 Module C2: Conformity to Type Based on Internal Production Control plus Supervised Pressure Equipment Checks at Random Intervals

This module describes that part of procedure whereby the Manufacturer ensures and declares that pressure equipment is in conformity with the type as described in the EU type-examination certificates– Design Type and satisfies the requirements of the PED to which they apply.

The Manufacturer must affix the EC marking to each item of pressure equipment and draw up a written declaration of conformity.

6.4.6.1 Characteristics of the Module

This module is only applicable for the manufacturing of the pressure equipment in series without QA. It is always associated with the module B (EU type-examination – Production Type).

6.4.6.2 Tasks of the Manufacturer

(a) Ensure that the manufacturing process produces pressure equipment that complies with the type as described in the EU type-examination certificate. (The PED does not restrict the use of Modules; the manufacturer may choose the most appropriate Module).
(b) Choose an NB
(c) Affix CE marking and NB identification number.

6.4.6.3 Tasks of the Notified Body

(a) Monitor the final assessment by unexpected visits
(a) Ensure that the Manufacturer performs the final assessment according to the PED
(b) Take samples of pressure equipment at manufacturing and storage premises to conduct checks.

6.4.7 Module D: Conformity to Type Based on QA of the Production Process

This module describes procedures where the Manufacturer ensures and declares that the pressure equipment concerned is in conformity with the type described in the EU design-examination certificate and satisfies the requirements of the PED to which they apply.

6.4.7.1 Characteristics of this Module

This module is only applicable for the manufacturing of the pressure equipment in series or by unit, with QA for risk categories III or IV. It is always associated with the module B (EU type examination, production type or design type).

6.4.7.2 Tasks of the Manufacturer

(a) Set up and operate quality system for production, final inspection, and testing, which ensures compliance of the pressure equipment with the type described in the EU type examination – Production Type certificate, or the EU type examination – Design Type certificate.
(b) Lodge application for assessment of quality system with an NB as described in module D1
(c) Affix CE marking and NB identification number
(d) Draw up written declaration of conformity.

6.4.7.3 Tasks of the Notified Body

(a) Assess quality system including an inspection visit to the Manufacturer's premises.
(b) Carry out surveillance visits to ensure that the Manufacturer fulfills the obligation arising from the approved quality system.
(c) Carry out periodic audits such that a full reassessment is carried out.
(d) Carry out unexpected visits to verify that the quality system is functioning correctly.
(e) Notify the Manufacturer of assessment decision.

6.4.8 Module D1: Quality Assurance of the Production Process

This module is applicable for conception and for the manufacturing of pressure equipment. It is not associated with another module.

6.4.8.1 Characteristics of the Module

This module is applicable for risk category II with QA for production in series or by unit.

6.4.8.2 Tasks of the Manufacturer

(a) Draw up technical documentation covering design, manufacture, and final inspection. The documents given to the NB for final inspection shall contain
  (1) certificates of qualification of NDT personnel, welders, brazing personnel
  (2) data dealing with heat treatment (diagram of temperatures)
  (3) inspection documents for the base materials and the consumables
  (4) procedures for ensuring materials traceability
  (5) test reports of NDT, including radiographic films
  (6) test reports of destructive tests
  (7) forming conformity certificate.
(b) Set up and operate quality system for production, final inspection and testing (e.g., International Organization for Standardization (ISO) 9002), which ensures compliance of the pressure equipment with the PED.
(c) Give to the NB the documentation on the quality system including a description of quality objectives and organization structure.
(d) Affix EC marking and draw up written declaration of conformity.

6.4.8.3 Tasks of the Notified Body

(a) Assess quality system including an inspection visit to the manufacturer's premises.
(b) Carry out periodic audits such that a full reassessment is conducted.
(c) Carry out unexpected visits to verify that the quality system is functioning correctly.
(d) Notify the Manufacturer of assessment decision.

6.4.9 Module E: Conformity to Type Based on Pressure Equipment Quality Assurance

This module is applicable only for the manufacturing of pressure equipment. It is associated with module B (conception).

6.4.9.1 Characteristics of the Module

This module is applicable for risk category III with QA for production in series.

6.4.9.2 Tasks of the Manufacturer

(a) Set up and operate quality system for products, which ensures compliance of the pressure equipment with the type described in the EU type examination certificate.
(b) Lodge application for assessment of quality system with an NB as described in module E1 (para. 4.10).
(c) Affix EC marking and notified body identification number.
(d) Draw up written declaration of conformity.

6.4.9.3 Tasks of the Notified Body

(a) Assess quality system, including technical aspect, with an inspection visit to the Manufacturer's premises.
(b) Carry out periodic audits such that a full reassessment is carried out.
(c) Carry out unexpected visits to verify that the quality system is functioning correctly.
(d) Notify the Manufacturer of assessment decision.

6.4.10 Module E1: Quality Assurance of Final Pressure Equipment Inspection and Testing

This module is applicable for conception and for manufacturing of pressure equipment. It is not associated with another module.

6.4.10.1 Characteristics of the Module

This module is applicable for risk category II with QA for production in series and by unit.

6.4.10.2 Tasks of the Manufacturer

(a) Draw up technical documentation covering design, manufacture, and final inspection.
(b) Set up a quality system for products, and operate this QA for final assessment and testing.
(c) Affix EC marking and notified body identification number.
(d) Draw up written declaration of conformity.

6.4.10.3 Tasks of the Notified Body

(a) Assess quality system, including technical aspect, with an inspection visit to the Manufacturer's premises.
(b) Carry out periodic audits such that a full reassessment is conducted.
(c) Carry out unexpected visits to verify that the quality system is functioning correctly.
(d) Notify the Manufacturer of assessment decision.

6.4.11 Module F: Conformity to Type Based on Pressure Equipment Verification

This module is applicable only for the manufacturing of pressure equipment, including power boilers. It is associated with modules B.

6.4.11.1 Characteristics of the Module

This module is applicable for category III or IV without QA for production in series or by unit.

6.4.11.2 Tasks of the Manufacturer

(a) Ensure that the manufacturing process produces pressure equipment that is in conformity with the type described in the EU type-examination certificate (B), Production Type or Design Type.
(b) Choose an NB.
(c) Affix EC marking and notified body identification number.
(d) Draw up written declaration of conformity.

6.4.11.3 Tasks of the Notified Body

(a) Examine and test each item of pressure equipment, to verify that every item conforms to the type.
(b) Verify qualification of personnel responsible for permanent joining and NDT examination,
(c) Carry out final inspection and proof test.
(d) Draw up written certificate of conformity relating to the test.

6.4.12 Module G: Conformity Based on Unit Verification

This module is applicable for design and manufacturing pressure equipment, including power boilers. It is not associated with another module.

6.4.12.1 Characteristics of the Module

This module is applicable for category IV, without QA and for production by unit.

6.4.12.2 Tasks of the Manufacturer

(a) Lodge application for unit verification with an NB that must include
  (1) The technical documentation as described under module A2 and additional modules, as appropriate.
  (2) Information relating to the approval of the manufacturing and test procedures.
  (3) Information of the qualifications or approvals of staff carrying out permanent joining and non-destructive tests.
(b) Affix EC marking.
(c) Draw up written declaration of conformity.

6.4.12.3 Tasks of the Notified Body

(a) Examine design and construction of each item.
(b) Examine technical documentation with respect to design and manufacturing procedures.
(c) Perform additional examinations of materials from material Manufacturers, as appropriate.
(d) Approve procedures for permanent joining of parts or check previous approval.
(e) Verify personnel responsible for permanent joining of parts and non-destructive testing.
(f) Perform during manufacture appropriate tests set out in relevant harmonized standards or equivalent to ensure the conformity to the PED.
(g) Carry out final inspection and perform, or have performed, the proof test.
(h) Examine the safety devices, if applicable.
(i) Affix identification number or have it affixed to the pressure equipment.
(j) Draw up certificate of conformity for the tests carried out.

6.4.13 Module H: Conformity Based on Full QA

This module is applicable for conception and for the manufacturing of pressure equipment. It is not associated with another module.

6.4.13.1 Characteristics of the Module

This module is applicable for risk category III with QA for production by unit.

6.4.13.2 Tasks of the Manufacturer

(a) Implement an approved quality system for design, manufacture, and final inspection and testing (e.g., ISO 9001), which must ensure compliance of the pressure equipment with the requirements of the PED that apply to it.
(b) Lodge application for assessment of the quality system with an NB, which includes
  (1) relevant information on the pressure equipment concerned
  (2) documentation on the quality system including a description of quality objectives and organizational structure
  (3) technical design specifications, including standards, that will be applied
  (4) design control and technical verifications, process and systematic measures, particularly the procedures for permanent joining

(5) examinations and tests to be carried out
(6) quality records, such as inspection reports, test data, and the qualifications or approvals of the personnel concerned particularly with permanent joining
(7) means of monitoring quality and quality system.

(c) Undertake the fulfilment of obligations arising out of the quality system.
(d) Affix EC marking and identification number of the NB responsible for surveillance.
(e) Draw up declaration of conformity.

6.4.13.3 Tasks of the Notified Body

(a) Assess quality system including an inspection visit to the Manufacturer's premises.
(b) Presume conformity with respect to the elements of the quality system that implements a relevant harmonized standard (e.g., ISO 9001).
(c) Notify the Manufacturer of assessment decision.
(d) Carry out surveillance visits to ensure that the Manufacturer fulfils the obligations arising from the approved quality system.
(e) Carry out periodic audits such that a full reassessment is carried out every three years.
(f) Carry out unexpected visits to verify that the quality system is functioning correctly.
(g) Assess proposed changes to the quality system. For category III and IV vessels for group 1 and group 2 gases and group 1 liquids and steam generators, the NB, when performing unexpected visits, must take a sample of equipment and perform, or have performed, the proof test.

For one-off production of category III steam generators, the NB must perform, or have performed, the proof test for each unit.

6.4.14 Module H1: Conformity Based on Full QA Plus Design Examination

This module is applicable to Category IV pressure equipment, including power boilers.

6.4.14.1 Tasks of the Manufacturer

(a) Lodge application for examination of the design with an NB. The application must enable the design, manufacture, and operation of the pressure equipment to be understood and enable conformity with the relevant requirements of the PED to be assessed. It must include
(1) technical design specifications, including standards
(2) necessary supporting evidence for their adequacy, in particular where harmonized standards have not been applied in full
(b) Inform the NB of all modifications to the approved design.

6.4.14.2 Tasks of the Notified Body

(a) Examine the application and, if satisfied, issue an EC design examination certificate.
(b) Carry out surveillance of the final assessment in the form of unexpected visits, which must include examinations on the pressure equipment.
(c) Assess any modifications to the approved design and give additional approval.

6.5 Summary of Activities of Manufacturers and NBs

A summary of the activities of Manufacturers and NBs in accordance with the CA Procedures is provided in Appendix F of this Guide.

7 ESSENTIAL SAFETY REQUIREMENTS (ESR) (ARTICLES 4 AND 6, ANNEX I OF THE PED)

7.1 Introduction

The technical requirements concerning the Pressure Equipment itself are included in Annex I of the PED under the designation ESR. The following principles apply.

(a) All pressure equipment above the thresholds mentioned in Article 4 of the PED (i.e., classified in Hazard Category I, II, III, or IV) shall comply with all these ESR. They concern the various steps of the construction: design, material selection, fabrication, inspection, and safety devices.

(b) These ESR are generally formulated in general terms of safety objectives, such as, "Pressure Equipment shall be constructed in such a way to ensure its safety in reasonable foreseeable conditions."

The PED does not provide the means to achieve these requirements; this is the role of the Harmonized Standards. Some quantitative requirements are provided by PED §7 of Annex I, which "apply as a general rule." Manufacturers can depart from these quantitative requirements, but they shall convince the NB that "they have taken appropriate measures to achieve an equivalent overall level of safety."

(c) It is the role of European Committee for Standardization (CEN) Harmonized Standards (harmonized to the PED), such as EN13445 for Unfired Pressure Vessel developed by CEN/TC54), to quantify each of these requirements. As a consequence, this gives them a presumption of conformity to the PED (see PED Article 12-§1).

However, use of these Harmonized Standards is not compulsory. The Manufacturer may construct its pressure vessel using any Code or Standard but must be able to demonstrate to the NB that the vessel complies with each of the ESR of PED Annex I. Or, the Manufacturer shall show that it has used a quantitative requirement different from the Harmonized Standards, provided an equivalent level of safety is achieved.

(d) The Manufacturer is free to use one of the following three options to prove that this Equipment complies with the ESR.

(1) use of the EN Harmonized Standard, which will give presumption of conformity to the ESR

(2) use of a recognized Code like ASME BPVC, French Code for Construction of Unfired Pressure Vessel (CODAP), etc. (supplemented by additional requirements to ensure compliance with the PED)

(3) by applying directly the ESR and providing calculation sheets carrying out tests, etc.

In options 2 and 3, the Manufacturer will have to convince the NB of its compliance with the ESR.

(e) The stringency of some of these ESR depend on the Hazard Category of the Equipment, especially:

(1) approval of welding operating permanent joining procedures (Annex I-§3.1.2 of the PED)

(2) approval of welders (Annex I-§3.1.2 of the PED)

(3) approval of non-destructive test personnel (Annex I-§3.1.3 of the PED)

(4) types of material certificate (Annex I-§4.3 of the PED).

7.2 General Discussion of ESR (Annex I of the PED)

7.2.1 Preliminary Remarks

(a) All equipment above the thresholds specified in PED Article 4-§1 (i.e., Equipment classified in Categories I, II, III, and IV) shall meet each of the ESR of Annex I of the PED. This applies to assemblies (Article 4-§2 of the PED), taking into account the derogation specified in clause Article 4-§2.3 (see Annex I-§2.8 of the PED).

(b) The ESR are mandatory. These are expressed qualitatively in terms of general purposes. Only some numerical values are given in Annex I-§7 of the PED (joint efficiency, proof test pressure, etc.). The Manufacturer is not obliged to use these values provided an equivalent overall level safety has been achieved (Annex I-§7 of the PED).

7.2.1.1 General (Annex I-§1 of the PED)

Equipment shall be constructed in such a way that their safety is ensured (Annex I-§1.1 of the PED). The Manufacturer shall carry out an analysis of hazards and risks, which shall be used as indicated in Annex I-§1.2 and Annex I-§1.3 of the PED.

7.2.1.2 Design (Annex I-§2 of the PED)

7.2.1.2.1 General (Annex I-§2.1 of the PED)

Pressure equipment shall be "properly designed" to ensure that the equipment will be safe throughout its intended life, taking into account

(a) suitable safety margins against the different failure modes
(b) loads corresponding to the intended use (pressure, temperature, wind, earthquake, etc.)
(c) expected working conditions (corrosion, erosion, fatigue, etc.), (Annex I-§2.2.1 of the PED).

7.2.1.2.2 Design Method

Two methods for design are proposed (Annex I-§2.2.2 of the PED):

(a) Calculation Method. This method is applicable to all cases (Annex I-§2.2.3 of the PED).
(1) This method shall specify the maximal allowable stresses to prevent possible failure modes including creep, corrosion, fatigue, and instability (Annex I-§2.2.3a of the PED).
(2) The allowable general membrane stress, Sa, is defined below, for each type of material (Annex I-§7.1.2 of the PED).

Figure 7-1: Allowable General Membrane Stress Values

Material	Allowable General Membrane Stress, S_a
Ferritic steel, including normalized steel and excluding fine-grain steel and specially heat treated steel	Lesser of $R_{e/t}$ /1.5 and $R_{m/20}$ /2.4
Austenitic steel if A > 30%	$R_{e/t}$ /1.5
Austenitic steel if A > 35%	Lesser of $R_{e/t}$ /1.2 and R_m /$_t$ /3
Cast steel	Lesser of $R_{e/t}$ /1.9 and $R_{m/20}$ /3
Aluminium	$R_{e/t}$ /1.5
Aluminium alloys (excluding precipitation hardened alloys)	Lesser of $R_{e/t}$ /1.5 and $R_{m/20}$ /2.4

A = elongation, %
$R_{e/t}$ = specified minimum yield strength at calculation (design) temperature
$R_{m/20}$ = specified minimum ultimate tensile strength at 20°C (room temperature)
$R_{m/t}$ = ultimate tensile strength at calculation (design) temperature

NOTE: These stress values apply as a general rule. Other values may be used if an equivalent overall level of safety is achieved (PED Annex I-§7).

(3) The method shall take into account the following (PED Annex I-§2.2.3.b):
(i) the calculation pressure (greater than or equal to PS), the calculation temperature, and the possible combinations
(ii) the maximal stresses and stress concentrations

(iii) the joint efficiency according to the level of testing of welded joints (Annex I-§7.2 of the PED).

Figure 7-2: Joint Efficiency Values

Extent of Examination	Joint Efficiency
100% Radiographic Testing (RT) or Ultrasonic Testing (UT)	1.0
Random NDE by RT or UT (spot RT or UT)	0.85
Visual examination only	0.70

NOTE: These joint efficiency values apply as a general rule. Greater values may be used if an equivalent overall level of safety has been achieved (Annex I-§7 of the PED). Joint efficiency of 1 may be used for equipment subject to destructive and non-destructive tests which confirm that the whole series of joints show no significant defects.

(a) Experimental Method. When no calculations are performed, this method is applicable only for (Annex I-§2.2.4 of the PED):
(1) vessels that have a PS x V less than 6,000 bar L (3,072 psi x ft^3)
(2) piping that has a PS x DN less than 3,000 bar mm (1,713 psi x in.).

This method does not apply when CA is carried out according to Module B, EU Type Examination – Design Type. The Manufacturer shall draw up a test program on a representative sample, subjected to the agreement of the Notified Body in charge of the design assessment module.

7.2.1.2.3 Other Requirements for Design

Other requirements regarding design shall cover the following, if relevant (PED references are noted in parentheses).
(a) safety of handling and operation (Annex I-§2.3)
(b) means of inspection (Annex I-§2.4)
(c) means of draining and venting (Annex I-§2.5)
(d) corrosion and chemical attack (Annex I-§2.6)
(e) wear (Annex I-§2.7)
(f) reliability of assemblies (Annex I-§2.8)
(g) provisions for filling and discharge (Annex I-§2.9)
(h) protection against exceeding the allowable limits (Annex I-§2.10)
(i) safety accessories (Annex I-§2.11)
(j) external fire (Annex I-§2.12).

7.2.1.3 Fabrication (Annex I-§3 of the PED)

7.2.1.3.1 Manufacturing Procedures

(a) The Manufacturer shall ensure that design specifications are effectively applied at fabrication stage (Annex I-§3.1 of the PED), especially regarding the following aspects (PED references are noted in parentheses).
(1) preparation of the component parts (Annex I-§3.1.1)
(2) permanent joining (Annex I-§3.1.2)
(3) heat treatments (Annex I-§3.1.4)
(4) traceability (Annex I-§3.1.5).

(b) Permanent joining (Annex I-§3.1.2 of the PED) by welding, brazing, etc., shall be performed using qualified personnel and in accordance with qualified operating procedures. For pressure equipment in Categories II, III, and IV, the operating procedures and personnel shall be approved by a competent third party which, at the Manufacturer's discretion, may be a Notified Body, or a third party organization recognized by a Member State, as provided for in Article 20.

Figure 7-3: Welding Procedure Qualifications and Welder Qualifications

Category of Equipment	Approval of Welding Procedure Qualification and Welder Qualification By	
Category I	Manufacturer	
Category II Category III Category IV	Notified Body (PED Article 30) or Third-party organization recognized by a Member State	Chosen by the Manufacturer

7.2.1.3.2 Non-Destructive Testing (NDT) (Annex I-§3.1.3of the PED)

This shall be performed by qualified personnel. Body in charge of the approval of these qualifications depends on the Category in which the Pressure Equipment is classified is as follows.

Equipment Category	Approval of NDE Personnel By
Category I Category II	Manufacturer
Category III Category IV	Third-party organization recognized by a Member State (PED Article 20)

7.2.1.3.3 Final Assessment (Annex I-§3.2 of the PED)

Pressure Equipment shall undergo a final assessment to ensure the compliance with the ESR. This final assessment must include a final examination and a proof test performed by the Manufacturer or the Notified Body according to the assessment module that applies.

(a) Final examination (Annex I-§3.2.1 of the PED) comprises
  (1) internal and external visual examination of the Equipment
  (2) examination of the accompanying documents of the Equipment.

(b) Proof test (Annex I-§3.2.2 of the PED), generally hydrostatic, carried out at a pressure P_t defined in Annex I-§7.4 of the PED. The test pressure shall be the larger of the following.

$$P_t = 1.25\, P_s \left(\frac{f_a}{f_t}\right)$$

$$P_t = 1.43\, P_s$$

where,

P_s = allowable maximum operating pressure
f_a = nominal design stress at test temperature
f_t = nominal design stress at operating temperature.

NOTE: Lower values may be used if an equivalent overall level of safety has been achieved (Annex I-§7 of the PED).

(a) Exceptionally, where the hydrostatic pressure test is impractical, an "equivalent test" (e.g., a pneumatic test) may be performed.
(b) The test shall be performed for each equipment, unless the equipment is classified in Category I (where the test may be carried out on a statistical basis).
(c) For assemblies, an examination of the safety accessories shall be performed additionally.

7.2.1.3.4 Marking and Operating Instructions

(a) In addition to CE Marking, information specified in PED Annex I-§3.3 shall be affixed on the Equipment.
(b) Pressure Equipment shall be accompanied with instructions covering all information necessary for the user (mounting, start-up, use, maintenance). (See Annex I-§3.4 of the PED.)

7.2.1.4 Materials (Annex I-§4 of the PED)

The word *Material* includes the parent materials (i.e., base metals, such as steel, aluminum, etc.) as well as joining materials (for welding, brazing, etc.). Welding consumables and other joining materials are subject only to some of the parent material requirements.

7.2.1.4.1 Materials Intended for Pressure Parts (Annex I-§4.1 of the PED)

Materials must have appropriate properties for all operating conditions reasonably foreseeable and for test conditions, especially regarding (Annex I-§7.5 of the PED). Materials shall be sufficiently ductile and tough, which can be demonstrated by the following properties:
(a) ductility: for steel, elongation after rupture, A % not less than 14%
(b) toughness: for steel, impact test energy not less than 27J (20 ft-lb).

NOTE: Other means of achieving sufficiently ductile and tough material may be adopted as long as an equivalent overall level of safety can be assured.

The materials shall be sufficiently chemically resistant and not be affected by aging, etc.

7.2.1.4.2 Material Characteristics (Annex I-§4.2 of the PED)

(a) The Manufacturer shall define material characteristics required by equipment design and material use (Annex I-§4.2a of the PED).
(b) The Manufacturer shall record in the technical documentation the justification for compliance with one of the following forms:
  (1) Material that complies with Harmonized Standards. Thus, the material is presumed to comply with the ESR
  (2) Material subject to a EAM (Article 15 of the PED)
  (3) Material subject to a PMA, which shall be carried out by a body depending on the Risk Category in which the equipment is classified. (See below)

Equipment Category	PMA Carried Out by
Category I Category II	Manufacturer
Category III Category IV	NB in charge of evaluation and approval of the Pressure Equipment

(c) Materials shall be accompanied by an inspection document established by the material producer. For pressure parts the type of inspection document depends on the Equipment Risk Category (Annex I-§4.3 of the PED), as follows.

Equipment Category	Type of Inspection Document (According to EN10204)
Category I	Test report Type 2.2 (Certificate of Compliance) Inspection certificate
Category II Category III Category IV	Type 3.1 or Type 3.2 (if the material manufacturer does not have an approved quality system)

NOTE: See Section VII of this Guide for more details regarding PED requirements for materials.

7.2.1.5 Specific Requirements Applicable to Fired Equipment (Annex I-§5 of the PED)

This pressure equipment shall be constructed so as to avoid or minimize risks of a significant loss of containment from overheating.

7.2.1.6 Specific Requirements Applicable to Piping (Annex I-§6 of the PED)

This equipment shall be constructed so as to ensure that the risks listed in sub-clauses (a) to (g) in PED Annex I-§ 6 are taken into account or minimized.

7.2.1.7 Specific Quantitative Requirements for All Equipment (Annex I-§7 of the PED)

(a) The quantitative requirements specified in this clause of Annex I may be superseded by other requirements (or other values) provided that these values result in an equivalent overall level of safety.

(b) These requirements have been included in Annex I-§7, sub-clauses 2, 3, and 4 of the PED. They deal with the following items.

(1) allowable stresses (Annex I-§7.1)
(2) joint coefficients (Annex I-§7.2)
(3) means of pressure limitation (Annex-§7.3)
(4) hydrostatic test pressure (Annex I-§7.4)
(5) material characteristics (Annex I-§7.5).

7.3 Hazard Analysis (Annex I of the PED)

Annex I of the PED (Preliminary Observations-§3) requires the Manufacturer to perform an assessment of hazards and risks and design and build the equipment taking account this analysis.

NOTE: Such a hazard analysis has no relationship with the Category concept, defined in PED Article 13, whose purpose is to determine the level of hazard presented by Pressure Equipment.

The hazard and risk analysis should be performed as follows.

7.3.1 Identify the Hazard Due to Pressure

All potential failure mechanisms or dangers that can be anticipated during operation of the Pressure Equipment should be considered, such as:

(a) effect of operating parameters (pressure, temperature, fluid, etc.)
(b) effect of static stresses
(c) effect of fluctuating stresses
(d) corrosion, erosion, abrasion
(e) creep

(f) modification of mechanical properties due to temperature, manufacturing process (forming, etc.), aging, etc.
(g) potential misuse of the Pressure Equipment during operation.

NOTE: Only hazards due to pressure need to be considered for the PED. Other hazards (such as electrical hazards, electromagnetic hazards, and transportation hazards) may be covered by other Directives.

7.3.2 Evaluation

Evaluate the hazards and risks to determine if the hazards and risks can be eliminated (using adequate safety margins in design, adequate materials, adequate testing and inspection, etc.) or reduced to an acceptable level (PED Annex 1, §1.2, first indent).

NOTE: This is not a risk evaluation. The severity and probability of risk is not in the scope of the PED, which does not account for the consequences of a failure of the Pressure Equipment. This appears clearly in the determination of the Hazard Category of the Equipment.

7.3.3 Reduction of Hazards

Reduce hazards and risks that cannot be eliminated by applying protective measures during operation of the Equipment.

7.3.4 Informing Users

Inform Users of residual hazards so that they can take adequate measures (PED Annex I-§1.2, third indent). This also covers potential misuse of the Equipment by the User during operation (PED Annex I-§1.3).

7.3.5 Documentation

The results of the hazard analysis shall be included in the Technical Documentation.

The ESR contained in Annex I apply only when the corresponding hazards due to the pressure existing on the Pressure Equipment under operating conditions that are “reasonably foreseeable by the Manufacturer” (PED Annex I—Preliminary Observations, §2).

8 MATERIALS (ARTICLE 15, ANNEX I, SECTION 4 OF THE PED)

8.1 General

(a) Before a material can be used in Pressure Equipment, it must comply with the applicable ESR specified in PED Annex I-§4 (also see paragraph 7.2.1.4 of this Guide):
- *(1)* The material shall have appropriate properties for all foreseeable operating and test conditions.
- *(2)* It shall be sufficiently ductile: e.g., 14% minimum elongation for steel.
- *(3)* It shall have sufficient notch toughness: 27J at 20°C (or 20 ft-lb at 68°F) for steel but not higher than the lowest scheduled operating temperature.
- *(4)* It shall be sufficiently chemically resistant to the fluid contained in the pressure equipment.
- *(5)* It shall not be significantly affected by aging.
- *(6)* It shall be suitable for the intended processing procedures during manufacture of the pressure equipment.
- *(7)* It shall be selected to avoid undesirable (e.g., galvanic) effects when different materials are joined.
- *(8)* It shall be suitable for such application during the scheduled lifetime unless replacement is foreseen.

(b) For selecting a material for Pressure Equipment, the Manufacturer has three options (Annex I-§4.2b of the PED):
- *(1)* Use material specification taken from an EN Material Harmonized Standard. Materials taken from these Standards are presumed to conform to the ESR and there will be no requirement to demonstrate compliance with the essential requirements for materials.
- *(2)* Use material covered by EAM as explained below. This procedure is only applicable for materials intended for repeated use.
- *(3)* Use of material covered by a PMA. Any material may be used in pressure equipment if it can be demonstrated that it complies with the ESR for the material.

8.2 Materials that Comply with Harmonized Materials Standards

A European standard may be adopted as a "Harmonized Standard" if the following conditions are fulfilled.

(a) Conforms to the addressed essential requirements
(b) Has an annex ZA
(c) Has been evaluated by the CEN consultant
(d) Is sent to the EC for publication in the OJEU. Harmonized Standards for materials devoted to pressure equipment are issued by CEN. Examples are as follows.
- *(1)* EN 10028 Series: Flat products made of steels for pressure purposes.
- *(2)* EN 10216 Series: Seamless tubes for pressure purposes.

8.3 European Approval of Pressure Equipment Materials (Article 15 of the PED)

8.3.1 General

When the Pressure Equipment material is not covered by a Harmonized Standard, the Manufacturer of Pressure Equipment can request an EAM to the NB.
The general procedure is as follows.

(a) The Manufacturer prepares a Data Sheet containing all the technical information relevant to the material specification.
(b) The NB performs appropriate inspections and tests to certify the conformity of the material to the applicable ESR. If the material was recognized as being safe before the implementation of the PED, the NB takes into account the existing data.

(c) The NB must comment on the material Data Sheet to the Member States and the European Commission who can disapprove the EAM within three months.
(d) If there is no disapproval during these three months the NB issues an EAM specification that will be published in the OJEU.
(e) This material specification is presumed to conform to the applicable ESR and can be used at any time. It has therefore the same status as a Harmonized Standard material.

An EAM is a technical document defining the characteristics of materials intended for repeated use in the manufacture of pressure equipment that are not covered by any harmonized standard.

An EAM will be issued, at the request of one or more Manufacturers of materials or equipment by an NB specifically designated for the task.

8.3.2 General Requirements for Obtaining EAMs of Pressure Equipment Materials

8.3.2.1 European Approvals of Nationally Approved Specifications of EU Member Countries for Pressure Equipment Materials.

EAMs are established by transforming the material specifications for pressure equipment originally covered in national standards of CEN member countries or in national technical material datasheets approved by the body competent for such approvals. The following requirements shall apply.

(a) The national material specification existed before the work on the relevant European Standard commenced.
(b) The material represents a real alternative to the materials covered in the relevant European Material Standard or an already existing European Approval for pressure equipment materials.
(c) The sampling and testing conditions are equivalent to, or more stringent than, those specified in the relevant European Material Standard.
(d) The requirements specified in the national specification shall in general be backed by statistical data.

8.3.2.2 EAM Covered in Non-EU Member Specifications

An EAM may be issued for a special or novel material grade not included in a European material standard harmonized under the PED. Such a material grade shall have a particular chemistry or specific mechanical properties or characteristics, such as corrosion resistance.
An EAM will not be issued for a grade of material listed in the current of former national material standard that has a specification covered by a harmonized European material standard.

NOTE: Guideline 7/26 includes additional information on European Approval of Materials. Note 2 to the Guideline further states the EAM shall be withdrawn by the NB if the type of material is covered by a harmonized standard.

8.3.2.3 Procedure for Incorporation of Existing National Material Specifications into European Material Data Sheets (EMDS)

8.3.2.3.1 Applications

Applications shall be made in writing to an NB for incorporation of the material specification.

8.3.2.3.2 The NB Shall Verify the Requirements of Annex I in the PED

Where appropriate, the NB shall complete a questionnaire with the assistance of the applicant. After consideration, the NB shall prepare a draft EMDS. The draft EMDS may contain restrictions or

supplementary requirements to ensure compliance of the specified material with the requirements of the main part.

The draft EMDS shall be submitted to the EU Member States and the European Commission.

8.4 PMA (Annex I-§4.2c of the PED)

This approach is intended for a material that is not listed in a Harmonized Standard or for which an EAM has not been issued. It shall be in the following form:

(a) The pressure equipment manufacturer shall always provide in his technical documentation for compliance with the material specifications of the Directive. It shall be in the form of PMA if the material is not listed in a Harmonized Standard.

(b) Where the pressure equipment is Category III or Category IV, a specific assessment of the PMA shall be performed by the NB in charge of CA procedures for the pressure equipment.

The material specification shall be reviewed for compliance with the ESR and, if necessary, additional tests must be carried out.

A PMA indicates that the Material complies with the applicable ESR, but is limited to its application to the conditions specified. If the vessel manufacturer wants to use the material outside that range, it must reapply to the NB for extension of the approval.

To grant approval, the NB may require additional tests to be carried out. Subject to these results, the NB may approve the use of the material for those particular conditions. Decisions made concerning the suitability of a material within a specified range of conditions do not need to be repeated.

8.5 Material Certificates (Annex I-§4.3 of the PED)

All materials shall have documentation, issued by the Material Manufacturer, which confirms compliance with an appropriate material specification. Where the component is a main pressure part of equipment in Category II, III, or IV, this documentation shall be a Certificate of specific product control, e.g., EN 10204, Type 3.1. Certificates of Conformity (e.g., Type 2.2) are acceptable only for pressure equipment in Category I.

8.6 Material Manufacturers

Material certificates issued by Material Manufacturers that hold certification, issued by a European Accredited Certification Body, can be presumed by the Pressure Equipment Manufacturer to comply with the relevant material ESR.

Where the Material Manufacturer does not have such certification, its certificates are not presumed to comply with the relevant requirements and, therefore, it is up to the Pressure Equipment Manufacturer to determine if the certificate is acceptable or if independent inspection is required. The Pressure Equipment Manufacturer may also need to convince the NB that the Material Manufacturer's certificates are acceptable. Direct inspection by a Competent Body, appointed by the Pressure Equipment Manufacturer, is an appropriate route. An alternative to the quality system certification of the manufacturer is Type 3.2 certification of conformance.

There are two options for Manufacturers with ISO 9001 Certification without a Legal Entity in the EU:

(a) Annex I, paragraph 4.3 assessment by Notified Body

(b) Type 3.2 certification.

9 NOTIFIED BODIES (ARTICLE 24 OF THE PED)

(a) The PED provides for the involvement of an NB to assess the conformity of the Equipment to the requirements of the PED.

(b) These NBs shall comply with various requirements in terms of technical competence, organization, independence, etc. (See PED, Article 24).

They are designated by the official authorities of each Member State, who notify the references of these bodies to the Commission of the EC. The Commission publishes the list of the NB in the OJEU.

(a) The Manufacturer may select any of the NB from this list.

(b) According to the PED, the approval of permanent joining procedures, joint operators (particularly welders) and NDT operators may also be performed by RTPOs (PED Article 24); however, an NDT examiner may only be qualified by the RTPOs.

These entities shall comply with criteria similar to those of the NB.

10 CE MARKING (ARTICLE 18, ARTICLE 19, OF THE PED)

(a) The CE Marking is the visual symbol affixed on an Equipment placed on the EU market. It attests that the Equipment complies with all the provisions of the PED (Article 12). This marking allows the free movement of the Equipment in the territory of the EU.

(b) The CE Marking is affixed by the Manufacturer, who takes in this way the responsibility to declare that the Equipment complies with the requirements of the Directive.

(c) A product may be subject simultaneously to various New Approach Directives. Thus, a piece of Equipment might be subject to the Machinery Directive if it is made of mobile parts, to the Low Voltage Directive if electrical energy is involved, etc.

In such cases, a single CE Marking must be affixed, which attests the compliance with all applicable Directives. It is therefore the responsibility of the Manufacturer to verify the list of Directives to which the equipment may be subjected.

The size of the CE Marking shall meet certain rules (see Article 30 of EC Regulation no. 765 / 2008).

11 SPECIFIC ISSUES

11.1 Assemblies (Article 6, Article 12 of the PED)

(a) PED covers also Assemblies, which are defined in the PED (Article 2-§6) as "several pieces of Pressure Equipment assembled by a Manufacturer to constitute an integrated and functional whole." Typical examples are pressure-cookers and boilers. Two cases are possible:
- *(1)* If the Manufacturer of an assembly intends to place it on the European Market and put it into service as an assembly (and not in the form of its constituent non-assembled elements), that assembly shall comply with the PED.
- *(2)* If the assembly of Pressure Equipment is performed by the user on its site and under its responsibility (as in the case of industrial installations), that assembling operation is outside the scope of the PED.

(b) The following requirements apply:
- *(1)* Assemblies including at least a Pressure Equipment above the thresholds shall comply with the ESR (Article 4-§2 of the PED).
- *(2)* Assessment of the integration of the various Equipment of the assembly is determined by the highest Category of its Equipment, ignoring Safety Accessories. Design shall be conducted as stated in Annex I-§2.8 of the PED.

(c) Clauses of PED dealing with assemblies:
- *(1)* Article 2-§6: Definition
- *(2)* Article 4-§2(a): Boilers
- *(3)* Article 14-§6: CA
- *(4)* Article 19-§3: CE Marking
- *(5)* Annex I-§2.8: Design
- *(6)* Annex I-§3.2.3: Inspection of Safety Devices.

11.2 User Inspectorates (Article 25 of the PED)

(a) Member States may authorize in their territory the placing on the market, and the putting into service by Users, of Pressure Equipment whose conformity with the essential requirements has been assessed by a User Inspectorate (Article 16-§1 of the PED).

(b) Tasks and responsibilities of an NB may be transferred to a User Inspectorate under the following conditions.
- *(1)* the User Inspectorate has been designated by one of the Member States (Article 16-§6 and 7 of the PED)
- *(2)* the Equipment must be assessed according to one of the following modules: A2, C2, F, or G (Article 16-§5 of the PED)
- *(3)* the User Inspectorate shall act exclusively for the organization of which he or she is part

(c) The consequences are as follows.
- *(1)* the Equipment so assessed shall not bear the CE Marking (Article 16-§2 of the PED)
- *(2)* the Equipment may be used only in establishments operated by the group of which the User Inspectorate is part (Article 16-§3 of the PED)

11.3 Specific Cases

The following specific cases do not follow the general rules of the PED and the User should refer to the concerned Articles of the PED.

(a) Heat exchangers consisting of pipes for the purpose of cooling or heating air. (See Article 1-§2(f) of the PED)

(b) Unfired Pressure Vessels and Boilers containing dangerous fluids (Group1), classified in Hazard Category III or IV and assessed by QA procedures. (See Article 14-§4 of the PED)

(c) Boilers of one-off production in Hazard Category III and module H. (See Article 14-§5 of the PED)
(d) Vessels containing a dangerous unstable gas in Hazard Category I or II. (See Annex II, Table 2 of the PED)
(e) Piping containing a dangerous unstable gas in Hazard Category I or II. (See Annex II, Table 6 of the PED)
(f) Portable extinguishers and bottles for Breathing Equipment. (See Annex II, Table 2 of the PED)
(g) Pressure-cookers. (See Annex II, Table 5 of the PED)
(h) Piping containing gas at T <350°C, in Hazard Category II. (See Annex II, Table 7 of the PED)

11.4 Manufacturer's Responsibility

(a) The PED lays down definitions and responsibilities for the Manufacturer, the Authorized Inspector (AI), the NB, the Importer, and the Distributor.

In the New Legislative Framework (the New Approach), "the Manufacturer is the person who is responsible for designing and manufacturing a product with a view of placing it on the European Market on his behalf." This definition, means that the Manufacturer is fully responsible for the design of the Pressure Equipment. There is no allowance made for sharing the responsibility with the User or an engineering contractor or designer.

The Manufacturer can subcontract the Design but will remain fully responsible for the Pressure Equipment when placed on the market or put into service in Europe.

(b) The responsibility of the Manufacturer appears explicitly in the PED at the following clauses:
(1) *Article 6, Obligations of Manufacturers*: "the CA Procedures of Annex III, at its choice."
(2) *Annex I, Preliminary Observations, §3*: "The Manufacturer is under an obligation to analyze the hazards and risks in order to identify those which apply to his Equipment on account of pressure; he shall then design and construct it taking account of his analysis."
(3) *Annex I-§1 (General)*: shows the responsibility of the Manufacturer pertaining to design and manufacture the construction of his Equipment.
(4) *Annex I-§2 (Design)*: shows the responsibility of the Manufacture pertaining to the Design of his Equipment.
(5) *Annex I-§3 (Manufacturing):* The manufacturer is responsible for selecting the appropriate conformity procedure and the documentation.
(6) *Annex I-§4 (Materials)*: "Materials used for the manufacture for the Equipment shall be suitable for such application during the scheduled lifetime."
(7) *Annex III (CA Procedures)*: Whatever are the CA Procedures selected by the Manufacturer, its responsibilities are as follows:
(8) More details on the Manufacturer's responsibility is given in Appendix H of this Guide, which covers the following items.
(i) responsibility of the Manufacturer
(ii) placing on the market and putting into service

(c) The Manufacturer is also responsible to ensure its product complies with the obligations of all Directives which apply to it. The Manufacturer shall affix the CE Marking to each Pressure Equipment. By affixing the CE Marking, the Manufacturer officially declares that its product complies with all relevant Directives.

11.5 Operating Instructions

When pressure equipment is placed on the market, it shall be accompanied, as far as relevant, by instructions for the user, containing all the necessary safety information relating to:

- *(a)* information as affixed to the equipment and required by Annex I, §3.3 of the PED (Marking and Labeling) with the exception of serial identification
- *(b)* necessary safety information (see Annex I, §3.4 of the PED) relating to
  - *(1)* mounting, including assembling of different pieces of pressure equipment
  - *(2)* putting into service
  - *(3)* use
  - *(4)* maintenance, including checks by the user
  - *(5)* drawings necessary for a full understanding of the information, if applicable
- *(c)* In particular, this information shall include the elements of the design files used for the in-service verification or for eventual modifications or repairs, such as materials nature, minimal design thicknesses, corrosion allowance, joints coefficients.

Where appropriate, this information shall be accompanied by the technical documents for a full understanding of this information and instructions.

Furthermore, for all the modules, a Declaration of Conformity (see Annex VII of the PED) is established by the Manufacturer and for modules F and G, a Certificate of Conformity is established by the NB.

The Directive does not specify that these two documents shall be given with the equipment but they can be furnished on request.

12 COMPARISON OF ASME AND PED REQUIREMENTS

Figure 12-1: Comparison of ASME Section I Requirements with PED 2014/68/EU, Annex I

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
1	**2**	**4**	**5**	**6**	**7**	**8**
1						
	PRELIMINARY OBSERVATIONS					
1.	The obligations arising from the essential requirements listed in this annex for pressure equipment also apply to assemblies where the corresponding hazard exists.	See Art. 2, Point 6 for definition of "assemblies"	Yes	PG-11 PG-58 PG-59 PG-60 PG-67 PG-68 PG-71	Sect. I covers the complete boiler assembly, including piping, appurtenances, and safety relief devices	
2.	The essential requirements laid down in the directive are compulsory. The obligations laid down in these essential requirements apply only if the corresponding hazard exists for the pressure equipment in question when it is used under the conditions that are reasonably foreseeable by the manufacturer.	Informative statement				
3.	The manufacturer is under an obligation to analyze the hazards and risks in order to identify those which apply to his equipment on account of pressure; He shall then design and construct it taking account of his analysis.		None None		Sect. I does not require hazard analysis.	Note 1 Note 2
4.	The general requirements are to be interpreted and applied in such a way as to take account of the state of the art and current practice at the time of design and manufacture as well as of technical and economic considerations that are consistent with a high degree of health and safety protection.	Informative statement	Yes	Foreword, Preamble	Note A	

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
1.	GENERAL					
1.1	Pressure equipment must be designed, manufactured, and checked and, if applicable, equipped and installed in such a way as to ensure its safety when put into service in accordance with the manufacturer's instructions, or in reasonably foreseeable conditions.		Partial	Sect. I, Foreword	Note B	Note 3, Note 4
1.2	In choosing the most appropriate solutions, the manufacturer shall comply with the principles set out below in the following order:		Partial			
	a) Eliminate or reduce hazards as far as is reasonably practicable	Hazards during operation of the vessel	Yes			Note 5
	b) Apply appropriate protection measures against hazards that cannot be eliminated	Pressure relief devices, temperature controls, low-water cutoffs, etc.	Yes	PG-67 through PG-73, PMB-17 & PEB-16		
	c) Where appropriate, inform users of residual hazards and indicate whether it is necessary to take appropriate special measures to reduce risks at the time of installation and/or use.		None			
1.3	Where the potential for misuse is known or can be clearly foreseen, the pressure equipment shall be designed to prevent danger from such misuse or,		Yes	PG-60, PG-61		Note 6
	If that is not possible, adequate warning (must be) given that the pressure equipment must not be used in that way.		Partial		Note B	

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
2	**DESIGN REQUIREMENTS**					
2. 2.1	DESIGN General					
	The pressure equipment shall be properly designed taking all relevant factors into account in order to ensure that the equipment will be safe throughout its intended life. The design shall incorporate appropriate safety coefficients using comprehensive methods such as are known to incorporate adequate safety margins against all relevant failure modes in a consistent manner.	(The PED does not define how this is to be accomplished in a "consistent manner.")	Partial Yes	PG-16, PG-23 through PG-38, PG-43, PG-46, PG-52, PG-53 and PW-9 See above	Note C Note D	Note 4
2.2 2.2.1	Design for Adequate Strength The pressure equipment shall be designed for loadings appropriate to its intended use and other reasonably foreseeable operating conditions. In particular, the following factors shall be taken into account: a) Internal/external pressure,		Partial Yes	PG-22 PG-27		
	b) Ambient and operational temperatures,		Yes	PG-21 and PG-27		
	c) Static pressure and mass of contents in operating and in test conditions,		Yes	PG-22.1		
	d) Traffic, wind, earthquake loading,		Partial	PG-22.1	Except traffic.	
	e) Reaction forces and moments that result from the supports, attachments, piping, etc.		Yes	PG-22.2, B31.1 Sect. 119		
	f) Corrosion and erosion, fatigue, etc.		Partial	PG-27.4, Note 3, B31.1 §102.4	Sect. I addresses need, not how to analyze	
	g) Decomposition of unstable fluids.		None		Note E	Note 7

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	h) Various loadings that can occur at the same time shall be considered, taking into account the probability of their simultaneous occurrence.		Yes	PG-22, B31.1 §101.5		
2.2.2	Design for adequate strength shall be based on: 1. as a general rule, a calculation method, as described in 2.2.3, and		Yes	PG-27 through PG 53,		
	2. supplemented if necessary by an experimental design method as described in 2.2.4, or		Partial	PG 100		Note 8
	3. an experimental design method without calculation, as described in 2.2.4, when the product of the maximum allowable pressure PS and the volume V is less than 6000 bar x L, or the product PS x DN less than 3,000 bar		Partial		There is no limit on pressure and volume in PG 100	
2.2.3	Calculation method (a) Pressure containment and other loading aspects. The allowable stresses for pressure equipment shall be limited having regard to reasonably foreseeable failure modes under operating conditions.		Yes	PG-23		
	To this end, safety factors must be applied to eliminate fully any uncertainty arising out of manufacture, actual operational conditions, stresses, calculation models and the properties and behavior of the material.	(It is not possible to fully eliminate any uncertainty).	Yes	PG-23		
	These calculations methods shall provide sufficient safety margins consistent, where applicable, with the requirements of Sect. 7.	See Fig. 12-2: Q1 of this Guide	Yes	Sect. II, Part D, App.1		
	The requirements set out above may be met by applying one of the following methods, as appropriate, if necessary as a supplement to or in combination with another method:					
	(1) design by formula		Yes	PG-27 to PG-53		

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	(2) design by analysis		Partial			
	(3) design by fracture mechanics	Not applicable				
	(b) Resistance Appropriate design calculations shall be used to establish the resistance of the pressure equipment concerned.		Yes			
	In particular: *(1)* the calculation pressures shall not be less than the maximum allowable pressures and take into account static head, and dynamic fluid pressures; and the decomposition of unstable fluids. Where a vessel is separated into individual pressure-containing chambers, the partition wall shall be designed on the basis of the highest possible chamber pressure relative to the lowest pressure possible in the adjoining chamber. *(2)* the calculation temperatures shall allow for appropriate safety margins, *(3)* the design shall take appropriate account of all possible combinations of temperature and pressure which might arise under reasonably foreseeable operating conditions for the equipment *(4)* the maximum stress and peak stress combinations must be kept within safe limits. *(5)* the calculation for pressure containment shall utilize the values appropriate to the properties of the material, based on the documented data, having regard to the provisions set out in Point 4 together with the appropriate safety factors.	See Fig 7-1 of this Guide for the PED design factors	Yes Yes Yes None Yes Yes Yes Yes Yes Yes Yes	PG-21 PG-22.1 PG-16.2 PG-21, Note 9 PG-21, Note 9, PG 27-4, Note 2 PG-22, PG-23 PG-23 and Sect. II, Part D, App. 1	Note E	Note 7

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	Materials characteristics to be considered, where applicable, include:		Partial			
	(a) yield strength, 0.2% or 1.0% proof strength as appropriate at the calculation temperature,		Yes	PG-5, PG-23		
	(b) tensile strength,		Yes	PG-23 and Sect. II, Part D, App. 1		
	(c) time-dependent strength, i.e. creep strength,		Partial	PG-23 and Sect. II, Part D, App. 5	Note I	
	(d) fatigue data,		Partial	PG-22	Note F	
	(e) Young's modulus (modulus of elasticity),		Yes	Sect. II, Part D, App.5		
	(f) appropriate amount of plastic strain,		Partial		Note G	Note 9
	(g) impact strength,		None			Note 33
	(h) fracture toughness,		None			Note 33
	(6) appropriate joint facts shall be applied to the materials properties depending, for example, on the type of NDT, the materials joined an the operating conditions envisaged,	See 7.2.1.4 of this Guide	Partial	PG-27.4, Note 1, PW-11 and PW-41	Note H	
	(7) the design shall take appropriate account of all reasonably foreseeable degradation mechanisms (e.g. corrosion, creep, fatigue) commensurate with the intended use of the equipment.		Yes	PG-22, PG-23, PG-27 Note 3 and Sect. II, Part D, App. 6	Note I	
	Attention shall be drawn, in the instructions referred to in Point 3.4, to particular features of the design which is relevant to the life of the equipment, for example:					Note 3
	(a) for creep; design hours of operation at specified temperatures,		Partial		Note I	Note 10
	(b) for fatigue: design number of cycles at the specified stress levels,		Partial		Note J	Note 10

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	(c) for corrosion: design corrosion allowance;		None		Note K	
	(d) Stability Aspects Where the calculated thickness does not allow for adequate structural stability, the necessary measures shall be taken to remedy the situation taking into account the risks from transport and handling.	Including transport of original vessel	Yes Partial	PG-22 PG-55	Note L	Note 11
2.2.4	Experimental design method					
	The design of the equipment may be validated, in all or in part, by an appropriate test program carried out on a sample representative of the equipment or the category of equipment. The test program shall be clearly defined prior to testing and accepted by the notified body responsible for the design CA module, where it exists. This program 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.		Yes None Yes Yes Yes	App. A-22 App. A-22.10 and PG 91.1.5 App. A-22.11.3 App. A-22.11.1	 Note M 	 Note 12

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	The test program 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 sufficient leaks or deterioration exceeding a determined threshold.		Yes	App. A-22	Notes N, O	
	The test pressure shall be determined on the basis of the differences between the values of the geometrical and material characteristics measures under test conditions and the values used for design purposes; it shall take into account the differences between the test and design temperatures; (b) Where the risk of creep or fatigue exists, appropriate tests determined on the basis of the service conditions laid down for the equipment, for instance, hold time at specified temperatures, number of cycles at specified stress-levels, etc.; (c) Where necessary, additional tests concerning other factors referred to in 2.2.1 such as corrosion, external damage, etc.		Yes Yes None None	App. A-22 App. A-22	Note P Note J	Note 8 Note 8
2.3	Provisions to ensure safe handling and operation The method of operation specified for pressure equipment shall be such as to preclude any reasonable foreseeable risk in operation of the equipment. Particular attention shall be paid, where appropriate, to: a) closures and opening;		None Partial	PG-32 through PG-44, PFT-43, PWT-14	Note Q	Note 13

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	b) dangerous discharge of pressure relief blow-off c) devices to prevent physical access while pressure or vacuum exists, d) surface temperature taking into consideration the intended use e) decomposition of unstable fluids.		Partial None None None	B31.1, App. II		
	In particular, pressure equipment fitted with an access door shall be equipped with an automatic or manual device enabling the user easily "to ascertain that the opening will not present any risk". Furthermore, where the opening can be operated quickly, the pressure equipment shall be fitted with a device to prevent it being opened whenever the pressure or temperature of the fluid presents a risk.		Partial N/A	PWT-14	Note R Boilers are typically not fitted with quick-actuating closures	Note 14
2.4	Means of examination (a) Pressure equipment shall be designed and constructed so that all necessary examinations to ensure safety can be carried out; (b) Means of determining the internal condition of the equipment shall be available, where it is necessary to ensure the continued safety of the equipment, such as access openings allowing physical access to the inside of the pressure equipment so that appropriate examinations can be carried out safely and ergonomically; (c) Other means of ensuring the safe condition of the pressure equipment may be applied in any of the following situations : *(1)* where it is too small for physical internal access, or		Partial Yes Yes Yes	Part PG, Part PW PG-44, PWT-14, and PFT-43 PG-44	Implied, but rules are not given for inspection stubs, etc. Note S Handholes are required	

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	(2) where opening the pressure equipment would adversely affect the inside, or *(3)* where the substance contained has been shown not to be harmful to the material from which the pressure equipment is made and no other internal degradation mechanisms are reasonably foreseeable.		N/A N/A		Does not apply to boilers Sect. I requires all boilers to have inspection openings	Note 15
2.5	Means of draining and venting Adequate means shall be provided for draining and venting of pressure equipment where necessary: a) to avoid harmful effects such as water hammer, vacuum collapse, corrosion and uncontrolled chemical reactions. b) All stages of operations and testing, particularly pressure testing, shall be considered, c) to permit cleaning, inspection, and maintenance in a safe manner.		 Yes Yes Yes Yes	 PG-59.4 and B31.1 §122.1.5 PG-59.1 PG-59.4 PG-59.3 and PG-59.4	 Note T Note U Note V Ample drains are required for all boiler components Blowoff connections are required	 Note 16
2.6	Corrosion or other chemical attack Where necessary, adequate allowance or protection against corrosion or other chemical attack shall be provided, taking due account of the intended and reasonably foreseeable use.		 Partial	 PG-5.5, Note 1, PG-27.4, Note 3		Note 17
2.7	Wear Where severe conditions of erosion or abrasion may arise, adequate measures shall be taken to: a) minimize the effect by appropriate design, e.g. additional material thickness, or by the use of liners or cladding materials,		 Partial Partial	 B31.1 §102.4 B31.1 §102.4	 Note W	 Note 18

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	b) permit replacement of parts which are most affected, c) draw attention, in the instructions referred to in Point 3.4, to measures necessary for continued safe use.		Partial None		Boiler components such as piping and tubing are accessible for replacement Note B	 Note 3
2.8	Assemblies <u>Assemblies shall</u> be so designed that: a) the components to be assembled together are suitable and reliable for their duty, b) all the components are properly integrated and assembled in an appropriate manner.		 Yes Yes	 Part PG and Part PW	 Note X	 Note 19
2.9	Provisions for filling and discharge <u>Where appropriate</u>, the pressure equipment shall be so designed and provided with accessories, or provisions made for their fitting, as to ensure safe filling and discharge in particular with respect to hazards such as: (a) on filling: 1. overfilling or over pressurization having regard in particular to the filling ratio and to vapor pressure at the reference temperature 2. instability of the pressure equipment (b) on discharge: the uncontrolled release of the pressurized fluid; (c) on filling or discharge: unsafe connection and disconnection.		 N/A N/A N/A N/A N/A		 Note Y Note Y	
	SAFETY DEVICES REQUIREMENTS					

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
2.10	Protection against exceeding the allowable limits of pressure equipment Where under reasonably foreseeable conditions, the allowable limits could be exceeded, the pressure equipment shall be fitted with, or provisions made for the fitting of, suitable protective devices, within an assembly.		Yes	PG-67 through PG-73		
	The suitable device or combination of such devices shall be determined on the basis of the particular characteristics of the equipment or assembly.		Yes	PG-67 through PG-73		
	Suitable protective devices and combinations thereof comprise: (a) safety accessories as defined in Article 2, Point 4; (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.		Yes Yes	PG-67 through PG-73 PG-60.1, PG-60.2, PG 60.6, PFT-47, PMB-13, PMB-17, PEB-13, and PEB-16	Note Z	Note 20
2.11	Safety accessories					
2.11.1	Safety accessories shall: a) be so designed and constructed as to be reliable and suitable for their intended duty and take into account the maintenance and testing requirements of the devices, where applicable,		Yes	PG-67 through PG-73		

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	b) be independent of other functions, unless their safety function cannot be affected by such other functions, c) comply with the appropriate design principles in order to obtain suitable and reliable protection. These principles include, in particular, fail-safe modes, redundancy, diversity, and self-diagnosis.		Yes Yes	PG-71 and PVG-12.3.4 PG-60.3, PG-61	 Note AA	 Note 21
2.11.2	Pressure limiting devices The devices shall be so designed that the pressure will not permanently exceed the maximum allowable pressure PS; however, a short duration pressure surge in keeping with the specifications laid down in Point 7.3 is allowable, where appropriate.	Pressure surge is limited to 10% by in 7.3 of the PED.	Yes	PG-67		
2.11.3	Temperature monitoring devices These devices shall have an adequate response time on safety grounds, consistent with the measurement function.		Partial	PEB-16	Note BB	Note 22
2.12	External fire Where necessary, pressure equipment shall be so designed and, where appropriate, fitted with suitable accessories, or provision made for their fitting, to meet damage-limitation requirements in the event of external fire, having particular regard to the intended use.		N/A		Intended for pressure vessels	
	FABRICATION REQUIREMENTS					
3	MANUFACTURING					

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
3.1	Manufacturing procedures The manufacturer shall ensure the competent execution of the provisions set out at the design stage by applying the appropriate techniques and relevant procedures, especially with the view to the aspects set out below.		Yes	PG-75 through PG-82		
3.1.1	Preparation of the component parts Preparation of the component parts (e.g., forming and chamfering) shall not give rise to defects or cracks or changes in the mechanical characteristics likely to be detrimental to the safety of the pressure equipment.		Yes	PG-11, PG-75 through PG-82, PW-29, and PW-33		
3.1.2	Permanent joining Permanent joints and adjacent zones shall be free of any surface or internal defects detrimental to the safety of the equipment. The properties of permanent joints shall meet the minimum properties specified for the materials to be joined unless other relevant property values are specifically taken into account in the design. For pressure equipment, permanent joining of components which contribute to the pressure resistance of the equipment and components which are directly attached to them shall be carried out by suitably qualified personnel according to suitable operating procedures.		Yes Yes	PW-29 and PW-33 PW-5.4 and PW-28 PW-28	Note CC	

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	For pressure equipment in categories II, III, and IV, operating procedures and personnel shall be approved by a competent third party which, at the manufacturer's discretion, may be: *(a)* a notified body, *(b)* A third party organization recognized by a Member State as provided in Article 20. To carry out these approvals the third party shall perform examinations and tests as set out in the appropriate harmonized standards or	See harmonized standard EN ISO 15607 for welding procedure qualifications	None None None			Note 23 Note 24
	equivalent examinations and tests or must have them performed.		Partial Partial	PW-28 PW-28		
3.1.3	Non-destructive tests For pressure equipment, non-destructive tests of permanent joints shall be carried out by suitable qualified personnel. For pressure equipment in categories III and IV the personnel shall be approved by a third party organization recognized by a Member State pursuant to Article 20.		Yes Partial	PW-51 and PW-52		Note 25
3.1.4	Heat treatment Where there is a risk that the manufacturing process will change the material properties to an extent which would impair the safety of the pressure equipment, suitable heat treatment shall be applied at the appropriate stage of manufacture.		Yes	PW-38 and PW-39		

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
3.1.5	Traceability Suitable procedures shall be established and maintained for identifying the material making up the components of the equipment which contribute to pressure resistance by suitable means from receipt, through production, up to the final test of the manufactured pressure equipment.		Yes	PG-77, PG-90.1.6, PG-90.1.7, and App. 302.4		
	INSPECTION REQUIREMENTS					
3.2	Final assessment Pressure equipment shall be subjected to final assessment as described below:	Final inspection plus proof test				
3.2.1	Final inspection Pressure equipment shall undergo a final inspection to assess visually and by examination of the accompanying documents compliance with the requirements of the Directive. Tests carried out during manufacture may be taken into account As far as is necessary on safety grounds, the final inspection shall be carried out internally and externally on every part of the equipment, where appropriate in the course of manufacture (e.g. where examination during the final inspection is no longer possible).		Yes Partial Yes	PG-90.1.13, PG-99.2 PG-90, PG-1121 and App. A-350 through A-357 PG-90, PG-93		Note 26
3.2.2	Proof test					

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	Final assessment of pressure equipment shall include a test for the pressure containment aspect, which will normally take the form hydrostatic pressure test at a pressure at least equal, where appropriate, to the value laid down in Point 7.4. For category I series produced equipment, this test may be performed on a statistical basis. Where the hydrostatic pressure test is harmful or impractical, other tests of a recognized value may be carried out. For test other than the hydrostatic pressure test, additional measures, such as non-destructive tests or other methods of equivalent validity, shall be applied before those tests are carried out.		Yes N/A Yes	PG-99 B31.1 Sect. 137	Note DD Sect. I has no provisions for series produced boilers B31.1 allows for alternatives to hydro testing, Sect. I does not.	
3.2.3	Inspection of safety devices For assemblies, the final assessment shall also include a check of the safety devices intended to check full compliance with the requirements referred to in Point 2.10.		Yes	PG-90.1.14, PG-90.1.15, and PG-112.2.8	Note Z	
3.3	Marking and labeling In addition to the CE marking referred to in Articles 18 & 19 and the information to be provided in accordance with Article 6(6) and Article 8(3) of the PED, the following information shall be provided: (a) For all pressure equipment: 1. the name and address or other means of identification of the manufacturer and, where appropriate, of his authorized representative established within the European Community;		Yes	PG-106 through PG-111	This can be on one or more nameplates. Note EE	Note 27

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	2. The year of manufacture,		Yes	PG-106 through PG-111		
	3. Identification of the pressure equipment according to its nature, such as type, series or batch identification and serial number,		Yes	PG-106.4.1	Serial number on stamping plate.	
	4. Essential maximum/minimum allowable limits;		Yes	PG-106.4.1		
	(b) Depending on the type of pressure equipment, further information necessary for safe installation, operation or use and, where applicable, maintenance and periodic inspection, such as: 1. the volume V of the pressure equipment in L, 2. the nominal size for piping DN, 3. the test pressure PT applied in bar and date, 4. safety device set pressure in bar, 5. output of the pressure equipment in kW,		None		Generally not required in Sect. I.	Note 27
	6. supply voltage in V (volts), 7. intended use, 8. filling ration kg/L, 9. maximum filling mass in kg, 10. tare mass in kg, 11. the fluid group; *(c)* where necessary, warnings fixed to the pressure equipment drawing attention to misuse which experience has shown might occur.		None		Not included in Sect. I requirements.	Note 28

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	The information referred to in Points a, b, and c of Annex I shall be given on the pressure equipment or on a data plate firmly attached to it, with the following exceptions: 1. where applicable, appropriate documents may be used to avoid repetitive marking of individual parts such as piping components, intended for the same assembly. This applies to CE marking and other marking and labeling referred to in this Annex; 2. where the pressure equipment is too small, e.g., accessories, the information referred to in (b) may be given on a label attached to that pressure equipment; 3. labeling or other adequate means may be used for the mass to be filled and the warnings referred to in (c), provided it remains legible for the appropriate period of time.		Partial Yes Yes None	PG-106 PG-106.8.2 and PG-109 PG-106.8.2	Sect. I does not cover CE marking. Refers to the permanence of warnings affixed to the boiler	Note 29
3.4	Operating instructions (a) When pressure equipment is placed on the market, it shall be accompanied, as far as relevant, with instructions for the user, containing all the necessary safety information relating to: 1. mounting including assembling of different pieces of pressure equipment, 2. putting into service, 3. use, 4. maintenance including checks by the user. (b) Instructions shall cover information affixed to the pressure equipment in accordance with Point 3.3, with the exception of serial identification, and		None		Note B	Note 3

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	shall be accompanied, where appropriate, By the technical documents, drawings, and diagrams necessary for a full understanding of these instructions; (c) If appropriate, these instructions must also refer to hazards arising from misuse in accordance with Point 1.3 and particular features of the design in accordance with Point 2.2.3.					
	MATERIAL REQUIREMENTS					
4.	MATERIALS Materials used for the manufacture of pressure equipment must be suitable for such application during the scheduled lifetime unless replacement is foreseen.		Yes	PG-5, PG-12, Sect. II, App. 6.		Note 30
	Welding consumables and other joining materials need fulfill only the relevant requirements of Points 4.1 and 4.2(a), and the first paragraph of Point 4.3, in an appropriate way, both individually and in a joined structure.		Yes	PW-5.4, Sect. II, Part C.		Note 31
4.1	Materials for pressurized parts must: (a) Have appropriate properties for all operating conditions which are reasonably foreseeable and for all test conditions, and in particular they should be sufficiently ductile and tough. Where appropriate, the characteristics of the materials shall comply with the requirements of Point 7.5.	As general rules, with the option of providing an equivalent overall level of safety. See PED Sect. 7.5	Partial Partial Partial Partial Partial	PG-5 through PG-12, Sect. II, Parts A, B, C, D. PG-5 through PG-12	For Sect. I applications, brittle-type fracture is not a	Note 32 Note 33 Note 34

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	Moreover, due care should be exercised in particular in selecting materials in order to prevent brittle-type fracture where necessary; where for specific reasons brittle material has to be used appropriate measures must be taken;		Partial Yes	Sect. II, Parts A, B, C, D. PG-8, PG-11	significant failure mode.	
	(b) Be sufficiently chemically resistant to the fluid contained in the pressure equipment;		Partial	PG-5, Note 1, PG-6, PG-7, PG-8 and PG-9	Note FF	Note 32
	the chemical and physical properties necessary for operational safety shall not be significantly affected within the scheduled lifetime of the equipment;		Partial	Sect. II, Part D, App. 5, 6.	Note FF	
	(c) Not be significantly affected by aging;		Partial	Sect. II, Part D, App. 5, 6.		Note 32
	(d) Be suitable for the intended processing procedures;	(Fabrication)	Yes	PG-6, PG-7, PG-8, PG-9		
	(e) Be selected in order to avoid significant undesirable effects when the various materials are put together.		Yes	PW-5, PW-28 and PW-39		
4.2	The pressure equipment manufacturer shall: (a) define in an appropriate manner the values necessary for the design calculations referred to in Point 2.2.3 and the essential characteristics of the materials and their treatment referred to in Point 4.1;		Yes Partial Partial	Sect. II Part D, App.1		Note 32 and 34
	(b) provide in his technical documentation elements relating to compliance with the material specification of the Directive in one of the following forms: 1. by using materials which comply with harmonized standards		None			Note 35

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	2. by using materials covered by a European approval of pressure equipment materials in accordance with Article 15, 3. by a PMA, (c) For pressure equipment in categories III and IV, particular appraisal as referred to in the third indent of (b) shall be performed by the notified body in charge of the CA procedures for the pressure equipment.	Performed by the NB for category III and IV vessels	None None None			Note 36
4.3	The equipment manufacturer shall take appropriate measures to ensure that the material used conforms to the required specification. In particular, documentation prepared by the material manufacturer affirming compliance with the specification shall be obtained for all materials.		Yes Yes	PG-77, App. A-302.4 PG-77, App. A-302.4		
	For the main pressure bearing parts of equipment in categories II, III, and IV, this shall take the form of certificate of specific product control. Where a material manufacturer has an appropriate quality-assurance system, certified by a competent body established within the Community and having undergone a specific assessment for materials, certificates issued by the manufacturer are presumed to certify conformity with relevant requirements of this section.		Partial None	PG-77, App. A-302.4		Note 37 Note 38
	SPECIFIC REQUIREMENTS FOR HEATED PRESSURE VESSELS					
	SPECIFIC PRESSURE EQUIPMENT REQUIREMENTS					

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	In addition to the applicable requirements of Points 1 to 4, the following requirements apply to the pressure equipment covered by Points 5 and 6.					
5	FIRED OR OTHERWISE HEATED PRESSURE EQUIPMENT WITH RISK OF OVERHEATING AS REFERRED TO IN ARTICLE 4(1)				Note HH	
	This pressure equipment includes: a) Steam and hot water generators as referred to in Article 4(1)(b), such as fired steam and hot-water boilers, superheaters and reheaters, waste-heat boilers, waste incineration boilers, electrode or immersion-type electrically heated boilers, pressure cookers, together with their accessories and	Scope statement	Partial	Preamble	Sect. I does not cover vessels in which steam is generated for internal use such as pressure cookers.	
	b) Process heating equipment for other than steam and hot water generation falling under Art. 4(1)(a), such as heaters for chemical and other similar processes and pressurized food-processing equipment. This pressure equipment shall be calculated, designed, and constructed so as to avoid or to minimize risks of a significant loss of containment from overheating. In particular it must be ensured, where applicable, that: (a) appropriate means of protection are provided to restrict operating parameters such as heat input, heat take-off and, where applicable, fluid level so as to avoid any risk of local and general overheating;		Partial Yes Yes	Preamble Part PG PG6-60 and PG-61	Unfired steam boilers can be built to either Sect. I or Sect. VIII.	

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	(b) sampling points are provided where required to allow evaluation of the properties of the fluid so as to avoid risks related to deposits and/or corrosion. (c) adequate provisions are made to eliminate risks of damage from deposits, (d) safe removal of residual heat after shutdown are provided, (e) steps are taken to avoid a dangerous accumulation of ignitable mixtures and combustible substances and air, or flame flowback.		Yes Yes None None	PG-59.3 and PG-59.4 PG-59.3		 Normally provided for by boiler designers Normally provided for by boiler designers
6.	PIPING AS REFERRED TO IN ARTICLES 4.1(c) of the PED	Internal and external piping comprising the complete boiler system		Note II		Note 39
	Design and construction must ensure:		Yes	PG-27.2.2, PG-58		
	(a) that the risk of overstressing from inadmissible free movement or excessive forces being produced, e.g., on flanges, connections, bellows, or hoses, is adequately controlled by means such as support, constraint, anchoring, alignment, and pre-tension; (b) that where there is a possibility of condensation occurring inside pipes for gaseous fluids, means are provided for drainage and removal of deposits from low areas to avoid damage from water hammer or corrosion. (c) that due consideration is given to the potential damage from turbulence and formation of vortices; the relevant parts of 2.7 are applicable;		Yes Yes Yes	PG-59.1.2; B31.1 §119, 120, 121 and 122.1.1 PG-58.3.7 and PG-59.4; B31.1 §'s 101.5.1 and 122.1.5 PG-59.2; B31.1 §102.4		

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	(d) that due consideration is given to the risk of fatigue due to vibrations in pipes; (e) that, where fluids of Group 1 are contained in the piping, appropriate means are provided to isolate "take-off" pipes the size of which represents a significant risk; (f) that the risk of inadvertent discharge is minimized; the take-off points must be clearly marked on the permanent side, indicating the fluid contained; (g) that the position and route of underground piping is at least recorded in the technical documentation to facilitate safe maintenance, inspection, or repair.		Yes N/A N/A None	PG-59.1.2; B31.1 §101.5.4 and App. D		Note 40 Note 41
	QUANTITATIVE REQUIREMENTS					
7.	SPECIFIC QUANTITATIVE REQUIREMENTS FOR CERTAIN PRESSURE EQUIPMENT					
	The following provisions apply as a general rule. However, where they are not applied, including in cases where materials are not specifically referred to and no harmonized standards are applied, the manufacturer must demonstrate that appropriate measures have been taken to achieve an equivalent overall level of safety. This section is an integral part of Annex I. The provisions laid down in this section supplement the essential requirements of Sect. 1 to 6 for the pressure equipment to which they apply.	Manufacturer can depart from these quantitative requirements, but it will have to prove to the NB that an equivalent level of safety is achieved.				Note 42
7.1	Allowable stresses					Note 43
7.1.1	Symbols					

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	$R_{e/t}$, yield limit, indicates the value at the calculation temperature of: a) upper flow limit for a material presenting upper and lower flow limits, b) the 1.0% proof strength of austenitic steel and non-alloyed aluminum c) the 0.2% proof strength in other cases. $R_{m/20}$ indicates the minimum value of the ultimate strength at 20°C $R_{m/t}$ designates the ultimate strength at the calculation temperature.	These quantitative requirements have been reincorporated in the previous sections.				
7.1.2	The permissible general membrane stress for predominantly static loads and for temperatures outside the range in which creep is significant must not exceed the smaller of the following values, according to the material used:	Included in Fig. 12-2: Q1 of this Guide	Yes	Sect. II, Part D, Table 1A and App. 1.	Note GG	Note 44
	a) in the case of ferritic steel including normalized (normalized rolled) steel and excluding fine grain steel and specially heat-treated steel, 2/3 of $R_{e/t}$ and 5/12 of $R_{m/20}$; b) in the case of austenitic steel: 1. if its elongation after rupture exceeds 30%, 2/3 of $R_{e/t}$ 2. or, alternatively, and if its elongation after rupture exceeds 35%, 5/6 of $R_{e/t}$, and 1/3 of $R_{m/20}$; c) in the case of non-alloy or low alloy cast steel, 10/19 of $R_{e/t}$ and 1/3 of $R_{m/20}$; d) in the case of aluminum, 2/3 of $R_{e/t}$; e) in the case of aluminum alloys, excluding precipitation hardening alloys, 2/3 of $R_{e/t}$ and 5/12 of $R_{m/20}$.					Note 45

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
7.2	Joint coefficients For welded joints, the joint coefficient must not exceed the following values: a) for equipment subject to destructive and nondestructive tests which confirm that the whole series of joints show no significant defects: 1, b) for equipment subject to random NDT: 0.85,	To be applied as a general rule. Demonstration of an equivalent overall level of safety required by Annex I, §2.2.3(b). Also included in Fig. 12-3: Q2 of this Guide	Yes	PG-27.4, Note 1, PW-11 and PW-41		
	c) for equipment not subject to NDT other than visual inspection: 0.7. <u>If necessary</u>, the type of stress and the mechanical and technological properties of the joint must also be taken into account.		Yes	PG-39.6, PFT-12.2, and PWT-11		
7.3	Pressure limiting devices, particularly for pressure vessels The momentary pressure surge referred to in 2.11.2 must be kept to 10% of the maximum allowable pressure.		Yes	PG-67.2	PG-67.2 limits this to 6%.	
7.4	Hydrostatic test pressure					
	For pressure vessels, the hydrostatic test pressure referred to in 3.2.2 must be no less than: a) that corresponding to the maximum loading to which the pressure equipment may be subject in service, taking into account its maximum allowable pressure and its maximum allowable temperature, multiplied by the coefficient 1.25, or b) the maximum allowable pressure multiplied by the coefficient 1.43, whichever is the greater.	Included in Fig. 12-4:Q3 of this Guide. See 7.2.1.3.3 of this Guide.	Yes Yes	PG-99	Note DD	

PED REQUIREMENTS			RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
7.5	Material characteristics Unless other values are required in accordance with other criteria that must be taken into account, a steel is considered as sufficiently ductile to satisfy 4.1(a) if, in a tensile test carried out by a standard procedure, its elongation after rupture is no less than 14% and		Yes			Note 34
	its bending rupture energy measured on an ISO V test-piece is no less than 27 J, at a temperature no greater than 20°C but not higher than the lowest scheduled operating temperature		Partial		27 J is not specified in ASME Section I.	Note 33

Note: Any reference to the Code in this table or its notes means ASME Boiler and Pressure Vessel Code, Section I.
N/A = not applicable.

Notes in Fig. 12-1 of this Guide on ASME Section I Requirements

A. ASME BPVC Section I (the Code [3]) is based on "design by rule." It requires the use of the design rules provided in the Code. Other methods may be used only if no rules are provided in the Code.

B. ASME BPVC Section I does not require manufacturers to issue operating instructions or warnings regarding potential hazards or misuse of pressure equipment. The PED requires the manufacturers to provide such instructions; see Notes 3 and 4.

C. ASME BPVC Section I includes requirements for new construction and therefore only includes considerations for in-service degradation that can be anticipated by the designer. The user is generally responsible for operating the equipment within the limits of those considerations, which, although not a requirement of ASME BPVC Section I, are commonly provided to the user by the boiler manufacturer.

D. Safety factors are built into the ASME BPVC Section I allowable design stresses, ligament efficiencies, joint efficiencies/NDE requirements, etc. The Code does not include margins for in-service degradation.

E. ASME BPVC Section I does not specifically address decomposition of unstable fluids.

F. ASME BPVC Section I recognizes the need for fatigue analysis in cyclic service, but does not have rules on how to perform fatigue analysis. ASME BPVC Section I does require consideration of cyclic and dynamic loading in design of pressure equipment, if appropriate (PG-22). In base load cases, such loadings do not exceed the limits given in PG-22 and are not a significant failure mode in power boilers covered by ASME BPVC Section I. For two shift or load following operation, then detailed fatigue analysis of critical components may be necessary. In these cases, established documented methods should be used to determine fatigue degradation.

G. ASME BPVC Section I does not have a direct limit on plastic strain, but other limits indirectly control this, such as those defining establishment of allowable stresses in the creep range.

H. ASME BPVC Section I requirements take into account experience demonstrating that welded joints exempted from NDE by ASME BPVC Section I have given safe and reliable service. (PW-11.1). Note that the joint factor applied by ASME BPVC Section I does not apply to tube welds, where no volumetric NDE is required by ASME BPVC Section I. Because the practice in Europe is to perform 10% RT on tube welds, some notified bodies may require some percentage of NDE to be performed.

I. Corrosion must be taken into account in ASME BPVC Section I by the Code design requirements for a particular boiler or component (PG-27, 4.3). Creep is taken into account by the Code design basis for establishing the allowable stresses in the creep range. The Code design in the creep range is based on average stress to cause rupture in 100,000 hours. That number is intended as a base criterion for design, and does not imply that the equipment is only intended for use up to 100,000 hours, because ASME BPVC Section I's use of conservative design margins provides for a much longer service life. This is demonstrated by the successful service history of ASME BPVC Section I equipment. Design hours of operation at specified temperatures should be based on the manufacturer's experience and calculations.

J. ASME BPVC Section I does not require design for specific hours in the creep range, nor specific number of cycles at specified stress levels. PG-22, requires consideration of cyclic loads in the design but, because of their low impact on boiler failure modes, only when their magnitude exceeds 10% of the allowable working stress on the component.

K. ASME BPVC Section I does <u>not</u> require the design corrosion allowance to be shown on the Data Report for in-service use. To comply with Annex I, §2.6, this information must be provided to the end user in the operating instructions.

L. ASME BPVC Section I does not address design for transport or handling loads. However, provisions are given in PG-55 for attachment of supports and attachment lugs to the pressure-retaining boundary.

M. PG-90.1.5 of ASME BPVC Section I requires witnessing the tests and approval of the test results by the AI, but not necessarily acceptance of the test program by the AI prior to testing. All of these functions would be the responsibility of the NB.

N. ASME BPVC Section I Appendix A-22 is written to consider leakage to be failure by rupture. The threshold for sufficient leaks in the context of the PED is therefore zero.

O. In the context of ASME BPVC Section I Appendix A-22, deterioration is defined as excessive strain. The thresholds for such are defined in Appendix 22.

P. These requirements are included in ASME BPVC Section I Appendix A-22. Appendix 22 is conservative in that the proof test pressures are based on test temperature rather than design temperature, requiring the application of a higher level of stress.

Q. ASME BPVC Section I provides partial coverage of the items listed in Annex I, §2.3. See Note 13.

R. ASME BPVC Section I only addresses this aspect for firing doors in water tube boilers (PWT-14). The requirements for access doors to be fitted with devices "to ascertain that the opening will not present a hazard" or to prevent from opening quick opening closures when the pressure or temperature of the fluid may present a hazard is something that boiler manufacturers already provide for. The PED requires that this practice be documented.

S. ASME BPVC Section I provides for inspection openings large enough for physical access to the interior of the boiler, as well as for handholes when such access is not practical.

T. ASME BPVC Section I and B31.1 [6] address drains and venting of all boiler and piping components.

U. Water hammer and piping system reactions such as thermal expansion and contraction are addressed in ASME BPVC Section I and B31.1. Uncontrolled chemical reactions are partially addressed in ASME BPVC Section I.

V. ASME BPVC Section I does not specifically address vacuum vents as vacuum conditions do not normally exist in boilers.

W. Erosion is addressed in B31.1, Sect. 104.

X. ASME BPVC Section I is a system code, so it does address assemblies in its inherent requirements for various boiler components and how they are connected.

Y. This requirement is primarily aimed at pressure vessels and how they are filled and emptied. ASME BPVC Section I does not require accessories "to assure safe filling and discharge" with respect to the hazards listed in Annex I, §2.9, and for the most part, these requirements do not apply to boilers.

Z. ASME BPVC Section I has specific requirements for monitoring devices, such as gage glasses, water level indicators, and low water cutoffs referred to in Annex I §2.10(b). PG-90.1.15 requires the AI to verify that all required safety accessories are installed in compliance with the requirements of ASME BPVC Section I. Each boiler constructed to ASME BPVC Section I must be provided with a copy of Data Report Form P-7 which records all required safety valves, or for boilers provided with a single safety valve, this must be documented in the remarks section of Data Report Forms P-2 or P-3. See PG-112.2.8.

AA. Fail-safe modes, redundancy, diversity, and self-diagnosis are addressed in ASME BPVC Section I. See Note 21.

BB. The response time of temperature monitory devices is not specifically addressed in ASME BPVC Section I.

CC. ASME BPVC Section I requires the minimum tensile properties of the weld metal to meet the specified minimum tensile properties of the base metal. See ASME BPVC Section II, Part D, Table 1A[4].

DD. ASME BPVC Section I, PG-99 requires a hydrotest pressure of 1.5 times Maximum Allowable Working Pressure (MAWP), which exceeds the value given in Annex I, §7.4. PG-99. Section I also limits the amount of stress on any component in the boiler system.

EE. The ASME BPVC Section I requirements for marking of boilers, components, and safety valves are included in PG-106 through PG-111. The requirements for Data Reports are included PG-112, PG-113, and in Appendices A-350 through A-357. The name and address of the vessel manufacturer shall be listed in the Data Reports.

FF. Chemical and physical properties for operational safety are implied in ASME BPVC Section I. Specific guidance is given in PG-5.

GG. ASME BPVC Section I permits the use of higher design stresses when components are contained within the boiler setting.

HH. The scope of ASME BPVC Section I includes most of the equipment listed, except pressure cookers where steam is generated for use internal to itself, and some process heating equipment, which may be built to either ASME BPVC Section I or Section VIII, Division 1.

II. The PED Annex I, §6 addresses all types of piping. Some requirements are not applicable to what ASME BPVC Section I refers to as boiler proper piping. For ASME BPVC Section I boilers, the requirements of ASME B31.1 must also be used for external piping, and the appropriate paragraph references in B31.1 are shown in the Code Reference column of section 12 of this Guide.

Additional Notes in Fig. 12-1 of this Guide on Considerations for Annex I ESR:

GENERAL
Many of the recommendations contained in the following notes address requirements of the PED that are not specifically covered in ASME Section I [3]. For the majority of these situations, the manufacturer would be performing these activities in the normal course of equipment design. Included in the guidance given in the following notes is information on which of those common activities need to be documented for PED compliance.

1. The manufacturer must perform a hazard analysis in accordance with *Article 6, Annex I, Preliminary Observations 3, and Annex II* of the PED [1]. Manufacturers of power boilers have always taken the hazards due to pressure into consideration, but demonstration of compliance with a standard such as ASME Section I has, in the past, been sufficient to demonstrate consideration of such hazards. The PED requires documentation that all hazards described in *Annex II* of the PED have been addressed, regardless of the standard used for design and construction. Typical hazards for pressure containment that may have to be considered are:
   (a) Brittle fracture,
   (b) Stress corrosion cracking,
   (c) Creep,
   (d) Damage during transport or installation,
   (e) Rapid release of high pressure fluid,
   (f) Special operational hazards.

   It should be noted that it is a hazard assessment that is specified not a Hazard and Operability (HAZOP), which is generally associated with a Piping and Instrumentation Diagram (P&ID).
2. The manufacturer is required to design and construct the pressure equipment to comply with all the ESR in Annex I. Annex I of the PED does not assign any responsibility to "User." That makes it the duty of the manufacturer to achieve safety and comply with the ESRs, or, document that the purchaser has stipulated certain design considerations or fabrication requirements. For a boiler plant, the manufacturer is normally the designer and therefore is responsible for all aspects of complying with the PED. In cases where the design is performed by a separate organization or the utility is carrying out a major modification to existing equipment using a supplier who was not the original equipment manufacturer, there is an onus on the utility to ensure that the manufacturer of equipment is given sufficient information on the operation of the plant to carry out a hazard analysis.
3. The manufacturer shall prepare, as far as relevant, instructions for the User, containing the necessary safety information listed in PED, Annex I, §3.4. The instructions shall include the following:
   (a) Marking and labeling as required by §3.3 of Annex I of the PED,
   (b) Installation instructions, including assembling different pieces of pressure equipment,
   (c) Putting into service,
   (d) Use,
   (e) Maintenance, including checks by the User,
   (f) Drawings necessary for full understanding of the information, if applicable,
   (g) Design information for in-service verification, modification, or repairs,
   (h) Warnings to prevent the danger of misuse of the equipment,
   (i) Declaration of Conformity.

Most manufacturers of pressure equipment provide their customers with some degree of instructions and service information. On boilers the operation and maintenance manuals normally cover this. The PED requires that this practice be documented in the language of the country to which the product is destined, or that which is specified by the purchaser, and that it includes all of the aspects contained in Annex I, §3.4.

4. The manufacturer must also consider the following specific aspects (not specifically addressed in ASME Section I):
   (a) Inform users of residual hazards,
   (b) Prevent dangers from foreseeable misuse,
   (c) Take into account foreseeable degradation mechanisms,
   (d) Ensure safety throughout the intended life of the pressure equipment.

   A checklist on the hazard assessment is beneficial. It should be noted that this is not a full hazard analysis that includes the likelihood and consequences of failure. Again, most manufacturers who construct to ASME BPVC Section I provide their customers with this type of information. The PED requires that this practice be documented in the language of the country to which the product is destined, or that which is specified by the purchaser.

5. The manufacturer must:
   (a) Eliminate or reduce hazards as far as it is reasonably possible,
   (b) Apply appropriate protection measures against hazards that cannot be eliminated,
   (c) Where appropriate, inform users of any residual hazards and any additional measures to be taken to reduce risks during installation and/or use.

   Consultation with the NB, considering the provisions of ASME Section I and its long-standing history of providing for safe operation throughout the boiler's intended life, will provide for the first two aspects. The third aspect is not covered by ASME Section I, but is something that manufacturers may already be providing to their customers and which will become routine whenever their product is destined for Europe.

6. The manufacturer must provide the necessary safeguards (e.g., temperature measuring devices, water level gages and other sensors, etc.) where there is potential for misuse or improper use of the pressure equipment. ASME Section I contains requirements for many such safeguards, but the manufacturer may have to supply additional information, such as wall clearances to allow access, that are not covered by ASME BPVC Section I. The potential for rapid startup and shutdown rates may have to be considered as being reasonably foreseeable.

7. Annex I of the PED requires consideration of decomposition of unstable fluids in the design. This could affect manufacturers of organic vapor generators under Part PVG of ASME BPVC Section I. ASME BPVC Section I provides some guidance on handling these fluids, but the manufacturer may have to document any additional considerations made.

8. ASME BPVC Section I Appendix A-22 provides for establishment of MAWP by proof testing. In order to verify a design under the PED using an experimental design method, Annex I, §2.2.4, may require additional test for fatigue, creep, corrosion rates, and impose additional limitations consistent with those in the PED (e.g., hold time at temperature, number of fatigue cycles at a given stress level, corrosion rates, etc.).

9. Manufacturers using ASME BPVC Section I can generally demonstrate that plastic strain is not a consideration beyond that which is limited in the criteria for establishing allowable stresses in the creep range.

10. Any limitations on design life from operation at the design temperature in creep range, fatigue cycles, and corrosion allowance must be specified in operating instructions.

11. The design calculations must take into account supporting structures, including during transport and handling, as appropriate. These must be documented, as appropriate. PG-55 addresses attachment of lugs and supports, and this can be referenced in such documentation.

12. The manufacturer must obtain approval from the notified body (NB) responsible for the CA module, if one exists, for the experimental test program. ASME BPVC Section I (Appendix A-22) gives guidance on a comprehensive test program, including witnessing of tests by the AI (PG-90.1.5). The difference for PED compliance would be the presence of the NB in place of the AI.

13. The experimental method must take into account leakage and deterioration of pressure equipment (e.g. corrosion). The manufacturer must consider the following aspects to ensure safe handling and preclude risk operation from:

    (a) closures and openings,

    (b) discharge of pressure relief blowoff,

    (c) access while pressure or vacuum exists in the pressure equipment,

    (d) surface temperature, taking into account the intended use of the equipment,

    (e) decomposition of unstable fluids.

    Most of these items are directed toward pressure vessels in various applications. ASME BPVC Section I contains design requirements for inspection openings, but not their operation, except for firing doors in watertube boilers, whose operation is covered in PWT-14. B31.1 Appendix I addresses design of safety valve discharge piping, and although Part PVG of ASME BPVC Section I addresses boilers using organic fluids as a working medium, it does not address the decomposition of the fluid in the boiler. For PED compliance, the manufacturer can demonstrate that some of the above pose no hazard due to pressure, while others can be addressed in the operation manual or with signage on the boiler itself.

14. Boilers fitted with access doors must be equipped with automatic or manual devices enabling the user "to ascertain that the opening will not present any hazards."

15. Provisions for safe condition inside the boiler, where applicable, must be included in operating instructions.

16. The boiler manufacturer must provide adequate means for venting and draining (including vacuum vents), as required by PED, Annex 1, §2.5 for all stages of operation and testing to avoid harmful effects, such as water hammer, corrosion, uncontrolled chemical reaction, etc. Any drains, vents, or blowoff connections provided in addition to that required by ASME BPVC Section I and B31.1 should be documented.

17. ASME BPVC Section I provides for consideration of other forms of chemical attack besides corrosion, such as stress induced cracking in the presence of chlorides, as required by PED Annex I, §2.6. The manufacturer needs to allow for and/or protect against any other types of chemical attack.

18. Erosion must be considered in the design, where appropriate, to meet the requirements of PED, Annex I, §2.7. Design of boiler piping systems generally takes this into account, although it is not specifically addressed in ASME BPVC Section I.

19. ASME BPVC Section I is essentially a system code taking into account the assembly of various types of equipment and piping into a completed boiler unit. The manufacturer must make certain that all assemblies comply with the requirements of Annex I, §2.8. (The PED defines assemblies as several pieces of pressure equipment assembled by the manufacturer to constitute an integral and functional

whole.) The rules of ASME BPVC Section I taken as a whole fulfill these requirements and the manufacturer will benefit from working with a NB that is experienced in the application of ASME BPVC Section I to demonstrate compliance.

20. The manufacturer may need to consult with its NB to demonstrate that the indicators, cutoffs, and alarms required by ASME BPVC Section I meet the requirements of PED, Annex I, §2.10.

21. The design of safety accessories shall comply with the requirements of PED, Annex I, §2.11, including fail-safe modes, redundancies, diversity, and self-diagnosis. ASME BPVC Section I accomplishes this in several ways such as gage glass connections, backup feed pumps, duplicate water level indicators, and consideration that components such as tubing within the boiler setting will not pose a hazard due to pressure should they fail. Consultation with an NB familiar with the application of ASME BPVC Section I will confirm that the intent of this requirement has been met.

22. Temperature monitoring devices must have adequate response time, consistent with the measurement function. ASME BPVC Section I only requires temperature controls for electric boilers in Part PEB. Manufacturers who use temperature controls consider the device's performance characteristics when choosing the appropriate device. When they are used, the requirement of PED Annex I, §2.11.3 applies and must be documented based on the control manufacturer's specifications.

23. See PED Article 24 for requirements related to notified bodies and Article 13 for RTPOs.

24. For pressure equipment in Categories II, III, and IV, welders and welding operators shall meet the requirements of EN ISO 9606 and qualification of welding procedures the requirements of EN ISO 15607 (European Harmonized Standards). The welder, welding operator, and welding procedure qualification shall be approved by a Notified Body or by an approved third party organization. To carry out these approvals, the third party shall perform (or have performed) examinations and test as set out in the approved European Harmonized Standards or equivalent examinations and tests. Consultation with a NB familiar with the application of ASME BPVC Section I is necessary in this case. See also Guidelines 6/1, 6/6, and 6/12. This also applies to ongoing certification of welders.

    NOTE: For welders, the ISO 9606 qualification for butt welds does not cover fillet welding without an additional test piece.

25. For pressure equipment in Categories III and IV, the NDE personnel shall be approved by an approved third party organization recognized by a member state in the European Community. (See PED, Article 24 for RTPOs.) Manufacturers that utilize the ASNT Central Certification Program (ACCP) to meet their ASME Section I NDE personnel qualification requirements may be able to benefit from an arrangement between American Society for Nondestructive Testing (ASNT) and RW-TUV to recognize each other's testing programs.

    NOTE: The PED does not provide any specific requirements for qualification of NDE personnel; therefore, the qualification in accordance with Recommended Practice No. SNT-TC-1A should be acceptable for radiographic examination of Category I and II pressure equipment and for Categories III and IV if issued by an RTPO.

26. The manufacturer must provide the additional documentation to demonstrate compliance with the PED. The following list should be reviewed to determine what information is covered by the manufacturer's ASME Quality Control (QC) manual and the AI's duties for inspection in PG-90. Any information not fully covered needs to be documented for PED compliance.

    (a) Qualifications of NDT personnel

    (b) Qualifications of welders and welding operators

    (c) Welding procedure qualifications

(d) Heat treat procedures and data

(e) Material approvals, certifications. and inspection documents for base metal and welding consumables

(f) Procedures for ensuring material traceability

(g) NDT reports, including radiographic films

(h) Test reports of mechanical tests (e.g., on test coupons)

(i) Reports on defects and deviations during manufacture

(j) Forming and other manufacturing procedures

(k) Other technical documentation in accordance with the applicable CA Module

27. In addition to the CE marking, the vessel manufacturer must provide the additional information provided in PED, Annex I, §3.3(a) and §3.3(b), as applicable. The name and address of manufacturer's representative in the European Community is not covered by ASME Sect. I, and if the information for the manufacturer is insufficient, the information for the representative must be supplied for PED compliance. The information required by Annex I, §3.3(b) generally does not apply to boilers, or is covered by marking and Data Report requirements of ASME BPVC Section I. If a boiler has an "S" stamp nameplate, a separate nameplate will be necessary to supply the extra information required by the PED.

28. Based on the type of boiler and intended service, and only where necessary, the PED requires that warning labels be attached to the boiler giving warnings about its potential misuse, based on past experience. (Examples of such misuse could be bypassing safety devices, lack of maintenance of water level indicators, etc.)

29. The manufacturer needs to provide the necessary CE marking and labels (where applicable) in accordance with the requirements in PED, Annex I, §3.3.

30. The PED requires the manufacturer to select material, which is suitable for the scheduled lifetime of the vessel, therefore specific consideration must be given to various degradation mechanisms, such as creep, fatigue, embrittlement, etc., some of which are not addressed in ASME Section I. See Annex I, §'s 3.1.4, 4.1, 4.2, 4.3, 7.1, and 7.5 for additional requirements. Boiler manufacturers choose their materials for construction based on these considerations, even though they are not specifically stated in ASME BPVC Section I. This practice may need to be documented for PED compliance, or consultation with a NB familiar with the application of ASME BPVC Section I may suffice.

31. The properties of permanent welded joints (weld metal and heat affected zones) must meet the required minimum properties for the materials (including elongation and impact test requirements) to be joined unless other relevant property values are specifically taken into account in the design. The general principles in ASME BPVC Section I regarding selection of materials, P-numbers, and welding procedure qualifications all contribute to meeting these requirements. This is another case where consultation with an NB that is familiar with the application of ASME BPVC Section I will contribute to determination of having achieved an overall equivalent level of safety.

32. Although it is implied by the considerations in ASME BPVC Section I when taken as a whole, some of the materials requirements in §4.1 of Annex I are not specifically addressed in the Code, such as aging and the materials being sufficiently resistant of fluids contained in the boiler. The PED requires the manufacturer to be responsible for material selection for the intended service that meet the requirements of Annex I, §4.1(a) through §4.1(e). Boiler manufacturers choose their materials for construction based on these considerations, even though they are not spelled out in ASME BPVC Section I. This practice may need to be documented for PED compliance.

33. Annex I, §7.5 requires materials to have minimum average impact test value of 27 J (20 ft-lb) at 20°C (68°F) but no higher than the lowest scheduled operating temperature. For ASME BPVC Section I boilers, the operating range is not near the transition temperature. Note: The previous EC's Working Group "Pressure" (WGP) Guideline 7/17 states that specified impact properties are not required for steel grades: "When selecting ductile materials that are not subject to ductile/brittle transition at the foreseeable conditions the equipment will be exposed to." The Guideline also states, "Where the application of these rules indicate that the material will not behave in a brittle manner and all aspects of the chosen design code have been followed, sufficient confidence is gained in the behavior of the material not to require specific impact properties. When these codes are applied, also other items need to be taken into account." The Guideline 7/17 then goes on to list additional considerations, such as full range of the chemical analysis, the extreme mechanical properties, etc.

34. Materials will only be approved if they have the following properties, or if an equivalent level of safety can be demonstrated:

    It may be necessary to demonstrate that the hydrotest temperature is above the brittle transition temperature to support decisions described in this note.

    (a) Have appropriate properties for all foreseeable operating and test conditions

    (b) Are sufficiently ductile (14% minimum elongation for steel)

    (c) Are sufficiently tough (27 J minimum average for steel) at 20°C (68°F), or at the lowest operating temperature.

    In the case of ASME BPVC Section I, its long history of boilers with safe service life can be demonstrated through consultation with an NB that is familiar with the application of ASME BPVC Section I.

35. Materials must conform to one of the following:

    (a) Materials that are specified in a European harmonized product standard.

    (b) Pressure equipment materials that are covered by an EAM.

    (c) Materials that are issued with a PMA, for equipment in Category III and IV.

    NOTE: In 2001, the European Commission determined that on the basis of Article 11 of Directive 97/23/EC (now 2014/68/EU), §5, no EAMs would be issued covering materials for which there exists (or is under development) a harmonized European material specification. ASME's attempts to process EAMs for SA materials were all rejected on this basis. Therefore, the only way to use ASME SA materials in ASME BPVC Section I boiler construction intended for CE marking is to perform PMAs for each material. Notified bodies are issuing PMAs to manufacturers of ASME equipment based on their long history of safe service when used in compliance with the appropriate ASME BPVC section. Repeated use of the same material grade in subsequent jobs can be achieved with PMAs based on previous approvals, easing the process.

36. If the boiler is classified in Category III or Category IV, the PMA of the material must be approved by the NB in charge of the CA procedure for that boiler.

37. The manufacturer must ensure that the material conforms to one of the appropriate specifications and is supported by appropriate certification:

    (a) For main pressure parts in Categories II, III, and IV the test certificates shall be in accordance with EN 10204, Types 3.1 or 3.2. Type 3.2 certificate is alternative if the materials manufacturer does not have an appropriate quality system. (NOTE: Certificates of Compliance required by ASME material specifications may not be completely acceptable and may need to be augmented.)

(b) Certificates of Type 2.2 are acceptable for Category I equipment.

(c) Certificates of Type 2.2 are acceptable for welding consumables for pressure equipment in all categories.

(NOTE: See Section 8.5 of this Guide for the types of EN 10204 material certificates required for material used in boilers, depending on hazard category.)

38. If the material manufacturer holds accredited certification from a certification body established within the European community, a material certificate of the EN 10204, 3.1 is acceptable. Where the material manufacturer does not hold such a certification, the boiler manufacturer is responsible for determining the certification requirements.

    NOTE: ISO is not referenced in the PED; it just states "competent body," therefore ISO or another quality system is acceptable. The Materials Manufacturer must have undergone a specific assessment for materials, not just systems.

39. ASME BPVC Section I contains requirements for piping within the boiler proper as defined in Fig. PG-58.3.1 and Fig. PG-58.3.2. Those figures also define the limits of Boiler External Piping, the design and construction rules for which are contained in ASME B31.1, Power Piping. PED compliance for the completed boiler will be demonstrated by using the combination of ASME Section I and ASME B31.1 to meet the ESRs for piping.

40. Note 3 to ASME B31.1 §119.7 describes how fatigue is considered in the stress intensification factors of Appendix D. Manufacturers may have to describe this in the context of a proven history of safe operation of B31.1 piping systems to demonstrate compliance with this requirement.

41. Neither ASME BPVC Section I nor B31.1 contain requirements for mapping of underground piping. Such documentation would have to be furnished and can easily be derived from plans and blueprints for the buried piping system.

42. The specified quantitative requirements apply as a general rule. Other values may be used, but the manufacturer must be able to demonstrate to the NB that the appropriate measures have been taken to demonstrate that equivalent overall levels of safety have been achieved.

43. For the materials listed in Annex I §7.1, the allowable stresses are left to the manufacturer, who shall demonstrate that an overall safety has been achieved. For this objective, the manufacturer may refer to Harmonized Standards, codes, and specifications approved by the CEN Technical Committee (e.g., EN 13345,), or may use the criteria used in ASME BPVC Section I, combined with all other aspects of that Code that contribute to the overall level of safety.

44. The permissible general membrane stresses used in the calculations shall conform to the criteria listed in Annex I, para. 7.1 of the PED. Also, see Fig. 12-2 of this Guide. In case of the ferritic steel, including normalized steel and excluding fine grain steel and specially heat-treated steel, the lesser of:

    (a) 2/3 of the specified minimum yield strength ($R_{e/t}$), and

    (b) 5/12 of the specified minimum ambient temperature tensile strength ($R_{m/20}$).

    In general, the allowable design stresses in ASME BPVC Section II, Part D, are acceptable. However, the Code allows the design stresses to be 90% of the specified minimum yield strength for certain materials (stainless steel and some strain hardening materials). The manufacturer shall verify that the ASME BPVC allowable design stresses meet the PED criteria in each particular case.
    Note: Although not stated in Annex 1, the allowable stresses for ferritic steels also apply to fine grain steels. (See Fig. 12-2 of this PED Guide.)

45. ASME Section I permits allowable stress, $S \leq 0.9\ SY$, for certain austenitic stainless steels. This exceeds the allowable stresses permitted in Annex I, §7.1.

QUANTITATIVE REQUIREMENTS IN PED, ANNEX I TO BE APPLIED AS A GENERAL RULE

Figure 12-2: Q1 Safety Factors for Allowable Stresses Given in Annex I, §7.1.2

Material	Allowable Stress, S_a
Ferritic steel and low-alloy steel	Lesser of $R_e/1.5$ and $R_m/2.4$
Fine grain steel	Allowable stresses are not given in the PED
Austenitic steel with A > 30%	$R_e/1.5$
Austenitic steel with A > 35%	Lesser of $R_e/1.2$ and $R_m/3$
Cast steel	Lesser of $R_e/1.9$ and $R_m/3$
Aluminum	$R_e/1.5$
Aluminum alloys (not quenched)	Lesser of $R_e/1.5$ and $R_m/2.4$

A = elongation, %
R_e = specified minimum yield strength at design temperature
R_m = specified minimum tensile strength at room temperature

Figure 12-3: Q2 Joint Efficiencies Given in Annex I, §7.2

Extent of Examination	Joint Efficiency
100% RT or UT	1.0
Partial examination by RT or UT and destructive testing	0.85
Visual examination only	0.70

RT = radiographic testing
UT = ultrasonic testing
Note: examination requirements of ASME Section I may differ from other pressure vessel codes (i.e., EN 13445).

Figure 12-4: Q3 Formula for Calculating Hydrostatic Test Pressure Given in Annex I, §7.4

Test pressure, P_t shall be the larger of:

$P_t = 1.25\ P_s \left(\frac{S_t}{S} \right)$ and

$P_t = 1.43\ P_s$
P_s = maximum allowable operating pressure
S_t = allowable nominal design stress at test temperature

S = allowable nominal design stress at design temperature

ADDITIONAL CONSIDERATIONS FOR APPLICATION OF ASME BPVC SECTION I, POWER BOILERS WITHIN THE SCOPE OF PED 2014/68/EU

13 ADDITIONAL CONSIDERATIONS FOR APPLICATION OF ASME BPVC SECTION I, POWER BOILERS WITHIN THE SCOPE OF PED 2014/68/EU, ANNEX I

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
	PRELIMINARY OBSERVATIONS		
1.	The obligations arising from the essential requirements listed in this annex for pressure equipment also apply to assemblies where the corresponding hazard exists.	PG-11, PG-58, PG-59, PG-60, PG-67, PG-68, PG-71	
2.	The essential requirements laid down in the directive are compulsory. The obligations laid down in these essential requirements apply only if the corresponding hazard exists for the pressure equipment in question when it is used under the conditions that are reasonably foreseeable by the manufacturer.	Informative	
3.	The manufacturer is under an obligation to analyze the hazards and risks in order to identify those that apply to his equipment on account of pressure; They must then design and construct it taking account of his analysis.	(None) (Partial)	The manufacturer must perform hazards and risks analysis in accordance with Article 4, Article 13 and Annex II of the PED, documenting many of their common analyses. The manufacturer is required to design and construct the pressure equipment to comply with all the Essential Safety Requirements (ESR) in Annex I.
4.	The general requirements are to be interpreted and applied in such a way as to take account of the state of the art and current practice at the time of design and manufacture as well as of technical and economical considerations which are consistent with a high degree of health and safety protection.	Foreword, Preamble	
1.	**GENERAL**		
1.1	Pressure equipment shall be designed, manufactured, and checked and, if applicable, equipped and installed in such a way as to insure its safety when put into service in accordance with the manufacturer's instructions, or in reasonably foreseeable conditions.	Preamble, Sect. II, Part D, App. 6	The manufacturer must prepare instructions for the user containing the necessary safety information in accordance with Point. 3.4 of Annex I. The manufacturer must also consider the following aspects: a) Inform users of residual hazards, b) Prevent dangers from foreseeable misuse, c) Take into account foreseeable degradation mechanisms, d) Ensure safety throughout the intended life of the pressure equipment.

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
1.2	In choosing the most appropriate solutions, the manufacturer shall comply with the principles set out below in the following order: a) Eliminate or reduce hazards as far as is reasonably practicable. b) Apply appropriate protection measures against hazards which cannot be eliminated. d) Where appropriate, inform users of residual hazards and indicate whether it is necessary to take appropriate special measures to reduce risks at the time of installation and/or use.	 Parts PG and PW PG-67 through PG-73, PMB-17 and PEB-16 (partial) (None)	The manufacturer must: a) Eliminate or reduce hazards as far as it is reasonably practical through adequate design and construction, c) Apply appropriate protection measures against hazards that cannot be eliminated, such as controls and pressure relief devices, and e) Where appropriate, inform users of any residual hazards and any additional measures to be taken to reduce risks during installation and/or use.
1.3	Where the potential for misuse is known or can be clearly foreseen, the pressure equipment shall be designed to prevent danger from such misuse or, if that is not possible, adequate warning (shall be) given that the pressure equipment must not be used in that way.	PG-60, PG-61 (partial) (None)	The manufacturer must provide the necessary safeguards (e.g., temperature measuring devices, water level gages and other sensors, etc.) where there is potential for misuse of the pressure equipment. Where necessary, the manufacturer must provide appropriate warnings in operating instructions regarding improper use of the equipment. (See Point 3.4 of Annex I.)
2.	**DESIGN**		
2.1	The pressure equipment shall be properly designed taking all relevant factors into account in order to ensure that the equipment will be safe throughout its intended life. The design shall incorporate appropriate safety coefficients using comprehensive methods which are known to incorporate adequate safety margins against all relevant failure modes in a consistent manner.	Preamble, PG-16, PG-23 through PG-38, PG-43, PG-46, PG-52, PG- 53 and PW-9 (Partial) Sect. II, Part D, App. 1	The manufacturer must also consider the following factors in the design of the equipment: a) Take into account foreseeable degradation mechanisms, b) Ensure safety throughout the intended life of the pressure equipment.
2.2	Design for adequate strength		
2.2.1	The pressure equipment shall be designed for loadings appropriate to its intended use and other reasonably foreseeable operating conditions. In particular, the following factors must be taken into account: *(a)* internal/external pressure, *(b)* ambient and operational temperatures,	PG-22 PG-27, PG-21, and PG-27	

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
	(c) static pressure and mass of contents in operating and test conditions, *(d)* traffic, wind, earthquake loading *(e)* reaction forces and moments which result from the supports, attachments, piping, etc., *(f)* Corrosion, erosion, fatigue, etc. *(g)* decomposition of unstable fluids *(h)* Various loadings which can occur at the same time must be considered, taking into account the probability of their simultaneous occurrence.	PG-22.1 (partial) PG-22.2, B31.1 §119 PG-27.4, Note 3, B31.1 §102.4 (None) PG-22, B31.1 §101.5	(Note: Traffic loads are not generally considered to be applicable to boilers.) Sect. I addresses need, not how to analyze. Sect. I does not specifically address decomposition of unstable fluids. Manufacturers of organic vapor generators under Part PVG of Sect. I may have to document any additional considerations made.
2.2.2	Design for adequate strength shall be based on: *(a)* as a general rule a calculation method, described in 2.2.3, and supplemented, if necessary, by an experimental design method as described in 2.2.4, or *(b)* an experimental design method without calculation, as described in 2.2.4, when the product of the maximum allowable pressure PS and the volume V is less than 6,000 bar x L, or the product PS x DN (is) less than 3,000 bar.	PG-27 through PG-53, PG-100 (partial)	Sect. I App. 22 provides for establishment of MAWP by proof testing. An experimental design method, as described in §2.2.4 of Annex I may require additional tests for fatigue, creep, corrosion rates, and may have to impose additional limitations consistent with those in the PED. The manufacturer must ensure that the limitations on the allowable pressure PS and on volume V are not exceeded.
2.2.3	Calculation Method *(a)* Pressure containment and other loading aspects. The allowable stresses for pressure equipment shall be limited having regard to reasonably foreseeable failure modes under operating conditions. To this end, safety factors shall be applied to eliminate fully any uncertainty arising out of manufacture, actual operational conditions, stresses, calculation models, and the properties and behavior of the material. These calculation methods shall provide sufficient safety margins consistent, where applicable, with the requirements of Section 7.	PG-23 Sect. II, Part D, App. 1	

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
	The requirements set out above may be met by applying one of the following methods, as appropriate, if necessary as a supplement to or in combination with another method:		
	1. design by formula,	PG-27 to PG-53	
	2. design by analysis,	Preamble (partial)	
	3. design by fracture analysis.	N/A	
	(b) Resistance Appropriate design calculations must be used to establish the resistance of the pressure equipment concerned.		
	In particular:		
	(1) The calculation pressures shall not be less than the maximum allowable pressures and	PG-21,	Sect. I does not specifically address decomposition of unstable fluids. Manufacturers of organic vapor generators under Part PVG of Sect. I may have to document any additional considerations made.
	(a) take into account static head and dynamic fluid pressures and	PG-22.1	
	(b) the decomposition of unstable fluids.	(None)	
	(c) Where a vessel is separated into individual pressure containing chambers, the partition wall shall be designed on the basis of the highest possible chamber pressure relative to the lowest pressure possible in the adjoining chamber.	PG-16.2	
	(2) The calculation temperatures shall allow for appropriate safety margins.	PG-21, Note 9	
	(3) The design shall take appropriate account of all possible combinations of temperature and pressure which might arise under reasonably foreseeable operating conditions for the equipment.	PG-21, Note 9, PG-27.4, Note 2	
	(4) The maximum stresses and peak stress combinations must be kept within safe limits.	PG-22, PG-23	
	(5) The calculation for pressure equipment shall utilize the values appropriate to the properties of the material, based on the documented data, having regard to the provisions set out in Point 4 together with the appropriate safety factors. Material characteristics to be considered, where applicable, include:	PG-23 and Sect. II, Part D, App. 1	
	(a) Yield strength, 0.2% or 1.0% proof strength, as appropriate, at calculation temperature,	PG-5, PG-23	
	(b) Tensile strength,	PG-23 and Sect. II. Part D, App. 1	
	(c) Time-dependent strength, i.e., creep strength,	PG-23 and Sect. II, Part D, App. 5 (Partial)	

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
	(d) Fatigue data,	PG-22 (Partial)	Cyclic and dynamic loadings generally do not exceed the limits given in PG-22 and are not a significant failure mode in power boilers covered by Sect. I. Sect. I does not provide guidance on how a fatigue analysis should be performed.
	(e) Young's modulus (modulus of elasticity),	Sect. II, Part D, App. 5	
	(f) Appropriate amount of plastic strain,	(Partial)	Sect. I does not have a direct limit on plastic strain, but other limits indirectly control this. Plastic strain is generally not a consideration beyond that which is limited in the criteria for establishing allowable stresses in the creep range.
	(g) Impact strength,	None	See EC WG Pressure Guideline 7/17
	(h) Fracture toughness,	None	See EC WG Pressure Guideline 7/17
	(6) Appropriate joint factors shall be applied to the materials properties, depending, for example, on the type of NDT, the materials joined, and the operating conditions envisioned.	PG-27.4, Note 1, PW-11 and PW-41 (Partial)	Some partial percentage of volumetric NDE may need to be carried out on such joints as tube butts, where there is no joint factor.
	(7) The design shall take appropriate account of all reasonably foreseeable degradation mechanisms (e.g., corrosion, creep, fatigue) commensurate with the intended use of the equipment. Attention shall be drawn, in the instructions referred to in 3.4, to the particular features of the design which is relevant to the life of the equipment, for example:	PG-22, PG-23, PG-27 Note 3 and Sect. II, Part D, App. 6	Corrosion must be taken into account in Sect. I by the Code design requirements for a particular boiler or component (PG-27, Note 3).
	(a) for creep: design hours of operation at specified temperatures,	Sect. II, Part D, App. 5 (partial)	Any limitations on design life from operation at design temperature in creep range, fatigue cycles, and corrosion allowance must be specified in operating instructions.
	(b) for fatigue: design number of cycles at the specified stress levels,	PG-22 (partial)	PG-22 requires consideration of cyclic loads in the design but only when their magnitude exceeds 10% of the allowable working stress on the component.
	(c) for corrosion: design corrosion allowance.	PG-27, Note 3 (partial)	Sect. I does not provide guidance on how to arrive at the design corrosion allowance.

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
	(c) Stability Aspects Where the calculated thickness does not allow for adequate structural stability, the necessary measures must be taken to remedy the situation taking into account the risks from transport and handling.	PG-22 and PG-55	The design calculations must take into account structural stability, including transport and handling of vessels and assemblies. Sect. I does not address design for transport or handling loads. PG-55 addresses attachment of supports and attachment lugs to the pressure-retaining boundary.
2.2.4	Experimental Design Method The design of the equipment must be validated, in all or in part, by an appropriate test program carried out on a sample representative of the equipment or the category of the equipment.	App. A-22	
	The test program must be clearly defined prior to testing and accepted by the notified body responsible for the CA module, where it exists.	(None)	The manufacturer must obtain approval from the notified body responsible for the CA module, if one exists, for the experimental test program.
	The program must define test conditions and criteria for acceptance and refusal.	App. A-22.10 and PG-91.1.5	
	The actual values of the essential dimensions and characteristics of the materials which constitute the equipment tested shall be measured before the test.	App. A-22.11.3	
	Where appropriate, during tests, it must be possible to observe the critical zones of the pressure equipment with adequate instrumentation capable of registering strains and stresses with sufficient precision.	App. A-22.11.1	
	The test program must 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 sufficient leaks or deterioration exceeding a determined threshold.	App. A-22	When using the program in A-22, the threshold for sufficient leaks in the context of the PED is zero. In the context of Sect. I, App. A-22, the thresholds for deterioration by excessive strain are defined in App. 22.
	The test pressure must be determined on the basis of the differences between the values of the geometrical and material characteristics measures under test conditions and the values used for design purposes;	App. A-22	
	it must take into account the differences between the test and design temperatures.	App. A-22	A-22 is conservative in basing the test pressures on test temperature.

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
	(b) Where the risk of creep or fatigue exists, appropriate tests determined on the basis of the service conditions laid down for the equipment, for instance, hold time at specified temperatures, number of cycles at specified stress-levels, etc.;	(None)	An experimental design method, as described in §2.2.4 of Annex I may require additional tests and impose additional limitations consistent with those in the PED (hold time at specified temperatures, number of fatigue cycles at a given stress level, corrosion rates, external damage, etc.)
	(c) Where necessary, additional tests concerning other factors referred in 2.2.1, such as corrosion, external damage, etc.	(None)	
2.3	Provisions to Insure Safe Handling and Operation		
	The method of operation specified for pressure equipment must be such as to preclude any reasonable foreseeable risk in operation of the equipment. Particular attention must be paid, where appropriate, to:	(None)	For PED compliance, the manufacturer can demonstrate that some of these pose no hazard due to pressure, while others can be addressed in the operation manual or with warnings on the boiler itself.
	a) Closures and openings	PG-32 through PG-44, PFT-43, PWT-14 (partial)	Pressure equipment fitted with access doors must be equipped with automatic or manual devices to enable the user to ascertain that the opening will not present any hazards.
	Dangerous discharge of pressure relief blowoff,	B31.1, App. II (Partial)	
	c) Access while pressure or vacuum exists in the pressure equipment,	(None)	
	d) Surface temperature, taking into account the intended use of the equipment,	(None)	
	e) Decomposition of unstable fluids.	(None)	
	In particular, the pressure equipment fitted with an access door must be equipped with an automatic or manual device enabling the user easily "to ascertain that the opening will not present any hazard."	PWT-14	
	Furthermore, where the opening can be operated quickly, the pressure equipment must be fitted with a device to prevent it being opened whenever the pressure or temperature of the fluid presents a hazard.	N/A	Boilers are typically not fitted with quick actuating closures
2.4	Means of examination		
	(a) Pressure equipment must be designed and constructed so that all necessary examinations to ensure safety can be carried out.	Part PG, Part PW (partial)	

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
	(b) Means of determining the internal condition of the equipment shall be available, where it is necessary to ensure the continued safety of the equipment, such as access openings allowing physical access to the inside of the pressure equipment so that appropriate examinations can be carried out safely and ergonomically.	PG-44, PWT-14, and PFT-43	
	(c) Other means of ensuring the safe condition of the pressure equipment may be applied: 1) Where it is too small for physical internal access, or	PG-44	Sect. I requires all boilers to have inspection openings. Handholes are required.
	2) Where the opening of the pressure equipment would adversely affect the inside,	N/A	Does not apply to boilers
	3) Where the substance contained has been shown not to be harmful to the material from which the pressure equipment is made and no other internal degradation mechanisms are reasonably foreseeable.	N/A	
2.5	Means of venting and draining Adequate means shall be provided for draining and venting of pressure equipment, where necessary:	PG-59.4 and B31.1 §122.1.5	Any drains, vents, or blowoff connections provided in addition to that required by Sect. I and B31.1 should be documented.
	a) to avoid harmful effects, such as water hammer, vacuum collapse, corrosion, and uncontrolled chemical reactions.	PG-59.1 and B31.1 §122	
	b) All stages of operations and testing, particularly pressure testing, must be considered.	PG-59.4	Ample drains are required for all boiler components.
	c) To permit cleaning, inspection and maintenance in a safe manner.	PG-59.3 and PG-59.4	Blowoff connections are required
2.6	Corrosion or other chemical attack Where necessary, adequate allowance or protection against corrosion or other chemical attack must be provided, taking due account of the intended and reasonably foreseeable use.	PG-5.5, Note 1, PG-27.4, Note 3 (partial)	The manufacturer must document Sect. I considerations for other forms of chemical attack besides corrosion, where appropriate, as required by PED Annex I, Point 2.6.
2.7	Wear Where severe conditions of erosion or abrasion may arise, adequate measures must be taken to:	B31.1 §102.4 (partial)	Erosion and abrasion are generally considered in the design of boiler and piping systems and the results must be documented.
	a) minimize the effect by appropriate design, e.g., additional material thickness, or by the use of liners or cladding materials,	B31.1 §102.4 (partial)	
	b) permit replacement of parts which are most affected,	(Partial)	Boiler components such as piping and tubing are accessible for replacement

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	c) draw attention, in the instructions referred to in §3.4, to measures necessary for continued safe use.	(None)	The manufacturer usually prepares instructions for the user regarding the use of pressure equipment containing the necessary safety information in accordance with Point 3.4 of Annex I and including considerations for wear, where applicable, in accordance with Point 2.7.
2.8	Assemblies Assemblies must be so designed that: a) The assemblies to be assembled together are suitable and reliable for their duty, b) All the components are properly integrated and assembled in an appropriate manner.	Part PG and Part PW	Sect. I is a system code, so it does address assemblies in its inherent requirements for various boiler components and how they are connected. The manufacturer must make certain that all assemblies are so designed that they comply with the applicable PED requirements.
2.9	Provisions for filling and discharge Where appropriate, the pressure equipment must be so designed and provided with accessories, or provisions made for their fitting, as to ensure safe filling and discharge in particular with respect to hazards such as: (a) on filling: *(1)* Overfilling or over pressurization having regard in particular to the filling ratio and to the vapor pressure at the reference temperature, *(2)* Instability of pressure equipment (b) on discharge: the uncontrolled release of the pressurized fluid; (c) on filling or discharge: unsafe connection and disconnection.	N/A N/A N/A N/A	ASME Sect. I does not require accessories "to assure safe filling and discharge" with respect to the hazards listed in Annex I, Point 2.9, and for the most part, these requirements do not apply to boilers.
2.10	Protection against exceeding the allowable limits of pressure equipment Where under reasonably foreseeable conditions, the allowable limits could be exceeded, the pressure equipment must be fitted with, or provisions made for the fitting of, suitable protective devices, within an assembly. The suitable device or combination of such devices must be determined on the basis of the particular characteristics of the equipment or assembly.	PG-67 through PG-73 PG-67 through PG-73	Each boiler constructed to Sect. I must be provided with a copy of Data Report Form P-7 which records all required safety valves, or for boilers provided with a single safety valve, this must be documented in the remarks section of Data Report Forms P-2 or P-3.

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	Suitable protective devices and combination 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.	PG-67 through PG-73 PG-60.1, PG-60.2, PG-60.6, PFT-47, PMB-13, PMB-17, PEB-13, and PEB-16	Sect. I has specific requirements for monitoring devices, such as gage glasses, water level indicators, and low water cutoffs referred to in Annex I, Point 2.10(b).
2.11	Safety Accessories		
2.11.1	Safety accessories shall: a) Be so designed and constructed as to be reliable and suitable for their intended duty and take into account the maintenance and testing requirements of the devices, where applicable; b) Be independent of other functions, unless their safety function cannot be affected by such other functions; c) Comply with the appropriate design principles in order to obtain suitable and reliable protection. These principles include, in particular, fail-safe modes, redundancy, diversity, and self-diagnosis.	 PG-67 through PG-73 PG-71 and PVG-12.3.4 PG-60.3, PG-61	The design of safety accessories must comply with the requirements of PED Annex I, Point 2.4. Fail-safe modes, redundancy, diversity, and self-diagnosis are addressed in Sect. I. Consultation with a notified body familiar with the application of Sect. I will confirm that the intent of this requirement has been met.
2.11.2	Pressure limiting devices The devices must be so designed that the pressure will not permanently exceed the maximum allowable pressure PS; however, a short duration pressure surge in keeping with the specifications laid down in Point 7.3 is allowable, where appropriate.	 PG-67	 (Note: Allowable pressures above MAWP in PG-67 should be reviewed to ensure they do not exceed the PED maximum limitation of 10% in Annex I, §7.3.)
2.11.3	Temperature monitoring devices These devices must have an adequate response time on safety grounds, consistent with the measurement function.	 PEB-16 (Partial)	 The response time of temperature monitoring devices is not specifically addressed in Sect. I, except for electric boilers in Part PEB. The manufacturer must provide temperature monitoring devices that have adequate response time, consistent with the measurement function.
2.12	External fire Where necessary, pressure equipment must be so designed and, where appropriate, fitted with suitable accessories, or provision made for their fitting, to meet damage-limitation	 N/A	 (Intended for pressure vessels)

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	requirements in the event of external fire, having particular regard to the intended use.		
3.	**MANUFACTURING**		
3.1	Manufacturing procedures The manufacturer shall ensure the competent execution of the provisions set out in the design stage by applying the appropriate techniques and relevant procedures especially in view of the aspects set out below.	PG-75 through PG-82	
3.1.1	Preparation of the component parts Preparation of the component parts (e.g., forming and chamfering) shall not give rise to defects or cracks or changes in the mechanical characteristics likely to be detrimental to the safety of the pressure equipment.	PG-11, PG-75 through PG-82, PW-29, and PW-33	
3.1.2	Permanent joining Permanent joints and adjacent zones shall be free of any surface or internal defects detrimental to the safety of the equipment. The properties of permanent joints shall meet the minimum properties specified for the materials to be joined unless other relevant property values are specifically taken into account in the design. For pressure equipment, permanent joining of components which contribute to pressure resistance of the equipment and components which are directly attached to them must be carried out by suitably qualified personnel according to suitable operating procedures. For pressure equipment in categories II, III, and IV, operating procedures and personnel must be approved by a competent third party which, at the manufacturer's discretion, may be: a) A notified body, b) A third party organization recognized by a Member State as provided in Article 13.	PW-29 and PW-33 PW-54, PW-28 and Sect. II, Part D, Table 1A PW-28 (None) (None)	See PED, Article 6 for obligations of manufactures and Article 24 for requirements related to notified bodies and RTPOs for approval of welding procedure and welder qualifications for category II, III and IV pressure equipment. (Note: The manufacturer can use ASME welding procedure and welder qualifications for Category I vessels.) For pressure equipment in Categories II, III, and IV, qualification of welders and welding operators must meet the requirements of EN ISO 9606 and qualification of welding procedures the requirements of EN ISO 15607.

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	To carry out these approvals the third party must perform examinations and tests as set out in the appropriate harmonized standards, or equivalent tests or must have them performed.	(None) PW-28 (partial) PW-28 (partial)	The welder, welding operator and welding procedure qualifications must be approved by a notified body or an approved third party organization. This includes the ongoing certification of permanent joining personnel.
3.1.3	Nondestructive tests For pressure equipment, non-destructive tests of permanent joints shall be carried out by suitable qualified personnel. For pressure equipment in Categories III and IV the personnel must be approved by a third party organization recognized by a Member State pursuant to Article 20.	 PW-51 and PW-52 PW-51 and PW-52 (partial)	 For pressure equipment in Categories III and IV, the NDE personnel must be approved by an approved third party organization recognized by a Member State in the European Community. (Note: The manufacturer may use the certification required by ASME, Sect. I for pressure equipment in Categories I and II for radiographic examination.)
3.1.4	Heat treatment Where there is a risk that the manufacturing process will change the material properties to the extent which would impair the safety of the pressure equipment, suitable heat treatment shall be applied at the appropriate stage of the manufacture.	 PW-38 and PW-39	
3.1.5	Traceability Suitable procedures shall be established and maintained for identifying the material making up the components of the equipment which contribute to the pressure resistance by suitable means from receipt, through production, up to the final test of the manufactured pressure equipment.	 PG-77, PG-90.1.6, PG-90.1.7, and App. 302.4	
3.2	Final assessment Pressure equipment must be subjected to the final assessment as described below.		
3.2.1	Final Inspection Pressure equipment shall undergo a final inspection to access visually and by examination of the accompanying documents compliance with the requirements of the directive. Test carried out during manufacture may be taken into account.	 PG-90.1.13, PG-99.2 PG-90, PG-112 and App. A-350 through A-35 (Partial)	 The manufacturer must provide documentation to demonstrate compliance with the directive. This may be covered by the manufacturer's ASME QC manual

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	As far as necessary on safety grounds, the final inspection must be carried out internally and externally on every part of the equipment, where appropriate in the course of manufacture (e.g., where examination during the final inspection is no longer possible).	PG-90, PG-93	and the AI's duties for inspection in PG-90 and shall include: (1) Qualifications of the NDT personnel, (2) Qualification of welders and welding operators, (3) Welding procedure qualifications, (4) Heat treat procedures and data, (5) Material certification and inspection documents for base metal and welding consumables, (6) Procedures for insuring material traceability, (7) NDT reports, including radiographic films, (8) Test reports of mechanical tests (e.g., coupons) (9) Reports on defects and deviations during manufacture, (10) Forming and other manufacturing procedures, (11) Other technical documentation in accordance with the appropriate CA module.
3.2.2	Proof test Final assessment of pressure equipment must include a test for the pressure containment aspect, which will normally take the form of a hydrostatic pressure test at a pressure at least equal, where appropriate, to the value laid down in Point 7.4. For category I series produced equipment, this test may be performed on a statistical basis. Where a hydrostatic test pressure is harmful or impractical, other tests of a recognized value may be carried out. For test other than the hydrostatic pressure test, additional measures, such as non-destructive tests or other methods of equivalent validity, must be applied before those tests are carried out.	PG-99 (N/A) B31.1 §137	PG-99.3 limits the amount of stress on any component in the boiler system, which meets the intent of the EC's WG Pressure Guideline 8/2 Sect. I has no provisions for series produced boilers. B31.1 allows for alternatives to hydrotesting, Sect. I does not.

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3.2.3	Inspection of safety devices For assemblies, the final assessment must also include a check of the safety devices intended to check full compliance with the requirements referred to in Point 2.10.	PG-90.1.14, PG-90.1.15 and PG-112.2.8	PG-90.1.15 requires the AI to verify that all required safety accessories are installed in compliance with the requirements of Sect. I. Each boiler must be provided with a copy of Data Report Form P-7, or for boilers provided with a single safety valve, this must be documented in the remarks section of Data Report Forms P-2 or P-3.
3.3	Marking and Labeling In addition to the CE marking referred to in Article 18 and 19 and the information to be provided in accordance with Article 6(6) and Article 8(3), the following information must be provided:		In addition to the CE marking, the vessel manufacturer must provide the additional information required by PED, Annex I, §3.3(a) and §3.3(b), as applicable. This can be on one or more nameplates.
	(a) For all pressure equipment: *(1)* The name and address or other means of identification of the manufacturer and, where appropriate, of his authorized representative established within the Community,	PG-106 through PG-111	The name and address of manufacturer's representative in the European Community is not covered by Sect. I, and if the information for the manufacturer is insufficient, the information for the representative must be supplied for PED compliance.
	(2) The year of manufacture,	PG-106 through PG-111	Serial number on stamping plate.
	(3) Identification of the pressure equipment according to its nature, such as type, series or batch identification, and serial number,	PG-106.4.1	
	(4) The essential maximum/minimum allowable limits.	PG-106.4.1	

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	(b) Depending on the type of pressure equipment, further information necessary for safe installation, operation, or use and, where applicable, maintenance and periodic inspection such as: *(1)* The volume V of the pressure equipment in L, *(2)* The nominal size for piping, DN, *(3)* The test pressure PT applied in bar and date, *(4)* Safety device set pressure in bar, *(5)* Output of pressure equipment in kW, *(6)* Supply voltage in V (volts), *(7)* Intended use, *(8)* Filling ratio kg/L, *(9)* Maximum filling mass in kg, *(10)* Tare mass in kg, *(11)* The product group;	(None)	The information required by Annex I, §3.3(b) generally does not apply to boilers, or is covered by marking and Data Report requirements of Sect. I.
	(c) Where necessary, warnings fixed to the pressure equipment drawing attention to misuse which experience has shown might occur.	(None)	Based on the type of equipment and intended service, warning labels shall be attached to the pressure equipment giving warnings about potential misuse of the pressure equipment, based on past experience. (Examples of such misuse could be bypassing safety devices, lack of maintenance of water level indicators, etc.)
	The information referred to in Points (a), (b), and (c) shall be given on the pressure equipment or on a data plate firmly attached to it, with the following exceptions:	PG-106 (Partial)	The manufacturer needs to provide the necessary CE marking and labels (where applicable) in accordance with the requirements of PED, Annex I, Point 3.3.
	(1) where applicable, appropriate documents may be used to avoid repetitive marking of individual parts such as piping components, intended for the same assembly.	PG-106.8.2 and PG-109	
	(2) where the pressure equipment is too small, e.g. accessories, this information may be given on a label attached to that pressure equipment;	PG-106.8.2	
	(3) labeling or other adequate means may be used for the mass to be filled and the warnings referred to in Point (c), provided it remains legible for the appropriate period of time.	(None)	Refers to the permanence of warnings affixed to the boiler.
3.4	Operating instructions (a) When pressure equipment is placed on the market, it shall be accompanied, as far as relevant, with instructions for the user,	(None)	Sect. I does not require manufacturers to issue operating instructions or warnings regarding

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	containing all the necessary safety information relating to: *(1)* mounting including assembling of different pieces of pressure equipment, *(2)* putting into service, *(3)* use, *(4)* maintenance including checks by user; (b) Instructions must cover information affixed to the pressure equipment in accordance with 3.3, with the exception of serial identification, and must be accompanied, where appropriate, by the technical documents, drawings and diagrams necessary for a full understanding of these instructions;	(None)	potential hazards or misuse of pressure equipment. Manufacturers generally do provide such instructions; and for PED compliance, they shall include the information listed in Point 1.3, 2.2.3, 2.7, and in Point 3.4 of Annex I of the PED.
	(c) If appropriate, these instructions shall also refer to hazards arising from misuse in accordance with Point 1.3 and particular features of the design in accordance with Point 2.2.3.	(None)	
4.	**MATERIALS**		
	Materials used for manufacturing of pressure equipment must be suitable for such application during the scheduled lifetime unless replacement is foreseen.	PG-5 through PG-12, Sect. II, App. 6	The PED requires the manufacturer to select material (including bolting) that is suitable for the scheduled lifetime of the vessel. Boiler manufacturers choose their materials for construction based on these considerations, even though they are not spelled out in Sect. I. This practice may need to be documented for PED compliance, or consultation with a notified body familiar with the application of Sect. I may suffice.
	Welding consumables and other joining materials need fulfill only the relevant requirements of Points 4.1, 4.2(a), and the first paragraph of Point 4.3, in an appropriate way, both individually and in a joined structure.	PW-5.4, Sect. II, Part C	The general principles in Sect. I regarding selection of materials, P-numbers and welding procedure qualifications all contribute to meeting these requirements. This is another case where consultation with a notified body that is familiar with the application of Sect. I will contribute to determination of having achieved an overall equivalent level of safety.
4.1	Materials for pressurized parts shall: (a) Have appropriate properties for all operating conditions which are reasonably foreseeable and for all test conditions, and	PG-5 through PG-12, Sect. II, Parts A, B, C, D. (partial)	The manufacturer of pressure equipment is responsible for material selection for the intended service. The materials shall meet the requirements of Annex I, Points 4.1(a) through 4.1(e). Boiler manufacturers choose

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	in particular they should be sufficiently ductile and tough.		their materials for construction based on these considerations, even though they are not spelled out in Sect. I. This practice may need to be documented for PED compliance. Point 7.5 of Annex I requires materials to have 14% minimum elongation and to meet a minimum average value of 27 J (20 ft-lbs) at 20°C (68°F). Consultation with a notified body that is familiar with the application of Sect. I will contribute to determination of having achieved an overall equivalent level of safety.
	Where appropriate, the characteristics of the materials shall comply with the requirements of Point 7.5. Moreover, due care should be exercised in particular in selecting materials in order to prevent brittle type fracture where necessary; where for specific reasons brittle material has to be used, appropriate measures shall be taken;	PG-5 through PG-12, Sect. II, Parts A, B, C, and D. (partial)	For Sect. I applications, brittle-type fracture is not a significant failure mode. Materials will be approved if they have the following properties, or if an equivalent level of safety can be demonstrated. In the case of Sect. I, its long history of boilers with safe service life can be demonstrated through consultation with a notified body that is familiar with the application of Sect. I.
	(b) Be sufficiently chemically resistant to the fluid contained in the pressure equipment; the chemical and physical properties necessary for operational safety shall not be significantly affected within the scheduled lifetime of the equipment;	PG-5, Note 1, PG-6, PG-7, PG-8 and PG-9; Sect. II, Part D, App. 5, 6 (partial)	The PED requires the manufacturer to be responsible for material selection for the intended service. The materials must meet the requirements of Points 4.1(a) through 4.1(e) in Annex I. Chemical and physical properties for operational safety are implied in Sect. I. Specific guidance is given in PG-5, Note 1, and may have to be documented.
	(c) Not be significantly affected by aging;	Sect. II, Part D, App. 5, 6 (partial)	(Note: Sect. I has no specific requirements for aging.)
	(d) Be suitable for the intended processing procedures; (e) Be selected in order to avoid significant undesirable effects when the various materials are put together.	PG-6, PG-7, PG-8 and PG-9 PW-5, PW-28 and PW-39	
4.2	The pressure equipment manufacturer shall: (a) Define in an appropriate manner the values necessary for the design calculations referred to in 2.2.3 and the essential characteristics of the materials and their treatment referred to in 4.1.	PG-23, Sect. II Part D, App. 1 (partial)	Materials will only be approved if they have the specified properties or if an equivalent level of safety can be demonstrated. It may be necessary to demonstrate that the hydrotest temperature is above the brittle transition temperature to support decisions on selecting materials.

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	(b) The manufacturer shall provide in his technical documentation elements relating to compliance with the material specification of the Directive in one of the following forms: *(1)* by using materials which comply with harmonized standards, *(2)* by using materials covered by a European approval of pressure equipment materials in accordance with Article. 15, *(3)* by a particular appraisal. (c) For pressure equipment in categories III and IV, a specific assessment of the PMA shall be performed by the NB in charge of the CA procedures for the pressure equipment.	(None) (None) (None) (None) (None)	In 2001, the European Commission determined that on the basis of Art. 11, §5, no EAMs would be issued covering materials for which there exists (or is under development) an equivalent harmonized European material specification. Therefore, the only way to use ASME SA materials in Sect. I boiler construction intended for CE marking is to perform PMAs for each material for equipment in Category III and IV. This becomes a problem only when the manufacturer utilizes multiple notified bodies. PMAs performed by a notified body other than that being used for the equipment in question shall be repeated.
4.3	The equipment manufacturer shall take appropriate measures to ensure that the material used conforms to the required specification.	PG-77, App. A-302.4	
	In particular, documentation prepared by the material manufacturer affirming compliance with the specification shall be obtained for all materials.	PG-77, App. A-302.4	
	For the main pressure bearing parts of equipment in categories II, III, and IV, this shall take the form of certificate of specific product control.	PG-77, App. A-302.4 (partial)	The manufacturer must ensure that the material conforms to one of the appropriate specifications and is supported by appropriate certification. a) For main pressure parts of pressure equipment in Categories II, III, and IV the test certificates shall comply with EN 10204, Types 3.1 or 3.2. b) Certificates of Type 2.2 are acceptable for Category I equipment. c) Certificates of Type 2.2 are acceptable for welding consumables for pressure equipment in all categories.
	Where the material manufacturer has an appropriate QA system, certified by a competent body established within the Community and having undergone a specific assessment of materials, certificates issued by the manufacturer are presumed to certify the conformity with relevant requirements of this section.	(None)	For example, if the material manufacturer holds accredited certification to ISO 9000 from a certification body established within the European Community, a material certificate of the EN 10204, 3.1 is acceptable. Where the material manufacturer does not hold such a certification, the pressure equipment manufacturer is responsible for determining the certification requirements.

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5.	**SPECIFIC REQUIREMENTS FOR HEATED PRESSURE VESSELS**		
	Specific Pressure Equipment Requirements In addition to the applicable requirements of Points 1 to 4, the following requirements apply to the pressure equipment covered by Points 5 and 6.		
5.	FIRED OR OTHERWISE HEATED PRESSURE EQUIPMENT WITH RISK OF OVERHEATING AS REFERRED TO IN ARTICLE 4 (1) This pressure equipment includes:		
	(a) Steam and hot water generators as referred to in Article 4(1)(b), such as fired steam and hot-water boilers, superheaters and reheaters, waste-heat boilers, waste incineration boilers, electrode or immersion-type electrically heated boilers, pressure cookers, together with their accessories and where applicable their systems for treatment of feedwater and for fuel supply, and	Preamble (partial)	Sect. I does not cover vessels in which steam is generated for internal use such as pressure cookers.
	(b) Process heating equipment for other than steam and hot water generation falling under Article 3, section 1.1, such as heaters for chemical and other similar processes and pressurized food-processing equipment.	Preamble (Partial)	Unfired steam boilers can be built to either Sect. I or Sect. VIII.
	This pressure equipment shall be calculated, designed, and constructed so as to avoid or to minimize risks of a significant loss of containment from overheating. In particular it shall be ensured, where applicable, that:	Part PG	
	(a) appropriate means of protection are provided to restrict operating parameters such as heat input, heat take-off and, where applicable, fluid level so as to avoid any risk of local and general overheating,	PG-60 and PG-61	
	(b) sampling points are provided where required to allow evaluation of the properties of the fluid so as to avoid risks related to deposits and/or corrosion,	PG-59.3 and PG-59.4	
	(c) adequate provisions are made to eliminate risks of damage from deposits,	PG-59.3	
	(d) safe removal of residual heat after shutdown are provided,	None	Normally provided for by boiler designers
	(e) steps are taken to avoid a dangerous accumulation of ignitable mixtures and	None	Normally provided for by boiler designers

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	combustible substances and air, or flame flowback.		
6.	PIPING AS REFERRED TO IN ARTICLE 4(1)(c)		Sect. I contains requirements for piping within the boiler proper as defined in Fig. PG-58.3.1 and Fig. PG-58.3.2. Those figures also define the limits of boiler external piping, the design and construction rules for which are contained in ASME B31.1, Power Piping. PED compliance for the completed boiler will be demonstrated by using the combination of ASME Sect. I and ASME B31.1 to meet the ESRs for piping.
	Design and construction shall ensure:	PG-27.2.2, PG-58	
	(a) that the risk of overstressing from inadmissible free movement or excessive forces being produced, e.g., on flanges, connections, bellows or hoses is adequately controlled by means such as support, constraint, anchoring, alignment, and pretension;	PG-59.1.2; B31.1 §'s 119, 120, 121, and 122.1.1	
	(b) that where there is a possibility of condensation occurring inside pipes for gaseous fluids, means are provided for drainage and removal of deposits from low areas to avoid damage from water hammer or corrosion.	PG-58.3.7 and PG-59.4; B31.1 §'s 101.5.1 and 122.1.5	
	(c) that due to consideration is given to the potential damage from turbulence and formation of vortices; the relevant parts of Point 2.7 are applicable;	PG-59.2; B31.1 §102.4	
	(d) that due consideration is given to the risk of fatigue due to vibrations in pipes;	PG-59.1.2; B31.1 §101.5.4 and App. D	Note 3 to ASME B31.1 §119.7 describes how fatigue is considered in the stress intensification factors of App. D. Manufacturers may have to describe this in the context of a proven history of safe operation of B31.1 piping systems to demonstrate compliance with this requirement.
	(e) that, where fluids of Group 1 are contained in the piping, appropriate means are provided to isolate "take-off" pipes the size of which represents a significant risk;	N/A	
	(f) that the risk of inadvertent discharge is minimized; the take-off points must be clearly marked on the permanent side, indicating the fluid contained;	N/A	

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	(g) that the position and route of underground piping is at least recorded in the technical documentation to facilitate safe maintenance, inspection, or repair.	None	Neither Sect. I nor B31.1 contain requirements for mapping of underground piping. Such documentation would have to be furnished and can easily be derived from plans and blueprints for the buried piping system.
7.	**SPECIFIC QUANTITIVE REQUIREMENTS FOR CERTAIN PRESSURE EQUIPMENT**		
	The following provisions apply as a general rule. However, where they are not applied, including in cases where materials are not specifically referred to and no harmonized standards are applied, the manufacturer shall demonstrate that appropriate measures have been taken to achieve an equivalent overall level of safety. The provisions laid down in this section supplement the essential requirements of sections 1 to 6 for the pressure equipment to which they apply.		The specified quantitative requirements apply as a general rule. Other values may be used but the manufacturer must be able to demonstrate to the notified body that appropriate measures have been taken to demonstrate that equivalent overall level of safety has been achieved.
7.1	Allowable stresses		
7.1.1	Symbols $R_{e/t}$, yield limit, indicates the value at the calculation temperature of: a) The upper flow limit for a material presenting upper and lower flow limits, b) The 1.0% proof strength of austenitic steel and non-alloyed aluminum, c) The 0.2% proof strength in other cases. $R_{m/20}$ indicates the minimum value of the ultimate strength at 20°C. $R_{m/t}$ designates the ultimate strength at the calculation temperature.		For the materials not listed in §7.1, the allowable stresses are left to the manufacturer, who must demonstrate that an equivalent overall safety has been achieved. For this objective, the manufacturer may refer to harmonized ENs, codes, and specifications approved by the CEN Technical Committee (e.g., EN12952, Water Tube Boilers, and EN12953, Shell Boilers).
7.1.2	The permissible general membrane stress for predominantly static loads and for temperatures outside the range in which creep is significant must not exceed the smaller of the following values, according to the material used: a) in the case of ferritic steel including normalized (normalized rolled) steel and excluding fine grain steel and specially heat-treated steel, 2/3 of $R_{e/t}$ and 5/12 of $R_{m/20}$;	Sect. II, Part D, Table 1A, and App. 1 (Partial)	(Note: In general, the allowable design stresses in ASME Sect. II, Part D, are acceptable. The manufacturer must verify that the ASME BPVC allowable design stresses meet the PED criteria in each particular case.)

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	b) in the case of austenitic steel *(1)* if its elongation after rupture exceeds 30%, 2/3 of $R_{e/t}$ *(2)* or, alternatively, and if its elongation after rupture exceeds 35%, 5/6 of $R_{e/t}$ and 1/3 of $R_{m/20}$; c) in the case of non-alloy or low alloy cast steel, 10/19 of $R_{e/t}$ and 1/3 of $R_{m/20}$; d) in the case of aluminum, 2/3 of $R_{e/t}$; e) in the case of aluminum alloys, excluding precipitation hardening alloys, 2/3 of $R_{e/t}$ and 5/12 of $R_{m/20}$.	(Partial)	(Note: Sect. I permits allowable stress, S ≤ 0.9 SY for certain austenitic stainless steels that do not meet the limitations in Point 7.1.2 of Annex I.)
7.2	Joint Coefficients For welded joints, the joint coefficient must not exceed the following values: a) for equipment subject to destructive and non-destructive tests which confirm that the whole series of joints show no significant defects: 1, b) for equipment subject to random NDT: 0.85, c) for equipment not subject to NDT other than visual inspection: 0.7. If necessary, the type of stress and the mechanical and technological properties of the joint must also be taken into account,	PG-27.4, Note 1, PW-11 and PW-41	
7.3	Pressure limiting devices, particularly for pressure vessels The momentary surge referred to in 2.11.2 must be kept to 10% of the maximum allowable pressure.	PG-67.2	PG-67.2 limits this to 6% of MAWP.
7.4	Hydrostatic test pressure For pressure vessels, the hydrostatic test pressure referred to in Point 3.2.2 shall be no less than: a) That corresponding to the maximum loading to which the pressure equipment may be subject to in service, taking into account its maximum allowable pressure and its maximum allowable temperature, multiplied by a coefficient of 1.25, or b) The maximum allowable pressure multiplied by the coefficient 1.43, whichever is greater.	PG-99 PG-99	PG-99.3 limits the amount of stress on any component in the boiler system, which meets the intent of the EC's WG Pressure Guideline 8/2.

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS (ESR)	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
7.5	Material Characteristics		
	Unless other values are required in accordance with other criteria that must be taken into account, a steel is considered as sufficiently ductile to satisfy Point 4.1(a) if, in a tensile test carried out by a standard procedure, its elongation after rupture is no less than 14% and	PG-5 through PG-12, Sect. II, Parts A, B, C, D. (partial)	Materials will be approved if they have the listed properties, or if an equivalent level of safety can be demonstrated. In the case of Sect. I, its long history of boilers with safe service life can be demonstrated through consultation with a notified body that is familiar with the application of Sect. I.
	its bending rupture energy measured on an ISO V test-piece is no less than 27 J, at a temperature no greater than 20°C but not higher than the lowest scheduled operating temperature.	None	For Sect. I boilers, the operating range is not near the transition temperature and the WG Pressure Guideline 7/17 should apply. The guidelines related to the PED are in the process of being updated- see Section 14 of this document. Consultation with a notified body that is familiar with the application of Sect. I will contribute to determination of having achieved an overall equivalent level of safety.

Note: Any reference to the Code in this table means ASME Section I.
N/A = not applicable.