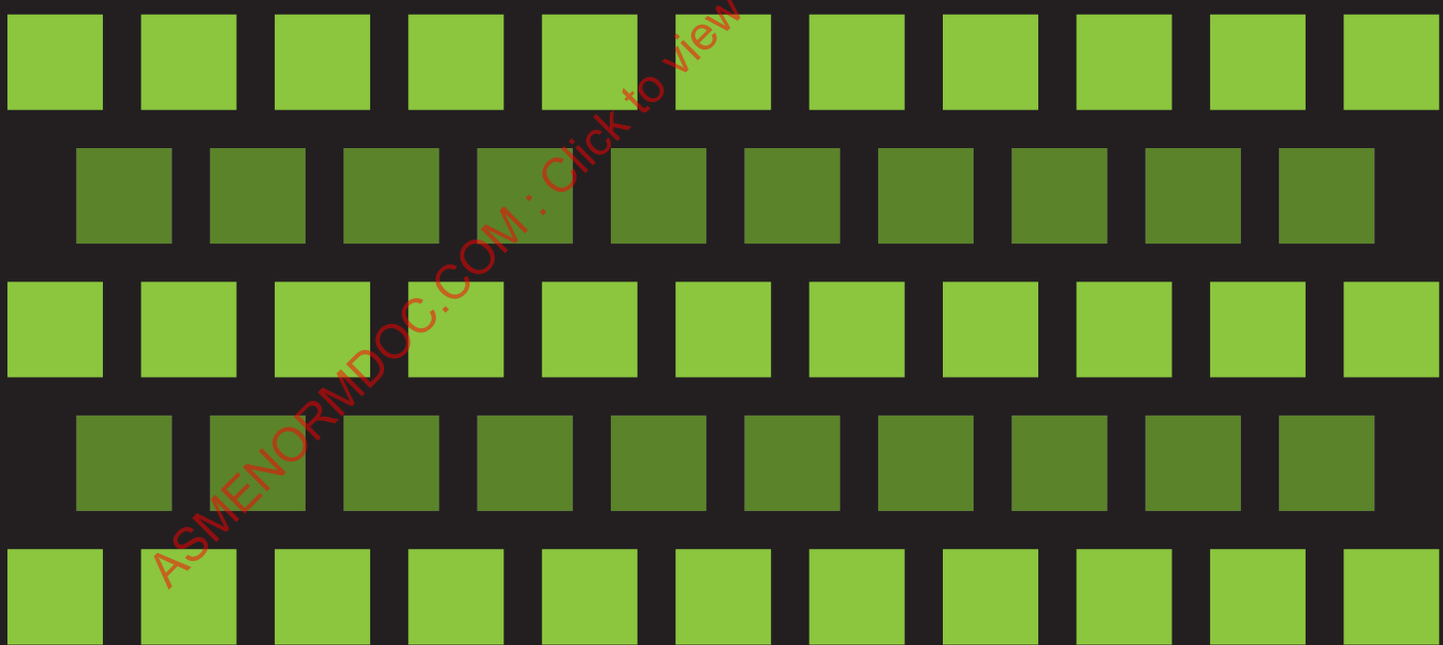
STP/PT-002

ASME SECTION I PED GUIDE

Supplement to Guide for ASME Stamp Holders Use of ASME Section I to Meet the EC Pressure Equipment Directive (97/23/EC)



ASME STANDARDS TECHNOLOGY, LLC

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Supplement to Guide for ASME Stamp Holders Use of ASME Section I to Meet the EC Pressure Equipment Directive (97/23/EC)

ASME STANDARDS TECHNOLOGY, LLC

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FOREWORD

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 Reference[1]. The result was the publication of the "ASME Guide for ASME Stamp Holders on Using Section VIII, Division 1 to meet the EC Pressure Equipment Directive."[2] Now, this guide provides information to manufacturers who want to use ASME Section I, Power Boilers to meet the PED.

Established in 1880, the American Society of Mechanical Engineers (ASME) is a 120,000 member professional not-for-profit organization focused on technical, educational and research issues of the engineering and technology community. ASME conducts one of the world's largest technical publishing operations, holds numerous technical conferences worldwide, and offers hundreds of professional development courses each year. ASME maintains and distributes 600 Codes and Standards used around the world for the design, manufacturing and installation of mechanical devices. Visit www.asme.org for more information.

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ABSTRACT

This guide is intended as a supplement for ASME stamp holders using ASME Boiler and Pressure Vessel Code (BPVC) Section I [3]as the basis for conformity with the European Commission (EC) Pressure Equipment Directive (PED), 97/23/EC[1]. This guide provides a comprehensive review of the PED and ASME Section I.

Manufacturers of Section I boilers will find this supplement, combined with the existing guide [2], to be useful tools when working with a Notified Body (NB) toward compliance with the PED and applying CE marking to their products.

This supplement is intended to be used in combination with the existing guide[2], which contains 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 existing guide goes into an in-depth analysis of the PED's concept of hazard categories and the various combinations of conformity assessment modules that can be used for each hazard category. Then, each of the PED Essential Safety Requirements (ESR) are covered, including materials, use of notified bodies, and requirements for CE marking. Those aspects are not reproduced in this supplement, as they are generic to all pressure equipment under the PED.

In this supplement, the reader is presented with some general guidance and updates on PED issues critical to ASME stamp holders. The majority of the supplement consists of a detailed comparison of the technical requirements of the PED with Section I, followed by a modified version of an "Annex ZA" for Section I. This Annex ZA provides instructions regarding what additional tasks must be completed to meet the administrative requirements of the PED.

PART I -
UPDATE OF ISSUES ON USING THE ASME CODE TO MEET THE PED

1. BACKGROUND

With the passing of the mandatory date for implementation of the PED, many questions that existed are beginning to be answered. CEN has managed to issue harmonized standards for most equipment, but there is little experience in using these standards, and the full suite of harmonized supporting standards remains incomplete. During the transition period from November 29, 1999 through May 30, 2002, few harmonized standards were available, so all of the equipment that was CE marked during that period was built to nonharmonized standards. Therefore, manufacturers have gained more experience using nonharmonized standards to construct pressure equipment with CE marking, and the ASME Boiler and Pressure Vessel Code (ASME Code) is one of the most commonly used for PED compliance, both within Europe and around the world. There are some basic steps that will facilitate the use of the ASME Code to meet the PED. This document helps explain what those steps are specifically in regards to Section I of the ASME Boiler and Pressure Vessel Code [3], and the special considerations that must be given to assemblies.

2. USE OF NONHARMONIZED STANDARD

When using a nonharmonized standard, many of the criteria for demonstrating compliance with the essential safety requirements of the PED revolve around the concept of "equivalent overall level of safety." For that reason, it is valuable to select a notified body (NB) that is familiar with the requirements and design/fabrication philosophies of the ASME Code. 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 Code and the PED and can advise manufacturers as to what needs to be done in addition to ASME requirements to meet the PED. This document will inform manufacturers of these additional requirements so they have more information to make a business decision as to whether to proceed to engage a NB in order to enter the European market.

ASME has spent the last several years working on issues related to the use of its standards to meet the PED. Through meetings with NBs, the European Commission (EC), and also through workshops with users of ASME standards in the United States, Europe, and Asia, it became clear that some issues require changes, either in the ASME standards themselves, or how the processes of the PED are used for their application. The following are some of the most recent developments in those important areas.

2.1 Material Specifications

In May 2002, ASME was committed to working with manufacturers submitting proposals for European Approval of Materials (EAM) to the European Commission to gain approval of ASME material specifications for repeated use under the PED. ASME began a program of funding the necessary data collection and submittal in concert with a European NB and a U.S. manufacturer. Over one dozen of the most commonly used pressure equipment materials were submitted at a cost of $20,000 USD. Other notified bodies also submitted proposed EAMs covering ASME materials. However, the European Commission determined that Article 11, paragraph five 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. There still remain some areas of uncertainty, the most recent being a guideline issued by the European Commission that

seems to imply that the material manufacturer must "guarantee" the properties used by the equipment manufacturer in his design under the PED. This guideline, 7/24, is being interpreted differently by different notified bodies and manufacturers should investigate this issue with potential notified bodies as part of the normal process for engaging the services of a NB prior to vessel construction.

2.2 Qualification of NDE Personnel

The PED requires that qualification of Nondestructive Examination (NDE) personnel be performed by a Recognized Third Party Organization (RTPO) recognized specifically for this task. The traditional ASME approach has been to place responsibility for qualification of such personnel on the manufacturer (employer). Some years ago, Section V of the ASME Boiler and Pressure Vessel Code [5] was revised to recognize the American Society for Nondestructive Testing (ASNT) ASNT Central Certificate Program (ACCP). This allowed manufacturers to utilize a central certification program instead of performing the testing themselves, provided the process was described in the manufacturer's quality program. In response to requests from Europe, a recent addendum to Section V expanded the provision even further, recognizing any national or regional certification program, provided it meets the minimum requirements of Section V and the process is described in the manufacturer's quality system. This allowed users of ASME standards in Europe to use their existing qualifications to meet both the ASME Code and the PED. In the United States, ASNT entered into an agreement with a European RTPO wherein the results of the ASNT ACCP program were acceptable as meeting the requirements of the equivalent European program, and those of the PED. Therefore, manufacturers that qualify their NDE personnel under the ACCP program realize cost savings by not having to develop their own testing programs, and they are able to meet the PED requirements at the same time.

2.3 Discussions with the European Commission

Beginning in April 2002, ASME has been involved in an exchange of correspondence between the U.S. Department of Commerce and the European Commission's Enterprise Directorate-General (DG), the office responsible for the PED. The issues discussed above, and others, were included in this correspondence, and the result was a meeting between the two offices held in May 2004 in Washington, D.C. There was general agreement among those present regarding what the major issues were in complying with the PED. There were also discussions regarding the U.S. pressure equipment regulatory system and the role that ASME Codes and Standards play in that system. Some suggestions were made regarding reconciliation of material specifications and another meeting was held in September 2004 that included industry representatives from both the United States and Europe. ASME will continue to pursue these and other avenues for progress in maintaining and improving the recognition of its Codes and Standards around the world through technical improvements and discussions with government authorities.

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PART II -
PED OVERVIEW

1. INTRODUCTION

1.1 National Regulations

Pressure components present inherent hazards due to the potential energy of their content, especially for gas. As a consequence of this, most industrial countries have regulated these products for many decades. This is the case with the European countries that have developed national regulations, which, quite often, are significantly different from each other. Some are very detailed (as in France), others contain only very general requirements (as in the UK), and some others have developed very detailed conformity assessment procedures for the pressure equipment (as in Germany). This profusion of different regulations leads to technical barriers to trade. In 1989 the EU decided to establish a "Pressure Equipment Directive" to eliminate these problems. Boilers have probably the longest history of being regulated and therefore boiler manufacturers are expected to be more familiar with the requirements of complying with regulations such as the Pressure Equipment Directive.

1.2 Intent of PED

The PED has three intents:

(a) Adopt a common regulation for Pressure Equipment throughout the EU.

(b) Delete 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.

This third intent is the most important one. 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, PED covers only the pressure hazard. Other directives may be applicable to cover other hazards. In particular on boiler plants, other directives can apply to equipment such as pulverizers, burners, and fans.

A list of those directives that may also be applicable to Pressure Equipment is given in Appendix X-2 in the "Guide for ASME Stamp Holders Use of ASME Section VIII, Division 1 to Meet the EC Pressure Equipment Directive"[2] 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.

1.3 Principles

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

(a) their NB: anywhere in the EU;

(b) the Conformity Assessment Procedure, which will be adapted to their fabrication;

(c) how they will comply with the Essential Safety Requirements - use of the European Harmonized Standard, or a National Code.

1.4 Types of Requirements

PED, like any European directive, includes three types of requirements:

(a) Requirements of legislative nature, which are contained in Art. 1 to 21 of the Directive[1];

(b) Requirements devoted to Conformity Assessment Procedures (detailed in Annex III of the Directive) which concern the responsibilities of manufacturers and NBs;

(c) Requirements devoted to the Equipment itself, so-called Essential Safety Requirements (detailed in Annex I of the Directive).

2. GENERAL CONCEPTS

The Pressure Equipment Directive was adopted on May 29, 1997 and published in the Official Journal of European Communities on July 9, 1997 under the reference 97/23/CE.

The two main purposes of this directive are as follows:

(a) Set up in the 15 countries of the European Union (EU), a common regulation for all Pressure Equipment in order to ensure a high level of safety throughout the European Union.

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

This directive came into force in November 1999 and became fully mandatory in May 2002.

The purpose of this report is to make the users familiar with the key elements of the directive.

Guidelines referenced in this report can be accessed by visiting the pressure equipment website of the European Commission at http://ped.eurodyn.com/ and clicking on "Guidelines."

2.1 Scope

The Directive [1] applies to all equipment (pressure vessels, piping, boilers) subject to a pressure greater than 0.5 bar.

Despite several exclusions, such as equipment in the nuclear power field, this scope is very wide as it covers usual products (such as pressure cookers) as well as large industrial equipment (such as chemical reactors or liquefied gas vessels).

The Directive applies only to new equipment.

It should be recognized that major replacements to boiler plants such as steam drums or reheater headers can be covered by the Directive even if they are replaced on a "like for like" basis.

Guideline 3/4 outlines the extent of a "boiler" stating that it covers from the feedwater inlet (including the inlet valve) to the steam outlet (again including the outlet valve). It includes all interconnecting pipework that may be exposed to a risk of overheating and are not capable of isolation from the main system. It also includes the associated safety accessories and the piping connected to the boiler involved in services such as draining, venting, desuperheating, etc. Readers will note that this scope of coverage is very similar to that of ASME Section I, Power Boilers [3].

Guideline 1/3 defines the application to repairs or modifications of pressure equipment. The complete replacement of pressure equipment by a new one is covered by the PED. Repairs are not covered but pressure equipment that has been subjected to important modifications that change the original characteristics, purpose and or type after it has been put into service has to be considered as a new product covered by the Directive. This has to be assessed on a case-by-case basis.

During the transition phase of the PED up to full implementation in May 2002 there were numerous discussions and meetings on the subject of "assemblies." Various guidelines were developed by the European Commission in an attempt to clarify the issue.

Chapter X, Section 1 of the ASME Section VIII PED Guide [2] outlines the definition in the PED but the specific Guidelines such as 3/2, 3/8, 3/9, and 3/10 give further clarification.

Guideline 3/2 defines the application to covering the joining of components at site and states that two cases have to be considered. The joining of component parts to make up an item of pressure equipment is subject to the requirements of the Directive.

Joining (welding) is not covered by the PED if it is carried out to constitute an installation under the responsibility of the user. In this case it is covered by national rules. It should be noted that when a user is putting items of pressure equipment or assemblies together, then the term “installation” is used to avoid confusion.

Guideline 3/8 states that items of pressure equipment form an assembly if:

(a) they are integrated, i.e., they are connected and designed to be compatible with each other.

(b) they are functional, i.e., they achieve specific, overall objectives and can be put into service.

(c) they form a whole, i.e., all items are necessary for the assembly to function and be safe.

The guideline also states that it is irrelevant whether the completion of the assembly takes place at the manufacturer’s workshop or by the manufacturer on site.

Clearly boilers fall into this definition of an assembly and in fact shell boilers and water tube boilers are listed on the guideline as examples of assemblies.

Guideline 3/9 states that the PED does not limit the extent of an assembly and therefore a utility boiler could be considered as one assembly. However, an assembly can itself be composed of other assemblies and further items of pressure equipment. This is likely to be the case on utility boilers where the pressure parts usually come for different manufacturers and suppliers.

When a manufacturer places on the market a product as a final assembly, consisting of assemblies and items of pressure equipment, intended to be put into service as such, he has to perform the global conformity assessment resulting in CE marking of the final assembly. If some of the constituent assemblies are not CE marked then the individual items of pressure equipment should be included in the global conformity assessment.

Guideline 3/10 advises that it is possible to put assemblies on the market that are not CE marked if it is the intention that the assembly is not put into service as such but will become part of a larger assembly.

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:

(a) the nature of the fluid contained (more or less hazardous),

(b) the internal pressure (higher or lower),

(c) the internal volume (larger or smaller).

Equipment below these thresholds is not subject to the requirements in the following clauses of the PED [1] (§3 to §6).

The majority of large industrial and utility boilers tend to be in the highest category, i.e., Category IV.

2.3 Conformity Assessment Procedures

Each item of pressure equipment must be subject to a Conformity Assessment Procedure in order to verify that it complies with the specifications of the Directive. For each Hazard Category, one or more 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 system.

2.4 Notified Body

The conformity assessment is performed by an independent inspection organization, notified by each of the Member States to the European Commission, who publishes the list in the Official Journal. The manufacturer may select any of the Notified Bodies from this list for the conformity assessment of his Equipment. It is recommended that the manufacturer select a NB with experience in boiler plants. This is particularly important in defining the breakdown of assemblies.

2.5 CE Marking

The CE marking must be affixed on each item of pressure equipment that complies with the specifications of the Directive, ensuring to the equipment the benefit of free movement in EU. On new boiler plants, one nameplate with the CE mark is sufficient.

2.6 Essential Safety Requirements

Each item of pressure equipment classified in one of the four Hazard Categories must fulfill all the Essential Safety Requirements specified in Annex I of the Directive. These technical requirements cover the design, material, fabrication, testing, and inspection aspects for the equipment.

3. STRUCTURE OF PED

PED has 21 Articles that are listed in App. II–1 of the ASME Section VIII PED Guide and also included in Table 1 of this supplement.

About half of these articles are of legal or administrative nature and are common to all New Approach Directives:

(a) Articles devoted to member states: Articles 2 (Market Surveillance), 4 (Free Movement), 5 (Presumption of Conformity), 8 (Safeguard Clause), 16, 17, 18, 19, and 21.

(b) Articles of administrative nature: Articles 6, 7.

These articles are of little interest to the pressure equipment manufacturer.

(c) Other articles form the cornerstone of the PED:

Article 1	Defines the scope of PED.
Article 3	Defines the thresholds (pressure and volume) above which the Pressure Equipment will have to be classified in “Hazard Categories” and subject to “Essential Safety Requirements”, listed in Annex I of the PED.
Article 9	Defines the 4 Hazard Categories (I, II, III, IV) which are obtained from graphs, given in Annex II of the PED.
Article 10	Defines the “Conformity Assessment Procedures,” detailed in Annex III of the PED, which enable the NB to inspect the Equipment.
Article 11	Defines the “European Approval for Materials.”
Article 12	Defines the role of the “Notified Bodies.”
Article 20	Defines the “Transitional Provisions.”

There articles are completed by seven annexes of technical nature (Annexes I, II, III) or administrative nature (Annexes IV to VII), which are listed in Table 1 of this report.

Figure 1 of this supplement presents a flowchart of the PED.

4. TRANSITIONAL PERIOD (ARTICLE 20)

The Directive was adopted on May 29, 1997. It was implemented on November 29, 1999 for a transitional period of 2.5 years, which ended on May 29, 2002.

(a) Before May 29, 1999, each of the member states must incorporate the PED in its national regulation (Art. 20 §1) [1].

(b) After November 29, 1999, beginning of the transitional period, the manufacturers of pressure equipment may choose between:

(1) Applying the PED. In this case each pressure equipment must bear the CE Marking and has the benefit of free movement within the EU.

(2) Applying the present National Regulation. In this case the equipment cannot bear the CE marking and will not have the free movement within the European Community.

(c) From May 30, 2002, end of the transitional period (Art. 20 §3)[1]:

The application of the PED shall be fully mandatory in the 15 countries of EU and shall supersede the current national regulations.

Any pressure equipment within the scope of the PED shall have to comply with it and bear the CE marking.

The PED applies only to new equipment. Equipment already in service shall not be subject to the PED, but will continue to meet the national regulations.

Table 1 - Contents of the PED

ARTICLES	
Article 1	Scope and definition
Article 2	Market surveillance
Article 3	Technical requirements
Article 4	Free movement
Article 5	Presumption of conformity
Article 6	Committee on technical standard and regulations
Article 7	Committee on "Pressure Equipment"
Article 8	Safeguard clause
Article 9	Classification of Pressure Equipment
Article 10	Conformity assessment
Article 11	European approval for materials
Article 12	Notified Bodies
Article 13	Recognized third-party organizations
Article 14	User inspectorates
Article 15	CE Marking
Article 16	Unduly affixed CE Marking
Article 17	Appropriate measures
Article 18	Decisions entailing refusal or restriction
Article 19	Repeal
Article 20	Transposition and transitional provisions
Article 21	Addresses of the Directive
ANNEXES	
ANNEX I	Essential Safety Requirements
ANNEX II	Conformity Assessment Tables
ANNEX III	Conformity Assessment Procedures
ANNEX IV	Criteria of the Notified Bodies
ANNEX V	Criteria of the User Inspectorates
ANNEX VI	CE Marking
ANNEX VII	Declaration of Conformity

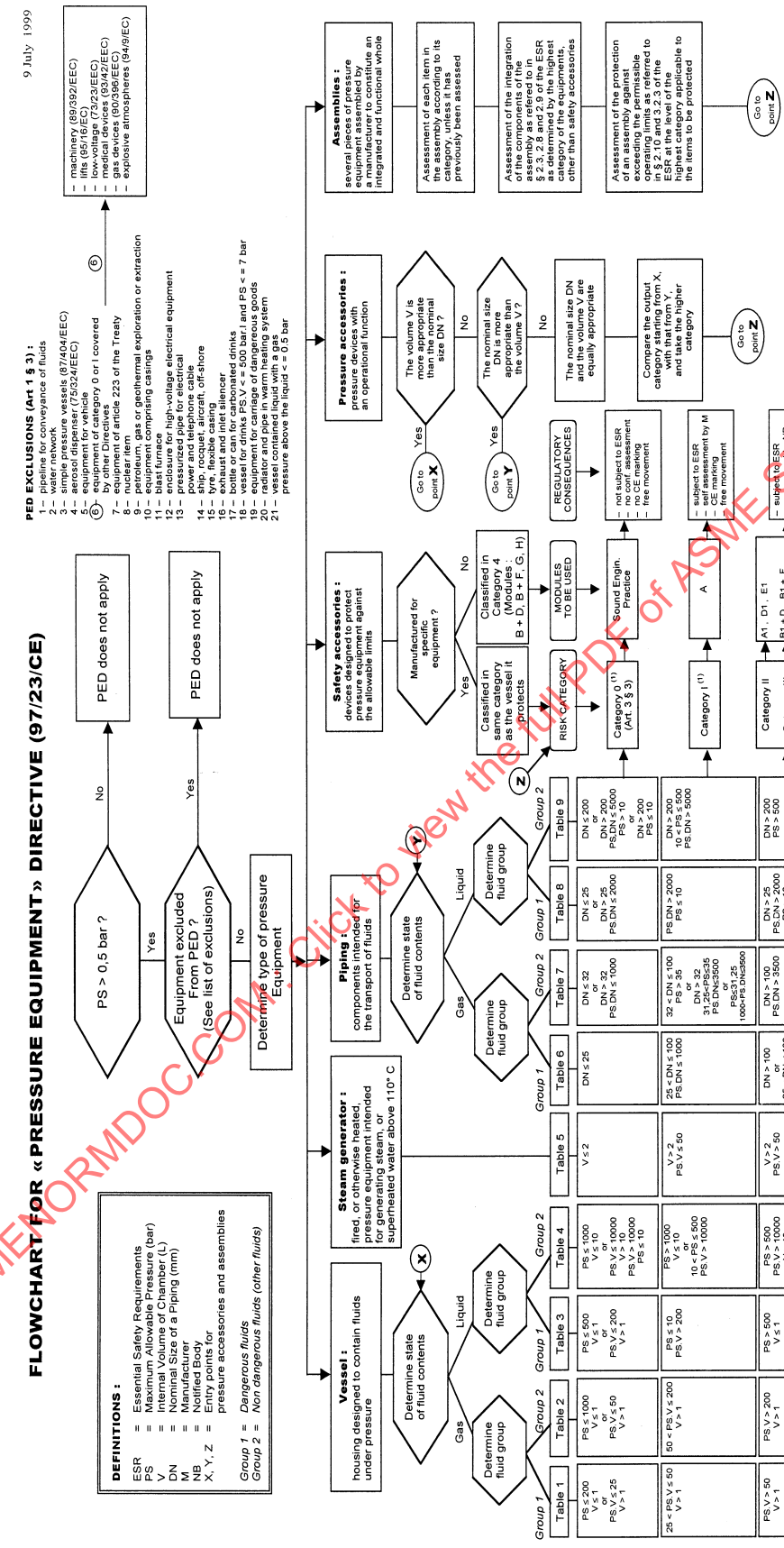

Figure 1 – Flowchart for PED (97/23/CE)

PART III– COMPARISON OF TECHNICAL REQUIREMENTS OF ASME SECTION I, WITH PED 97/23/EC, ANNEX I

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	GENERAL REQUIREMENTS						
	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.	Assembly 1	See Art. 1, Par. 2.1.5 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 in order to identify those which apply to his equipment on account of pressure; he must then design and construct it taking account of his analysis.	Req't. 1.a Req't. 1.b		None None		Sect. I does not require hazard analysis. See Notes 1 and 2	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 economical considerations that are consistent with a high degree of health and safety protection.	Statement	Informative statement	Yes	Foreword, Preamble	Note A	

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**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.	Req't. 2		Partial	Preamble, Sect. II, Part D, App. 6	Note B	Note 3, Note 4
1.2	In choosing the most appropriate solutions, the manufacturer must comply with the principles set out below in the following order:	Req't. 3	This supplements Req't.. 1.	Partial			
	▪ Eliminate or reduce hazards as far as is reasonably practicable	Req't. 3.a	Hazards during operation of the vessel	Yes			Note 5
	▪ Apply appropriate protection measures against hazards that cannot be eliminated	Req't. 3.b	Pressure relief devices, temperature controls, low-water cutoffs, etc.	Yes	PG-67 through PG-73, PMB-17 & PEB-16		
	▪ 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.	Req't. 3.c	Remaining hazards after Req't. 3.a and 3.b have been met	None			
1.3	Where the potential for misuse is known or can be clearly foreseen, the pressure equipment must be designed to prevent danger from such misuse or, if that is not possible, adequate warning (must be) given that the pressure equipment must not be used in that way.	Req't. 4.a		Yes	PG-60, PG-61		Note 6
		Req't. 4.b		Partial		Note B	

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	ANNEX I ESSENTIAL SAFETY REQUIREMENTS	GROUPING	COMMENTS	YES, NONE, PARTIAL	CODE REF.	COMMENTS	ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1
2	**DESIGN REQUIREMENTS**						
2.	DESIGN						
2.1	General						
	The pressure equipment must be properly designed taking all relevant factors into account in order to ensure that the equipment will be safe throughout its intended life.	Req't. 5		Partial	Preamble, PG-16, PG-23 through PG-38, PG-43, PG-46, PG-52, PG- 53 and PW-9	Note C	Note 4
	The design must 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.	Req't. 6	(The PED does not define how this is to be accomplished in a "consistent manner.")	Yes	See above	Note D	
2.2	Design for Adequate Strength						
2.2.1	The pressure equipment must 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:	Req't. 7		Partial	PG-22		
	▪ Internal/external pressure,	Req't. 7a		Yes	PG-27		
	▪ Ambient and operational temperatures,	Req't. 7b		Yes	PG-21and PG-27		
	▪ Static pressure and mass of contents in operating and in test conditions,	Req't. 7c		Yes	PG-22.1		
	▪ traffic, wind, earthquake loading,	Req't. 7d		Partial	PG-22.1	Except traffic.	
	▪ reaction forces and moments that result from the supports, attachments, piping, etc.	Req't. 7e		Yes	PG-22.2, B31.1 Sect. 119		

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	▪ corrosion and erosion, fatigue, etc.	Req't. 7f		Partial	PG-27.4, Note 3, B31.1 §102.4	Sect. I addresses need, not how to analyze	
	▪ decomposition of unstable fluids. Various loadings that can occur at the same time must be considered, taking into account the probability of their simultaneous occurrence.	Req't. 7g Req't. 8		None Yes	PG-22, B31.1 §101.5	Note E	Note 7
2.2.2	Design for adequate strength must be based on: ▪ as a general rule, a calculation method, as described in 2.2.3, and	Req't. 9 Req't. 9a		Yes	PG-27 through PG 53,		
	▪ supplemented if necessary by an experimental design method as described in 2.2.4, or			Partial	PG 100		Note 8
	▪ 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 less than 3,000 bar	Req't. 9b		Partial		There is no limit on pressure and volume in PG 100	
2.2.3	Calculation method (a) Pressure containment and other loading aspects		See Req't. 9a				
	The allowable stresses for pressure equipment must be limited having regard to reasonably foreseeable failure modes under operating conditions.	Req't. 10a		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.	Req't. 10b	(It is not possible to fully eliminate any uncertainty).	Yes	PG-23		
	These calculations methods must provide sufficient safety margins consistent, where applicable, with the requirements of Sect. 7.	Req't. 10c	See Req't. Q1 and Table 2 of this supplement	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:	Req't. 11					

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	ANNEX I ESSENTIAL SAFETY REQUIREMENTS	GROUPING	COMMENTS	YES, NONE, PARTIAL	CODE REF.	COMMENTS	ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1
	– design by formula	Req't. 11a		Yes	PG-27 to PG-53		
	– design by analysis	Req't. 11b		Partial	Preamble		
	– design by fracture mechanics	Req't. 11c	Not applicable				
	(b) Resistance	Req't. 12		Yes			
	Appropriate design calculations must be used to establish the resistance of the pressure equipment concerned.						
	In particular:						
	▪ the calculation pressures must not be less than the maximum allowable pressures and take into account static head, and dynamic fluid pressures; and	Req't. 13		Yes	PG-21		
		Req't. 14a		Yes	PG-22.1		
		Req't. 14b		Yes			
	the decomposition of unstable fluids.	Req't 14c		None		Note E	Note 7
	Where a vessel is separated into individual pressure-containing chambers, the partition wall must be designed on the basis of the highest possible chamber pressure relative to the lowest pressure possible in the adjoining chamber.	Req't. 15		Yes	PG-16.2		
	▪ the calculation temperatures must allow for appropriate safety margins,	Req't. 16		Yes	PG-21, Note 9		
	▪ the design must take appropriate account of all possible combinations of temperature and pressure which might arise under reasonably foreseeable operating conditions for the equipment	Req't. 17		Yes	PG-21, Note 9, PG 27-4, Note 2		
	▪ the maximum stress and peak stress combinations must be kept within safe limits.	Req't. 18		Yes	PG-22, PG-23		
	▪ the calculation for pressure containment must utilize the values appropriate to the properties of the material, based on the documented data, having regard to the provisions set out in Section 4 together with the appropriate safety factors.	Req't. 19b		Yes	PG-23 and Sect. II, Part D, App. 1		
		Req't. 19a	See Table 2 of this supplement for design factors	Yes			

PED PAR.	PED REQUIREMENTS ANNEX I ESSENTIAL SAFETY REQUIREMENTS	GROUPING	COMMENTS	RELATED ASME SECTION I REQUIREMENTS YES, NONE, PARTIAL	CODE REF.	COMMENTS	ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1
	Materials characteristics to be considered, where applicable, include:	Req't. 20		Partial			
	– yield strength, 0.2% or 1.0% proof strength as appropriate at the calculation temperature,	Req't 20a		Yes	PG-5, PG-23		
	– tensile strength,	Req't. 20b		Yes	PG-23 and Sect. II, Part D, App. 1		
	– time-dependent strength, i.e. creep strength,	Req't. 20c		Partial	PG-23 and Sect. II, Part D, App. 5	Note I	
	– fatigue data,	Req't. 20d		Partial	PG-22	Note F	
	– Young's modulus (modulus of elasticity),	Req't. 20e		Yes	Sect. II, Part D, App.5		
	– appropriate amount of plastic strain,	Req't. 20f		Partial		Note G	Note 9
	– impact strength,	Req't. 20g		None			Note 33
	– fracture toughness,	Req't. 20h		None			Note 33
	▪ appropriate joint facts must be applied to the materials properties depending, for example, on the type of non-destructive testing, the materials joined an the operating conditions envisaged,	Req't. 21	See Q2 and Table 3 of this supplement	Partial	PG-27.4, Note 1, PW-11 and PW-41	Note H	
	▪ the design must take appropriate account of all reasonably foreseeable degradation mechanisms (e.g. corrosion, creep, fatigue) commensurate with the intended use of the equipment.	Req't. 22		Yes	PG-22, PG-23, PG-27 Note 3 and Sect. II, Part D, App. 6	Note I	
	Attention must be drawn, in the instructions referred to in Section 3.4, to particular features of the design which is relevant to the life of the equipment, for example:	Req't. 23					Note 3
	– for creep; design hours of operation at specified temperatures,	Req't. 23a		Partial		Note I	Note 10
	– for fatigue: design number of cycles at the specified stress levels,	Req't. 23b		Partial		Note J	Note 10
	– for corrosion: design corrosion allowance;	Req't. 23c		None		Note K	

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	(c) Stability Aspects						
	Where the calculated thickness does not allow for adequate structural stability,	Req't. 24a		Yes	PG-22		
	the necessary measures must be taken to remedy the situation taking into account the risks from transport and handling.	Req't. 24b	Including transport of original vessel	Partial	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.	Req't. 25		Yes	App. A-22		
	The test program must be clearly defined prior to testing and accepted by the notified body responsible for the design conformity assessment module, where it exists.	Req't. 25a		None		Note M	Note 12
	This program must define test conditions and criteria for acceptance or refusal.	Req't. 25b		Yes	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.	Req't. 25c		Yes	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.	Req't. 25d		Yes	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.	Req't. 25e		Yes	App. A-22	Notes N, O	

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	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;	Req't. 25f		Yes	App. A-22		
	it must take into account the differences between the test and design temperatures;	Req't. 25g		Yes	App. A-22	Note P	
	(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;	Req't. 25h		None		Note J	Note 8
	(c) Where necessary, additional tests concerning other factors referred to in 2.2.1 such as corrosion, external damage, etc.	Req't. 25i		None			Note 8
2.3	Provisions to ensure 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:	Req't. 26		None		Note Q	Note 13
	▪ closures and opening;	Req't. 26a	Also see Req't. 27a and Req't. 27b	Partial	PG-32 through PG-44, PFT-43, PWT-14		
	▪ dangerous discharge of pressure relief blow-off	Req't. 26b		Partial	B31.1, App. II		
	▪ devices to prevent physical access while pressure or vacuum exists,	Req't. 26c		None			
	▪ surface temperature taking into consideration the intended use	Req't. 26d		None			
	▪ decomposition of unstable fluids.	Req't. 26e		None			

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	In particular, 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".	Req't. 27a		Partial	PWT-14	Note R	Note 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.	Req't. 27b		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;	Req't. 28		Partial	Part PG, Part PW	Implied, but rules are not given for inspection stubs, etc.	
	(b) Means of determining the internal condition of the equipment must 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;	Req't. 29a		Yes	PG-44, PWT-14, and PFT-43	Note S	
	(c) Other means of ensuring the safe condition of the pressure equipment may be applied:	Req't. 29b		Yes	PG-44	Handholes are required	
	– where it is too small for physical internal access, or	Req't. 29b1		Yes			
	– where opening the pressure equipment would adversely affect the inside, or	Req't. 29b2		N/A		Does not apply to boilers	Note 15
	– 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.	Req't. 29b3		N/A		Sect. I requires all boilers to have inspection openings	

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
2.5	Means of draining and venting Adequate means must be provided for draining and venting of pressure equipment where necessary:	Req't. 30		Yes	PG-59.4 and B31.1 §122.1.5	Note T	Note 16
	▪ to avoid harmful effects such as water hammer, vacuum collapse, corrosion and uncontrolled chemical reactions.	Req't. 30a		Yes	PG-59.1	Note U Note V	
	▪ All stages of operations and testing, particularly pressure testing, must be considered,	Req't. 30b		Yes	PG-59.4	Ample drains are required for all boiler components	
	▪ to permit cleaning, inspection, and maintenance in a safe manner.	Req't. 30c		Yes	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.	Req't. 31		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 must be taken to:	Req't. 32		Partial	B31.1 §102.4	Note W	Note 18
	▪ minimize the effect by appropriate design, e.g. additional material thickness, or by the use of liners or cladding materials,	Req't. 32a		Partial	B31.1 §102.4		
	▪ permit replacement of parts which are most affected,	Req't. 32b		Partial		Boiler components such as piping and tubing are accessible for replacement	
	▪ draw attention, in the instructions referred to in 3.4, to measures necessary for continued safe use.	Req't. 32c		None		Note B	Note 3

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
2.8	Assemblies Assemblies must be so designed that: ▪ the components to be assembled together are suitable and reliable for their duty, ▪ all the components are properly integrated and assembled in an appropriate manner.	Assembly 2		Yes Yes	Part PG and Part PW	Note X	Note 19
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: – overfilling or overpressurization having regard in particular to the filling ratio and to vapor pressure at the reference temperature – instability of the pressure equipment (b) on discharge: the uncontrolled release of the pressurized fluid; (c) on filling or discharge: unsafe connection and disconnection.	Req't. 33 Req't. 33 Req't. 33b Req't. 33c Req't. 33d		N/A N/A N/A N/A N/A		Note Y Note Y	
3	**SAFETY DEVICES REQUIREMENTS**						
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.	Req't. 34		Yes	PG-67 through PG-73		

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	The suitable device or combination of such devices must 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 Art. 1, Sect. 2.1.3; (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.	Req't. 35a Req't. 35b		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 must: ▪ 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, ▪ be independent of other functions, unless their safety function cannot be affected by such other functions, ▪ 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.	Req't. 36a Req't. 36b Req't. 36c		Yes Yes Yes	PG-67 through PG-73 PG-71 and PVG-12.3.4 PG-60.3, PG-61	Note AA	Note 21

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
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 7.3 is allowable, where appropriate.	Req't. 37a Req't. 37b	See Q3 (pressure surge is limited to 10% by Q3).	Yes	PG-67		
2.11.3	Temperature monitoring devices These devices must have an adequate response time on safety grounds, consistent with the measurement function.	Req't. 38		Partial	PEB-16	Note BB	Note 22
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 requirements in the event of external fire, having particular regard to the intended use.	Req't. 39		N/A		Intended for pressure vessels	
4	**FABRICATION REQUIREMENTS**						
3	MANUFACTURING						
3.1	Manufacturing procedures The manufacturer must 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.	Req't. 40		Yes	PG-75 through PG-82		

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
3.1.1	Preparation of the component parts Preparation of the component parts (e.g., forming and chamfering) must not give rise to defects or cracks or changes in the mechanical characteristics likely to be detrimental to the safety of the pressure equipment.	Req't. 41		Yes	PG-11, PG-75 through PG-82, PW-29, and PW-33		
3.1.2	Permanent joining Permanent joints and adjacent zones must be free of any surface or internal defects detrimental to the safety of the equipment.	Req't. 42		Yes	PW-29 and PW-33		
	The properties of permanent joints must meet the minimum properties specified for the materials to be joined unless other relevant property values are specifically taken into account in the design.	Req't. 43		Yes	PW-5.4 and PW-28	Note CC	
	For pressure equipment, permanent joining of components which contribute to the 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.	Req't. 44a Req't. 44b	Yes Yes		PW-28		
	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 notified body, ▪ A third party organization recognized by a Member State as provided in Article 13. To carry out these approvals the third party must perform examinations and tests as set out in the appropriate harmonized standards or	Req't. 45a Req't. 45b Req't. 46a	See definition in PED, Art. 12 See definition in PED, Art. 13 EN 287 and EN288 are the candidate harmonized standards.	None None None			Note 23 Note 24

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	equivalent examinations and tests or must have them performed.	Req't. 46b Req't. 46c		Partial Partial	PW-28 PW-28		
3.1.3	Non-destructive tests For pressure equipment, nondestructive tests of permanent joints must 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 13	Req't. 47 Req't. 48		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 must be applied at the appropriate stage of manufacture.	Req't. 49		Yes	PW-38 and PW-39		
3.1.5	Traceability Suitable procedures must 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.	Req't. 50		Yes	PG-77, PG-90.1.6, PG-90.1.7, and App. 302.4		
5	**INSPECTION REQUIREMENTS**						
3.2	Final assessment Pressure equipment must be subjected to final assessment as described below:	Statement	Final inspection plus proof test				

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
3.2.1	Final inspection						
	Pressure equipment must undergo a final inspection to assess 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	Req't. 51a Req't. 51b		Yes Partial	PG-90.1.13, PG-99.2 PG-90, PG-1121 and App. A-350 through A-357		Note 26
	As far as is 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).	Req't. 52		Yes	PG-90, PG-93		
3.2.2	Proof test	Req't. 53					
	Final assessment of pressure equipment must 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 7.4.	Req't. 53a		Yes	PG-99	Note DD	
	For category I series produce equipment, this test may be performed on a statistical basis.	Req't. 53b		N/A		Sect. I has no provisions for series produced boilers	
	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, must be applied before those tests are carried out.	Req't. 53c		Yes	B31.1 Sect. 137	B31.1 allows for alternatives to hydrotesting, Sect. I does not.	

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
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 2.10.	Assembly-3		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 Article 15, the following information must be provided:	Req't. 54				This can be on one or more nameplates.	
	(a) For all pressure equipment: ▪ the name and address or other means of identification of the manufacturer and, where appropriate, of his authorized representative established within the European Community;	Req't. 54a		Yes	PG-106 through PG-111	Note EE	Note 27
	▪ The year of manufacture,	Req't. 54b		Yes	PG-106 through PG-111		
	▪ Identification of the pressure equipment according to its nature, such as type, series or batch identification and serial number,	Req't. 54c		Yes	PG-106.4.1	Serial number on stamping plate.	
	▪ Essential maximum/minimum allowable limits;	Req't. 54d		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:			None		Generally not required in Sect. I.	Note 27
	▪ the volume V of the pressure equipment in L,	Req't. 54e					
	▪ the nominal size for piping DN,	Req't. 54f					
	▪ the test pressure PT applied in bar and date,	Req't. 54g					
	▪ safety device set pressure in bar,	Req't. 54h					
	▪ output of the pressure equipment in kW,	Req't. 54i					

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	▪ supply voltage in V (volts),	Req't. 54j					
	▪ intended use,	Req't. 54k					
	▪ filling ration kg/L,	Req't. 54l					
	▪ maximum filling mass in kg,	Req't. 54m					
	▪ tare mass in kg,	Req't. 54n					
	▪ the product group;	Req't. 54o					
	(c) where necessary, warnings fixed to the pressure equipment drawing attention to misuse which experience has shown might occur.	Req't. 54p		None		Not included in Sect. I requirements.	Note 28
	The CE marking and the required information must be given on the pressure equipment or on a dataplate firmly attached to it, with the following exceptions:	Req't. 55		Partial	PG-106	Sect. I does not cover CE marking.	Note 29
	▪ 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;	Req't. 55a		Yes	PG-106.8.2 and PG-109		
	▪ 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;	Req't. 55b		Yes	PG-106.8.2		
	▪ 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.	Req't. 55c		None		Refers to the permanence of warnings affixed to the boiler	

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
3.4	Operating instructions (a) When pressure equipment is placed on the market, it must be accompanied, as far as relevant, with instructions for the user, containing all the necessary safety information relating to: ▪ mounting including assembling of different pieces of pressure equipment, ▪ putting into service, ▪ use,; ▪ maintenance including checks by the 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; (c) If appropriate, these instructions must also refer to hazards arising from misuse in accordance with 1.3 and particular features of the design in accordance with 2.2.3.	 Req't. 56 Req't. 56a Req't. 56b Req't. 56c Req't. 56d Req't. 56e Req't. 56f, Req't. 56g Req't. 56h Req't. 56i Req't. 56j		None		Note B	Note 3
6	**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.	Req't. 57		Yes	PG-5, PG-12, Sect. II, App. 6.		Note 30

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	Welding consumables and other joining materials need fulfill only the relevant requirements of 4.1, 4.2(a), and the first paragraph of 4.3, in an appropriate way, both individually and in a joined structure.	Req't. 58	Req't. 43, 59 to 64, 65, 67, and 69 apply.	Yes	PW-5.4, Sect. II, Part C.		Note 31
4.1	Materials for pressurized parts must:	Req't. 59		Partial			
	(a) Have appropriate properties for all operating conditions which	Req't. 59a	As general rules, with the	Partial	PG-5 through PG-12, Sect.		Note 32
	are reasonably foreseeable and for all test conditions, and in particular they should be sufficiently ductile	Req't. 59b	option of providing an equivalent	Partial	II, Parts A, B, C, D.		
	and tough.	Req't. 59c	overall level of safety.	Partial			Note 33
	Where appropriate, the characteristics of the materials must comply with the requirements of 7.5.	Req't. 59d	See PED Sect. 7.5	Partial	PG-5 through PG-12	For Sect. I applications, brittle-type fracture is not a	Note 34
	Moreover, due care should be exercised in particular in selecting materials in order to prevent brittle-type fracture where necessary;	Req't. 60a		Partial	Sect. II, Parts A, B, C, D.	significant failure mode.	
	where for specific reasons brittle material has to be used appropriate measures must be taken;	Req't. 60b		Yes	PG-8, PG-11		
	(b) Be sufficiently chemically resistant to the fluid contained in the pressure equipment;	Req't. 61a		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 must not be significantly affected within the scheduled lifetime of the equipment;	Req't. 61b		Partial	Sect. II, Part D, App. 5, 6.	Note FF	
	(c) Not be significantly affected by aging;	Req't. 62		Partial	Sect. II, Part D, App. 5, 6.		Note 32
	(d) Be suitable for the intended processing procedures;	Req't. 63	(Fabrication)	Yes	PG-6, PG-7, PG-8, PG-9		

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	(e) Be selected in order to avoid significant undesirable effects when the various materials are put together.	Req't. 64		Yes	PW-5, PW-28 and PW-39		
4.2	(a) The pressure equipment manufacturer must define in an appropriate manner the values necessary for the design calculations referred to in 2.2.3 and	Req't. 65a		Yes	Sect. II Part D, App.1		Note 32 and 34
	the essential characteristics of the materials and	Req't. 65b		Partial			
	their treatment referred to in 4.1;	Req't. 65c		Partial			
	(b) The manufacturer must provide in his technical documentation elements relating to compliance with the material specification of the Directive in one of the following forms:						Note 35
	▪ by using materials which comply with harmonized standards	Req't. 66a		None			
	▪ by using materials covered by a European approval of pressure equipment materials in accordance with Article 11,	Req't. 66b		None			
	▪ by a particular material appraisal,	Req't. 66c	Performed by the NB for category III and IV vessels	None			
	(c) For pressure equipment in categories III and IV, particular appraisal as referred to in the third indent of (b) must be performed by the notified body in charge of the conformity assessment procedures for the pressure equipment.			None			Note 36
4.3	The equipment manufacturer must take appropriate measures to ensure that the material used conforms with the required specification.	Req't. 67a		Yes	PG-77, App. A-302.4		
	In particular, documentation prepared by the material manufacturer affirming compliance with the specification must be obtained for all materials.	Req't. 67b		Yes	PG-77, App. A-302.4		

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	For the main pressure bearing parts of equipment in categories II, III and IV, this must 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.	Req't. 68 Req't. 69		Partial None	PG-77, App. A-302.4		Note 37 Note 38
7.	**SPECIFIC REQUIREMENTS FOR HEATED PRESSURE VESSELS**						
	SPECIFIC PRESSURE EQUIPMENT REQUIREMENTS						
	In addition to the applicable requirements of Sect. 1 to 4, the following requirements apply to the pressure equipment covered by Sect. 5 and 6.	Statement	These requirements are in addition or requirements 1 to 72.				
5	FIRED OR OTHERWISE HEATED PRESSURE EQUIPMENT WITH RISK OF OVERHEATING AS REFERRED TO IN ARTICLE 3(1)					Note HH	
	This pressure equipment includes: ▪ Steam and hot water generators as referred to in Article 3, Sect. 1.2, 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	Req't. 70 Req't. 70a	Scope statement	Partial	Preamble	Sect. I does not cover vessels in which steam is generated for internal use such as pressure cookers.	

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	▪ Process heating equipment for other than steam and hot water generation falling under Art. 3, Sect. 1.1, such as heaters for chemical and other similar processes and pressurized food-processing equipment.	Req't. 70b		Partial	Preamble	Unfired steam boilers can be built to either Sect. I or Sect. VIII.	
	This pressure equipment must be calculated, designed, and constructed so as to avoid or to minimize risks of a significant loss of containment from overheating.	Req't. 71		Yes	Part PG		
	In particular it must be ensured, where applicable, that:	Req't. 72					
	(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,	Req't. 72a		Yes	PG6-60 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.	Req't. 72b		Yes	PG-59.3 and PG-59.4		
	(c) adequate provisions are made to eliminate risks of damage from deposits,	Req't. 72c		Yes	PG-59.3		
	(d) safe removal of residual heat after shutdown are provided,	Req't. 72d		None			Normally provided for by boiler designers
	(e) steps are taken to avoid a dangerous accumulation of ignitable mixtures and combustible substances and air, or flame flowback.	Req't. 72e		None			Normally provided for by boiler designers
6.	PIPING AS REFERRED TO IN ARTICLES 3 SECTION 1.3		Internal and external piping comprising the complete boiler system		Note II		Note 39
	Design and construction must ensure:	Req't. 73		Yes	PG-27.2.2, PG-58		

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	(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;	Req't. 73a		Yes	PG-59.1.2; B31.1 §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.	Req't. 73b		Yes	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 2.7 are applicable;	Req't. 73c		Yes	PG-59.2; B31.1 §102.4		
	(d) that due consideration is given to the risk of fatigue due to vibrations in pipes;	Req't. 73d		Yes	PG-59.1.2; B31.1 §101.5.4 and App. D		Note 40
	(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;	Req't. 73e		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;	Req't. 73f		N/A			
	(g) that the position and route of underground piping is at least recorded in the technical documentation to facilitate safe maintenance, inspection, or repair.	Req't. 73g		None			Note 41

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
8.	**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.	Statement Statement	Manufacturer can depart from these quantitative requirements, but t 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 $R_{e/t}$, yield limit, indicates the value at the calculation temperature of: ▪ upper flow limit for a material presenting upper and lower flow limits, ▪ the 1.0% proof strength of austenitic steel and nonalloyed aluminum ▪ 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 at the right place.				
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:	Quantitative Req't. Q1	Also included in Req't. 10c. See Table 2 of this supplement	Yes	Sect. II, Part D, Table 1A and App. 1.	Note GG	Note 44

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	▪ 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 $R_{m/20}$; ▪ in the case of austenitic steel: – if its elongation after rupture exceeds 30%, 2/3 of $R_{e/t}$ – or, alternatively, and if its elongation after rupture exceeds 35%, 5/6 of $R_{e/t}$, and 1/3 of $R_{m/20}$; ▪ in the case of non-alloy or low alloy cast steel, 10/19 of $R_{e/t}$ and 1/3 of $R_{m/20}$; ▪ in the case of aluminum, 2/3 of $R_{e/t}$; ▪ in the case of aluminum alloys, excluding precipitation hardening alloys, 2/3 of $R_{e/t}$ and 5/12 of $R_{m/20}$.	Req't. Q1a Q1b Q1b1 Q 1b2 Req't. Q1c Q1d Q1d					Note 45
7.2	Joint coefficients For welded joints, the joint coefficient must not exceed the following values: ▪ for equipment subject to destructive and nondestructive tests which confirm that the whole series of joints show no significant defects: 1, ▪ for equipment subject to random non-destructive testing: 0.85,	 Req't. Q2 Req't. Q2a Q2b	To be applied as a general rule. Demonstration of an equivalent overall level of safety required by Annex I, §2.2.3(b).	Yes	PG-27.4, Note 1, PW-11 and PW-41		

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	▪ for equipment not subject to non-destructive testing other than visual inspection: 0.7.	Q2c					
	If necessary, the type of stress and the mechanical and technological properties of the joint must also be taken into account.	Q2d		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.	Req't. Q3	Also included in Req't. 37b	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: ▪ 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 ▪ the maximum allowable pressure multiplied by the coefficient 1.43, whichever is the greater.	Req't. Q4 Q4a Q4b	See Table 4 of this supplement Also included in Req't. 53a. See Table 4 of this supplement	 Yes Yes	 PG-99	 Note DD	
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	Req't. Q5	Also included in Req't. 59b.	Yes			Note 34

PED REQUIREMENTS				RELATED ASME SECTION I REQUIREMENTS			
PED PAR.	**ANNEX I ESSENTIAL SAFETY REQUIREMENTS**	**GROUPING**	**COMMENTS**	**YES, NONE, PARTIAL**	**CODE REF.**	**COMMENTS**	**ADDITIONAL CONSIDERATIONS FOR PED, ANNEX 1**
	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	Req't. Q6	Also included in Req't. 59c.	Partial		27 J is not specified	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.

1. NOTES IN PART III ON ASME SECTION I REQUIREMENTS

A. 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. Section I does not require manufacturers to issue operating instructions or warnings regarding potential hazards or misuse of pressure equipment. Manufacturers generally do provide such instructions; see Notes 3 and 4.

C. 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 Section I, are commonly provided to the user by the boiler manufacturer.

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

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

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

I. Corrosion must be taken into account in Section I by the Code design requirements for a particular boiler or component (PG-27, Note 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 Section I's use of conservative design margins provides for a much longer service life. This is demonstrated by the successful service history of Section I equipment. Design hours of operation at specified temperatures should be based on the manufacturer's experience and calculations.

J. 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. For two shift or load following operation, detailed fatigue analysis of critical components may be necessary on high-temperature components where there may be combined creep/fatigue interaction.

K. Section I does not require the design corrosion allowance to be shown on the Data Report for in-service use. To comply with Annex I, §2.9, this information must be provided to the end user in the operating instructions.

L. 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-91.1.5 of Section I requires witnessing the tests and approval of the test results by the Authorized Inspector (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. 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 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 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. Section I provides partial coverage of the items listed in Annex I, §2.3. See Note 13.

R. Section I only addresses this aspect for firing doors in watertube 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. 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. 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 Section I and B31.1. Uncontrolled chemical reactions are partially addressed in Section I. See Note 17.

V. 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. 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 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. 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 Section I. Each boiler constructed to 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 Section I. See Note 21.

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

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

DD. 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-99.3 also limits the amount of stress on any component in the boiler system, which meets the intent of the following quote from the EC's Working Group (WG) Pressure Guideline 8/2: "The pressure value chosen for carrying out a hydrostatic pressure test must be such as to assure testing the pressure containment aspect of the pressure equipment with due consideration of the determined safety factors without causing a damage to the pressure equipment. Annex I, §7.4 provides additional formulas which may be applied only in due consideration of the above described general criteria (Annex I, §3.2.2)."

EE. The 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, and PG-113 and in Appendices A-350 through A-357. The name and address of the vessel manufacturer must be listed n the Data Reports.

FF. Chemical and physical properties for operational safety are implied in Section I. Specific guidance is given in PG-5, Note 1.

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

HH. The scope of 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 Section I or Section VIII, Division 1.

II. The PED Annex I, §6 addresses all types of piping and some requirements are not applicable to what Section I refers to as boiler proper piping. For 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 this Part III.

2. NOTES IN PART III ON ADDITIONAL CONSIDERATIONS FOR ANNEX I ESSENTIAL SAFETY REQUIREMENTS:

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 3, Article 9 and Annex II* of the PED [1]. (See Chapter VI §3 of the ASME Section VIII PED Guide [2].) 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 *Article 3, Article 9, and 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:

   (1) Brittle fracture,

   (2) Stress corrosion cracking,

   (3) Creep,

   (4) Damage during transport or installation,

   (5) Rapid release of high pressure fluid,

   (6) Special operational hazards,

   (7) Etc.

   It should be noted that it is a hazard assessment that is specified and 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 Essential Safety Requirements (ESRs) 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. (See Annex I, §3.4 and Chapter X §5 of the ASME Section VIII PED Guide [2]). The instructions shall include the following:

   (1) Marking and labeling as required by §3.3 of Annex I of the PED,

   (2) Installation instructions, including assembling different pieces of pressure equipment,

   (3) Putting into service,

   (4) Use,

(5) Maintenance, including checks by the User,

(6) Drawings necessary for full understanding of the information, if applicable,

(7) Design information for in-service verification, modification or repairs,

(8) Warnings to prevent the danger of misuse of the equipment,

(9) 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):

   (1) Inform users of residual hazards,

   (2) Prevent dangers from foreseeable misuse,

   (3) Take into account foreseeable degradation mechanisms,

   (4) 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 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:

   (1) Eliminate or reduce hazards as far as it is reasonably possible,

   (2) Apply appropriate protection measures against hazards that cannot be eliminated,

   (3) 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. 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 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 Section I. Section I provides some guidance on handling these fluids, but the manufacturer may have to document any additional considerations made.

8. Section I Appendix 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 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 conformity assessment module, if one exists, for the experimental test program. Section I (Appendix A-22) gives guidance on a comprehensive test program, including witnessing of tests by the Authorized Inspector (PG-90.1.5). The difference for PED compliance would be the presence of the NB in place of the AI.

13. The manufacturer must consider the following aspects to ensure safe handling and preclude risk during operation from:

    (1) closures and openings,

    (2) discharge of pressure relief blowoff,

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

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

    (5) decomposition of unstable fluids.

    Most of these items are directed toward pressure vessels in various applications. 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 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 Section I and B31.1 should be documented.

17. 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 Section I.

19. 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 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 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 Section I meet the requirements of PED, Annex I, §2.10.

21. The design of accessories shall comply with the requirements of PED, Annex I, §2.11, including fail-safe modes, redundancies, diversity, and self-diagnosis. 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 a NB familiar with the application of 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. 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 12 for notified bodies and Article 13 for recognized third party organizations. (See Chapter VIII of the ASME Section VIII PED Guide [2]for Stamp holders for additional information.)

24. For pressure equipment in Categories II, III, and IV, welders and welding operators, and welding procedures must be approved by a competent third party, which is either a Notified Body or an approved third party organization. To carry out these approvals, the third party must perform (or have performed) examinations and tests as set out in the approved European harmonized standards or equivalent examinations and tests (EN 287 and EN 288 are candidate European harmonized standards). As the phrase "equivalent examinations and tests" leaves room for interpretation, and as of May 2002 both EN 287 and EN 288 are not harmonized, it is possible to use a significant amount of the process for qualifications in Section IX to meet these requirements. Consultation with a NB familiar with the application of Section I is necessary in this case. See also EC's WG Pressure Guidelines 6/1, 6/6, and 6/12.

25. 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. (See PED, Article 13 for recognized third party organizations.) Manufacturers that utilize the ASNT Central Certification Program to meet their ASME Section I NDE personnel qualification requirements may be able to benefit from an arrangement between 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.

26. The manufacturer must provide the additional documentation to demonstrate compliance with the Pressure Equipment Directive. 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.

    (1) Qualifications of Nondestructive Testing (NDT) personnel

    (2) Qualifications of welders and welding operators

    (3) Welding procedure qualifications

    (4) Heat treat procedures and data

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

    (6) Procedures for ensuring material traceability

    (7) NDT reports, including radiographic films

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

    (9) Reports on defects and deviations during manufacture

    (10) Forming and other manufacturing procedures

    (11) Other technical documentation in accordance with the applicable Conformity Assessment 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 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 Section I. If a boiler has an "S" stamp nameplate, a separate nameplate may 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 and Chapter VII of the ASME Section VIII PED Guide [2] for additional information.) Boiler manufacturers choose their materials for construction based on these considerations, even though they are not spelled out in Section I. This practice may need to be documented for PED compliance, or consultation with a NB familiar with the application of 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 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 a NB that is familiar with the application of Section I will contribute to determination of having achieved an overall equivalent level of safety.

32. Although it is implied by the considerations in 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 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). For Section I boilers, the operating range is not near the transition temperature and the EC's WG Pressure 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 judgment shall be made taking into account the whole range of the steel grade specification and not the values of actual deliveries. Verification testing of specified impact property may not be required in cases where there is no doubt about the fulfillment of the essential safety requirement on sufficient toughness to avoid brittle fracture." Guideline 7/17 goes on to warn against using a material outside of its intended design code: "A 'history of safe use' (for a particular material) alone cannot replace the need for the specification of impact properties. This notion is inextricably linked to a particular code, set of safety factors and safety philosophy, and can therefore not necessarily be transferred to a different safety philosophy/concept." Consultation with a NB that is familiar with the application of Section I will contribute to determination of having achieved an overall equivalent level of safety.

34. Materials will be approved if they have the following properties, or if an equivalent level of safety can be demonstrated. In the case of Section I, its long history of boilers with safe service life can be demonstrated through consultation with a NB that is familiar with the application of Section I.

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

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

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

    It may be necessary to demonstrate that the hydrotest temperature is above the brittle transition temperature to support decisions described in Note 33, above.

35. Materials must conform to one of the following:

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

    (2) Pressure equipment materials that are covered by a European Approval of Materials (EAM).

    (3) Materials that are issued with a Particular Material Appraisal (PMA), for equipment in Category III and IV. (See Chapter VII of the ASME Section VIII PED Guide [2] for information on approval of material by Particular Material Appraisal.)

    In 2001, the European Commission determined that on the basis of Article 11, §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 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 Code 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 particular material appraisal (PMA) of the material must be by the Notified Body (NB) in charge of the conformity assessment procedure for that boiler. (See Chapter VII §4 of the ASME Section VIII PED Guide [2].)

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

    For main pressure parts in Categories II, III, and IV the test certificates shall be in accordance with EN 10204, Types 3.1A, 3.1B, 3.1C, or 3.2. (Certificates of Compliance required by ASME material specifications may not be completely acceptable and may need to be augmented.)

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

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

    (See Chapter. VII of the ASME Section VIII PED Guide [2] 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 to ISO 9000 from a certification body established within the European community, a material certificate of the EN 10204, 3.1.B is acceptable. Where the material manufacturer does not hold such a certification, the boiler manufacturer is responsible for determining the certification requirements.

39. 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 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 must 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, draft CEN Unfired Pressure Vessel Standard), or may use the criteria used in 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 must conform to the following:

In case of the ferritic steel, including normalized steel and excluding fine grain steel and specially heat-treated steel, the lesser of

(1) 2/3 of the specified minimum yield strength ($R_{e/t}$), and

(2) 5/12 of the specified minimum ambient temperature tensile strength ($R_{m/20}$).

In general, the allowable design stresses in ASME 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 Code 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 Chapter XI of the ASME Section VIII PED Guide [2].)

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.

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

Table 2 - 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

Table 3 - Joint Efficiencies Given in Annex I, §7.2

Extent of Examination	Joint Efficiency
100% RT or UT	1.0
Spot examination by RT or UT	0.85
Visual examination only	0.70

RT = radiographic testing

UT = ultrasonic testing

Note: examination requirements of ASME Section I may differ from other codes (i.e., EN 13445).

Table 4 - 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

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PART IV – ANNEX ZA, ADDITIONAL CONSIDERATIONS FOR APPLICATION OF SECTION I, POWER BOILERS WITHIN THE SCOPE OF PED 97/23/EC, ANNEX I

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ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS	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.		
3.	The manufacturer is under an obligation to analyze the hazards in order to identify those that apply to his equipment on account of pressure; he must then design and construct it taking account of his analysis.	(None)	The manufacturer must perform hazards analysis in accordance with Art. 3, Art. 9 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 must 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 Sect. 3.4 of Annex I. The manufacturer must also consider the following aspects: ▪ Inform users of residual hazards, ▪ Prevent dangers from foreseeable misuse, ▪ Take into account foreseeable degradation mechanisms, ▪ Ensure safety throughout the intended life of the pressure equipment.

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
1.2	In choosing the most appropriate solutions, the manufacturer must comply with the principles set out below in the following order: ▪ Eliminate or reduce hazards as far as is reasonably practicable. ▪ Apply appropriate protection measures against hazards which cannot be eliminated. ▪ 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: ▪ Eliminate or reduce hazards as far as it is reasonably practical through adequate design and construction, ▪ Apply appropriate protection measures against hazards that cannot be eliminated, such as controls and pressure relief devices, and ▪ 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 must be designed to prevent danger from such misuse or, if that is not possible, adequate warning (must 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 §3.4 of Annex I.)
2.	**DESIGN**		
2.1	The pressure equipment must 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 must 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: ▪ Take into account foreseeable degradation mechanisms, ▪ Ensure safety throughout the intended life of the pressure equipment.
2.2	Design for adequate strength		
2.2.1	The pressure equipment must 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: ▪ internal/external pressure, ▪ ambient and operational temperatures,	PG-22 PG-27, PG-21, and PG-27	

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
	▪ static pressure and mass of contents in operating and test conditions, ▪ traffic, wind, earthquake loading ▪ reaction forces and moments which result from the supports, attachments, piping, etc., ▪ Corrosion, erosion, fatigue, etc. ▪ decomposition of unstable fluids 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 must be based on: ▪ 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 ▪ 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 must be limited having regard to reasonably foreseeable failure modes under operating conditions. 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. These calculation methods must 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	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:		
	– design by formula,	PG-27 to PG-53	
	– design by analysis,	Preamble (partial)	
	– 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:		
	▪ The calculation pressures must 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.
	▪ take into account static head and dynamic fluid pressures and	PG-22.1	
	▪ the decomposition of unstable fluids.	(None)	
	▪ Where a vessel is separated into individual pressure containing chambers, the partition wall must be designed on the basis of the highest possible chamber pressure relative to the lowest pressure possible in the adjoining chamber.	PG-16.2	
	▪ The calculation temperatures must allow for appropriate safety margins.	PG-21, Note 9	
	▪ The design must 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	
	▪ The maximum stresses and peak stress combinations must be kept within safe limits.	PG-22, PG-23	
	▪ The calculation for pressure equipment must utilize the values appropriate to the properties of the material, based on the documented data, having regard to the provisions set out in Section 4 together with the appropriate safety factors. Material characteristics to be considered, where applicable, include:	PG-23 and Sect. II, Part D, App. 1	
	– Yield strength, 0.2% or 1.0% proof strength, as appropriate, at calculation temperature,	PG-5, PG-23	
	– Tensile strength,	PG-23 and Sect. II. Part D, App. 1	
	– 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	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
	– 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.
	– Young's modulus (modulus of elasticity),	Sect. II, Part D, App. 5	
	– 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.
	– Impact strength,	None	See EC WG Pressure Guideline 7/17
	– Fracture toughness,	None	See EC WG Pressure Guideline 7/17
	▪ Appropriate joint factors must be applied to the materials properties, depending, for example, on the type of non-destructive testing, 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.
	▪ The design must take appropriate account of all reasonably foreseeable degradation mechanisms (e.g., corrosion, creep, fatigue) commensurate with the intended use of the equipment.	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).
	Attention must 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:		
	– 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.
	– 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.
	– 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	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. The test program must be clearly defined prior to testing and accepted by the notified body responsible for the conformity assessment module, where it exists. The program must define test conditions and criteria for acceptance and 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 must be possible to observe the critical zones of the pressure equipment with adequate instrumentation capable of registering strains and stresses with sufficient precision. The test 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. 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; it must take into account the differences between the test and design temperatures.	App. A-22 (None) App. A-22.10 and PG-91.1.5 App. A-22.11.3 App. A-22.11.1 App. A-22 App. A-22 App. A-22	The manufacturer must obtain approval from the notified body responsible for the conformity assessment module, if one exists, for the experimental test program. 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. A-22 is conservative in basing the test pressures on test temperature.

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS	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.
	▪ 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)	
	▪ Access while pressure or vacuum exists in the pressure equipment,	(None)	
	▪ Surface temperature, taking into account the intended use of the equipment,	(None)	
	▪ 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	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
	(b) Means of determining the internal condition of the equipment must 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: ▪ Where it is too small for physical internal access, or	PG-44	Sect. I requires all boilers to have inspection openings. Handholes are required.
	▪ Where the opening of the pressure equipment would adversely affect the inside,	N/A	Does not apply to boilers
	▪ 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 drainage Adequate means must 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.
	▪ to avoid harmful effects, such as water hammer, vacuum collapse, corrosion, and uncontrolled chemical reactions.	PG-59.1 and B31.1 §122	
	▪ All stages of operations and testing, particularly pressure testing, must be considered.	PG-59.4	Ample drains are required for all boiler components.
	▪ 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, §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.
	▪ 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)	
	▪ permit replacement of parts which are most affected,	(Partial)	Boiler components such as piping and tubing are accessible for replacement

ANNEX I PARAGRAPH	ANNEX I ESSENTIAL SAFETY REQUIREMENTS	SECT. VIII, DIV. 1 REFERENCE	ADDITIONAL CONSIDERATIONS
	▪ 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 §3.4 of Annex I and including considerations for wear, where applicable, in accordance with §2.7.
2.8	Assemblies Assemblies must be so designed that: ▪ The assemblies to be assembled together are suitable and reliable for their duty, ▪ 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: – Overfilling or overpressurization having regard in particular to the filling ratio and to the vapor pressure at the reference temperature, – 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, Sect. 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. Suitable protective devices and combination thereof comprise:	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.