

EPR CODES AND STANDARDS FOR PRESSURE EQUIPMENTS

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ABSTRACT

In order to improve circulation of pressure equipments in Europe some minimum essential requirements have been issued in 1997 by the European Community. These requirements have to be fulfilled for all type of pressure equipments operating in Europe.

Each countries have transfer the general EC requirements in their own law and corresponding Codes & Standards, in accordance with PED are now under developments at the EC level..

All national Codes & standards in accordance with the PED can be used.

This paper presents :

- first the different PED requirements (allowable stress, hydrostatic test, conformity justification, notified body actions, material selection, fabrication and non destructive examination requests, overpressure protection rules...),
- second the status of national Codes & Standards and EC harmonised rules.

After the conventional pressure equipments, the paper presents a general overview of the new French nuclear regulation and the corresponding consequences for EPR design and fabrication Codes.

Keywords: Codes; Standards, Pressure Equipment; design; fabrication, nuclear, conventional.

1. INTRODUCTION

In 1997 a European Directive [1] was proposed to define the essential safety requirements for pressure equipments in order to put a pressure equipment on the European market, with the same minimum rules.

In the same time, the CEN (European Committee for Standardisation) developed a series of European Standards in accordance with the Pressure Equipment Directive (PED) for vessels, piping systems, valves, bolted flanges, materials, fabrication, control and protection against overpressure. A specific action was decided by different Codes and Standards to fulfill the PED requirement through an appendix Z.

Harmonized European Standards is presume to comply with the Essential Safety Requirements

In 2005, a new French regulation [2] decided that nuclear pressure equipments have to fulfill all the conventional pressure equipment requirements of the PED, with some additional requirements for nuclear application in connection with the Plant Safety Report. Consequently, nuclear Codes and Standards has been improved to fulfill all these new requirements.

2. PRESSURE EQUIPMENT DIRECTIVE

The Pressure Equipment Directive has been issued in 1997 and is mandatory since November 1999, in all European countries.

The scope of this PED is design, manufacture and conformity assessment for all pressure equipment with a difference between internal pressure and external pressure greater than 5 MPa.

The term Pressure Equipment includes vessels and heat exchangers, piping, safety accessory and pressure accessory. Where applicable, pressure equipment includes elements attached to pressurized parts, such as flanges, nozzles, couplings, supports, lifting lugs etc.

Vessels are defined as housing design and built to contain fluids under pressure.

Pipings means piping components intended for the transport of fluids, when connected together for integration into a pressure system.

Safety accessories means devices designed to protect pressure equipment against the allowable limits being exceeded.

Pressure accessories means devices with an operational function and having pressure bearing housings.

Assemblies mean several pieces of pressure equipment assembled by a manufacturer to constitute an integrated and functional whole.

In this case, the manufacturer has to fulfill a set of requirements and ask an independent notified body to check and agree the conformity of the fabricated pressure equipment with the PED.

The pressure equipment end user has to define its needs and precise all the operating condition : start-up and shutdown, all the normal transients, the exceptional situations and the test situation. The different pressure levels and temperature variations, and the fluids in contact with the inside and the outside of the pressure equipment.

With all these information, the manufacturer can decide the Code plans to use for design and fabrication, with the corresponding safety factors. He has to choose the Notified Body in charge of the conformity evaluation in a European Official list of Notified Bodies. In some large company, and under certain conditions the Notified Bodies can be replaced by a User Inspectorate, appointed by Member States to carry out the tasks of the notified body within their own organization under modules (table 4) A1, C1, F or G only (no CE marking in this case). Recognized third-party organizations may also be appointed by Member States to carry out the approval of welding procedures and personnel and non-destructive testing personnel as required for pressure equipment assemblies in categorie II,III and IV.

The manufacturer is now in charge of all the PED and End User requirements and can start :

- the design through
 - o an evaluation of the maximum allowable pressure (PS) and temperature (TS)
 - o a classification of the different pressure equipments through specific table in Pressure x Volume or Pressure x Nominal Diameter with distinction between vessels and piping, between water or gas, and between dangerous and non-dangerous type of fluids (table 1). The results are categories I to IV for vessel and I to III for piping (table 5); the smaller components (table 2) less than a certain threshold have to be designed by State of the Art rules available in European countries.
 - o a risk study of all potential degradation mechanisms
- the material choice in European Standards
- the fabrication and control operations
- the over-pressure protection
- the instruction report for the end user

All these activities has to be evaluated by the Notified body in order to check the conformity with essential safety requirements. Different modules can be used in regard of the pressure equipment risk category (table 3 and 4).

To finish the fabrication a specific hydrostatic pressure test has to be performed by the manufacturer, under notify body control.. At the end the notified body reports to the manufacturer the conformity of the pressure equipment to PED and the Manufacturer send it to end user. A CE marking is added on the pressure equipments. Concerning the materials, they have to receive a European Approval of Materials. It's a technical document defining the characteristics of material intended for repeated use in the manufacture of pressure equipment the type of which is NOT already covered by a harmonized standard. Notified bodies issue these documents. The notified body shall determine and perform the appropriate inspections and tests to certify the conformity of the type of material with the corresponding requirements of PED.

3. NON-NUCLEAR CODES AND STANDARDS

All the major conventional codes are now in accordance with the major PED requirements : CODAP [3] /CODETI [4] in France, AD Merkblatten [5] in Germany, BS5500 in UK [6]

In parallel to that a specific set of European harmonized rules have been developed under ECN control like :

- EN 13445 : Pressure Vessel [7]
- EN 13480 : Piping system and support [8]
- EN 1591 : Bolted flange [9]

4. NUCLEAR REGLEMENTATION

In France the safety class pressure equipments have to fulfill the French regulation:

- 1974 order for Primary system [10]
- 1990 regulatory guide II.3.8 for Secondary systems [11]
- 1999 decree for Primary and Secondary systems surveillance program [12]
- 1926 decree for safety class 2 and 3 [13]
- 1984 regulatory guide IV.1.a [14]

After 30 years of construction and surveillance of nuclear pressure equipments, during the period without decision of new plants, the French Safety Authority has defined a new set of regulation for nuclear pressure equipment, including a new classification process with corresponding requirements. The main idea is driven by the fact that nuclear pressure equipments have first to fulfill the non nuclear pressure equipment requirements, plus some complementary requirements to include some specific nuclear aspects as radioprotection, or safety requirements, or surveillance requirements in operation....

The different classifications of nuclear pressure equipment are function of:

- consequences of a break of the equipment in term of pressure risk and in term of radioactivity released in normal operation (new order)
- consequences of a break of the equipment in term of radioactivity released in faulted conditions or severe accident (safety report)
- consequences of a break of the equipment in term of accident management (safety report)

5. NUCLEAR CODES AND STANDARDS

In the same time the RCC-M [15] has to be updated in order to be in agreement with PED. This action is in progress after detailed review of differences between RCCM and essential safety requirements of PED.

Some examples of modifications under discussion are :

- define what is an assembly
- define the manufacturer and his responsibility
- explain the operating conditions used for design (normal, upset, emergency and test), and used for safety analysis (faulted conditions and severe accident)
- ask for a risk study, over-pressure protection and manufacture instruction guide for operation
- use of $R_{p1,00}$ instead of $R_{p0,2}$ for stainless steel
- design of pressure equipment with compartment through maximum pressure with no pressure in the other compartment instead of ΔP design
- define actions toward Notified Body
- add installation requirements
- requirements for wear, erosion, abrasion
- change hydrostatic test pressure requirement (minimum of 1.43 maximum allowable pressure)
- add all the requirements specific to pressure relieve valves
- material properties and European material standards have to be updated
- all type of ageing have to be considered during the design life of the pressure equipment
- put the allowable stress values for class 3 components and check the consistency for cast material with PED allowable stress

6. EPR CODES AND STANDARD

A series of constraints have to be considered for the choice of Construction Code for EPR :

- EPR France has to be similar to Finland EPR and perhaps to China EPR plants
- Need to have a very open market for proposals, in Europe or outside of Europe; different Codes will be acceptable with the same final quality
- End user (utility) has to fix safety level requirements, the manufacturer decides the better Code for him in connection with corresponding requirements
- Difficulties with some small modifications for some International Codes
- Take in consideration international field experience
- conformity to DESP essential safety requirements
- consequences of using different Codes, different materials for first installation and maintenance (replacement...)

Consequently we decided to use:

- for class 1 pressure equipments : RCC-M level 1

- for class 2 pressure equipments : RCC-M level 2, or ASME III – NC [16] or KTA level 2 [17], with some utility complementary specifications (one system will be designed with one Code, and all the corresponding Code requirements, no Code mixing will be accepted)
- for class 3 pressure equipments : harmonised EN standards with some utility complementary specification

7. CONCLUSIONS

A lot of changes have to be included in the French EPR design and fabrication process.:

- new regulation with new classification and new requirements
- nuclear requirements that have to fulfill first, non-nuclear requirements harmonized at the EC level for pressure equipment
- new set of European standards have to be checked to assure their applicability for nuclear plants
- conformity evaluation done by notified bodies, specific nuclear notified bodies for safety class 2 and 3 pressure equipments, except for class 1 components done by Safety Authority
- European agreement of materials
- needs for a larger market to assure competitiveness between manufacturers, all around the world, but with a similar level of quality
- include all the field experience in our specifications or codes & standards
- include maintenance requirements and radiation contamination at the design stage
- improvement of the reference nuclear codes (RCC-M or other codes) to fulfill new regulation requirements and updated references to standards.

It seems that we are closed to the final situation to prepare first bids of pressure equipments for any type of country (France, China...) around next summer, with limited differences with Finland on-going EPR project.

Are the major international nuclear code (ASME for example) in accordance with French nuclear regulation :

- in term of quality organization : not
- in term of technical requirements : just few complementary requirements are needed

International cooperation and harmonization remain an important task of this new process in a near future.

REFERENCES

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- [16] ASME Boiler & Pressure Vessel Code. Section III : "Rules for Construction of Nuclear Power Plant Components". Edition 2004
- [17] KTA : Sicherheitstechnische Regel des Kerntechnischer Ausschuss, Carl Heymans Verlag, Koln.

Table 1 : Fluid groups

| Group 1 fluids : dangerous | Group 2 fluids |
|---|--|
| Explosive, extremely flammable, highly flammable, flammable, very toxic, toxic, oxidising | All other fluids including water and steam |

Table 2: Product classification and relevant PED tables

| Type of equipment | Vessels | | | | Steam generators | Piping | | | |
|-------------------|---------|---|--------|---|------------------|--------|---|--------|---|
| | Gas | | Liquid | | | Gas | | Liquid | |
| Fluid content | | | | | | | | | |
| Fluid group | 1 | 2 | 1 | 2 | | 1 | 2 | 1 | 2 |
| PED table | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Table 3: Modules for each category

| Risk category | Conformity assessment modules |
|---------------|--|
| I | A |
| II | A1 D1 E1 |
| III | B1 + D B1 + F B + E B + C1 H |
| IV | B + D B + F G H1 |

Table 4 : Conformity assessment modules

| | |
|----|---|
| A | Internal production control |
| A1 | Internal production control With monitoring of final assessment |
| B | EC type – examination |
| B1 | EC design – examination |
| C1 | Monitoring of final assessment |
| D | Quality assurance for production, final inspection and testing |
| D1 | Quality assurance for production, final inspection and testing |
| E | Quality assurance for Final inspection and testing |
| E1 | Quality assurance for Final inspection and testing |
| F | Product verification |
| G | Unit verification |
| H | Full quality assurance |
| H1 | Full quality assurance with design examination and monitoring of final assessment |

Table 5 : Category classification for vessels and piping based on PED requirements [1]

Table 5-a : PED table 1 for vessels, gas group 1

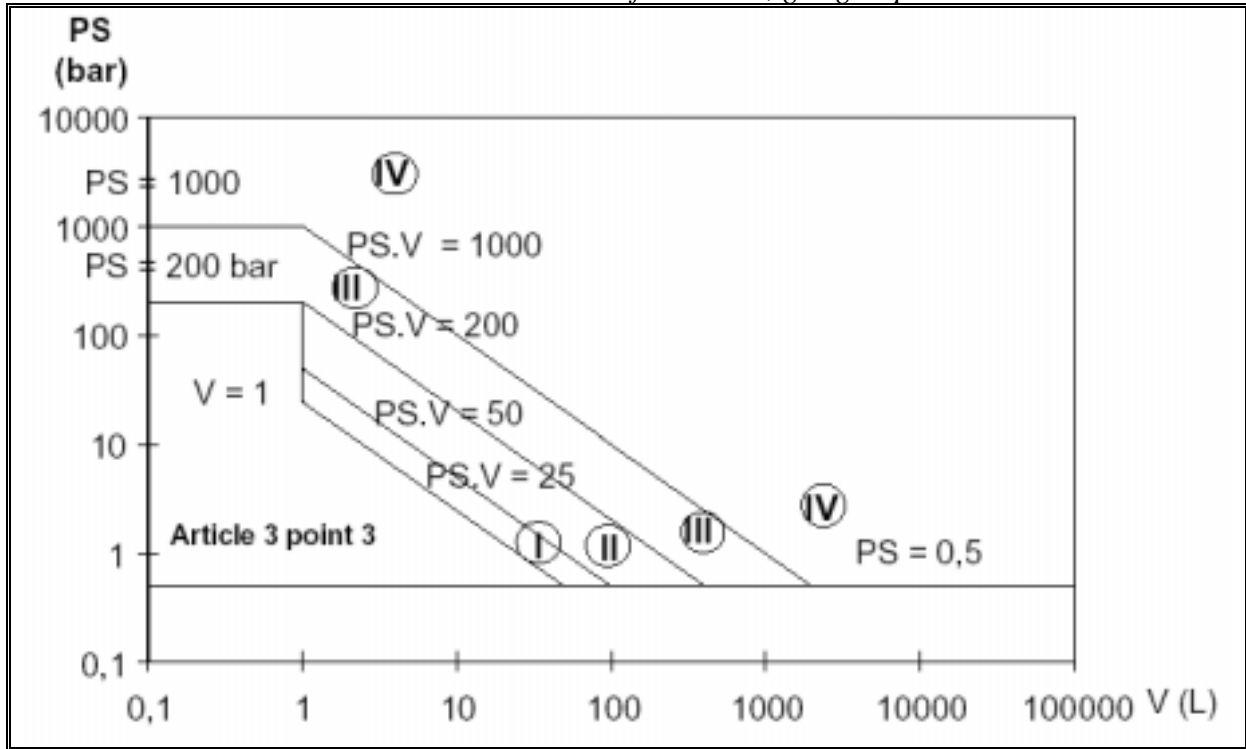


Table 5-b : PED table 2 for vessels, gas group 2

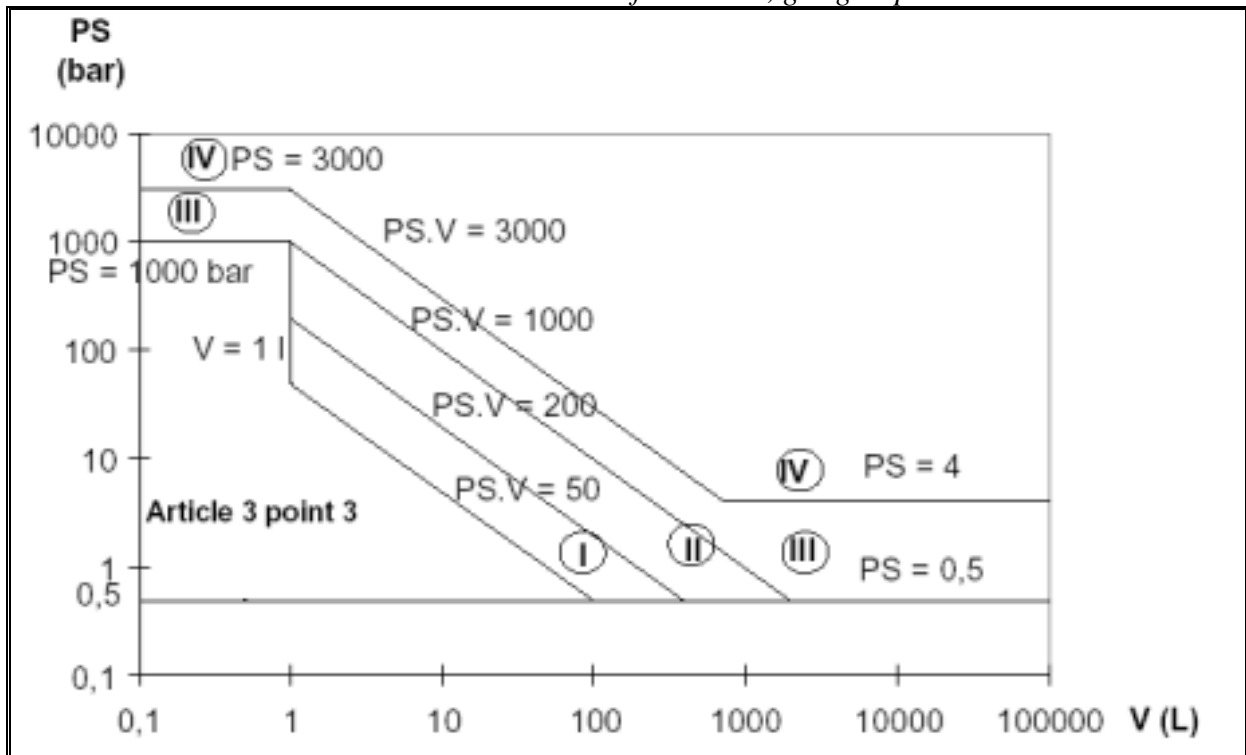


Table 5-c : PED table 3 for vessels, liquid group 1

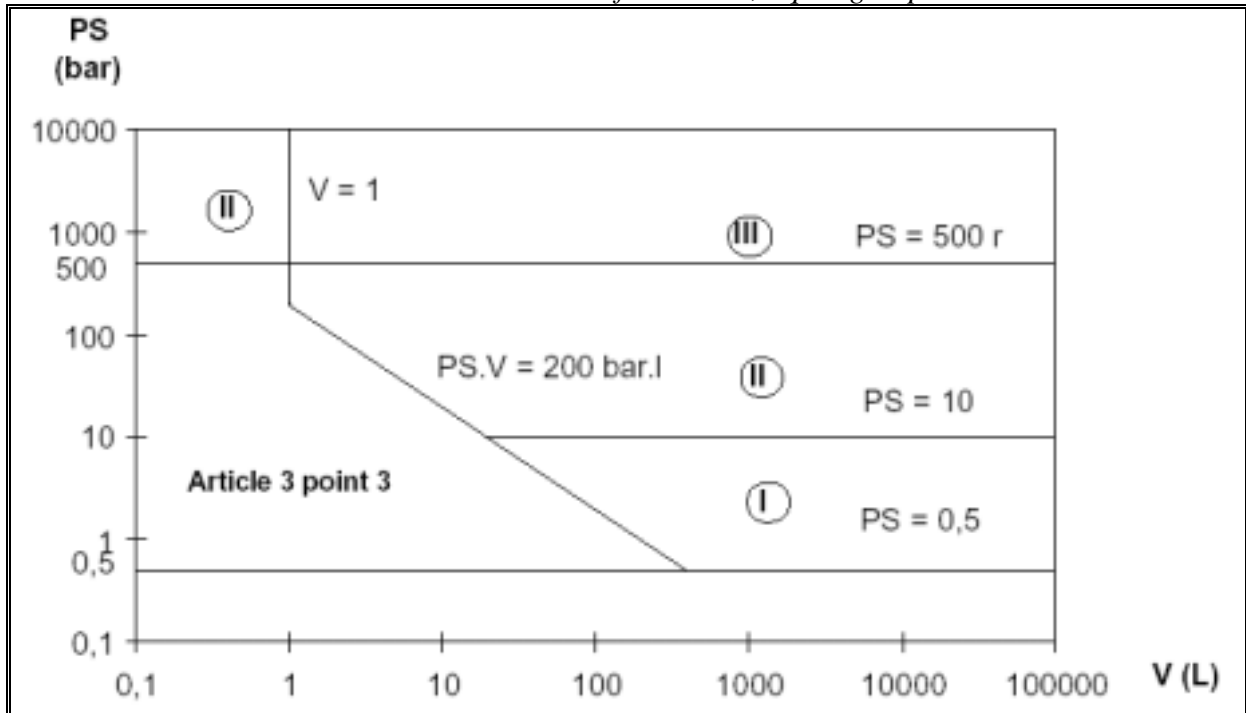


Table 5-d : PED table 4 for vessels, liquid group 2

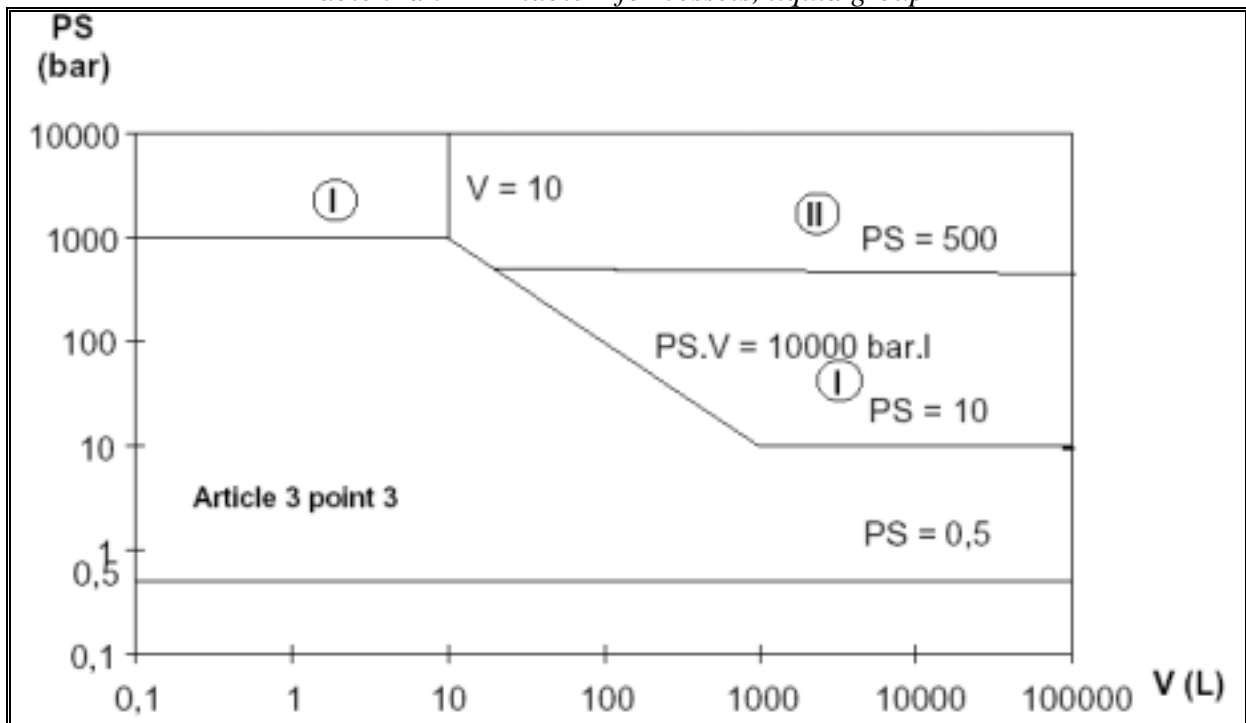


Table 5-e : PED table 6 for piping, gas group 1

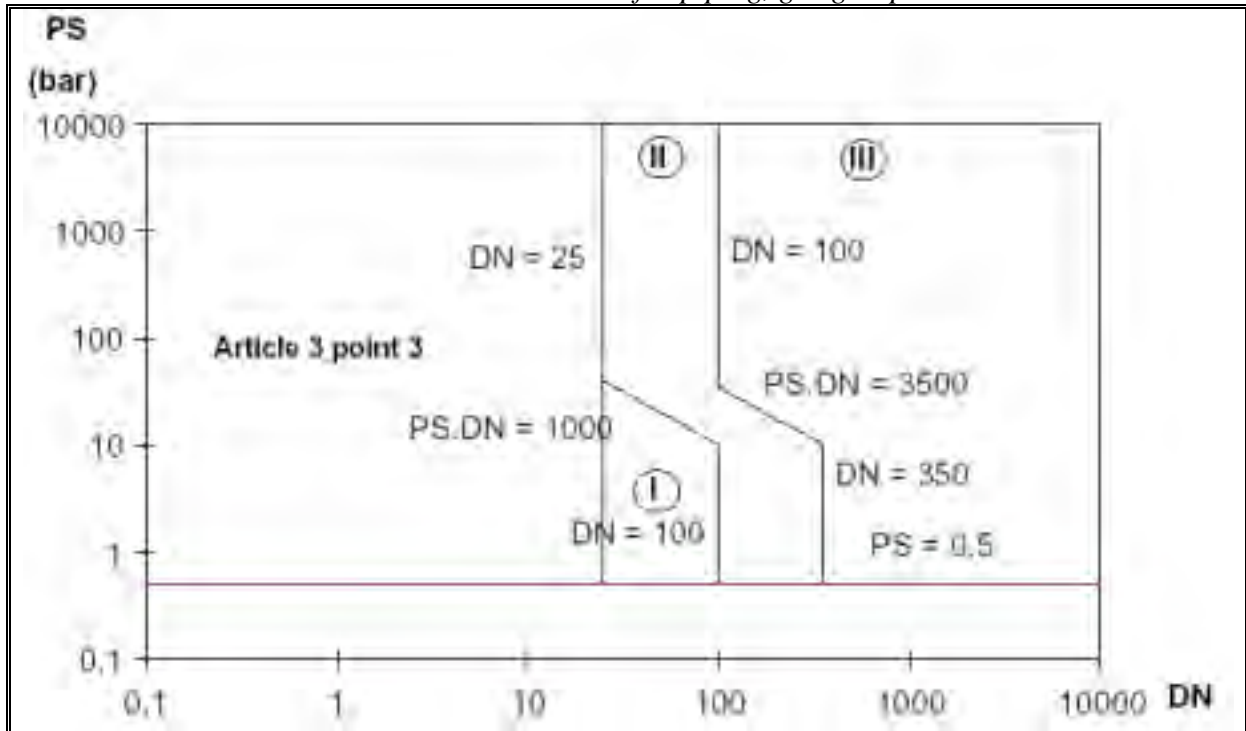


Table 5-f : PED table 7 for piping, gas group 2

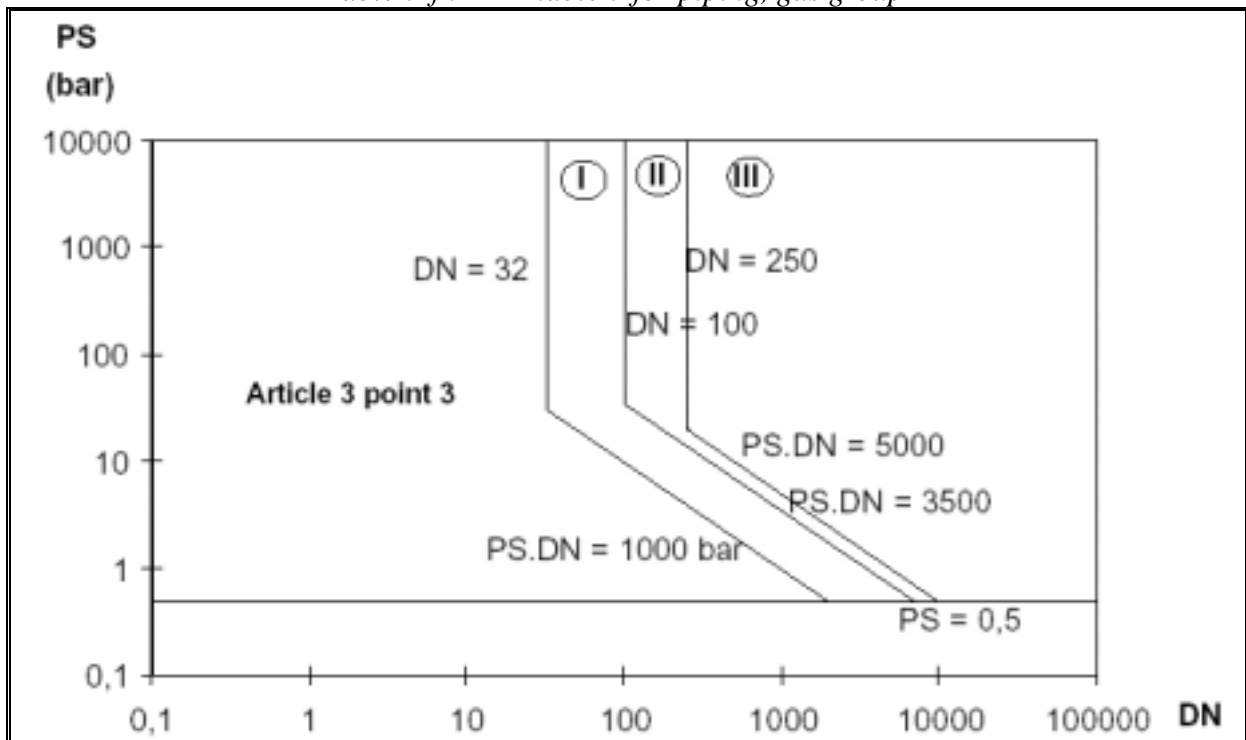


Table 5-g : PED table 8 for piping, liquid group 1

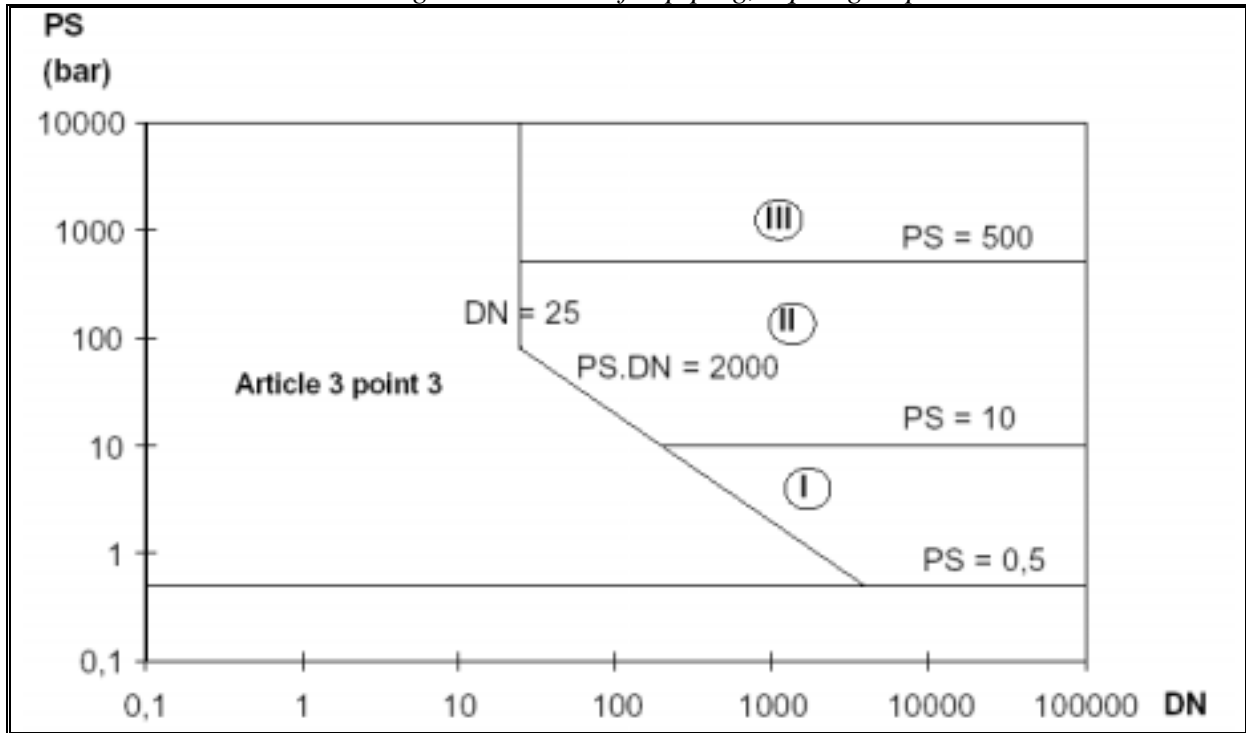


Table 5-h : PED table 9 for piping, liquid group 2

