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# PV Newsletter

Monthly Publication from CoDesign Process Equipment Group

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## **Introduction to ASME Boiler & Pressure Vessel Code, Section VIII, Div. 1**

*Definition:* Pressure vessels are containers for the containment of pressure, either internal or external. The pressure may be obtained from an external source, or by application of heat from a direct or indirect source, or any combination thereof.

### What is ASME BPVC Section VIII, Div. 1?

ASME BPVC Section VIII, Div. 1 (henceforth referred to as the Code) contains mandatory requirements, specific prohibitions, and non-mandatory guidance for pressure vessel materials, design, fabrication, examination, testing, certification, and pressure relief.

The Code does not address all aspects of these activities, and those aspects which are not specifically addressed should not be considered prohibited.

When engineering judgments are used, they should be consistent with the philosophy of the Code, and such judgments must never be used to overrule mandatory requirements or specific prohibitions of the Code.

### Structure of the Code

The Code is divided as following:

Subsection A: General requirements for all methods of construction, including:

- Materials
- Design
- Openings and Reinforcements
- Braced and Stayed Surfaces
- Ligaments
- Fabrication
- Inspections and Tests
- Markings and Reports
- Pressure Relief Devices
- Figures and Tables

Subsection B: Requirements pertaining to methods of fabrication of pressure vessels:

- UW Pressure vessels fabricated by welding
- UF Pressure vessels fabricated by forging
- UB Pressure vessels fabricated by brazing

Subsection C: Requirements pertaining to classes of materials:

UCS	Carbon and low alloy steels
UNF	Non-ferrous materials
UHA	High alloy steel
UCI	Cast Iron
UCL	Material with corrosion-resistant integral cladding, weld metal overlay cladding, of applied linings
UCD	Cast ductile iron
UHT	Ferritic steels with tensile properties enhanced by heat treatment
ULW	Layered construction
ULT	Materials having higher allowable stresses at low temperature
UHX	Shell & tube heat exchangers

Mandatory Appendices: They address specific subjects not addressed elsewhere in the Code, and their requirements are mandatory when the subject covered is included in the construction.

Non-Mandatory Appendices: They provide information and suggested good practices.

What vessels are not included in the scope of the Code?

Following classes of vessels are not included in the scope of the Code; however, any pressure vessel which meets all the applicable requirements of the Code may be stamped with the Code "U" symbol:

- a) Those within the scope of other ASME sections.
- b) Fired process tubular heaters.
- c) Pressure containers which are integral parts of components of rotating or reciprocating mechanical devices, such as pumps, compressors, turbines, generators, engines, and hydraulic or pneumatic cylinders where the primary design considerations and/ or stresses are derived from the functional requirements of the device.
- d) Structures whose primary function is the transport of fluids from one location to another within a system of which it is an integral part, that is, piping systems.
- e) Piping components, such as pipe, flanges, bolting, gaskets, valves, expansion joints, fittings, and the pressure containing parts of other components such as strainers and devices which serve such purposes as mixing, separating, snubbing, distributing, and metering or controlling flow, provided that pressure containing parts of such components are generally recognized as piping components or accessories.
- f) Vessel for containing water under pressure, including those containing air the compression of which serves only as a cushion, when none of the following limitations are exceeded:
  - 1) Design pressure of 2 MPa (300 psi)
  - 2) Design temperature of 99°C (210°F)
- g) Hot water supply storage tanks heated by steam or any other indirect means when none of the following limitations is exceeded:
  - 1) Heat input of 58.6 kW (200,000 Btu/ hr)
  - 2) Water temperature of 99°C (210°F)
  - 3) Nominal water containing capacity of 450 L (120 gal)
- h) Vessels not exceeding design pressure, at the top of the vessel, limitations below, with no limitation on size:
  - 1) Vessels having an internal or external pressure not exceeding 100 kPa (15 psi)

- 2) Combination units having an internal or external pressure not exceeding 100 kPa (15 psi) and differential pressure on the common elements not exceeding 100 kPa (15 psi).
- i) Vessels having an inside diameter, width, height, or cross section diagonal not exceeding 52 mm (6 in) with no limitation on the length of the vessel or the pressure.
- j) Pressure vessels for human occupancy.

**It is understood that the vessels that do not fall in the above categories shall be constructed in accordance with the rules of this Code**

What are other types of vessels that are included in the scope of the Code?

- 1) Unfired steam boilers can be constructed in accordance with either the rules of Section I or this Code.
- 2) Vessels known and evaporators or heat exchangers.
- 3) Vessels in which steam is generated by use of heat resulting from operation of a processing system containing a number of pressure vessels such as those used in the manufacture of chemical and petroleum products.
- 4) Vessels in which steam is generated but not withdrawn for external use.
- 5) Pressure vessels or parts subjected to direct firing from the combustion of fuel (solid, gaseous or liquid), which are not within the scope of sections I, III or IV.
- 6) Gas fired jacketed steam kettles with jacket operating pressures not exceeding 345 kPa (50 psi).

Pressure vessels listed below do not require inspection from inspectors

- I. exclusive of those mentioned in the earlier paragraphs, and
- II. not required to be fully radiographed, and
- III. are not provided with quick actuating closure, and
- IV. do not exceed the following volume and pressure limits
  - a. 0.14 m<sup>3</sup> (5 cu. Ft.) in volume and 1.7 MPa (250 psi)
  - b. 0.08 m<sup>3</sup> (3 cu. Ft.) in volume and 2.4 MPa (350 psi)
  - c. 0.04 m<sup>3</sup> (1.5 cu. Ft.) in volume and 4.1 MPa (600 psi)

Straight line interpolation for volumes and design pressures is permitted. Vessels fabricated in accordance with this rule shall be marked with the "UM" symbol.

Is there a maximum pressure limitation?

The Code rules have been formulated on the basis of design principles and construction practices applicable to vessels designed for pressures not exceeding 20 MPa (3000 psi). For pressures above this value, deviations from and additions to these rules are necessary to meet the requirements for these higher pressures. Only in the event that after having applied such additional design principles and construction practices, the vessel still complies with all of the requirements of the Code, may it be stamped with the Code symbol.

What does the scope of the Code include?

The scope of the Code shall include the following:

- 1) Where external piping, other pressure vessels, including heat exchangers, or mechanical devices such as pumps, mixers, or compressors, are to be connected to the vessel:

- a. Welding end connection for the first circumferential joint for the welded connection.
  - b. First threaded joint for screwed connections.
  - c. Face of the first flange for bolted flanged connections.
  - d. First sealing surface for proprietary connection or fittings.
- 2) Where non pressure parts are attached directly to either the internal or external pressure retaining surface of a pressure vessel, the scope shall include the design, fabrication, testing and material requirements established for non-pressure parts attachment.
  - 3) Pressure retaining covers for vessel openings, such as manhole or handhole covers, and bolted covers with their attaching bolting and nuts.
  - 4) The first sealing surface for proprietary fittings or components for which the rules are not provided by the Code, such as gages, instruments and non-metallic components.

### Duties and Responsibilities

The user or his designated agent is responsible for establishing the design requirements for pressure vessels, taking into consideration factors associated with normal operation, start up and shut down, and any abnormal conditions that may become design governing condition. Such consideration shall include but not be limited to:

- Corrosion allowances
- Lethal service
- Post weld heat treatment
- Special requirements for steam generating or water heating applications
- Non-destructive examination

The manufacturer of any vessel or part to be stamped with Code symbol has the responsibility of complying with all of the applicable requirements of the Code, and through proper certification, of assuring that all the work done by others also complies. A vessel may be designed and constructed using any combinations of methods of fabrication and classes of materials covered by the Code provided the rules applicable to each method and material class are complied with and the vessel is properly marked.

It is duty of the Inspector to make all inspections specified by the Code, and of monitoring the quality control and the examinations made by the manufacturer. He shall make such other inspections as in his judgment are necessary to permit him to certify that the vessel has been designed and constructed in accordance with the requirements. The Inspector has the duty of verifying that the applicable calculations have been made and are on file at Manufacturer's plant at the time the Data Report is signed.

The Code does not contain rules to cover all details of design and construction. Where complete details are not given, it is intended that the Manufacturer, subject to the acceptance of the Inspector, shall provide details of design and construction which will be as safe as rules provided by the Code.

### Field Assembly of vessels

Field assembly of vessels constructed to the rules of the Code may be performed as follows:

- 1) The Manufacturer of the vessel completes the vessel in the field, complete the U-1 or U-1A Manufacturer's Data Report, and stamps the vessel.
- 2) The Manufacturer of parts of a vessel to be completed in the field by some other party stamps these part in accordance with the Code and supplies the Form U-2 or U-2A Manufacturer's Partial Data Report to the other party. The other party, who must hold a valid U Certificate of Authorization, makes the final assembly, required NDE, final pressure test; completes the Form U-1 or U-1A Manufacturer's Data Report; and stamps the vessel.

- 3) The filed portion of the work is completed by a holder of valid U Certificate of Authorization other than the vessel manufacturer. The stamp holder performing the field work is required to supply the Form U-2 or U-2A Manufacturer's Partial Data Report covering the portion of the work completed by his organization to the Manufacturer responsible for the Code vessel. The vessel manufacturer applies his U Stamp in the presence of the representative from his inspection agency and completes the Form U-1 or U-1A Manufacturer's Data Report with his Inspector.

In all three alternatives, the party completing and signing the Form U-1 or U-1A Manufacturer's Data Report assumes full Code responsibility for the vessel. In all three cases, each manufacturer's Quality Control System shall describe the controls to assure compliance for each Code Stamp holder.

Standards referenced by the Code

Throughout the Code, references are made to various standards, such as ANSI standards which cover pressure-temperature rating, dimensional or procedural standards for pressure vessel parts. These standards, with the year of acceptable edition, are listed in Table U-3 of the Code.

## *Sources:*

1. ASME Boiler & Pressure Vessel Code, Section VIII, Division 1: Edition 2010

**\*\*\* END OF THE ARTICLE \*\*\***

## *About CoDesign Engineering*

*CoDesign Engineering* is involved in projects that promote sustainable development and improvement in system efficiencies with specific focus on energy and waste management. Its operations can be broadly classified into following business groups:

- ❖ Pressure Vessels and Heat Exchangers
- ❖ Combined Cycle Power Plants
- ❖ Solar Photovoltaic Power Plants
- ❖ Solid Waste Management

We provides training, consultancy, and operation and maintenance services as described below:

### **Training**

- ❖ Pressure vessel & heat exchanger design (ASME Section VIII, Div. 1)
- ❖ Power piping design (ASME B31.1 & B31.3)
- ❖ Combined cycle power plant system design
- ❖ Solar PV power plant design

### **Consultancy**

- ❖ Supply and installation of static equipment in power plants and refineries
- ❖ Project Management Consultancy for construction of combined cycle power plants
- ❖ PMC as well as EPC services for solar PV power plants
- ❖ Turnkey waste management solutions, including disposal of e-waste

*We have designed a 3-day training course for ASME BPVC Section VIII, Div. 1 that can be offered at New Delhi, Mumbai, Chennai, Pune and Bangalore in India. The course can also be offered in US as on-site course upon request. Please contact Ramesh Tiwari at [rtiwari123@gmail.com](mailto:rtiwari123@gmail.com) for rates and the contents of the course.*

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**Ramesh Tiwari holds a Master's degree (1988) in Mechanical Engineering from Clemson University in South Carolina, and is a registered Professional Engineer in the state of Maryland in the United States. He has over 21 years of experience designing pressure vessels, heat exchangers and tanks.**

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