

Guidance on the specification of Pressure vessels

PUBLICATION 211

Edition 1

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THE ENGINEERING EQUIPMENT AND MATERIALS USERS' ASSOCIATION

Guidance on the specification of Pressure vessels

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ENGINEERING EQUIPMENT AND MATERIALS USERS' ASSOCIATION

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Comments are considered by the relevant EEMUA Technical Committees and may be incorporated in future editions of this Publication. New editions are publicised on the EEMUA website.

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Foreword

The purpose of this Publication is to provide guidance on the specification of pressure vessels for circumstances not addressed in design codes. It has been prepared by the Pressure Vessels Committee (PRV) of EEMUA, the Engineering Equipment and Materials Users' Association. As such, this Publication brings together the practical lessons learnt about design, manufacturing and testing of pressure vessels by users in EEMUA member companies.

EEMUA 211 is composed of three Chapters:

1. Considerations on the Avoidance of Repeat Post-Weld Heat Treatment

Post-weld heat treatment (PWHT) may be of considerable importance to the structural integrity of a pressure vessel. This Chapter examines the circumstances under which repeat PWHT may be waived.

2. Design for Exceptional Internal Pressure

This Chapter describes methods for assessing both existing and new pressure vessels for exceptional internal pressures. Simple and advanced design methods are provided for two levels of service performance.

3. Minimum Nozzle Loadings and Nozzle Design

There are three sections to this Chapter which all relate to improvement in the specification and reliability of nozzles. In the first, tables of minimum design loadings are provided to ensure that nozzles, made in steel, nickel alloys or glass reinforced plastics, are suitable for certain minimum loadings. In the second, requirements on stand-out and minimum pipe schedule are given for nozzles made from pipe. In the third, particular designs of small bore nozzles are specified.



1. Considerations on the Avoidance of Repeat Post-Weld Heat Treatment

1.1 Introduction

Post-weld heat treatment (PWHT) relieves the residual stress at welds. It is beneficial in avoiding brittle fracture (for which the design codes give rules) and environmentally assisted cracking (for which purchasers determine requirements). In fabricating new equipment, PWHT may be planned into the manufacturing process and is generally very cost effective.

However, with existing vessels, carrying out repeat PWHT may present many practical difficulties. There may be restrictions at the site on keeping the components hot over the length of time needed. It may be difficult or impossible to provide sufficient heat. Undertaking PWHT in an oven, which is the standard practice for new fabrication, may not be feasible. The disturbance to adjacent equipment caused by carrying out PWHT may also be unacceptable.

Occasionally the need may arise to weld on a vessel after its original fabrication and heat treatment has been completed. Such a welding operation might be necessary almost immediately, before or during commissioning the vessel, due to a design change; however, the need is more likely to occur in-service. New clips or studs may be needed for insulation supports or new anchors for fire-proofing materials. Components such as doubler plates or nozzles may be needed because of corrosion, or due to a process or mechanical design change. Overlay welding may be necessary to build up the thickness of a corroded part. In the extreme, for a major modification, a full circumferential butt-weld may be needed.

This Chapter indicates the thicknesses of components on which the codes currently permit welding without PWHT. It also discusses the welding techniques by which welds on thicker components can be made without repeat PWHT. It applies predominantly to vessels made in ferritic (i.e. carbon, carbon manganese or low alloy) steels.

1.2 Exemptions from PWHT given in the Codes

1.2.1 When PWHT is a Code Requirement

1.2.1.1 Main Pressure Parts

For avoidance of brittle fracture, PWHT is usually specified for a given material above a certain thickness in the codes. Table 1 overleaf indicates the maximum thicknesses of components which may be welded without PWHT for vessels operating above 0°C in accordance with ASME VIII Div. 1⁽¹⁾ or PD 5500⁽²⁾. The rules apply particularly to new vessels, but are also a major influence when the feasibility of modifying existing vessels is under review.

Table 1 applies to the greater thickness of the two components being welded. A vessel may have been given PWHT because of the thickness of the main plates, but it may be that the proposed modification is on a component with a thickness less than that shown in Table 1 overleaf. For example, if the modification is to a nozzle and the wall thickness of the nozzle is less than that in Table 1, welding to the nozzle - a new flange for example - is permissible without repeat PWHT. Care

should be taken that the length of the nozzle is such that the heat of welding does not affect the shell. The flange itself should be checked for the need for PWHT and rules are given in the codes for determining the nominal thickness for resistance to brittle fracture of different components, e.g. flanges and compensation pads.

Table 1 Maximum thickness which may be welded without PWHT for vessels operating above 0°C

Code	Material			
	ASME P1/ PD 5500 Band M0 & M1 (C Mn steel)	ASME P3/ PD 5500 Band M2 (C Mo steel)	ASME P4/ PD 5500 Band M7 & M9 (1¼ and 2¼ Cr Mo steels)	ASME P5/ PD 5500 Band M10 (5 Cr Mo steel)
ASME VIII Div. 1 (Paragraph UCS-56)	32mm (38mm with 95°C preheat)	16mm with 95°C preheat and 0.25% C max.	16mm with 120°C preheat and 0.15% C max.	16mm with 150°C Preheat and 0.15% C max.
PD 5500 (Section 4)	35mm (40mm if minimum 27J at -20°C)	35mm (40mm if minimum 27J at -20°C)	PWHT required	PWHT required

1.2.1.2 Appurtenances

The requirements given in the codes as they apply to small attachments, or appurtenances, are summarised in Table 2 opposite. Details of the clips are listed in the left hand column and the three right hand columns refer to vessels manufactured in one of the following conditions:

- with no PWHT; or
- given PWHT to avoid process side environmentally assisted cracking (see Section 1.2.2); or
- subjected to PWHT because of code requirements to avoid brittle fracture.

The requirement for repeat PWHT is given in Table 2 as either a 'YES' or a 'NO'.