

EEMUA Publication 190 Guide for the design, construction and use of mounded horizontal cylindrical steel vessels for pressurised storage of LPG at ambient temperatures

PUBLICATION 190

Edition 1

(Reprinted 2021 incorporating all amendments and errata to date since original publication)

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Guide for the design, construction and use of mounded horizontal cylindrical vessels for pressurised storage of LPG at ambient temperature

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THE ENGINEERING EQUIPMENT AND MATERIALS USERS ASSOCIATION

**GUIDE FOR THE DESIGN, CONSTRUCTION AND USE OF MOUNDED HORIZONTAL
CYLINDRICAL VESSELS FOR PRESSURISED STORAGE OF LPG
AT AMBIENT TEMPERATURES**

PUBLICATION No 190 : 2000

AMENDMENTS No 2, AUGUST 2017
(incorporating Amendments No 1, November 2004)

The amendments below are issued under the authority of the EEMUA Storage Tanks Technical Committee which has responsibility for the maintenance of this publication. They have been carried through into the digital edition and are provided here for reference for those readers who have a paper copy.

2/1: §4.1.1 Underneath the bullet point “For hemispherical domed ends”, *add* the following text and table:

The following dimensions of straight flanges to hemispherical domed ends would normally be provided by manufacturers of such structures.

Table 1 Length of straight flange on domed ends

Outside diameter of vessel (D_o)	Length of straight flange
$3500 \text{ mm} < D_o \leq 4500 \text{ mm}$	30 mm
$4500 \text{ mm} < D_o \leq 6000 \text{ mm}$	40 mm
$6000 \text{ mm} < D_o \leq 8000 \text{ mm}$	50 mm

where: D_o = external diameter of vessel

2/2: §4.2 In the first and last bullet points, reference is incorrectly made to ‘Table D.1’ of PD 5500. The correct references are to ‘Table D.2’.

2/3: §4.3.4.2 *Amend* the first paragraph to read:

Unless environmental considerations, e.g. the presence of wet H_2S , require otherwise, the vessel shall be post-weld heat treated in accordance with the requirements of PD 5500 Table 4.4-1, and by PD 5500 Annex D where applicable. Recommended grades of steel are given in Appendix D.

2/4: §7.2 *Insert* as appropriate:

EN 10028-3	Specification for Flat Products Made of Steels for Pressure Purposes—Part 3: Weldable Fine Grain Steels, Normalised
EN 10222-4	Steel Forgings for Pressure Purposes—Part 4: Weldable Fine-grain Steels with High Proof Strength

2/5: §7.2, last line *Delete* the asterisk after ‘PD 5500’.

2/6: §7.3 *Insert* after entry for ISO 8503-1:

ISO 9329-3	Seamless Steel Tubes for Pressure Purposes—Technical Delivery Conditions—Part 3: Unalloyed and Alloyed Steels with Specified Low Temperature Properties
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2/7: **§A.2.2** Delete the following sentences:

The table is valid for propane vessels. For butane vessels the figures need to be increased by a further 10%.

2/8: **§A.2.2** Replace the present table by the following:

Table 2 Stress increase percentages for domed ends

product	diameter D_o	hemispherical heads	torispherical heads	
			with stiffener next to dome	without stiffener next to dome
propane	≤ 3600 mm	11	4	6
	$3600 \text{ mm} < D_o \leq 4500$ mm	11.6	4.3	6.3
	$4500 \text{ mm} < D_o \leq 6000$ mm	12.3	4.9	6.9
	$6000 \text{ mm} < D_o \leq 7200$ mm	15.2	5.7	7.7
	> 7200 mm	16	6	8
butane	≤ 3600 mm	12.1	4.4	6.6
	$3600 \text{ mm} < D_o \leq 4500$ mm	12.8	4.7	6.9
	$4500 \text{ mm} < D_o \leq 6000$ mm	14.6	5.4	7.6
	$6000 \text{ mm} < D_o \leq 7200$ mm	16.7	6.2	8.4
	> 7200 mm	17.6	6.6	8.8

2/9: **§A.2.2** Delete the existing sentence underneath the present table which reads:

For intermediate values of vessel diameter, interpolation should be used to calculate stress increases.

2/10: **§A.4.2.5.2** Replace the text ‘For a slope of 30°’ by:

For a slope of 2 : 3 (see also figure in B.2 Mound):

2/11: **§A.4.9** Add a new section “A.4.9 Allowable stresses” underneath section “A.4.8 Secondary Bending Stresses” and add the following text and table underneath:

Allowable stresses would normally be predicted by the appropriate design code that is used for the verification of the actual stresses which are detailed in Sections A.4.10 and further. The following allowable stresses would normally be applied:

Table 3 Load combinations and allowable stresses

Description	PD 5500	EN 13445
Normal operations f_1	$f_1 = \text{MIN} \left[\left(\frac{Re}{1.5} \right); \left(\frac{Rm}{2.35} \right) \right]$	$f_1 = \text{MIN} \left[\left(\frac{Re}{1.5} \right); \left(\frac{Rm}{2.4} \right) \right]$
Hydrostatic pressure without earth cover f_2	$f_2 = 0.9 \cdot Re$	$f_2 = 0.9 \cdot Re$
Hydrostatic pressure with earth cover f_3	$f_3 = 0.9 \cdot Re$	$f_3 = 0.9 \cdot Re$
Earthquake f_4	$f_4 = 1.2 \cdot f_1$	$f_4 = 1.2 \cdot f_1$
Explosion (blast load) f_5	$f_5 = 0.9 \cdot Re$	$f_5 = 0.9 \cdot Re$
Allowable stresses in fillet welds between web of stiffeners and shell plate and between web and flange of stiffeners f_6	$f_6 = 0.7 \cdot f_1$	$f_6 = 0.7 \cdot f_1$

2/12: **§A.4.9** Renumber section “A.4.9 Summary of Stresses” and all its subsections A.4.9.X to “A.4.10 Summary of Stresses” and A.4.10.X.

2/13: §A.4.10 *Renumber* section “A.4.10 Stability of Stiffening Rings, Eurocode 3” and all its subsections A.4.10.X to “A.4.11 Stability of Stiffening Rings, Eurocode 3” and A.4.11.X.

2/14: Appendix D *Replace* in its entirety by the attached page.

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August 2017
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APPENDIX D

RECOMMENDED STEEL GRADES

Note.— Materials not specified in this table may be used provided they have guaranteed minimum Charpy impact values at the required test temperature and meet the requirements of PD 5500 Table D.2.

PRODUCT ¹	THICKNESS (mm)	PLATE		PIPE MATERIAL ³	FORGINGS ³
		REQ'D IMPACT TEST TEMP (°C) ²	MATERIAL		
BUTANE	25 to < 35	-40	EN 10028-3 P355NL1	ISO 9329-3 Gr PL23 ASTM A 333 Gr 6	EN 10222-4 P355 QH
	All thicknesses	-20	EN 10028-3 P355N ASTM A 516 Gr 60, S5	ISO 9329-3 Gr PL23 ASTM A 333 Gr 6	EN 10222-4 P355 NH ASTM A 350 LF2
PROPANE	< 18	-40	EN 10028-3 P355NL1	ISO 9329-3 Gr PL23 ASTM A 333 Gr 6 ⁴	EN 10222-4 P355 QH
	< 30	-20	EN 10028-3 P355N ASTM A 516 Gr 60, S5	ISO 9329-3 Gr PL23 ASTM A 333 Gr 6	EN 10222-4 P355 NH ASTM A 350 LF2
	All thicknesses	-40	EN 10028-3 P355NL1	ISO 9329-3 Gr PL23 ASTM A 333 Gr 6 ⁵	EN 10222-4 P355 QH

Superscripted Notes

- 1 For gas mixtures it will be necessary to conduct a full appraisal using PD 5500.
- 2 Charpy impact test temperatures are derived from EN 10028-3.
- 3 Required impact test temperature for pipe material and forgings is -50°C.
- 4 T < 12 mm.
- 5 T < 40 mm.

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