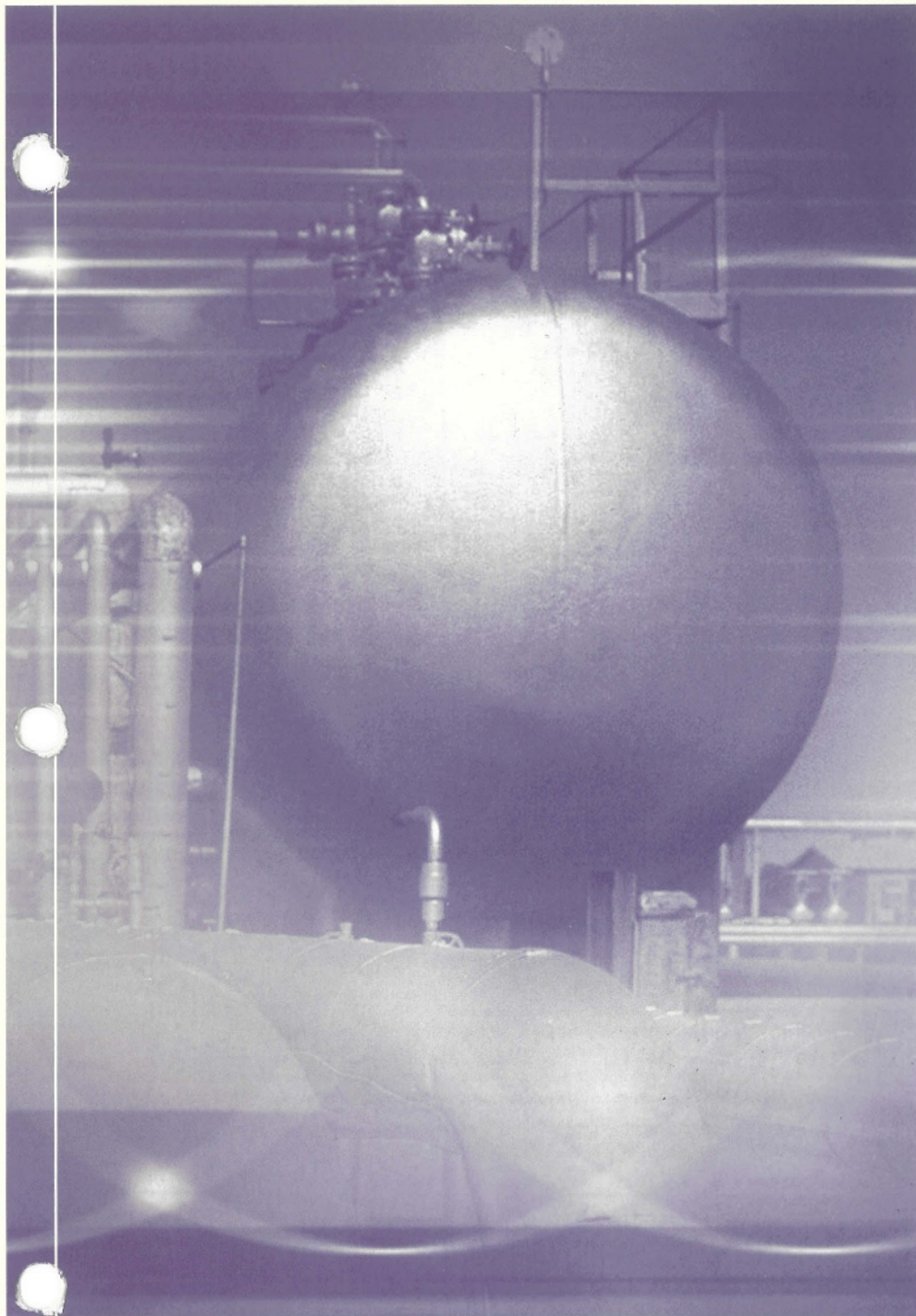




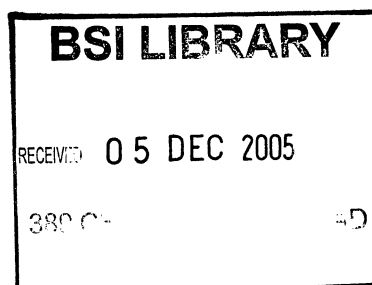
PD 5500:2003

Specification for
**Unfired fusion welded
pressure vessels**

WITHDRAWN

Specification for

Unfired fusion welded pressure vessels



ICS 23.020.30

Committees responsible for this Published Document

The preparation of this Published Document was entrusted to Technical Committee PVE/1, Pressure vessels, upon which the following bodies were represented:

Air Conditioning and Refrigeration Industry Board (ACRIB)
 British Chemical Engineering Contractors' Association
 British Compressed Gases Association
 British Refrigeration Association
 British Valve and Actuator Manufacturers' Association
 Department of Trade and Industry (Standards and Technical Regulations Directorate)
 Electricity Association
 Energy Industries Council
 Engineering Equipment and Materials Users' Association
 Health and Safety Executive
 LP Gas Association
 Lloyd's Register of Shipping
 Power Generation Contractors Association [PGCA (BEAMA Ltd.)]
 Process Plant Association
 Safety Assessment Federation Ltd.
 Society of British Gas Industries
 The Welding Institute

The following bodies were also represented in the drafting of the document, through subcommittees and panels:

Association of Consulting Engineers
 British Cryo Engineering Society
 University of Liverpool
 UK Steel Association
 University of Strathclyde
 Welding Manufacturers' Association (BEAMA Ltd.)

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 15 January 2003

© BSI 24 November 2005

First published as BS 5500
 March 1976
 Second edition January 1982
 Third edition January 1985
 Fourth edition January 1988
 Fifth edition January 1991
 Sixth edition January 1994
 Seventh edition January 1997
 First published as PD 5500
 January 2000
 Second edition January 2003

The following BSI references relate to the work on this specification:

Committee reference PVE/1

ISBN 0 580 41126 5

Amendments issued since publication

Amd. No.	Issue Date	Effective Date	Amendment designation	Comments
14534	September 2003	January 2004	Amendment 1, tagged A1 A1	See Foreword
14900 Corrigendum No. 1	March 2004	March 2004	Corrigendum 1, tagged C1 C1	See Foreword
15207	September 2004	January 2005	Amendment 2, tagged A2 A2	See Foreword
15942	November 2005	December 2005	Amendment 3, tagged A3 A3	See Foreword

Contents

	Page
Committees responsible	Inside front cover
Foreword	xvii
Summary of pages	xix
Section 1. General	
1.1 Scope	1/1
1.2 Interpretation	1/3
1.3 Definitions	1/3
1.4 Responsibilities	1/3
1.4.1 Responsibilities of the purchaser	1/3
1.4.2 Responsibilities of the manufacturer	1/4
1.4.3 Responsibilities of the Inspecting Authority	1/8
1.4.4 Certificate of Conformance	1/8
1.5 Information and requirements to be agreed and to be documented	1/11
1.5.1 Information to be supplied by the purchaser	1/11
1.5.2 Information to be supplied by the manufacturer	1/11
1.6 Thicknesses	1/12
Section 2. Materials	
2.1 Selection of materials	2/1
2.1.1 General	2/1
2.1.2 Materials for pressure parts	2/1
2.1.3 Materials for non-pressure parts	2/14
2.2 Materials for low temperature applications	2/15
2.3 Nominal design strength	2/17
2.3.1 General	2/17
2.3.2 Notation	2/17
2.3.3 Time-independent design strength	2/18
2.3.4 Time-dependent design strength	2/20
Section 3. Design	
3.1 General	3/1
3.2 Application	3/2
3.2.1 Consideration of loads	3/2
3.2.2 Design criteria	3/3
3.2.3 Design pressure	3/4
3.2.4 Maximum design temperature	3/4
3.2.5 Minimum design temperature	3/4
3.2.6 Thermal loads	3/4
3.2.7 Wind and earthquake loads	3/4
3.3 Corrosion, erosion and protection	3/5
3.3.1 General	3/5
3.3.2 Additional thickness to allow for corrosion	3/5
3.3.3 Linings and coatings	3/5
3.3.4 Wear plates	3/5
3.4 Construction categories and design stresses	3/6
3.4.1 Construction categories	3/6
3.4.2 Design stresses	3/6

	Page
3.5 Vessels under internal pressure	3/8
3.5.1 Cylindrical and spherical shells	3/8
3.5.2 Domed ends	3/10
3.5.3 Cones and conical ends	3/14
3.5.4 Openings and nozzle connections	3/21
3.5.5 Flat ends and flat plates	3/69
3.5.6 Spherically domed and bolted ends of the form shown in Figure 3.5-39	3/81
3.6 Vessels under external pressure	3/87
3.6.1 General	3/87
3.6.2 Cylindrical shells	3/90
3.6.3 Conical shells	3/94
3.6.4 Spherical shells	3/97
3.6.5 Hemispherical ends	3/98
3.6.6 Torispherical ends	3/98
3.6.7 Ellipsoidal ends	3/98
3.6.8 Procedure by which the departure from the mean circle may be obtained	3/98
3.7 Supports, attachments and internal structures	3/118
3.7.1 General	3/118
3.7.2 Supports	3/118
3.8 Bolted flanged connections	3/120
3.8.1 General	3/120
3.8.2 Notation	3/126
3.8.3 Narrow-faced gasketed flanges	3/128
3.8.4 Full-faced flanges with soft ring type gaskets	3/135
3.8.5 Ungasketed seal welded flanges	3/136
3.8.6 Reverse narrow-face flanges	3/136
3.8.7 Reverse full-face flanges	3/136
3.8.8 Full-faced flanges with metal to metal contact	3/138
3.9 Flat heat exchanger tubesheets	3/182
3.9.1 Notation	3/182
3.9.2 Characteristics of perforated plates	3/184
3.9.3 Tubesheets of exchangers with floating heads or U-tubes	3/185
3.9.4 Tubesheets of fixed tubesheet exchangers	3/194
3.9.5 Allowable shell and tube longitudinal stresses	3/200
3.9.6 Allowable tube joint end load	3/201
3.10 Design of welds	3/206
3.10.1 General	3/206
3.10.2 Welded joints for principal seams	3/207
3.10.3 Welded joints for other than principal seams	3/207
3.10.4 Welded joints in time dependent applications	3/207
3.11 Vessels with external jackets or limpet coils	3/209
3.11.1 General	3/209
3.11.2 Jacketed cylindrical shells	3/209
3.11.3 Welded jacket connections	3/210
3.11.4 Cylindrical shells with limpet coils	3/212
3.12 Manholes, inspection openings and quick release openings	3/214

	Page
3.13 Protective devices for excessive pressure or vacuum	3/214
3.13.1 Application	3/214
3.13.2 Capacity of relief device(s)	3/215
3.13.3 Pressure setting of pressure relieving devices	3/215
Section 4. Manufacture and workmanship	
4.1 General aspects of construction	4/1
4.1.1 General	4/1
4.1.2 Material identification	4/1
4.1.3 Order of completion of weld seams	4/1
4.1.4 Junction of more than two weld seams	4/1
4.1.5 Localized thinning	4/2
4.1.6 Rectification of departures from tolerance	4/2
4.2 Cutting, forming and tolerances	4/2
4.2.1 Cutting of material	4/2
4.2.2 Forming of shell sections and plates	4/3
4.2.3 Assembly tolerances	4/5
4.2.4 Tolerances for vessels subject to internal pressure	4/6
4.2.5 Tolerances for vessels subject to external pressure	4/8
4.2.6 Structural tolerances	4/8
4.3 Welded joints	4/9
4.3.1 General	4/9
4.3.2 Welding consumables	4/10
4.3.3 Preparation of plate edges and openings	4/10
4.3.4 Assembly for welding	4/10
4.3.5 Attachments and the removal of temporary attachments	4/10
4.3.6 Butt joints	4/11
4.3.7 Welding: general requirements	4/12
4.4 Heat treatment	4/12
4.4.1 Preheat requirements	4/12
4.4.2 Normalizing: ferritic steels	4/12
4.4.3 Post-weld heat treatment	4/13
4.4.4 Methods of heat treatment	4/14
4.4.5 Post-weld heat treatment procedure	4/14
4.4.6 Mechanical properties after heat treatment	4/17
4.5 Surface finish	4/17
Section 5. Inspection and testing	
5.1 General	5/1
5.2 Approval testing of fusion welding procedures	5/3
5.3 Welder and operator approval	5/5
5.4 Production control test plates	5/6
5.4.1 Vessels in materials other than 9 % Ni steel	5/6
5.4.2 9 % Ni steel vessels	5/6
5.5 Destructive testing	5/6
5.6 Non-destructive testing	5/6
5.6.1 General	5/6
5.6.2 Parent materials	5/7
5.6.3 Components prepared for welding	5/7
5.6.4 Non-destructive testing of welded joints	5/7
5.6.5 Choice of non-destructive test methods for welds	5/10

	Page
5.6.6 Non-destructive testing techniques for welds	5/10
5.7 Acceptance criteria for weld defects revealed by visual examination and non-destructive testing	5/12
5.7.1 General	5/12
5.7.2 Assessment of defects	5/12
5.7.3 Repair of welds	5/14
5.8 Pressure tests	5/22
5.8.1 General	5/22
5.8.2 Basic requirements	5/22
5.8.3 Hydraulic testing	5/23
5.8.4 Pneumatic tests	5/23
5.8.5 "Standard" test pressure	5/24
5.8.6 Proof hydraulic test	5/26
5.8.7 Combined hydraulic/pneumatic tests	5/27
5.8.8 Leak testing	5/27
5.8.9 Vessel nameplate	5/28
5.8.10 Final inspection	5/28
5.9 Inspection requirements for cast components	5/29
5.9.1 Examination	5/29
5.9.2 Defects	5/29
5.9.3 Identification and marking	5/29
Annex A Requirements for design where loadings and components are not covered by Section 3	A/1
Annex B Requirements for cylindrical, spherical and conical shells under combined loadings, including wind and earthquakes	B/1
Annex C Assessment of vessels subject to fatigue	C/1
Annex D Requirements for vessels designed to operate below 0 °C	D/1
Annex E Recommendations for welded connections of pressure vessels	E/1
Annex G Recommendations for the design of local loads, thermal gradients, etc.	G/1
Annex H Recommendations for post-weld heat treatment of dissimilar ferritic steel joints	H/1
Annex J Recommendations for pressure relief protective devices	J/1
Annex K Requirements for design stresses for British Standard materials	K/1
Annex L Guidance on structural tolerances	L/1
Annex M Requirements for establishing the allowable external pressure for cylindrical sections outside the circularity limits specified in 3.6	M/1
Annex N Requirements for vessel design and the provision of information concerning UK statutory requirements for the demonstration of the continued integrity of pressure vessels throughout their service life	N/1
Annex Q Recommendations for preparation and testing of production control test plates	Q/1
Annex R Guidance on additional information for flat ends and flat plates	R/1
Annex S Guidance on optional documentation for supply with vessel	S/1
Annex T Recommendations for arc welded tube to tubeplate joints	T/1
Annex U Guidance on the use of fracture mechanics analyses	U/1
Annex V Requirements for testing and inspection of serially produced pressure vessels	V/1
Annex W Worked examples	W/1
Annex Z Guidance on the application of PD 5500 to pressure vessels falling within the scope of the European Pressure Equipment Directive	Z/1

	Page
Aluminium supplement Requirements for aluminium and aluminium alloys in the design and construction of unfired fusion welded pressure vessels	Al/1
Copper supplement Requirements for copper and copper alloys in the design and construction of unfired fusion welded or brazed pressure vessels	Cu/1
Nickel supplement Requirements for nickel and nickel alloys in the design and construction of unfired fusion welded pressure vessels	Ni/1
Index	I
List of references	V
Figure 1.6-1 — Relationship of thickness definitions	1/13
Figure 3.5-1 — Domed ends	3/11
Figure 3.5-2 — Design curves for unpierced domed ends	3/13
Figure 3.5-3 — Conical shells: Vapour belt arrangement	3/15
Figure 3.5-4 — Values of coefficient β for cone/cylinder intersection without knuckle	3/18
Figure 3.5-5 — Geometry of cone/cylinder intersection: large end	3/19
Figure 3.5-6 — Geometry of cone/cylinder intersection: small end	3/20
Figure 3.5-7 — Offset cone	3/21
Figure 3.5-8 — Positions of openings or nozzles in dished ends	3/24
Figure 3.5-9 — Design curves for protruding nozzles in spherical vessels ($d/D < 0.5$) and for protruding nozzles in cylindrical and conical vessels ($d/D < 1/3$)	3/27
Figure 3.5-10 — Design curves for flush nozzles in spherical shells ($d/D < 0.5$) and for flush nozzles in conical shells ($d/D < 1/3$)	3/28
Figure 3.5-11 — Design curves for flush nozzles in cylindrical shells ($0 < d/D < 0.3$)	3/29
Figure 3.5-12 — Design curves for flush nozzles in cylindrical shells ($0.2 < d/D \leq 1.0$)	3/34
Figure 3.5-13 — Nozzle in a conical shell	3/36
Figure 3.5-14 — Notation applicable to spheres	3/37
Figure 3.5-15 — Notation applicable to spheres	3/37
Figure 3.5-15a) — Notation applicable to oblique nozzles in spheres	3/38
Figure 3.5-16 — Notation applicable to spheres	3/38
Figure 3.5-17 — Notation applicable to spheres	3/39
Figure 3.5-18 — Notation applicable to cylinders	3/39
Figure 3.5-19 — Notation applicable to cylinders	3/39
Figure 3.5-20 — Notation applicable to cylinders	3/40
Figure 3.5-21 — Notation applicable to cylinders	3/40
Figure 3.5-22 — Protruding rim	3/41
Figure 3.5-23 — Flush rim	3/41
Figure 3.5-24 — Arrangement factor g	3/41
Figure 3.5-25 — Nozzle compensation	3/42
Figure 3.5-26 — Notation applicable to spheres and cylinders	3/43
Figure 3.5-27 — Notation applicable to spheres and cylinders	3/43
Figure 3.5-28 — Notation applicable to spheres and cylinders	3/44
Figure 3.5-29 — Modified flush nozzle compensation	3/45
Figure 3.5-30 — Modified protruding nozzle compensation	3/46
Figure 3.5-31 — Maximum branch to body thickness ratio	3/54

	Page
Figure 3.5-32 — Reinforcement of openings and branches	3/55
Figure 3.5-33 — Reinforcement of non-radial branches	3/65
Figure 3.5-34 — Typical welded flat ends and covers	3/72
Figure 3.5-35 — Typical non-welded flat ends and covers	3/73
Figure 3.5-36 — Factor C for welded flat ends for $e_{\text{cyl}}/e_{\text{cyl0}} = 1$ to 3	3/75
Figure 3.5-37 — Factor C for welded flat ends for $e_{\text{cyl}}/e_{\text{cyl0}} = 3$ to > 10	3/76
Figure 3.5-38 — Typical stays: areas supported by stays	3/79
Figure 3.5-39 — Spherically domed and bolted end (narrow faced gasket)	3/81
Figure 3.6-1 — Effective lengths of cylinder	3/104
Figure 3.6-2 — Values of ε	3/105
Figure 3.6-3 — Values of n_{cyl}	3/106
Figure 3.6-4 — Values of Δ	3/107
Figure 3.6-5 — Stiffening ring with unsupported section	3/109
Figure 3.6-6 — Stiffening ring details	3/109
Figure 3.6-7 — Values of β	3/113
Figure 3.6-8 — Conical sections: typical stiffeners	3/114
Figure 3.8-1 — Loose keyed flange with mating components	3/133
Figure 3.8-2 — Forces and lever arms on loose keyed flange	3/133
Figure 3.8-3 — Typical lip arrangement for swing bolted flange	3/134
Figure 3.8-4 — Location of gasket load reaction	3/142
Figure 3.8-5 — Values of T , U , Y and Z	3/160
Figure 3.8-6 — Values of F (integral method factors)	3/161
Figure 3.8-7 — Values of V (integral method factors)	3/162
Figure 3.8-8 — Values of F_L (loose hub flange factors)	3/162
Figure 3.8-9 — Values of V_L (loose hub flange factors)	3/163
Figure 3.8-10 — Values of f (hub stress correction factors)	3/164
Figure 3.8-11 — Ungasketed, seal-welded-type flanges	3/165
Figure 3.8-12 — Contact face between loose and stub flanges in a lap joint where diameters A_2 and B_2 are defined by the same component	3/165
Figure 3.9-1 — Design curves: determination of C_0	3/186
Figure 3.9-2 — Design curves: determination of F_0	3/187
Figure 3.9-3 — Design curves: determination of F_0	3/188
Figure 3.9-4 — Design curves: determination of F_1	3/189
Figure 3.9-5 — Design curves: determination of F_1	3/190
Figure 3.9-6 — Typical clamped and simply supported configurations for floating head or U-tubesheets	3/191
Figure 3.9-7 — Flexural efficiency: triangular layout	3/192
Figure 3.9-8 — Flexural efficiency: square layout	3/193
Figure 3.9-9 — Tubesheet: determination of F_q	3/196
Figure 3.9-10 — Tubesheet: determination of H for $X_a > 4.0$	3/197
Figure 3.9-11 — Tubesheet: determination of H for $X_a < 4.0$	3/198
Figure 3.9-12 — Determination of the buckling length L_k	3/202
Figure 3.10-1 — Butt welds in plates of unequal thickness	3/208
Figure 3.10-2 — Butt welds with offset of median lines	3/209
Figure 3.11-1 — Some acceptable types of jacketed vessels	3/212
Figure 3.11-2 — Typical blocking ring and sealer ring construction	3/213
Figure 3.11-3 — Typical limpet coil	3/214

	Page
Figure 3.11-4 — Limpet coil arrangements	3/214
Figure 4.2-1 — Profile gauge details and application	4/9
Figure 4.3-1 — A thin limpet coil weld detail	4/11
Figure 5.6-1 — Illustration of welded joints for non-destructive testing	5/9
Figure 5.7-1 — Partial non-destructive testing (NDT) category 2 constructions	5/16
Figure A.1 — Stress categories and limits of stress intensity	A/7
Figure A.2 — Curve for the evaluation of Δ	A/12
Figure A.3 — Use of templates to check tolerances	A/13
Figure B.1 — Stresses in a cylindrical shell under combined loading	B/6
Figure B.2 — Stresses in a spherical shell under combined loading	B/7
Figure B.3 — Stresses in a conical shell under combined loading	B/8
Figure B.4 — Global loads	B/9
Figure C.1 — Illustration of fluctuating stress	C/2
Figure C.2 — Example of pressure vessel fatigue loading cycle and determination of stress ranges	C/6
Figure C.3 — Fatigue design $S-N$ curves for weld details applicable to ferritic steels up to and including 350 °C, austenitic stainless steels up to and including 430 °C and aluminium alloys up to and including 100 °C	C/7
Figure C.4 — Fatigue design $S-N$ curves for bolting applicable to ferritic steels up to and including 350 °C, austenitic stainless steels up to and including 430 °C and aluminium alloys up to and including 100 °C	C/7
Figure C.5 — Interaction criteria for assessing coplanar embedded slag inclusions	C/9
Figure C.6 — Distribution of stress measurement points for determining structural hot spot stress at a weld toe	C/23
Figure C.7 — Deviations from design shape at seam welds	C/27
Figure C.8 — Weld toe dressing	C/28
Figure D.1 — Permissible design reference temperature/design reference thickness/required impact test temperature relationships for as-welded components	D/3
Figure D.2 — Permissible design reference temperature/design reference thickness/required impact test temperature relationships for post-weld heat-treated components	D/4
Figure D.3 — Examples of details for attaching non-critical components to pressure shell	D/7
Figure D.4 — Location of Charpy V-notch specimens in weld metal (as-welded vessels)	D/10
Figure D.5 — Location of Charpy V-notch specimens in weld metal (stress relieved vessels)	D/11
Figure D.6 — Location of Charpy V-notch specimens in heat affected zone	D/11
Figure D.7 — Example of detail for avoidance of severe thermal gradients	D/12
Figure E.1 — Typical weld preparations for butt welds using the manual metal-arc process	E/2
Figure E.2 — Typical weld preparations for circumferential welds where the second side is inaccessible for welding	E/3
Figure E.3 — Typical weld preparations for butt welds using the submerged arc welding process	E/6
Figure E.4 — Typical weld preparations for butt welds using the manual inert gas arc welding for austenitic stainless and heat resisting steels only	E/7
Figure E.5 — Typical weld details for circumferential lap joints	E/8

	Page
Figure E.6 — Standard weld details	E/13
Figure E.7a) — Limitations on geometry of fillet weld applied to the edge or a part	E/14
Figure E.7b) — Transverse and longitudinal sections of branch connections	E/14
Figure E.8 — Weld details for set-in branches	E/15
Figure E.9 — Set-on branches	E/17
Figure E.10 — Set-on branches	E/18
Figure E.11 — Set-on branches	E/19
Figure E.12 — Set-on branches	E/20
Figure E.13 — Set-on branches	E/21
Figure E.14 — Set-on branches	E/22
Figure E.15 — Set-on branches	E/23
Figure E.16 — Set-in branches: fillet welded connections	E/24
Figure E.17 — Set-in branches: partial penetration butt welded connections	E/25
Figure E.18 — Set-in branches: full penetration connections	E/26
Figure E.19 — Set-in branches: full penetration connections	E/27
Figure E.20 — Set-in branches: full penetration connections with asymmetrical butt joints	E/28
Figure E.21 — Set-in branches: full penetration connections welded from one side only	E/29
Figure E.22 — Forged branch connections	E/30
Figure E.23 — Forged branch connections	E/31
Figure E.24 — Set-on branches with added compensation rings	E/32
Figure E.25 — Set-in branches with added compensation rings	E/33
Figure E.26 — Set-in branches with added compensation rings	E/34
Figure E.27 — Set-in branches with added compensation rings	E/35
Figure E.28 — Set-in branches with added compensation rings	E/36
Figure E.29 — Studded connections	E/37
Figure E.30 — Socket welded and screwed connections	E/39
Figure E.31 — Flanges	E/40
Figure E.32 — Flanges	E/41
Figure E.33 — Flanges	E/43
Figure E.34 — Jacketted vessels: typical vessel/blocking ring attachments	E/44
Figure E.35 — Jacketted vessels: typical blocking ring/jacket attachments	E/44
Figure E.36 — Jacketted vessels: typical sealer rings	E/46
Figure E.37 — Jacketted vessels: typical through connections	E/47
Figure E.38 — Flat ends and covers	E/48
Figure E.39 — Tubeplate to shell connections: accessible for welding on <i>both</i> sides of the shell	E/51
Figure E.40 — Tubeplate to shell connections: accessible for welding from <i>outside</i> of shell only	E/52
Figure E.41 — Tubeplate to shell connections: accessible for welding on <i>both</i> sides of shell	E/53

	Page
Figure E.42 — Tubeplate to shell connections	E/54
Figure E.43 — Tubeplate to shell connections	E/56
Figure E.44 — Tubeplate to shell connections	E/57
Figure G.2.2-1 — Restriction on vessel/attachment geometry	G/4
Figure G.2.2-2 — Vessel with central radial load	G/5
Figure G.2.2-3 — Vessel with radial load out of centre	G/5
Figure G.2.2-4 — Graph for finding equivalent length L_e	G/6
Figure G.2.2-5 — Chart for finding $64 \frac{r}{t} \left(\frac{C_x}{r} \right)^2$	G/7
Figure G.2.2-6 — Cylindrical shells with radial load: circumferential moment per millimetre width	G/8
Figure G.2.2-7 — Cylindrical shells with radial load: longitudinal moment per millimetre width	G/9
Figure G.2.2-8 — Cylindrical shells with radial load: circumferential membrane force per millimetre width	G/10
Figure G.2.2-9 — Cylindrical shells with radial load: longitudinal membrane force per millimetre width	G/11
Figure G.2.2-10 — Circumferential bending moment due to a radial line load variation round circumference	G/13
Figure G.2.2-11 — Longitudinal moment from radial line load variation round circumference	G/14
Figure G.2.2-12 — Circumferential membrane force from radial line load variation round circumference	G/15
Figure G.2.2-13 — Longitudinal membrane force from radial line load variation round circumference	G/16
Figure G.2.2-14 — Circumferential bending moment due to a radial line load variation along cylinder	G/19
Figure G.2.2-15 — Longitudinal moment due to a radial line load variation along cylinder	G/20
Figure G.2.2-16 — Circumferential membrane force due to a radial line load variation along cylinder	G/21
Figure G.2.2-17 — Longitudinal membrane force due to a radial line load variation along cylinder	G/22
Figure G.2.2-18 — Maximum radial deflection of a cylindrical shell subjected to a radial load W for r/t between 15 and 100	G/23
Figure G.2.2-19 — Maximum radial deflection of a cylindrical shell subjected to a radial load W for r/t between 100 and 300	G/24
Figure G.2.2-20 — Graphs for finding the square $2C_1 \times 2C_1$ equivalent to a rectangular loading area $2C_x \times 2C_\phi$	G/25
Figure G.2.3-1 — Circumferential moment	G/28
Figure G.2.3-2 — Longitudinal moment	G/28
Figure G.2.3-3 — Sector stresses	G/33
Figure G.2.3-4 — Notation for external loads at a nozzle or attachment on a cylindrical shell	G/33
Figure G.2.4-1 — Chart for finding s and u	G/39
Figure G.2.4-2 — Spherical shell subjected to a radial load	G/40
Figure G.2.4-3 — Deflections of a spherical shell subjected to a radial load W	G/41
Figure G.2.4-4 — Meridional moment M_x in a spherical shell subjected to radial load W	G/42
Figure G.2.4-5 — Circumferential moment M_ϕ in a spherical shell subjected to a radial load W	G/43

	Page
Figure G.2.4-6 — Meridional force N_x in a spherical shell subjected to a radial load W	G/44
Figure G.2.4-7 — Circumferential force N_ϕ in a spherical shell subjected to a radial load W	G/45
Figure G.2.4-8 — Spherical shell subjected to an external moment	G/47
Figure G.2.4-9 — Deflections of a spherical shell subjected to an external moment M	G/48
Figure G.2.4-10 — Meridional moment M_x in a spherical shell subjected to an external moment M	G/49
Figure G.2.4-11 — Circumferential moment M_ϕ in a spherical shell subjected to an external moment M	G/50
Figure G.2.4-12 — Meridional force N_x in a spherical shell subjected to an external moment M	G/51
Figure G.2.4-13 — Circumferential force N_ϕ in a spherical shell subjected to an external moment M	G/52
Figure G.2.5-1 — Maximum stress in sphere for internal pressure (flush nozzles)	G/56
Figure G.2.5-2 — Maximum stress in sphere for internal pressure (protruding nozzles)	G/56
Figure G.2.5-3 — Maximum stress in sphere for thrust loading (flush nozzles)	G/57
Figure G.2.5-4 — Maximum stress in sphere for thrust loading (protruding nozzles)	G/57
Figure G.2.5-5 — Maximum stress in sphere for moment loading (flush nozzles)	G/58
Figure G.2.5-6 — Maximum stress in sphere for moment loading (protruding nozzles)	G/58
Figure G.2.5-7 — Maximum stress in sphere for shear loading (flush nozzles)	G/59
Figure G.2.5-8 — Maximum stress in sphere for shear loading (protruding nozzles)	G/59
Figure G.2.6-1 — Shakedown values for pressure loading (flush nozzle)	G/61
Figure G.2.6-2 — Shakedown values for pressure loading (protruding nozzle)	G/61
Figure G.2.6-3 — Shakedown values for thrust and moment loadings (flush nozzle)	G/62
Figure G.2.6-4 — Shakedown values for thrust and moment loadings (protruding nozzle)	G/62
Figure G.2.6-5 — Shakedown values for thrust and moment loadings (flush nozzle)	G/63
Figure G.2.6-6 — Shakedown values for thrust and moment loadings (protruding nozzle)	G/63
Figure G.2.6-7 — Shakedown values for thrust and moment loadings (flush nozzle)	G/64
Figure G.2.6-8 — Shakedown values for thrust and moment loadings (protruding nozzle)	G/64
Figure G.2.8-1 — Moment and force vectors	G/67
Figure G.2.8-2 — Allowable axial nozzle load	G/69
Figure G.2.8-3 — Allowable nozzle moment	G/70
Figure G.2.8-4 — Calculation factor C_2	G/75
Figure G.2.8-5 — Calculation factor C_3	G/75
Figure G.2.8-6 — Calculation factor C_4	G/76
Figure G.3.1-1 — Typical brackets	G/83
Figure G.3.1-2 — Typical reinforcing plates on cylindrical shells	G/84
Figure G.3.2-1 — Typical ring support	G/86

	Page
Figure G.3.2-2 — Typical steelwork under ring support	G/87
Figure G.3.2-3 — Leg supports for vertical vessels	G/87
Figure G.3.2-4 — Typical ring girder	G/89
Figure G.3.3-1 — Typical supports for horizontal vessels	G/91
Figure G.3.3-2 — Cylindrical shell acting as beam over supports	G/93
Figure G.3.3-3 — Factor for bending moment at mid-span	G/94
Figure G.3.3-4 — Factors for bending moment at supports	G/95
Figure G.3.3-5 — Portion of shell ineffective against longitudinal bending	G/96
Figure G.3.3-6 — Circumferential bending moment diagrams	G/100
Figure G.3.3-7 — Saddle supports	G/102
Figure G.3.3-8 — Typical ring stiffeners	G/103
Figure G.3.3-9 — Graph of rigid end factor, F_A	G/108
Figure G.3.3-10 — Graph of saddle width factor, F_B	G/109
Figure G.3.3-11 — Graph of saddle interaction factor, F_I	G/110
Figure G.3.3-12 — Graph of length change factor, F_L	G/111
Figure G.3.3-13 — Graph of saddle wrap-around factor, F_θ	G/112
Figure G.4.3-1 — Nozzle geometry	G/117
Figure G.4.3-2 — Transient fluid and metal temperatures	G/117
Figure G.4.3-3 — Inner surface thermal stress factors K_1 and k_1	G/118
Figure G.4.3-4 — Outer surface thermal stress factors K_2 and k_2	G/119
Figure G.4.3-5 — Mean temperature factors K_b and k_s	G/120
Figure J.1 — Typical pressure term relationships	J/2
Figure L.1 — Tolerances on nozzles	L/1
Figure L.2 — Tolerances after erection of a vertical vessel	L/2
Figure L.3 — Tolerances on saddles and supports for horizontal vessels	L/3
Figure L.4 — Tolerances on saddles and supports for vertical vessels	L/4
Figure T.1 — Tube to tubeplate connections, tube end fusion	T/4
Figure T.2 — Tube to tubeplate connections, castellated weld	T/5
Figure T.3 — Tube to tubeplate connections, plain fillet weld	T/6
Figure T.4 — Tube to tubeplate connections, front face bore fillet weld	T/7
Figure T.5 — Tube to tubeplate connections, groove plus fillet weld	T/8
Figure T.6 — Tube to tubeplate connections, groove weld	T/9
Figure T.7 — Tube to tubeplate connections, back face inset bore weld	T/10
Figure T.8 — Tube to tubeplate connections, back face stub bore weld	T/11
Figure T.9 — General arrangement of push-out test piece for front face and back face welds	T/12
Figure T.10 — Push-out test piece for tube ends on triangular pitch	T/13
Figure T.11 — Push-out test piece for tube ends on square pitch	T/14
Figure W.1-1 — Stiffener proportions	W/6
Figure W.2-1 — Vessel on saddle supports	W/16
Figure W.2-2 — Internal ring stiffener in plane of saddle	W/24
Figure W.2-3 — External ring stiffeners adjacent to the saddle	W/25
Figure W.2-4 — Vessel on ring and leg support	W/33
Figure W.2-5 — Channel and shell as ring girder	W/35
Figure W.6-1 — Potential failure locations in circumferential lap joint	W/55
Figure W.6-2 — Maximum axisymmetric principal stress contours in lap joint	W/60
Figure W.6-3 — Circumferential stress in lap joint	W/61
Figure W.6-4 — Loading spectrum	W/75

	Page
Figure W.6-5 — Reservoir cycle count	W/77
Figure Al.E.1 — Typical full penetration joint preparations for one-sided welding only: aluminium and its alloys	Al/20
Figure Al.E.2 — Typical full penetration joint preparations for two-sided welding only: aluminium and its alloys	Al/21
Figure Al.E.3 — Typical full penetration joint preparations for one-sided welding with temporary backing or permanent backing: aluminium and its alloys	Al/23
Figure Cu.E.1(1) — Typical full penetration joint preparation for one-sided welding only: copper and its alloys only	Cu/13
Figure Cu.E.1(2) — Typical full penetration joint preparation for two-sided welding: copper and its alloys	Cu/14
Figure Cu.E.1(3) — Typical full penetration joint preparation for one-sided welding with either temporary or permanent backing: copper and its alloys	Cu/15
Figure Cu.E.1(4) — Alternative joint preparations	Cu/16
Figure Cu.E.2(1) — Typical brazed joints for gunmetal bosses to copper vessels	Cu/17
Table 1.4-1 — Purchase specification options	1/5
Table 1.4-2 — Items for manufacturer, purchaser and/or Inspecting Authority agreement	1/6
Table 2.1-1 — Material banding	2/2
Table 2.1-2 — List of materials covered by BS EN material standards	2/3
Table 2.1-3 — Additional materials that may be used for category 3 construction	2/14
Table 2.2-1 — Bolting materials for low-temperature	2/16
Table 2.3-1 — Temperature above which time dependent properties shall be considered	2/18
Table 3.4-1 — Construction categories	3/7
Table 3.5-1 — Values of factor for ellipsoidal ends	3/12
Table 3.5-2 — Values of $e/D \times 10^3$ for unpierced domed ends in terms of h_e/D and p/f	3/14
Table 3.5-3 — Values of coefficient β or cone/cylinder intersection without knuckle	3/19
Table 3.5-4 — Thickness of nozzles	3/26
Table 3.5-5 — Design values of e_{rb}/e_{rs}	3/30
Table 3.5-6 — Values of Ce_{rs}/e_{ps} for Figure 3.5-9, Figure 3.5-10 and Figure 3.5-11 when $e_{rb}/e_{rs} = 0$	3/33
Table 3.5-7 — Allowable taper/taper thread sizes	3/49
Table 3.5-8 — Values of factor C for welded flat ends to Figure 3.5-34b) and Figure 3.5-34c), (for Figure 3.5-36 and Figure 3.5-37)	3/77
Table 3.6-1 — Values for G and N	3/99
Table 3.6-2 — Definitions of cylinder lengths	3/99
Table 3.6-3 — E values for ferritic and austenitic steels (Young's modulus)	3/100
Table 3.6-4 — Values of $(\sigma_e/E) (d/e_w)^2$ for internal flat bar stiffeners	3/100
Table 3.6-5 — Values of $(\sigma_e/E) (d/e_w)^2$ for external flat bar stiffeners	3/101
Table 3.6-6 — Values of L_e/L_s	3/102
Table 3.6-7 — Values of Z'	3/103
Table 3.8-1 — Recommended design stress values for flange bolting materials	3/122
Table 3.8-2 — Bolt root areas	3/123
Table 3.8-3 — Recommended surface finish on gasket contact faces for body flanges and flanges fitted with covers	3/125

	Page
Table 3.8-4 — Gasket materials and contact facings: gasket factors (m) for operating conditions and minimum design seating stress (y)	3/139
Table 3.8-5 — Values of T , Z , Y and U (factors involving K)	3/143
Table 3.9-1 — Values of ΔC as a function of F_s and R for all tubesheets, and C_o for U-tubesheets only	3/186
Table 3.9-2 — Values of F_r for typical tube joints	3/203
Table 4.2-1 — Circumference	4/6
Table 4.2-2 — Tolerance on depth of domed ends	4/6
Table 4.2-3 — Maximum permitted peaking	4/7
Table 4.2-4 — Maximum permitted peaking when special analysis is used	4/7
Table 4.4-1 — Requirements for post-weld heat treatment of ferritic steel vessels	4/15
Table 4.4-2 — Deleted	4/18
Table 5.1-1 — Inspection stages in the course of which participation by the Inspecting Authority is mandatory	5/2
Table 5.1-2 — Other principal stages of inspection	5/3
Table 5.2-1 — Tensile test temperature	5/3
Table 5.2-2 — Weld procedure tests for butt welds in 9 % Ni steel	5/5
Table 5.6-1 — Thickness limits for examination of internal flaws	5/8
Table 5.7-1 — Radiographic acceptance levels	5/13
Table 5.7-2 — Ultrasonic acceptance levels applicable to ferritic steels and weld metals in the thickness range 7 mm to 100 mm inclusive	5/15
Table 5.7-3 — Visual and crack detection acceptance level	5/17
Table 5.7-4 — Radiographic acceptance levels (reassessment of category 2 construction)	5/20
Table 5.7-5 — Ultrasonic acceptance levels (reassessment of category 2 construction)	5/21
Table A.1 — Classification of stresses for some typical cases	A/8
Table C.1 — Details of fatigue design curves	C/8
Table C.2 — Classification of weld details	C/10
Table C.3 — Values of M_1 , M_2 and M_3	C/24
Table C.4 — Weld defect acceptance levels	C/24
Table C.5 — Fatigue test factor F	C/24
Table D.1 — Design reference temperature for heat exchanger tubes	D/5
Table D.2 — Required impact energy	D/8
Table D.3 — Minimum design reference temperature for omission of impact test	D/8
Table D.4 — Reference thickness of weld joint components e	D/13
Table G.2.2-1 — Values of K_1 and K_2	G/12
Table G.2.8-1 — Coefficients to define factors C_2 , C_3 or C_4	G/74
Table G.3.2-1 — Moments in a ring girder	G/88
Table G.3.3-1 — Design factors K_1 and K_2	G/97
Table G.3.3-2 — Design factors K_3 and K_4 and allowable tangential shearing stresses	G/99
Table G.3.3-3 — Design factor K_6	G/100
Table G.3.3-4 — Values of constants C_4 , C_5 , K_5 , K_7 and K_8	G/101
Table G.3.3-5 — Values of K_9	G/105
Table G.3.3-6 — Coefficients for F_A , with $x = A/r$	G/106
Table G.3.3-7 — Coefficients for F_B , with $x = b_1/r$	G/106
Table G.3.3-8 — Coefficients for F_I , with $x = L_g/r$	G/107

	Page
Table G.3.3-9 — Coefficients for F_L , with $x = L/r$	G/107
Table G.3.3-10 — Coefficients for F_θ , with $x = \theta$	G/107
Table G.3.3-11 — Values of K_{10} and K_{11}	G/113
Table G.4.3-1 — Circumferential stress factor C_1	G/123
Table G.4.3-2 — Bending stress factor C_2	G/123
Table G.4.3-3 — Meridional stress factor C_3	G/124
Table G.4.3-4 — Branch bending stress factor C_4	G/124
Table H.1 — Classification of materials	H/2
Table K.1-1 — Design strength values: index of steels	K/1
Table K.1-2 — Design strength values (N/mm ²)	K/2
Table K.1-3 — Design strength values (N/mm ²)	K/6
Table K.1-4 — Design strength values (N/mm ²)	K/10
Table K.1-5 — Design strength values (N/mm ²)	K/12
Table K.1-6 — Design strength values (N/mm ²)	K/15
Table K.1-7 — Design strength values (N/mm ²)	K/21
Table K.1-8 — Design strength values (N/mm ²)	K/24
Table K.1-9 — Design strength values (N/mm ²)	K/27
Table K.1-10 — Design strength values (N/mm ²)	K/29
Table K.1-11 — Design strength values (N/mm ²)	K/31
Table K.1-12 — Design strength values (N/mm ²)	K/33
Table T.1 — Tube to tubesheet joints: essential tests and the suitability of joint types for optional tests	T/15
Table W.1-1 — Design data assumed for cylindrical sections	W/4
Table W.1-2 — Summary of calculation for e	W/4
Table W.1-3 — Derivation of L_e/L_s	W/5
Table W.1-4 — Design data assumed for complete vessel	W/8
Table W.1-5 — Values required for stiffener design	W/10
Table W.1-6 — Design data assumed for cylindrical sections	W/11
Table W.1-7 — Measured radii and departure from mean circle	W/11
Table W.1-8 — Values of α_n , b_n and $p_{m(n)}$	W/12
Table W.1-9 — Values of $\sigma_{br(n)}$	W/13
Table W.2-1 — Design data	W/14
Table W.2-2 — Interpolation of Table G.3.3-3 for K_6	W/22
Table W.2-3 — Summary of stresses	W/38
Table W.6-1 — Results of calculations of allowable stress range	W/59
Table W.6-2 — Summary of results from Example 1	W/62
Table W.6-3 — Summary of results for Example 2	W/69
Table W.6-4 — Cyclic loading regime for case A	W/70
Table W.6-5 — Fatigue load cycle stress ranges	W/72
Table W.6-6 — Summary of damage calculation values for case A	W/73
Table W.6-7 — Cyclic loading regime for case B	W/74
Table W.6-8 — Fatigue load cycle stress ranges	W/77
Table W.6-9 — Summary of damage calculation for case B	W/78
Table W.6-10 — Summary of results	W/79
Table W.C.1 — Thermal stress	W/83
Table Z.1 — PD 5500 compliance with PED ESRs	Z/2
Table Al.2.3-1 — Design strength values: aluminium and aluminium alloys	Al/2
Table Al.3.4-1 — Construction categories	Al/3
Table Al.3.6-3 — E values for aluminium alloys (Young's modulus)	Al/4

	Page
Table Al.3.8-1 — Recommended design stress values for flange bolting materials	Al/4
Table Al.5.7-1 — Acceptance levels	Al/15
Table Al.5.8-1 — Principal stages of inspection	Al/17
Table Cu.2.3-1 — Design strength values of copper and copper alloys	Cu/2
Table Cu.3.4-1 — Construction categories for copper and copper alloy construction	Cu/3
Table Cu.3.5-2 — Thickness of nozzles	Cu/4
Table Cu.3.6-3 — E values for copper and copper alloys (Young's modulus)	Cu/4
Table Cu.4.2-1 — Hot forming temperatures	Cu/5
Table Cu.5.5-1 — Mechanical test requirements for butt weld procedure and welder approval	Cu/8
Table Cu.5.7-1 — Acceptance levels	Cu/10
Table Ni.2.3-1 — Design strength values for nickel and nickel alloy plate conforming to BS 3072	Ni/1
Table Ni.2.3-2 — Design strength values for nickel and nickel alloy seamless tube conforming to BS 3074	Ni/2
Table Ni.2.3-3 — Design strength values for nickel and nickel alloy seamless tube conforming to BS 3074	Ni/2
Table Ni.2.3-4 — Design strength values for nickel and nickel alloy seamless tube conforming to BS 3074	Ni/2
Table Ni.2.3-5 — Design strength values for nickel and nickel alloy forgings conforming to BS 3076	Ni/3
Table Ni.3.4-1 — Construction categories	Ni/4
Table Ni.4.2-1 — Maximum temperature for heating nickel and nickel alloys	Ni/5
Table Ni.4.4-1 — Annealing temperature for nickel and nickel alloys	Ni/6

Foreword

This Published Document has been prepared by Technical Committee PVE/1, Pressure vessels, to supersede PD 5500:2000 on 15 January 2003. It provides a specification for the design, manufacture, inspection and testing of pressure vessels manufactured from carbon, ferritic alloy and austenitic steels, nickel and aluminium.

The start and finish of text introduced or altered by amendment or corrigendum is indicated in the text by tags **[A]** **[A]** or **[C]** **[C]**. Minor editorial changes are not tagged. Tags indicating changes to the text carry the designation number of the amendment or corrigendum. For example, text altered by amendment 1 is indicated by **[A]** **[A]**, text altered by corrigendum 1 is indicated by **[C]** **[C]**.

The form and content of the original issue of PD 5500 was derived, without technical amendment, from the 1997 edition of BS 5500, *Specification for unfired fusion welded pressure vessels*, and all amendments issued thereto, up to and including No. 6 (September 1999). At the time PD 5500 differed from BS 5500 only insofar as it did not retain the latter's status as a national standard. This specification is thus, founded on the experience derived from the application of BS 5500 and the first edition of PD 5500, providing an integrated set of rules which have been shown to provide vessels of suitable integrity for a wide range of duties and risk environments.

BS 5500:1997 was withdrawn because its status as a national standard was incompatible with BSI's obligations to CEN consequent to the development of the European Standard EN 13445, *Unfired pressure vessels*. That European Standard was published in May 2002.

The process of development of EN 13445 by CEN and its reference in the Official Journal of the European Communities creates, for equipment which conforms to that standard, a presumption of conformity with the essential safety requirements of the EU's pressure equipment directive, 97/23/EC (see article 5 of that directive). This Published Document does not provide that presumption of conformity. However, this Published Document can be used, for vessels within the scope of directives, subject to:

- adherence of the directive's conformity assessment requirements;
- the manufacturer satisfying himself that this PD covers all the technical requirements of the Directive relevant to the vessel in question.

This use may be to cover the full range of applicable vessel requirements or to cover an issue not, at the time, appropriately supported in EN 13445.

The normative form of wording is used in this Published Document, even though this does not have the status of a national standard, in order to ensure clarity in the definition of its requirements and recommendations.

Reference is made in the text to a number of standards which have been withdrawn. Such standards are identified in the list of references (see page V). Consideration is currently being given as to whether replacement standards are available or are being developed, for example, in the European programme, and to the implications for PD 5500 of such replacement standards. When a decision is made about any replacements standards, these will be identified by the issue of an amendment.

The British Standards Institution will be pleased to receive constructive proposals based on experience or research that may lead to improvements in this Published Document. PVE/1 intends to keep the content and technical status of this specification under review along with the need to publish appropriate supplements covering other types of pressure vessels. If there is sufficient demand from industry, this Published Document will be extended to cover other non-ferrous materials.

The requirements for materials not listed in Section 2. Materials, are given in supplements to the main text, which are to be read in conjunction with the main text so as to provide comprehensive requirements for pressure vessels produced in the relevant material. Annexes to the main text are provided which can be either normative (i.e. requirements) or informative (i.e. recommendations). These annexes can include additional requirements to the main text or informative guidance or recommendations, or can provide worked examples. Enquiry cases are published primarily to give guidance and clarification of possible ambiguities in the main text and will be incorporated into the main text or into an annex at an appropriate stage. Some Enquiry cases are published to provide new information and are identified as “preliminary rules”.

It should be noted that the effective date of amendments to this Published Document will be later than the publication date to allow users time to amend their own working procedures and documentation. See the introduction to the summary of pages table.

The following figures are reproduced by courtesy of the American Welding Research Council.

Figure G.2.5-1 was originally published as Figure 2 on page 21 of WRC Bulletin 90 September 1963.

Figure G.2.5-2 was originally published as Figure 3 on page 21 of WRC Bulletin 90 September 1963.

Figure G.2.5-3 was originally published as Figure 7 on page 24 of WRC Bulletin 90 September 1963.

Figure G.2.5-4 was originally published as Figure 8 on page 24 of WRC Bulletin 90 September 1963.

Figure G.2.5-5 was originally published as Figure 9 on page 25 of WRC Bulletin 90 September 1963.

Figure G.2.5-6 was originally published as Figure 10 on page 25 of WRC Bulletin 90 September 1963.

Figure G.2.5-7 was originally published as Figure 11 on page 26 of WRC Bulletin 90 September 1963.

Figure G.2.5-8 was originally published as Figure 12 on page 26 of WRC Bulletin 90 September 1963.

Figure G.2.6-1 to Figure G.2.6-8 are reproduced by courtesy of the *International Journal of Solids and Structures*, 1967.

This document may be referred to by the UK Health and Safety Executive (HSE) when giving guidance.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a Published Document does not of itself confer immunity from legal obligations.

Summary of pages

This specification is kept up to date by the issue, from time to time, of replacement pages.

Tags (**A₁**, **A₂**, **C₁**, **C₂**) on replacement pages will indicate that changes of technical or reference significance have been made at that point. The tags applied for any particular amendment or corrigendum carry the same designation number, commencing with 1 for the first amendment, then 2 for the second amendment, and 1 for the first corrigendum, then 2 for the second corrigendum, and so on. Minor editorial changes are not tagged.

The following table identifies for each page of the specification whether or not an amendment or corrigendum has been made to that page and the designation number of the amendment or corrigendum made. Each amended page becomes part of the authorized version at the effective date given for each amendment or corrigendum on the inside front cover.

NOTE Following the introduction of the tagging process the copyright date printed on each page is no longer used to identify the authorized version of that page.

Page No.	Status/Amendment designation	Page No.	Status/Amendment designation
Front cover	Amendment 3	3/47 to 3/54	Amendment 2
Inside front cover	Amendment 3	3/55 to 3/56	Amendment 1
i to xvi	Amendment 2	3/57 to 3/58	Corrigendum 1
xvii to xviii	Corrigendum 1	3/59 to 3/62	Amendment 1
xix to xxi	Amendment 3	3/63 to 3/64	Amendment 2
xxii	blank	3/65 to 3/68	Amendment 3
Section 1		3/69 to 3/70	Amendment 2
1/1 to 1/2	Amendment 3	3/71 to 3/72	Amendment 3
1/3 to 1/4	No amendment	3/73 to 3/86	Amendment 2
1/5 to 1/6	Amendment 2	3/87 to 3/90	Amendment 3
1/7 to 1/8	Amendment 3	3/91 to 3/94	Amendment 2
1/9 to 1/13	No amendment	3/95 to 3/96	Amendment 3
1/14	blank	3/97 to 3/108	Amendment 2
Section 2		3/109 to 3/112	Amendment 1
2/1 to 2/4	Amendment 2	3/113 to 3/114	Amendment 2
2/5 to 2/12	Amendment 3	3/115 to 3/116	Amendment 1
2/13 to 2/20	Amendment 2	3/117 to 3/126	Amendment 2
Section 3		3/127 to 3/178	Amendment 1
3/1 to 3/2	Amendment 2	3/179 to 3/180	Amendment 2
3/3 to 3/4	No amendment	3/181 to 3/184	Amendment 1
3/5 to 3/6	Amendment 2	3/185 to 3/186	Amendment 3
3/7 to 3/8	No amendment	3/187 to 3/190	Amendment 1
3/9 to 3/10	Corrigendum 1	3/191 to 3/194	Amendment 3
3/11 to 3/12	No amendment	3/195 to 3/200	Amendment 1
3/13 to 3/22	Amendment 2	3/201 to 3/206	Amendment 2
3/23 to 3/24	No amendment	3/207 to 3/212	Amendment 1
3/25 to 3/26	Amendment 1	3/213 to 3/215	Amendment 3
3/27 to 3/28	Amendment 2	3/216	blank
3/29 to 3/32	No amendment	Section 4	
3/33 to 3/34	Amendment 1	4/1 to 4/2	No amendment
3/35 to 3/40	No amendment	4/3 to 4/4	Amendment 3
3/41 to 3/42	Amendment 2	4/5 to 4/6	Amendment 2
3/43 to 3/44	No amendment	4/7 to 4/8	Amendment 1
3/45 to 3/46	Amendment 1	4/9 to 4/10	Amendment 2

Page No.	Status/Amendment designation	Page No.	Status/Amendment designation
4/11 to 4/12	No amendment	<i>Annex E</i>	
4/13 to 4/14	Amendment 2	E/1 to E/2	Amendment 1
4/15 to 4/16	Amendment 3	E/3 to E/6	No amendment
4/17	Amendment 2	E/7 to E/57	Amendment 1
4/18	<i>blank</i>	E/58	<i>blank</i>
<i>Section 5</i>		<i>Annex F</i>	<i>Deleted</i>
5/1 to 5/2	No amendment	<i>Annex G</i>	
5/3 to 5/4	Amendment 2	G/1 to G/2	Amendment 1
5/5 to 5/6	No amendment	G/3 to G/4	Amendment 2
5/7 to 5/8	Amendment 3	G/5 to G/10	No amendment
5/9 to 5/10	Amendment 2	G/11 to G/12	Amendment 1
5/11 to 5/12	Amendment 3	G/13 to G/26	No amendment
5/13 to 5/16	Amendment 1	G/27 to G/30	Amendment 1
5/17 to 5/20	No amendment	G/31 to G/32	No amendment
5/21 to 5/22	Amendment 1	G/33 to G/38	Amendment 1
5/23 to 5/24	Amendment 3	G/39 to G/52	No amendment
5/25 to 5/28	Amendment 1	G/53 to G/58	Amendment 3
5/29	No amendment	G/59 to G/64	No amendment
5/30	<i>blank</i>	G/64 to G/66	Corrigendum 1
<i>Annex A</i>		G/67 to G/68	Amendment 3
A/1 to A/4	No amendment	G/69 to G/72	Amendment 1
A/5 to A/6	Amendment 3	G/73 to G/74	Amendment 3
A/7 to A/8	Amendment 1	G/75 to G/78	Amendment 1
A/9 to A/10	Amendment 3	G/79 to G/80	Amendment 2
A/11 to A/13	No amendment	G/81 to G/88	Amendment 1
A/14	<i>blank</i>	G/89 to G/90	Amendment 2
<i>Annex B</i>		G/91 to G/96	Amendment 1
B/1 to B/2	Amendment 3	G/97 to G/98	Amendment 3
B/3 to B/4	Amendment 1	G/99 to G/104	Amendment 1
B/5 to B/9	No amendment	G/105 to G/106	Amendment 2
B/10	<i>blank</i>	G/107 to G/110	Amendment 1
<i>Annex C</i>		G/111 to G/112	Corrigendum 1
C/1 to C/2	Amendment 1	G/113 to G/114	Amendment 1
C/3 to C/8	Amendment 2	G/115 to G/118	Amendment 2
C/9 to C/10	Amendment 1	G/119 to G/120	Amendment 1
C/11 to C/18	No amendment	G/121 to G/122	Corrigendum 1
C/19 to C/20	Amendment 1	G/123 to G/124	Amendment 1
C/21 to C/30	Amendment 2	G/125 to G/126	Amendment 2
<i>Annex D</i>		<i>Annex H</i>	
D/1 to D/8	No amendment	H/1 to H/2	No amendment
D/9 to D/10	Amendment 3	<i>Annex J</i>	
D/11 to D/12	Amendment 1	J/1 to J/3	No amendment
D/13 to D/16	No amendment	J/4	<i>blank</i>
D/17 to D/18	Amendment 1	<i>Annex K</i>	
D/19 to D/21	No amendment	K/1 to K/4	Amendment 1
D/22	<i>blank</i>	K/5 to K/8	No amendment
		K/9 to K/10	Amendment 1

Page No.	Status/Amendment designation	Page No.	Status/Amendment designation
K/11 to K/30	No amendment	W/51 to W/54	Amendment 1
K/31 to K/32	Amendment 2	W/55 to W/56	Amendment 3
K/33 to K/34	No amendment	W/57 to W/58	Amendment 1
K/35 to K/37	Amendment 2	W/59 to W/60	No amendment
K/38	<i>blank</i>	W/61 to W/62	Amendment 1
<i>Annex L</i>		W/63 to W/64	No amendment
L/1 to L/2	Amendment 3	W/65 to W/66	Amendment 1
L/3 to L/4	No amendment	W/67 to W/70	Amendment 3
<i>Annex M</i>		W/71 to W/72	Amendment 2
M/1 to M/2	Amendment 2	W/73 to W/76	Amendment 1
<i>Annex N</i>		W/77 to W/80	No amendment
N/1 to N/3	No amendment	W/81 to W/82	Amendment 2
N/4	<i>blank</i>	W/83 to W/85	Amendment 1
<i>Annex P</i>	<i>Deleted</i>	W/86	<i>blank</i>
<i>Annex Q</i>		<i>Annex Y</i>	<i>Deleted</i>
Q/1 to Q/2	Amendment 1	<i>Annex Z</i>	
<i>Annex R</i>		Z/1 to Z/2	No amendment
R/1	Amendment 2	Z/3 to Z/4	Amendment 1
R/2	<i>blank</i>	Z/5 to Z/8	Amendment 2
<i>Annex S</i>		<i>Aluminium supplement</i>	
S/1	Amendment 1	Al/1 to Al/6	Amendment 2
S/2	<i>blank</i>	Al/7 to Al/8	Amendment 1
<i>Annex T</i>		Al/9 to Al/10	Amendment 2
T/1 to T/2	Amendment 2	Al/11 to Al/12	Amendment 1
T/3 to T/4	Amendment 3	Al/13 to Al/14	Amendment 2
T/5 to T/10	No amendment	Al/15 to Al/16	Amendment 3
T/11 to T/15	Amendment 2	Al/17 to Al/23	Amendment 1
T/16	<i>blank</i>	Al/24	<i>blank</i>
<i>Annex U</i>		<i>Copper supplement</i>	
U/1 to U/2	Amendment 2	Cu/1 to Cu/2	Amendment 2
<i>Annex V</i>		Cu/3 to Cu/4	Amendment 3
V/1 to V/3	No amendment	Cu/5 to Cu/6	Amendment 1
V/4	<i>blank</i>	Cu/7 to Cu/10	Amendment 3
<i>Annex W</i>		Cu/11 to Cu/12	Amendment 2
W/1 to W/2	Amendment 1	Cu/13 to Cu/16	Amendment 1
W/3 to W/12	Amendment 2	Cu/17 to Cu/18	Amendment 2
W/13 to W/14	Amendment 1	<i>Nickel supplement</i>	
W/15 to W/16	Corrigendum 1	Ni/1 to Ni/2	Amendment 1
W/17 to W/24	Amendment 1	Ni/3 to Ni/6	Amendment 3
W/25 to W/26	Amendment 2	Ni/7 to Ni/16	Amendment 1
W/27 to W/34	Amendment 1	<i>Index</i>	
W/35 to W/36	Corrigendum 1	I to III	Amendment 2
W/37 to W/40	Amendment 1	IV	<i>blank</i>
W/41 to W/42	No amendment	<i>List of references</i>	
W/43 to W/46	Amendment 1	V to back cover	Amendment 3
W/47 to W/48	Corrigendum 1		
W/49 to W/50	No amendment		

Section 1. General

1.1 Scope

1.1.1 This Published Document specifies requirements for the design, construction, inspection, testing and verification of compliance of ^(A3) new ^(A3) unfired fusion welded pressure vessels. The materials of construction are specified in Section 2. The term “pressure vessel” as used in this specification includes branches up to the point of connection to the connecting piping by bolting, screwing or welding, and supports, brackets or other attachments directly welded to the pressure containing shell. The term “unfired” excludes vessels that are subject to direct generated heat or flame impingement from a fired process. It does not exclude vessels subject to electrical heating or heated process streams.

^(E3) **NOTE** Whilst this specification is limited to the construction of new vessels, with the agreement of the relevant parties it can be used to guide the maintenance or any modification of existing vessels. Where these existing vessels were designed and constructed using an earlier edition of PD 5500, with the agreement of the relevant parties, that earlier edition can be used to guide the maintenance or any modification. ^(A3)

1.1.2 In addition to the definitive requirements this specification also requires the items detailed in 1.5 to be documented. For compliance with this specification, both the definitive requirements and the documented items have to be satisfied.

1.1.3 This specification applies only to pressure vessels manufactured under the survey of a competent engineering Inspecting Authority or Organization. The competent engineering Inspection Authority or Organization shall either be:

- a) a notified body appointed by a member state of the European Union for the Pressure Equipment Directive 97/23/EC for the range of activities covered by this specification; or

NOTE Within the UK the United Kingdom Accreditation Service (UKAS) acts on behalf of the regulating authority in accrediting inspection bodies.

- b) accredited to BS EN 45004, to Type A independence criteria, for inspection in the subject matter of this specification; or
- c) accredited by an organization authorized by the local Regulatory Authority in countries outside the EU and in circumstances where the Pressure Equipment Directive 97/23/EC does not apply.

The intent of this requirement is regarded as satisfied where inspection is carried out by competent personnel of a separate engineering inspection department maintained by the purchaser of the vessel (in which case Type B independence criteria shall be met). An inspection department maintained by the manufacturer does not satisfy this requirement except:

- a) that specific responsibilities may be delegated at the discretion of the Inspecting Authority or Organization; or
- b) in the case of vessels for the manufacturer’s own use and not for resale.

This specification applies only to vessels made by manufacturer’s who can satisfy the Inspecting Authority or Organization that they are competent and suitably equipped to fulfil the appropriate requirements of this specification.

The requirements for testing and inspecting serially manufactured pressure vessels are given in Annex V. In all other respects the appropriate requirements in the specification apply.

Glass lined steel vessels require special design considerations subject to the limits imposed by the method of construction which should have the agreement of the Inspecting Authority.

1.1.4 This specification does not cover the following.

- a) Storage tanks designed for the storage of liquids at near atmospheric pressures, i.e. where the pressure additional to that due to the hydrostatic head does not exceed 140 mbar¹⁾ above or 6 mbar below atmospheric pressure. ~~A2~~ Text deleted ~~A2~~
- b) Low pressure, above ground storage tanks which have a single vertical axis of revolution designed for the storage of liquids at a pressure not exceeding 1 bar¹⁾.
- c) Vessels in which the stresses calculated in accordance with the Equations given in Section 3 are less than 10 % of the design stress permitted by Section 3.
- d) Multilayered, autofrettaged, prestressed vessels or other special designs of vessels which may be appropriate for very high pressures.
- e) Transport vessels, i.e. vessels used for transport of contents under pressure.
- f) Vessels for specific applications which are covered by standards listed in the *BSI Catalogue*.

NOTE 1 PD 5500 may be used for the design and manufacture of liquid and bulk powder road tankers, provided consideration is given to the following:

~~A3~~ — chapter 6.8.2 of ADR (European Agreement concerning International Carriage of Dangerous Goods by Road); in particular relating to static and dynamic stresses in motion, protection of the shell and supports and fittings, minimum thickness and the provision of anti-surge plates;

— chapter 9.7.5.1 of ADR relating to stability. ~~A3~~

BS 3441 gives guidance on the design and construction of tanks for the transport of milk and liquid milk products.

Road tankers used to transport non-hazardous substances in the UK and which operate at a pressure above 0.5 bar g are subject to the Pressure Systems Safety Regulations, 2000 (SI 128).

~~A5~~ NOTE 2 See Note 1 of 3.2.2 regarding the applicability of PD 5500 Section 3 to thick walled vessels.

NOTE 3 The titles of the publications referred to in this specification are listed at the end of the document. ~~A3~~

1.1.5 This specification does not address the nature or consequences of a fire in the vicinity of a pressure vessel. Any consideration of the effect of a fire hazard in the design of a pressure vessel would have to be under the direction of the plant owner or his responsible agent such as the plant architect/engineer, with analysis of the consequences of a fire adjacent to a pressure vessel being undertaken in accordance with a comprehensive specification of the fire conditions, impingement parameters, analytical methods and assessment criteria.

1.1.6 This specification addresses materials in various ways.

- a) The main text gives requirements for steels.
- b) Certain other materials are covered by supplements which identify either where the main text is applicable or where specific requirements of the supplement apply.

1.1.7 When another standard or specification calls for the provisions of PD 5500 to be applied, the responsibility for defining the manner in which the provisions are applied and their appropriateness for the intended duty, is defined in that other document.

1.1.8 Guidance on the application of PD 5500 to pressure vessels that fall within the scope of the European Pressure Equipment Directive is given in Annex Z.

¹⁾ 1 mbar = 10² N/m² = 100 Pa.

1 bar = 10⁵ N/m² = 0.1 N/mm² = 100 kPa.

1.2 Interpretation

If any ambiguity be found or doubt arise as to the meaning or effect of any part of this specification or as to whether anything ought to be done or omitted to be done in order that this specification should be complied with in full, the question shall be referred to the Pressure Vessels Technical Committee (PVE/1) of the British Standards Institution, whose interpretation of the requirements of this specification upon the matter at issue shall be given free of charge and shall be final and conclusive. Parties adopting this specification for the purposes of any contract shall be deemed to adopt this provision unless they expressly exclude it or else import an arbitration provision in terms extending to interpretation of this specification. However, this provision is limited to questions of interpretation and does not confer upon the committee any power, duty or authority to adjudicate upon the contractual rights or duties of any person under a contract except in so far as they may necessarily be affected by the interpretation arrived at by the committee.

Findings or rulings of the committee upon all enquiries, including matters of interpretation, which are of sufficient importance that both enquiries and replies be made public as soon as possible will be published in an enquiry reply form for inclusion in the PD 5500 ring binder as Enquiry Cases. Their availability will be notified in *BSI News*.

After taking into account any public comment thereon, Enquiry Cases may be incorporated, as appropriate, into this specification as amendments which will form part of the next convenient annual updating.

1.3 Definitions

For the purposes of this specification the following definitions apply.

1.3.1

purchaser

the organization or individual who buys the finished pressure vessel for its own use or as an agent for the owner

1.3.2

manufacturer

the organization that designs, constructs and tests the pressure vessel in accordance with the purchaser's order. The design function may be carried out by the purchaser or his agent, independently from the organization that constructs and tests the vessel (see 1.4.2)

1.3.3

Inspecting Authority

the body or organization that verifies that the vessel has been designed, constructed and tested in accordance with this specification

1.3.4

Regulating Authority

the authority in the country of installation that is legally charged with the enforcement of the requirements of the law and regulations of that country relating to pressure vessels

1.4 Responsibilities

NOTE Reference should be made to Annex Z when this specification is being used to satisfy the EU's pressure equipment directive, 97/23/EC, or any national implementation thereof.

1.4.1 Responsibilities of the purchaser

The purchaser shall be responsible for furnishing the manufacturer and the Inspecting Authority with the information required by 1.5.1.

The purchaser shall detail in a purchase specification any requirements additional to those of this specification. Table 1.4-1 summarizes where this specification identifies additional purchase specification options.

Where the Inspecting Authority is nominated by the purchaser, the purchaser shall be responsible for ensuring that any information which the manufacturer is required to supply, as specified in this specification, is made available to the Inspecting Authority.

Where necessary, it shall be the responsibility of the purchaser to ensure that the Inspecting Authority is acceptable to the Regulating Authority.

Where the purchaser elects to perform the design function for the vessel, the purchaser shall be responsible for maintaining a complete design dossier for the vessel (see 1.5.1) and for ensuring that all the information contained in it, or agreed modifications to it, comply with this specification; the purchaser shall also be responsible for the accuracy of all design calculations for the vessel.

1.4.2 Responsibilities of the manufacturer

The manufacturer shall be responsible for the completeness and accuracy of all design calculations and for compliance with all applicable requirements of this specification for the whole vessel. The manufacturer shall, as required at various points in this specification, obtain the agreement of the purchaser and/or Inspecting Authority for aspects of vessel design, material choice, manufacture and testing (summarized in Table 1.4-2). These agreements shall be documented for inclusion in the vessel records [see 1.5.2.2e)].

If during fabrication unexpected deviations from the requirements of this specification arise, that the manufacturer can justify will not impair the intended functionality or integrity of the vessel, the manufacturer may submit a justification to the purchaser and Inspecting Authority for their approval. Such approved deviations shall be documented for inclusion in the vessel records [see 1.5.2.2e)] and require the application of suffix XX to Form X (see 1.4.4 and Note 1 to Form X).

Where the Inspecting Authority is not nominated by the purchaser, the manufacturer shall appoint an Inspecting Authority. The manufacturer shall be responsible for ensuring that the Inspecting Authority is provided with any information the manufacturer is required to supply, as specified in this specification.

The organization which discharges the manufacturer's responsibilities for construction and testing shall assume overall responsibility for compliance with this specification during all related activities including part manufacture and subsequent fabrication to completion at works and/or site. It shall satisfy the Inspecting Authority, as necessary, under the general provisions of 1.1 that it is competent to ensure by appropriate control or surveillance of such activities, whether carried out by itself or by subcontractors, that all the relevant requirements of this specification are met.

Examinations carried out by the Inspecting Authority do not absolve the manufacturer from his responsibility for compliance with the applicable requirements of this specification.

Where the purchaser elects to perform the design function for the vessel, the manufacturer shall be responsible for ensuring that all the design information he requires to construct and test the vessel is provided by the purchaser and for ensuring that all construction and testing is carried out in compliance with this specification. The manufacturer shall also be responsible for the accuracy of any information he provides to enable the purchaser to fulfil the design function.

Table 1.4-1 — Purchase specification options

Clause	Item
1.4.1	Table 1.4-1, identification of purchase specification options
1.4.3b)	Responsibility of IIA regarding purchase specification
1.5.1b)	Information supplied by purchaser regarding purchase specification
2.1.1.2	Any special material limits
2.1.2.1	Use of castings for pressure parts
2.2.4	Requirements for material bands M5 and M7 to M10
3.1.5, Note	Zero negative thickness tolerance
3.2.2	Service life and design margin for fatigue vessels
3.2.4	Design lifetime for time dependant stresses
3.3.1	Identification of the risk of stress corrosion cracking
3.3.2	Required corrosion allowance
3.3.3	Surface finish for coated vessels
3.4.1	Choice of construction category
3.4.2.1	Reduced design stress for operational reasons
3.4.2.1a)	Any special material tests
3.8.1, Note 5	Special requirements for leak tight flanges
A1 3.9.4.1 A1	Tubesheet design for as-new condition
3.9.4.3.4	Tubesheet design for simultaneous shellside and tubeside pressures
3.13.2, Note 2	Additional relief capacity for the event of fire
4.2.1.2	Supplementary NDT in addition to visual inspection
4.2.6	Supplementary structural tolerances
4.3.1c)	Production control test plates
4.4.3.1d)	PWHT
4.5.2	Special finish
Table 5.1-1	Material examination etc.
5.4.1	Requirements for production control test plates for non 9 % Ni
5.6.2	NDT or parent plates
5.6.6.6	Specific method of marking
5.8.2.6	Use of differential pressure in testing of multi-compartment vessels
5.8.8.1	Gas leak test before hydraulic or pneumatic tests
C.1.2.3	Design conditions for cyclic operation in creep range
D.7.2.2	Heat treatment of production test plates with the vessel
D.7.2.2a)	Use of previous results of production test plates
D.7.2.2b)	Requirements for production weld test plates
D.7.2.2	Additional tests on test plates
N.1.1	Use of Annex N for non-UK applications
N.1.3	Definition of information for purchase specification
N.2.2	Extent information to be provided by manufacturer
N.2.3	Requirement for manufacturer to recommend periodic examination
Annex S	Optional documentation
T.5.1	Optional tube-end joint tests
V.7	Records for serially produced vessels
Al.5.4.1	Need for production control test plates
Al.5.5.3	Transverse tensile tests for welder approval
Al.5.6.6.6	Specific marking for NDT
Cu.3.4.1	Choice of construction category
Cu.5.4.1	Production control test pieces for C106 alloy

Table 1.4-2 — Items for manufacturer, purchaser and/or Inspecting Authority agreement

Clause	Item
2.1.2.1c)	Use of non BS, BS EN or European approved materials
2.3.1.1a)	Procedure for determination of design strength
2.1.2.2.1	Choice of equivalent M band
2.2.1	Consideration of materials for low temperature testing
2.2.4	Requirements for material in bands M5 and M7 to M10
2.1.2.2.2.1	Use of steels with C content > 0.25 %
2.1.2.2.2.7, Note 2	Use of rolling process to achieve normalized properties
Table 2.1-3, Note 5	Additional procedure for correction of minor defects in category 3 components
3.2.2b)	Alternative design methods
3.2.2b)4)	Alternative design by comparison with similar vessels
3.2.3	Design vacuum with break valve
3.3.3	Cladding thickness included in calculation in thickness
3.4.2.1b)2)	Alloy design stresses with PWHT not to Table 4.4-1
3.8.1.4	Bolt design stresses higher than Table 3.8-1
3.8.1.5	Use of plate material for hubbed flanges
3.9.2.1, Note	Ligament efficiency of non-standard tube end fixing
4.1.1	Commencement of manufacture before drawing approval
4.1.1	Modification of approved drawings
4.1.6	Additional NDT after rectification of departure from tolerance
4.2.1.1	Dressing of cut edges of ferritic steels
4.2.1.2	Major defect notification and rectification
4.2.2.2	NDT method on butt welded plates prior to forming
4.2.2.4.1	Ferritic steel: forming procedure involving plate heating; possible supporting data
4.2.2.4.2	Austenitic steel: forming procedure involving plate heating
4.2.2.5	Sectional flanging for dished ends
4.2.3.1a)	Assembly tolerance of longitudinal joints $e > 200$ mm
4.2.3.1b)	Assembly tolerance of circumferential joints $e > 200$ mm
4.2.4.2.3	Circularity tolerance at nozzle
4.3.2.2	Weld metal properties for 9 % Ni
4.3.2.4	Austenitic stainless steel consumables for 9 % Ni below -101 °C
4.3.6.2	Permanent backing strips for inaccessible second side
4.3.6.2	Backing strips for tubes
4.4.3.1a)	PWHT ferritic steel thicker than Table 4.4-1
4.4.3.1	Welding of lightly loaded parts after heat treatment
4.4.3.5	PWHT for austenitic stainless steel
4.4.4.4b)	Requirements for local heat treatment of branches
	[A₂] Text deleted [A₂]
4.4.5.1	PWHT for non-M0 or M1 materials
Table 4.4-1	Thickness limits for PWHT of 3½ Ni
Table 4.4-1, Note 3	PWHT of 9 % Ni
5.2.5	Criteria for all weld test
5.3.3	Retake whole or part of welder approval test
5.4.1	Number and details of production control test plates for non-9 % Ni
5.4.2	Number and details of production control test plates for 9 % Ni
5.6.2	Acceptance standards for flaws in parent plates and NDT of repairs

Table 1.4-2 — Items for manufacturer, purchaser and/or Inspecting Authority agreement (continued)

Clause	Item
5.6.4.1.2	Method of examination for surface flaws in type A welds
5.6.4.3	Additional testing for visual examination of category 3 components
5.6.5.1	Choice of NDT method
5.6.5.2	Alternative NDT methods to assess depth surface defects
5.6.6.1	Alternative radiographic techniques
5.7.2.2	Deviation from acceptance criteria of Table 5.7-1, Table 5.7-2 and Table 5.7-3
5.7.2	Assessment of defects to Annex U
5.7.3	Repair of welds
5.8.2.2	Pressure test procedure
5.8.2.4	Elevation of test temperature to avoid brittle fracture
5.8.2.5	Pressure test procedure for large vessels
5.8.4.1	Consultation for pneumatic testing
5.8.5.5	Testing vacuum vessels with anti-vacuum valves
5.8.6.1	Proof test procedure
5.8.6.2	Strain indicating coating for proof test
5.9.1	Quality specification for castings
5.9.2	Examination and heat treatment of weld repair of cast components
C.3.4.3.1	Raising the weld class for cyclic loading
C.3.4.6.4	Stress factor for machined weld toes
D.1	Alternative to Annex D requirements
D.7.1, Note	Alternative toughness requirements using Annex U
D.7.2.2	Waiving of impact testing of production weld test plates
D.7.2.3, Note	Position of impact test specimen
H.3.2	PWHT of different material grades with differences in temperature >10 °C
H.5.3	Time at PWHT
Annex J	Fitting of additional pressure relief valve(s)
K.1.4.1.2	Extrapolation of upper temperature stress values
K.1.4.2, Note 1d)	Design strengths at higher temperatures
K.1.4.2, Note 17	Design strengths for slit rimming tubes
Q.1.3	Selection of test specimen
Q.2.3.2	Maximum strength of all-weld tensiles
Q.2.6	Micro-examination of production control test plates
T.4.3a)	Alternative leak test method for tube-end joints
T.5.3	Tracer gas test of tube-end joints
T.5.4	Radiography for back-face tube to tubesheet welds
T.5.5	Testing production control test pieces
T.5.5	Frequency of production control test pieces for tube-end joints
U.1	Fracture mechanics approach
V.4.4	Reduction in extent of weld examination for serially produced vessels
Al, Table Al.2.3-1, Note 1	Tube produced by the porthole/bridge method
Al.4.2.2.1	Use of local heating and hammering for forming
Al.4.2.2.4.2	Softening for cold worked aluminium
Al.4.3.6.2	Use of backing rings in circumferential butt joints in tubing
Al.4.3.7.7	Alternative to two layers of weld metal at branches etc.

Table 1.4-2 — Items for manufacturer, purchaser and/or Inspecting Authority agreement (continued)

Clause	Item
Al.4.4.3.1	Details of any post weld heat treatment
Al.5.4.1	Number and detail of production control test plates
Al.5.4.4	Selection of test specimen
Al.5.5.5	Optional micro examination of production, welder and production control tests
Al.5.6.2	Acceptance standards and techniques for defects in parent materials
Al.5.6.4.1.2	Need for surface flaw examination of full penetration butt welds
Al.5.6.5.2	Alternative method for surface flaw detection
Al.5.7.3.2	Alternative acceptance levels for assessment defects
Al.5.7.4	Repair of welds
Ni.4.4.1	Heat treatment procedure for PWHT
Cu.4.2.2.3	Heat treatment after cold forming
Cu.Cu.4.3.2	Non-matching filler rod metals
Cu.4.3.6	Temporary/consumable backing strips for circumferential tube welds
Cu.4.4.1	Preheat requirements for each type of weld
Cu.Cu.5.4.1	Details of production control testing of C106 sheet
Cu.5.4.2	Details of production control testing of non-C106 alloys
Cu.5.5.4	Macro- and micro-examination of test specimen
Cu.5.6.2	Acceptance standards for defects in parent material
Cu.5.6.6.1	Alternative to radiographic techniques
A3 Enquiry cases	Application of any specific enquiry cases A3

1.4.3 Responsibilities of the Inspecting Authority

The Inspecting Authority shall be responsible for verifying:

- that all parts of the vessel have been designed in accordance with the requirements of this specification as are applicable for the conditions specified by the purchaser according to 1.5.1;
- that the vessel has been constructed and tested in accordance with this specification and any additional requirements in respect of purchaser options covered in the purchase specification (see 1.4.1).

1.4.4 Certificate of Conformance

On completion of the vessel the manufacturer shall issue Form X to certify that the vessel has been designed, constructed and tested in every respect in accordance with this specification and with any additional requirements in respect of purchaser's options covered by this specification. Form X shall be countersigned by the Inspecting Authority as required.

Where some of the activities covered by this specification are performed under the surveillance of a second Inspecting Authority, each Inspecting Authority shall attach a statement to Form X, countersigned as required thereon, confirming which part of the total works has been carried out under its surveillance.

The countersigned Certificate and its attachments (if any) shall be furnished to the purchaser with a copy of the Regulating Authority if required.

Where the purchaser or his appointed design consultant/contractor elects to perform the design function for the vessel, the purchaser or his appointed design consultant/contractor shall complete the section of Form X which certifies that the design of the vessel complies with this specification.

If a vessel is subject to deviations from the requirements of this specification the vessel serial number on Form X shall have the suffix XX added (see 1.4.2).

NOTE Form X may be reproduced as hard copy or by electronic means provided that such reproductions are fair copies of the original. All copies should state "Reproduced from PD 5500" with a reference to the current issue.

Form X Certificate of Conformance*Vessel description*

Type

Approx. overall dimensions

Approved drawing number(s)

.....

.....

.....

.....

Manufacture

Year of manufacture Relevant PD 5500 edition including Amd. No(s).

Purchaser Purchaser's serial no.

Name of manufacturer

Manufacturer's serial number (see Note 1)

Name of Design Organization (if not above manufacturer)

Name of Inspecting Authority

*Design***Design conditions of principal components**

(see Note 2 and Note 3)

Design pressure

bar

Design temp.

°C

Construction category**Corrosion allowance**
mm

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Other factors affecting design (e.g. weight, nature of contents, environment)
(see Note 3 and Note 4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

*Post-weld heat treatment***Component****Temperature**
°C**Holding time**
h

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

*Pressure test***Location****Test pressure****Test medium and temperature****Date**

(see Note 5)

bar

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Form X (continued)**Certificate of Conformance (design)**

We hereby certify that the design of this vessel conforms to PD 5500.

Date:

For manufacturer (see Note 6):

Position:

Name of company:

We hereby confirm that we have checked the design of the above vessel and that this conforms to PD 5500.

Date:

For Inspecting Authority:

Position:

Name of company:

Certificate of Conformance (construction and testing)

We hereby certify that this vessel has been constructed and tested in conformance with PD 5500.

Date:

For manufacturer:

Position:

Name of company:

We hereby confirm that the construction and testing of the above vessel has been carried out under our surveillance and that to the best of our knowledge and belief all aspects of this work conforms to PD 5500.

Date:

For Inspecting Authority:

Position:

Name of company:

To this certificate shall be attached, where appropriate, the records of any items that caused an XX designation along with the records of the decisions arrived at on any items from Table 1.4-2 that were subject to agreement.

NOTE 1 The suffix "XX" is to be added to the serial number of each vessel for which any deviations or concessions have been authorized (see 1.4.2 and 1.4.4).

NOTE 2 The design conditions associated with the operational duties specified by the purchaser should be given.

If a purchaser wishes to change the operational duty of a vessel, revised design conditions, consistent with the vessel scantlings, will be established separately, as appropriate.

NOTE 3 Where the design covers operation below 0 °C the various combinations of temperature, pressure and calculated membrane stresses considered in determining the minimum design temperature (see 3.2.5 and Annex D) should be stated.

NOTE 4 Where appropriate, cross reference to drawings or specifications will suffice.

NOTE 5 Where a vessel is tested in a different orientation to that in which it will normally operate, this should be stated.

NOTE 6 This part of the Certificate is to be signed by the purchaser in cases where the purchaser elects to perform the design function (see 1.4.4).

1.5 Information and requirements to be agreed and to be documented

1.5.1 Information to be supplied by the purchaser

The following information shall be supplied by the purchaser and shall be fully documented.

- a) The normal working conditions of the required vessel, together with details of any transient cyclic and/or adverse conditions in which the vessel is required to operate and any special requirements for in-service inspection.
- b) Any requirements relating to the various options covered by the purchase specification (see 1.4.1).
- c) Any special statutory or other regulations with which the finished vessel is required to comply.
- d) The name of the Inspecting Authority to be commissioned by the purchaser.
- e) The name of the Regulating Authority (if any).
- f) The requirement to obtain copies for record purposes of any documents other than those listed in 1.5.2.2a) to 1.5.2.2g). (To facilitate the identification of such documents, a check list of optional documents is given in Annex S.)

Where the purchaser elects to perform the design function for the vessel, the purchaser shall supply any additional design information required by the manufacturer in accordance with 1.4.2. The design dossier maintained by the purchaser in accordance with 1.4.1 shall cover all the information (whether supplied by the purchaser or by the manufacturer) which the manufacturer would otherwise be required by 4.1.1 to submit before commencing manufacture.

The fulfilment of specified requirements and the availability of documentation/records identified shall both be satisfied before a claim of conformance with the specification can be made and verified.

1.5.2 Information to be supplied by the manufacturer

The information in 1.5.2.1 and 1.5.2.2 shall be supplied by the manufacturer and shall be fully documented.

The fulfilment of specified requirements and the availability of documentation/records identified shall both be satisfied before a claim of conformance with the specification can be made and verified.

1.5.2.1 *Before commencement of manufacture*

The manufacturer shall submit the information specified in 4.1.1 for approval before commencement of manufacture. In submitting this information, the manufacturer shall identify, in an appropriate manner, any features of the proposed design and/or in the proposed manufacturing, inspection or test procedures which by the terms of this specification require to be approved by the purchaser.

NOTE Table 1.4-2 lists such features. The features should be identified in an appropriate document such as purchase order, approved drawing or an approved working procedure (e.g. weld preparation procedure, heat treatment procedure, welding procedure etc.).

1.5.2.2 *On completion of construction*

The manufacturer shall supply to the purchaser for record purposes a copy of the following documentation, as finally approved, for each vessel or batch of vessels.

- a) A fully dimensioned drawing of the vessel, as built, together with any relevant supporting information as specified in 4.1.1 and which is not covered by items b) to g) as follows.
- b) A list of materials (including welding consumables) used in the construction of the vessel with details of any special heat treatments carried out by the material supplier.

NOTE 1 For materials specified to a British Standard the date of the standard is to be given. Where other materials are used [see 2.1.2.1b)] the full specification is to be supplied.

- c) Factors effecting the equipment operation or design life – safe operating limits and design basis (which may be on the drawings).

- d) Factors effecting the design life i.e.
 - 1) Creep – design hours of operation at specified temperature.
 - 2) Fatigue – design number of cycles at specified stress levels.
 - 3) Corrosion – design corrosion allowance.
 - 4) Residual hazards not prevented by design or protective measures that might arise from foreseeable misuse.
 - 5) Information about replaceable parts (liners, wear plates etc.).
- e) The welding procedures used during vessel manufacture (see 5.2.2).
- f) The procedures used for radiography, ultrasonic inspection and/or crack detection of welds (see 5.6.6.1, 5.6.6.2, 5.6.6.3 and 5.6.6.4).
- g) Records detailing all deviations from this specification and the decision made on all matters subject to agreement (see 1.4.2).
- h) A Certificate of Conformance (Form X) for each vessel (see 1.4.4).
- i) A facsimile of the vessel nameplate (see 5.8.9).
- j) Details of any statutory required marking (e.g. CE marking).
- k) Operating instructions for mounting, putting into service its use and maintenance (as far as is relevant).

NOTE 2 The duration for which a manufacturer will retain all records produced during the manufacture of a vessel is influenced by a number of factors which are outside the scope of this standard.

1.6 Thicknesses

Thicknesses are referred to in several ways in this specification in accordance with the following definitions.

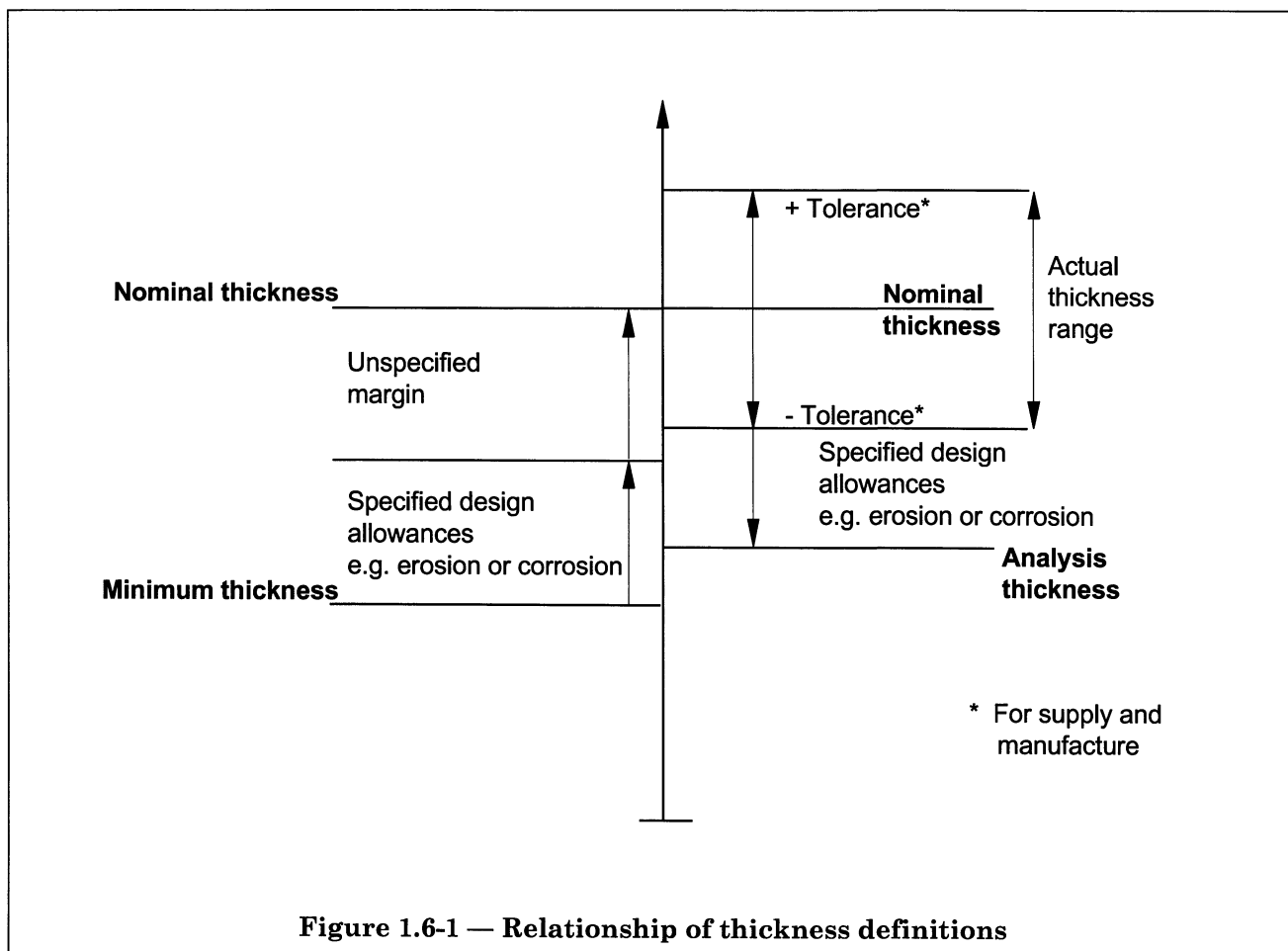
- a) Minimum thickness; the thickness calculated in Section 3 and some design annexes, to satisfy the relevant design requirement.
- b) Nominal thickness; the thickness as specified on the construction drawing which includes all allowances and tolerances.
- c) Analysis thickness; the thickness used in design calculations and assessments, which equals the nominal thickness less corrosion allowances and less any other allowances and tolerances.

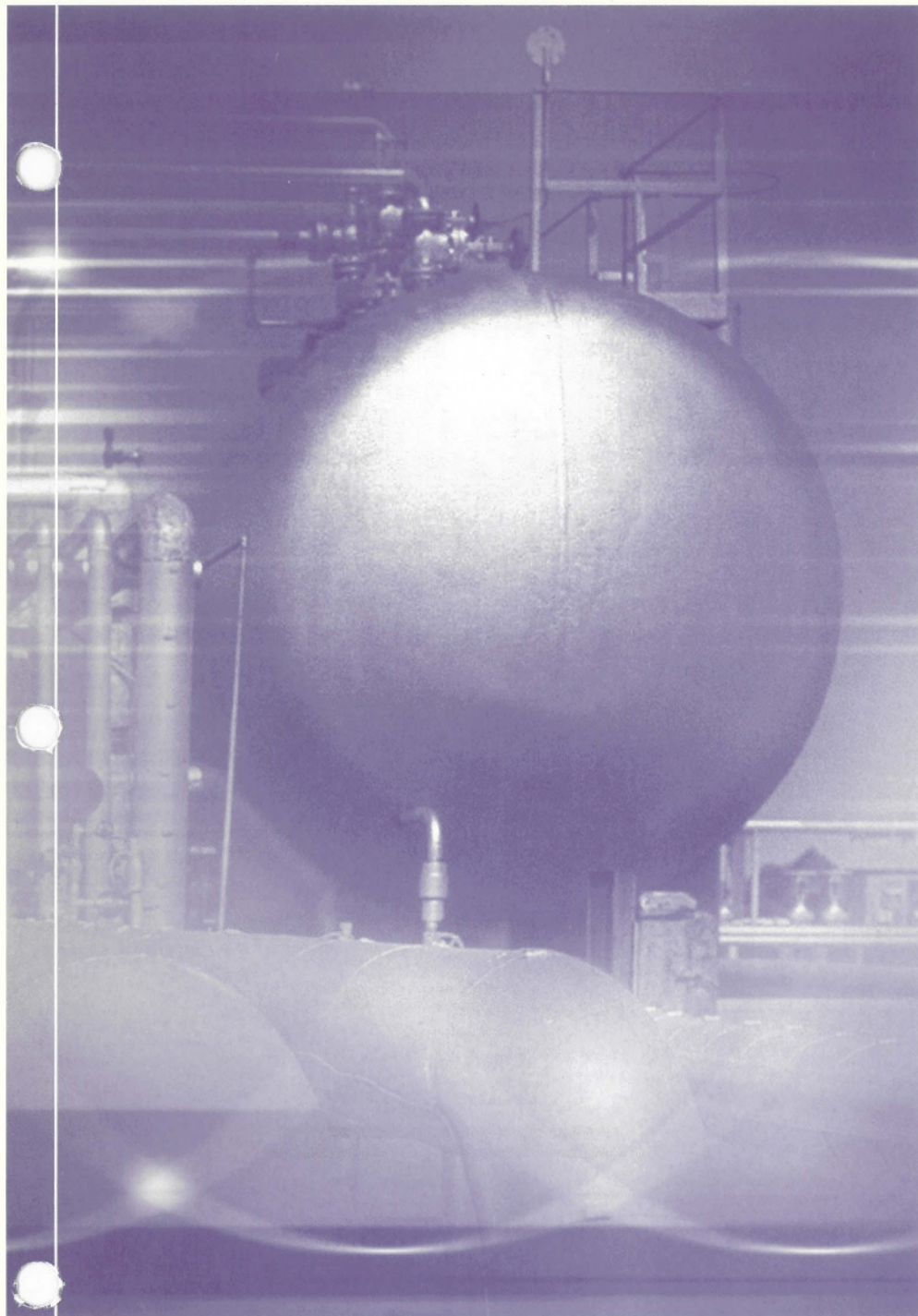
The nominal thickness, less any negative tolerance permitted by the specification to which the material is ordered, shall not be less than the minimum thickness plus any allowances specified for corrosion, erosion etc.

The relationships between the defined thicknesses are shown in Figure 1.6-1. This figure indicates:

- a) on the left hand side, that the thickness calculated from the rules is increased by the amount of the specified allowances (for effects such as corrosion) and possibly by an unspecified margin (in consideration, for example, of materials availability);
- b) on the right hand side, that the nominal thickness should be reduced by any negative supply (i.e. negative plate thickness) tolerance and any manufacturing (i.e. dishing) allowances as well as by the specified design allowances, to arrive at the analysis thickness.

NOTE Following the replacement of BS 1501 by BS EN 10028, it should be noted that plate conforming to this latter specification is normally supplied in accordance with BS EN 10029 class B which permits a negative tolerance of 0.3 mm for all nominal thicknesses. However, the purchaser may specify a zero negative tolerance.





Section 2
Materials

PD 5500:2003

Specification for
**Unfired fusion welded
pressure vessels**

Section 2. Materials

2.1 Selection of materials

2.1.1 General

2.1.1.1 The selection of the materials of construction for pressure containing parts and their integral attachments shall take into account the suitability of the material with regard to fabrication¹⁾ and to the conditions under which they will eventually operate.

2.1.1.2 Any special limits for the materials of construction, e.g. composition, heat treatment and non-destructive testing (NDT), which are different to those given in this specification shall be specified in the purchase specification.

2.1.1.3 For the ease of reference throughout this specification, ferritic materials, with the exception of the following, have been grouped into “M” bands as summarized in Table 2.1-1 (which also indicates the equivalent material group, as used by CEN, derived from PD CR ISO 15608:2000):

- 1½Ni;
- martensitic stainless steel;
- ferritic stainless steel;
- austenitic stainless steel;
- clad material;
- duplex austenitic-ferritic stainless steel;
- quenched and tempered fine grain steel.

2.1.2 Materials for pressure parts

2.1.2.1 General

All the materials used in the manufacture of pressure parts shall:

- a) conform to BS EN steels given in Table 2.1-2; or
- b) conform to BS steels given in Table K.1-2 to Table K.1-12; or
- c) be agreed between purchaser, Inspecting Authority and manufacturer, be documented [see 1.5.2.2b)] and shall conform to 2.1.2.2; or
- d) be the subject of a “European approval for material” in accordance with the EU directive 97/23/EC; or
- e) be detailed in supplements, annexes or enquiry cases to this specification.

Welding material shall conform to Section 4 and Section 5.

The option to be able to use castings for pressure parts shall be specified in the purchase specification. An appropriate “quality specification” for such castings shall be agreed between the manufacturer and material supplier at the time of enquiry, specifying the standards of inspection to be applied and of acceptance for defects. As a minimum, all accessible fillets and changes of section, etc., shall be subject to magnetic particle or penetrant inspection.

2.2.2.1 Materials for bolts and nuts shall conform to the specifications listed in Table 3.8-1 or Table Al.3.8-1. Requirements for bolting materials for low temperature application are referred to in 2.2.2. **2.2.2.2**

2.1.2.2 Materials covered by 2.1.2.1c)

2.1.2.2.1 General

The material shall be covered by a written specification at least as comprehensive as the nearest equivalent British Standard listed in Table 2.1-2. The written specification shall as a minimum specify the manufacturing process, compositional limits for all constituents, deoxidation practice, heat treatment and appropriate mechanical properties for acceptance and other purposes.

An equivalent “M” band for the material shall be chosen and agreed between manufacturer, inspection authority and purchaser. This “M” banding shall be used to assist in the selection of manufacturing and inspection requirements of Section 4 and Section 5.

¹⁾ See BS EN 1011 for general guidance on the susceptibility of materials to lamellar tearing during fabrication.

Table 2.1-1 — Material banding

PD 5500 Band	Material type	^{A2} Material group according to PD CR ISO 15608:2000 ^{A2}
M0, M1	Carbon and carbon manganese steel	1.1, 1.2, 1.3, 1.5, 2.1
M2	Carbon molybdenum steel	^{A2} 1.1, 1.2, 1.4, 2.1 ^{A2}
M4	Low alloy magnesium chromium molybdenum vanadium steel	4.1, 4.2
M5	3½Ni	9.1, 9.2
M6	9Ni	9.3
M7	1 to 1½Cr ½Mo	5.1
M8	½Cr½Mo¼V	6.1
M9	2¼Cr1Mo	5.2
M10	5Cr½Mo	5.3
M11	9Cr1Mo	5.4
M12	12Cr1Mo1V	6.4

Table 2.1.2 — List of materials covered by BS EN material standards

1 No.	2 Product form	3 EN standard	4 Material description	5 Grade	6 Material number	7 Heat treatment ^a	8 Thickness mm		9 Material group to PD CR ISO 15608:2000 ⁴²	10 Notes
							min.	max.		
1	Plate and strip	BS EN 10028-2	Elevated temperature properties	P235GH	1.0345	N	0	150	1.1	a)
2	Plate and strip	BS EN 10028-2	Elevated temperature properties	P265GH	1.0425	N	0	150	1.1	a)
3	Plate and strip	BS EN 10028-2	Elevated temperature properties	P295GH	1.0481	N	0	150	1.2	a)
4	Plate and strip	BS EN 10028-2	Elevated temperature properties	P355GH	1.0473	N	0	150	1.2	a)
5	Plate and strip	BS EN 10028-2	Elevated temperature properties	16Mo3	1.5415	N	0	150	1.1	a) f)
6	Plate and strip	BS EN 10028-2	Elevated temperature properties	13CrMo4-5	1.7335	NT	0	60	5.1	a)
7	Plate and strip	BS EN 10028-2	Elevated temperature properties	13CrMo4-5	1.7335	NT QT	60	100	5.1	a)
8	Plate and strip	BS EN 10028-2	Elevated temperature properties	13CrMo4-5	1.7335	QT	100	150	5.1	a)
9	Plate and strip	BS EN 10028-2	Elevated temperature properties	10CrMo9-10	1.7380	NT	0	60	5.2	a)
10	Plate and strip	BS EN 10028-2	Elevated temperature properties	10CrMo9-10	1.7380	NT QT	60	100	5.2	a)
11	Plate and strip	BS EN 10028-2	Elevated temperature properties	10CrMo9-10	1.7380	QT	100	150	5.2	a)
12	Plate and strip	BS EN 10028-2	Elevated temperature properties	11CrMo9-10	1.7383	NT QT	0	60	5.2	a)
13	Plate and strip	BS EN 10028-2	Elevated temperature properties	11CrMo9-10	1.7383	QT	60	100	5.2	a)
14	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P275N	1.0486	N	0	150	1.1	a)
15	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P275NH	1.0487	N	0	150	1.1	a)
16	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P275NL1	1.0488	N	0	150	1.1	a)
17	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P275NL2	1.1104	N	0	150	1.1	a)
18	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P355N	1.0562	N	0	150	1.2	a)
19	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P355NH	1.0565	N	0	150	1.2	a)
20	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P355NL1	1.0566	N	0	150	1.2	a)
21	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P355NL2	1.1106	N	0	150	1.2	a)
22	Plate and strip	BS EN 10028-4	Low temperature properties	11MnNi5-3	1.6212	N NT	0	50	9.1	a)
23	Plate and strip	BS EN 10028-4	Low temperature properties	13MnNi6-3	1.6217	N NT	0	50	9.1	a)
24	Plate and strip	BS EN 10028-4	Low temperature properties	15NiMn6	1.6228	N NT QT	0	50	9.1	a)
25	Plate and strip	BS EN 10028-4	Low temperature properties	12Ni14	1.5637	N NT QT	0	50	9.2	a)
26	Plate and strip	BS EN 10028-4	Low temperature properties	12Ni19	1.5680	N NT QT	0	50	9.2	a)
27	Plate and strip	BS EN 10028-4	Low temperature properties	X8Ni9	1.5662	N NT QT	0	50	9.3	a)
28	Plate and strip	BS EN 10028-4	Low temperature properties	X7Ni9	1.5663	QT	0	50	9.3	a)
29	Plate and strip	BS EN 10028-6	Fine grain steel, quenched/tempered	P355Q	1.8866	QT	0	150	1.2	a)
30	Plate and strip	BS EN 10028-6	Fine grain steel, quenched/tempered	P355QH	1.8867	QT	0	150	1.2	a)
31	Plate and strip	BS EN 10028-6	Fine grain steel, quenched/tempered	P355QL1	1.8868	QT	0	150	1.2	a)

Table 2.1-2 — List of materials covered by BS EN material standards (continued)

1 No.	2 Product form	3 EN standard	4 Material description	5 Grade	6 Material number	7 Heat treatment ^a	8 Thickness mm		9 Material group to PD CR ISO 15608:2000 ⁽²⁾	10 Notes
							min.	max.		
32	Plate and strip	BS EN 10028-6	Fine grain steel, quenched/tempered	P355QL2	1.8869	QT	0	150	1.2	a)
33	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNi18-7	1.4318	AT	0	75	8.1	a)
34	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNi18-9	1.4307	AT	0	75	8.1	a)
35	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNi19-11	1.4306	AT	0	75	8.1	a)
36	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNi18-10	1.4311	AT	0	75	8.1	a)
37	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X5CrNi18-10	1.4301	AT	0	75	8.1	a)
38	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X5CrNi19-9	1.4315	AT	0	75	8.1	a)
39	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X6CrNi18-10	1.4948	AT	0	75	8.1	a)
40	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X6CrNi23-13	1.4950	AT	0	75	8.2	a)
41	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X6CrNi25-20	1.4951	AT	0	75	8.2	a)
42	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X6CrNiTi18-10	1.4541	AT	0	75	8.1	a)
43	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X6CrNiTiB18-10	1.4941	AT	0	75	8.1	a)
44	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNiMo17-12-2	1.4404	AT	0	75	8.1	a)
45	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNiMoN17-11-2	1.4406	AT	0	75	8.1	a)
46	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X5CrNiMo17-12-2	1.4401	AT	0	75	8.1	a)
47	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X6CrNiMoTi17-12-2	1.4571	AT	0	75	8.1	a)
48	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNiMo17-12-3	1.4432	AT	0	75	8.1	a)
49	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNiMo18-14-3	1.4435	AT	0	75	8.1	a)
50	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNiMoN17-13-5	1.4439	AT	0	75	8.1	a)
51	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X1NiCrMoCu25-20-5	1.4539	AT	0	75	8.2	a)
52	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X5NiCrAlTi31-20	1.4958	AT	0	75	8.2	a)
53	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X5NiCrAlTi31-20 + RA	1.4958 + RA	RA	0	75	8.2	a)
54	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X8NiCrAlTi32-21	1.4959	AT	0	75	8.2	a)
55	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X3CrNiMoBN17-13-3	1.4910	AT	0	75	8.1	a)
56	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X1CrNi25-21	1.4335	AT	0	75	8.2	a)
57	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X6CrNiNb18-10	1.4550	AT	0	75	8.1	a)
58	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X8CrNiNb16-13	1.4961	AT	0	75	8.1	a)
59	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X1CrNiMoN25-22-2	1.4466	AT	0	75	8.2	a)
60	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X6CrNiMoNb17-12-2	1.4580	AT	0	75	8.1	a)
61	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X2CrNiMoN17-13-3	1.4429	AT	0	75	8.1	a)
62	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X3CrNiMoN17-13-3	1.4436	AT	0	75	8.1	a)

Table 2.1-2 — List of materials covered by BS EN material standards (continued)

1 No.	2 Product form	3 EN standard	4 Material description	5 Grade	6 Material number	7 Heat treatment ^a	8 Thickness mm		9 Material group to PD CR ISO 15608:2000 ^(A2)	10 Notes
							min.	max.		
63	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X2CrNiMoN18-12-4	1.4434	AT	0	75	8.1	a)
64	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X2CrNiMo18-15-4	1.4438	AT	0	75	8.1	a)
65	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X1NiCrMoCu31-27-4	1.4563	AT	0	75	8.2	a)
66	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X1CrNiMoCuN25-25-5	1.4537	AT	0	75	8.2	a)
67	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X1CrNiMoCuN20-18-7	1.4547	AT	0	75	8.2	a)
68	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X1NiCrMoCuN25-20-7	1.4529	AT	0	75	8.2	a)
69	Bar	BS EN 10272	Stainless steel, austenitic	X2CrNi18-9	1.4307	AT	0	250	8.1	a)
70	Bar	BS EN 10272	Stainless steel, austenitic	X2CrNi19-11	1.4306	AT	0	250	8.1	a)
71	Bar	BS EN 10272	Stainless steel, austenitic	X2CrNi18-10	1.4311	AT	0	250	8.1	a)
72	Bar	BS EN 10272	Stainless steel, austenitic	X5CrNi18-10	1.4301	AT	0	250	8.1	a)
73	Bar	BS EN 10272	Stainless steel, austenitic	X6CrNiTi18-10	1.4541	AT	0	250	8.1	a)
74	Bar	BS EN 10272	Stainless steel, austenitic	X2CrNiMo17-12-2	1.4404	AT	0	250	8.1	a)
75	Bar	BS EN 10272	Stainless steel, austenitic	X2CrNiMoN17-11-2	1.4406	AT	0	250	8.1	a)
76	Bar	BS EN 10272	Stainless steel, austenitic	X5CrNiMo17-12-2	1.4401	AT	0	250	8.1	a)
77	Bar	BS EN 10272	Stainless steel, austenitic	X6CrNiMoTi17-12-2	1.4571	AT	0	250	8.1	a)
78	Bar	BS EN 10272	Stainless steel, austenitic	X2CrNiMo17-12-3	1.4432	AT	0	250	8.1	a)
79	Bar	BS EN 10272	Stainless steel, austenitic	X2CrNiMo18-14-3	1.4435	AT	0	250	8.1	a)
80	Bar	BS EN 10272	Stainless steel, austenitic	X2CrNiMo17-13-5	1.4439	AT	0	250	8.1	a)
81	Bar	BS EN 10272	Stainless steel, austenitic	X1NiCrMoCu25-20-5	1.4539	AT	0	250	8.2	a)
82	Bar	BS EN 10272	Stainless steel, austenitic	X6CrNiNb18-10	1.4550	AT	0	250	8.1	a)
83	Bar	BS EN 10272	Stainless steel, austenitic	X6CrNiMoNb17-12-2	1.4580	AT	0	250	8.1	a)
84	Bar	BS EN 10272	Stainless steel, austenitic	X2CrNiMoN17-13-3	1.4429	AT	0	250	8.1	a)
85	Bar	BS EN 10272	Stainless steel, austenitic	X3CrNiMo17-13-3	1.4436	AT	0	250	8.1	a)
86	Bar	BS EN 10272	Stainless steel, austenitic	X1NiCrMoCu31-27-4	1.4563	AT	0	250	8.2	a)
87	Bar	BS EN 10272	Stainless steel, austenitic	X1CrNiMoCuN20-18-7	1.4547	AT	0	250	8.2	a)
88	Bar	BS EN 10272	Stainless steel, austenitic	X1NiCrMoCuN25-20-7	1.4529	AT	0	250	8.2	a)
89	Bar	BS EN 10273	Elevated temperature properties	P235GH	1.0345	N	0	150	1.1	a)
90	Bar	BS EN 10273	Elevated temperature properties	P250GH	1.0460	N	0	150	1.1	a)
91	Bar	BS EN 10273	Elevated temperature properties	P265GH	1.0425	N	0	150	1.1	a)
92	Bar	BS EN 10273	Elevated temperature properties	P295GH	1.0481	N	0	150	1.2	a)
93	Bar	BS EN 10273	Elevated temperature properties	P355GH	1.0473	N	0	150	1.2	a)

Table 2.1-2 — List of materials covered by BS EN material standards (continued)

1 No.	2 Product form	3 EN standard	4 Material description	5 Grade	6 Material number	7 Heat treatment ^a	8 Thickness mm		9 Material group to PD CR ISO 15608:2000 ^{A3}	10 Notes
							min.	max.		
94	Bar	BS EN 10273	Elevated temperature properties	P275NH	1.0487	N	0	150	1.1	a)
95	Bar	BS EN 10273	Elevated temperature properties	P355NH	1.0565	N	0	150	^{A3} 1.2 ^{A3}	a)
96	Bar	BS EN 10273	Elevated temperature properties	P355QH	1.8867	QT	0	150	1.2	a)
97	Bar	BS EN 10273	Elevated temperature properties	16Mo3	1.5415	N	0	150	1.1	a) f)
98	Bar	BS EN 10273	Elevated temperature properties	13CrMo4-5	1.7335	NT QT	60	100	5.1	a)
99	Bar	BS EN 10273	Elevated temperature properties	13CrMo4-5	1.7335	QT	100	150	5.1	a)
100	Bar	BS EN 10273	Elevated temperature properties	10CrMo9-10	1.7380	NT	0	60	5.2	a)
101	Bar	BS EN 10273	Elevated temperature properties	10CrMo9-10	1.7380	NT QT	60	150	5.2	a)
102	Bar	BS EN 10273	Elevated temperature properties	11CrMo9-10	1.7383	NT QT	0	60	5.2	a)
103	Bar	BS EN 10273	Elevated temperature properties	11CrMo9-10	1.7383	QT	60	100	5.2	a)
104	Seamless tube	^{A3} BS EN 10216-1	Room temperature properties	P195TR2	1.0255	N	0	60	1.1	a)
105	Seamless tube	BS EN 10216-1	Room temperature properties	P235TR2	1.0258	N	0	60	1.1	a)
106	Seamless tube	BS EN 10216-1	Room temperature properties	P265TR2	1.0259	N	0	60	1.1	a)
107	Seamless tube	BS EN 10216-2	Elevated temperature properties	P195GH	^{A3} 1.0348	N	0	16	1.1	a)
108	Seamless tube	BS EN 10216-2	Elevated temperature properties	P235GH	1.0345	N	0	60	1.1	a)
109	Seamless tube	BS EN 10216-2	Elevated temperature properties	P265GH	1.0425 ^{A3}	N	0	60	1.1	a)
110	Seamless tube	BS EN 10216-2	Elevated temperature properties	20MnNb6	1.0471	N	0	60	^{A3} 1.2 ^{A3}	a)
111	Seamless tube	BS EN 10216-2	Elevated temperature properties	16Mo3	1.5415	N	0	60	1.2	a) f)
112	Seamless tube	BS EN 10216-2	Elevated temperature properties	8MoB5-4	1.5450	N	0	16	^{A3} 1.3 ^{A3}	a)
113	Seamless tube	BS EN 10216-2	Elevated temperature properties	14MoV6-3	1.7715	NT QT c)	0	60	6.1	a)
114	Seamless tube	BS EN 10216-2	Elevated temperature properties	10CrMo5-5	1.7338	NT QT c)	0	60	5.1	a)
115	Seamless tube	BS EN 10216-2	Elevated temperature properties	13CrMo4-5	^{A3} 1.7335	NT QT c)	0	60	5.1	a)
116	Seamless tube	BS EN 10216-2	Elevated temperature properties	10CrMo9-10	1.7380	NT QT c)	0	60	5.2	a)
117	Seamless tube	BS EN 10216-2	Elevated temperature properties	11CrMo9-10	1.7383	QT	0	60	5.2	a)
118	Seamless tube	BS EN 10216-2	Elevated temperature properties	25CrMo4	1.7218 ^{A3}	QT	0	60	5.1	a) b)
119	Seamless tube	BS EN 10216-2	Elevated temperature properties	20CrMoV13-5-5	1.7779	QT	0	60	6.3	a)
120	Seamless tube	BS EN 10216-2	Elevated temperature properties	15NiCuMoNb5-6-4	1.6368	NT QT c)	0	80	^{A3} 4.2 ^{A3}	a)
121	Seamless tube	BS EN 10216-2	Elevated temperature properties	X11CrMo5 + I	^{A3} 1.7362 + I	I	0	100	5.3	a)
122	Seamless tube	BS EN 10216-2	Elevated temperature properties	X11CrMo5 + NT1	1.7362 + NT1	NT	0	100	5.3	a)
123	Seamless tube	BS EN 10216-2	Elevated temperature properties	X11CrMo5 + NT2	1.7362 + NT2	NT QT c)	0	100	5.3	a)
124	Seamless tube	BS EN 10216-2 ^{A3}	Elevated temperature properties	X11CrMo9-1 + I	1.7386 + I ^{A3}	I	0	60	5.4	a)

Table 2.1-2 — List of materials covered by BS EN material standards (continued)

1 No.	2 Product form	3 EN standard	4 Material description	5 Grade	6 Material number	7 Heat treatment ^a	8 Thickness mm		9 Material group to PD CR ISO 15608:2000 Δ_2	10 Notes
							min.	max.		
125	Seamless tube	BS EN 10216-2	Elevated temperature properties	X11CrMo9-1 + NT	1.7386 + NT	NT QT c)	0	60	5.4	a)
126	Seamless tube	BS EN 10216-2	Elevated temperature properties	X10CrMoVNb9-1	1.4903	NT QT c)	0	100	6.4	a)
127	Seamless tube	BS EN 10216-2	Elevated temperature properties	X20CrMoV11-1	1.4922	NT QT c)	0	100	6.4	a)
128	Seamless tube	BS EN 10216-3	Fine grain steel	P275NL1	1.0488	N	0	100	1.1	a)
129	Seamless tube	BS EN 10216-3	Fine grain steel	P275NL2	1.1104	N	0	100	1.1	a)
130	Seamless tube	BS EN 10216-3	Fine grain steel	P355N	1.0562	N	0	100	1.2	a)
131	Seamless tube	BS EN 10216-3	Fine grain steel	P355NH	1.0565	N	0	100	1.2	a)
132	Seamless tube	BS EN 10216-3	Fine grain steel	P355NL1	1.0566	N	0	100	1.2	a)
133	Seamless tube	BS EN 10216-3	Fine grain steel	P355NL2	1.1106	N	0	100	1.2	a)
134	Seamless tube	BS EN 10216-3	Fine grain steel	P460NH	1.8935	N c)	0	100	1.3	a)
135	Seamless tube	BS EN 10216-3	Fine grain steel	P460NL2	1.8918	N c)	0	100	1.1	a)
136	Seamless tube	BS EN 10216-4	Low temperature properties	P215NL	1.0451	N	0	10	1.1	a)
137	Seamless tube	BS EN 10216-4	Low temperature properties	P255QL	1.0452	QT	0	40	1.1	a) f)
138	Seamless tube	BS EN 10216-4	Low temperature properties	P265NL	1.0453 Δ_3	N	0	25	1.1	a)
139	Seamless tube	BS EN 10216-4	Low temperature properties	26CrMo4-2	1.7219	QT	0	40	5.1	a) b)
140	Seamless tube	BS EN 10216-4	Low temperature properties	11MnNi5-3	1.6212	N NT c)	0	40	9.1	a)
141	Seamless tube	BS EN 10216-4	Low temperature properties	13MnNi6-3	1.6217	N NT c)	0	40	9.1	a)
142	Seamless tube	BS EN 10216-4	Low temperature properties	12Ni14	1.5637	NT	0	40	9.2	a)
143	Seamless tube	BS EN 10216-4	Low temperature properties	12Ni14 + QT	1.5637	QT	0	40	9.2	a)
144	Seamless tube	BS EN 10216-4	Low temperature properties	X12Ni5	1.5680 Δ_3	N	0	40	9.2	a)
145	Seamless tube	BS EN 10216-4	Low temperature properties	X12Ni5 + QT	1.5680 Δ_3	QT	0	40	9.2	a)
146	Seamless tube	BS EN 10216-4	Low temperature properties	X10Ni9	1.5682	N NT	0	40	9.3	a)
147	Seamless tube	BS EN 10216-4 Δ_1	Low temperature properties	X10Ni9 + QT	1.5682	QT	0	40	9.3	a)
148	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X2CrNi18-9	1.4307	AT	0	60	8.1	a)
149	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X2CrNi19-11	1.4306	AT	0	60	8.1	a)
150	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X2CrNi18-10	1.4311	AT	0	60	8.1	a)
151	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X5CrNi18-10	1.4301	AT	0	60	8.1	a)
152	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X6CrNiTi18-10	1.4541	AT	0	60	8.1	a)
153	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X6CrNiNb18-10	1.4550	AT	0	60	8.1	a)
154	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X2CrNiMo18-14-3	1.4435	AT	0	60	8.1	a)
155	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X2CrNiMo17-12-2	1.4404	AT	0	60	8.1	a)

Table 2.1.2 — List of materials covered by BS EN material standards (continued)

1 No.	2 Product form	3 EN standard	4 Material description	5 Grade	6 Material number	7 Heat treatment ^a	8 Thickness mm		9 Material group to PD CR ISO 15608:2000 ⁽²⁾	10 Notes
							min.	max.		
156	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X5CrNiMo17-12-2	1.4401	AT	0	60	8.1	a)
157	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X1CrNiMoN25-22-2	1.4466	AT	0	60	8.2	a)
158	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X6CrNiMoTi17-12-2	1.4571	AT	0	60	8.1	a)
159	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X6CrNiMoNb17-12-2	1.4580	AT	0	60	8.1	a)
160	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X2CrNiMoN17-13-3	1.4429	AT	0	60	8.1	a)
161	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X3CrNiMo17-13-3	1.4436	AT	0	60	8.1	a)
162	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X1CrNi25-21	1.4335	AT	0	60	8.2	a)
163	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X2CrNiMoN17-13-5	1.4439	AT	0	60	8.1	a)
164	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X1NiCrMoCu31-27-4	1.4563	AT	0	60	8.2	a)
165	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X1NiCrMoCu25-20-5	1.4539	AT	0	60	8.2	a)
166	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X1CrNiMoCuN20-18-7	1.4547	AT	0	60	8.2	a)
167	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X1NiCrMoCuN25-20-7	1.4529	AT	0	60	8.2	a)
168	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X2NiCrAlTi32-20	1.4558	AT	0	60	8.2	a)
169	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X6CrNi18-10	1.4948	AT	0	60	8.1	a)
170	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X7CrNiTi18-10	—	AT	0	60	8.1	a)
171	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X7CrNiNb18-10	—	AT	0	60	8.1	a)
172	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X7CrNiTiB18-10	1.4941	AT	0	60	8.1	a)
173	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X6CrNiMo17-13-2	—	AT	0	60	8.1	a)
174	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X5NiCrAlTi31-20	1.4958	AT	0	60	8.2	a)
175	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X8NiCrAlTi32-21	1.4959	AT	0	60	8.2	a)
176	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X3CrNiMoNb17-13-3	1.4910	AT	0	60	8.1	a)
177	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X8CrNiNb16-13	1.4961	AT	0	60	8.1	a)
178	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X8CrNiMoVNb16-13	1.4988	AT	0	60	8.1	a)
179	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X8CrNiMoNb16-16	1.4981	AT	0	60	8.1	a)
180	Seamless tube	prEN 10216-5	Stainless steel, austenitic	X10CrNiMoMnNbVB15-10-1	1.4982	AT	0	60	8.1	a)
181	Welded tube	^(A) BS EN 10217-1	Room temperature properties	P195TR2	1.0108	N	0	40	1.1	a)
182	Welded tube	BS EN 10217-1	Room temperature properties	P235TR2	1.0255	N	0	40	1.1	a)
183	Welded tube	BS EN 10217-1	Room temperature properties	P265TR2	1.0259	N	0	40	1.1	a)
184	Welded tube	BS EN 10217-2	Elevated temperature properties	P195GH	—	N	0	16	1.1	a)
185	Welded tube	BS EN 10217-2	Elevated temperature properties	P235GH	—	N	0	16	1.1	a)
186	Welded tube	BS EN 10217-2 ^(A)	Elevated temperature properties	P265GH	—	N	0	16	1.1	a)