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Specification for unfired pressure vessels

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Contents

Foreword xv

Section 1. General 1/1

- 1.1 Scope 1/1
- 1.2 Interpretation 1/3
- 1.3 Definitions 1/4
 - 1.3.1 purchaser 1/4
 - 1.3.2 manufacturer 1/4
 - 1.3.3 Inspecting Authority 1/4
 - 1.3.4 Regulating Authority 1/4
- 1.4 Responsibilities 1/4
 - 1.4.1 Responsibilities of the purchaser 1/4
 - 1.4.2 Responsibilities of the manufacturer 1/6
 - 1.4.3 Responsibilities of the Inspecting Authority 1/10
 - 1.4.4 Certificate of Conformance 1/11
- 1.5 Information and requirements to be agreed and to be documented 1/14
 - 1.5.1 Information to be supplied by the purchaser 1/14
 - 1.5.2 Information to be supplied by the manufacturer 1/14
- 1.6 Thicknesses 1/15

Section 2. Materials 2/1

- 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 2/25
- 2.2 Materials for low temperature applications 2/25
- 2.3 Nominal design strength 2/27
 - 2.3.1 General 2/27
 - 2.3.2 Notation 2/28
 - 2.3.3 Time-independent design strength 2/29
 - 2.3.4 Time-dependent design strength 2/30

Section 3. Design 3/1

- 3.1 General 3/1
- 3.2 Application 3/2
 - 3.2.1 Consideration of loads 3/2
 - 3.2.2 Design criteria 3/7
 - 3.2.3 Design pressure 3/8
 - 3.2.4 Maximum design temperature 3/9
 - 3.2.5 Minimum design temperature 3/9
 - 3.2.6 Thermal loads 3/9
 - 3.2.7 Wind and earthquake loads 3/10
- 3.3 Corrosion, erosion and protection 3/10
 - 3.3.1 General 3/10
 - 3.3.2 Additional thickness to allow for corrosion 3/10
 - 3.3.3 Linings and coatings 3/10
 - 3.3.4 Wear plates 3/11
- 3.4 Construction categories and design strengths 3/11
 - 3.4.1 Construction categories 3/11
 - 3.4.2 Design strengths 3/12
- 3.5 Vessels under internal pressure 3/14
 - 3.5.1 Cylindrical and spherical shells 3/14
 - 3.5.2 Dished ends 3/15
 - 3.5.3 Cones and conical ends 3/20
 - 3.5.4 Openings and nozzle connections 3/28
 - 3.5.5 Flat ends and flat plates 3/78
 - 3.5.6 Spherically domed and bolted ends of the form shown in Figure 3.5-39 3/91

3.6	Vessels under external pressure	3/97
3.6.1	General	3/97
3.6.2	Cylindrical shells	3/100
3.6.3	Conical shells	3/105
3.6.4	Spherical shells	3/108
3.6.5	Hemispherical ends	3/108
3.6.6	Torispherical ends	3/108
3.6.7	Ellipsoidal ends	3/109
3.6.8	Procedure by which the departure from the mean circle may be obtained	3/109
3.7	Supports, attachments and internal structures	3/132
3.7.1	General	3/132
3.7.2	Supports	3/132
3.8	Bolted flanged connections	3/134
3.8.1	General	3/134
3.8.2	Notation	3/141
3.8.3	Narrow-faced gasketed flanges	3/143
3.8.4	Full-faced flanges with soft ring type gaskets	3/150
3.8.5	Ungasketed seal welded flanges	3/151
3.8.6	Reverse narrow-face flanges	3/151
3.8.7	Reverse full-face flanges	3/152
3.8.8	Full-faced flanges with metal to metal contact	3/153
3.9	Flat heat exchanger tubesheets	3/194
3.9.1	Notation	3/198
3.9.2	Characteristics of perforated plates	3/201
3.9.3	Tubesheets of exchangers with floating heads or U-tubes	3/202
3.9.4	Tubesheets of fixed tubesheet exchangers	3/211
3.9.5	Allowable shell and tube longitudinal stresses	3/218
3.9.6	Allowable tube joint end load	3/219
3.9.7	Tubesheet flanged extension with narrow-face gasket	3/220
3.10	Design of welds	3/223
3.10.1	General	3/223
3.10.2	Welded joints for principal seams	3/224
3.10.3	Welded joints for other than principal seams	3/226
3.10.4	Welded joints in time dependent applications	3/227
3.11	Vessels with external jackets or limpet coils	3/227
3.11.1	General	3/227
3.11.2	Jacketed cylindrical shells	3/227
3.11.3	Welded jacket connections	3/228
3.11.4	Cylindrical shells with limpet coils	3/231
3.12	Manholes, inspection openings and quick release openings	3/232
3.13	Protective devices for excessive pressure or vacuum	3/233
3.13.1	Application	3/233
3.13.2	Capacity of relief device(s)	3/234
3.13.3	Pressure setting of pressure relieving devices	3/234
Section 4	Manufacture and workmanship	4/1
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	4/2
4.1.4	Junction of more than two weld seams	4/2
4.1.5	Localized thinning	4/2
4.1.6	Rectification of departures from tolerance	4/2
4.2	Cutting, forming and tolerances	4/3
4.2.1	Cutting of material	4/3
4.2.2	Forming of shell sections and plates	4/3
4.2.3	Assembly tolerances	4/6
4.2.4	Tolerances for vessels subject to internal pressure	4/7
4.2.5	Tolerances for vessels subject to external pressure	4/11

4.2.6	Structural tolerances	4/11
4.3	Welded joints	4/11
4.3.1	General	4/11
4.3.2	Welding consumables	4/11
4.3.3	Preparation of plate edges and openings	4/12
4.3.4	Assembly for welding	4/12
4.3.5	Attachments and the removal of temporary attachments	4/12
4.3.6	Butt joints	4/13
4.3.7	Welding: general requirements	4/14
4.4	Permanent joints other than welding	4/14
4.4.1	General	4/14
4.4.2	Mechanical roller expansion	4/14
4.4.3	Brazing	4/15
4.5	Heat treatment	4/15
4.5.1	Preheat requirements	4/15
4.5.2	Normalizing: ferritic steels (material groups 1 to 6, 9 and 11)	4/15
4.5.3	Post-weld heat treatment	4/16
4.5.4	Methods of heat treatment	4/17
4.5.5	Post-weld heat treatment procedure	4/18
4.5.6	Mechanical properties after heat treatment	4/21
4.6	Surface finish	4/22

Section 5. Inspection and testing 5/1

5.1	General	5/1
5.2	Approval testing of fusion welding procedures	5/2
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	5/11
5.6.6	Non-destructive testing techniques for welds	5/12
5.7	Acceptance criteria for weld defects revealed by visual examination and non-destructive testing	5/14
5.7.1	General	5/14
5.7.2	Assessment of defects	5/14
5.7.3	Repair of welds	5/15
5.8	Pressure tests	5/24
5.8.1	General	5/24
5.8.2	Basic requirements	5/25
5.8.3	Hydraulic testing	5/26
5.8.4	Pneumatic tests	5/27
5.8.5	"Standard" test pressure	5/28
5.8.6	Proof hydraulic test	5/30
5.8.7	Combined hydraulic/pneumatic tests	5/32
5.8.8	Leak testing	5/32
5.8.9	Vessel nameplate	5/32
5.8.10	Final inspection	5/33
5.9	Inspection requirements for cast components	5/34
5.9.1	Examination	5/34
5.9.2	Defects	5/34
5.9.3	Identification and marking	5/34

Annexes

- 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 strengths 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 X: Guidance for the tensile testing of 9% nickel steel weld metal using strain-gauged tensile specimens X/1
- Annex Z: Guidance on the application of PD 5500 to pressure vessels falling within the scope of the UK Pressure Equipment (Safety) Regulations 2016 and the EU Pressure Equipment Directive Z/1

Supplements

- Aluminium supplement: Requirements for aluminium and aluminium alloys in the design and construction of unfired pressure vessels Al/1
- Copper supplement: Requirements for copper and copper alloys in the design and construction of unfired pressure vessels Cu/1
- Duplex supplement: Requirements for duplex and super duplex steels (austenitic-ferritic stainless steels) in the design and construction of unfired pressure vessels Du/1
- Nickel supplement: Requirements for nickel and nickel alloys in the design and construction of unfired pressure vessels Ni/1
- Titanium supplement: Requirements for titanium and titanium alloys in the design and construction of unfired pressure vessels Ti/1

Index /

List of references v

List of figures

- Figure Form X – Certificate of Conformance – 1/12
- Figure Form X – Certificate of Conformance (*continued*) – 1/13
- Figure 1.6-1 – Relationship of thickness definitions 1/16
- Figure 3.5-1 – Dished ends 3/17
- Figure 3.5-2 – Design curves for unpierced dished ends 3/19
- Figure 3.5-3 – Conical shells: Vapour belt arrangement 3/21
- Figure 3.5-4 – Values of coefficient β for cone/cylinder intersection without knuckle 3/24

Figure 3.5-5 – Geometry of cone/cylinder intersection: large end	3/26
Figure 3.5-6 – Geometry of cone/cylinder intersection: small end	3/28
Figure 3.5-7 – Offset cone	3/28
Figure 3.5-8 – Positions of openings or nozzles in dished ends (for weld details see Annex E)	3/32
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 ($d/D < 1/3$)	3/35
Figure 3.5-10 – Design curves for flush nozzles in spherical shells ($d/D < 0.5$) and for flush nozzles in conical shells ($d/D < 1/3$)	3/36
Figure 3.5-11 – Design curves for flush nozzles in cylindrical shells ($0 < d/D < 0.3$)	3/37
Figure 3.5-12 – Design curves for flush nozzles in cylindrical shells ($0.2 < d/D \leq 1.0$)	3/38
Figure 3.5-13 – Nozzle in a conical shell	3/45
Figure 3.5-14 – Notation applicable to spheres	3/45
Figure 3.5-15 – Notation applicable to spheres	3/45
Figure 3.5-15a – Notation applicable to oblique nozzles in spheres	3/46
Figure 3.5-16 – Notation applicable to spheres	3/46
Figure 3.5-17 – Notation applicable to spheres	3/46
Figure 3.5-18 – Notation applicable to cylinders	3/47
Figure 3.5-19 – Notation applicable to cylinders	3/47
Figure 3.5-20 – Notation applicable to cylinders	3/47
Figure 3.5-21 – Notation applicable to cylinders	3/48
Figure 3.5-22 – Protruding rim	3/48
Figure 3.5-23 – Flush rim	3/48
Figure 3.5-24 – Arrangement factor g	3/49
Figure 3.5-25 – Nozzle compensation	3/50
Figure 3.5-26 – Notation applicable to spheres and cylinders	3/50
Figure 3.5-27 – Notation applicable to spheres and cylinders	3/51
Figure 3.5-28 – Notation applicable to spheres and cylinders	3/51
Figure 3.5-29 – Modified flush nozzle compensation	3/52
Figure 3.5-30 – Modified protruding nozzle compensation	3/53
Figure 3.5-31 – Maximum branch to body thickness ratio	3/61
Figure 3.5-32 – Reinforcement of openings and branches	3/62
Figure 3.5-33 – Reinforcement of non-radial branches	3/74
Figure 3.5-34 – Typical welded flat ends and covers (for typical weld joint details, see Figure E.38)	3/83
Figure 3.5-35 – Typical non-welded flat ends and covers	3/84
Figure 3.5-36 – Factor C for welded flat ends for $e_{cyl}/e_{cyl0} = 1$ to 3	3/85
Figure 3.5-37 – Factor C for welded flat ends for $e_{cyl}/e_{cyl0} = 3$ to > 10	3/86
Figure 3.5-38 – Typical stays: areas supported by stays	3/89
Figure 3.5-39 – Spherically domed and bolted end (narrow faced gasket)	3/92
Figure 3.6-1 – Effective lengths of cylinder	3/116
Figure 3.6-2 – Values of ε	3/118
Figure 3.6-3 – Values of n_{cyl}	3/119
Figure 3.6-4 – Values of Δ	3/120
Figure 3.6-5 – Stiffening ring with unsupported section	3/121
Figure 3.6-6 – Stiffening ring details	3/122
Figure 3.6-7 – Values of β	3/127
Figure 3.6-8 – Conical sections: typical stiffeners	3/128
Figure 3.8-1 – Loose keyed flange with mating components	3/149
Figure 3.8-2 – Forces and lever arms on loose keyed flange	3/149
Figure 3.8-3 – Typical lip arrangement for swing bolted flange	3/150
Figure 3.8-4 – Location of gasket load reaction	3/172
Figure 3.8-5 – Values of T , U , Y and Z	3/173
Figure 3.8-6 – Values of F (integral method factors)	3/174
Figure 3.8-7 – Values of V (integral method factors)	3/174
Figure 3.8-8 – Values of F_L (loose hub flange factors)	3/175

- Figure 3.8-9 – Values of V_L (loose hub flange factors) 3/175
- Figure 3.8-10 – Values of f (hub stress correction factors) 3/176
- Figure 3.8-11 – Ungasketted, seal-welded-type flanges 3/176
- 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 3/177
- Figure 3.9-1 – Shell and tube heat exchangers 3/196
- Figure 3.9-2 – Tubesheet layout 3/202
- Figure 3.9-3 – Determination of area S 3/202
- Figure 3.9-4 – Design curves: determination of C_0 3/204
- Figure 3.9-5 – Design curves: determination of F_o 3/205
- Figure 3.9-6 – Design curves: determination of F_o 3/206
- Figure 3.9-7 – Design curves: determination of F_i 3/207
- Figure 3.9-8 – Design curves: determination of F_i 3/208
- Figure 3.9-9 – Typical clamped and simply supported configurations for floating head or U-tubesheets 3/209
- Figure 3.9-10 – Flexural efficiency: triangular layout 3/210
- Figure 3.9-11 – Flexural efficiency: square layout 3/211
- Figure 3.9-12 – Tubesheet: determination of F_q 3/214
- Figure 3.9-13 – Tubesheet: determination of H for $X_a > 4.0$ 3/215
- Figure 3.9-14 – Tubesheet: determination of H for $X_a < 4.0$ 3/216
- Figure 3.9-15 – Determination of the buckling length L_k 3/219
- Figure 3.10-1 – Butt welds in plates of unequal thickness 3/225
- Figure 3.10-2 – Butt welds with offset of median lines 3/226
- Figure 3.11-1 – Some acceptable types of jacketed vessels 3/230
- Figure 3.11-2 – Typical blocking ring and sealer ring construction 3/231
- Figure 3.11-3 – Typical limpet coil 3/232
- Figure 3.11-4 – Limpet coil arrangements 3/232
- Figure 4.2-1 – Profile gauge details and application 4/10
- Figure 4.3-1 – A thin limpet coil weld detail 4/13
- Figure 5.6-1 – Illustration of welded joints for non-destructive testing 5/10
- Figure 5.7-1 – Partial non-destructive testing (NDT) category 2 constructions 5/19
- 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/14
- Figure B.1 – Stresses in a cylindrical shell under combined loading B/4
- Figure B.2 – Stresses in a spherical shell under combined loading B/5
- Figure B.3 – Stresses in a conical shell under combined loading B/6
- Figure B.4 – Global loads B/8
- 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/8
- Figure C.3 – Fatigue design $S-N$ curves for weld details applicable for temperatures up to and including those specified in C.1.2.3 C/9
- Figure C.4 – Fatigue design $S-N$ curves for bolting applicable for temperatures up to and including those specified in C.1.2.3 C/10
- Figure C.5 – Interaction criteria for assessing coplanar embedded slag inclusions C/28
- Figure C.6 – Stress measurement points for determining structural hot spot stress at a weld toe C/30
- Figure C.7 – Deviations from design shape at seam welds C/34
- Figure C.8 – Weld toe dressing C/36
- 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/25
- Figure D.5 – Location of Charpy V-notch specimens in weld metal (stress relieved vessels) D/25
- Figure D.6 – Location of Charpy V-notch specimens in heat affected zone D/25
- Figure D.7 – Example of detail for avoidance of severe thermal gradients D/26
- 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
- Figure E.6 – Standard weld details E/14
- Figure E.7a) – Limitations on geometry of fillet weld applied to the edge or a part E/15
- Figure E.7b) – Transverse and longitudinal sections of branch connections E/15
- Figure E.8 – Weld details for set-in branches E/16
- Figure E.9 – Set-on branches E/18
- Figure E.10 – Set-on branches E/19
- Figure E.11 – Set-on branches E/20
- Figure E.12 – Set-on branches E/21
- Figure E.13 – Set-on branches E/22
- Figure E.14 – Set-on branches E/23
- Figure E.15 – Set-on branches E/24
- Figure E.16 – Set-in branches: fillet welded connections E/25
- Figure E.17 – Set-in branches: partial penetration butt welded connections E/26
- Figure E.18 – Set-in branches: full penetration connections E/27
- Figure E.19 – Set-in branches: full penetration connections E/28
- Figure E.20 – Set-in branches: full penetration connections with asymmetrical butt joints E/29
- Figure E.21 – Set-in branches: full penetration connections welded from one side only E/30
- Figure E.22 – Forged branch connections E/31
- Figure E.23 – Forged branch connections E/32
- Figure E.24 – Set-on branches with added compensation rings E/33
- Figure E.25 – Set-in branches with added compensation rings E/34
- Figure E.26 – Set-in branches with added compensation rings E/35
- Figure E.27 – Set-in branches with added compensation rings E/36
- Figure E.28 – Set-in branches with added compensation rings E/37
- Figure E.29 – Studded connections E/38
- Figure E.30 – Socket welded and screwed connections E/40
- Figure E.31 – Flanges E/41
- Figure E.32 – Flanges E/42
- Figure E.33 – Flanges E/44
- Figure E.34 – Jacketed vessels: typical vessel/blocking ring attachments E/45
- Figure E.35 – Jacketed vessels: typical blocking ring/jacket attachments E/45
- Figure E.36 – Jacketed vessels: typical sealer rings E/47
- Figure E.37 – Jacketed vessels: typical through connections E/48
- Figure E.38 – Flat ends and covers E/49
- Figure E.39 – Tubeplate to shell connections: accessible for welding on *both* sides of the shell E/52
- Figure E.40 – Tubeplate to shell connections: accessible for welding from *outside* of shell only E/53

- Figure E.41 – Tubeplate to shell connections: accessible for welding on *both* sides of shell E/54
- Figure E.42 – Tubeplate to shell connections E/55
- Figure E.43 – Tubeplate to shell connections E/57
- Figure E.44 – Tubeplate to shell connections E/58
- Figure G.2.2-1 – Restriction on vessel/attachment geometry G/5
- 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/6
- 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/8
- Figure G.2.2-6 – Cylindrical shells with radial load: circumferential moment per millimetre width G/9
- Figure G.2.2-7 – Cylindrical shells with radial load: longitudinal moment per millimetre width G/10
- Figure G.2.2-8 – Cylindrical shells with radial load: circumferential membrane force per millimetre width G/11
- Figure G.2.2-9 – Cylindrical shells with radial load: longitudinal membrane force per millimetre width G/12
- Figure G.2.2-10 – Circumferential bending moment due to a radial line load variation round circumference G/15
- Figure G.2.2-11 – Longitudinal moment from radial line load variation round circumference G/16
- Figure G.2.2-12 – Circumferential membrane force from radial line load variation round circumference G/17
- Figure G.2.2-13 – Longitudinal membrane force from radial line load variation round circumference G/18
- 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/24
- 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/25
- 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/26
- Figure G.2.3-1 – Circumferential moment G/29
- Figure G.2.3-2 – Longitudinal moment G/29
- Figure G.2.3-3 – Sector stresses G/34
- Figure G.2.3-4 – Notation for external loads at a nozzle or attachment on a cylindrical shell G/35
- Figure G.2.4-1 – Chart for finding s and u G/42
- Figure G.2.4-2 – Spherical shell subjected to a radial load G/43
- Figure G.2.4-3 – Deflections of a spherical shell subjected to a radial load W G/44
- Figure G.2.4-4 – Meridional moment M_x in a spherical shell subjected to radial load W G/45
- Figure G.2.4-5 – Circumferential moment M_ϕ in a spherical shell subjected to a radial load W G/46
- Figure G.2.4-6 – Meridional force N_x in a spherical shell subjected to a radial load W G/47
- Figure G.2.4-7 – Circumferential force N_ϕ in a spherical shell subjected to a radial load W G/48
- Figure G.2.4-8 – Spherical shell subjected to an external moment G/50

- Figure G.2.4-9 – Deflections of a spherical shell subjected to an external moment M G/51
- Figure G.2.4-10 – Meridional moment M_x in a spherical shell subjected to an external moment M G/52
- Figure G.2.4-11 – Circumferential moment M_ϕ in a spherical shell subjected to an external moment M G/53
- Figure G.2.4-12 – Meridional force N_x in a spherical shell subjected to an external moment M G/54
- Figure G.2.4-13 – Circumferential force N_ϕ in a spherical shell subjected to an external moment M G/55
- Figure G.2.5-1 – Maximum stress in sphere for internal pressure (flush nozzles) G/60
- Figure G.2.5-2 – Maximum stress in sphere for internal pressure (protruding nozzles) G/61
- Figure G.2.5-3 – Maximum stress in sphere for thrust loading (flush nozzles) G/61
- Figure G.2.5-4 – Maximum stress in sphere for thrust loading (protruding nozzles) G/62
- Figure G.2.5-5 – Maximum stress in sphere for moment loading (flush nozzles) G/62
- Figure G.2.5-6 – Maximum stress in sphere for moment loading (protruding nozzles) G/63
- Figure G.2.5-7 – Maximum stress in sphere for shear loading (flush nozzles) G/63
- Figure G.2.5-8 – Maximum stress in sphere for shear loading (protruding nozzles) G/64
- Figure G.2.6-1 – Shakedown values for pressure loading (flush nozzle) G/65
- Figure G.2.6-2 – Shakedown values for pressure loading (protruding nozzle) G/66
- Figure G.2.6-3 – Shakedown values for thrust and moment loadings (flush nozzle) G/66
- Figure G.2.6-4 – Shakedown values for thrust and moment loadings (protruding nozzle) G/67
- Figure G.2.6-5 – Shakedown values for thrust and moment loadings (flush nozzle) G/67
- Figure G.2.6-6 – Shakedown values for thrust and moment loadings (protruding nozzle) G/68
- Figure G.2.6-7 – Shakedown values for thrust and moment loadings (flush nozzle) G/68
- Figure G.2.6-8 – Shakedown values for thrust and moment loadings (protruding nozzle) G/69
- Figure G.2.8-1 – Moment and force vectors G/72
- Figure G.2.8-2 – Allowable axial nozzle load G/74
- Figure G.2.8-3 – Allowable nozzle moment G/75
- Figure G.2.8-4 – Calculation factor C_2 G/80
- Figure G.2.8-5 – Calculation factor C_3 G/80
- Figure G.2.8-6 – Calculation factor C_4 G/81
- Figure G.3.1-1 – Typical brackets G/88
- Figure G.3.1-2 – Typical reinforcing plates on cylindrical shells G/89
- Figure G.3.2-1 – Typical ring support G/91
- Figure G.3.2-2 – Typical steelwork under ring support G/92
- Figure G.3.2-3 – Leg supports for vertical vessels G/92
- Figure G.3.2-4 – Typical ring girder G/95
- Figure G.3.3-1 – Typical supports for horizontal vessels G/97
- Figure G.3.3-2 – Cylindrical shell acting as beam over supports G/99
- Figure G.3.3-3 – Factor for bending moment at mid-span G/100
- Figure G.3.3-4 – Factors for bending moment at supports G/101
- Figure G.3.3-5 – Portion of shell ineffective against longitudinal bending G/102
- Figure G.3.3-6 – Circumferential bending moment diagrams G/108

- Figure G.3.3-7 – Saddle supports G/113
 Figure G.3.3-8 – Typical ring stiffeners G/114
 Figure G.3.3-9 – Graph of rigid end factor, F_A G/119
 Figure G.3.3-10 – Graph of saddle width factor, F_B G/120
 Figure G.3.3-11 – Graph of saddle interaction factor, F_I G/121
 Figure G.3.3-12 – Graph of length change factor, F_L G/122
 Figure G.3.3-13 – Graph of saddle wrap-round factor, F_θ G/123
 Figure G.4.3-1 – Nozzle geometry G/129
 Figure G.4.3-2 – Transient fluid and metal temperatures G/129
 Figure G.4.3-3 – Inner surface thermal stress factors K_1 and k_1 G/130
 Figure G.4.3-4 – Outer surface thermal stress factors K_2 and k_2 G/131
 Figure G.4.3-5 – Mean temperature factors K_b and k_s G/132
 Figure J.1 – Typical pressure term relationships J/2
 Figure L.1 – Tolerances on nozzles L/2
 Figure L.2 – Tolerances after erection of a vertical^{a)} vessel L/3
 Figure L.3 – Tolerances on saddles and supports for horizontal vessels L/4
 Figure L.4 – Tolerances on saddles and supports for vertical vessels L/5
 Figure T.1 – Tube to tubeplate connections, tube end fusion T/3
 Figure T.2 – Tube to tubeplate connections, castellated weld T/4
 Figure T.3 – Tube to tubeplate connections, plain fillet weld T/5
 Figure T.4 – Tube to tubeplate connections, front face bore fillet weld T/6
 Figure T.5 – Tube to tubeplate connections, groove plus fillet weld T/7
 Figure T.6 – Tube to tubeplate connections, groove weld T/8
 Figure T.7 – Tube to tubeplate connections, back face inset bore weld T/9
 Figure T.8 – Tube to tubeplate connections, back face stub bore weld T/10
 Figure T.9 – General arrangement of push-out test piece for front face and back face welds T/13
 Figure T.10 – Push-out test piece for tube ends on triangular pitch T/14
 Figure T.11 – Push-out test piece for tube ends on square pitch T/15
 Figure T.12 – Test piece for the tube ends on triangular pitch T/16
 Figure T.13 – Typical examples of macro-examination specimens T/17
 Figure T.14 – Typical examples of macro-examination specimens T/19
 Figure W.1-1 – Stiffener proportions W/7
 Figure W.2-1 – Vessel on saddle supports W/16
 Figure W.2-2 – Internal ring stiffener in plane of saddle W/27
 Figure W.2-3 – External ring stiffeners adjacent to the saddle W/27
 Figure W.2-4 – Vessel on ring and leg support W/32
 Figure W.2-5 – Channel and shell as ring girder W/35
 Figure W.6-1 – Potential failure locations in circumferential lap joint W/53
 Figure W.6-2 – Maximum axisymmetric principal stress contours in lap joint W/59
 Figure W.6-3 – Circumferential stress in lap joint W/60
 Figure W.6-4 – Loading spectrum W/74
 Figure W.6-5 – Reservoir cycle count W/75
 Figure X.1 – Dimensions of tensile test specimen X/2
 Figure X.2 – Method of attaching strain gauges X/2
 Figure X.3 – Test circuit X/2
 Figure Al.E.1 – Typical full penetration joint preparations for one-sided welding only: aluminium and its alloys Al/24
 Figure Al.E.2 – Typical full penetration joint preparations for two-sided welding only: aluminium and its alloys Al/25
 Figure Al.E.3 – Typical full penetration joint preparations for one-sided welding with temporary backing or permanent backing: aluminium and its alloys Al/27
 Figure Cu.E.1(1) – Typical full penetration joint preparation for one-sided welding only: copper and its alloys Cu/17
 Figure Cu.E.1(2) – Typical full penetration joint preparation for two-sided welding: copper and its alloys Cu/18

- 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/19
- Figure Cu.E.1(4) – Alternative joint preparations Cu/20
- Figure Cu.E.2(1) – Typical brazed joints for gunmetal bosses to copper vessels Cu/21
- Figure Du.D.1a) – Permissible design reference temperature/design reference thickness/required impact test temperature relationships for duplex and super duplex steels with $R_e \leq 385 \text{ N/mm}^2$ Du/14
- Figure Du.D.1b) – Permissible design reference temperature/design reference thickness/required impact test temperature relationships for duplex and super duplex steels with $R_e \leq 465 \text{ N/mm}^2$ Du/15
- Figure Du.D.1c) – Permissible design reference temperature/design reference thickness/required impact test temperature relationships for duplex and super duplex steels with $R_e \leq 550 \text{ N/mm}^2$ Du/16

List of tables

- Table 1.4-1 – Purchase specification options 1/5
- Table 1.4-2 – Items for manufacturer, purchaser and/or Inspecting Authority agreement 1/7
- Table 2.1-1 – Material grouping 2/3
- Table 2.1-2 – List of materials covered by BS EN material standards 2/6
- Table 2.1-3 – Maximum chemical composition of steels 2/23
- Table 2.1-4 – Additional materials that may be used for category 3 construction 2/25
- Table 2.2-1 – Bolting materials for low-temperature 2/26
- Table 2.3-1 – Temperature above which time dependent properties shall be considered 2/28
- Table 3.2-1 – Load combinations 1/2
- Table 3.4-1 – Construction categories 3/11
- Table 3.5-1 – Values of factor for ellipsoidal ends 3/19
- Table 3.5-2 – Values of $e/D \times 10^3$ for unpierced dished ends in terms of h_e/D and p/f 3/20
- Table 3.5-3 – Values of coefficient β for cone/cylinder intersection without knuckle (for Figure 3.5-4) 3/25
- Table 3.5-4 – Thickness of nozzles 3/39
- Table 3.5-5 – Design values of e_{rb}/e_{rs} 3/40
- Table 3.5-5 – Design values of e_{rb}/e_{rs} 3/41
- Table 3.5-5 – Design values of e_{rb}/e_{rs} 3/42
- Table 3.5-6 – Values of $C_{e_{rs}}/e_{ps}$ for Figure 3.5-9, Figure 3.5-10 and Figure 3.5-11 when $e_{rb}/e_{rs} = 0$ 3/42
- Table 3.5-7 – Allowable taper/taper thread sizes 3/56
- 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) 3/87
- Table 3.6-1 – Values for G and N 3/109
- Table 3.6-2 – Definitions of cylinder lengths 3/110
- Table 3.6-3 – E values for ferritic and austenitic steels (modulus of elasticity) 3/111
- Table 3.6-4 – Values of $(\sigma_e/E) (d/e_w)^2$ for internal flat bar stiffeners 3/112
- Table 3.6-5 – Values of $(\sigma_e/E) (d/e_w)^2$ for external flat bar stiffeners 3/113
- Table 3.6-6 – Values of L_e/L_s 3/114
- Table 3.6-7 – Values of Z' 3/115
- Table 3.8-1 – Recommended design strength values for flange bolting materials^a 3/137
- Table 3.8-2 – Bolt root areas 3/139
- Table 3.8-3 – Recommended surface finish on gasket contact faces for body flanges and flanges fitted with covers 3/140
- Table 3.8-4 – Gasket materials and contact facings: gasket factors (m) for operating conditions and minimum design seating stress (y) 3/155
- Table 3.8-5 – Values of T , Z , Y and U (factors involving K) 3/158

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 (for other types of tubesheets C_o is obtained from Figure 3.9-4)	3/201
Table 3.9-2 – Values of F_r for typical tube joints	3/220
Table 4.2-1 – Circumference	4/7
Table 4.2-2 – Tolerance on depth of dished ends	4/8
Table 4.2-3 – Maximum permitted peaking	4/9
Table 4.2-4 – Maximum permitted peaking when special analysis is used	4/10
Table 4.5-1 – Requirements for post-weld heat treatment of ferritic steel vessels	4/19
Table 5.1-1 – Inspection stages in the course of which participation by the Inspecting Authority is mandatory	5/1
Table 5.1-2 – Other principal stages of inspection	5/2
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	5/16
Table 5.7-2 – Ultrasonic acceptance levels applicable to ferritic steels and weld metals in material groups 1 to 6, 7.1, 9 and 11, in the thickness range 7 mm to 100 mm inclusive	5/17
Table 5.7-3 – Visual and crack detection acceptance level	5/20
Table 5.7-4 – Radiographic acceptance levels (reassessment of category 2 construction)	5/23
Table 5.7-5 – Ultrasonic acceptance levels (reassessment of category 2 construction)	5/24
Table A.1 – Classification of stresses for some typical cases	A/9
Table C.1 – Details of fatigue design curves	C/7
Table C.2 – Classification of weld details	C/13
Table C.3 – Values of M_1 , M_2 and M_3	C/26
Table C.4 – Weld defect acceptance levels	C/28
Table C.5 – Details of fatigue design curves for joints with weld toe improvement	C/30
Table C.6 – Fatigue test factor F	C/31
Table D.1 – Design reference temperature for heat exchanger tubes ($^{\circ}\text{C}$)	D/5
Table D.2 – Required impact energy	D/8
Table D.3 – Minimum design reference temperature for omission of impact test (as allowed by D.6.2)	D/9
Table D.4 – Reference thickness of weld joint components e	D/10
Table G.2.2-1 – Values of K_1 and K_2	G/13
Table G.2.8-1 – Coefficients to define factors C_2 , C_3 or C_4	G/79
Table G.3.2-1 – Moments in a ring girder	G/93
Table G.3.3-1 – Design factors K_1 and K_2	G/103
Table G.3.3-2 – Design factors K_3 and K_4 and allowable tangential shearing stresses	G/105
Table G.3.3-3 – Design factor K_6	G/107
Table G.3.3-4 – Values of constants C_4 , C_5 , K_5 , K_7 , and K_8	G/112
Table G.3.3-5 – Values of K_9	G/115
Table G.3.3-6 – Coefficients for F_A , with $x = A/r$	G/116
Table G.3.3-7 – Coefficients for F_B , with $x = b_1/r$	G/117
Table G.3.3-8 – Coefficients for F_l , with $x = L_s/r$	G/117
Table G.3.3-9 – Coefficients for F_L , with $x = L/r$	G/117
Table G.3.3-10 – Coefficients for F_{θ} , with $x = \theta$ (in degrees)	G/118
Table G.3.3-11 – Values of K_{10} and K_{11}	G/124
Table G.4.3-1 – Circumferential stress factor C_1	G/135
Table G.4.3-2 – Bending stress factor C_2	G/136
Table G.4.3-3 – Meridional stress factor C_3	G/137
Table G.4.3-4 – Branch bending stress factor C_4	G/138
Table H.1 – Classification of materials	H/1
Table K.1-1 – Design strength values: index of steels	K/2

Table K.1-2 – Design strength values (N/mm ²)	K/4
Table K.1-3 – Design strength values (N/mm ²)	K/8
Table K.1-4 – Design strength values (N/mm ²)	K/12
Table K.1-5 – Design strength values (N/mm ²)	K/14
Table K.1-6 – Design strength values (N/mm ²)	K/17
Table K.1-7 – Design strength values (N/mm ²)	K/23
Table K.1-8 – Design strength values (N/mm ²)	K/26
Table K.1-9 – Design strength values (N/mm ²)	K/29
Table K.1-10 – Design strength values (N/mm ²)	K/31
Table K.1-11 – Design strength values (N/mm ²)	K/33
Table K.1-12 – Design strength values (N/mm ²)	K/35
Table T.1 – Tube to tubesheet joints: essential tests and the suitability of joint types for optional tests	T/10
Table T.2 – Range of tubeplate and tube thickness for approval of a welder	T/17
Table T.3 – Range of diameters for approval of a welder	T/18
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/10
Table W.1-7 – Measured radii and departure from mean circle	W/12
Table W.1-8 – Values of a_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/15
Table W.2-2 – Interpolation of Table G.3.3-3 for K_6	W/22
Table W.2-3 – Summary of stresses (N/mm ²)	W/36
Table W.6-1 – Results of calculations of allowable stress range	W/59
Table W.6-2 – Summary of results from Example 1	W/60
Table W.6-3 – Summary of results for Example 2	W/67
Table W.6-4 – Cyclic loading regime for case A	W/71
Table W.6-5 – Fatigue load cycle stress ranges	W/72
Table W.6-6 – Summary of damage calculation values for case A	W/72
Table W.6-7 – Cyclic loading regime for case B	W/72
Table W.6-8 – Fatigue load cycle stress ranges	W/75
Table W.6-9 – Summary of damage calculation for case B	W/76
Table W.6-10 – Summary of results	W/77
Table W.C.1 – Thermal stress	W/81
Table Z.1 – PD 5500 compliance with PER ESRs as amended by PSMR	Z/3
Table Z.2 – PD 5500 compliance with PED ESRs	Z/9
Table Al.2.1-1 – Material grouping	Al/1
Table Al.2.3-1 – Design strength values (N/mm ²): aluminium and aluminium alloys	Al/3
Table Al.3.4-1 – Construction categories	Al/5
Table Al.3.6-3 – E values for aluminium alloys (modulus of elasticity)	Al/6
Table Al.3.8-1 – Recommended design strength values for flange bolting materials	Al/6
Table Al.5.7-1 – Acceptance levels	Al/15
Table Al.5.8-1 – Principal stages of inspection	Al/21
Table Cu.2.1-1 – Material grouping	Cu/1
Table Cu.2.3-1 – Design strength values (N/mm ²) of copper and copper alloys	Cu/3
Table Cu.2.3-2 – BS EN material standards for copper and copper alloys	Cu/4
Table Cu.3.4-1 – Construction categories	Cu/5
Table Cu.3.5-4 – Thickness of nozzles	Cu/6
Table Cu.3.6-3 – E values for copper and copper alloys (modulus of elasticity)	Cu/6
Table Cu.4.2-1 – Hot forming temperatures	Cu/8

Table Cu.5.5-1 – Mechanical test requirements for butt weld procedure and welder approval	Cu/11
Table Cu.5.7-1 – Acceptance levels	Cu/14
Table Du.2.1-2 – List of duplex and super duplex steels covered by BS EN material standards	Du/2
Table Du.2.1-3 List of duplex and super duplex steels covered by ASTM material standards	Du/3
Table Du.2.3-1 – Design strength values (N/mm ²) for BS EN duplex and super duplex steels	Du/5
Table Du.2.3-2 – Design strength values (N/mm ²) for ASTM A240, A789, A790, A182, A479 and A815 duplex and super duplex steels	Du/5
Table Du.3.4-1 – Construction categories	Du/6
Table Du.3.6-3 – <i>E</i> values for duplex steels (modulus of elasticity)	Du/7
Table Ni.2.1-1 – Material grouping	Ni/1
Table Ni.2.3-1 – Design strength values (N/mm ²) for nickel and nickel alloy plate conforming to BS 3072	Ni/3
Table Ni.2.3-2 – Design strength values (N/mm ²) for nickel and nickel alloy seamless tube conforming to BS 3074	Ni/4
Table Ni.2.3-3 – Design strength values (N/mm ²) for nickel and nickel alloy seamless tube conforming to BS 3074	Ni/4
Table Ni.2.3-4 – Design strength values (N/mm ²) for nickel and nickel alloy seamless tube conforming to BS 3074	Ni/5
Table Ni.2.3-5 – Design strength values (N/mm ²) for nickel and nickel alloy forgings conforming to BS 3076	Ni/5
Table Ni.2.3-6 – BS EN material standards for nickel alloys	Ni/5
Table Ni.3.4-1 – Construction categories	Ni/6
Table Ni.3.6-3 – <i>E</i> values for nickel alloys (modulus of elasticity)	Ni/8
Table Ni.4.2-1 – Maximum temperature for heating nickel and nickel alloys	Ni/8
Table Ni.4.5-1 – Annealing temperature for nickel and nickel alloys	Ni/11
Table Ti.2.1-1 – Material grouping	Ti/1
Table Ti.2.3-1 – Design strength values (N/mm ²): commercially pure titanium and titanium alloys of material specifications ASTM B265, B338, B348, B363, B381, B861, and B862	Ti/3
Table Ti.3.4-1 – Construction categories	Ti/5
Table Ti.3.6-3 – <i>E</i> values for titanium alloys (modulus of elasticity)	Ti/6
Table Ti.4.2.2-1 – Minimum bend radii	Ti/7
Table Ti.4.5-1 – Heat treatment temperatures for commercially pure titanium and titanium alloys	Ti/10

Summary of pages

This document comprises a front cover, an inside front cover, pages i to xxii, pages 1/1 to 5/34, pages A/1 to Z/18, pages Al/1 to Ti/12, pages I to XVI, an inside back cover and a back cover.

Foreword

Publishing information

This Published Document is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 January 2024. It was prepared by Technical Committee PVE/1, *Pressure vessels*, to provide a specification for the design, manufacture, inspection and testing of pressure vessels manufactured from carbon, ferritic alloy and austenitic steels, aluminium and aluminium alloys, copper and copper alloys, nickel and nickel alloys, titanium and titanium alloys, and duplex and super duplex steels. A list of organizations represented on this committee can be obtained on request to the committee manager.

Supersession

PD 5500:2024+A2:2025 supersedes PD 5500:2024+A1:2024, which is withdrawn. 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.

Information about this document

Text introduced or altered by Amendments No.1 and No. 2, respectively is indicated in the text by tags   and  . Minor editorial changes are not tagged.

For this edition, the opportunity has been taken to make some minor editorial changes. For Amendment No. 2, two new Enquiry Cases have been added.

PD 5500 is amended annually and the DPC (draft for public comment) is normally issued in January each year. Users of the specification are encouraged to review and comment on the proposed amendments in the DPC. This can be done by registering on the BSI standards development portal at <https://standardsdevelopment.bsigroup.com/> or by obtaining a hard copy from BSI Customer Services.

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 first published in May 2002. A new edition of EN 13445 was published in 2021.

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, 2014/68/EU (see article 12 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 13345.

Following the UK's withdrawal from the EU, the PED 2014/68/EU, as implemented by the Pressure Equipment (Safety) Regulations 2016, is no longer applicable for vessels placed on the market in Great Britain (England, Scotland and Wales). For pressure vessels placed on the market in Northern Ireland, the PED, as implemented by the Pressure Equipment (Safety) Regulations 2016, as modified by Schedule 2 of The Pressure Vessels (Amendment) (Northern Ireland) (EU Exit) Regulations 2020 is still applicable – see 1.1.3, 1.4 and Annex Z.

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".

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.

Presentational conventions

The provisions of this document are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

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Compliance with a Published Document cannot confer immunity from legal obligations.

Summary of Changes

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

Tags (**A₂**) and (**A₂**) on replacement pages will indicate that changes of technical 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.

Page No.	Status/Amendment designation
Front cover	Amendment 2
Inside front cover	Amendment 2
i to xxii	Amendment 2
<i>Section 1</i>	
1/1 to 1/2	Amendment 1
1/3 to 1/4	No amendment
1/5 to 1/10	Amendment 1
1/11 to 1/16	No amendment
<i>Section 2</i>	
2/1 to 2/2	Amendment 1
2/3 to 2/4	No amendment
2/5 to 2/6	Amendment 2
2/7 to 2/22	No amendment
2/23 to 2/24	Amendment 1
2/25 to 2/26	Amendment 2
2/27 to 2/30	Amendment 1
<i>Section 3</i>	
3/1 to 3/4	Amendment 1
3/5 to 3/8	No amendment
3/9 to 3/18	Amendment 1
3/19 to 3/20	No amendment
3/21 to 3/22	Amendment 1
3/23 to 3/28	No amendment
3/29 to 3/30	Amendment 1
3/31 to 3/32	No amendment
3/33 to 3/34	Amendment 2
3/35 to 3/52	No amendment
3/53 to 3/54	Amendment 1
3/55 to 3/56	No amendment
3/57 to 3/58	Amendment 1
3/59 to 3/76	No amendment
3/77 to 3/82	Amendment 1
3/83 to 3/86	No amendment
3/87 to 3/92	Amendment 1
3/93 to 3/94	No amendment
3/95 to 3/98	Amendment 1
3/99 to 3/102	No amendment
3/103 to 3/104	Amendment 2
3/105 to 3/108	No amendment
3/109 to 3/112	Amendment 2
3/113 to 3/114	No amendment
3/115 to 3/118	Amendment 2
3/119 to 3/130	No amendment
3/131 to 3/132	Amendment 2
3/133 to 3/134	No change
3/135 to 3/138	Amendment 1
3/139 to 3/140	Amendment 2
3/141 to 3/148	Amendment 1
3/149 to 3/176	No amendment
3/177 to 3/194	Amendment 1
3/195 to 3/198	Amendment 2
3/199 to 3/200	Amendment 1
3/201 to 3/202	No amendment
3/203 to 3/204	Amendment 1
3/205 to 3/206	No amendment
3/207 to 3/210	Amendment 2
3/211 to 3/212	No amendment
3/213 to 3/214	Amendment 1

3/215 to 3/216 3/217 to 3/220 3/221 to 3/222 3/223 to 3/224 3/225 to 3/226 3/227 to 3/228 3/229 to 3/230 3/231 to 3/232 3/233 to 3/234 3/235 to 3/236	No amendment Amendment 1 Amendment 2 Amendment 1 No amendment Amendment 1 No amendment Amendment 1 Amendment 2 No amendment
<i>Section 4</i>	
4/1 to 4/10 4/11 to 4/16 4/17 to 4/18 4/19 to 4/20 4/21 to 4/22	No amendment Amendment 2 No amendment Amendment 2 No amendment
<i>Section 5</i>	
5/1 to 5/2 5/3 to 5/6 5/7 to 5/8 5/9 to 5/10 5/11 to 5/14 5/15 to 5/16 5/17 to 5/28 5/29 to 5/30 5/31 to 5/32 5/33 to 5/34	No amendment Amendment 1 No amendment Amendment 1 Amendment 2 Amendment 1 No amendment Amendment 2 Amendment 1 No amendment
<i>Annex A</i>	
A/1 to A/2 A/3 to A/4 A/5 to A/6 A/7 to A/16	Amendment 1 No amendment Amendment 1 No amendment
<i>Annex B</i>	
B/1 to B/2 B/3 to B/6 B/7 to B/8 B/9 to B/10	Amendment 1 No amendment Amendment 1 No amendment
<i>Annex C</i>	
C/1 to C/2 C/3 to C/4 C/5 to C/38	No amendment Amendment 1 No amendment
<i>Annex D</i>	
D/1 to D/6 D/7 to D/8 D/9 to D/28	No amendment Amendment 2 No amendment
<i>Annex E</i>	
E/1 to E/58	No amendment

<i>Annex G</i>	
G/1 to G/30	No amendment
G/31 to G/32	Amendment 1
G/33 to G/34	No amendment
G/35 to G/38	Amendment 1
G/39 to G/68	No amendment
G/69to G/70	Amendment 1
G/71 to G/84	No amendment
G/85 to G/86	Amendment 1
G/87 to G/92	No amendment
G/93 to G/94	Amendment 1
G/95to G/102	No amendment
G/103 to G/114	Amendment 1
G/115 to G/124	No amendment
G/125 to G/126	Amendment 1
G/127 to G/1	No amendment
<i>Annex H</i>	
H/1 to H/4	No amendment
<i>Annex J</i>	
J/1 to J/2	No amendment
<i>Annex K</i>	
K/1 to K/2	Amendment 2
K/3 to K/38	Amendment 1
<i>Annex L</i>	
L/1 to L/6	No amendment
<i>Annex M</i>	
M/1 to M/2	No amendment
<i>Annex N</i>	
N/1 to N/4	No amendment
<i>Annex Q</i>	
Q/1 to Q/2	Amendment 1
Q/3 to Q/4	No amendment
<i>Annex R</i>	
R/1 to R/2	No amendment
<i>Annex S</i>	
S/1 to S/2	No amendment
<i>Annex T</i>	
T/1 to T/20	No amendment
<i>Annex U</i>	
U/1 to U/4	No amendment
<i>Annex V</i>	
V/1 to V/4	No amendment

<i>Annex W</i>	
W/1 to W/2	No amendment
W/3 to W/4	Amendment 1
W/5 to W/6	No amendment
W/7 to W/10	Amendment 1
W/11 to W/14	No amendment
W/15 to W/22	Amendment 1
W/23 to W/28	No amendment
W/29 to W/30	Amendment 1
W/31 to W/32	No amendment
W/33 to W/36	Amendment 1
W/37 to W/40	No amendment
W/41 to W/44	Amendment 1
W/45 to W/50	No amendment
W/51 to W/54	Amendment 1
W/55 to W/60	No amendment
W/61 to W/62	Amendment 1
W/63 to W/66	No amendment
W/67 to W/68	Amendment 1
W/69 to W/84	No amendment
<i>Annex X</i>	
X/1 to X/2	Amendment 1
<i>Annex Z</i>	
Z/1 to Z/4	Amendment 1
Z/5 to Z/14	No amendment
Z/15 to Z/16	Amendment 1
Z/17 to Z/18	No amendment
<i>Aluminium supplement</i>	
Al/1 to Al/6	Amendment 1
Al/7 to Al/8	No amendment
Al/9 to Al/10	Amendment 2
Al/11 to Al/16	No amendment
Al/17 to Al/20	Amendment 2
Al/21 to Al/28	No amendment
<i>Copper supplement</i>	
Cu/1 to Cu/2	Amendment 1
Cu/3 to Cu/4	Amendment 2
Cu/5 to Cu/6	Amendment 1
Cu/7 to Cu/8	No amendment
Cu/9 to Cu/10	Amendment 2
Cu/11 to Cu/22	No amendment
<i>Duplex supplement</i>	
Du/1 to Du/4	Amendment 2
Du/5 to Du/6	Amendment 1
Du/7 to Du/18	No amendment
<i>Nickel supplement</i>	
Ni/1 to Ni/2	Amendment 2
Ni/3 to Ni/4	Amendment 1
Ni/5 to Ni/8	Amendment 2
Ni/9 to Ni/12	No amendment
<i>Titanium supplement</i>	
Ti/1 to Ti/6	Amendment 1
Ti/75 to Ti/12	No amendment
<i>Index</i>	
I to IV	No amendment

<i>List of references</i>	
V to VI	Amendment 1
VII to X	Amendment 2
XI to XII	Amendment 1
XIII to XIV	Amendment 2
XV to XVI	No amendment
<i>Enquiry Cases: Introduction</i>	
EC/1 to EC/4	Amendment 2
<i>Enquiry Case 33</i>	
EC/1 to EC/8	No amendment
<i>Enquiry Case 73</i>	
EC/1 to EC/2	Amendment 1
<i>Enquiry Case 82</i>	
EC/1 to EC/2	Amendment 1
<i>Enquiry Case 91</i>	
EC/1 to EC/2	Amendment 1
EC/2 to EC/6	No amendment
<i>Enquiry Case 107</i>	
EC/1 to EC/2	No amendment
<i>Enquiry Case 123</i>	
EC/1 to EC/2	No amendment
<i>Enquiry Case 127</i>	
EC/1 to EC/26	No amendment
<i>Enquiry Case 128</i>	
EC/1 to EC/2	Amendment 1
EC/3 to EC/4	No amendment
<i>Enquiry Case 133</i>	
EC/1 to EC/2	Amendment 1
EC/3 to EC/4	No amendment
EC/5 to EC/8	Amendment 1
<i>Enquiry Case 134</i>	
EC/1 to EC/2	Amendment 1
<i>Enquiry case 135</i>	
EC/1 to EC/2	No amendment
<i>Enquiry Case 137</i>	
EC/1 to EC/22	No amendment
<i>Enquiry Case 138</i>	
EC/1 to EC/6	No amendment
<i>Enquiry Case 139</i>	
EC/1 to EC/2	No amendment
EC/3 to EC/12	Amendment 1
EC/13 to EC/16	No amendment
EC/17 to EC/18	Amendment 1
EC/19 to EC/20	No amendment
<i>Enquiry Case 140</i>	
EC/1 to EC/2	Amendment 1
EC/3 to EC/4	No amendment
<i>Enquiry Case 141</i>	
EC/1 to EC/2	Amendment 1
EC/3 to EC/6	No amendment

<i>Enquiry Case 142</i>	
EC/1 to EC/2	No amendment
<i>Enquiry Case 144</i>	
EC/1 to EC/4	Amendment 1
<i>Enquiry Case 145</i>	
EC/1 to EC/46	Amendment 2
<i>Enquiry Case 147</i>	
EC/1 to EC/4	Amendment 2

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 new unfired 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.

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.

- 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 (see 1.3.3 and 1.4.3). The competent engineering Inspection Authority or Organization shall be one of the following:
- a) an organization accredited to BS EN ISO/IEC 17020:2012, to Type A independence criteria, for inspection in the subject matter of this specification, for pressure vessels placed on the market; or
 - b) competent personnel of a separate engineering inspection department maintained by the purchaser of the vessel and accredited to BS EN ISO/IEC 17020:2012, to Type B independence criteria, for inspection in the subject matter of this specification, for pressure vessels for the purchaser’s own use and not for resale. An inspection department maintained by the manufacturer does not satisfy this requirement except:
 - 1) that specific responsibilities may be delegated at the discretion of the Inspecting Authority or Organization; or
 - 2) in the case of vessels for the manufacturer’s own use and not for resale; or
 - c) an organization accredited by the local Regulating Authority in countries outside the UK and the EU and in circumstances where the Pressure Equipment (Safety) Regulations 2016 (PER) and the Pressure Equipment Directive 2014/68/EU (PED) do not apply.

NOTE 1 Within the UK, the United Kingdom Accreditation Service (UKAS) acts on behalf of the regulating authority in accrediting inspection bodies.

NOTE 2 In Great Britain (England, Scotland and Wales), approved bodies and user inspectorates are appointed by the UK government for carrying out specified duties under the PER, as amended by Schedule 24 of The Product Safety and Metrology etc. (Amendment etc.) (EU Exit) Regulations 2019.

NOTE 3 In Northern Ireland, approved bodies and user inspectorates are appointed by the UK government for carrying out specified duties under the PER, as amended by Schedule 2 of The Pressure Vessels (Amendment) (Northern Ireland) (EU Exit) Regulations 2020.

NOTE 4 In the European Union, notified bodies and user inspectorates are appointed by member states of the EU for carrying out specified duties under the EU PED, or any national implementation thereof.

NOTE 5 In countries outside the UK and the EU, local regulations can require the appointment of an inspection organization accredited by the local Regulating Authority. The role of these inspection organizations is separate from that of the Inspecting Authority as defined in 1.3.3, but in practice one organization can perform both functions.

This specification applies only to vessels made by manufacturers 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.
- 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 σ_A strength σ_A 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:

- chapter 6.8, clause 6.8.2 of ADR (European Agreement concerning International Carriage of Dangerous Goods by Road) 2019; in particular relating to static and dynamic stresses in motion, protection of the shell and

¹⁾ 1 mbar = 10² N/m² = 100 Pa.
1 bar = 10⁵ N/m² = 0.1 N/mm² = 100 kPa.

supports and fittings, minimum thickness and the provision of anti-surge plates;

- *chapter 9.7, clause 9.7.5.1 of ADR relating to stability.*

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 are subject to the Pressure Systems Safety Regulations, 2000 (SI 128).

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.

- 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 UK Pressure Equipment (Safety) Regulations or the EU Pressure Equipment Directive is given in Annex Z.

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 *Update Standards*.

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

organization or individual who buys the finished pressure vessel for its own use or as an agent for the owner (see 1.4.1)

1.3.2 manufacturer

organization that designs, constructs and tests the pressure vessel in accordance with the purchaser's order

NOTE 1 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).

NOTE 2 When this specification is being used to satisfy requirements of the UK PER or the EU PED, or any national implementation thereof, the definition of the manufacturer is different from that given above. For the purposes of this specification the definition given above shall apply.

1.3.3 Inspecting Authority

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

NOTE When this specification is being used to satisfy requirements of the UK PER or the EU PED, or any national implementation thereof, the approved body, notified body or user inspectorate can also act as the Inspecting Authority, and for permanent joining a Recognized Third Party Organization (RTPO) can act as the Inspecting Authority.

1.3.4 Regulating Authority

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 requirements of the UK PER or the EU PED 2014/68/EU, or any national implementation thereof. Care should be taken to differentiate between the legal responsibilities of the manufacturer under the PER or the PED and the responsibilities of the manufacturer under this specification given in 1.4.2 (see also Z.2).

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.

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 groups 5 and 6, and sub-group 9.2
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 dependent R_{A1} design strength R_{A1}
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 R_{A1} strength R_{A1} for operational reasons
3.4.2.1a)	Any special material tests
3.8.1, Note 4	Special requirements for leak tight flanges
3.9.4.1	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
4.5.3.1d)	PWHT
4.6.2	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 of parent materials
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

Table 1.4-1 Purchase specification options (continued)

Clause	Item
N.1.1	Use of Annex N for non-UK applications
N.1.3c)	Definition of information for purchase specification
N.2.2	Extent of 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
AI.5.4.1	Need for production control test plates
AI.5.5.3	Transverse tensile tests for welder approval
AI.5.6.6.6	Specific marking for NDT
Cu.5.4.1	Production control test pieces for C106 alloy
Du.4.2.1.2	Supplementary NDT in addition to visual inspection
Du.4.3.1	Production control test plates
Ti.4.6.2	Method used to remove the alpha case surface layer

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 design, construction and testing may elect to have any of these activities carried out by subcontractors. It 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 1.4-2 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
2.1.2.2.1	Choice of equivalent material group
Table 2.1-3	Use of steels with C content > 0.25 %
2.1.2.2.2.3	Acceptance of properties obtained by other recognized test methods
2.1.2.2.2.4	Acceptance of properties obtained by other recognized test methods
2.1.2.2.2.7, Note 2	Use of rolling process to achieve normalized properties
Table 2.1-4, Note 5	Additional procedure for correction of minor defects in category 3 components
2.2.1b)	Consideration of materials for low temperature testing
2.2.4	Requirements for material in groups 5 and 6, and sub-group 9.2
2.3.1.1a)	Procedure for determination of design strength
2.3.1.1	Extrapolation of material strength data at high temperature
2.3.3.2 Note	Use of $R_{e(T)}$ values equal to those of a material with similar composition and heat treatment
2.3.3.3 Note	Use of $R_{e(T)}$ values equal to those of a material with similar composition and heat treatment
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 σ_{A1} strengths σ_{A1} with PWHT not to Table 4.5-1
3.8.1.4	Bolt design σ_{A1} strengths σ_{A1} higher than Table 3.8-1
3.8.1.5	Use of plate material for hubbed flanges
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

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

Clause	Item
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
4.5.3.1	PWHT ferritic steel thicker than Table 4.5-1
4.5.3.1	Welding of lightly loaded parts after heat treatment
4.5.3.5	PWHT for austenitic stainless steel
4.5.4.4b)	Requirements for local heat treatment of branches
4.5.5.1	PWHT for materials other than sub-groups 1.1, 1.2 or 1.3
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
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	Assessment of defects to Annex U
5.7.2.2	Deviation from acceptance criteria of Table 5.7-1, Table 5.7-2 and Table 5.7-3
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
5.8.4.1b)	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.7.2.3a), 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

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

Clause	Item
Annex J	Fitting of additional pressure relief valve(s)
K.1.4.1.2	Extrapolation of upper temperature σ_{A1} strength σ_{A1} 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.2.3.3	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	Frequency of production control test pieces for tube-end joints
T.5.5	Testing production control test pieces
U.1	Fracture mechanics approach
V.4.4	Reduction in extent of weld examination for serially produced vessels
Al.2.1.2.1b)	Use of non BS EN or European approved materials
Al.2.3.1.3	Extrapolation of material strength data at high temperature
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.
Al.4.5.3.1	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
Cu.2.1.2.1c)	Use of non BS, BS EN or European approved materials
Cu.2.3.1.6	Extrapolation of material strength data at high temperature
Cu.4.2.2.3	Heat treatment after cold forming
Cu.4.3.2	Non-matching filler rod metals
Cu.4.3.6	Temporary/consumable backing strips for circumferential tube welds
Cu.4.5.1	Preheat requirements for each type of weld
Cu.5.2	Standard for approval testing of welding and brazing procedures
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

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

Clause	Item
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
Du.2.1.2.1c)	Use of non BS, BS EN or European approved materials
Du.2.1.2.2	Choice of equivalent grouping for material covered by Du.2.1.2.1c)
Du.2.3.1.1	Extrapolation of material strength data at high temperature
Du.4.3.5.3	Dissimilar metal welds
Du.4.5.3	Requirement for post weld heat treatment
Du.4.5.5	Post-weld heat treatment procedure
Du.5.3	Acceptance limits for micro structural analysis of welder and operator approval tests
Du.5.7.3.3	Use of multiple weld repairs
Du.D.2	Material properties for minimum design temperature below -50°C, and/or a nominal thickness of greater than 50 mm
Ni.2.1.2.1c)	Use of non BS or European approved materials
Ni.2.3.1.3	Extrapolation of material strength data at high temperature
Ni.4.5.5	Heat treatment procedure for PWHT
Ti.2.1.2.1b)	Use of non ASTM or European approved materials
Ti.2.3.1.3	Extrapolation of material strength data at high temperature
Ti.4.5.3	Requirement for post-weld heat treatment
Ti.4.5.5	Heat treatment procedure for PWHT
Enquiry cases	Application of any specific enquiry cases

1.4.3 Responsibilities of the Inspecting Authority

The Inspecting Authority shall be responsible for verifying:

- a) 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**;
- b) 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 the 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				
	Approximate 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).				
Design	Name of Inspecting Authority				
	Design conditions of principal components (see NOTES 2 and 3)	Design pressure bar	Design temp. °C	Construction category	Corrosion allowance mm
	Other factors affecting design (e.g. weight, nature of contents, environment) (see NOTES 3 and 4)				
Post-weld heat treatment	Component	Temperature °C	Holding time h		
Pressure test	Location (see NOTE 5)	Test pressure bar	Test medium and temperature	Date	

Form X — Certificate of Conformance (continued)

Certificate of Conformance (design)

Approved drawing number(s)
.
.

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

For manufacturer (see NOTE 6): Date:

Position: Name of Company:

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

For Inspecting Authority: Date:

Position: Name of Company:

Certificate of Conformance (construction and testing)

Manufacturer’s serial number:

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

For manufacturer : Date:

Position: Name of Company:

We hereby certify 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 conform to PD 5500.

For Inspecting Authority: Date:

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’ should 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 operational duties specified by the purchaser should be given. Where a vessel is subject to more than one loading/temperature condition, each of the conditions should be given.
- If a purchaser wishes to change the operational duty of a vessel, revised design conditions, consistent with the vessel scantlings, should 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 is acceptable.
- 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.
For materials specified to a British Standard the date of the standard shall be given. Where other materials are used (see 2.1.2.1b)) the full specification shall be supplied.
- c) Factors affecting the equipment operation or design life – safe operating limits and design basis (which may be on the drawings).
- d) Factors affecting 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 specification.

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.

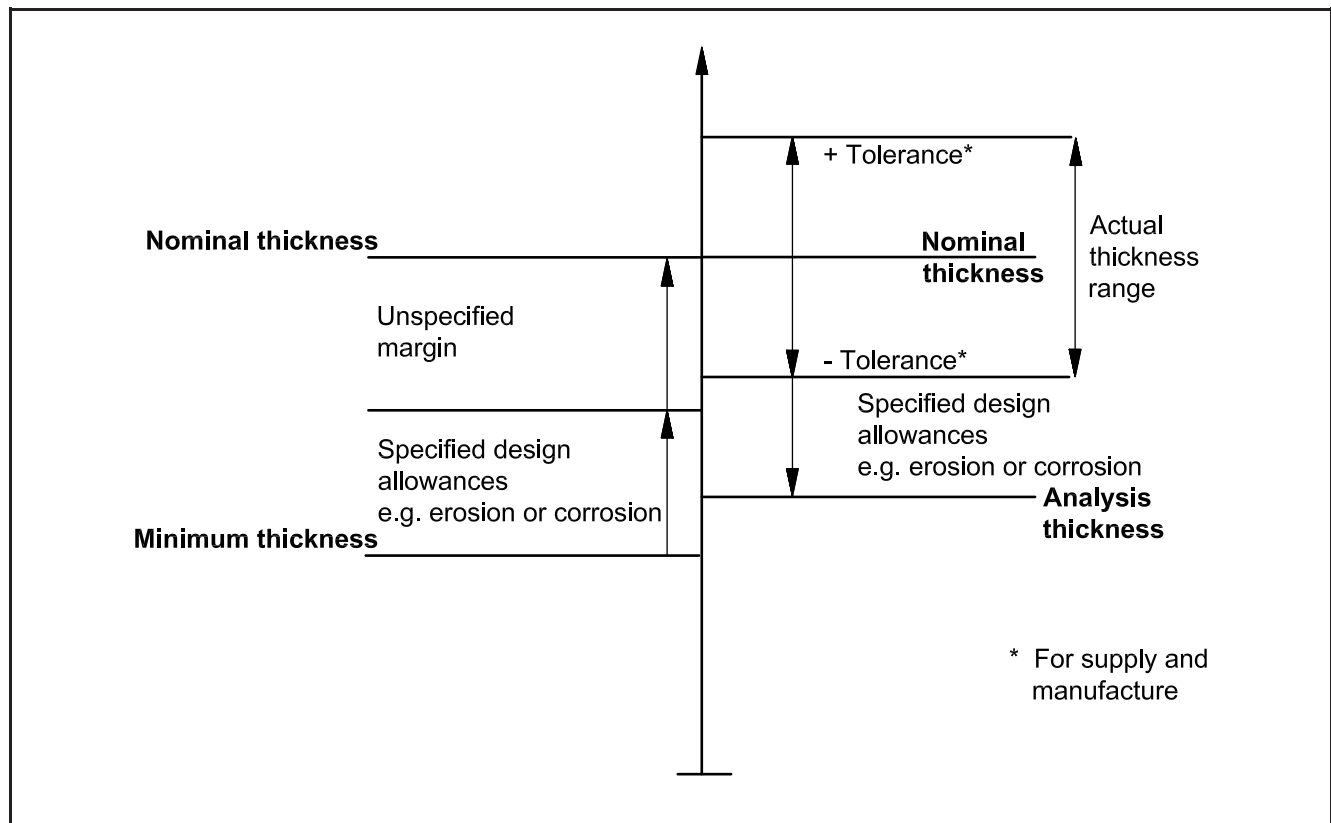
The nominal thickness, less any negative tolerance permitted by the specification to which the material is ordered, shall not be less than the minimum thickness plus any allowances specified for corrosion, erosion etc.

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

- 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);
- 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.

Figure 1.6-1 Relationship of thickness definitions



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, materials, with the exception of clad material, are identified by a group number which has been derived from PD CEN ISO/TR 15608:2017. This grouping is summarized in Table 2.1-1.
- 2.1.1.4** All material chemical compositions are specified in percentage by mass, in accordance with material standards and industry norms.

2.1.2 Materials for pressure parts

2.1.2.1 General

Pressure parts are defined as components (see **3.4.1**) which constitute the envelope under pressure and which are essential for the integrity of the vessel. Examples of pressure parts are shells, ends, flanges, nozzles, and heat exchanger tubes and tubesheets.

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

- conform to BS EN steels given in Table 2.1-2; or
- conform to BS steels given in Table K.1-2 to Table K.1-12 ^{A1} (see Note 1) ^{A1}; or
- be agreed between purchaser, Inspecting Authority and manufacturer, be documented [see **1.5.2.2b**] and shall conform to **2.1.2.2**; or
- be the subject of a "European approval for material" in accordance with the EU directive 2014/68/EU (see Note ^{A1} 2 ^{A1}); or
- be detailed in supplements, annexes or enquiry cases to this specification. ^{A1}

NOTE 1 The British Standards listed in Annex K, Tables K.1-2 to Table K.1-12, have been withdrawn and replaced by European standards (see Table 2.1-2 and Enquiry Case 5500/134). ^{A1}

NOTE ^{A1} 2 ^{A1} Use of materials covered by European approval for material does not provide compliance with the Pressure Equipment (Safety) Regulations 2016, as amended by Schedule 24 of the Product Safety and Metrology etc. (Amendment etc.) (EU Exit) Regulations 2019.

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

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

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.

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

NOTE  3  For equipment that is subject to the Pressure Equipment Directive PED 2014/68/EU, requirements for the selection of bolting are given in BS EN 1515-4.

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 grouping for the material (see 2.1.1.3) shall be chosen and agreed between manufacturer, inspection authority and purchaser. This grouping shall be used to assist in the selection of manufacturing and inspection requirements of Section 4 and Section 5.

Table 2.1-1 Material grouping

Sub-group	Type of steel
Group 1	
—	Steels with a specified minimum yield strength $R_{eH} \leq 460 \text{ N/mm}^{2a}$ and with analysis in %: $C \leq 0.25$ $Si \leq 0.60$ $Mn \leq 1.8$ $Mo \leq 0.70^b$ $S \leq 0.045$ $P \leq 0.045$ $Cu \leq 0.40^b$ $Ni \leq 0.5^b$ $Cr \leq 0.3$ (0.4 for castings) ^b $Nb \leq 0.06$ $V \leq 0.1^b$ $Ti \leq 0.05$
1.1	Steels with a specified minimum yield strength $R_{eH} \leq 275 \text{ N/mm}^2$
1.2	Steels with a specified minimum yield strength $275 \text{ N/mm}^2 < R_{eH} \leq 360 \text{ N/mm}^2$
1.3	Normalized fine grain steels with a specified minimum yield strength $R_{eH} > 360 \text{ N/mm}^2$
1.4	Steels with improved atmospheric corrosion resistance whose analysis may exceed the requirements for the single elements as indicated in group 1
Group 2	
—	Thermomechanically treated fine grain steels and cast steels with a specified minimum yield strength $R_{eH} > 360 \text{ N/mm}^2$
2.1	Thermomechanically treated fine grain steels and cast steels with a specified minimum yield strength $360 \text{ N/mm}^2 < R_{eH} \leq 460 \text{ N/mm}^2$
2.2	Thermomechanically treated fine grain steels and cast steels with a specified minimum yield strength $R_{eH} > 460 \text{ N/mm}^2$
Group 3	
—	Quenched and tempered and precipitation hardened fine grain steels, except stainless steels, with a specified minimum yield strength $R_{eH} > 360 \text{ N/mm}^2$
3.1	Quenched and tempered fine grain steels with a specified minimum yield strength $360 \text{ N/mm}^2 < R_{eH} \leq 690 \text{ N/mm}^2$
3.2	Quenched and tempered fine grain steels with a specified minimum yield strength $R_{eH} > 690 \text{ N/mm}^2$
3.3	Precipitation hardened fine grain steels except stainless steels
Group 4	
—	Low vanadium alloyed Cr-Mo-(Ni) steels with $Mo \leq 0.7\%$ and $V \leq 0.1\%$
4.1	Steels with $Cr \leq 0.3\%$ and $Ni \leq 0.7\%$
4.2	Steels with $Cr \leq 0.7\%$ and $Ni \leq 1.5\%$

Table 2.1-1 Material grouping (continued)

Sub-group	Type of steel
Group 5	
—	Cr-Mo steels free of vanadium with $C \leq 0.35\%$
5.1	Steels with $0.75\% \leq Cr \leq 1.5\%$ and $Mo \leq 0.7\%$
5.2	Steels with $1.5\% < Cr \leq 3.5\%$ and $0.7\% < Mo \leq 1.2\%$
5.3	Steels with $3.5\% < Cr \leq 7.0\%$ and $0.4\% < Mo \leq 0.7\%$
5.4	Steels with $7.0\% < Cr \leq 10.0\%$ and $0.7\% < Mo \leq 1.2\%$
Group 6	
—	High vanadium alloyed Cr-Mo-(Ni) steels
6.1	Steels with $0.3\% \leq Cr \leq 0.75\%$, $Mo \leq 0.7\%$ and $V \leq 0.35\%$
6.2	Steels with $0.75\% < Cr \leq 3.5\%$, $0.7\% < Mo \leq 1.2\%$ and $V \leq 0.35\%$
6.3	Steels with $3.5\% < Cr \leq 7.0\%$, $Mo \leq 0.7\%$ and $0.45\% \leq V \leq 0.55\%$
6.4	Steels with $7.0\% < Cr \leq 12.5\%$, $0.7\% < Mo \leq 1.2\%$ and $V \leq 0.35\%$
Group 7	
—	Ferritic, martensitic or precipitation hardened stainless steels with $C \leq 0.35\%$ and $10.5\% \leq Cr \leq 30\%$
7.1	Ferritic stainless steels
7.2	Martensitic stainless steels
7.3	Precipitation hardened stainless steels
Group 8	
—	Austenitic stainless steels, $Ni \leq 35\%$
8.1	Austenitic stainless steels with $Cr \leq 19\%$
8.2	Austenitic stainless steels with $Cr > 19\%$
8.3	Manganese austenitic stainless steels with $4.0\% < Mn \leq 12.0\%$
Group 9	
—	Nickel alloy steels with $Ni \leq 10.0\%$
9.1	Nickel alloy steels with $Ni \leq 3.0\%$
9.2	Nickel alloy steels with $3.0\% < Ni \leq 8.0\%$
9.3	Nickel alloy steels with $8.0\% < Ni \leq 10.0\%$
Group 10	
—	Austenitic ferritic stainless steels (duplex)
10.1	Austenitic ferritic stainless steels with $Cr \leq 24.0\%$ and $Ni > 4.0\%$
10.2	Austenitic ferritic stainless steels with $Cr > 24.0\%$ and $Ni > 4.0\%$
10.3	Austenitic ferritic stainless steels with $Ni \leq 4.0\%$

Table 2.1-1 **Material grouping** *(continued)*

Sub-group	Type of steel
Group 11	
—	Steels covered by group 1 ^c except 0.25% ^d < C ≤ 0.85%
11.1	Steels as indicated under 11 with 0.25% ^d < C ≤ 0.35%
11.2	Steels as indicated under 11 with 0.35% < C ≤ 0.5%
11.3	Steels as indicated under 11 with 0.5% < C ≤ 0.85%

Based on the actual product analysis, group 2 steels may be considered group 1 steels.
If a material has different minimum specified yield strengths depending on the thickness, the highest yield strength shall be used for the determination of the subgroup.

^a In accordance with the specification of the steel product standards, R_{eH} may be replaced by $R_{p0.2}$ or $R_{t0.5}$.

^b A higher value is accepted provided that $Cr + Mo + Ni + Cu + V \leq 0.75\%$.

^c A higher value is accepted provided that $Cr + Mo + Ni + Cu + V \leq 1\%$.

^d The minimum carbon content in PD CEN ISO/TR 15608:2017 has been increased to 0.30%, but for group 11 materials in PD 5500 the minimum carbon content shall be taken as 0.25%

Table 2.1-2 List of materials covered by BS EN material standards

1	2	3	4	5	6	7	8	9	10	
No.	Product form	EN standard	Material description	Grade	Material number	Heat treat- ment ^a	Thickness mm		Material group to PD CEN ISO/TR 15608:2017	
							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	18MnMo4-5	1.5414	NT	0	150	1.2	a)
7	Plate and strip	BS EN 10028-2	Elevated temperature properties	13CrMo4-5	1.7335	NT	0	60	5.1	a)
8	Plate and strip	BS EN 10028-2	Elevated temperature properties	13CrMo4-5	1.7335	NT QT	60	100	5.1	a)
9	Plate and strip	BS EN 10028-2	Elevated temperature properties	13CrMo4-5	1.7335	QT	100	150	5.1	a)
10	Plate and strip	BS EN 10028-2	Elevated temperature properties	13CrMoSi5-5	1.7336	NT QT	0	100	5.1	a)
11	Plate and strip	BS EN 10028-2	Elevated temperature properties	13CrMoSi5-5	1.7336	QT	100	150	5.1	a)
12	Plate and strip	BS EN 10028-2	Elevated temperature properties	10CrMo9-10	1.7380	NT	0	60	5.2	a)
13	Plate and strip	BS EN 10028-2	Elevated temperature properties	10CrMo9-10	1.7380	NT QT	60	100	5.2	a)
14	Plate and strip	BS EN 10028-2	Elevated temperature properties	10CrMo9-10	1.7380	QT	100	150	5.2	a)
15	Plate and strip	BS EN 10028-2	Elevated temperature properties	11CrMo9-10	1.7383	NT QT	0	60	5.2	a)
16	Plate and strip	BS EN 10028-2	Elevated temperature properties	11CrMo9-10	1.7383	QT	60	100	5.2	a)

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

1	2	3	4	5	6	7	8	9	10	
No.	Product form	EN standard	Material description	Grade	Material number	Heat treat- ment ^a	Thickness mm		Material group to PD CEN ISO/TR 15608:2017	Notes
							min.	max.		
17	Plate and strip	BS EN 10028-2	Elevated temperature properties	12CrMo9-10	1.7375	NT QT	0	150	5.2	a)
18	Plate and strip	BS EN 10028-2	Elevated temperature properties	X12CrMo5	1.7362	NT	0	150	5.3	a)
19	Plate and strip	BS EN 10028-2	Elevated temperature properties	X10CrMoVNb9-1	1.4903	NT	0	150	6.4	a)
20	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P275NH	1.0487	N	0	150	1.1	a)
21	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P275NL1	1.0488	N	0	150	1.1	a)
22	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P275NL2	1.1104	N	0	150	1.1	a)
23	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P355N	1.0562	N	0	150	1.2	a)
24	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P355NH	1.0565	N	0	150	1.2	a)
25	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P355NL1	1.0566	N	0	150	1.2	a)
26	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P355NL2	1.1106	N	0	150	1.2	a)
27	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P420NH	1.8932	N	0	150	1.3	a)
28	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P420NL1	1.8912	N	0	150	1.3	a)
29	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P420NL2	1.8913	N	0	150	1.3	a)
30	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P460NH	1.8935	N	0	150	1.3	a)
31	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P460NL1	1.8915	N	0	150	1.3	a)
32	Plate and strip	BS EN 10028-3	Fine grain steel normalized	P460NL2	1.8918	N	0	150	1.3	a)
33	Plate and strip	BS EN 10028-4	Low temperature properties	11MnNi5-3	1.6212	N NT	0	50	9.1	a)
34	Plate and strip	BS EN 10028-4	Low temperature properties	13MnNi6-3	1.6217	N NT	0	50	9.1	a)
35	Plate and strip	BS EN 10028-4	Low temperature properties	15NiMn6	1.6228	N NT QT	0	50	9.1	a)
36	Plate and strip	BS EN 10028-4	Low temperature properties	12Ni14	1.5637	N NT QT	0	50	9.2	a)
37	Plate and strip	BS EN 10028-4	Low temperature properties	X12Ni15	1.5680	N NT QT	0	50	9.2	a)
38	Plate and strip	BS EN 10028-4	Low temperature properties	X8Ni9	1.5662	N NT QT	0	50	9.3	a)
39	Plate and strip	BS EN 10028-4	Low temperature properties	X7Ni9	1.5663	QT	0	50	9.3	a)
40	Plate and strip	BS EN 10028-6	Fine grain steel, quenched/tempered	P355Q	1.8866	QT	0	150	1.2	a)
41	Plate and strip	BS EN 10028-6	Fine grain steel, quenched/tempered	P355QH	1.8867	QT	0	150	1.2	a)

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

1	2	3	4	5	6	7	8		9	10
							Thickness mm	Heat treat- ment ^a	Material group to PD CEN ISO/TR 15608:2017	
							min.	max.		
42	Plate and strip	BS EN 10028-6	Fine grain steel, quenched/tempered	P355QL1	1.8868	QT	0	150	1.2	a)
43	Plate and strip	BS EN 10028-6	Fine grain steel, quenched/tempered	P355QL2	1.8869	QT	0	150	1.2	a)
44	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNiN18-7	1.4318	AT	0	75	8.1	a)
45	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNi18-9	1.4307	AT	0	75	8.1	a)
46	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNi19-11	1.4306	AT	0	75	8.1	a)
47	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNiN18-10	1.4311	AT	0	75	8.1	a)
48	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X5CrNi18-10	1.4301	AT	0	75	8.1	a)
49	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X5CrNiN19-9	1.4315	AT	0	75	8.1	a)
50	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X6CrNi18-10	1.4948	AT	0	75	8.1	a)
51	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X6CrNi23-13	1.4950	AT	0	75	8.2	a)
52	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X6CrNi25-20	1.4951	AT	0	75	8.2	a)
53	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X6CrNiTi18-10	1.4541	AT	0	75	8.1	a)
54	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X6CrNiTiB18-10	1.4941	AT	0	75	8.1	a)
55	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNiMo17-12-2	1.4404	AT	0	75	8.1	a)
56	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNiMoN17-11-2	1.4406	AT	0	75	8.1	a)
57	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X5CrNiMo17-12-2	1.4401	AT	0	75	8.1	a)
58	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X6CrNiMoTi17-12-2	1.4571	AT	0	75	8.1	a)
59	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNiMo17-12-3	1.4432	AT	0	75	8.1	a)
60	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNiMo18-14-3	1.4435	AT	0	75	8.1	a)
61	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X2CrNiMoN17-13-5	1.4439	AT	0	75	8.1	a)
62	Plate and strip	BS EN 10028-7	Stainless steel, austenitic	X3CrNiMoBN17-13-3	1.4910	AT	0	75	8.1	a)
63	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X1CrNi25-21	1.4335	AT	0	75	8.2	a)
64	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X6CrNiNb18-10	1.4550	AT	0	75	8.1	a)
65	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X8CrNiNb16-13	1.4961	AT	0	75	8.1	a)
66	Plate and strip	BS EN 10028-7	Stainless steel, austenitic, special	X1CrNiMoN25-22-2	1.4466	AT	0	75	8.2	a)