

CONTENTS

| | |
|---|-----------|
| Foreword | vi |
| Personnel | vii |
| Introduction | x |
| Edition Summary of Changes | xii |
| Chapter I Scope and Definitions | 1 |
| 100 General | 1 |
| Chapter II Design | 9 |
| Part 1 Conditions and Criteria | 9 |
| 101 Design Conditions | 9 |
| 102 Design Criteria | 10 |
| Part 2 Pressure Design of Piping Components | 15 |
| 103 Criteria for Pressure Design of Piping Components | 15 |
| 104 Pressure Design of Components | 15 |
| Part 3 Selection and Limitations of Piping Components | 28 |
| 105 Pipe | 28 |
| 106 Fittings, Bends, and Intersections | 29 |
| 107 Valves | 29 |
| 108 Pipe Flanges, Blanks, Flange Facings, Gaskets, and Bolting | 30 |
| Part 4 Selection and Limitations of Piping Joints | 31 |
| 110 Piping Joints | 31 |
| 111 Welded Joints | 31 |
| 112 Flanged Joints | 32 |
| 113 Expanded or Rolled Joints | 32 |
| 114 Threaded Joints | 32 |
| 115 Flared, Flareless, and Compression Joints | 32 |
| 116 Bell End Joints | 38 |
| 117 Brazed and Soldered Joints | 38 |
| 118 Sleeve Coupled and Other Proprietary Joints | 38 |
| Part 5 Expansion, Flexibility, and Pipe Supporting Element | 39 |
| 119 Expansion and Flexibility | 39 |
| 120 Loads on Pipe Supporting Elements | 41 |
| 121 Design of Pipe Supporting Elements | 42 |
| Part 6 Systems | 45 |
| 122 Design Requirements Pertaining to Specific Piping Systems | 45 |
| Chapter III Materials | 60 |
| 123 General Requirements | 60 |
| 124 Limitations on Materials | 61 |
| 125 Materials Applied to Miscellaneous Parts | 62 |
| Chapter IV Dimensional Requirements | 63 |
| 126 Material Specifications and Standards for Standard and Nonstandard Piping Components | 63 |
| Chapter V Fabrication, Assembly, and Erection | 70 |
| 127 Welding | 70 |
| 128 Braze and Soldering | 78 |
| 129 Bending and Forming | 79 |
| 130 Requirements for Fabricating and Attaching Pipe Supports | 80 |
| 131 Welding Preheat | 80 |

| | | |
|-------------------|--|-----------|
| 132 | Postweld Heat Treatment | 81 |
| 133 | Stamping | 87 |
| 135 | Assembly | 87 |
| Chapter VI | Inspection, Examination, and Testing | 89 |
| 136 | Inspection and Examination | 89 |
| 137 | Pressure Tests | 93 |
| Figures | | |
| 100.1.2(A) | Code Jurisdictional Limits for Piping — Forced Flow Steam Generator With No Fixed Steam and Water Line | 2 |
| 100.1.2(B) | Code Jurisdictional Limits for Piping — Drum-Type Boilers | 3 |
| 100.1.2(C) | Code Jurisdictional Limits for Piping — Spray-Type Desuperheater | 4 |
| 104.2.1 | Nomenclature for Pipe Bends | 14 |
| 104.3.1(D) | Reinforcement of Branch Connections | 20 |
| 104.3.1(G) | Reinforced Extruded Outlets | 22 |
| 104.5.3 | Types of Permanent Blanks | 26 |
| 104.8.4 | | 27 |
| 122.1.7(C) | Typical Globe Valves | 49 |
| 122.4 | Desuperheater Schematic Arrangement | 53 |
| 127.3 | Butt Welding of Piping Components With Internal Misalignment | 71 |
| 127.4.2 | Welding End Transition — Maximum Envelope | 72 |
| 127.4.4(A) | Fillet Weld Size | 74 |
| 127.4.4(B) | Welding Details for Slip-On and Socket-Welding Flanges; Some Acceptable Types of Flange Attachment Welds | 75 |
| 127.4.4(C) | Minimum Welding Dimensions Required for Socket Welding Components Other Than Flanges | 75 |
| 127.4.8(A) | Typical Welded Branch Connection Without Additional Reinforcement | 75 |
| 127.4.8(B) | Typical Welded Branch Connection With Additional Reinforcement | 75 |
| 127.4.8(C) | Typical Welded Angular Branch Connection Without Additional Reinforcement | 75 |
| 127.4.8(D) | Some Acceptable Types of Welded Branch Attachment Details Showing Minimum Acceptable Welds | 76 |
| 127.4.8(E) | Typical Full Penetration Weld Branch Connections for NPS 3 and Smaller Half Couplings or Adapters | 77 |
| 127.4.8(F) | Typical Partial Penetration Weld Branch Connection for NPS 2 and Smaller Fittings | 77 |
| 135.5.3 | Typical Threaded Joints Using Straight Threads | 88 |
| Tables | | |
| 102.3.2(C) | Stress Range Reduction Factors | 11 |
| 102.4.3 | Longitudinal Weld Joint Efficiency Factors | 13 |
| 102.4.5 | | 14 |
| 102.4.6(B.1.1) | | 15 |
| 102.4.6(B.2.2) | | 15 |
| 104.1.2(A) | Values of y | 17 |
| 112 | Piping Flange Bolting, Facing, and Gasket Requirements | 33 |
| 114.2.1 | | 38 |
| 121.5 | Suggested Pipe Support Spacing | 43 |
| 121.7.2(A) | Carrying Capacities of Threaded ASTM A 36, A 575, and A 576 Hot-Rolled Carbon Steel | 44 |
| 122.2 | | 50 |
| 122.8.2(B) | Minimum Wall Thickness Requirements for Toxic Fluid Piping | 57 |
| 126.1 | Specifications and Standards | 64 |
| 127.4.2 | Reinforcement of Girth and Longitudinal Butt Welds | 73 |
| 129.3.2 | Approximate Lower Critical Temperatures | 80 |
| 132 | Postweld Heat Treatment | 82 |

| | | |
|--------------------------------|--|-----|
| 132.1 | Alternate Postweld Heat Treatment Requirements for Carbon and Low Alloy Steels | 86 |
| 136.4 | Mandatory Minimum Nondestructive Examinations for Pressure Welds or Welds to Pressure-Retaining Components | 91 |
| 136.4.1 | Weld Imperfections Indicated by Various Types of Examination | 92 |
| Mandatory Appendices | | |
| Appendix A | Table A-1, Carbon Steel | 97 |
| | Table A-2, Low and Intermediate Alloy Steel | 110 |
| | Table A-3, Stainless Steels | 124 |
| | Table A-4, Nickel and High Nickel Alloys | 156 |
| | Table A-5, Cast Iron | 164 |
| | Table A-6, Copper and Copper Alloys | 166 |
| | Table A-7, Aluminum and Aluminum Alloys | 170 |
| | Table A-8, Temperatures 1200°F and Above | 178 |
| | Table A-9, Titanium and Titanium Alloys | 184 |
| Appendix B | Table B-1, Thermal Expansion Data | 189 |
| | Table B-1 (SI), Thermal Expansion Data | 192 |
| Appendix C | Table C-1, Moduli of Elasticity for Ferrous Material | 196 |
| | Table C-1 (SI), Moduli of Elasticity for Ferrous Material | 197 |
| | Table C-2, Moduli of Elasticity for Nonferrous Material | 198 |
| | Table C-2 (SI), Moduli of Elasticity for Nonferrous Material | 200 |
| Appendix D | Table D-1, Flexibility and Stress Intensification Factors | 202 |
| | Chart D-1, Flexibility Factor k and Stress Intensification Factor i | 206 |
| | Chart D-2, Correction Factor c | 207 |
| | Fig. D-1, Branch Connection Dimensions | 208 |
| Appendix F | Referenced Standards | 209 |
| Appendix G | Nomenclature | 212 |
| Appendix H | Preparation of Technical Inquiries | 218 |
| Appendix J | Quality Control Requirements for Boiler External Piping (BEP) | 219 |
| Nonmandatory Appendices | | |
| Appendix II | Rules for the Design of Safety Valve Installations | 221 |
| Appendix III | Rules for Nonmetallic Piping and Piping Lined With Nonmetals | 241 |
| Appendix IV | Corrosion Control for ASME B31.1 Power Piping Systems | 260 |
| Appendix V | Recommended Practice for Operation, Maintenance, and Modification of Power Piping Systems | 264 |
| Appendix VI | Approval of New Materials | 274 |
| Appendix VII | Procedures for the Design of Restrained Underground Piping | 275 |
| Index | 286 | |

CONTENTS

| | |
|---|-----------|
| Foreword | vi |
| Committee Roster | vii |
| Introduction | xi |
| Summary of Changes | xiii |
| Chapter I Scope and Definitions..... | 1 |
| 100 General | 1 |
| Chapter II Design | 12 |
| Part 1 Conditions and Criteria | 12 |
| 101 Design Conditions | 12 |
| 102 Design Criteria | 13 |
| Part 2 Pressure Design of Piping Components | 19 |
| 103 Criteria for Pressure Design of Piping Components | 19 |
| 104 Pressure Design of Components | 19 |
| Part 3 Selection and Limitations of Piping Components | 33 |
| 105 Pipe | 33 |
| 106 Fittings, Bends, and Intersections | 34 |
| 107 Valves | 35 |
| 108 Pipe Flanges, Blanks, Flange Facings, Gaskets, and Bolting | 36 |
| Part 4 Selection and Limitations of Piping Joints | 37 |
| 110 Piping Joints | 37 |
| 111 Welded Joints | 37 |
| 112 Flanged Joints | 37 |
| 113 Expanded or Rolled Joints | 37 |
| 114 Threaded Joints | 42 |
| 115 Flared, Flareless, and Compression Joints, and Unions | 42 |
| 116 Bell End Joints | 43 |
| 117 Brazed and Soldered Joints | 43 |
| 118 Sleeve Coupled and Other Proprietary Joints | 43 |
| Part 5 Expansion, Flexibility, and Pipe Supporting Element | 43 |
| 119 Expansion and Flexibility | 43 |
| 120 Loads on Pipe Supporting Elements | 46 |
| 121 Design of Pipe Supporting Elements | 47 |
| Part 6 Systems | 50 |
| 122 Design Requirements Pertaining to Specific Piping Systems | 50 |
| Chapter III Materials | 65 |
| 123 General Requirements | 65 |
| 124 Limitations on Materials | 66 |
| 125 Materials Applied to Miscellaneous Parts | 68 |
| Chapter IV Dimensional Requirements | 69 |
| 126 Material Specifications and Standards for Standard and Nonstandard Piping Components | 69 |
| Chapter V Fabrication, Assembly, and Erection | 77 |
| 127 Welding | 77 |
| 128 Braze and Soldering | 88 |
| 129 Bending and Forming | 89 |
| 130 Requirements for Fabricating and Attaching Pipe Supports | 90 |
| 131 Welding Preheat | 90 |

| | | |
|--------------------|--|------------|
| 132 | Postweld Heat Treatment | 91 |
| 133 | Stamping | 99 |
| 135 | Assembly | 99 |
| Chapter VI | Inspection, Examination, and Testing | 101 |
| 136 | Inspection and Examination | 101 |
| 137 | Pressure Tests | 105 |
| Chapter VII | Operation and Maintenance | 108 |
| 138 | General | 108 |
| 139 | Operation and Maintenance Procedures | 108 |
| 140 | Condition Assessment of CPS | 108 |
| 141 | CPS Records | 109 |
| Figures | | |
| 100.1.2(A.1) | Code Jurisdictional Limits for Piping — An Example of Forced Flow Steam Generators With No Fixed Steam and Water Line | 2 |
| 100.1.2(A.2) | Code Jurisdictional Limits for Piping — An Example of Steam Separator Type Forced Flow Steam Generators With No Fixed Steam and Water Line | 3 |
| 100.1.2(B) | Code Jurisdictional Limits for Piping — Drum-Type Boilers | 4 |
| 100.1.2(C) | Code Jurisdictional Limits for Piping — Spray-Type Desuperheater | 5 |
| 102.4.5 | Nomenclature for Pipe Bends | 17 |
| 104.3.1(D) | Reinforcement of Branch Connections | 24 |
| 104.3.1(G) | Reinforced Extruded Outlets | 28 |
| 104.5.3 | Types of Permanent Blanks | 31 |
| 104.8.4 | Cross Section Resultant Moment Loading | 33 |
| 122.1.7(C) | Typical Globe Valves | 55 |
| 122.4 | Desuperheater Schematic Arrangement | 59 |
| 127.3 | Butt Welding of Piping Components With Internal Misalignment | 78 |
| 127.4.2 | Welding End Transition — Maximum Envelope | 79 |
| 127.4.4(A) | Fillet Weld Size | 82 |
| 127.4.4(B) | Welding Details for Slip-On and Socket-Welding Flanges; Some Acceptable Types of Flange Attachment Welds | 83 |
| 127.4.4(C) | Minimum Welding Dimensions Required for Socket Welding Components Other Than Flanges | 83 |
| 127.4.8(A) | Typical Welded Branch Connection Without Additional Reinforcement | 83 |
| 127.4.8(B) | Typical Welded Branch Connection With Additional Reinforcement | 83 |
| 127.4.8(C) | Typical Welded Angular Branch Connection Without Additional Reinforcement | 83 |
| 127.4.8(D) | Some Acceptable Types of Welded Branch Attachment Details Showing Minimum Acceptable Welds | 84 |
| 127.4.8(E) | Some Acceptable Details for Integrally Reinforced Outlet Fittings | 85 |
| 127.4.8(F) | Typical Full Penetration Weld Branch Connections for NPS 3 and Smaller Half Couplings or Adapters | 86 |
| 127.4.8(G) | Typical Partial Penetration Weld Branch Connection for NPS 2 and Smaller Fittings | 87 |
| 135.5.3 | Typical Threaded Joints Using Straight Threads | 100 |
| Tables | | |
| 102.4.3 | Longitudinal Weld Joint Efficiency Factors | 16 |
| 102.4.5 | Bend Thinning Allowance | 17 |
| 102.4.6(B.1.1) | Maximum Severity Level for Casting Thickness $4\frac{1}{2}$ in. (114 mm) or Less | 18 |
| 102.4.6(B.2.2) | Maximum Severity Level for Casting Thickness Greater Than $4\frac{1}{2}$ in. (114 mm) | 18 |

| | | |
|--------------------------------|--|-----|
| 102.4.7 | Weld Strength Reduction Factors to Be Applied When Calculating the Minimum Wall Thickness or Allowable Design Pressure of Components Fabricated With a Longitudinal Seam Fusion Weld | 20 |
| 104.1.2(A) | Values of y | 22 |
| 112 | Piping Flange Bolting, Facing, and Gasket Requirements | 38 |
| 114.2.1 | Threaded Joints Limitations | 42 |
| 121.5 | Suggested Pipe Support Spacing | 48 |
| 121.7.2(A) | Carrying Capacity of Threaded ASTM A 36, A 575, and A 576 Hot-Rolled Carbon Steel | 49 |
| 122.2 | Design Pressure for Blowoff/Blowdown Piping Downstream of BEP Valves | 55 |
| 122.8.2(B) | Minimum Wall Thickness Requirements for Toxic Fluid Piping | 62 |
| 126.1 | Specifications and Standards | 70 |
| 127.4.2 | Reinforcement of Girth and Longitudinal Butt Welds | 81 |
| 129.3.1 | Approximate Lower Critical Temperatures | 89 |
| 132 | Postweld Heat Treatment | 92 |
| 132.1 | Alternate Postweld Heat Treatment Requirements for Carbon and Low Alloy Steels | 97 |
| 136.4 | Mandatory Minimum Nondestructive Examinations for Pressure Welds or Welds to Pressure-Retaining Components | 103 |
| 136.4.1 | Weld Imperfections Indicated by Various Types of Examination | 104 |
| Mandatory Appendices | | |
| A | Table A-1, Carbon Steel | 112 |
| | Table A-2, Low and Intermediate Alloy Steel | 124 |
| | Table A-3, Stainless Steels | 134 |
| | Table A-4, Nickel and High Nickel Alloys | 164 |
| | Table A-5, Cast Iron | 176 |
| | Table A-6, Copper and Copper Alloys | 178 |
| | Table A-7, Aluminum and Aluminum Alloys | 182 |
| | Table A-8, Temperatures 1,200°F and Above | 190 |
| | Table A-9, Titanium and Titanium Alloys | 196 |
| | Table A-10, Bolts, Nuts, and Studs | 200 |
| B | Table B-1, Thermal Expansion Data | 206 |
| C | Table C-1, Moduli of Elasticity for Ferrous Material | 214 |
| | Table C-1 (SI), Moduli of Elasticity for Ferrous Material | 215 |
| | Table C-2, Moduli of Elasticity for Nonferrous Material | 216 |
| | Table C-2 (SI), Moduli of Elasticity for Nonferrous Material | 218 |
| D | Table D-1, Flexibility and Stress Intensification Factors | 220 |
| | Chart D-1, Flexibility Factor, k , and Stress Intensification Factor, i | 224 |
| | Chart D-2, Correction Factor, c | 225 |
| | Fig. D-1, Branch Connection Dimensions | 226 |
| F | Referenced Standards | 227 |
| G | Nomenclature | 231 |
| H | Preparation of Technical Inquiries | 237 |
| J | Quality Control Requirements for Boiler External Piping (BEP) | 238 |
| Nonmandatory Appendices | | |
| II | Rules for the Design of Safety Valve Installations | 240 |
| III | Rules for Nonmetallic Piping and Piping Lined With Nonmetals | 260 |
| IV | Corrosion Control for ASME B31.1 Power Piping Systems | 280 |
| V | Recommended Practice for Operation, Maintenance, and Modification of Power Piping Systems | 284 |
| VI | Approval of New Materials | 294 |
| VII | Procedures for the Design of Restrained Underground Piping | 295 |
| Index | | 306 |