## CONTENTS

### Chapter 1
**Background and General Information**
- History of B31.1 ......................................................... 1
- Scope of B31.1 ............................................................. 2
- What is Piping? .......................................................... 4
- Intent ........................................................................... 4
- Responsibilities ........................................................ 8
  - Owner ...................................................................... 8
  - Designer .................................................................. 8
  - Manufacturer, Fabricator, and Erector ....................... 9
  - Inspector .................................................................. 9
- How is B31.1 Developed and Maintained ....................... 9
- Code Editions and Addenda ........................................ 10
- How Do I Get Answers to Questions About the Code? ........ 10
- How can I Change the Code? ...................................... 11

### Chapter 2
**Organization of B31.1**
- Boiler External and Nonboiler External Piping ................. 13
- Code Organization ...................................................... 13
- Non-Mandatory Appendices ........................................ 14

### Chapter 3
**Design Conditions and Criteria**
- Design Conditions ..................................................... 15
  - Design Pressure ..................................................... 15
  - Design Temperature ............................................... 16
- Allowable Stress ....................................................... 16
- Weld Joint Efficiency and Casting Quality Factors .......... 17
- Weld Joint Strength Reduction Factors ........................ 17
- Allowances for Temperature and Pressure Variations ...... 20
- Overpressure Protection ............................................. 20

### Chapter 4
**Pressure Design**
- Methods for Internal Pressure Design .......................... 23
- Pressure Design of Straight Pipe for Internal Pressure ...... 24
- Pressure Design for Straight Pipe Under for External Pressure .... 29
- Pressure Design of Welded Branch Connections .......... 33
- Pressure Design of Extruded Outlet Header ................... 37
## Contents

1. Overview
2. Allowable Stress for Thermal Expansion
3. How to Combine Different Displacement Cycle Conditions
4. Pressure Design of Reducers
5. Pressure Design of Blind Flanges (Para. 104.52)
6. Flexibility Analysis Equations
7. Allowable Stress for Thermal Expansion
8. How to Combine Different Displacement Cycle Conditions
9. Pressure Design of Reducers
10. Pressure Design of Flanges (Para. 104.51)
11. Pressure Design of Closures
12. Pressure Design of Flanges (Para. 104.51)
13. Pressure Design of Blanks
14. Pressure Design of Reducers
15. Specially Designed Components
16. Overview
17. Primary Longitudinal Stresses
18. Sustained Longitudinal Stress
19. Limits of Calculated Stress from Occasional Loads
20. Overview
21. How to Combine Different Displacement Cycle Conditions
22. Pressure Design of Reducers
23. Pressure Design of Flanges (Para. 104.51)
24. Pressure Design of Flanges (Para. 104.51)
25. Pressure Design of Blanks
26. Pressure Design of Reducers
27. Specially Designed Components
28. Overview
29. How to Combine Different Displacement Cycle Conditions
30. Pressure Design of Reducers
31. Pressure Design of Flanges (Para. 104.51)
32. Pressure Design of Blanks
33. Pressure Design of Reducers
34. Specially Designed Components
35. Overview
36. How to Combine Different Displacement Cycle Conditions
37. Pressure Design of Reducers
38. Pressure Design of Flanges (Para. 104.51)
39. Pressure Design of Blanks
40. Pressure Design of Reducers
41. Specially Designed Components
42. Overview
43. How to Combine Different Displacement Cycle Conditions
44. Pressure Design of Reducers
45. Pressure Design of Flanges (Para. 104.51)
46. Pressure Design of Blanks
47. Pressure Design of Reducers
48. Specially Designed Components
49. Overview
50. How to Combine Different Displacement Cycle Conditions
51. Pressure Design of Reducers
52. Pressure Design of Flanges (Para. 104.51)
53. Pressure Design of Blanks
54. Pressure Design of Reducers
55. Specially Designed Components
56. Overview
57. How to Combine Different Displacement Cycle Conditions
58. Pressure Design of Reducers
59. Pressure Design of Flanges (Para. 104.51)
60. Pressure Design of Blanks
61. Pressure Design of Reducers
62. Specially Designed Components
63. Overview
64. How to Combine Different Displacement Cycle Conditions
65. Pressure Design of Reducers
66. Pressure Design of Flanges (Para. 104.51)
67. Pressure Design of Blanks
68. Pressure Design of Reducers
69. Specially Designed Components
70. Overview
71. How to Combine Different Displacement Cycle Conditions
72. Pressure Design of Reducers
73. Pressure Design of Flanges (Para. 104.51)
74. Pressure Design of Blanks
75. Pressure Design of Reducers
76. Specially Designed Components
77. Overview
78. How to Combine Different Displacement Cycle Conditions
79. Pressure Design of Reducers
80. Pressure Design of Flanges (Para. 104.51)
81. Pressure Design of Blanks
82. Pressure Design of Reducers
Contents

Chapter 10
Supports and Restraints ................................................................. 83
10.1 Overview of Supports .............................................................. 83
10.2 Materials and Allowable Stress ............................................... 83
10.3 Design of Supports .............................................................. 84
10.4 Spring and Hanger Supports .................................................. 92
10.5 Fabrication of Supports .......................................................... 93

Chapter 11
Load Limits for Attached Equipment ................................................. 95
11.1 Overview of Equipment Load Limits ...................................... 95
11.2 Temperature Limits .............................................................. 100
11.3 Other Equipment Load Limits ............................................... 100
11.4 Means of Reducing Loads on Equipment ................................... 101

Chapter 12
Requirements for Materials .......................................................... 99
12.1 Overview of Material Requirements ...................................... 99
12.2 Temperature Limits .............................................................. 100
12.3 Material Limitations ............................................................. 100
12.4 How to Use the Allowable Stress Tables in Appendix A ................. 101

Chapter 13
Fabrication, Assembly, and Erection ................................................. 103
13.1 Overview of Chapter V ......................................................... 103
13.2 General Welding Requirements ............................................. 103
13.3 Welding Procedure Specifications .......................................... 111
13.4 Welding Procedure Qualification Record .................................. 111
13.5 Welder Performance Qualification .......................................... 112
13.6 Pre-heating ................................................................. 113
13.7 Heat Treatment ................................................................. 113
13.8 Governing Thickness for Heat Treatment .................................. 116
13.9 Pipe Bends ................................................................. 116
13.10 Brazing ............................................................... 116
13.11 Bolted Joints ............................................................... 116
13.12 Welded Joint Details ......................................................... 117
13.13 Miscellaneous Assembly Requirements .................................. 118

Chapter 14
Examination .............................................................................. 117
14.1 Overview of Examination Requirements .................................. 117
14.2 Required Examination ....................................................... 118
14.3 Visual Examination ........................................................... 118
14.4 Radiographic Examination ................................................... 120
14.5 Ultrasonic Examination ....................................................... 121
14.6 Liquid-Penetrant Examination ............................................... 121
14.7 Magnetic-Particle Examination ............................................. 122

Chapter 15
Pressure Testing ........................................................................ 123
15.1 Overview of Pressure Test Requirements .................................. 123
## Contents

15.2 Hydrostatic Testing .................................................................................. 124  
15.3 Pneumatic Testing .................................................................................. 124  
15.4 Mass-Spectrometer and Halide Testing .................................................... 125  
15.5 Initial Service Testing ............................................................................. 125  
15.6 Retesting After Repair or Additions.......................................................... 125

Chapter 16

Non-metallic Piping ....................................................................................... 127  
16.1 Organization and Scope ......................................................................... 127  
16.2 Design Conditions .................................................................................. 128  
16.3 Allowable Stress .................................................................................... 128  
16.4 Pressure Design ..................................................................................... 128  
16.5 Limitations on Components and Joints ................................................... 129  
16.6 Flexibility and Support .......................................................................... 129  
16.7 Materials ................................................................................................. 130  
16.8 Fabrication, Assembly, and Erection ....................................................... 131  
16.9 Examination and Testing........................................................................ 137

Chapter 17

POST-CONSTRUCTION .................................................................................. 139

Appendix I

Useful Information for Pressure Design

Appendix II

Guidelines for Computer Flexibility Analysis

Appendix III

Useful Information for Flexibility Analysis

Appendix IV

Expansion Joint Guide

Appendix V

Conversion Factors

References

Index