

# Table of Contents

## Part 1: Principles/Policy

<b>1</b>	<b>Introduction .....</b>	<b>11</b>
1.1	Background.....	11
1.2	Why do we need this Handbook? .....	12
1.3	Objectives .....	13
1.4	Key Terms .....	14
<b>2</b>	<b>Sustainability in the Context of the Life Sciences Industry.....</b>	<b>17</b>
2.1	Introduction .....	17
2.2	Relevance to Latitude/Hemisphere.....	17
<b>3</b>	<b>Legislation .....</b>	<b>23</b>
3.1	Introduction .....	23
3.2	Legislative Engagement.....	23
3.3	Carbon Trading Schemes .....	26
3.4	The Place of Assessment and Life Cycle.....	27
<b>4</b>	<b>Regulation .....</b>	<b>29</b>
4.1	Introduction .....	29
4.2	Energy Management Systems.....	29
4.3	Achieving Energy Reduction.....	32
<b>5</b>	<b>Sustainability Policy Development .....</b>	<b>35</b>
5.1	Reasons to Create a Sustainability Policy .....	35
5.2	Setting Goals .....	36
5.3	Promoting Initiatives.....	37
5.4	Management.....	38
5.5	Predicting and Measuring Performance.....	39
<b>6</b>	<b>Sustainability Assessment for Buildings and Products .....</b>	<b>41</b>
6.1	Introduction .....	41
6.2	Benefits of Building Assessment.....	41
6.3	Current Building Assessment Systems .....	42
6.4	Facility Assessment Systems versus Custom Facility Performance Goals .....	43
6.5	Product Rating Systems .....	45
<b>7</b>	<b>Future Directions and Opportunities .....</b>	<b>47</b>
7.1	Introduction .....	47
7.2	Future Trends in Waste Management.....	49

## Part 2: Design/Engineering Application

<b>8 Energy .....</b>	<b>53</b>
8.1 The Importance of Knowing the Energy Use within a Facility.....	53
8.2 Evaluating Energy Use – In both Existing and Proposed Facilities .....	54
8.3 Benchmarking and Target Setting For Energy Use.....	59
8.4 Designing for Lower Embedded Carbon.....	59
8.5 Designing for Lower Energy Use .....	60
8.6 Operating for Lower Energy Use .....	61
8.7 Carbon Footprinting .....	61
<b>9 Process Development and Bulk Drug Products Manufacture.....</b>	<b>63</b>
9.1 Introduction .....	63
9.2 Green Chemistry.....	67
9.3 Raw Materials .....	68
<b>10 Formulation and Packaged Drug Product Manufacture and Logistics .....</b>	<b>71</b>
10.1 Oral Solid Dosage Form .....	72
10.2 Process Equipment and its Impact on Sustainability Considerations .....	73
<b>11 Pharmaceutical and Biopharmaceutical Manufacturing Supply Chain .....</b>	<b>81</b>
11.1 Introduction .....	81
11.2 Life Cycle Waste Minimization Assessment.....	82
<b>12 Site and Facility Design Considerations .....</b>	<b>85</b>
12.1 Introduction .....	85
12.2 Principal Pharmaceutical Facility Building Types.....	86
12.3 Sustainable Design Principles .....	87
12.4 General Sustainability-Based Siting Considerations.....	87
12.5 Landscape .....	88
12.6 Building Construction Systems .....	92
12.7 Building Services Distribution .....	92
12.8 Construction Materials and Design.....	93
12.9 URS Development and Concepts for Regulated Facilities .....	94
12.10 Whole Building Energy Modeling .....	94
12.11 Whole Building Life Cycle Assessment and Life Cycle Cost Analysis .....	96
<b>13 HVAC .....</b>	<b>99</b>
13.1 Introduction: Common Considerations.....	99
13.2 New Facilities and Major Renovations.....	100
13.3 Renovated Facilities.....	101
13.4 Site and Location Issues.....	102
13.5 System and Equipment Sustainable Design Concepts.....	102
13.6 Operation and Maintenance Issues .....	105
<b>14 Electricity.....</b>	<b>107</b>
14.1 Electric Motor Efficiency and Control .....	107
14.2 Electrical Power Quality .....	108
14.3 Voltage Optimization .....	110
14.4 Cable Sizing for Life Cycle Cost Benefit .....	111
14.5 Transformers.....	112
14.6 High-Voltage Switchgear.....	113
14.7 Uninterruptible Power Supply Systems.....	113

<b>15 Utilities .....</b>	<b>117</b>
15.1 Clean Utilities .....	117
15.2 Facility Utilities .....	127
<b>16 Waste Management .....</b>	<b>135</b>
16.1 Introduction .....	135
16.2 Definition of Waste .....	137
16.3 General Principles in Waste Management .....	137
16.4 Waste Streams from Pharmaceutical Facilities .....	140
16.5 Gaseous Wastes .....	144
16.6 Liquid Waste .....	149
16.7 Solid Waste .....	157
16.8 Waste Management Practice .....	160
<b>17 Appendix 1 – Sustainability Policies, Legislation, and Guidance Net Resource ....</b>	<b>163</b>
<b>18 Appendix 2 – Components of a Corporate Sustainability Policy .....</b>	<b>169</b>
<b>19 Appendix 3 – Environmental Assessment Methods .....</b>	<b>173</b>
<b>20 Appendix 4 – References .....</b>	<b>177</b>
<b>21 Appendix 5 – Glossary .....</b>	<b>185</b>
21.1 Acronyms and Abbreviations .....	185
21.2 Definitions .....	188