IEC 62264-2:2026-03 (E)

Enterprise-control system integration - Part 2: Objects and attributes for enterprise-control system integration

Contents

Page

FOREWORD 16
INTRODUCTION 19
1 Scope 20
2 Normative references 20
3 Terms, definitions, abbreviated terms and conventions 21
3.1 Terms, definitions and abbreviated terms 21
3.2 Abbreviated terms 22
3.3 Conventions 22
3.3.1 General 22
3.3.2 Conceptual object model vs. logical data model and physical data models for implementation 23
3.3.3 UML notation in object models 23
3.3.4 Relationship types and name convention 25
3.3.5 Object color convention 35
3.3.6 Relationship table 35
3.3.7 Relationship role table 37
3.3.8 Object attribute table 38
3.3.9 Relationships between resource reference objects in operations management information models and resource models 39
4 Manufacturing operations management information models 51
4.1 Field of application of information models 51
4.2 Relationships of common information models to operations management information models 52
4.3 Cross-model relationships between conceptual operations management information models 53
4.4 Cross-model relationships for MOM activity context in information exchanges 59
4.5 Attributes of an object in an information model 61
4.5.1 General 61
4.5.2 Minimum object attribute sets 61
4.5.3 Data types of object attributes 61
4.5.4 Object attribute extensibility 62
4.5.5 Common header attributes for primary objects and property objects 62
4.5.6 Unit of measure attribute 69
4.5.7 Comment attribute 70
4.5.8 Personnel identification manifest attribute 71
4.5.9 Value attribute and types 73
4.5.10 Measurement uncertainty sub-properties for value and quantity attributes 76
5 Common object models 78
5.1 Hierarchy scope information 78
5.2 Spatial definition information 79
5.3 Operational location information 82
5.3.1 Operational location model 82

5.3.2 Operational location class 83
5.3.3 Operational location class property 84
5.3.4 Operational location 86
5.3.5 Operational location property 87
5.4 Personnel information 88
5.4.1 Personnel model 88
5.4.2 Personnel class 90
5.4.3 Personnel class property 91
5.4.4 Person 93
5.4.5 Person property 95
5.5 Role-based equipment information 96
5.5.1 Role-based equipment model 96
5.5.2 Equipment class 98
5.5.3 Equipment class property 100
5.5.4 Equipment 101
5.5.5 Equipment property 103
5.6 Physical asset information 105
5.6.1 Physical asset model 105
5.6.2 Physical asset class 107
5.6.3 Physical asset class property 109
5.6.4 Physical asset 111
5.6.5 Physical asset property 113
5.6.6 Equipment asset mapping 114
5.7 Material information 115
5.7.1 Material model 115
5.7.2 Material class 118
5.7.3 Material class property 121
5.7.4 Material definition 123
5.7.5 Material definition property 125
5.7.6 Material lot 127
5.7.7 Material lot property 131
5.7.8 Material sublot 133
5.7.9 Assemblies 136
5.8 Process segment information 138
5.8.1 Process segment model 138
5.8.2 Process segment 143
5.8.3 Process segment parameter 147
5.8.4 Personnel segment specification 148
5.8.5 Personnel segment specification property 150
5.8.6 Equipment segment specification 153
5.8.7 Equipment segment specification property 155
5.8.8 Physical asset segment specification 157
5.8.9 Physical asset segment specification property 160
5.8.10 Material segment specification 162
5.8.11 Material segment specification property 168
5.8.12 Segment dependency 170
5.9 Operations test information 173
5.9.1 Operations test model 173
5.9.2 Operations test requirement 175
5.9.3 Testable object and testable object property 176
5.9.4 Test specification 178
5.9.5 Test specification property 181

5.9.6 Test specification criteria 182
5.9.7 Evaluated property 183
5.9.8 Test result 184
5.9.9 Property measurement 186
5.9.10 Resource actual 188
5.10 Operations record information 189
5.10.1 Operations record model (abstract) 189
5.10.2 Operations record specification (abstract) 190
5.10.3 Operations record template (abstract) 194
5.10.4 Operations record entry template (abstract) 197
5.11 Operations event information 199
5.11.1 Operations event model 199
5.11.2 Operations event class 201
5.11.3 Operations event class property 203
5.11.4 Operations event class record specification 205
5.11.5 Operations event definition 208
5.11.6 Operations event definition property 213
5.11.7 Operations event definition record specification 214
5.11.8 Operations event 218
5.11.9 Operations event property 222
5.11.10 Operations event record 223
5.11.11 Operations event record entry 225
5.12 Containers, tools, and software 228
5.12.1 Containers 228
5.12.2 Tools 228
5.12.3 Software 229
Operations management information 229
6.1 Operations definition information 229
6.1.1 Operations definition model 229
6.1.2 Operations definition 234
6.1.3 Operations material bill 238
6.1.4 Operations material bill item 240
6.1.5 Operations segment 242
6.1.6 Parameter specification 246
6.1.7 Personnel specification 248
6.1.8 Personnel specification property 251
6.1.9 Equipment specification 254
6.1.10 Equipment specification property 256
6.1.11 Physical asset specification 259
6.1.12 Physical asset specification property 261
6.1.13 Material specification 264
6.1.14 Material specification property 268
6.1.15 Segment dependency 271
6.2 Operations schedule information 273
6.2.1 Operations schedule model 273
6.2.2 Operations schedule 277
6.2.3 Operations request 280
6.2.4 Segment requirement 282

6.2.5 Segment parameter 286
6.2.6 Personnel requirement 288
6.2.7 Personnel requirement property 292
6.2.8 Equipment requirement 294
6.2.9 Equipment requirement property 297
6.2.10 Physical asset requirement 299
6.2.11 Physical asset requirement property 303
6.2.12 Material requirement 305
6.2.13 Material requirement property 310
6.2.14 Requested segment response 313
6.3 Operations performance information 313
6.3.1 Operations performance model 313
6.3.2 Operations performance 317
6.3.3 Operations response 320
6.3.4 Segment response 322
6.3.5 Segment data 325
6.3.6 Personnel actual 327
6.3.7 Personnel actual property 329
6.3.8 Equipment actual 331
6.3.9 Equipment actual property 334
6.3.10 Physical asset actual 336
6.3.11 Physical asset actual property 338
6.3.12 Material actual 340
6.3.13 Material actual property 344
6.4 Operations capability information 346
6.4.1 Operations capability model 346
6.4.2 Operations capability 348
6.4.3 Personnel capability 351
6.4.4 Personnel capability property 354
6.4.5 Equipment capability 356
6.4.6 Equipment capability property 359
6.4.7 Physical asset capability 361
6.4.8 Physical asset capability property 364
6.4.9 Material capability 365
6.4.10 Material capability property 370
6.5 Process segment capability information 372
6.5.1 Process segment capability model 372
6.5.2 Process segment capability 374
6.6 Operations segment capability information 378
6.6.1 Operations segment capability model 378
6.6.2 Operations segment capability 380
7 Cross-reference between IEC 62264-1 data flow models and the corresponding IEC 62264-2 object model 384
8 List of objects 388
9 Conformance 391
Annex A (informative) Value syntax in the value attribute 392
Annex B (informative) Implementation options for specifying values in unit of measurement attribute 393

B.1 Specifying value(s) for the “value unit of measurement” attribute in operations-related class and definition property objects (IEC 62264-2) and work-related definition and type property objects (IEC 62264-4) 393
B.2 Specifying value(s) for the “unit of measurement” attribute where no object specifies permissible values 394
Annex C (informative) Use cases and examples 398
C.1 Use case and examples 398
C.2 Application of the standard 403
C.3 Database mapping of the models 404
C.4 XML usage 405
Annex D (informative) Example data sets 410
D.1 General 410
D.2 Material model example 410
D.3 Equipment model and hierarchy scope examples 414
D.4 Personnel model example 418
D.5 Operations capability example 420
D.6 Operations performance example 421
D.7 Operations test model use case examples 422
D.8 Example of planning and response state attributes and defined values 431
D.9 Operations event definition record specification example 433
D.10 Resource acquired example 434
D.11 Work commenced/redirected/completed/aborted example 437
Annex E (informative) Questions and answers about object use 439
E.1 General 439
E.2 Inflow materials 439
E.3 Multiple products per process segment 439
E.4 Process segments vs. operations segments 440
E.5 Segment parameter references 441
E.6 Use of hierarchy scope in parameter objects 441
E.7 Use of spatial definition in personnel objects 442
E.8 How class name and property IDs are used to identify elements 443
E.9 Possible capability overcounts 444
E.10 Routing and process capability 445
E.11 Product and process capability dependencies 447
E.12 Representation of dependencies 448
E.13 How a material transfer is handled 449
E.14 How to extend the standard when properties cannot be used 449
E.15 Modeling of tools as equipment and materials 449
E.16 What is difference between equipment and a physical asset? 450
E.17 How should dependencies in the operations schedule and operations response be handled? 450
E.18 How are “mixed” operations types used? 451
E.19 What is the relationship between this standard and MESA International’s B2MML? 452
Annex F (informative) Implementation considerations for inheritance and persistence of data exchange object models 453
F.1 Object inheritance considerations 453
F.2 Record inheritance 454
F.3 Object persistence considerations 455

Annex G (informative) Logical information flows 458
Annex H (informative) Conceptual model to implementation model transformations 460
Annex I (informative) Conceptual model to implementation data model examples 464
I.1 General 464
I.2 Conceptual object model example: personnel model 464
I.3 MESA – B2MML 7.0 (XSD) implementation model 466
I.4 Simplified XSD implementation model 467
I.5 Object Management Group (OMG) – Interface Definition Language (IDL) – Common Data Representation (CDR) implementation model 468
I.6 OPC Unified Architecture (UA) implementation model 468
I.7 Flat buffers – Interactive Data Language (IDL) implementation model 470
I.8 Internet Engineering Task Force (IETF) – JavaScript Object Notation (JSON) – Schema implementation model 471
I.9 Open Source Robotics Foundation (OSRF) as so known as Open Robotics, Robot Operating System (ROS) message description specifications (MDS) 471
I.10 World Wide Web Consortium (W3C) Resource Description Framework (RDF) schema 472
I.11 SQL database model 472
I.12 Transport Protocols 472
Bibliography 474

Figure 1 – Example of aggregation relationship notation 27
Figure 2 – Example of composition relationship notation 28
Figure 3 – Example: Object model using the simplified UML diagram for an information model, personnel model 36
Figure 4 – Simplified UML model convention for cross-model relationships between resource objects 39
Figure 5 – Operations information models supporting operations management activities 51
Figure 6 – Information and object model inter-relationships for operations management information exchanges 54
Figure 7 – Data flow diagram for defined cross-model MOM relationships between operations management and work information models 60
Figure 8 – Hierarchy scope model 78
Figure 9 – Example, value attribute for WKT in 2D (3D is equally supported) 81
Figure 10 – Operational location model 82
Figure 11 – Personnel model 89
Figure 12 – Role-based equipment model 97
Figure 13 – Physical asset model 106
Figure 14 – Physical asset and equipment relationships 107
Figure 15 – Material model 116
Figure 16 – Example, material with an assembly 138
Figure 17 – Process segment model 139
Figure 18 – Example, Segment dependency 173
Figure 19 – Operations test model 174
Figure 20 – Operations record model (abstract) 190
Figure 21 – Operations event model 200

Figure 22 – Example, Relationship of operations event definition with operations events 209
Figure 23 – Operations definition model 230
Figure 24 – Operations schedule model 273
Figure 25 – Operations performance model 314
Figure 26 – Operations capability model 347
Figure 27 – Process segment capability model 373
Figure 28 – Operations segment capability model 379
Figure C.1 – Personnel model 399
Figure C.2 – Instances of a person class 401
Figure C.3 – UML model for class and class properties 401
Figure C.4 – Class property 402
Figure C.5 – Instances of a person properties 402
Figure C.6 – Instances of person and person properties 403
Figure C.7 – XML schema for a person object 406
Figure C.8 – XML schema for person properties 407
Figure C.9 – Example of person and person property 408
Figure C.10 – Example of person class information 408
Figure C.11 – Adaptor to map different property IDs and values 409
Figure D.1 – Example of simplified job order state model 433
Figure D.2 – Typical MOM functions subscribing to the *ResourceAcquired* event 434
Figure D.3 – Typical MOM functions subscribing to the *WorkCommenced, WorkRedirected, WorkCompleted* and *WorkAborted* events 437
Figure E.1 – Class and property IDs used to identify elements 443
Figure E.2 – A property defining overlapping subsets of the capability 445
Figure E.3 – Routing for a product 446
Figure E.4 – Routing with co-products and material dependencies 446
Figure E.5 – Product and process capability relationships 447
Figure E.6 – Time-based dependencies 448
Figure E.7 – Mixed operation example 451
Figure G.1 – Enterprise to manufacturing system conceptual information flows 458
Figure G.2 – Conceptual information flows among multiple systems 459
Figure I.1 – Conceptual object model example: personnel model 464
Figure I.2 – OPC UA Specification Notation 469
Figure I.3 – OPC UA representation of the personnel model 470

Table 1 – Simplified UML symbols and notation used in object models 24
Table 2 – Relationship role name template with examples for each relationship name by relationship type 30
Table 3 – Object color convention 35
Table 4 – Example: Relationship table for an object model, personnel model relationships 36
Table 5 – Example: Relationship role table, Personnel class relationship roles 37
Table 6 – Example: Usage of object attribute table 38

Table 7 – Detailed UML model relationships in Figure 4 40
Table 8 – Resource reference object relationship roles 42
Table 9 – Example: Personnel requirement cross-model relationships to the personnel model (resource group and resource) 43
Table 10 – Example: Personnel requirement cross-model relationships to the personnel reference objects 43
Table 11 – Resource reference object property relationship roles 44
Table 12 – Example: Personnel requirement property cross-model relationships to the personnel model 44
Table 13 – Example: Personnel requirement property cross-model relationships to the personnel reference object properties 45
Table 14 – Resource group relationship roles 45
Table 15 – Example: Personnel requirement cross-model relationships to the personnel class 46
Table 16 – Resource group property relationship roles 46
Table 17 – Example: Personnel requirement property cross-model relationships with the personnel class property 46
Table 18 – Resource relationship roles 47
Table 19 – Example: Personnel requirement cross-model relationships to the person 47
Table 20 – Resource property relationship roles 47
Table 21 – Example: Personnel requirement property cross-model relationships with the person property 48
Table 22 – Base resource reference object relationship roles 48
Table 23 – Example: Personnel requirement cross-model relationships to the personnel specification 48
Table 24 – Base resource reference object property relationship roles 49
Table 25 – Example: Personnel requirement property cross-model relationships to the personnel specification property 49
Table 26 – Applied resource reference object relationship roles 49
Table 27 – Example: Personnel actual cross-model relationships to the personnel requirement 50
Table 28 – Applied resource reference object property relationship roles 50
Table 29 – Example: Personnel actual property cross-model relationships to the personnel requirement property 50
Table 30 – Operations management and work information models cross-model relationships to resource information models and base/applied resource reference objects 55
Table 31 – Cross-model MOM relationship description 60
Table 32 – Common header attributes for a primary object 63
Table 33 – Common header attributes for a property object 67
Table 34 – Class, definition, or type property objects with permissible value and value attributes 69
Table 35 – Comment sub-attributes 70
Table 36 – Personnel identification manifest sub-attributes 72
Table 37 – Commonly used CCTS types for exchange 74
Table 38 – Hierarchy scope relationships 78
Table 39 – Hierarchy scope relationship roles 79

Table 40 – Hierarchy scope attributes 79
Table 41 – Attributes of spatial definition 80
Table 42 – Operational location model relationships 82
Table 43 – Operational location class relationship roles 84
Table 44 – Operational location class attributes 84
Table 45 – Operational location class property relationship roles 85
Table 46 – Operational location class property attributes 85
Table 47 – Operational location relationship roles 86
Table 48 – Operational location attributes 87
Table 49 – Operational location property relationship roles 88
Table 50 – Operational location property attributes 88
Table 51 – Personnel model relationships 89
Table 52 – Personnel class relationship roles 90
Table 53 – Personnel class attributes 91
Table 54 – Personnel class property relationship roles 92
Table 55 – Personnel class property attributes 93
Table 56 – Person relationship roles 94
Table 57 – Person attributes 94
Table 58 – Person property relationship roles 95
Table 59 – Person property attributes 96
Table 60 – Role-based equipment model relationships 97
Table 61 – Equipment class relationship roles 98
Table 62 – Equipment class attributes 99
Table 63 – Equipment class property relationship roles 100
Table 64 – Equipment class property attributes 101
Table 65 – Equipment relationship roles 102
Table 66 – Equipment attributes 103
Table 67 – Equipment property relationships 104
Table 68 – Equipment property attributes 105
Table 69 – Physical asset model relationships 106
Table 70 – Physical asset and equipment relationships 107
Table 71 – Physical asset class relationship roles 108
Table 72 – Physical asset class attributes 109
Table 73 – Physical asset class property relationship roles 110
Table 74 – Physical asset class property attributes 110
Table 75 – Physical asset relationship roles 111
Table 76 – Physical asset attributes 112
Table 77 – Physical asset property relationship roles 113
Table 78 – Physical asset property attributes 114
Table 79 – Equipment asset mapping relationship roles 114
Table 80 – Equipment asset mapping attributes 115
Table 81 – Material model relationships 117
Table 82 – Material class relationship roles 118

Table 83 – Material class attributes 119
Table 84 – Material class property relationship roles 122
Table 85 – Material class property attributes 122
Table 86 – Material definition relationship roles 123
Table 87 – Material definition attributes 124
Table 88 – Material definition property relationship roles 126
Table 89 – Material definition property attributes 127
Table 90 – Material lot relationship roles 128
Table 91 – Material lot attributes 129
Table 92 – Material lot property relationship roles 132
Table 93 – Material lot property attributes 132
Table 94 – Material sublot relationship roles 134
Table 95 – Material sublot attributes 134
Table 96 – Process segment model relationships 140
Table 97 – Process segment relationship roles 144
Table 98 – Process segment attributes 146
Table 99 – Process segment parameter relationship roles 147
Table 100 – Process segment parameter attributes 148
Table 101 – Personnel segment specification relationship roles 148
Table 102 – Personnel segment specification attributes 150
Table 103 – Personnel segment specification property relationship roles 151
Table 104 – Personnel segment specification property attributes 152
Table 105 – Equipment segment specification relationship roles 153
Table 106 – Equipment segment specification attributes 154
Table 107 – Equipment segment specification property relationship roles 155
Table 108 – Equipment segment specification property attributes 157
Table 109 – Physical asset segment specification relationship roles 158
Table 110 – Physical asset segment specification attributes 159
Table 111 – Physical asset segment specification property relationship roles 160
Table 112 – Physical asset segment specification property attributes 161
Table 113 – Material segment specification relationship roles 162
Table 114 – Material segment specification attributes 164
Table 115 – Material segment specification property relationships 168
Table 116 – Material segment specification property attributes 170
Table 117 – Segment dependency relationship roles 171
Table 118 – Segment dependency attributes 171
Table 119 – Operations test model relationships 174
Table 120 – Instances of operations test requirement 175
Table 121 – Operations test requirement relationship roles in the operations test model 176
Table 122 – Associated resource objects as testable object / testable object property pair 177
Table 123 – Testable object relationship roles in operations test model 177
Table 124 – Testable object property relationship roles in the operations test model 178

Table 125 – Test specification relationship roles 179
Table 126 – Test specification attributes 179
Table 127 – Test specification property relationship roles 181
Table 128 – Test specification property attributes 181
Table 129 – Test specification criteria relationship roles 182
Table 130 – Test specification criteria attributes 182
Table 131 – Evaluated property relationship roles 184
Table 132 – Evaluated property attributes 184
Table 133 – Test result relationship roles 185
Table 134 – Test result attributes 185
Table 135 – Property measurement relationship roles 187
Table 136 – Property measurement attributes 187
Table 137 – Instances of resource actual 188
Table 138 – Resource actual relationship roles in operations test model 189
Table 139 – Operations record model (abstract) relationships 190
Table 140 – Operations record specification relationship roles 191
Table 141 – Operations record specification attributes 192
Table 142 – Operations record template relationship roles 195
Table 143 – Operations record template attributes 195
Table 144 – Operations record entry template relationships 197
Table 145 – Operations record entry template attributes 198
Table 146 – Operations Event model relationships 200
Table 147 – Operations event class relationship roles 202
Table 148 – Operations event class attributes 202
Table 149 – Example of operations event class locked hierarchy 203
Table 150 – Operations event class property relationship roles 204
Table 151 – Operations event class property attributes 204
Table 152 – Operations event class record specification relationship roles 206
Table 153 – Operations event class record specification attributes 207
Table 154 – Operations event definition relationship roles 209
Table 155 – Operations event definition attributes 210
Table 156 – Operations event definition property relationship roles 213
Table 157 – Operations event definition property attributes 214
Table 158 – Operations event definition record specification relationship roles 215
Table 159 – Operations event definition record specification attributes 216
Table 160 – Operations event relationship roles 219
Table 161 – Operations event attributes 219
Table 162 – Operations event property relationship roles 222
Table 163 – Operations event property attributes 223
Table 164 – Operations event record relationship roles 223
Table 165 – Operations event record attributes 224
Table 166 – Operations event record entry relationships 226
Table 167 – Operations event record entry attributes 227

Table 168 – Operations definition model relationships 231
Table 169 – Operations definition relationship roles 236
Table 170 – Operations definition attributes 237
Table 171 – Operations material bill relationship roles 239
Table 172 – Operations material bill attributes 239
Table 173 – Operations material bill item relationship roles 240
Table 174 – Operations material bill item attributes 240
Table 175 – Operations segment relationship roles 243
Table 176 – Operations segment attributes 245
Table 177 – Parameter specification relationship roles 247
Table 178 – Parameter specification attributes 248
Table 179 – Personnel specification relationship roles 249
Table 180 – Personnel specification attributes 251
Table 181 – Personnel specification property relationship roles 252
Table 182 – Personnel specification property attributes 253
Table 183 – Equipment specification relationship roles 254
Table 184 – Equipment specification attributes 256
Table 185 – Equipment specification property relationship roles 257
Table 186 – Equipment specification property attributes 258
Table 187 – Physical asset specification relationship roles 259
Table 188 – Physical asset specification attributes 261
Table 189 – Physical asset specification property relationship roles 262
Table 190 – Physical asset specification property attributes 263
Table 191 – Material specification relationship roles 264
Table 192 – Material specification attributes 266
Table 193 – Material specification property relationship roles 269
Table 194 – Material specification property attributes 270
Table 195 – Segment dependency relationship roles 271
Table 196 – Segment dependency attributes 272
Table 197 – Operations schedule model relationships 274
Table 198 – Operations schedule relationship roles 277
Table 199 – Operations schedule attributes 278
Table 200 – Operations request relationship roles 280
Table 201 – Operations request attributes 281
Table 202 – Segment requirement relationship roles 283
Table 203 – Segment requirement attributes 285
Table 204 – Segment parameter relationship roles 287
Table 205 – Segment parameter attributes 288
Table 206 – Personnel requirement relationship roles 289
Table 207 – Personnel requirement attributes 291
Table 208 – Personnel requirement property relationship roles 292
Table 209 – Personnel requirement property attributes 293
Table 210 – Equipment requirement relationship roles 295

Table 211 – Equipment requirement attributes 296
Table 212 – Equipment requirement property relationships 297
Table 213 – Equipment requirement property attributes 299
Table 214 – Physical asset requirement relationship roles 300
Table 215 – Physical asset requirement attributes 301
Table 216 – Physical asset requirement property relationship roles 303
Table 217 – Physical asset requirement property attributes 304
Table 218 – Material requirement relationship roles 305
Table 219 – Material requirement attributes 307
Table 220 – Material requirement property relationship roles 311
Table 221 – Material requirement property attributes 312
Table 222 – Requested segment response relationship roles 313
Table 223 – Operations performance model relationships 315
Table 224 – Operations performance relationship roles 318
Table 225 – Operations performance attributes 318
Table 226 – Operations response relationship roles 320
Table 227 – Operations response attributes 321
Table 228 – Segment response relationship roles 323
Table 229 – Segment response attributes 324
Table 230 – Segment data relationship roles 326
Table 231 – Segment data attributes 326
Table 232 – Personnel actual relationship roles 328
Table 233 – Personnel actual attributes 329
Table 234 – Personnel actual property relationship roles 330
Table 235 – Personnel actual property attributes 331
Table 236 – Equipment actual relationship roles 332
Table 237 – Equipment actual attributes 333
Table 238 – Equipment actual property relationship roles 334
Table 239 – Equipment actual property attributes 335
Table 240 – Physical asset actual relationship roles 336
Table 241 – Physical asset actual attributes 337
Table 242 – Physical asset actual property relationship roles 339
Table 243 – Physical asset actual property attributes 340
Table 244 – Material actual relationship roles 341
Table 245 – Material actual attributes 342
Table 246 – Material actual property relationship roles 345
Table 247 – Material actual property attributes 346
Table 248 – Operations capability model relationships 347
Table 249 – Operations capability relationship roles 349
Table 250 – Operations capability attributes 349
Table 251 – Personnel capability relationship roles 352
Table 252 – Personnel capability attributes 353
Table 253 – Personnel capability property relationship roles 355

Table 254 Personnel capability property attributes 355
Table 255 – Equipment capability relationship roles 356
Table 256 – Equipment capability attributes 357
Table 257 – Equipment capability property relationships 360
Table 258 – Equipment capability property attributes 360
Table 259 – Physical asset capability relationship roles 361
Table 260 – Physical asset capability attributes 362
Table 261 – Physical asset capability property relationship roles 364
Table 262 – Physical asset capability property attributes 365
Table 263 – Material capability relationship roles 366
Table 264 – Material capability attributes 367
Table 265 – Material capability property relationship roles 371
Table 266 – Material capability property attributes 372
Table 267 – Process segment capability model relationships 374
Table 268 – Process segment capability relationship roles 375
Table 269 – Process segment capability attributes 376
Table 270 – Operations segment capability model relationships 379
Table 271 – Operations segment capability relationship roles 381
Table 272 – operations segment capability attributes 382
Table 273 – IEC 62264-1:2013 elements to IEC 62264-2 cross-reference 384
Table 274 – Common resource objects 388
Table B.1 – Class, definition, or type property objects defining permissible values for value UoM attribute 394
Table B.2 – Objects with an attribute pair containing a UoM attribute with no defined permissible value 395
Table C.1 – Personnel model relationships 399
Table C.2 – Person relationship roles 400
Table C.3 – Person attributes 400
Table C.4 – Database structure for *person* 404
Table C.5 – Database structure for person property 404
Table C.6 – Database for *person* with data 404
Table C.7 – Database for *person property* with data 405
Table D.1 – Pulp and paper equipment model example 414
Table D.2 – Semiconductor manufacturing equipment model example 417
Table D.3 – Planning and job order execution states and defined values of IEC 62264 432
Table D.4 – Operations event definition for the operations event, *ResourceAcquired* 435
Table D.5 – Entry set 1 for an operations event definition record specification 435
Table D.6 – Entry set 2 for minimal operations event definition record specification 436
Table D.7 – Entry set 3 for an operations event definition record specification 436
Table D.8 – Entry set 4 for operations event definition record specification 4 437
Table D.9 – Operations event definition record specification for *WorkCommenced* and *WorkRedirected* 438
Table D.10 – Operations event definition record specification for *WorkCompleted* and *WorkAborted* 438

Table E.1 – Definition of segment types 441
Table E.2 – Examples of materials and equipment 450
Table E.3 – Equipment and physical assets 450
Table F.1 – Common defined states for child or member dataset to differentiate types of records 455
Table F.2 – Behavior of records when creating, modifying, or deleting a record, depending on its initial dataset state 455
Table I.1 – Example: Personnel class relationships 465
Table I.2 – Example: Personnel class attributes 466