

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 subplot.....	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 <i>ResourceAcquired</i> event.....	434
Figure D.3 – Typical MOM functions subscribing to the <i>WorkCommenced</i> , <i>WorkRedirected</i> , <i>WorkCompleted</i> and <i>WorkAborted</i> 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 subplot relationship roles	134
Table 95 – Material subplot 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 <i>person</i>	404
Table C.5	Database structure for person property	404
Table C.6	Database for <i>person</i> with data	404
Table C.7	Database for <i>person property</i> 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, <i>ResourceAcquired</i>	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 <i>WorkCommenced</i> and <i>WorkRedirected</i>	438
Table D.10	Operations event definition record specification for <i>WorkCompleted</i> and <i>WorkAborted</i>	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