ISO 80601-2-84:2020-07 (E)

Medical electrical equipmen t - Part 2-84: Particular requirements for the basic safety and essential perfor mance of ventilators for the emergency medical services environment

Contents

Page

Foreword xxii

Introduction xxiv

1 Scope of the integrated model and fundamental principles 1

1.1 Contents of this document 1

1.2 Scope of the QIF Version 3.0 information model 1

1.3 Conformance 3

2 Normative references 4

3 Terms and definitions 6

3.1 Terms defined in ISO 22093:2011 and ANSI/DMIS 105.3-2016, Part 1 6

3.1.1 actual 6

3.1.2 dimensional measuring equipment (DME) 6

3.1.3 nominal 6

3.1.4 measurement 6

3.1.5 part coordinate system (PCS) 6

3.2 Terms defined in XML Schema Part 0: Primer Second Edition, W3C Recommendation 28 October 2004 6

3.2.1 attribute 6

3.2.2 complexType 6

3.2.3 element 6

3.2.4 instance file 7

3.3 Terms defined in XML Schema Part 1: Structures Second Edition, W3C Recommendation 28 October 2004 7

3.3.1 attribute information item 7

3.3.2 element information item 7

3.3.3 enumeration 7

3.3.4 extension 7

3.3.5 key 7

3.3.6 keyref 7

3.3.7 schema (or XML schema) 7
3.3.8 schema document (or schema file) 7
3.3.9 simple type 8
3.3.10 string 8
3.3.11 token 8
3.4 Terms defined in the QIF standard 8
3.4.1 accuracy test 8
3.4.2 action 8
3.4.3 action group 8
3.4.4 action method 8
3.4.5 actual component 8
3.4.6 actual component set 8
3.4.7 application area 9
3.4.8 articulating arm CMM 9
3.4.9 aspect 9
3.4.10 definition aspect 9
3.4.11 nominal aspect 9
3.4.12 item aspect 9
3.4.13 measured aspect 9
3.4.14 assembly 9
3.4.15 assembly path 9
3.4.16 assignable cause 9
3.4.17 attribute characteristic 9
3.4.18 attribute data 10
3.4.19 autocollimator 10
3.4.20 bias 10
3.4.21 bill of characteristics (BoC) 10
3.4.22 boolean condition 10
3.4.23 calibration 10
3.4.24 caliper 10
3.4.25 capability 10
3.4.26 capacitive sensor 10
3.4.27 carriage 10
3.4.28 Cartesian CMM 10
3.4.29 characteristic 10
3.4.30 characteristic item 11
3.4.31 charge coupled device camera sensor 11
3.4.32 checked 11
3.4.33 clipping plane 11

3.4.34 complex tactile probe sensor 11
3.4.35 component 11
3.4.36 composite feature 11
3.4.37 computed tomography 11
3.4.38 confocal chromatic sensor 11
3.4.39 constructed feature 11
3.4.40 control limits 11
3.4.41 control points 11
3.4.42 coordinate measuring machine 12
3.4.43 control polygon 12
3.4.44 corrective action 12
3.4.45 corrective action plan 12
3.4.46 data/information quality 12
3.4.47 datum definition 12
3.4.48 datum reference frame 12
3.4.49 dial caliper 12
3.4.50 digital caliper 12
3.4.51 digital micrometer 12
3.4.52 draw wire sensor 12
3.4.53 DVRT sensor 12
3.4.54 eddy current sensor 13
3.4.55 entity 13
3.4.56 evaluation 13
3.4.57 event 13
3.4.58 external product definition 13
3.4.59 feature 13
3.4.60 file unit 13
3.4.61 fixture 13
3.4.62 gage 13
3.4.63 gage repeatability and reproduceability (gage R&R) 14
3.4.64 generatrix 14
3.4.65 generic feature 14
3.4.66 geometric 14
3.4.67 geometric characteristic 14
3.4.68 inspection 14
3.4.69 inspection traceability 14

3.4.70 internal product definition 14
3.4.71 item 14
3.4.72 key characteristic 15
3.4.73 knot vector 15
3.4.74 laser radar 15
3.4.75 laser tracker 15
3.4.76 laser triangulation sensor 15
3.4.77 light pen CMM 15
3.4.78 linearity 15
3.4.79 Long Term Archiving and Retrieval 15
3.4.80 LVDT sensor 15
3.4.81 magneto-inductive sensor 15
3.4.82 manufacturing traceability 16
3.4.83 measurand 16
3.4.84 measure feature method 16
3.4.85 measurement 16
3.4.86 measurement device 16
3.4.87 measurement plan 16
3.4.88 measurement resource 16
3.4.89 measurement result 16
3.4.90 measurement room 16
3.4.91 mesh 16
3.4.92 micrometer 17
3.4.93 microscope 17
3.4.94 multiple carriage CMM 17
3.4.95 non-dimensional quality data 17
3.4.96 normal 17
3.4.97 normal vector 17
3.4.98 notable event 17
3.4.99 note 17
3.4.100 noted event 17
3.4.101 optical comparator 17
3.4.102 parallel link CMM 17
3.4.103 part 17
3.4.104 persistent identifier 18

3.4.105 plan element 18
3.4.106 plan note 18
3.4.107 plan root 18
3.4.108 point sampling strategy 18
3.4.109 process variation 18
3.4.110 product 18
3.4.111 product and manufacturing information (PMI) 18
3.4.112 production 18
3.4.113 QIF persistent identifier (QPId) 18
3.4.114 qualification 18
3.4.115 rule 19
3.4.116 sampling category 19
3.4.117 sampling method 19
3.4.118 sensor 19
3.4.119 sensor qualification 19
3.4.120 set 19
3.4.121 simple tactile probe 19
3.4.122 sine bar 19
3.4.123 stability 19
3.4.124 standard deviation 19
3.4.125 statistical study plan 20
3.4.126 statistical study results 20
3.4.127 structured light sensor 20
3.4.128 tactile probe sensor 20
3.4.129 theodolite 20
3.4.130 thread specification 20
3.4.131 tolerance 20
3.4.132 tool 20
3.4.133 touch probe 20
3.4.134 traceability 21
3.4.135 trimming contour 21
3.4.136 ultrasonic sensor 21
3.4.137 universal length measuring machine 21
3.4.138 version 21
3.4.139 weld characteristic 21
3.4.140 weld symbol 21

3.4.141 wire-frame 21
3.4.142 work instruction 21
3.4.143 workpiece 21
4 Symbols and abbreviated terms 22
5 Overview of the Quality Information Framework (QIF) information model 24
5.1 Purpose 24
5.2 Model based definition manufacturing quality workflow 24
5.3 QIF design requirements 27
5.4 QIF Data Quality 28
5.4.1 XML implementation 28
5.4.2 Redundancy Checks 31
5.4.3 Product Data Quality 31
5.4.4 Digital Signature 31
5.4.5 Long Term Archiving and Retrieval 32
5.5 QIF manufacturing functional requirements 33
5.6 QIF and STEP 33
5.7 QIF information model design guidelines 34
5.8 Overview of XML schema file modularity 34
5.9 Data structures 35
5.9.1 The QIFDocument element 35
5.9.2 Four aspects of features data 40
5.9.3 Four aspects of characteristics 45
5.9.4 Default tolerances and characteristics 48
5.9.5 Relationships between the aspects 50
5.10 Hierarchy of required information 55
5.10.1 QIF use of optional elements 55
5.10.2 Example: diameter characteristic 55
5.10.3 ScaleCoefficient 58
5.11 Actual parts and assemblies 58
5.12 Checking connections between data objects 60
5.13 Tracking information through the product lifecycle 63
5.13.1 Persistent Identifiers 63

5.13.2 UUIDs and QPIds 63
5.13.3 External File References 64
5.13.4 QIF data flow 65
5.13.5 Using QPIds in QIF 66
5.14 Linking PMI information to product shape models 69
5.15 Welding Characteristics and Symbols 71
5.15.1 Base parameters 72
5.15.2 Location Significance parameter 72
5.15.3 Weld Characteristic parameters 72
5.15.4 Supplementary parameters 75
5.15.5 Non-Destructive Testing types 75
5.15.6 Compound Welds 75
5.16 QIF handling of transforms, transformations, and coordinate systems 76
5.16.1 Coordinate Spaces 76
5.16.2 Transformation matrix 76
5.16.3 Transforms 82
5.16.4 Coordinate systems 82
5.16.5 CAD coordinate systems 85
5.16.6 Coordinate system lists 85
5.17 Feature control frames 86
5.17.1 Geometric tolerance characteristic types 86
5.17.2 Tolerance zone size 87
5.17.3 Zone shape 88
5.17.4 Zone extents 88
5.17.5 Other zone modifiers 89
5.17.6 Datum reference frames 89
5.18 QIF handling of units 91
5.18.1 Introduction 91
5.18.2 PMI units 92
5.18.3 Default units 93
5.18.4 Other units 93
5.19 Modeling slots in QIF 94
5.19.1 Introduction 94
5.19.2 Internal and external 94

5.19.3 Location and size 94
5.19.4 End types 96
5.19.5 Bottom types 99
5.19.6 Taper 99
5.19.7 Draft 99
5.19.8 Feature measurement 100
5.20 Modeling cones and conical segments in QIF 100
5.20.1 Introduction 100
5.20.2 Location, orientation and angle 101
5.20.3 Linear extents 102
5.21 Modeling pattern features in QIF 105
5.21.1 Circular pattern feature 106
5.21.2 Circular arc pattern feature 107
5.21.3 Linear pattern feature 108
5.21.4 Parallelogram pattern feature 109
5.22 Modeling threads in QIF 109
5.22.1 Thread specification types 110
5.23 Feature measurement determination 110
5.23.1 Checked and set features 110
5.23.2 Measurement and construction 111
5.23.3 Measurement points 111
5.23.4 Construction methods 111
5.24 CharacteristicDesignators - encoding "balloon" numbers in QIF 113
5.25 Attributes and Part Notes 114
5.26 Detailed requirements 116
5.26.1 XML naming and design rules (NDR) 116
5.26.2 Annotation conventions 118
6 QIF Library 120
6.1 Introduction 120
6.1.1 Changes in the QIF Library from QIF Version 2.1 121
6.2 Auxiliary.xsd 121
6.3 Characteristics.xsd 122
6.3.1 Characteristics *element* 122

6.3.2 Characteristic definitions, nominals, items, and measurements 122
6.3.3 DefaultCharacteristicDefinitions 126
6.3.4 DefaultToleranceDefinitions 126
6.3.5 CharacteristicGroups 126
6.3.6 Constraint checking for characteristics 126
6.3.7 ToleranceZones 127
6.3.8 Substitution groups in Characteristics.xsd 127
6.4 Expressions.xsd 127
6.4.1 Types Defined in Expressions.xsd 128
6.4.2 Substitution groups in Expressions.xsd 128
6.5 Features.xsd 128
6.5.1 Features *element* 128
6.5.2 Feature types 129
6.5.3 Constraint checking for features 132
6.5.4 Feature construction methods 132
6.5.5 Substitution groups for features 133
6.6 GenericExpressions.xsd 133
6.6.1 Arithmetic Expressions 133
6.6.2 String Expressions 133
6.6.3 Boolean Expressions 134
6.7 Geometry.xsd 134
6.8 IntermediatesPMI.xsd 136
6.9 Primitives.xsd 137
6.10 PrimitivesPD.xsd 138
6.11 PrimitivesPMI.xsd 138
6.12 Statistics.xsd 138
6.12.1 Basic Statistics Types 138
6.12.2 Characteristic Statistics Evaluation Types 140
6.13 Topology.xsd 142
6.14 Traceability.xsd 143
6.14.1 *InspectionTraceabilityType* 144
6.14.2 *PreInspectionTraceabilityType* 144
6.14.3 *ProductTraceabilityType* 145

6.14.4 *ActualProductTraceabilityType* 145
6.14.5 *ManufacturingProcessTraceabilityType* 146
6.15 Units.xsd 147
6.15.1 FileUnits 147
6.15.2 Conversions 148
6.15.3 FileUnitsExample 149
6.15.4 Instance File Example Using Units 150
6.16 Visualization.xsd 151
7 QIF Model Based Definition (MBD) information model 154
7.1 Foreword 154
7.2 Introduction 154
7.3 Scope 154
7.3.1 Contents of this clause 154
7.3.2 QIF MBD Information Model Application Architecture 155
7.4 QIF MBD information model requirements 157
7.5 Overview of the product data model 157
7.5.1 Design principles 157
7.5.2 Geometry 166
7.5.3 Topology 243
7.5.4 Product structure 272
7.5.5 Transformations 287
7.5.6 Auxiliary data 288
7.5.7 Visualization data 293
7.5.8 Validation properties 338
7.5.9 High level description of the product data 343
8 QIF Plans information model 345
8.1 Foreword 345
8.2 Introduction 346
8.3 Scope 347
8.3.1 Contents of this clause 347
8.3.2 Workflow of QIF Plans data for manufacturing quality 347
8.3.3 QIF Plans information model 348

8.3.4 QIF Plans scope 348
8.3.5 QIF Plans use cases 349
8.3.6 QIF Plans product definition support 351
8.4 Data types and *element*s of the QIF Plans information model 351
8.4.1 Plan 351
8.4.2 PlanElement 351
8.4.3 Action 351
8.4.4 Action Groups 352
8.4.5 Nesting of Action Groups 353
8.4.6 Action Group Functions 353
8.4.7 Measurand 354
8.4.8 Action Method 354
8.4.9 Measure Feature Method 354
8.4.10 Work Instruction 355
8.5 Tracking information through the product lifecycle 355
8.6 QIF Plans data flow to results 355
8.7 QIF Results reference to QIF Plans 355
8.8 Item tracking and persistence between QIF Plans and QIF Results 355
8.9 High level description of QIF Plans.xsd 356
8.9.1 High level structure of the QIF Plans schema 356
8.9.2 Major *elements* 358
8.9.3 Simplified relationships *element*s 359
8.9.4 Conditional Action Groups 359
8.9.5 Plan Variables 360
9 QIF Resources information model 361
9.1 Foreword 361
9.2 Introduction 361
9.3 Scope 362
9.3.1 Contents of this clause 362
9.4 QIF Resources Requirements 362
9.5 The QIF Resources data model 363
9.5.1 QIF Resources Instance Data 363
9.5.2 *MeasurementResourceBaseType* 364

9.5.3 Measurement Devices 367
9.5.4 Coordinate Measuring Machine (CMM) 370
9.5.5 Sensors and Tools 373
9.5.6 Rotary Table 375
9.5.7 Resolution Types 375
9.5.8 Working Volumes 375
9.5.9 Axis Types 375
9.5.10 Environmental Data 375
9.5.11 Calibrations 376
9.5.12 *MeasurementRoomType* 376
10 QIF Rules information model 377
10.1 Introduction 377
10.1.1 Why 377
10.1.2 What 377
10.1.3 How 378
10.1.4 Changes from QIF 2.1 379
10.2 Design principles of QIF Rules 379
10.2.1 Structure of a Rule 379
10.2.2 Feature Rules 380
10.2.3 DME Selection Rules 381
10.3 QIF Rules schema files 382
10.4 QIF Rules *element*s and data types 382
10.4.1 QIF Rules top level 382
10.4.2 Feature Rules 383
10.4.3 DME Selection Rules 386
11 QIF Results information model 392
11.1 Foreword 392
11.2 Introduction 392
11.3 Scope 392
11.3.1 Workflow of QIF Results data for manufacturing quality 392
11.3.2 Design guidelines for the QIF Results information model 393
11.4 The QIFResults.xsd schema file 394
11.4.1 High level structure of the QIF Results schema 394

11.5 Data dictionary: QIFResults.xsd 398
12 QIF Statistics information model 399
12.1 Foreword 399
12.2 Introduction 399
12.3 Scope 400
12.3.1 Contents of this clause 400
12.4 Requirements 400
12.4.1 QIF Statistics quality metrology activity diagram 401
12.5 The QIF Statistics data model 403
12.5.1 Design principles of QIF Statistics 403
12.5.2 QIF Statistics data sets 404
12.5.3 Statistical and summary values 406
12.5.4 Statistical study criteria 413
12.5.5 Data groups and subgroups 414
12.5.6 High level structure of the QIF Statistics schema 419
12.5.7 Referencing measurement results 420
12.6 QIF Statistics samples 421
12.6.1 Typical quality data examples 421
12.6.2 Typical quality study type examples 427
Annex A – Graphical conventions of the data dictionary 455
Annex B – Sample QIF instance files 458
Annex C – ISO GPS support in QIF 3.0 493
Annex D – DMSC Volunteer Agreement 497
Bibliography 498

Figures

Figure 1 – QIF version 3.0 information architecture 2
Figure 2 – QIF Model-Based Quality Workflow 25
Figure 3 – QIF XML schema directory structure 35
Figure 4 – Structure of the **QIFDocument** *element* 37
Figure 5 – Reference connections among feature data objects in a QIF XML instance file 40
Figure 6 – A plate with four holes 40
Figure 7 – A plate with four holes and GD&T 41

Figure 8 – A plate with four holes with names. 42
Figure 9 – References among characteristic data objects in a QIF XML instance file 46
Figure 10 – A plate with ballooned tolerances 46
Figure 11 – Connections at the PMI Stage 53
Figure 12 – Connections at the Planning Stage 54
Figure 13 – Connections at the post-measurement stage 54
Figure 14 – QIF id and reference types 60
Figure 15 – ***QPIdType*** elements 67
Figure 16 – ***QPIdFullReferenceType*** elements 68
Figure 17 – Weld Characteristics Hierarchy 71
Figure 18 – Location Significance 72
Figure 19 – Weld Characteristic Parameters Hierarchy 73
Figure 20 – Weld Characteristic Parameters 73
Figure 21 – Melt Through 75
Figure 22 – Non-Destructive Testing with Multiple Reference Lines 75
Figure 23 – Compound Weld 76
Figure 24 – Transformation matrix example 81
Figure 25 – An opposite parallel lines feature with round closed ends 95
Figure 26 – An opposite parallel planes feature with flat closed ends 96
Figure 27 – A slot with non-tangent round ends 97
Figure 28 – A flat-ended slot with rounded corners 98
Figure 29 – Opposite planes features with open ends 98
Figure 30 – A tapered slot (opposite angled lines) 99
Figure 31 – A slot with draft (opposite angled plane feature) 100
Figure 32 – An unbounded cone located at a reference diameter and defined by its half angle 101
Figure 33 – An unbounded cone located at its vertex and defined by its full angle 102
Figure 34 – A bounded, truncated cone located at a reference diameter 103
Figure 35 – A bounded, truncated cone located at a virtual reference diameter 103
Figure 36 – A bounded, truncated cone located at its small end 104
Figure 37 – A bounded, truncated cone located at its large end 104
Figure 38 – A bounded pointed cone located at its vertex 105
Figure 39 – A bounded truncated cone located at its vertex 105
Figure 40 – **PatternFeatureCircle** with **FeatureDirection** omitted 106
Figure 41 – **PatternFeatureCircle** with **FeatureDirection** 107
Figure 42 – **PatternFeatureCircularArc** 108
Figure 43 – **PatternFeatureLinear** 108
Figure 44 – **PatternFeatureParallelogram** 109
Figure 45 – Threaded features 110
Figure 46 – **Attributes** element names and types 114
Figure 47 – Types with **Attributes** element 115
Figure 48 – **Characteristics** element 122
Figure 49 – Characteristic types 126
Figure 50 – Tolerance zone types 127
Figure 51 – **Features** element 129
Figure 52 – Feature Types (below) 130
Figure 53 – Comparison of feature definitions in QIF and DMIS 131
Figure 54 – Individual geometry types 135

Figure 55 – Geometry set types 135
Figure 56 – Alignment operations 136
Figure 57 – Datums and datum reference frames 136
Figure 58 – ISO-specific types 137
Figure 59 – Types with enumeration or user definition 138
Figure 60 – Basic Statistics Types 139
Figure 61 – **CharacteristicStatsEval** types (continued on next page) 140
Figure 62 – Criterion Types 142
Figure 63 – Summary Statistics Types 142
Figure 64 – Individual topology types 143
Figure 65 – Topology set types 143
Figure 66 – Elements of ***InspectionTraceabilityType*** 144
Figure 67 – Elements of ***PreInspectionTraceabilityType*** 145
Figure 68 – Elements of ***ProductTraceabilityType*** 145
Figure 69 – Elements of ***ActualProductTraceabilityType*** 146
Figure 70 – Elements of ***ManufacturingProcessTraceabilityType*** 146
Figure 71 – **FileUnits** element 147
Figure 72 – Derivation hierarchy of values with units 148
Figure 73 – Conversion of units 149
Figure 74 – **FileUnits** snippet 150
Figure 75 – Instance file snippets using units 151
Figure 76 – **VisualizationSet** *element* 152
Figure 77 – ***ViewSetType*** 153
Figure 78 – Workflow of QIF MBD Information 156
Figure 79 – Entity attributes 162
Figure 80 – Geometry Types 167
Figure 81 – **Point** 168
Figure 82 – 2D Parametric Curve 169
Figure 83 – 2D Curves Types 169
Figure 84 – 2D Segment 170
Figure 85 – 2D Polyline 171
Figure 86 – 2D Circular Arc 172
Figure 87 – 2D Circular Arc (turned) 172
Figure 88 – 2D Conic Arc (form = PARABOLA) 173
Figure 89 – 2D Conic Arc (form = PARABOLA, turned = true) 174
Figure 90 – 2D Conic Arc (form = ELLIPSE) 174
Figure 91 – 2D Conic Arc (form = ELLIPSE, turned = true) 174
Figure 92 – 2D Conic Arc (form = HYPERBOLA) 175
Figure 93 – 2D Conic Arc (form = HYPERBOLA, turned = true) 175
Figure 94 – 2D Spline Curve 178
Figure 95 – 2D NURBS Curve 180
Figure 96 – 2D Aggregate Curve 182
Figure 97 – 3D Parametric Curve 184
Figure 98 – 3D Curve Types 184
Figure 99 – 3D Segment 186
Figure 100 – 3D Polyline 186
Figure 101 – 3D Circular Arc 187
Figure 102 – 3D Conic Arc (form = PARABOLA) 189

Figure 103 – 3D Conic Arc (form = ELLIPSE) 189
Figure 104 – 3D Conic Arc (form = HYPERBOLA) 190
Figure 105 – 3D Spline Curve 192
Figure 106 – 3D NURBS Curve 194
Figure 107 – 3D Aggregate Curve 196
Figure 108 – Parametric Surface 198
Figure 109 – Parametric Surface Types 199
Figure 110 – Scaling coefficient 200
Figure 111 – Plane 201
Figure 112 – Plane (Parameter Space) 201
Figure 113 – Cylinder 203
Figure 114 – Cylinder (turnedV = true) 204
Figure 115 – Cylinder (Parametric Space) 204
Figure 116 – Cone 206
Figure 117 – Cone (turnedV = true) 207
Figure 118 – Cone (Parametric Space) 207
Figure 119 – Sphere 209
Figure 120 – Sphere (turnedV = true) 210
Figure 121 – Sphere (Parametric Space) 210
Figure 122 – Torus 213
Figure 123 – Torus (turnedV = true) 214
Figure 124 – Torus (Parametric Space) 214
Figure 125 – Extrude Surface 217
Figure 126 – Extrude Surface (Parametric Space) 217
Figure 127 – Ruled Surface 219
Figure 128 – Ruled Surface (turnedSecondCurve = true) 220
Figure 129 – Ruled Surface (Parametric Space) 220
Figure 130 – Surface Of Revolution 222
Figure 131 – Surface Of Revolution (turned Generatrix) 223
Figure 132 – Surface Of Revolution (Parametric Space) 223
Figure 133 – Spline Surface 225
Figure 134 – Spline Surface (Parameter Space) 225
Figure 135 – NURBS Surface 229
Figure 136 – NURBS Surface (Parameter Space) 229
Figure 137 – Offset Surface 232
Figure 138 – Offset Surface (Parametric Space) 232
Figure 139 – The edge ‘w’ of triangle ‘t’ 235
Figure 140 – Triangulation Path 236
Figure 141 – Two sewn triangles 238
Figure 142 – Triangle Mesh 239
Figure 143 – Triangle Mesh with special normals 240
Figure 144 – Topology Types 243
Figure 145 – Boundary Representation 244
Figure 146 – Vertex 245
Figure 147 – Edge 246
Figure 148 – Loop 248
Figure 149 – Co-Edge 250

Figure 150 – Outer Loop....251
Figure 151 – Inner Loop....252
Figure 152 – Slit Loop....253
Figure 153 – Vertex Loop....254
Figure 154 – Mesh Loop....255
Figure 155 – Mesh Co-Edge....257
Figure 156 – Face....258
Figure 157 – Mesh Face....259
Figure 158 – Mesh Face (Triangle Visibility and Color)....260
Figure 159 – Shell....262
Figure 160 – Shell Faces....263
Figure 161 – Body....264
Figure 162 – Cloud of Points....266
Figure 163 – Cloud of Point with Defined Normals....266
Figure 164 – Point Cloud (Point Visibility and Color)....267
Figure 165 – Sewn Faces (normals of the underlying surfaces are conformed: $Turned_0 = Turned_1$ FALSE)....269
Figure 166 – Sewn Faces (normals of the underlying surfaces are not conformed: $Turned_0$ (FALSE) ≠ $Turned_1$ (TRUE))....270
Figure 167 – Tolerant Edges and Vertices....271
Figure 168 – Product directed acyclic graph....272
Figure 169 – Unfolded product tree....274
Figure 170 – Reference of a part entity within an assembly....276
Figure 171 – Multiple representations for parts and assemblies....279
Figure 172 – Point....288
Figure 173 – Line....289
Figure 174 – Reference Plane....290
Figure 175 – Coordinate System....291
Figure 176 – Annotation View....298
Figure 177 – Text....299
Figure 178 – Balloons....299
Figure 179 – Leader....301
Figure 180 – Double head leader....303
Figure 181 – Extended leader....304
Figure 182 – Double head extended leader....305
Figure 183 – Circular leader....306
Figure 184 – Double head circular leader....307
Figure 185 – Witness Lines....308
Figure 186 – Circular Witness Line....309
Figure 187 – Rectangular frame....310
Figure 188 – Circular frame....311
Figure 189 – Flag frame....312
Figure 190 – Triangular form frame....313
Figure 191 – Pentagonal form frame....313
Figure 192 – Hegaxonal form frame....314
Figure 193 – Octagonal form frame....315
Figure 194 – Weld Symbol frame....316
Figure 195 – Irregular form frame....317

Figure 196 – Graphic presentation....318
Figure 197 – Saved view....320
Figure 198 – Simplified Representation....322
Figure 199 – Exploded View....323
Figure 200 – Display Style....325
Figure 201 – Zone Section with one section plane....327
Figure 202 – Zone Section with three section planes....327
Figure 203 – Positions of the section planes....328
Figure 204 – The result of Section Plane 1 AND Section Plane 2....328
Figure 205 – The result of (Section Plane 1 AND Section Plane 2) OR Section Plane 3....329
Figure 206 – Logical operations tree....329
Figure 207 – Sections of wire, sheet and solid bodies....330
Figure 208 – Hatching Pattern....333
Figure 209 – Combination of patterns....334
Figure 210 – Orthographic Camera....336
Figure 211 – Perspective Camera....337
Figure 212 – High level view of QIF MBD highest level *element*s....344
Figure 213 – Measurement Scope (e.g., Bill of Characteristics) with QIF Plans....350
Figure 214 – Inspection Process Planning with QIF Plans....351
Figure 215 – Sub-*element*s of the Plan data type....357
Figure 216 – QIF Plans Major *Element*s with Simplified Relations....358
Figure 217 – QIF Resources instance data high level view....363
Figure 218 – ***MeasurementResourceBaseType***....365
Figure 219 – ***MeasurementResourceBaseType***....366
Figure 220 – ***MeasurementResourceBaseType*** derived type inheritance diagram: tool with integrated sensor close-up....367
Figure 221 – ***MeasurementDeviceType*** overview....368
Figure 222 – CMM type inheritance diagram....371
Figure 223 – Cartesian CMM geometry types....372
Figure 224 – Method 1 for mounting a sensor on a universal device....373
Figure 225 – Method 2 for mounting a sensor on a universal device....373
Figure 226 – **Rules** *element* and ***QIFRulesType***....382
Figure 227 – **FeatureRules** *element* and ***FeatureRulesType***....383
Figure 228 – **DMESelectionRules** *element* and ***DMESelectionRulesType***....386
Figure 229 – **DMEThen** *element* and ***DMEThenType***....387
Figure 230 – **DMEDecisionClass** *element* and ***DMEDecisionClassType***....388
Figure 231 – **DMEDecisionId** *element* and ***DMEDecisionIdType***....390
Figure 232 – **DMEDecisionMakeModel** *element*....391
Figure 233 – Example of QIF Results information flow....393
Figure 234 – The **Results** *element*....394
Figure 235 – High level view of the **MeasurementResults** *element*....396
Figure 236 – The ***ActualComponentType*** data type....398
Figure 237 – QIF Statistics workflow....401
Figure 238 − Highest level QIF Statistics elements....420
Figure 239 − Sample QIF widget....421

TABLES

Table 1 – XSLT Checks 29
Table 2 – Weld Parameters 74
Table 3 – Material Condition Values 87
Table 4 – Binary Arrays 159
Table 5 – Binary Representation 160
Table 6 – Line Styles 293
Table 7 – Special Symbols 297
Table 8 – Leader Head Types 303
Table 9 − Statistical values and their associated mnemonics. 409
Table 10 − Statistical summary values and their associated mnemonics. 411
Table 11 − Subgroup statistical values and their associated mnemonics. 417