

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

Medical electrical equipment - Part 2-84: Particular requirements for the basic safety and essential performance 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 (QPIId).....	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 <i>element</i>	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 <i>element</i>	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	<i>InspectionTraceabilityType</i>	144
6.14.2	<i>PreInspectionTraceabilityType</i>	144
6.14.3	<i>ProductTraceabilityType</i>	145

6.14.4	<i>ActualProductTraceabilityType</i>	145
6.14.5	<i>ManufacturingProcessTraceabilityType</i>	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 <i>elements</i> 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 <i>elements</i>	358
8.9.3	Simplified relationships <i>elements</i>	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	<i>MeasurementResourceBaseType</i>	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	<i>MeasurementRoomType</i>	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 <i>elements</i> 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 <i>element</i>	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 <i>element</i>	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 – Hexagonal 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 <i>elements</i>	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- <i>elements</i> of the Plan data type	357
Figure 216 – QIF Plans Major <i>Elements</i> 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 <i>element</i> and QIFRulesType	382
Figure 227 – FeatureRules <i>element</i> and FeatureRulesType	383
Figure 228 – DMESelectionRules <i>element</i> and DMESelectionRulesType	386
Figure 229 – DMEMThen <i>element</i> and DMEMThenType	387
Figure 230 – DMEDecisionClass <i>element</i> and DMEDecisionClassType	388
Figure 231 – DMEDecisionId <i>element</i> and DMEDecisionIdType	390
Figure 232 – DMEDecisionMakeModel <i>element</i>	391
Figure 233 – Example of QIF Results information flow.....	393
Figure 234 – The Results <i>element</i>	394
Figure 235 – High level view of the MeasurementResults <i>element</i>	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