Changes from QIF 2.1 to QIF 3.0

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1. Introduction

This document describes changes in the Quality Information Framework (QIF) model from version 2.1 to version 3.0. All but the last of the following sections describes the changes in one of the 22 QIF schema files. The last section describes changes in the XSLT files.

The reader should be aware that whereas QIF 2.1 had eight separate normative text documents, QIF 3.0 has one document, “Quality Information Framework (QIF) – An Integrated Model for Manufacturing Quality Information” version 3.0. It includes all the material that was previously in the eight documents.

Understanding the changes listed in this document will probably require studying the text document and the in-line documentation in the schema files (or the on-line HTML view of the contents of the schema files at https://qualityinformationframework.github.io/qif3-browser/qif3.html).

The schema files (and more) may be download from qifstandards.org/download.

Types are shown in ***this font***.

Elements are shown in **this font**.

One massive change is that "Actual" was changed to "Measured" or "Measurement" in over 800 places. These are not itemized below. "Actual" still appears, but only in the following element and type names.

- **ActualComponent**
- **ActualComponentId**
- **ActualComponentIds**
- **ActualComponentSet**
- **ActualComponentSets**
- ***ActualComponentSetsType***
- ***ActualComponentSetType***
- ***ActualComponentType***
- ***ActualProductTraceabilityType***
- **ActualSinglePointAccuracy**
- **ActualTransformId**
- **ActualTransforms**
- **ActualVolumetricAccuracy**

- **CoordinateSystemActualTransformAssociation**
- **CoordinateSystemActualTransformAssociations**
- ***CoordinateSystemActualTransformAssociationsType***
- ***CoordinateSystemActualTransformAssociationType***
- **DRFTransformActualId**

2. QIFDocument.xsd

1. In the ***QIFDocumentType***

1a. The following optional elements are added using ref:

- **StandardsDefinitions** (see IntermediatesPMI.xsd)
- **SoftwareDefinitions**(see IntermediatesPMI.xsd)
- **AlgorithmDefinitions** (see IntermediatesPMI.xsd)
- **FeatureZones** (see Features.xsd)

These elements and their types are defined in other schema files as indicated in parentheses.

1b. Two element names are changed:

- **MeasurementPlan** ==> **Plan**
- **MeasurementsResults** ==> **Results**

1c. The fixed value of the **versionQIF** element is changed from 2.1.0 to 3.0.0.

2. The keys and keyrefs are updated.

3. QIFMeasurementResources.xsd

1. Measurement Rooms

1a. In the ***MeasurementResourcesType***, the optional **MeasurementRooms** element of type ***MeasurementRoomsType*** is added.

1b. The ***MeasurementRoomType*** is defined as a derived type of ***MeasurementResourceBaseType***.

1c. The ***MeasurementRoomsType*** is defined having one or more **MeasurementRoom** elements.

2. Wherever ***ActualDecimalType*** was used as the type of an element in ***EffectiveUserDefinedWorkingVolumeType*** in QIF 2.1, it is replaced by ***MeasuredDecimalType***.

3. Caliper

3a. The ***CaliperDialType*** and ***CaliperDigitalType*** are added as more specialized derived types of ***CaliperType***.

3b. Global elements **CaliperDial** and **CaliperDigital** are defined and added to the substitutionGroup of **ManualMeasurementDevice**.

4. Micrometer

4a. In the ***MicrometerType***, an optional **InternalExternal** element is added with default value "INTERNAL".

4b. The ***MicrometerAnalogType*** and ***MicrometerDigitalType*** are added as more specialized derived types of ***MicrometerType***.

4c. Global elements **MicrometerAnalog**, and **MicrometerDigital** are defined and added to the substitutionGroup of **ManualMeasurementDevice**.

5. Laser radar

5a. The ***LaserRadarType*** is added as a derived type of ***UniversalDeviceType***.

5b. Global element **LaserRadar** is added to the substitutionGroup of **MeasurementDevice**.

6. The type of the **LocationId** element of ***MeasurementResourceBaseType*** is changed from ***QIFReferenceFullType*** to ***QIFReferenceType***.

7. Base types

7a. The names of all abstract types whose names did not end in "BaseType" are changed to end in "BaseType". The new names are:

- ***DetachableSensorBaseType***
- ***ToolBaseType***
- ***ToolWithIntegratedSensorBaseType***
- ***WorkingVolumeBaseType***
- ***EffectiveWorkingVolumeBaseType***
- ***ResolutionBaseType***

7b. All types that were not abstract but should have been are changed to be abstract and their names are changed to end in "BaseType". The new names are:

- ***UserAxisBaseType***
- ***CMMAxisDirectionsBaseType***
- ***MeasurementDeviceScalesBaseType***

- ***CMMSpeedsBaseType***

7c. Wherever one of these types is used as the type of an element or an extension base, the type name is updated.

7d. Elements that

(1) are at the head of substitutionGroups and

(2) were not abstract but should have been

are made abstract. The types of these elements are all base types. This applies to the following global elements:

- **CartesianCMMAccuracyTest**
- **AACMMAccuracyTest**
- **DetachableSensor**
- **WorkingVolume**
- **Resolution**
- **Axis**
- **Scales**
- **CMMAxisDirections**
- **Tool**

4. QIFPlans.xsd

1. The name of the root element is changed from **MeasurementPlan** to **Plan**, and the name of its type is changed from ***MeasurementPlanType*** to ***PlanType***.

2. Numerical-valued variables may be declared, set, and evaluated. The value of a variable may be used in arithmetic expressions. To implement this:

2a. A **LocalVariables** element of type ***LocalVariablesType*** is added to the ***PlanType***.

2b. ***VariableDeclarationType*** is defined and is used in ***LocalVariablesType***.

2c. ***LocalVariablesType*** is defined and is used in ***PlanType***.

2d. ***VariableSetType*** is defined as a derived type of ***PlanElementBaseType*** so that setting a variable can be a step in a plan. The **VariableSet** element is added to the substitutionGroup of **PlanElement**.

2e. ***VariableValueType*** is defined as derived type of ***ArithmeticExpressionBaseType*** so that a variable value can be used in an arithmetic expression. The **VariableValue** element is added to the substitutionGroup of **ArithmeticExpression**.

3. The "If" action group is added. It includes zero to many **ElseIfs** and an **ElseDo**. It behaves the way "If" behaves in some widely-used programming languages.

3a. The ***IfActionGroupType*** is defined as a derived type of ***ActionGroupBaseType*** with elements:

- **If** of type ***TestAndPlanElementType***
- **ElseIf** (optional and may appear many times) of type ***TestAndPlanElementType***
- **ElseDo** (optional) of type ***ElseDoType***

3b. The ***TestAndPlanElementType*** and ***ElseDoType*** are defined.

4. A "While" action group is added. It behaves the way "while" behaves in some widely-used programming languages. The ***WhileActionGroupType*** is defined as a derived type of ***ActionGroupBaseType*** with elements **BooleanExpression** and **PlanElement**.

5. Expressions were defined for use in rules in version 2.1, but they were not used in plans. In QIF version 3.0, expressions are used in plans in the tests made in "If" and "While".

6. The ability to reference a measurement taken while executing a plan is added. This is done by defining the ***VirtualMeasurementType*** with an id and putting an optional **VirtualMeasurement** element in the ***CharacteristicItemBaseType*** and the ***FeatureItemBaseType***. Measured values can be obtained during plan execution by referencing the id in the **VirtualMeasurement** element.

7. String (actually xs:token) expressions are added with very limited use. A test can be made whether two strings are identical.

8. ***HaltActionType*** is added as a derived type of ***ActionBaseType*** so that execution of a plan can be stopped before completion. The **Halt** element is added to the substitutionGroup of **PlanElement**.

9. ***LaserRadarMeasureFeatureMethodType*** is added, and the **LaserRadarMeasureFeatureMethod** element is added to the substitutionGroup of **ActionMethod**.

10. The ***QIFReferenceFullType*** is changed to the ***QIFReferenceType*** in the following elements of the following types:

- ***ActionBaseType***
    - **PreferredActionMethodId**
    - **AlternativeActionMethodIds**
    - **PreferredResourceIds**
- ***EvaluateCharacteristicMeasurandType***
    - **CharacteristicItemId**

11. The ***ArrayReferenceFullType*** is changed to the ***ArrayReferenceType*** in the following elements of the following types:

- ***PlanElementBaseType***
  - **WorkInstructionId**s
- ***ActionBaseType***
  - **PreferredActionMethodId**
  - **PreferredResourceIds**
- ***MeasureEvaluateSpecifiedActionType***
  - **CharacteristicItemIds**
- ***EvaluateSpecifiedCharacteristicsActionType***
  - **CharacteristicItemIds**
- ***MeasureSpecifiedFeaturesActionType***
  - **FeatureItemIds**
- ***MeasureSpecifiedMeasurandsActionType***
  - **MeasurandIds**
- ***ActionMethodBaseType***
  - **ChosenResourceIds**
  - **WorkInstructionIds**

12. ***ArithmeticParameterValueType*** is added as a derived type of ***ArithmeticExpressionBaseType*** with elements **Parameter** (a parameter name) and **ObjectId** (the object with the parameter).

13. ***TokenParameterValueType*** is added as a derived type of ***TokenExpressionBaseType*** with elements **Parameter** (a parameter name) and **ObjectId** (the object with the parameter).

5. QIFProduct.xsd

1. Materials

1a. A **MaterialLibrary** element is added to the ***ProductType*** using ref. The element is defined in IntermediatesPMI.xsd.

1b. The **Materials** element is removed from ***PartAssemblyBaseType***.

2. A **UUID** element of ***QPIdType*** is added to the ***PartAssemblyBaseType***.

3. A **FeatureZoneIds** element of type ***ArrayReferenceType*** is added to the ***PartAssemblyBaseType***.

4. A materialIndex attribute of type ***NaturalType*** is added to the ***PartAssemblyBaseType***.

5. Folders

5a. A **FoldersPart** element is added to the ***PartType*** using ref.

5b. A **FoldersAssembly** element is added to the ***AssemblyType*** using ref.

5c. The following items dealing with folders are included

- ***FolderPartType***
- ***FoldersPartType***
- ***FolderAssemblyType***
- ***FoldersAssemblyType***
- ***FolderPartAssemblyBaseType***

6. A **UUID** element is added to the ***ComponentType***.

7. The element type is changed from ***ArrayReferenceFullType*** to ***ArrayReferenceType*** for the following elements of ***PartAssemblyBaseType***:

- **FeatureNominalIds**
- **CharacteristicNominalIds**
- **NoteIds**
- **PartNoteIds**
- **DatumDefinitionIds**
- **DatumTargetDefinitionIds**
- **DatumReferenceFrameIds**

6. QIFResults.xsd

1. A **MeasuredPointSets** element is added to the ***MeasurementResultsType***. This represents a significant change in the way measured points are reported and used.

2. The name of the **CoordinateSystemActualTransforms** element of ***MeasurementResultsType*** is changed to **CoordinateSystemActualTransformAssociations** and its type is changed from ***CoordinateSystemActualTransformsType*** to ***CoordinateSystemActualTransformAssociationsType***. Those two types are significantly different.

3. The ***MeasurementResultsType*** is renamed ***ResultsType***.

4. The **MeasurementsResults** element is renamed **Results** and its type is changed to ***ResultsType***.

7. QIFRules.xsd

1. DME Selection

1a. See sections 10.2.3 and 10.4.3 of the QIF 3.0 text document for details of how the DME selection rules work.

1b. A **DMESelectionRules** element of ***DMESelectionRulesType*** was already in the ***QIFRulesType*** in QIF 2.1, but the ***DMESelectionRulesType*** was a stub.

1c. The ***DMESelectionRulesType*** is revised (and moved). It is still a list of rule elements, but the element name is changed from **DMESelectionRule** to **DMEDecisionRule** to broaden the implied function of a rule (which may exclude DMEs as well as include them in what may be selected). Also, a **defaultDesirability** element is added.

1d. The stub global element **DMESelectionRule** is removed.

1e. A substitutionGroup for **DMEDecision** (of ***DMEDecisionBaseType***) is added with three members in addition to the head.

- **DMEDecisionClass** of ***DMEDecisionClassType***
- **DMEDecisionId** of ***DMEDecisionIdType***
- **DMEDecisionMakeModel** of ***DMEDecisionMakeModelType***

1f. A substitutionGroup for **Applicability** (of ***ApplicabilityBaseType***) is added with three members in addition to the head.

- **QIFMust** of ***QIFMustType***
- **QIFMustNot** of ***QIFMustNotType***
- **QIFMay** of ***QIFMayType***

1g. Other types added to this schema file to support DME selection are:

- ***DMEThenType***
- ***DMEParameterConstraintSetType***
- ***DMEParameterConstraintType***
- ***IfThenDMERuleType***
- ***ZeroToOneType***

2. The cuboid feature is entirely removed from QIF 3.0, so in this file the following items are removed:

- ***IfThenCuboidRuleType***
- **IfThenCuboidRule** global element
- ***CuboidPointSamplingStrategyType***

3. The ***IfThenElongatedCircleRuleType*** is added. The elongated circle feature type is new in QIF 3.0. It was not in QIF 2.1. In this file the following items are added:

- ***IfThenElongatedCircleRuleType***
- **IfThenElongatedCircleRule** global element
- ***ElongatedCirclePointSamplingStrategyType***

4. The ***RulesUnitsType*** is defined and replaces ***OtherUnitsType*** as the type of the **RulesUnits** element of the ***QIFRulesType***.

5. The **SamplingRigorMax** element is removed from the ***FeatureRulesType***.

6. An optional **UUID** element of type ***QPIdType*** is added to the ***QIFRuleBaseType*** so that each rule may be given a universally unique identifier.

7. The type of the **ThenFittingAlgorithm** element is changed from ***FeatureOfSizeSubstituteFeatureAlgorithmType*** or ***NonFeatureOfSizeSubstituteFeatureAlgorithmType*** to ***SubstituteFeatureAlgorithmType*** everywhere the **ThenFittingAlgorithm** element occurs (24 places). ***FeatureOfSizeSubstituteFeatureAlgorithmType*** and ***NonFeatureOfSizeSubstituteFeatureAlgorithmType*** are removed from QIF 3.0.

8. QIFStatistics.xsd

1. ***ArrayReferenceFullType*** is changed to ***ArrayReferenceType*** in the following types and elements:

- ***StatisticalStudyPlanBaseType***
  - **FeatureItemIds**
  - **CharacteristicItemIds**
- ***LinearityStudyPlanType***
  - **MeasurementDeviceIds**
- ***StabilityStudyPlanType***
  - **MeasurementDeviceIds**
- ***BiasStudyPlanType***
  - **MeasurementDeviceIds**
- ***GageRandRStudyPlanType***
  - **MeasurementDeviceIds**
- ***LinearityStudyResultsType***
  - **MeasurementDeviceIds**
- ***StabilityStudyResultsType***
  - **MeasurementDeviceIds**
- ***BiasStudyResultsType***
  - **MeasurementDeviceIds**
- ***GageRandRStudyResultsType***

    - **MeasurementDeviceIds**

2. ***QIFReferenceFullType*** is changed to ***QIFReferenceType*** in the following types and elements:

- ***StatisticalStudyPlanBaseType***
    - **PlanId**
    - **CorrectiveActionPlanId**
- ***ProcessDifferenceStudyPlanType***
    - **ManufacturingProcessId**
- ***StatisticalStudyResultsBaseType***
    - **StudyId**
- ***ProcessDifferenceStudyResultsType***
    - **ManufacturingProcessId**

3. The following elements of the ***StatisticalStudyPlanBaseType*** may now appear multiple times.

- **StatsValuesPerChar**
- **StatsValuesPerSubgroup**
- **StatsValuesSummarys**

4. An optional choice of **SoftwareId** or **StandardId** elements is added to ***StatisticalStudyPlanBaseType***.

5. The **StatisticalStudyResults** global element is made abstract since it should not be instantiated.

6. "Actual" is changed to "Measurement" in 37 places.

9. Auxiliary.xsd

1. The ***AuxiliaryBaseType*** is changed from non-abstract to abstract

2. The ***PointAuxiliaryType*** is changed from abstract to non-abstract.

3. The ***LineAuxiliaryType*** is changed from abstract to non-abstract.

10. Characteristics.xsd

1. The term "actual" is replaced by "measured" or "measurement" when referring to a value established by measurement or constructed using measured values. This change is made in over 500 places in Characteristics.xsd.

2. In QIF version 2.1, the first element of ***CharacteristicAspectsListsType*** was **FormalStandard**, which identified a standard directly. In version 3.0, a list of formal

standards is an element of **QIFDocument**, and the first element of ***CharacteristicAspectsListsType*** is now **FormalStandardId**, the id of a formal standard in the list.

3. Zone limits are reworked as follows.

The following types are removed:

- ***CharacteristicDirectionalZoneLimitType***
- ***CharacteristicRectangularZoneLimitType***
- ***CharacteristicCircularZoneLimitType***
- ***PointWithNameType*** (was used in ***CharacteristicDirectionalZoneLimitType***)

Elements that used those types (**CircularZoneLimit**, **DirectionalZoneLimit**, and **RectangularZoneLimit**) are removed from:

- ***OrientationCharacteristicNominalBaseType***
- ***FlatnessCharacteristicNominalType***
- ***SurfaceProfileCharacteristicNominalType***

The **ZoneLimit** element of ***CharacteristicDirectionalZoneLimitType*** is removed from:

- ***StraightnessCharacteristicNominalType***
- ***CircularityCharacteristicNominalType***
- ***CylindricityCharacteristicNominalType***
- ***PositionCharacteristicNominalType***
- ***AngleFromCharacteristicNominalType***
- ***AngleBetweenCharacteristicNominalType***
- ***DistanceFromCharacteristicNominalType***
- ***DistanceBetweenCharacteristicNominalType***
- ***RunoutCharacteristicNominalBaseType***
- ***CoaxialityCharacteristicNominalType***
- ***ConcentricityCharacteristicNominalType***
- ***LineProfileCharacteristicNominalType***
- ***SurfaceProfileCharacteristicNominalType***
- ***SurfaceProfileNonUniformCharacteristicNominalType***

In QIF version 3.0 there is a **FeatureZones** element in **QIFDocument** with a wider variety of feature zones than in version 2.1. Where some nominal characteristics had zone limit elements in version 2.1, now every nominal characteristic can reference feature zone ids. In connection with this, the ***PositionCoordinateMethodEnumType*** and ***PositionCoordinateMethodType*** are defined for use with position characteristics.

4. An optional **ToleranceDualValue** element of ***LinearDualValueType*** is added to each of the following characteristics. This enables giving the ToleranceValue in two different units.

- ***CompositeSegmentDefinitionBaseType***
- ***OrientationCharacteristicDefinitionBaseType***
- ***StraightnessCharacteristicDefinitionType***
- ***FlatnessCharacteristicDefinitionType***
- ***CircularityCharacteristicDefinitionType***
- ***ConicityCharacteristicDefinitionType***
- ***CylindricityCharacteristicDefinitionType***
- ***EllipticityCharacteristicDefinitionType***
- ***SphericityCharacteristicDefinitionType***
- ***ToroidicityCharacteristicDefinitionType***
- ***OtherFormCharacteristicDefinitionType***
- ***LocationCharacteristicDefinitionBaseType***
- ***RunoutCharacteristicDefinitionBaseType***
- ***ProfileCharacteristicDefinitionBaseType***

5. In the ***AngleBetweenCharacteristicNominalType*** and the ***DistanceBetweenCharacteristicNominalType***, a **FeatureNominalPairs** element is added.

6. The **Bonus** element is added to the ***PositionCharacteristicMeasurementType*** and the ***StraightnessCharacteristicMeasurementType***. In version 2.1, **Bonus** was only in the ***OrientationCharacteristicActualType*** (which is renamed ***OrientationCharacteristicMeasurementType***).

7. The term "KeyCharacteristic" is replaced by the term "CharacteristicDesignator" in several places to better match the meaning of the term. In connection with that ***KeyCharacteristicBalloonType*** is renamed ***CharacteristicBalloonType***. Also, an optional **UUID** element is now in the ***CharacteristicDesignatorType***.

8. Simultaneous requirements and separate requirements are reworked so that both may (optionally) be recorded explicitly.

In QIF version 2.1, simultaneity was handled using the ***CharacteristicSimultaneityGroupType***. The **CharacteristicSimultaneityGroup** element was included in the substitutionGroup of the **CharacteristicGroup** element. Multiple **CharacteristicGroup** elements could appear in the **CharacteristicGroups** element. The **CharacteristicGroups** element is still used, but each group must now be a **CharacteristicManufacturingProcessGroup**.

CharacteristicSimultaneityGroupType is removed.

The following new types are defined:

- ***SimultaneousRequirementGroupType***
- ***SimultaneousRequirementGroupsType***
- ***SimultaneousRequirementEnumType*** (values are SEP_REQ and SIM_REQ)
- ***CompositeSegmentLowerLevelEnumType*** (used in ***SimultaneousRequirementGroupType***)

An optional **SimultaneousRequirementGroups** element is added to the ***CharacteristicAspectsListsType***.

9. The ***QIFReferenceFullType*** is changed to the ***QIFReferenceType*** in the following elements of the following types:

- ***CharacteristicMeasurementBaseType*** (was ***CharacteristicActualBaseType***)
    - **CharacteristicItemId**
    - **ManufacturingProcessId**
- ***CompositeSegmentMeasurementBaseType*** (was ***CompositeSegmentActualBaseType***)
    - **DRFTransformActualId**
- ***OrientationCharacteristicMeasurementBaseType*** (was ...***ActualBaseType***)
    - **DRFTransformActualId**
- ***PositionCharacteristicMeasurementType*** (was ...***ActualType***)
    - **DRFTransformActualId**
- ***ProfileCharacteristicMeasurementBaseType*** (was ...***ActualBaseType***)
    - **DRFTransformActualId**
- ***CharacteristicGroupType***
    - **TransformId**
- ***CharacteristicManufacturingProcessGroupType***
    - **ManufacturingProcessId**
- ***ThreadCharacteristicDefinitionType***
    - **ThreadSpecificationId**

10. In the ***CharacteristicNominalBaseType***, optional **SubstituteFeatureAlgorithm** and **FeatureZoneIds** elements are added.

11. In the ***CharacteristicMeasurementBaseType***, an optional **SubstituteFeatureAlgorithm** element is added.

12. In the ***CharacteristicItemBaseType***, the **Name** element is made optional.

13. The ***ArrayReferenceFullType*** is changed to the ***ArrayReferenceType*** in the following elements of the following types:

- ***CharacteristicItemBaseType***
    - **FeatureItemIds**
    - **NotableEventIds**

- **MeasurementDeviceIds**

- ***CharacteristicMeasurementBaseType*** (was ***CharacteristicActualBaseType***)
    - **FeatureMeasurementIds**
    - **MeasurementDeviceIds**
    - **ManufacturingProcessId**
    - **NotedEventIds**
- ***CharacteristicGroupType***
    - **CharacteristicItemIds**

14. In the ***CharacteristicItemBaseType***, the **VirtualMeasurement** element is added. This is to enable referencing a measurement during execution of a CMM program derived from a QIF plan.

15. In the ***CriticalityLevelEnumType***, the "KEY" enumeration value is added.

16. In the ***CharacteristicBalloonStyleEnumType***, (formerly the ***KeyCharacteristicBalloonStyleEnumType***), the ELONGATED_HEXAGON, FORWARD_CHEVRON, and BACKWARD_CHEVRON enumeration values are added.

17. In the ***CharacteristicDefinitionBaseType***, optional **CommonTolerance** and **Independency** elements are added.

18. In the ***CharacteristicDefinitionBaseType***, the **UnitedFeature** element is renamed **UnitedOrContinuousFeature**.

19. In the ***CharacteristicMeasurementBaseType***, an optional **TimeStamp** element is added.

20. In the ***DimensionalCharacteristicDefinitionBaseType***, an optional **DimensionModifiers** element is added.

21. In the ***UserDefinedAttributeCharacteristicDefinitionType***, a **WhatToMeasure** element is added.

22. In the ***UserDefinedAttributeCharacteristicNominalType***, the **PassValues** and **FailValues** elements are made optional.

23. In the ***CompositeSegmentDefinitionBaseType***, an optional **CharacteristicDesignator** element is added. (As previously mentioned, **ToleranceDualValue** is also added)

24. In the ***CompositeSegmentPositionDefinitionType***, an optional **MaximumToleranceValue** element is added.

25. In the ***OriginReferenceType***, the **FeatureItemId** element is replaced by a **FeatureNominalId** element.

26. An optional **SizeCharacteristicDefinitionId** element is added to the ***OrientationCharacteristicDefinitionBaseType***.

27. In the ***StraightnessCharacteristicDefinitionType***, optional **SizeCharacteristicDefinitionId** and **MaximumToleranceValue** elements are added. (As previously mentioned, **ToleranceDualValue** is also added)

28. In the ***StraightnessCharacteristicNominalType***, the **ZoneLimit** element is removed as part of the reworking of zone limits, and an optional **DirectionCurveId** element is added.

29. In the ***FlatnessCharacteristicDefinitionType***, optional **MaterialCondition**, **SizeCharacteristicDefinitionId**, and **MaximumToleranceValue** elements are added. (As previously mentioned, **ToleranceDualValue** is also added).

30. In the ***CircularityCharacteristicNominalType***, an optional **ProfileCurveId** element is added.

31. In the ***PositionCharacteristicNominalType***, an optional **CoordinateMethod** element is added.

32. In the ***AngleBetweenCharacteristicNominalType***, an optional **FeatureNominalPairs** element is added.

33. In the ***DistanceBetweenCharacteristicNominalType***, an optional **FeatureNominalPairs** element is added.

34. In the ***LineProfileCharacteristicNominalType***, an optional **ProfileCurveId** element is added.

35. In the ***PositionNonDiametricalZoneType***, **ZoneOrientationEnum** and **CoordinateSystemId** elements are added.

36. In the ***PositionCharacteristicDefinitionType***, **SizeCharacteristicDefinitionId** and **MaximumToleranceValue** elements are added.

37. In the ***LinearCharacteristicNominalBaseType***, a **TargetDualValue** element is added.

38. In the ***DistanceBetweenCharacteristicNominalType***, a **FeatureNominalPairs** element is added.

39. In the ***CircularRunoutCharacteristicNominalType***, a **ProfileCurveId** element is added.

40. In the ***CharacteristicStatusEnumType***, BASIC is changed to BASIC_OR_TED.

41. In the ***PointDeviationType***, the element name **MeasurePointMeasurementId** is changed to **MeasurePointId**, and its type is changed to ***PointSetReferenceSingleType*** (a new type defined in IntermediatesPMI.xsd).

42. Elements that are not intended to be instantiated (because a derived type is required), which head substitutionGroups are now all marked abstract. The types of these elements always have "Base" in their names. In Characteristics.xsd, the following elements that were not abstract in QIF 2.1 are now abstract.

- **CharacteristicDefinition**
- **CharacteristicNominal**
- **CharacteristicMeasurement**
- **CharacteristicItem**

43. The ***WeldGrooveCharacteristicMeasurementType*** and the ***WeldGrooveCharacteristicNominalType*** are no longer abstract.

44. The keys and keyrefs are updated.

11. Expressions.xsd

1. A few changes to documentation are made to account for the fact that expressions are now used in selecting DMEs.

2. The ***PrismPointSamplingStrategyEnumType*** is removed since it applied only to the cuboid feature, which is removed.

3. To enable testing the type of a feature in a DME selection rule, the ***FeatureTypeEnumType*** is defined, and the ***FeatureIsType*** is also defined as a derived type of ***BooleanExpressionBaseType***. The ***FeatureIsType*** returns true if the feature being considered is of a given type.

4. The ***DMEClassNameEnumType*** is added. These are the names of DME types defined in QIFMeasurementResources.xsd.

5. Types of arithmetic comparison are enumerated in the ***ArithmeticComparisonEnumType***.

6. The ***ArithmeticParameterBaseType*** is defined as an abstract derived type of ***ArithmeticExpressionBaseType***.

7. The ***ArithmeticFeatureParameterType***, which was derived directly from ***ArithmeticExpressionBaseType*** in QIF 2.1 is now derived from ***ArithmeticParameterBaseType***.

8. The ***ArithmeticCharacteristicParameterType***, which was derived directly from ***ArithmeticExpressionBaseType*** in QIF 2.1 is now derived from ***ArithmeticParameterBaseType***.

9. The ***ArithmeticDMEParameterType*** is added as a child type of ***ArithmeticParameterBaseType***.

10. The ***ArithmeticPartParameterType*** is added as a child type of ***ArithmeticParameterBaseType***.

11. The ***CharacteristicToleranceType*** is added as a child type of ***ArithmeticExpressionBaseType***.

12. The ***FeatureSizeType*** is added as a child type of ***ArithmeticExpressionBaseType***.

13. The **ArithmeticDMEParameter**, **ArithmeticPartParameter**, and **FeatureSize** global elements are added to the substitutionGroup of **ArithmeticExpression**.

14. The **FeatureTypeIs** element is added to the substitutionGroup of **BooleanExpression**.

15. The ***SamplingRigorIsType*** is renamed ***SamplingCategoryIsType***, and it tests the sampling category in the environment rather than the sampling rigor in the environment.

12. Features.xsd

1. The term "actual" is replaced by "measured" or "measurement" when referring to a value established by measurement or constructed using measured values. This change is made in over 300 places in Features.xsd. To avoid wordiness, the rest of this list of changes is written as though "Actual" is replaced by "Measurement" in the names of QIF 2.1 features.

2. Feature Hierarchy

2a. In QIF 2.1, the derivation hierarchy of feature types was only three levels deep, for example

```
 FeatureBaseType
    FeatureNominalBaseType
        CircleFeatureNominalType
```

In QIF 3.0 there are more intermediate base types, for example
FeatureBaseType
ShapeFeatureBaseType
ShapeFeatureNominalBaseType
CurveFeatureNominalBaseType
CircleFeatureNominalType

Omitting the detailed shape features (circle, plane, etc.), the hierarchy looks like this (where Nominal may be replaced by Item, Definition, or Measurement)
FeatureBaseType
NonShapeFeatureBaseType
NonShapeFeatureNominalBaseType
MarkingFeatureNominalType
OtherNonShapeFeatureNominalType
ShapeFeatureBaseType
ShapeFeatureNominalBaseType
CurveFeatureNominalBaseType
GroupFeatureNominalType
PatternFeatureNominalBaseType
OtherShapeFeatureNominalType
PointFeatureNominalBaseType
SpecifiedFeatureNominalBaseType
SurfaceFeatureNominalBaseType

2b. Restructuring the feature hierarchy has little effect on the validity of instance files. It is done to give more structure to the hierarchy and makes the relationship of feature types easier to see. It may also help with writing computer programs that use object classes derived from the XSDL types.

3. Non-shape features are introduced in QIF 3.0. There were none in QIF 2.1. The non-shape features have the same four aspects as the shape features, but ignoring the aspects there are only two instantiable non-shape feature types: MarkingFeature and OtherNonShapeFeature. Including aspects, there are five non-shape feature base types; they are abstract and hence non-instantiable.

4. An optional **UUID** element is added to the ***FeatureItemBaseType***.

5. As compared with the ***FeatureItemBaseType*** of QIF 2.1, three more elements are added to the ***ShapeFeatureItemBaseType*** of QIF 3.0:

- **PointList**
- **SubstituteFeatureAlgorithm**
- **VirtualMeasurement**

In connection with this, the declaration of the **SubstituteFeatureAlgorithm** element is removed from all specific feature item types (since that element is inherited from the parent type).

5. As compared with the ***FeatureNominalBaseType*** of QIF 2.1, two optional elements are added to the ***FeatureNominalBaseType*** of QIF 3.0:

- **UUID**
- **ParentFeatureNominalId**

and an optional **SubstituteFeatureAlgorithm** element is added to ***ShapeFeatureNominalBaseType***.

6. The handling of both nominal and measured measurement points is revised.

6a. For nominal measurement points:

In QIF 2.1 target measurement points had to be duplicated in order to reuse them. In QIF 3.0, **NominalPointSets** (a set of sets of nominal points) is an element of the **Features** element. One or many of those points can be referenced by nominal shape features by using a set id with or without specifying a range or an individual point index in the set.

In connection with this:

The ***PointListNominalType*** is renamed ***PointSetNominalType*** and is given an id attribute to make it referenceable.

The ***NominalPointSetListType*** is defined. It is a set of instances of ***PointSetNominalType***.

6b. For measured points:

In QIF 2.1 a **FeatureActual** element had a **PointList** element consisting of **MeasurePoint** elements that were measured points. Each **MeasurePoint** had an id so it could be referenced by a measured characteristic.

In QIF 3.0:

The ***MeasuredPointSetType*** is defined. It includes up to 15 elements for describing points and their provenence. It has an id attribute to make it referenceable. Referencing is done as with **NominalPointSets**.

The ***MeasuredPointSetsType*** is defined. It is a list of elements of ***MeasuredPointSetType***.

The **MeasurementResults** element is given a **MeasuredPointsSets** element of ***MeasuredPointSetsType***.

7. An optional **Constructed** element is added to the following nominal feature types:

- ***CircleFeatureNominalType***
- ***CircularArcFeatureNominalType***
- ***ConeFeatureNominalType***
- ***ConicalSegmentFeatureNominalType***
- ***CylinderFeatureNominalType***
- ***CylindricalSegmentFeatureNominalType***
- ***EdgePointFeatureNominalType***
- ***EllipseFeatureNominalType***
- ***EllipticalArcFeatureNominalType***
- ***ElongatedCylinderFeatureNominalType***
- ***ExtrudedCrossSectionFeatureNominalType***
- ***LineFeatureNominalType***
- ***OppositeAngledLinesFeatureNominalType***
- ***OppositeAngledPlanesFeatureNominalType***
- ***OppositeParallelLinesFeatureNominalType***
- ***OppositeParallelPlanesFeatureNominalType***
- ***PlaneFeatureNominalType***
- ***PointDefinedCurveFeatureNominalType***
- ***PointDefinedSurfaceFeatureNominalType***
- ***PointFeatureNominalType***
- ***SphereFeatureNominalType***
- ***SphericalSegmentFeatureNominalType***
- ***SurfaceOfRevolutionFeatureNominalType***
- ***ThreadedFeatureNominalType***
- ***ToroidalSegmentFeatureNominalType***
- ***TorusFeatureNominalType***

The following new nominal feature types also have the **Constructed** element:

- ***ElongatedCircleFeatureNominalType***
- ***OtherCurveFeatureNominalType***
- ***OtherShapeFeatureNominalType***
- ***OtherSurfaceFeatureNominalType***

8. The Cuboid feature is entirely removed.

9. Sweep changes

9a. The optional Sweep element is replaced by optional **SweepMeasurementRange** and **SweepFull** elements in:

- ***CircularArcFeatureMeasurementType***
- ***ConeFeatureMeasurementType***
- ***ConicalSegmentFeatureMeasurementType***
- ***CylinderFeatureMeasurementType***
- ***CylindricalSegmentFeatureMeasurementType***
- ***EllipseFeatureMeasurementType***
- ***EllipticalArcFeatureMeasurementType***
- ***SurfaceOfRevolutionFeatureMeasurementType***

9b. Optional **SweepMeasurementRange** and **SweepFull** elements are added to ***CircleFeatureMeasurementType***.

9c. The optional **LatitudeLongitudeSweep** element is replaced by optional **LatitudeLongitudeSweepMeasurementRange** and **LatitudeLongitudeSweepFull** elements in:

- ***SphereFeatureMeasurementType***
- ***SphericalSegmentFeatureMeasurementType***
- ***ToroidalSegmentFeatureMeasurementType***
- ***TorusFeatureMeasurementType***

9d. An optional **Sweep** element is added to ***CircleFeatureNominalType***.

10. The ElongatedCircleFeature is added (with the usual aspects, fitting type, constructions, etc.). This is the 2D analog of the ElongatedCylinderFeature; i.e., two semicircles connected by straight line segments tangent to the semicircles at their ends.

11. The **Width** element of ***ElongatedCylinderFeatureDefinitionType*** is removed and the **Width**, **WidthMax**, and **WidthMin** elements of the ***ElongatedCylinderFeatureMeasurementType*** are removed.

12. The generic feature type is removed and is replaced by other curve feature, other surface feature, and other non-shape feature, which did not exist in QIF 2.1.

13. The **Through** construction method is added to ***PlaneConstructionMethodType***, and the ***PlaneThroughType*** is defined.

14. Two new elements, **Rectangle** and **Circle**, are added to ***PlaneFeatureNominalType*** for specifying the boundary of the plane.

15. Composite/group feature changes

15a. Composite feature is replaced by group feature, which is not abstract (and, hence, can be instantiated).

15b. The profile group and runout group features are removed and replaced by optional **IsProfileGroup** and **IsRunoutGroup** elements in ***GroupFeatureDefinitionType***. That type also has optional **IsCountersunkHole**, **IsCounterboredHole**, and **IsSpotface** elements.

15c. Compound feature is removed.

15d. Pattern feature is now derived from group feature. It was formerly derived from composite feature. Four new specific types of pattern features are defined:

- PatternFeatureLinear
- PatternFeatureParallelogram
- PatternFeatureCircularArc
- PatternFeatureCircle

16. Feature zones

16a. ***FeatureZoneBaseType*** is defined with the following derived types:

- ***FeatureZonePointType***
- ***FeatureZoneCurveBaseType***
    - ***FeatureZoneCurveLineType***
    - ***FeatureZoneCurveCircularType***
    - ***FeatureZoneCurveIrregularType***
- ***FeatureZoneAreaBaseType***
    - ***FeatureZoneAreaCircularType***
    - ***FeatureZoneAreaRectangularType***
    - ***FeatureZoneAreaIrregularType***
    - ***FeatureZoneAreaCylindricalType***
    - ***FeatureZoneAreaBetweenType***
    - ***FeatureZoneAreaSphericalType***

16b. A substitutionGroup for the **FeatureZone** element is defined using all of the instantiable types listed above (that excludes ***FeatureZoneCurveBaseType*** and ***FeatureZoneAreaBaseType***).

16c. The ***FeatureZoneListType*** and **FeatureZones** element are defined. The **FeatureZones** element is made an element of **QIFDocument**.

17. The keys and keyrefs in the **FeatureTypes** element are updated.

18. The substitutionGroups for features are updated and put into strict alphabetical order.

19. As compared with the ***FeatureActualBaseType*** of QIF 2.1, two elements are added to the ***FeatureMeasurementBaseType*** of QIF 3.0:

- **TimeStamp**
- **FeatureName**

20. As compared with the ***FeatureActualBaseType*** of QIF 2.1, two more elements are added to the ***ShapeFeatureMeasurementBaseType*** of QIF 3.0:

- **SubstituteFeatureAlgorithm**
- **ProxyMeasurementId**

21. In the ***FeatureItemBaseType***, the **FeatureNominalId** element is no longer optional.

22. The element type is changed from ***QIFReferenceFullType*** to ***QIFReferenceType*** for the following types and elements:

- ***FeatureItemBaseType***
    - **ParentFeatureItemId**
- ***ThreadedFeatureDefinitionType***
    - **ThreadSpecificationId**

23. The element type is changed from ***ArrayReferenceFullType*** to ***ArrayReferenceType*** for the **NotableEventIds** element of ***FeatureItemBaseType***.

24. The ***xs:positiveInteger*** type is replaced by ***NaturalType*** (so that no sign is allowed) in the following types and elements:

- ***PointRangeType***
    - **Start**
    - **Stop**
- ***PointIndexType***
    - **Single**
- ***BaseFeaturePointSetType***
    - **SequenceNumber**
- ***TransformationReferenceType***
    - **SequenceNumber**

25. The ***CircleIntersectionType*** and ***CircularArcIntersectionType*** are changed to be more general. Previously one of the intersecting features was an **IntersectionPlane** and the other was an **IntersectionFeature**. Now there are two **IntersectionFeature**s. Note that two intersecting spheres always intersect in a circle. Also, a cylinder and sphere do if the center of the sphere is on the cylinder axis.

26. The **TangentThrough** construction method element is added to the ***PlaneConstructionMethodType***. The type of the element is the newly defined ***PlaneTangentThroughType***.

27. **Rectangle** and **Circle** elements are added as alternatives to the **Polyline** element in the ***PlaneFeatureNominalType***.

13. GenericExpressions.xsd

1. ***PolyadicArithmeticExpressionBaseType*** is added. This is an arithmetic expression that operates on any number of arithmetic expressions.

2. ***PlusType*** is changed from being derived from ***BinaryArithmeticExpressionBaseType*** to being derived from ***PolyadicArithmeticExpressionBaseType***. This simplifies writing an instruction to add several numerical expressions together.

3. ***MinType*** and ***MaxType*** are defined as the minimum and maximum of a set of two or more numerical expressions. These are derived from ***PolyadicArithmeticExpressionBaseType***.

4. ***TimesType*** is changed from being derived from ***BinaryArithmeticExpressionBaseType*** to being derived from ***PolyadicArithmeticExpressionBaseType***. This simplifies writing an instruction to multiply several numerical expressions together.

5. **Max** and **Min** are added to the substitutionGroup of **ArithmeticExpression**.

6. Token (i.e., well-behaved string) expressions are added. This includes:

- ***TokenExpressionBaseType***
- ***TokenConstantType***
- **TokenExpression** element
- **TokenConstant** element

7. Boolean equal comparison of two token expressions is added in the ***TokenEqualType***, and **TokenEqual** is added to the substitutionGroup of **BooleanExpression**.

8. The ***ArithmeticEqualType*** is changed from abstract to non-abstract.

9. The **BooleanExpression** element is made abstract.

10. The **ArithmeticExpression** element is made abstract.

14. Geometry.xsd

1. In ***TriangleVertexNormalType***, the vertex attribute is made required.

2. The following elements (each of which is the head of a subsitution group) are made abstract.

- **Curve12**
- **Curve13**
- **Curve12Core**
- **Curve13Core**
- **Surface**
- **SurfaceCore**

15. IntermediatesPMI.xsd

1. "Actual" is replaced by "Measured" in several names.

2. ***FormalStandardEnumType*** is removed. Formal standards are now defined in more detail in the ***StandardsType*** using the ***StandardType***, the ***StandardsOrganizationType***, the ***StandardsOrganizationEnumType***, and the **StandardsDefinitions** element. ***StandardType*** includes an id attribute for referencing. **StandardsDefinitions** is now an element of **QIFDocument**, and standards can be referenced by id.

3. **SizeCharacteristicDefinitionId** and **SubstituteFeatureAlgorithm** elements are added to the ***DatumType***.

4. The **SubstituteFeatureAlgorithm** element is added to the ***MeasuredDatumFeatureType***.

5. Substitute Feature Algorithms

5a. The following types are removed:

- ***SubstituteFeatureAlgorithmBaseType***
- ***NonFeatureOfSizeSubstituteFeatureAlgorithmType***
- ***CurveSubstituteFeatureAlgorithmType***
- ***SurfaceSubstituteFeatureAlgorithmType***
- ***CurveSubstituteFeatureAlgorithmEnumType***
- ***FeatureOfSizeSubstituteFeatureAlgorithmEnumType***
- ***NonFeatureOfSizeSubstituteFeatureAlgorithmEnumType***
- ***SurfaceSubstituteFeatureAlgorithmEnumType***

5b. The ***SubstituteFeatureAlgorithmEnumType*** is defined containing all the enumeration values in the four enum types that are removed plus the following:

- DEFAULT
- MAXINNERLOCALSIZE
- MAXOUTERLOCALSIZE

- MININNERLOCALSIZE
- MINOUTERLOCALSIZE
- ONESIDED

5c. The ***AlgorithmType*** and ***AlgorithmsType*** are defined. These are not necessarily all substitute feature algorithms. An **AlgorithmDefinitions** element of ***AlgorithmsType*** is added to **QIFDocument**.

5d. The ***SubstituteFeatureAlgorithmType*** is defined. It provides a choice of an enumeration value, the id of an algorithm in the **AlgorithmDefinitions**, or a text description of an algorithm.

6. The ***CompoundFeatureGeometryEnumType*** is removed.

7. The ***LinearToleranceType*** is modified by adding **MaxDualValue** and **MinDualValue** optional elements.

8. Datum targets

8a. The ***DatumTargetDefinitionBaseType*** is replaced by the ***DatumTargetType***, which has all of the elements of ***DatumTargetDefinitionBaseType*** plus a **TargetZoneId**.

8b. The derived types of ***DatumTargetDefinitionBaseType*** are all removed, namely:

- ***DatumTargetPointDefinitionType***
- ***DatumTargetLineDefinitionType***
- ***DatumTargetCircularAreaDefinitionType***
- ***DatumTargetCircularLineDefinitionType***
- ***DatumTargetCylindricalAreaDefinitionType***
- ***DatumTargetRectangularAreaDefinitionType***
- ***DatumTargetSphereDefinitionType***
- ***DatumTargetIrregularAreaDefinitionType***

However, these all have FeatureZone equivalents in QIF 3.0 (in Features.xsd).

8c. The substitutionGroup of **DatumTarget** is removed since the types of its elements no longer exist.

9. Software

9a. Two elements (**URI** and **ReferencedStandardIds**), and an id attribute are added to ***SoftwareType***.

9b. The ***SoftwaresType*** is defined.

9c. The **SoftwareDefinitions** element is defined, and it is an element of **QIFDocument**.

10. Materials

10a. The definition of ***MaterialsType*** is changed from a list of strings to a list of ***MaterialType***.

10b. The ***MaterialType*** is defined with 13 optional elements that give physical properties of a material. It also has Index and id attributes.

10c. The ***MaterialClassEnumType*** is defined, and is the type of the **MaterialClassEnum** element of ***MaterialType***.

10d. The **MaterialLibrary** element is defined, and it is an element of **QIFDocument**/**Product**.

11. The ***PointSetReferenceBaseType***, ***PointSetReferenceWholeType***, ***PointSetReferenceRangeType*** and ***PointSetReferenceSingleType*** are defined. They are used in Features.xsd for identifying points.

12. In the following types, the type of the **SequenceNumber** element is changed from ***xs***:***positiveInteger*** to ***NaturalType*** (so no sign is allowed):

- ***SequencedDatumType***
- ***SequencedBaseFeatureType***
- ***CoordinateSystemType***
- ***NotedEventType***

13. In the ***DatumFeatureBaseType***, the **FeatureItemId** element is replaced by a **FeatureNominalId** element.

14. In the ***SectionModifierEnumType***, the enumeration value SCS is added.

15. In the following elements of the following types, the type of the element is changed from ***QIFReferenceFullType*** to ***QIFReferenceType***.

- ***MeasurePointNominalType***
    - **MeasurementDeviceId**
    - **SensorId**
    - **TipId**
- ***NotedEventType***
    - **NotableEventId**
- ***ZoneDataType***
    - **FeatureItemId**

16. The ***MeasurePointActualType*** is removed as part of the overall rebuilding of the way measured points are handled.

17. The ***TargetPointNominalType*** is renamed ***DefiningPointNominalType***, and a **SequenceNumber** element is added. Similarly, ***TargetPointActualType*** is renamed ***DefiningPointMeasurementType***, and a **SequenceNumber** element is added. These types are used only for point defined curves and surfaces.

18. In the ***BaseFeatureType***, the **FeatureItemId** element is renamed **FeatureId**, since the referenced feature is not required to be a feature item.

19. The **AlignmentOperation** element is made abstract since only its subtypes may be instantiated.

20. The modeling of coordinate systems is revised.

20a. The ***MachineCoordinateSystemType*** is added.

20b. The ***CoordinateSystemsType*** is added.

20c. ***CoordinateSystemListType*** is redefined

20d. The **CoordinateSystems** element is redefined to be ***CoordinateSystemsType*** rather than ***CoordinateSystemListType***.

20e. ***CoordinateSystemActualTransformType*** is renamed ***CoordinateSystemActualTransformAssociationType***.

20f. ***CoordinateSystemActualTransformsType*** is renamed ***CoordinateSystemActualTransformAssociationsType***

20g. The **CoordinateSystemActualTransforms** element is renamed **CoordinateSystemActualTransformAssociations**

21. In the ***SingleLeadThreadSpecificationType*** the type of the **ThreadDensity** element is changed to ***SpecifiedDecimalType***.

22. In the ***MultiLeadThreadSpecificationType*** the type of the **ThreadLeadStarts** element is changed from ***xs***:***positiveInteger*** to ***NaturalType*** (so no sign is allowed).

23. The ***CompoundFeatureGeometryEnumType*** is removed (in connection with the rebuilding of the feature types in Features.xsd).

24. In the ***DimensionModifierEnumType*** two enumeration values are changed. BASIC is changed to BASIC_OR_TED and REFERENCE is changed to REFERENCE_OR_AUXILIARY.

25. The ***DimensionDeterminationEnumType*** is added.

26. The ***SignificantDimensionEnumType*** is added.

27. The ***DimensionModifiersType*** is added.

16. PrimitivesPD.xsd

1. Additional values are added to ***LineStyleEnumType***:
- DASH_DOT
- DASH_DOT_DOT
- DASH_DOT_DOT_DOT
- DASH_DASH_DOT
- DASH_DASH_DOT_DOT
- DASH_DASH_DOT_DOT_DOT
- SHORT_DASH
- LONG_DASH
- MEDIUM_LONG_DASH
- MEDIUM_DASH_SHORT_DASH_SHORT_DASH
- LONG_DASH_SHORT_DASH
- LONG_DASH_SHORT_DASH_SHORT_DASH
- LONG_DASH_DOT_DOT
- LONG_DASH_DOT
- MEDIUM_DASH_DOT_SHORT_DASH_DOT
- SPARSE_DOT

17. PrimitivesPMI.xsd

1. Several types (and an attribute group) formerly in Primitives.xsd whose names include "Actual" are moved into PrimitivePMI.xsd, and "Actual" is changed to "Measured", namely:
- AttrMeasuredPoint
- ***MeasuredAxisType***
- ***MeasuredPlaneType***
- ***MeasuredPointType***
- ***MeasuredUnitVectorType***

2. In several types, if the name included "Actual", that is changed to "Measured"
- ***MeasuredEndRadiusType***
- ***MeasuredPointAndVectorType***
- ***MeasuredZoneAxisType***

3. Several additional types are defined, mostly dealing with statistics:

- ***ListAccumulatedStatsValuesListType***
- ***ListSubgroupStatsValuesListType***
- ***ListSummaryStatsValuesListType***
- ***StatsMeasuredDecimalType***
- ***StatsMeasuredDecimalWithReferenceType***
- ***StatsNonNegativeIntegerType***
- ***StatsNonNegativeIntegerWithReferencesType***
- ***StatsWithReferenceBaseType***
- ***SubgroupDecimalArrayType***
- ***SubgroupIntegerArrayType***
- ***SummaryStatsValuesListType***
- ***ZoneOrientationEnumType***

4. Several statistics types are transferred into PrimitivesPMI.xsd from Statistics.xsd:

- ***ListAccumulatedStatsValuesType***
- ***ListSubgroupStatsValuesType***
- ***ListSummaryStatsValuesType***
- ***StatsValuesEnumType***
- ***SubgroupDecimalsType***
- ***SubgroupDecimalType***
- ***SubgroupIntegersType***
- ***SubgroupIntegerType***
- ***SubgroupStatsValuesEnumType***
- ***SummaryStatsValuesEnumType***
- ***SummaryStatsValuesListType***
- ***SummaryStatsValuesType***

5. The ***ZoneOrientationEnumType*** is added.

6. In the ***SecurityClassificationEnumType***, the enumeration value OFFICAL_USE_ONLY is changed to OFFICIAL_USE_ONLY.

18. Primitives.xsd

1. For simple types representing multiple items, the n attribute is changed to count. This is so that the XSLT check on the number of elements (which uses n) will work if the number of elements is zero. In connection with this, the XSLT check is changed so that it no longer requires at least one element in order to make the check. The change from "n" to "count" is made in:

- ***BinaryDataType***
- ***ArrayPoint2dType***

- ***ArrayPointType***
- ***ArrayUnitVectorType***
- ***ArrayNaturalType***
- ***ArrayUnsignedByteType***
- ***ArrayIntType***
- ***ArrayI2Type***
- ***ArrayI3Type***
- ***ArrayDoubleType***
- ***ArrayBinaryType***

2. Four simple list types are added:

- ***ListBooleanType***
- ***ListDateTimeType***
- ***ListTokenType***
- ***ListQIFReferenceSimpleType***

3. **AttrActualPoint** is renamed **AttrMeasuredPoint** and moved to PrimitivesPMI.

4. Several complex types whose name included "Actual" have "Actual" replaced by "Measured". They are moved into PrimitivesPMI.xsd. Primitives.xsd now has no types whose name includes "Actual" or “Measured”.

- ***ActualPointType*** ==> ***MeasuredPointType***
- ***ActualUnitVectorType*** ==> ***MeasuredUnitVectorType***
- ***ActualPlaneType*** ==> ***MeasuredPlaneType***
- ***ActualAxisType*** ==> ***MeasuredAxisType***

5. The hierarchy of QIF ids and references to ids is rebuilt.

5a. In QIF 2.1 the hierarchy was:

- ***QIFIdType***
  - ***QIFReferenceType***
  - ***QIFReferenceActiveType***
  - ***QIFReferenceFullType***

5b. In QIF 3.0 the hierarchy is:

- ***QIFIdAndReferenceBaseType***
  - ***QIFIdType***
  - ***QIFReferenceBaseType***
    - ***QIFReferenceSimpleType***
    - ***QIFReferenceType***
      - ***QIFReferenceActiveType***
      - ***QIFReferenceFullType***

6. ComplexType lists of QIF references are added:

- ***ListQIFReferenceType***
- ***ListQIFReferenceFullType***
- ***ListQIFReferenceSimpleType***
- ***ArrayBinaryQIFReferenceType***
- ***ArrayBinaryQIFReferenceFullType***

7. ***Natural2Type*** (a list of two naturals) is added.

8. ***QIFFeaturePairType*** is added.

9. ***ArrayPairReferenceFullType*** is added.

10. The ***AttributeTimeType*** is defined. Also, the **AttributeTime** element of type ***AttributeTimeType*** is defined and added to the substitutionGroup of **Attribute**. This enables user defined attributes of type ***xs:dateTime.***

11. The **Attribute** element is made abstract since only its subtypes can be instantiated.

19. Statistics.xsd

1. "Actual" is changed to "Measured" in over 60 places. "Actual" is simply deleted in a few places:

- ***ActualSubgroupType*** became ***SubgroupType***
- ***ActualSubgroupsType*** became ***SubgroupsType***

2. Several statistics types are moved from Statistics.xsd into PrimitivesPMI.xsd:

- ***ListAccumulatedStatsValuesType***
- ***ListSubgroupStatsValuesType***
- ***ListSummaryStatsValuesType***
- ***StatsValuesEnumType***
- ***SubgroupDecimalsType***
- ***SubgroupDecimalType***
- ***SubgroupIntegersType***
- ***SubgroupIntegerType***
- ***SubgroupStatsValuesEnumType***
- ***SummaryStatsValuesEnumType***
- ***SummaryStatsValuesListType***
- ***SummaryStatsValuesType***

3. Changes are made to allow identifying individual exclusions or subsets of exclusions by id or index. In particular:

The name ***ExclusionType*** is changed to ***ExclusionIdType***.

ExclusionIndexType and ***ExclusionsIndexType*** are defined.

The name ***ExclusionsType*** is changed to ***ExclusionsIdType***.

4. ***StatsValuesType*** is defined and used in ***SubgroupValuesType***.

5. In ***CharacteristicStatsEvalBaseType***:

A choice of **SoftwareId**, **StandardId**, or **AlgorithmId** elements is added.

A choice between **MeasuredValues** and **SubgroupValues** is added.

6. Several types that contained ordered lists of optional elements each of which could occur at most once are changed by replacing the lists with a single element that can occur multiple times. The single element is head of a substitutionGroup of global elements, each of which has the same name as one of the elements in the list. The ordering of the list was irrelevant, and the new method has no ordering. The requirement that each element could appear at most once is eliminated, since the same element could be calculated by different methods.

6a. type: ***StatsBaseType***
new element name: **CommonStatsValue**
type of new element: ***StatsWithReferenceBaseType***
number of substitutes: 5

6b. type: ***StatsNumericalBaseType***
new element name: **NumericCharacteristicStatsValue**
type of new element: ***StatsWithReferenceBaseType***
number of substitutes: 39

6c. type: ***StatsWithTolNumericalBaseType***
new element name: **NumericCharacteristicWithTolStatsValue**
type of new element: ***StatsWithReferenceBaseType***
number of substitutes: 20

Note: The **Cpm** element is added.

6d. type: ***StatsPassFailType***
new element name: **PassFailStatsValue**
type of new element: ***StatsWithReferenceBaseType***
number of substitutes: 2

6e. type: ***SummaryStatisticsType***
new element name: **SummaryStatsValue**

type of new element: ***StatsWithReferenceBaseType***
number of substitutes: 5

Note: element names are changed by adding the prefix "Summary".

7. CharacteristicStatsEval types and global elements are added for weld characteristics:
   - ***WeldBevelCharacteristicStatsEvalType***
   - ***WeldCompoundCharacteristicStatsEvalType***
   - ***WeldEdgeCharacteristicStatsEvalType***
   - ***WeldFilletCharacteristicStatsEvalType***
   - ***WeldFlareBevelCharacteristicStatsEvalType***
   - ***WeldFlareVCharacteristicStatsEvalType***
   - ***WeldJCharacteristicStatsEvalType***
   - ***WeldPlugCharacteristicStatsEvalType***
   - ***WeldScarfCharacteristicStatsEvalType***
   - ***WeldSeamCharacteristicStatsEvalType***
   - ***WeldSlotCharacteristicStatsEvalType***
   - ***WeldSpotCharacteristicStatsEvalType***
   - ***WeldSquareCharacteristicStatsEvalType***
   - ***WeldStudCharacteristicStatsEvalType***
   - ***WeldSurfacingCharacteristicStatsEvalType***
   - ***WeldUCharacteristicStatsEvalType***
   - ***WeldVCharacteristicStatsEvalType***

8. ***ArrayReferenceFullType*** is changed to ***ArrayReferenceType*** in the following types and elements:

   - ***StatsArrayIdType***
     - **Ids**
   - ***AssignableCauseType***
     - **CorrectiveActionIds**
   - ***StudyIssueType***
     - **AssignableCauseIds**
     - **CorrectiveActionIds**
     - **CharacteristicMeasurementIds** (was named **CharacteristicIds**)
     - **SubgroupIds**

9. A **BonusStats** element is added to the following types:

   - ***FlatnessCharacteristicStatsEvalType***
   - ***StraightnessCharacteristicStatsEvalType***
   - ***PositionCharacteristicStatsEvalType***

10. The **CharacteristicStats** element is made abstract since it is the head of a substitutionGroup for which only the substitutes can be instantiated.

20. Topology.xsd

1. The materialIndex attribute is added to ***BodyType***.

2. The following elements (each of which is the head of a subsitution group) are made abstract.

- **LoopBase**
- **FaceBase**

21. Traceability.xsd

1. "Actual" is changed to "Measured" in three places.

2. In ***InspectionProgramType*** and in ***PreInspectionTraceabilityType***, the **FormalStandard** element of type ***FormalStandardType*** is changed to the **FormalStandardId** element of type ***QIFReferenceType*** (since formal standards are now gathered together under **QIFDocument**).

3. In ***InspectionSoftwareItemsType***, the type of the **InspectionProgramGenerationSoftware**, **AnalysisSoftware**, **CADSoftware**, **DMESoftware**, and **InspectionProgramExecutionSoftware** elements is changed from ***SoftwaresType*** to ***ArrayReferenceType*** (since software is now gathered together under **QIFDocument**).

4. The element type ***QIFReferenceFullType*** is changed to ***QIFReferenceType*** in the following types and elements (since an asmPath is not needed).

- ***ProductTraceabilityType***
  - **ManufacturingProcessId**
  - **FixtureId**
- ***ActualProductTraceabilityType***
  - **ManufacturingProcessId**
  - **FixtureId**
- ***ManufacturingProcessTraceabilityType***
  - **PreviousOperationId**
  - **AssociatedTraceabilityId**

5. The element type ***ArrayReferenceFullType*** is changed to ***ArrayReferenceType*** in the following types and elements (since an asmPath is not needed).

- ***ProductTraceabilityType***
  - **NotableEventIds**

    - **MeasurementDeviceIds**
- ***ActualProductTraceabilityType***
    - **NotableEventIds**
    - **NotedEventIds**
    - **MeasurementDeviceIds**

22. Units.xsd

1. "Actual" is changed to "Measured" in over three dozen places.

2. The ***LinearDualValueType*** is added.

23. Visualization.xsd

1. ***AlignmentEnumType*** is defined and an optional **Alignment** element is added to ***FontType***.

2. An optional **GroupID** element is added to ***PMIDisplayType***.

3. An optional color attribute is added to ***Polyline2dType***.

4. In the ***Triangulation2dType***, optional **TrianglesColor** and **TrianglesColorBinary** elements are added to the second choice. Also, minOccurs is removed from all elements.

5. ***WitnessLinesType*** is changed by allowing circular lines as well as straight lines. Also, extension points are added in the case of straight lines.

6. The ***TrailingZeroDisplayType*** is added and used as the type of the **TrailingZeroDisplay** element, which is added as an optional element of the ***VisualizationSetType***. The following new types are defined

- ***TrailingZeroDimensionalCharacteristicDisplayGroupType***
- ***TrailingZeroDimensionalCharacteristicDisplayGroupsType***
- ***TrailingZeroGeometricCharacteristicDisplayGroupType***
- ***TrailingZeroGeometricCharacteristicDisplayGroupsType***

The last two of those are used as the types of two of the elements of

TrailingZeroDisplayType.

7. ***FrameType*** (which is abstract) is renamed ***FrameBaseType***.

8. The **Frame** element is made abstract.

24. XSLT Changes

The QIF 3.0 XSLT files (included in the download) are a normative part of the standard. There were three improvements in the XSLT check between versions 2.1 and 3.0.

First, over 300 checks were added that check that a specified entity in an external QIF document is the right kind of entity. These correspond to the same sort of check made using key and keyref within a single QIF document. For example, the value of the **FeatureDefinitionId** of an instance of ***CircleFeatureNominalType*** must be the id of an instance of ***CircleFeatureDefinitionType***.

Second, the check of the n attribute that is used in QIF for the number of instances of an element whenever the element has maxOccurs="unbounded" was improved so that it works when there are no instances of the element. In QIF 2.1, the check would run only if there was at least one instance.

Third, a check was added that the length of a unit vector is very close to 1.