April 16th, 2024

Primer on the new DMSC Model-Based Characteristic (MPC) Standard

Persistent Identification and Related Digital Practices

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NSC-614-5877 dated January / 2024
Unclassified Unlimited Release

Outline

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- Scope & Purpose
- Product Characteristics (PC)
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- Product Characteristics Identification Framework
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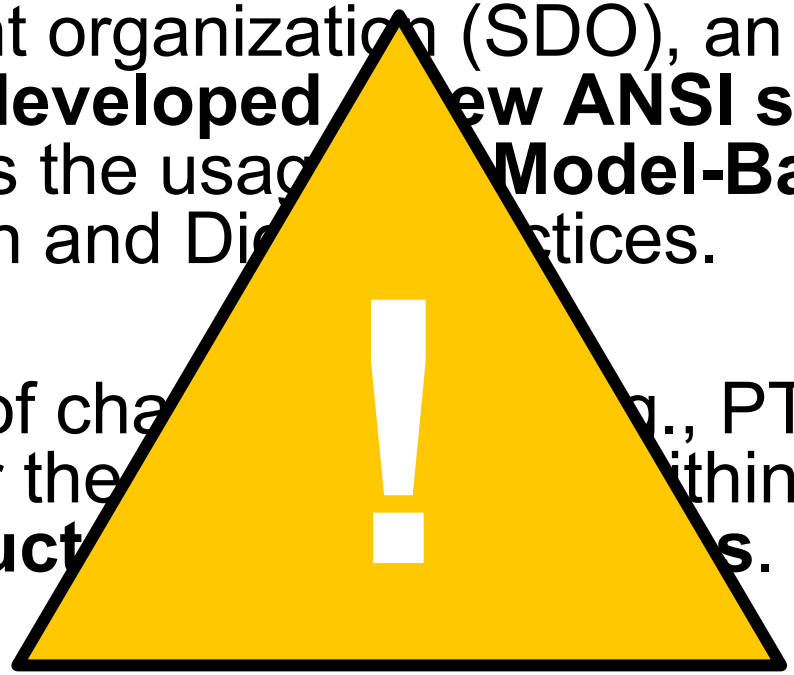
  - Instance ID
  - Use-Cases
- Applications
  - PTC Control Characteristics
  - QIF Characteristics
- Questions

BLUF – Bottom Line Up Front

The **Digital Metrology Standards Consortium** (DMSC), an ANSI standards development organization (SDO), an ISO TC184 SC4 A-Liaison member, has **developed a new ANSI standard** that defines, extends, and describes the usage of **Model-Based Characteristics** – Persistent Identification and Digital Signatures.



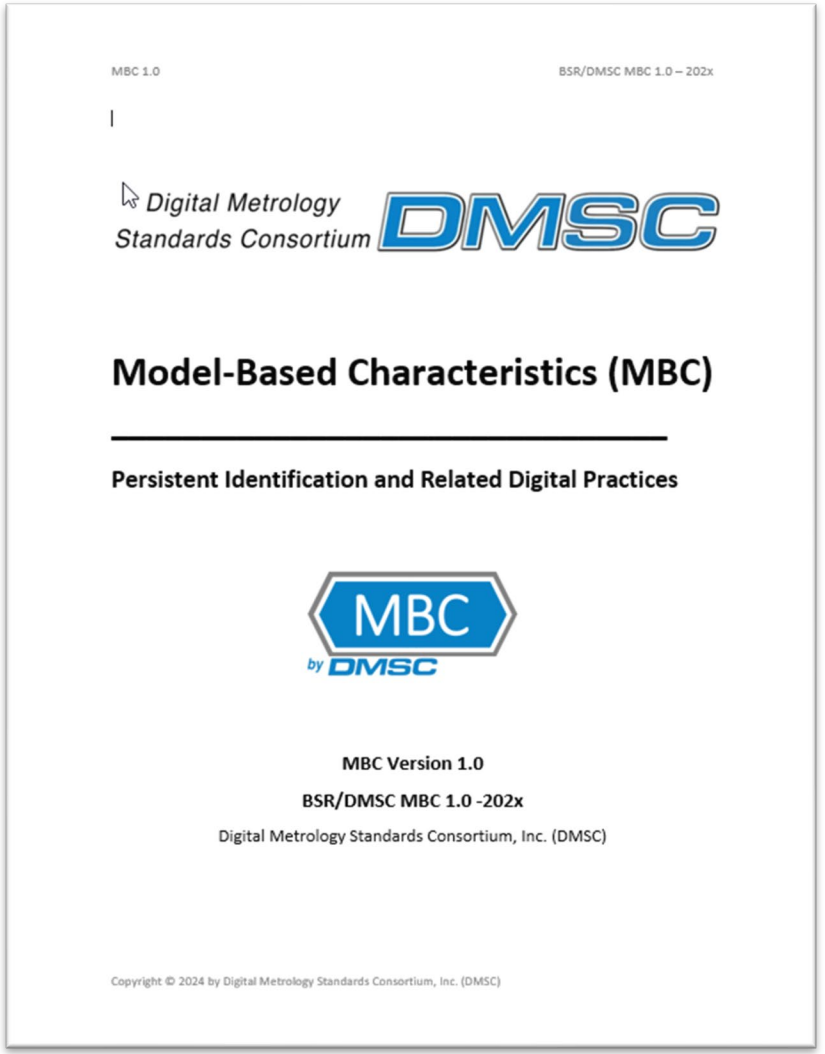
Standardizes the use of characteristics (e.g., PTC, QIF) to **establish connection points** for the **product** within the model-based definition, digital **product** **s**.

A BRS/DMSC MBC v1.0 -2024 is available for DMSC members and working group volunteers. Once the standard is available as ANSI/DMSC MBC v1.0 – 2024, it will be available as a **free** download from the DMSC 3Q24.

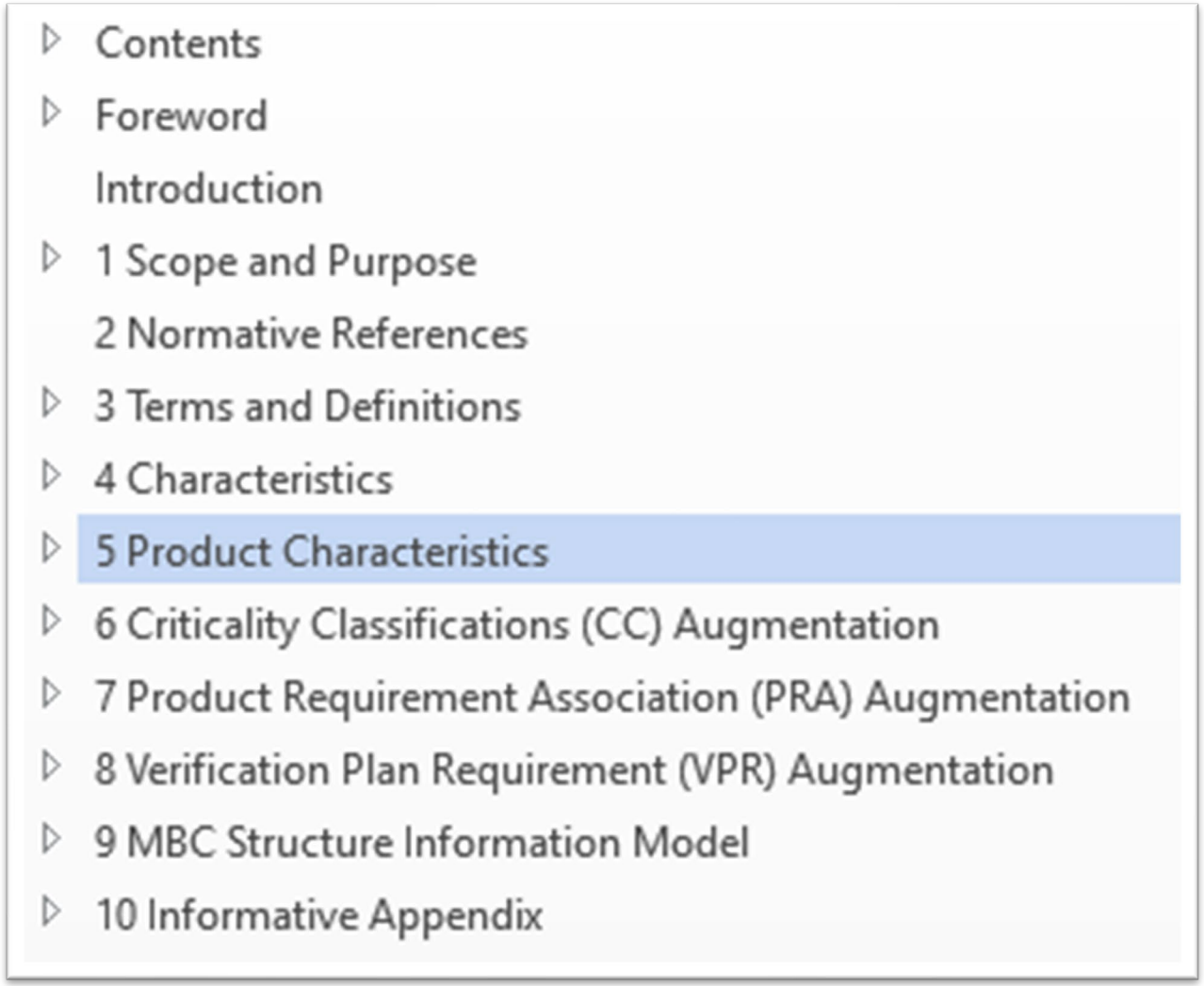
Introduction

BSR/DMSC MBC v1.0 2024 Model-Based Characteristics (MBC) standard:

- **defines** common nomenclature, definitions, symbols, data structures
- **practices** for identifying, communicating, and exchanging model-based characteristics with various optional augmentations
- **behaviors** within a model-based system
- **through** both a logical data model and supporting documentation.



BSR/DMSC MBC v1.0 2024 - Outline



BSR/DMSC Model-Based Characteristics:
Persistent Identification and Related Digital Practices

Digital Metrology Standards Consortium (DMSC) – developers and maintainers of the ANSI/ISO DMIS* and ANSI/ISO QIF**.

Will be available free of charge from the DMSC
On-line Article “Finish Line in Sight for New MBC Standard”
https://qifstandards.org/finish-line-in-sight-for-new-mbc-standard

* Dimensional Measuring Interface Standard (DMIS) – ISO 22093
** Qualify Information Framework (QIF) – ISO 23952

DMSC MBC Working Group & Contributors

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- Nathan Denver, L3Harris
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- Fred McMaier, Lockheed Martin
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- Andrew Pierce, GE Appliances
- Jacob Sherwood, Pratt & Whitney
- Ray Stahl, 2BMobile
- Robert Stone, Origin International
- Jon Stothfang, B&W Software
- Annalise **Suzuki**, Elysium
- Mark Thomas, DMSC
- Mark White, LANL
- Benny Yap, Lam Research

Scope and Purpose:

- Establishes a **baseline** for **characteristics** that are applied to product definition.
- Focuses on **Product Characteristics** (**PC**) and their optional **augmentations:**
  - Criticality classifications (CC),
  - Product requirement associations (PRA), and
  - Verification plan requirements (VPR).
- **Uniquely identifies verification requirement(s**) from annotations and specification documentation. (“Taming the wild west of print ballooning the drawing” – B. Stone)
- Introduces a **Product Characteristic identification framework** that specifies both the use of:
  - locally unique, **human-readable tag** identifiers coupled with
  - universally unique, **machine-readable** identifiers (**UUIDs**).

Scope and Purpose:

- Complements and contributes to **extending** the Quality Information Framework (**QIF**) via next-gen QIF.
- Enables connection points that establishes a **digital thread** at the PC definition level
- Facilitates **persistent** and **explicit** means for:
  - Identifying verification Items for a **Bill of Characteristics**
  - Referencing Items within product definition **change control**
  - Referencing Items within Non-Conformance **Reports**
  - Obfuscating Item's Sensitive Information
- Captures MPC framework as **SysML** block diagrams
- Describes **system behaviors** for model-based applications that produce and/or use product characteristics.

Terms and Definitions

Contains: Fifty-one Terms (noun, adjectives) w/ Definitions: (Samples)

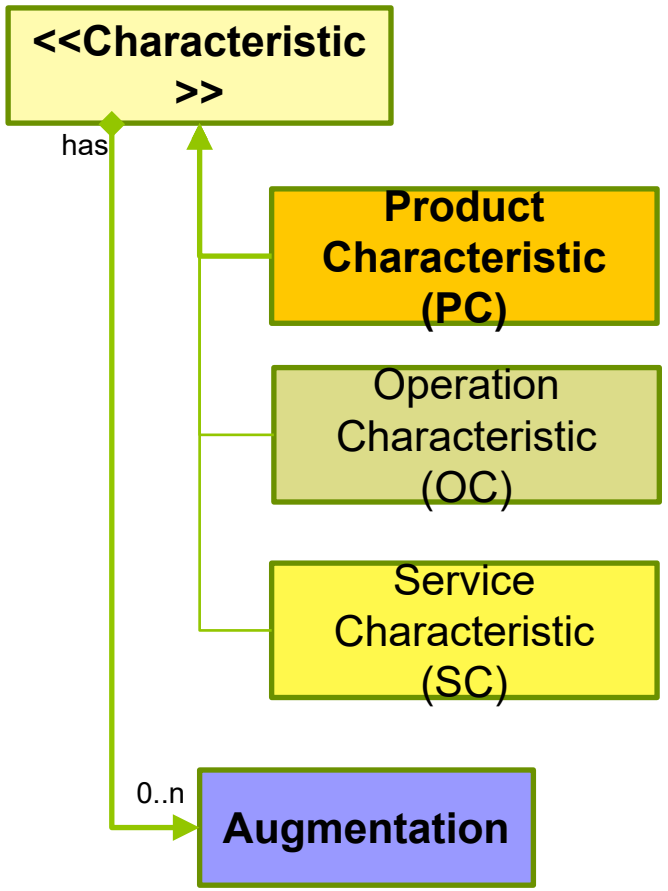
- Characteristic
- Characteristic Augmentation
- Characteristic, Product (PC)
- Criticality Classification (CC)
- Designator
- Identifier, Product Characteristic Extension
- Identifier, Product Characteristic Instance
- Identifier, Product Characteristic Reference
- Model, Model-Based Definition (MBD)
- Product Requirement Association (PRA)
- Tag, Product Characteristic
- Tag, General
- Universally Unique Identifier
- Verification Plan Requirement (VPR)

Mode-Based Characteristic (MBC)

Establishes a **baseline for characteristics**, they can be a:

- **Product Characteristic (PC)**
  - a characteristic, which is created to identify a verification requirement, applied to a feature or of a product, initiated during the product definition activity.
- Operation (Process) Characteristics (OC)
  - a characteristic, which is created to identify an operation or process requirement for the product realization process of a product or of a feature of a product.
- Service Characteristic (SC)
  - a characteristic, which is created to identify a service or maintenance requirement for the sustainment of a product or of a feature of a product.

Has zero or many augmentations:



This version of the MBC standard specifically **focuses** on **product characteristics** (PC) and **their optional augmentations**.

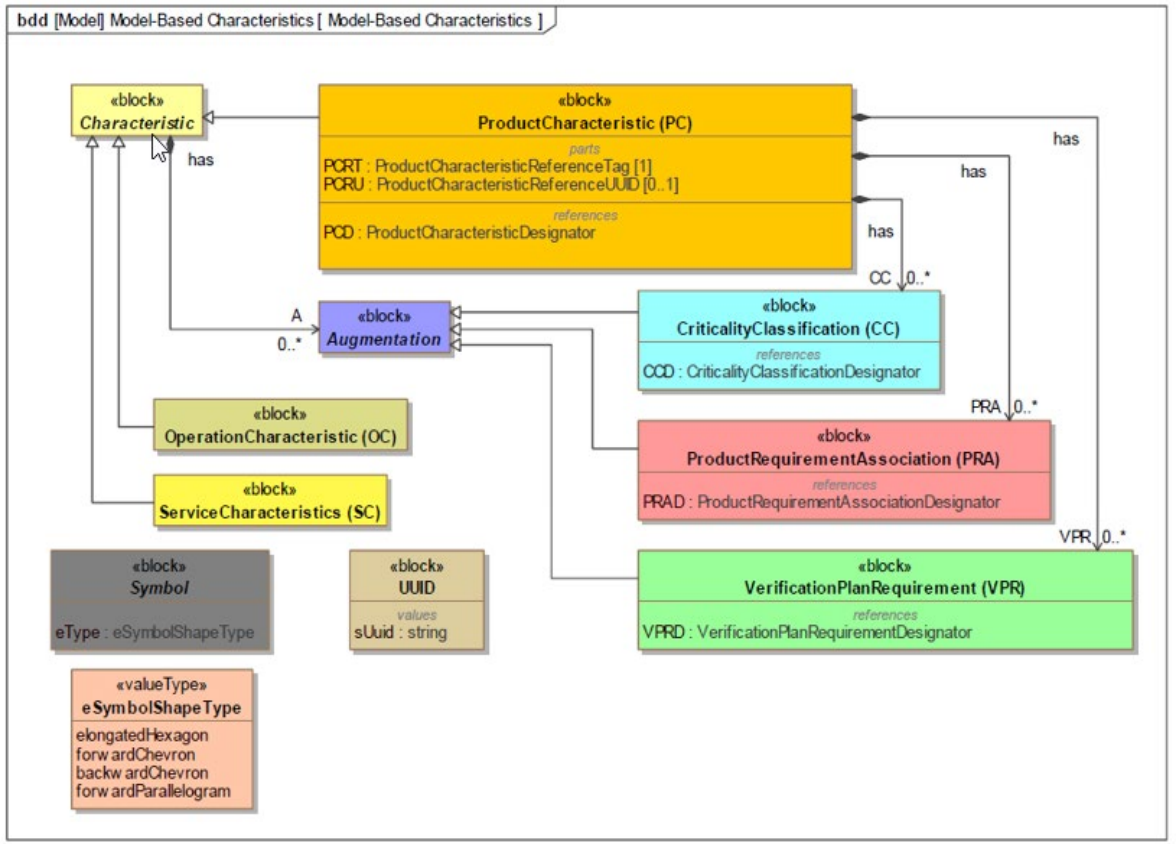
Product Characteristic (PC)

Is a **Characteristic** which is **created to identify a verification requirement applied to a product or a feature of a product.**

Has zero or many **augmentations**:

- Criticality Classification (CC)
- Product Requirement Association (PRA)
- Verification Plan Requirement (VPR)

Verification Requirements are **tolerances** or **specifications** applied to a part feature or product which **requires verification** to **assure product acceptance**, typically **communicated** via **annotations**, attributes, and/or **specification documents**.



Product Characteristic Identifier Structure

Locally Unique, Human-Readable Tag Identifier

PC Tag Formats	With PC Prefix	Without PC Prefix
PC Designator Symbol	⟨PC42⟩	⟨007⟩
PC Designator Textual	<PC42>	<007>

PC Reference Tag Designator Presentation Examples

Universally Unique, Machine-Readable Identifying Attribute (UUID)

DA8612FE-B1E4-423B-8191-B746E224C595

PC Reference UUID adheres to the **ISO/IEC 9834-8 standard** as a universal unique identifier

Product Characteristics Designations

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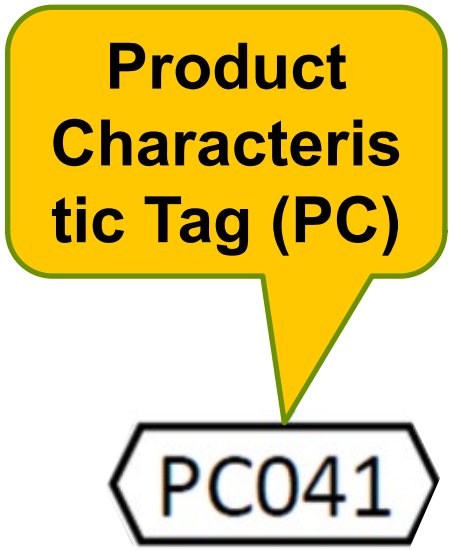
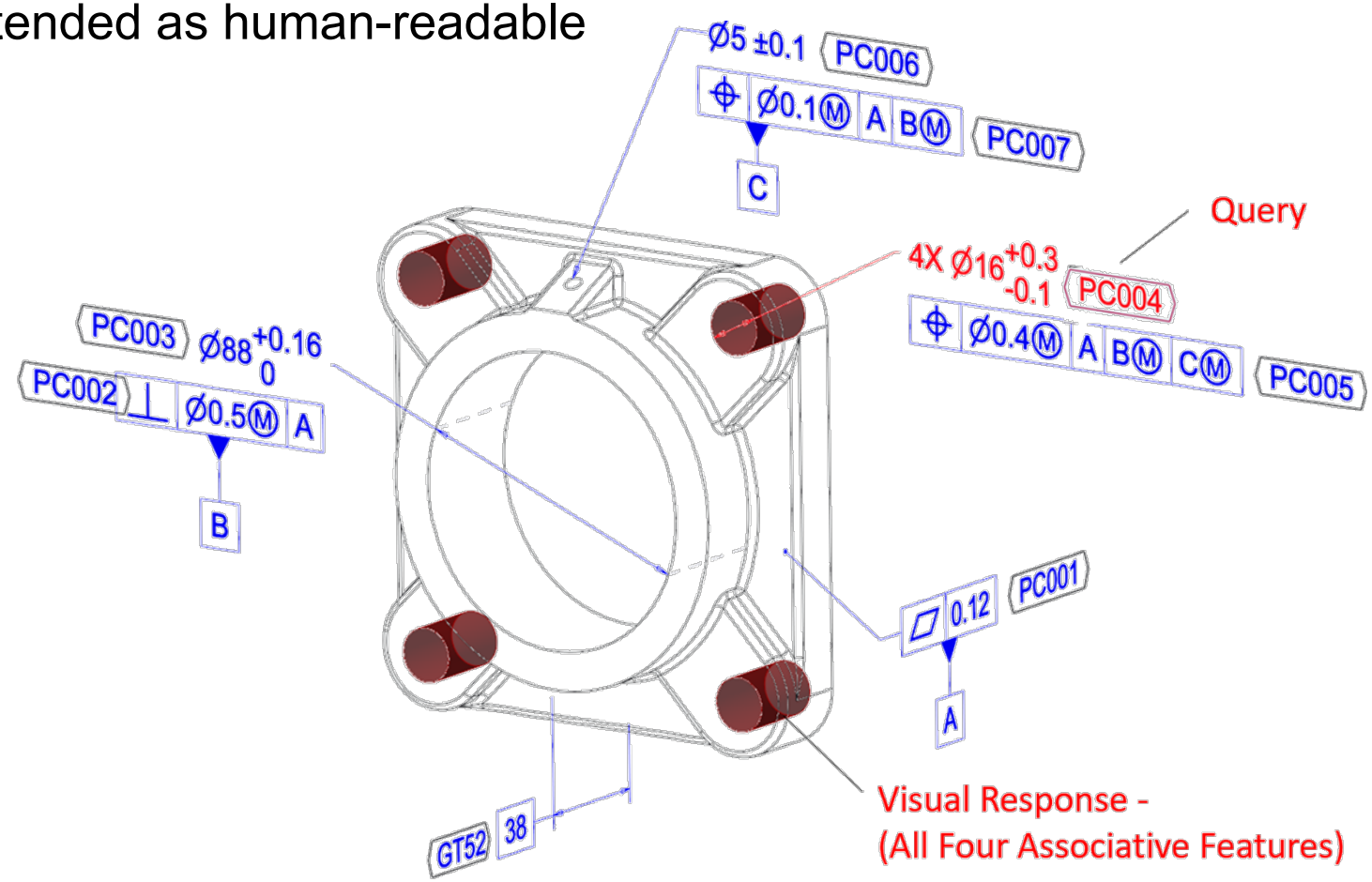


PC Reference Tag

Product Characteristic (PC) Tag w/Annotation

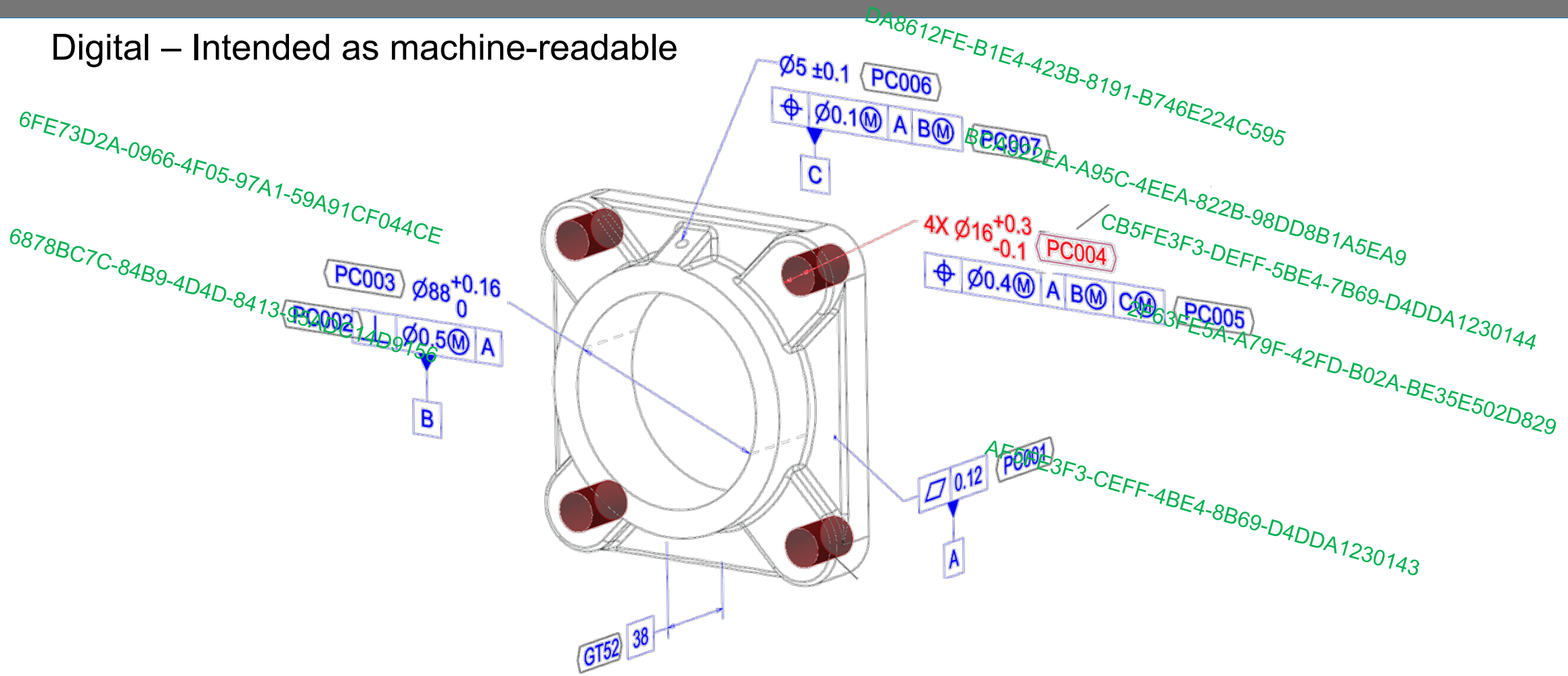
Electronic – Intended as human-readable



Visualization of a Model-Based Definition with Product Characteristic Reference Tags

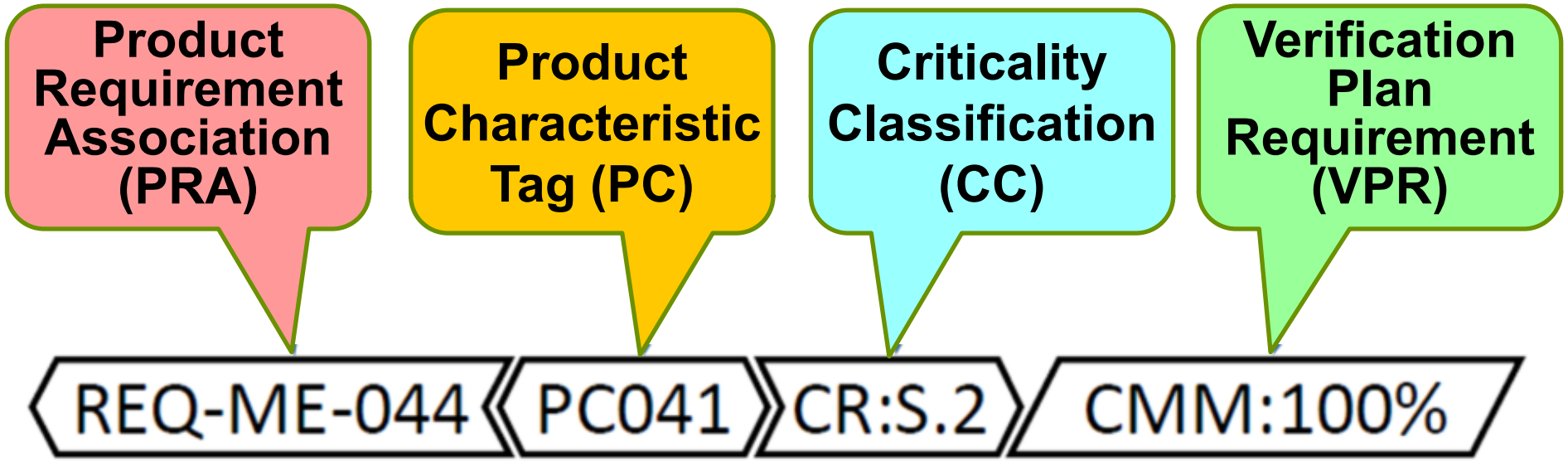
Product Characteristic (PC) UUID Attributes

Digital – Intended as machine-readable



Representation of a Model-Based Definition with Product Characteristic Reference Tags & UUIDs

Product Characteristics Designations with all optional Augmentations Example



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PC Reference Tag with All Augmentations

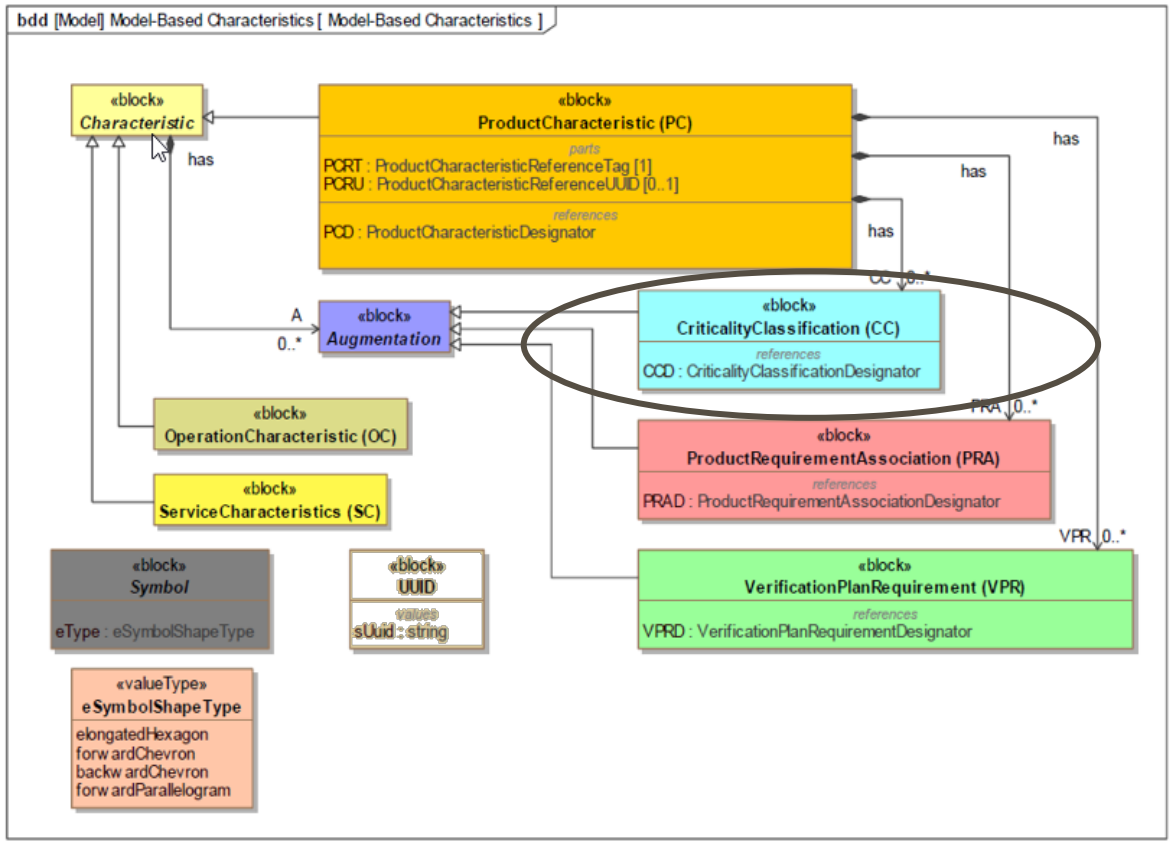
Product Characteristic (PC) w/CC

Is a Characteristic which is created to identify a verification requirement applied to a product or a feature of a product.

Has zero or many augmentations :

- **Criticality Classification (CC)**
- Product Requirement Association (PRA)
- Verification Plan Requirement (VPR)

Verification Requirements are **tolerances** or **specifications** applied to a part feature or product which **requires verification** to **assure product acceptance**, typically **communicated** via annotations, attributes, and/or specification documents.cc



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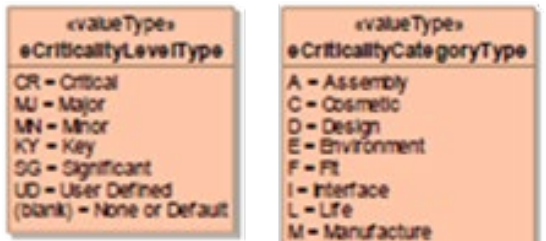
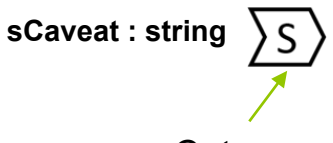
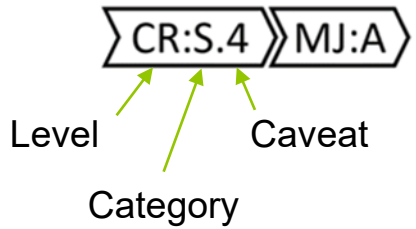
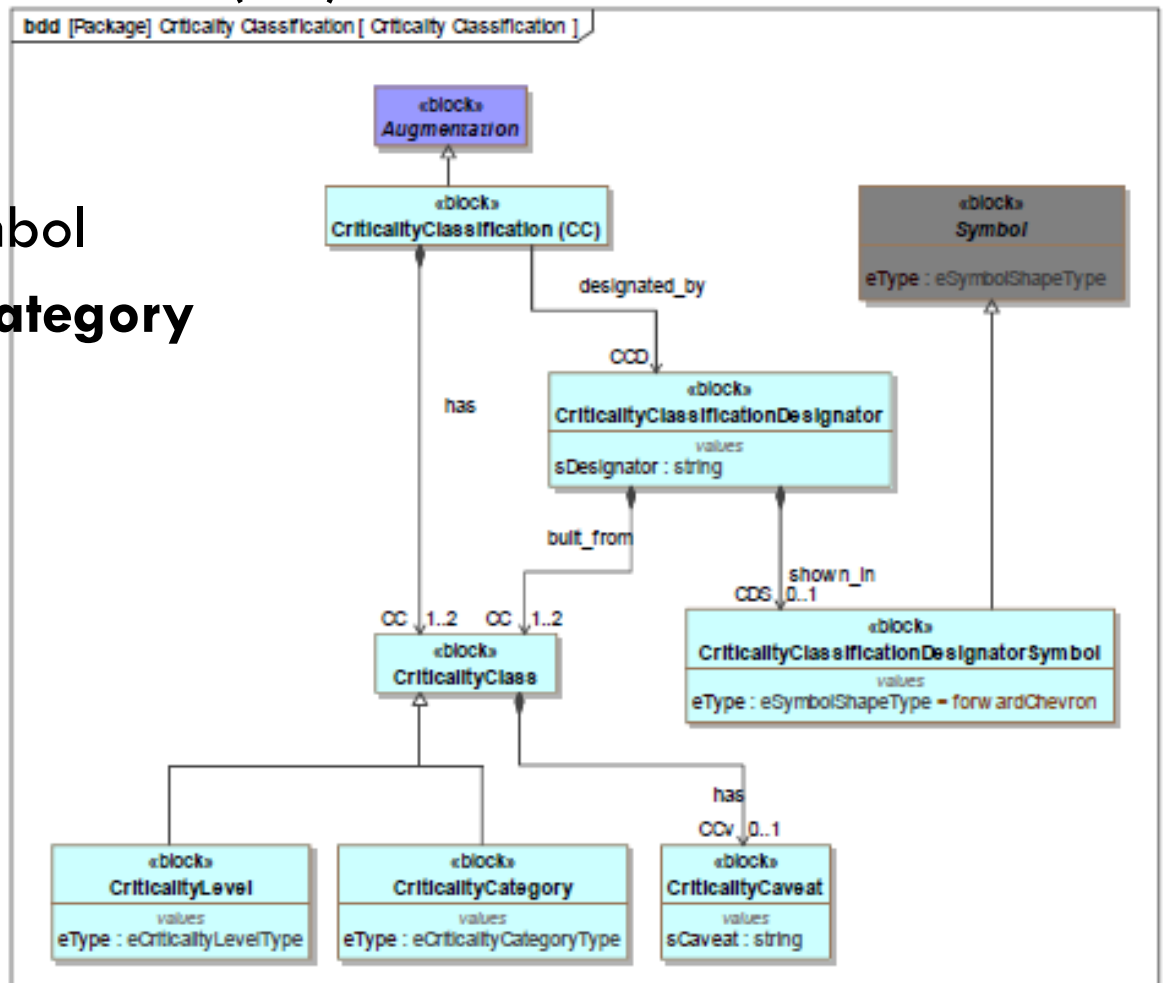
Criticality Classification (CC) Augmentation

- A **PC** may have one or many **Criticality Classifications** (CC)
- CC is a PC Augmentation
- CC designates the criticality of the PC
- CC has a designator w/**Forward-Chevron** symbol
- CC has a **Criticality Level** and/or **Criticality Category**
- CC may have a **Criticality Caveat**

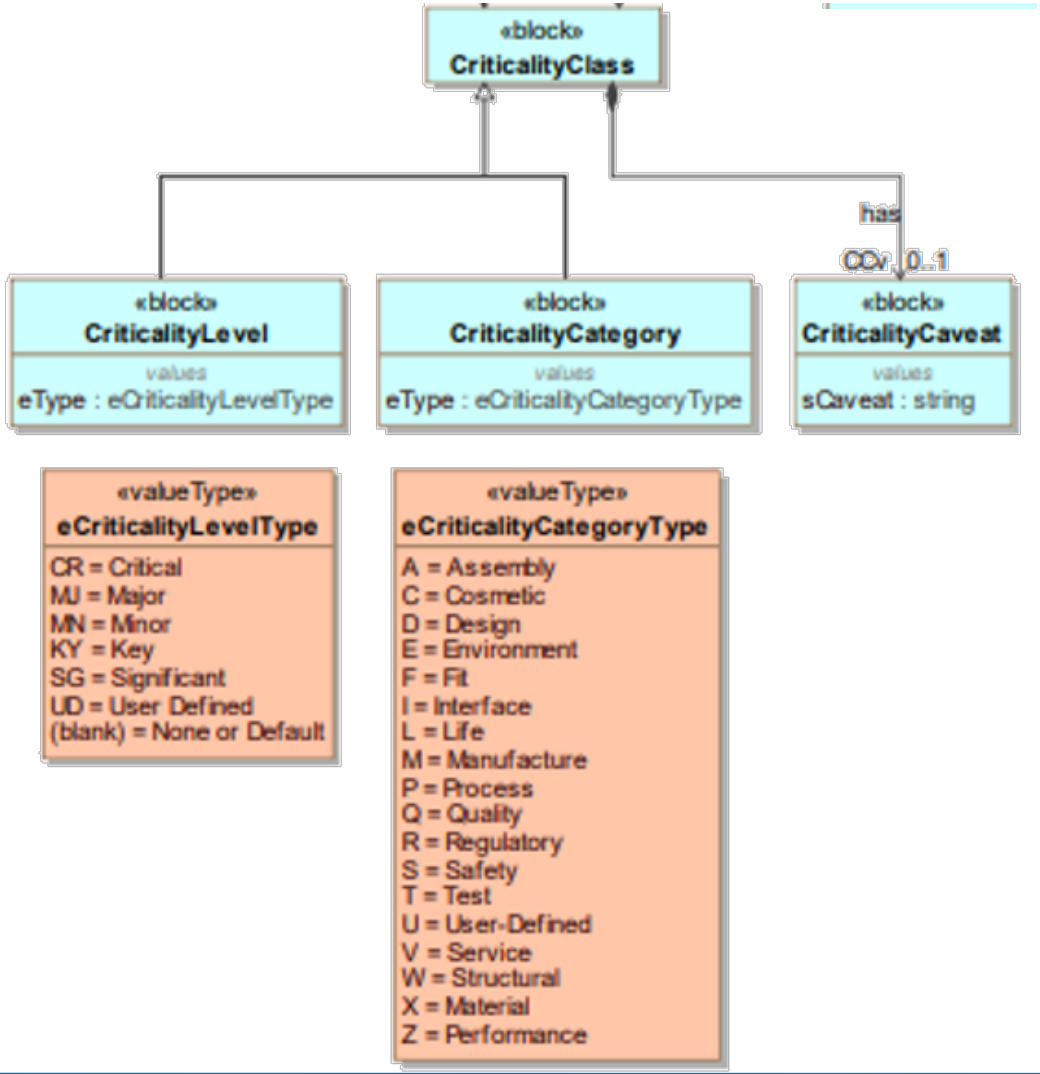




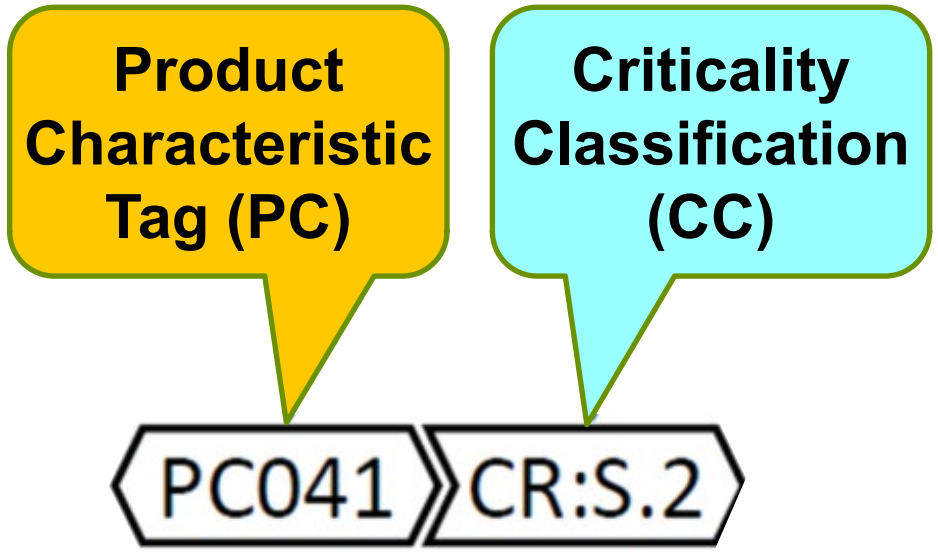




Criticality Levels, Categories, & Caveats



Product Characteristic Designation with an optional CC Augmentation Designation



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PC Reference Tag with an Augmentation

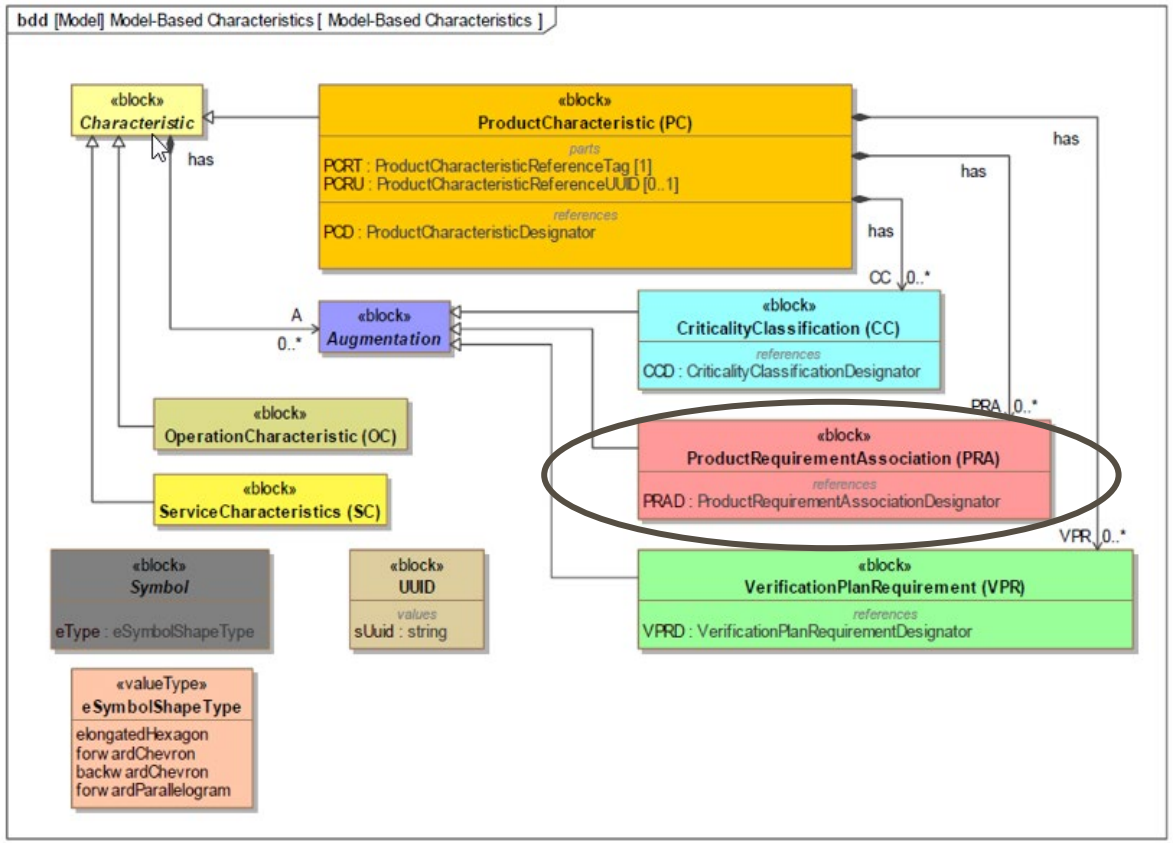
Product Characteristic (PC) w/PRA

Is a Characteristic which is created to identify a verification requirement applied to a product or a feature of a product.

Has zero or many augmentations :

- Criticality Classification (CC)
- ***Product Requirement Association (PRA)***
- Verification Plan Requirement (VPR)

Verification Requirements are **tolerances** or **specifications** applied to a part feature or product which **requires verification** to **assure product acceptance**, typically **communicated** via annotations, attributes, and/or specification documents.cc



Product Requirement Association (PRA) Augmentation

A **PC** may have one or many **Product Requirement Associations** (PRA)

- PRA is an PC Augmentation
- PRA designates/associates the Product Requirement driving this PC
- PRA has a Designator w/Backward-Chevron Symbol
- PRA may have a **UUID**
- PRA may have a **Reference Link**

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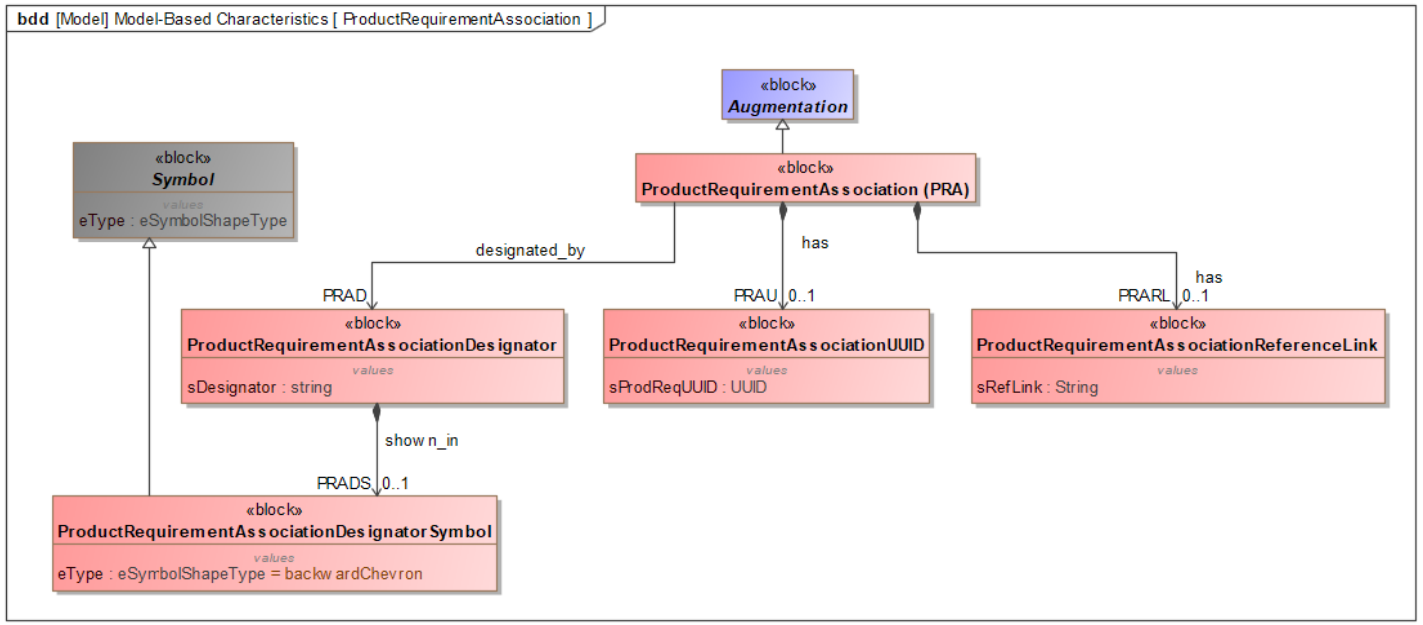
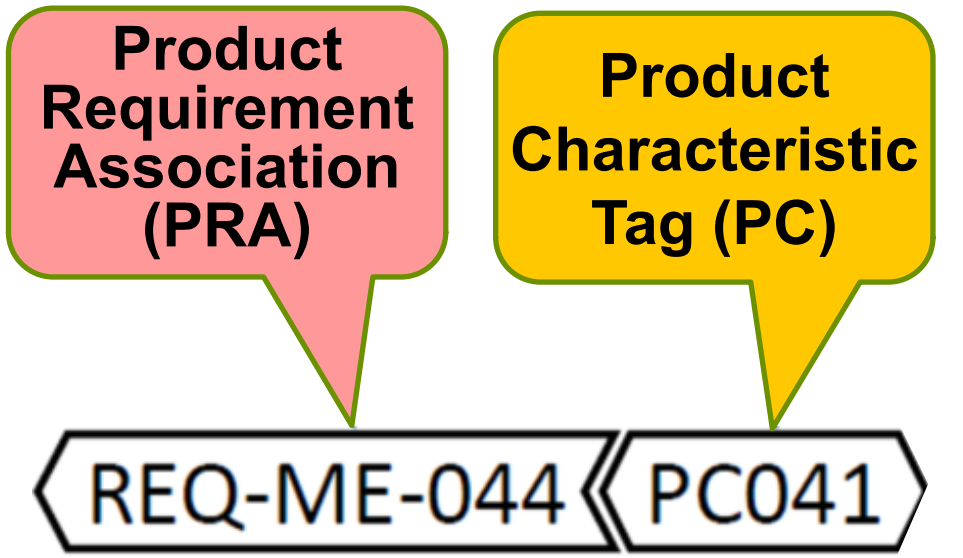


Product Characteristic Designation with an optional PRA Augmentation Designation



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PC Reference Tag with an Augmentation

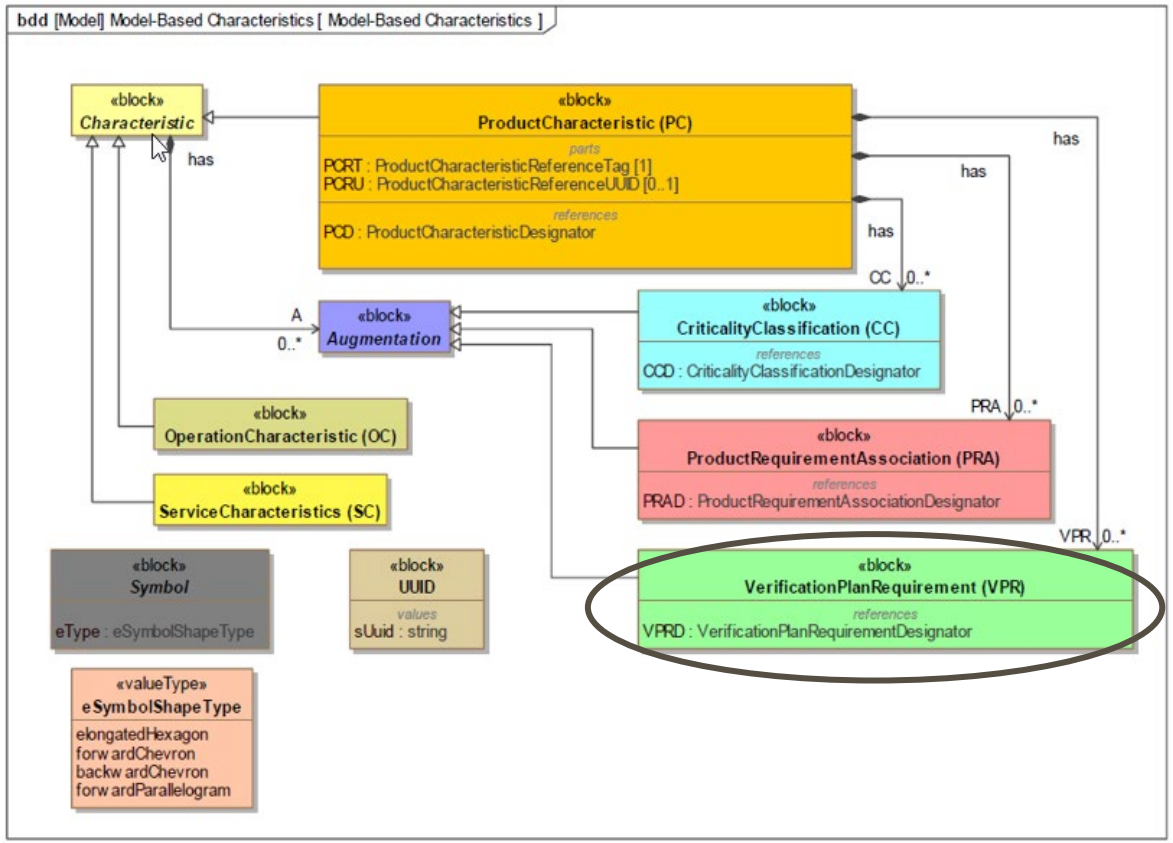
Product Characteristic (PC) w/VPR

Is a Characteristic which is created to identify a verification requirement applied to a product or a feature of a product.

Has zero or many augmentations :

- Criticality Classification (CC)
- Product Requirement Association (PRA)
- ***Verification Plan Requirement (VPR)***

Verification Requirements are **tolerances** or **specifications** applied to a part feature or product which **requires verification** to **assure product acceptance**, typically **communicated** via annotations, attributes, and/or specification documents.cc



Verification Plan Requirement (VPR) Augmentation

A **PC** may have one or many **Verification Plan Requirements** (VPR)

- VPR is a PC Augmentation
- VPR designates requirements for the product Verification Plan
- VPR has a Designation w/Forward-Parallelogram Symbol
- VPR has a **Verification Method**
- VPR may have a **Verification Context**
- VPR may have a **Verification Alternative**
- VPR may have a **Sampling Plan**

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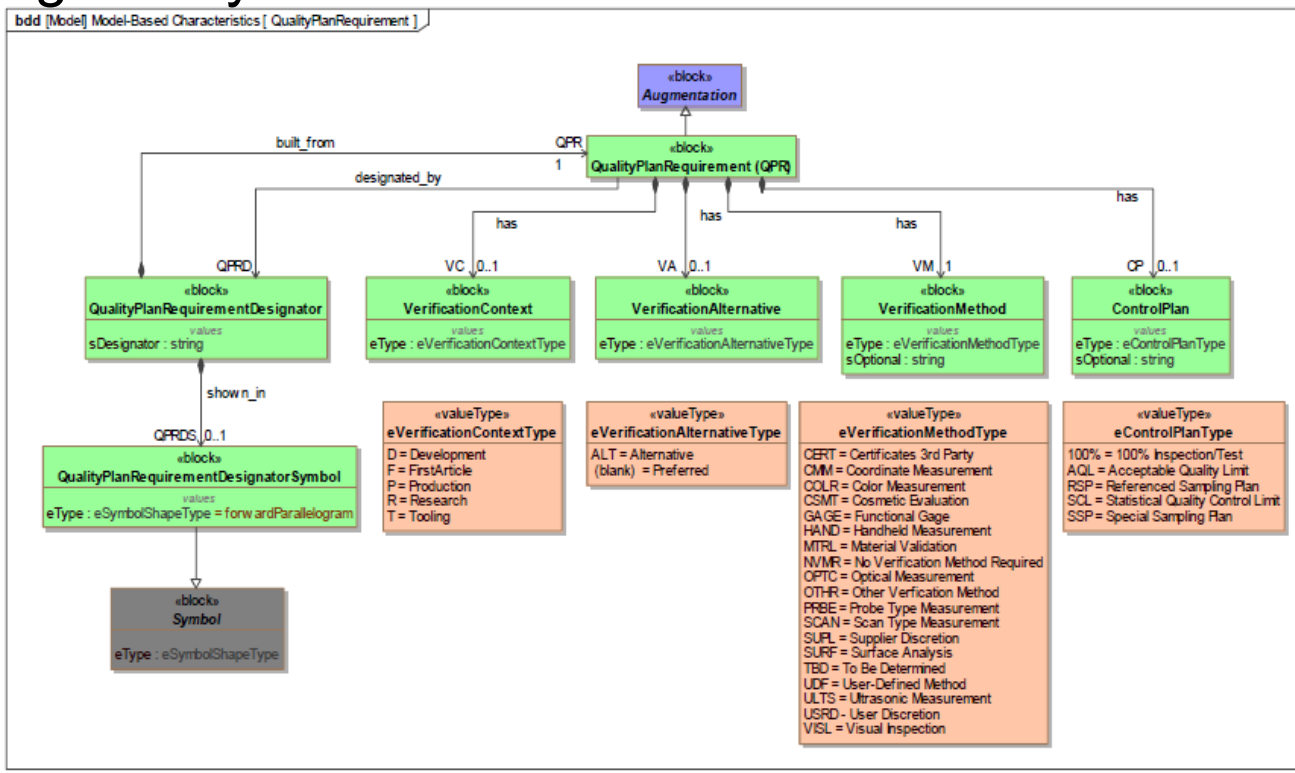
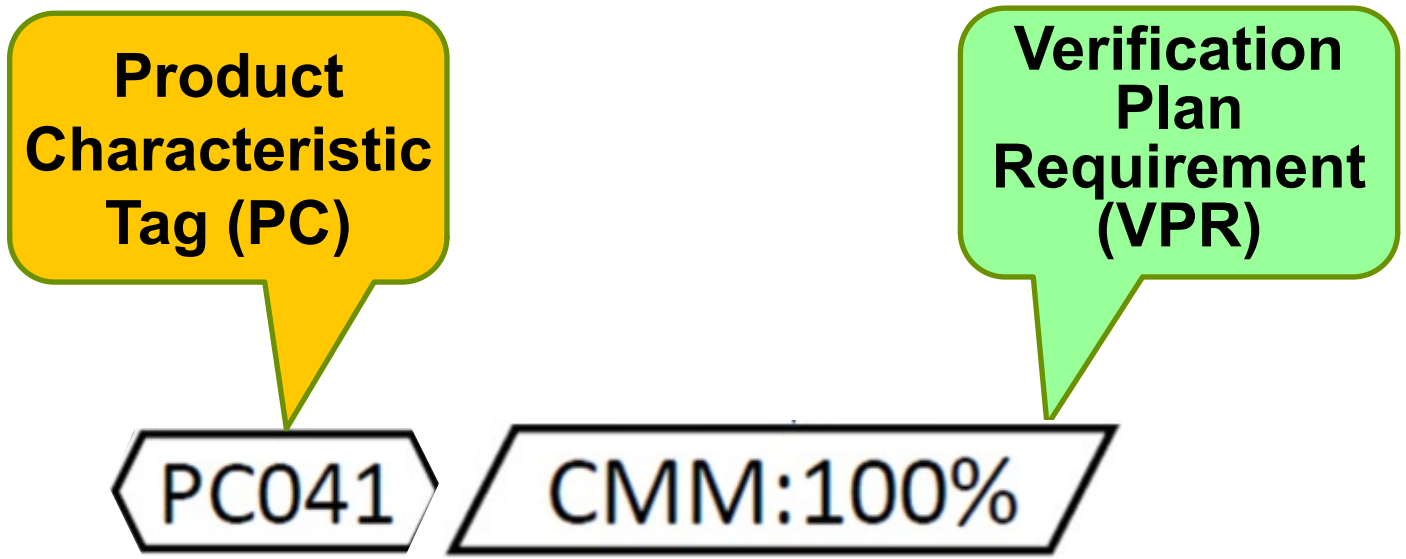
P: CMM: SP: 67%

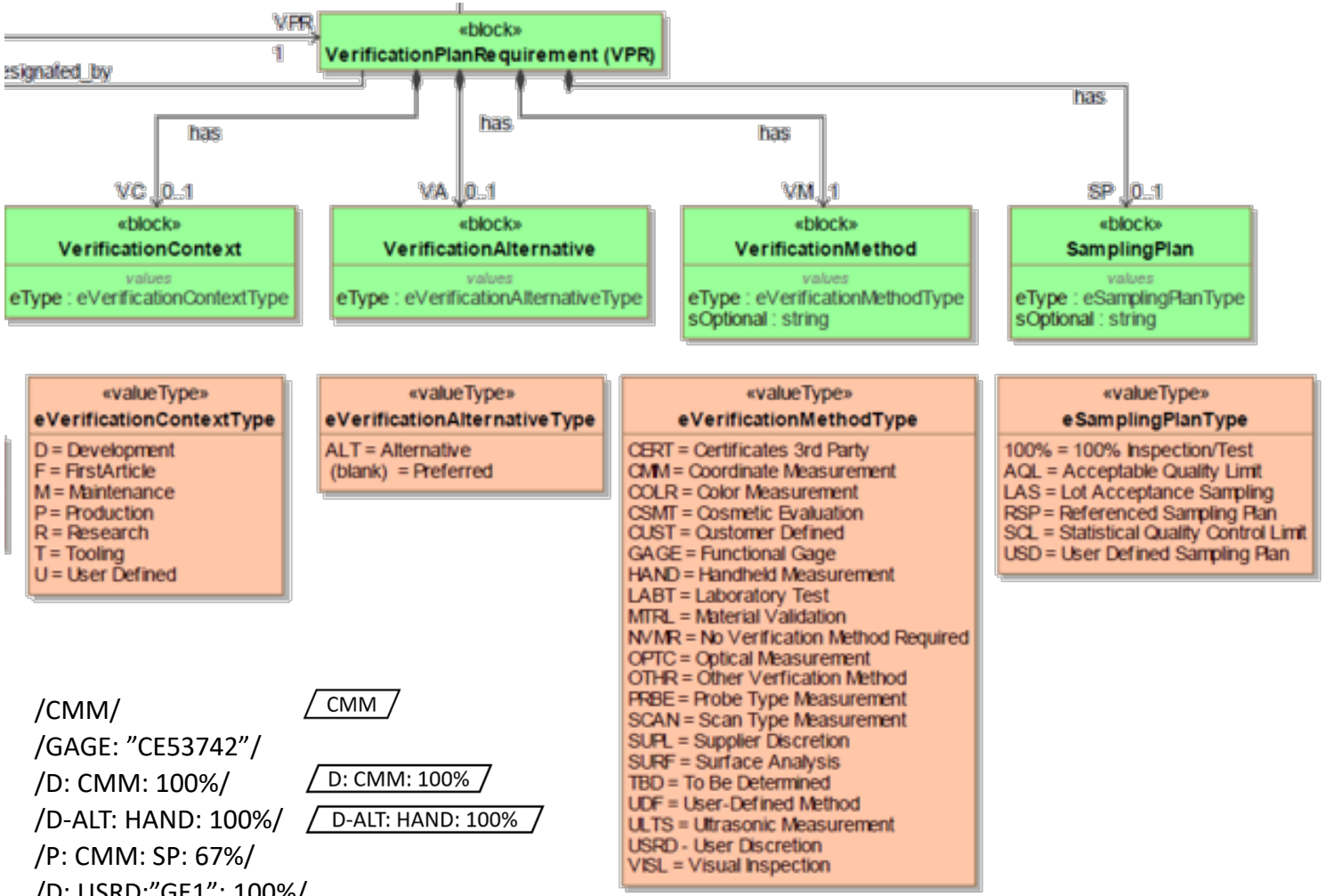


Product Characteristic Designation with an optional VPR Augmentation Designation



PC Reference Tag with an Augmentation

Verification Plan Requirement (VPR) Method, Context, Alternative, Sampling Plan



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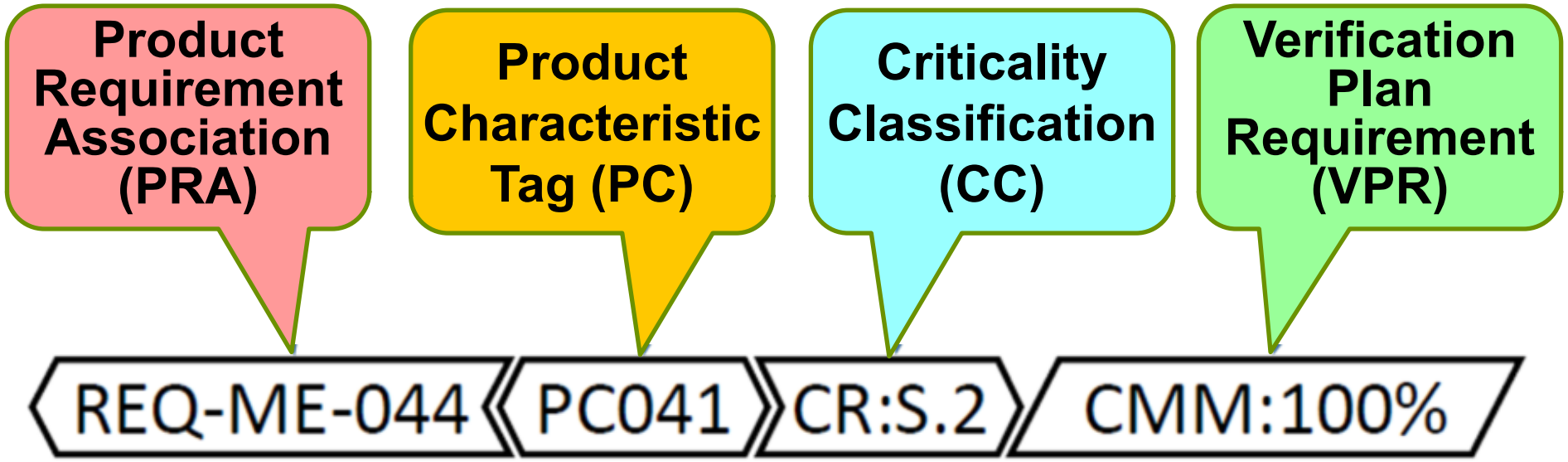
Product Characteristics Designations with all optional Augmentations Example



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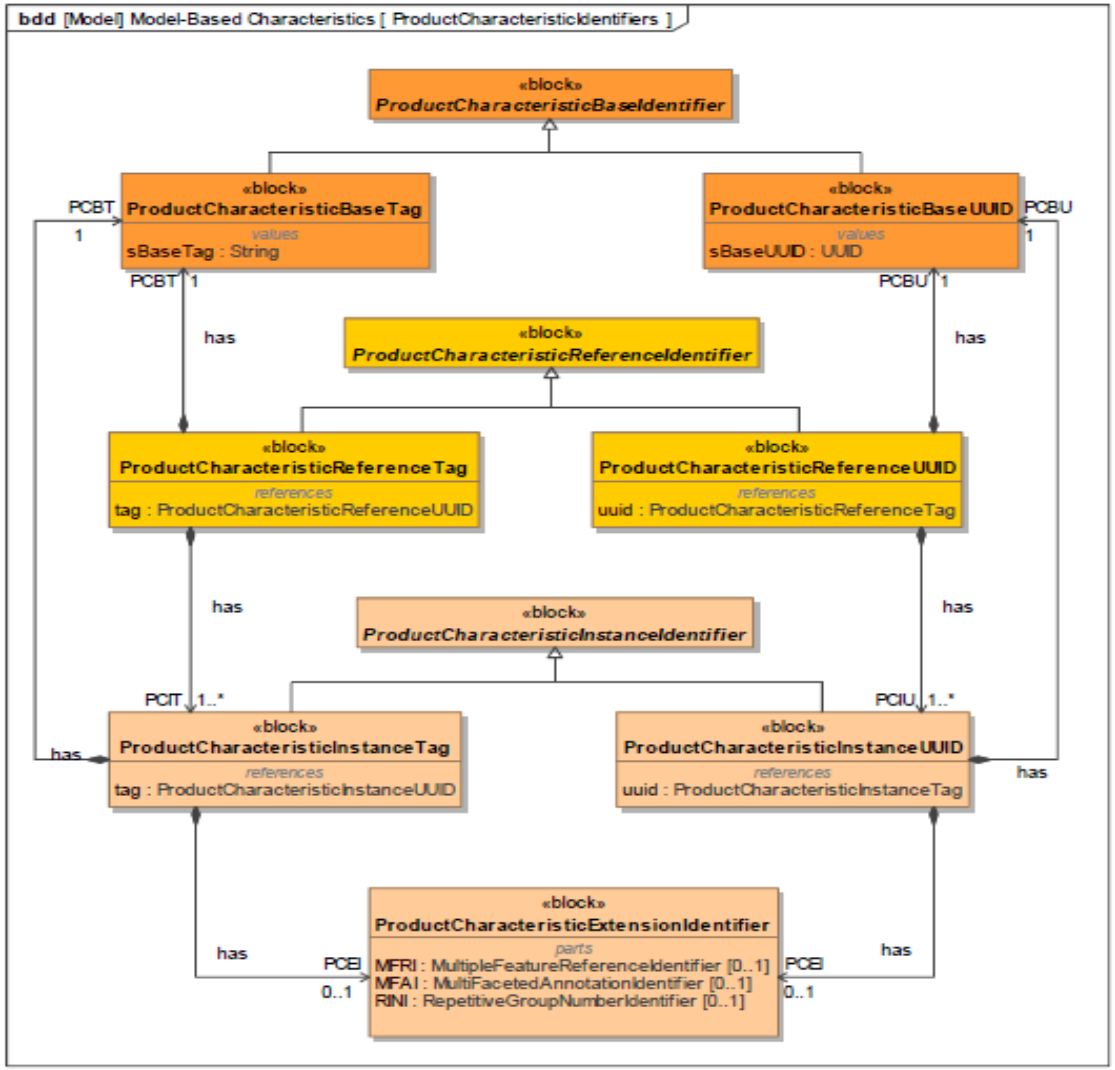
PC Reference Tag with All Augmentations

PC Identification Framework

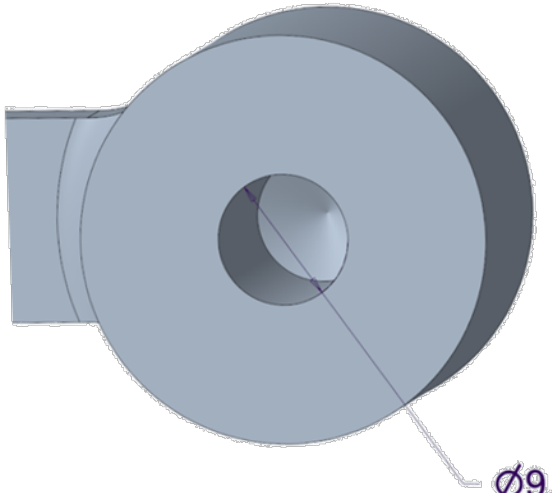
- Human & Computer **Identifiers**
  - **Tags**
  - **UUIDs**
- **Base** Identifier, basis for:
  - Reference Identifiers
  - Instance Identifiers
- **Reference** Identifiers
- **Instance** Identifiers
- **Extension** Identifiers
  - Uniquely extends Instance ID
  - Multi-Faceted Annotation
  - Multiple Feature Reference
  - Repetitive Group Number



PC Identification Framework – PC Reference ID

- PC **Reference** Identifier – Section [5]
  - Associated with Annotation [Verification Requirement] (e.g., Tolerance, Specification)
  - Has a human-readable **PC Reference Tag**
    - Shown with Annotation [Verification Requirement]
  - Should have a computer-readable **PC Reference UUID**
  - Has one or many **PC Instance** Identifiers
    - As Human-Readable PC Instance Tag
    - As Computer-Readable PC Instance UUID
- Non-PC **General** Tag (GT) – Section [5.19]
  - Shown with annotation [Non-Verification Requirement] (e.g., BASIC Dimension)

Product Characteristic for an Application
[5.6]



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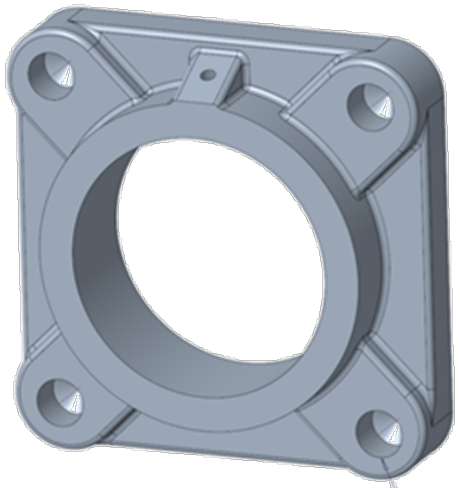

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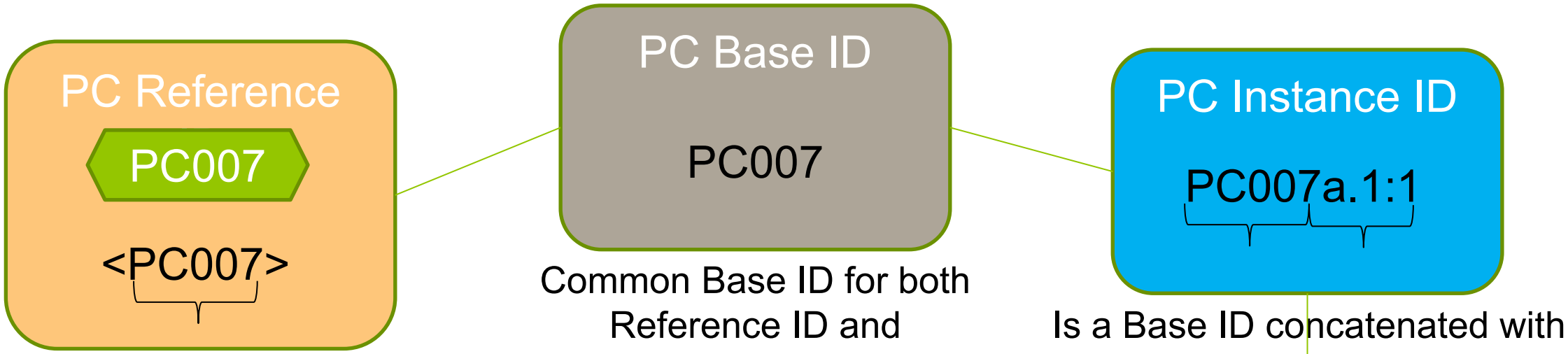
PC Identification Framework

- The PC **Reference** Identifier and PC **Instance** Identifier are both **built from** a common PC **Base** Identifier.
- PC ID can be a **human-readable Tag** or **computer-consumable UUID**



Is a Base ID housed within a Symbol or Bookend with “<“ and “>”; Used to designate a Product Characteristic

Common Base ID for both Reference ID and Instance ID

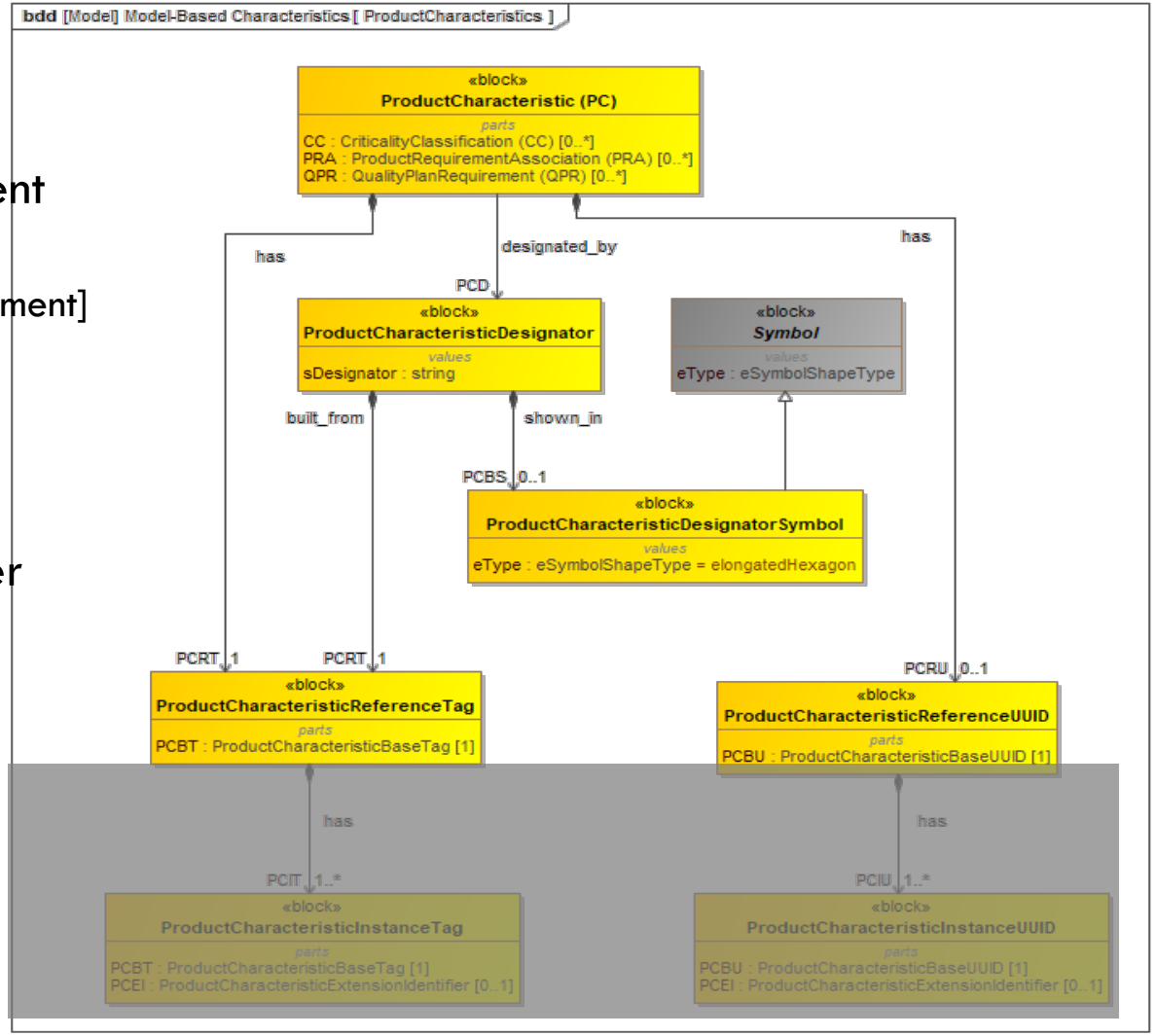
Is a Base ID concatenated with an Extension ID. Used to designate multi verification instance use-cases.

PC Extension ID

- Multi-Faceted Annotation
- Multiple Feature Reference
- Repetitive Group Number

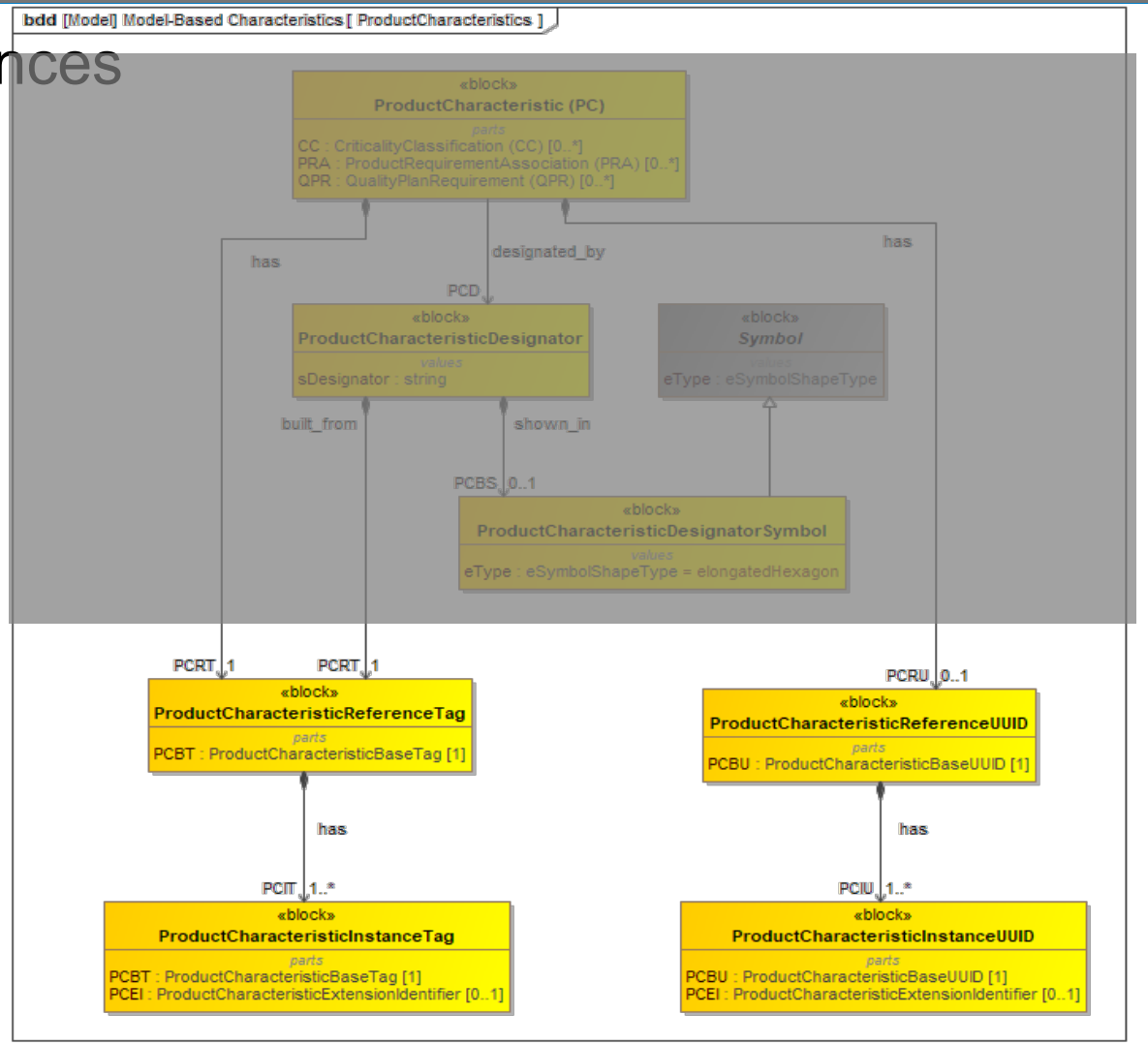
PC Identification Framework

- Has a PC **Reference** Tag
  - Is a human-readable PC **Reference** Identifier
  - Is shown/identified with a Verification Requirement
    - CAD Annotation [Verification Requirement]
    - Non-CAD Specification/Requirement [Verification Requirement]
  - Is associated with PC **Reference** UUID
  - Has one or many PC **Instance** Tags
- Has a PC **Reference** UUID
  - Is a computer-consumable PC **Reference** Identifier
  - Is associated with PC **Reference** Tag
  - Has one or many PC **Instance** UUIDs
- Designated by a PC Designator
  - Shown in a PC Designator Symbol
  - Built from the PC Reference Tag

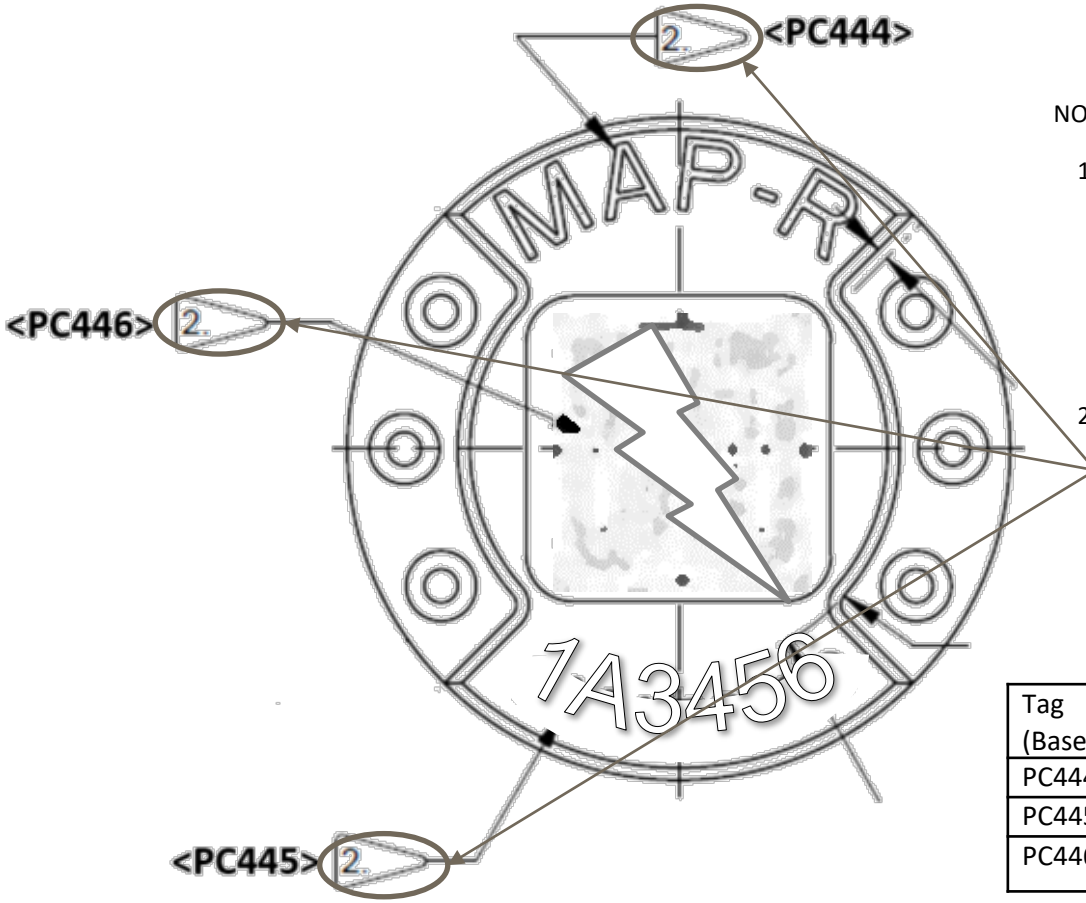


PC Identification Framework

- PC Reference has one or many PC Instances
- A PC **Instance** Tag
  - Is a human-readable PC **Instance** Identifier
  - Is associated with PC **Reference** Tag
  - Shares PC **Base** Tag with PC **Reference** Tag
  - Has a PC **Extension** Tag
- A PC **Instance** UUID
  - Is a computer-consumable PC **Instance** Identifier
  - Is associated with PC **Reference** UUID
  - Shares PC **Base** Tag with PC **Reference** Tag
  - Has a PC **Extension** Tag
- Designated by a PC Designator
  - Built from the PC **Reference** ID's Base ID
  - Built from the PC Reference Tag



Product Characteristics – Flagged Notes



NOTES:

1. PRODUCT CHARACTERISTICS ARE DENOTED BY <PC####>. GENERAL TAGS ARE DENOTED BY <GT####>. THESE SYMBOLS ARE USED TO REFER TO CORRESPONDING ANNOTATIONS.
   1A. THERE ARE 52 PRODUCT CHARACTERISTICS ON THIS DRAWING. THE NUMBERS RANGED FROM PC0001 TO PC0054. NUMBERS NOT USE ARE: PC0013.
   1B. THERE ARE 27 GENERAL TAGS ON THIS DRAWING. THE NUMBERS RANGED FROM GT5000 TO GT5026. NUMBERS NOT USED ARE: NONE.
2. PART MARKINGS:

2. MARK PART NAME, PART NUMBER, AND LOGOS AS SHOWN PER CLASS K-1-A, PER

Tag (Base)	UUID (Base)	Description
PC444	f0079160-e989-420a-b83a-19df30d57c7b	Marking of Part Name
PC445	7f92f319-3175-4214-8eb2-62f857f1c3b4	Marking of Part Number
PC446	5ce27d7f-e66d-404a-8327-d7c24229b20d	Marking of Logo

Product Characteristics - Supplemental Specification Document

SS1A345

Special Specifications for part 1A345:

1 – Special Workmanship

1.1 – Statement about …

1.2 – Statement about …

1.3 – Statement about …

<PC901> 1.4 – Verify that …

<PC902> 1.5 – Verify that …

1.6 – Statement about …

<PC903> 1.7 – Verify that …

<PC904> 1.8 – Verify that …

2 – Special Markings

2.1 – Statement about …

<PC905> 2.2 – Verify that …

2.3 – Statement about …

Tag (Base)	UUID (Base)	Description
PC901	48bf4540-63eb-4460-999d-bdaffad3f793	Doc. SS1A345, Sect. 1.4
PC902	af11745b-d897-491c-8887-05404c5941cc	Doc. SS1A345, Sect. 1.5
PC903	9e2f8155-113d-4f0d-8159-b766c836065d	Doc. SS1A345, Sect. 1.7
PC904	ecf53b0d-8891-4634-8cb9-0dd50ac25e53	Doc. SS1A345, Sect. 1.8
PC905	7bbfbae1-65d8-4970-9987-da22e84f5403	Doc. SS1A345, Sect. 2.2

Product Characteristics - General Notes

Only **notes** that have a **verify or shall statement** (e.g., verification requirement) should be **tagged** as a PC

5.6.5 Individual General Notes

NOTES:
1. First General Note
<PC825> 2. Second General Note with verify …
<PC826> 3. Third General Note with verify …
<PC827> 4. Deleted General Note with verify …
5. Fifth General Note

5.8.6 Group General Note:

<PC811> NOTES:
1. First General Note
2. Second General Note with verify …
3. Third General Note with verify …
4. Deleted General Note with verify …
5. Fifth General Note

Tag (Base)	UUID (Base)	Description
PC825	1af1745b-d897-491c-8887-05404c5941cc	Second General Note
PC826	29ef8155-113d-4f0d-8159-b766c836065d	Third General Note
PC827	cef53b0d-8891-4634-8cb9-0dd50ac25e53	Deleted General Note

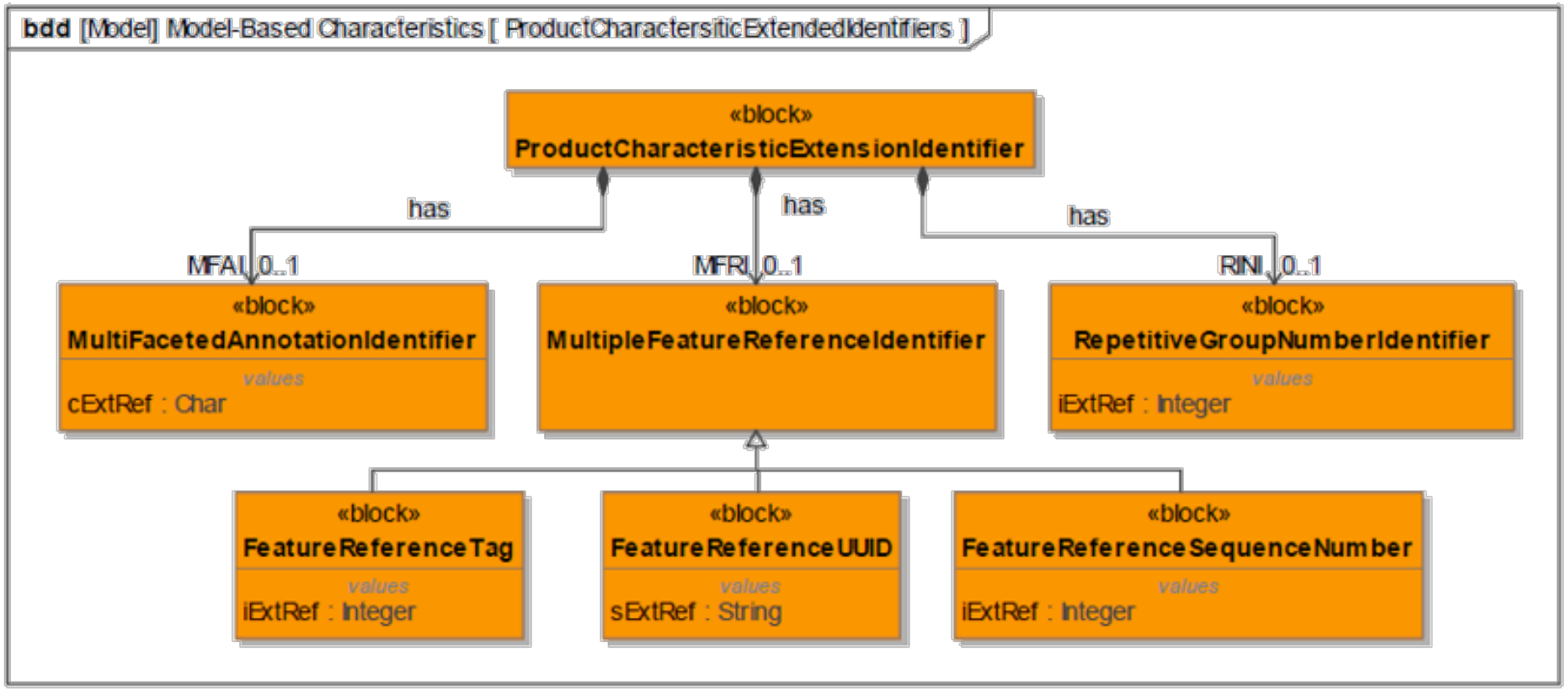
PC Base ID	PC Extension ID			PC Instance ID Example
	MFAI	MFRI	RGNI	
PC811	n	Y	n	PC811.2
PC811	n	Y	n	PC811.3
PC811	n	Y	n	PC811.4

PC Identification Framework

- PC **Instance** Identifier
  - Has a PC Reference Identifier
  - Can be a PC Instance Tag
  - Can be a PC Instance UUID
  - Built from a PC Base Identifier AND one or more PC Extension Identifiers
- PC **Base** Identifier
- PC **Extension** Identifier
  - Has zero or one Multi-Faceted Annotation Identifier (MFAI)
  - Has zero or one Multiple Feature Reference Identifier (MFRI)
    - Can be a Feature Reference Tag
    - Can be a Feature Reference UUID
    - Can be a Feature Reference Sequence Number
  - Has zero or one Repetitive Group Number Identifier (RGNI)

Product Characteristic Extension Identifiers

- The Instance Identifier is extended by the Extension Identifier for use-cases involving multi-faceted annotations, multiple feature references, and repetitive groups.

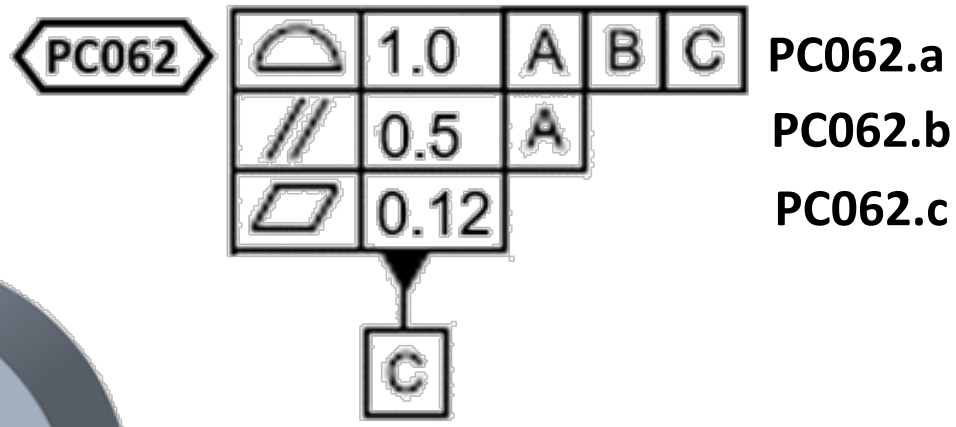


PC Extension Identifiers

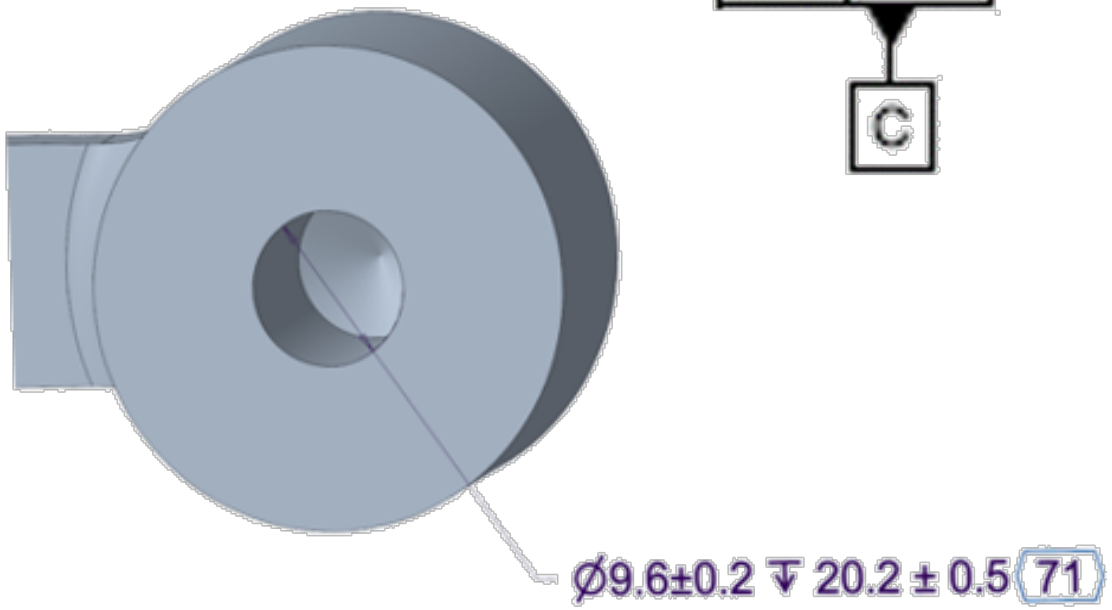
- **Multi-Faceted** Annotations Identifier (MFAI). See section 5.4.7.1 for more details.
  - PC007**a**
  - PC007**b**
  - PC007**c**
- **Multiple Feature** Reference Identifier (MFRI). See section 5.4.7.2 for more details.
  - Feature Reference Tag (FRT). See section 5.4.7.2.1 for more details.
    - PC007.**518**
    - PC007.**1961**
    - PC007.**1982**
  - Feature Reference UUID (FRU). See section 5.4.7.2.2 for more details.
    - PC007. **A64B5992-3A8B-456C-81E6-39020C268C13**
    - PC007. **C3F0BAB3-DA40-4C21-B04B-DC495336A4D0**
  - Feature Reference Sequence Number (FRSN). See section 5.4.7.2.3 for more details.
    - PC007.**1**
    - PC007.**2**
    - PC007.**3**
- **Repetitive Group** Number Identifier (RGNI). See section 5.4.7.3 for more details.
  - PC007.1:**1**
  - PC007.1:**2**
  - PC007.1:**3**

PC Instance w/derived Multi Faceted Annotation [5.8]

- PC007a
- PC007b
- PC007c



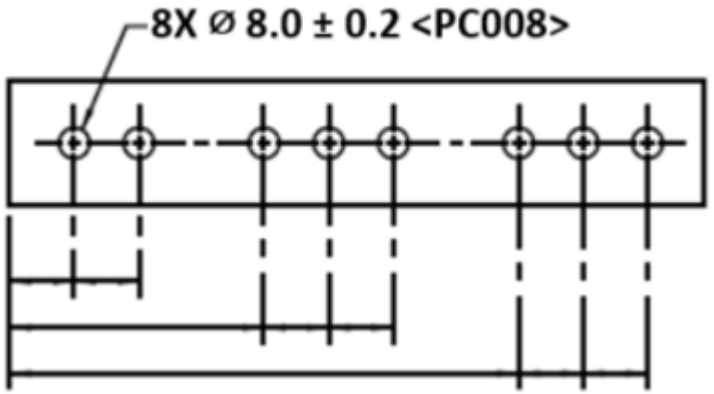
PC062.a
PC062.b
PC062.c



71.a 71.b

Digital Metrology Standards Consortium

PC Instances with Multiple Feature References



Repetitive Feature Tolerance with Reference Tag

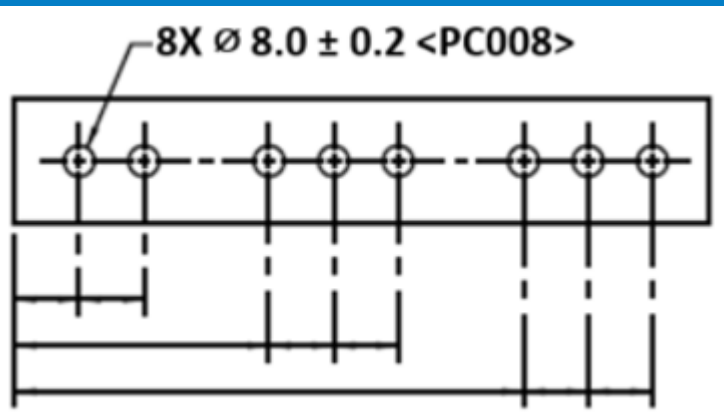
Example:

- **PC Reference Tag <PC008>** is **applied** to **eight different features**!
  - Thus <PC008> has eight verification occurrences.
- So, how do we specify each feature instance?
  - With a unique **PC Instance Tag** for each verification occurrence.
  - Which, **requires** a **unique Feature Reference Tag** for each multiple feature PC Instance Tag
- MBC specification allows for **three approaches** based upon the **maturity** and **capabilities** of the application system and/or organizational business practices.
  - By **FeatureReferenceTag** (e.g., 518, 1961, 1982)
  - By **FeatureReferenceUUID** (e.g., A64B5992-3A8B-456C-81E6-39020C268C13, C3F0BAB3-DA40-4C21-B04B-DC495336A4D0)
  - By **FeatureReferenceSequenceNumber** (e.g., 1, 2, 3, 4)

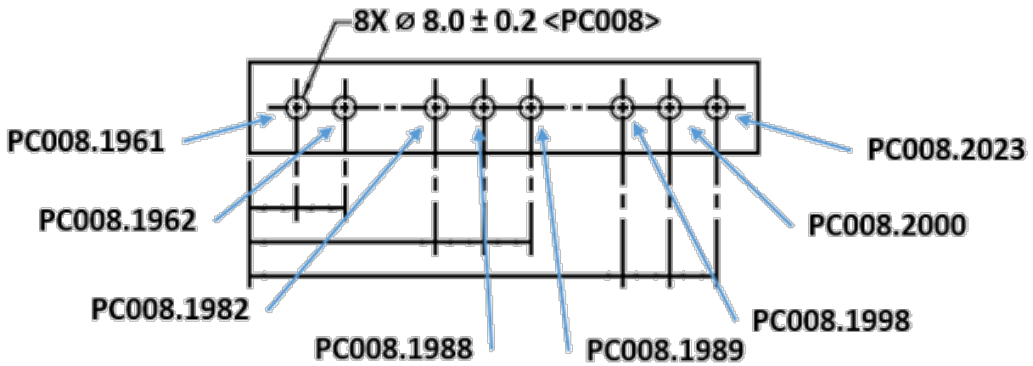
Dimensional Tolerance w/Multiple Feature Instances

- PC008.1961
- PC008.1962
- PC008.1982
- PC008.1988
- PC008.1989
- PC008.1998
- PC008.2000
- PC008.2023

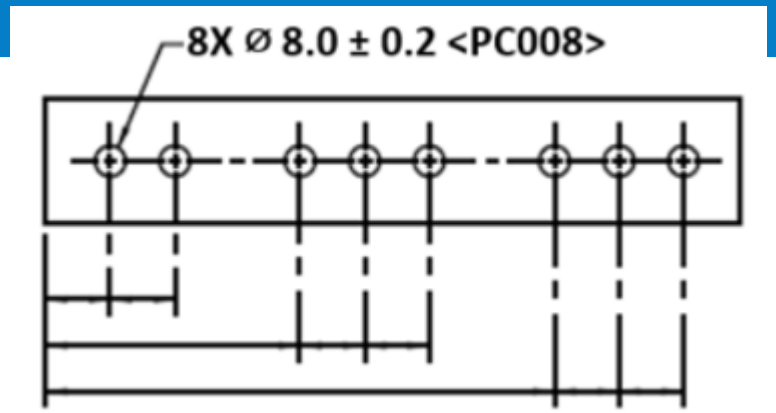
Repetitive Feature Size Tolerance with PC Instance Tags using the modeler's **Feature Reference Tag**

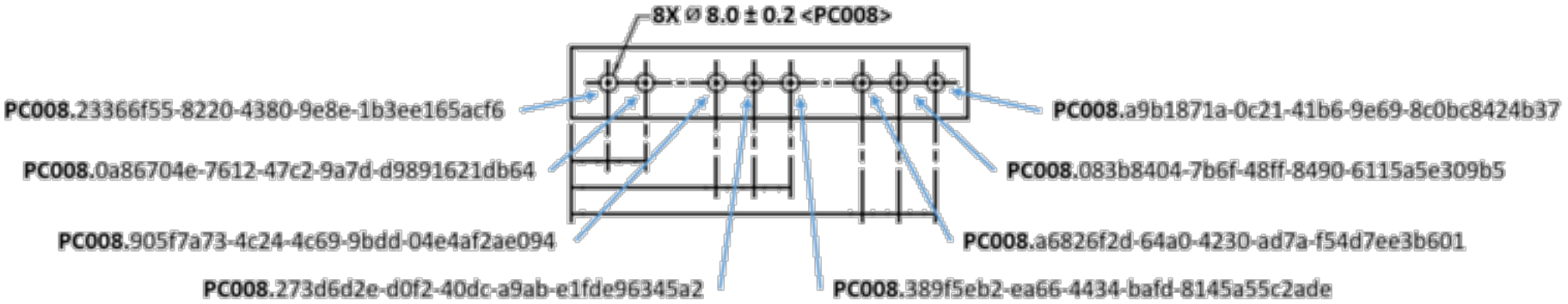


Repetitive Feature Size Tolerance with Reference Tag



Dimensional Tolerance w/Multiple Feature Instances

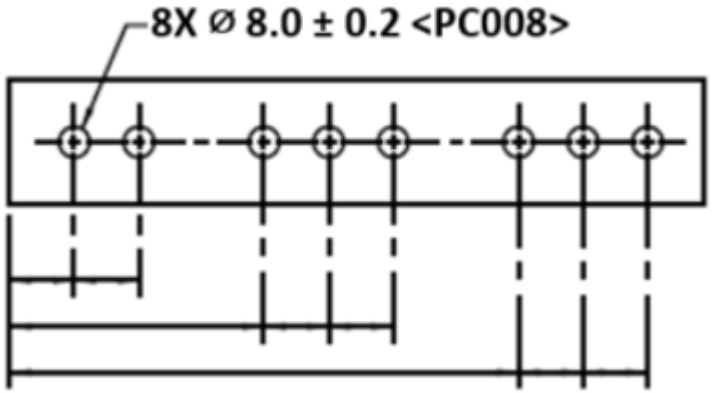




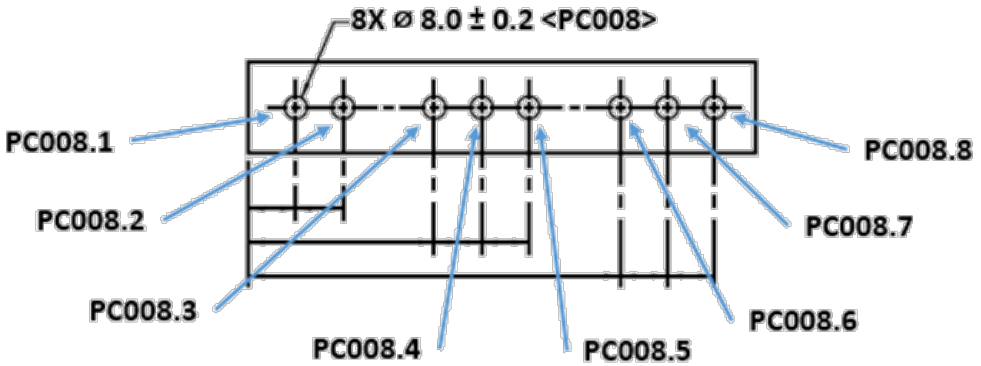
Repetitive Feature Size Tolerance with PC Instance Tags using **Feature Reference UUID**

Dimensional Tolerance w/Multiple Feature Instances

- PC008.1
- PC008.2
- PC008.3
- PC008.4
- PC008.5
- PC008.6
- PC008.7
- PC008.8

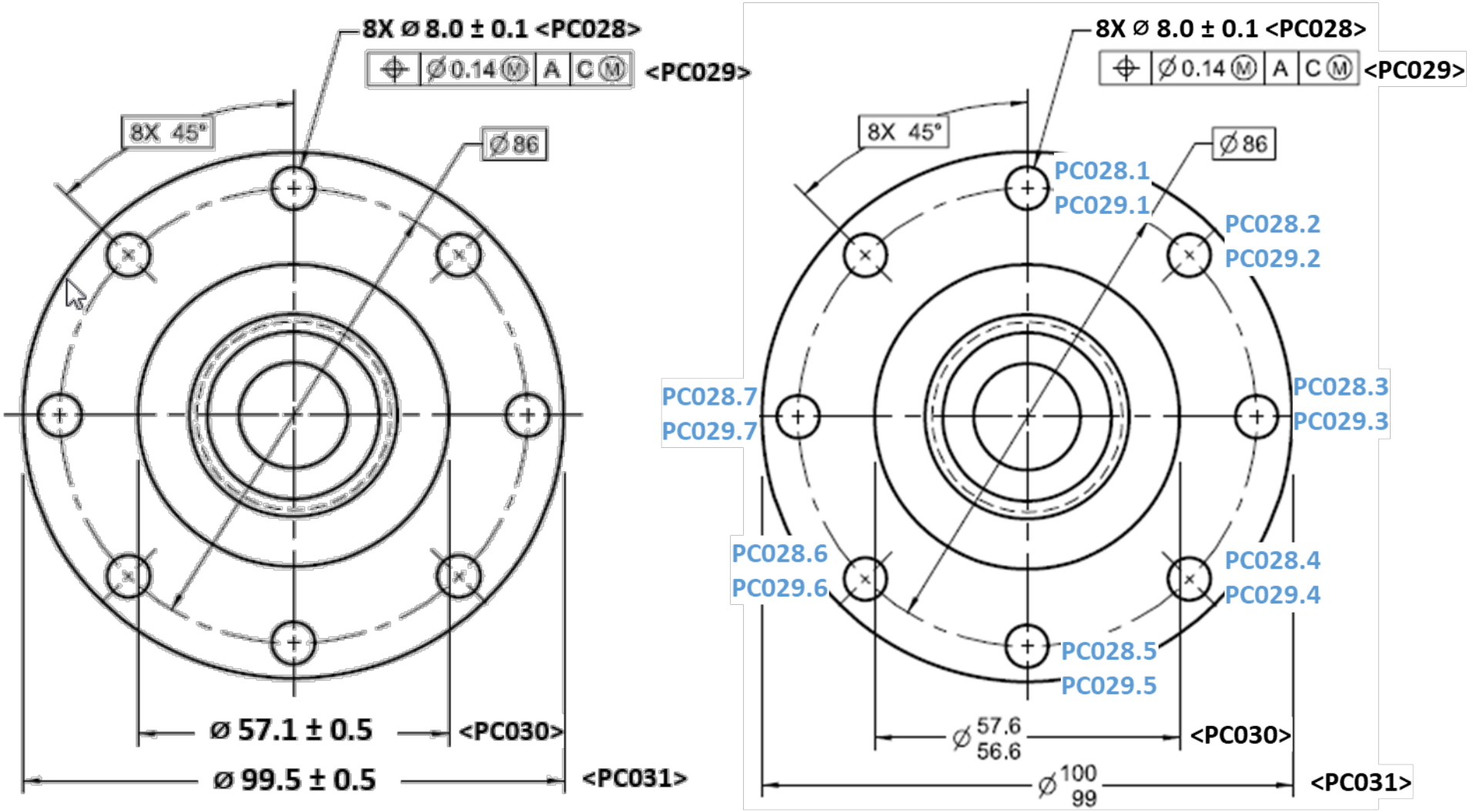


Repetitive Feature Size Tolerance with Reference Tag



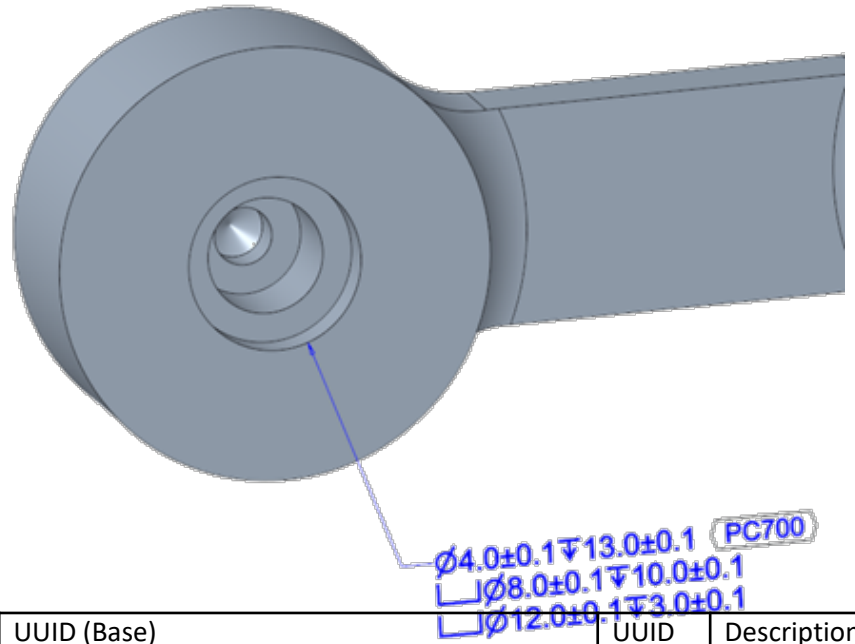
Repetitive Feature Size Tolerance with Instance Tags using a **Feature Sequencing** algorithm

Geometric Tolerance w/Multiple Feature Instances



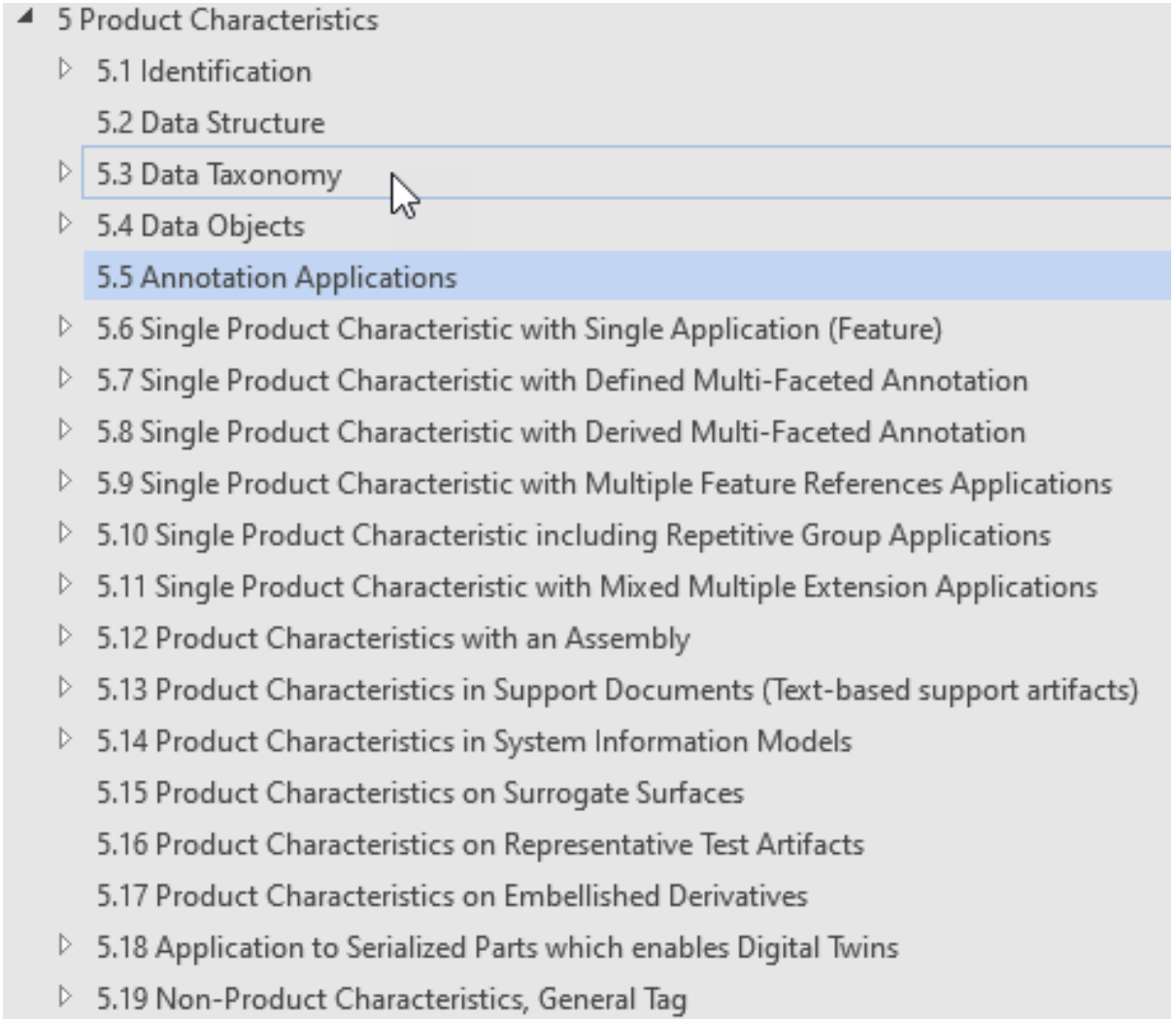
PC with Mixed Multiple Extensions

- PC700a.1
- PC700b.1
- PC700a.2
- PC700b.2
- PC700a.3
- PC700b.3



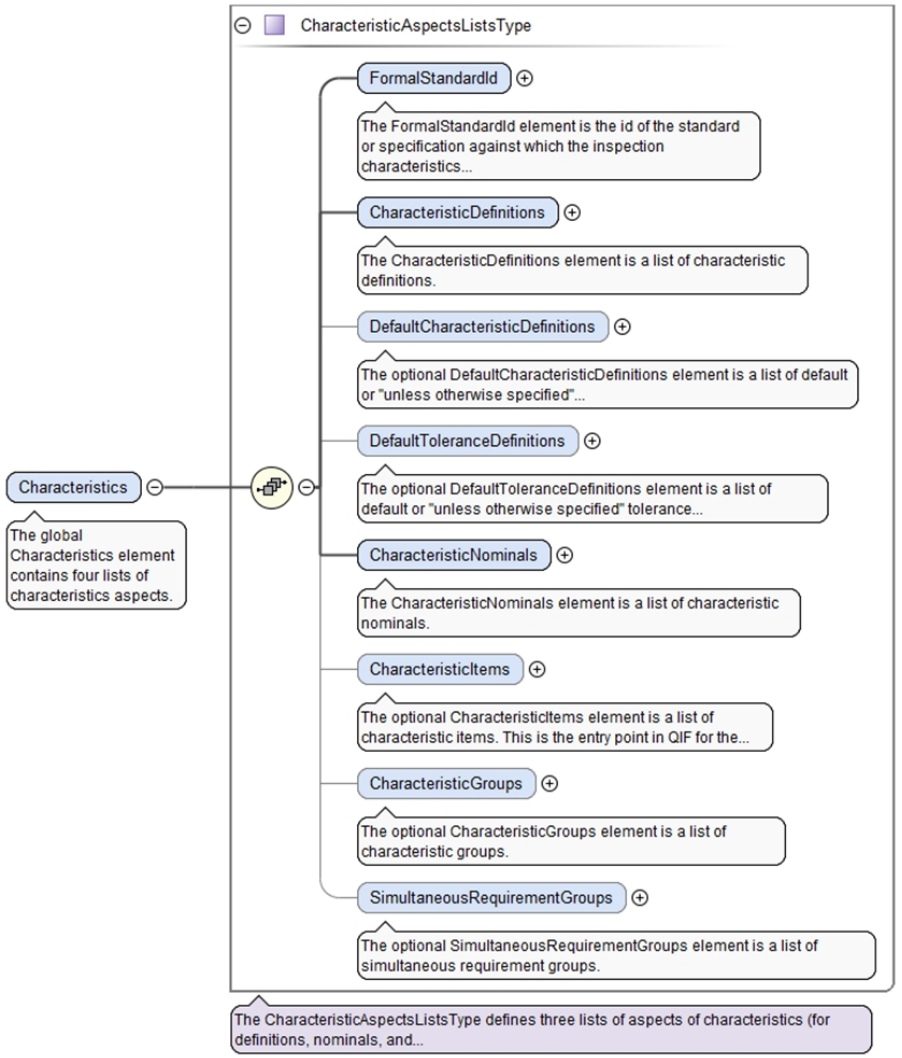
Tag (Base)	Tag (Ext)	UUID (Base)	UUID (Ext)	Description
PC700	a.1	3f2e8414-5074-48c9-976f-0b890cefcd00	a.1	± 0.1 for Ø 4.0 Diameter
PC700	b.1	3f2e8414-5074-48c9-976f-0b890cefcd00	b.1	± 0.1 for ↧ 13.0 Hole Depth
PC700	a.2	3f2e8414-5074-48c9-976f-0b890cefcd00	a.2	± 0.1 for Ø 8.0 Counterbore Diameter
PC700	b.2	3f2e8414-5074-48c9-976f-0b890cefcd00	b.2	± 0.1 for ↧ 10.0 Counterbore Depth
PC700	a.3	3f2e8414-5074-48c9-976f-0b890cefcd00	a.3	± 0.1 for Ø 12.0 Counterbore Diameter
PC700	b.3	3f2e8414-5074-48c9-976f-0b890cefcd00	b.3	± 0.1 for ↧ 3.0 Counterbore Depth

Other PC Use-Cases



QIF Characteristics

- Within QIF, the Characteristic object contains four types of characteristics aspects [QIF 5.9.3]
  - Definition
  - Nominal
  - Item
  - Measurement
- Characteristic Designation Includes optional:
  - Designation (Tag)
  - Criticality Level
  - UUID
- MPC includes a QIF Mapping/Comparison appendix [Annex J]
- The Next QIF (i.e., QIF 4.0) incorporates MPC characteristic capabilities.



Questions?