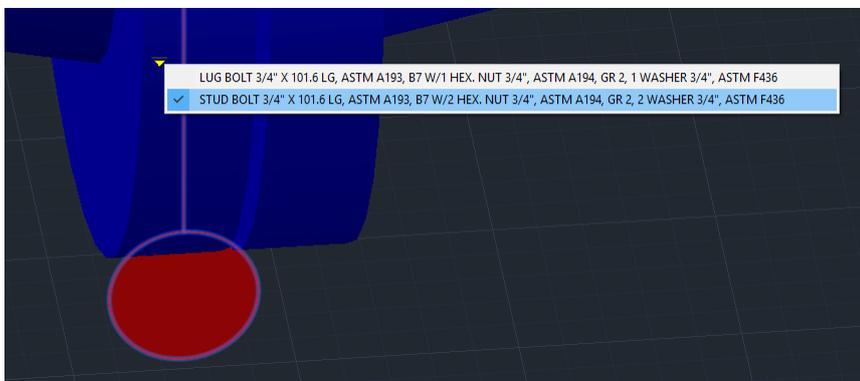


Metric Bolts in a Mixed-Metric Plant 3D Project

AutoCAD Plant 3D 2018

The standard bolt lengths used for ANSI fittings in AutoCAD Plant 3D are defined using an Imperial Bolt Mapping Standard. When using the default isometric styles in mixed-metric projects the bolt sizes and lengths contained within the ASME catalogues and specs produce a BOM showing imperial bolt diameters with metric lengths, often rounded to inappropriate values.



The default isometric styles always display bolt diameters in imperial units for mixed-metric projects and always display lengths in metric units. The values in the PipelinesSettings.xml file are not observed and bolt diameters are read from the Imperial value in the BoltSizeMappings.xml file.

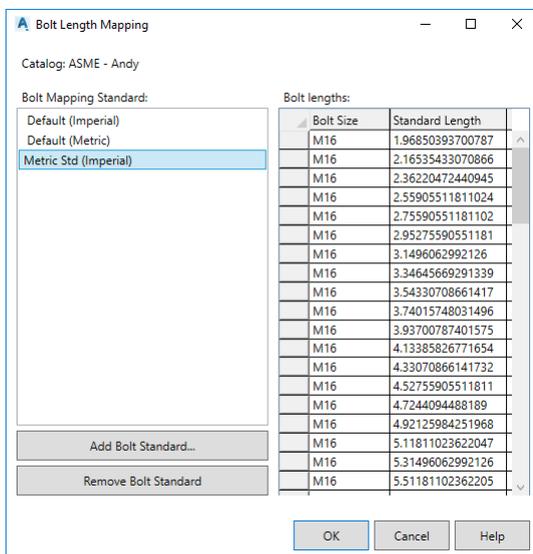
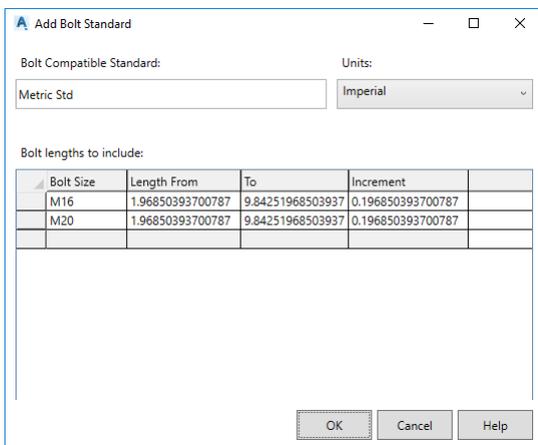
However, with a little non-standard setup and configuration, it is possible to implement fully metric bolt sizes in a mixed-metric project. In the following discussion we will explore how we might do this.

Bolt Set

The first thing we need to do is to create a metric bolt set that we can use in our mixed-metric project. This will be defined in the Catalog Editor with *Inch* nominal units, as we will be using this bolt set with ANSI fittings. However, we will specify metric bolt sizes and bolt lengths to comply with our standard bolt lengths.

Unfortunately, because we must specify Inch nominal units for our bolt set, we must use an *Imperial* bolt mapping standard to define our standard bolt lengths and this is the root of most bolt length issues in mixed-metric projects.

To define the bolt mapping standard we must convert our metric lengths to inches by dividing by 25.4.



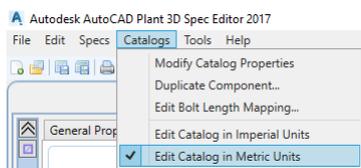
In the “**Metric Std**” bolt mapping standard shown above we have converted into inches bolt lengths from 50mm to 250mm at 5mm increments.

We will assign our “Metric Std” bolt mapping standard to our bolt set and then specify the default lengths for our bolts, not forgetting to enter the corresponding **Flange Thickness**.

| Piping Component Properties | |
|-----------------------------|-----------------|
| Long Description (Family): | Metric Bolt Set |
| Compatible Standard: | |
| Manufacturer: | |
| Material: | |
| Material Code: | |
| Short Description: | Metric Bolt Set |
| Design Std: | |
| Design Pressure Factor: | |
| Weight Unit: | |
| Pattern: | |
| Is Lug Set: | False |
| Stud Type Description: | Stud Bolt |
| Stud Description: | |
| Bolt Compatible Standard: | Metric Std |
| Iso Symbol Type: | BOLT |
| Iso Symbol SKEY: | |

*Note: we must set the **Is Lug Set** flag to **true** and then back to **false** when we create our bolt set, otherwise the value may be set to **NULL** when we add the bolt to a spec – this would cause the default **Flanged joint** connection setting to fail in Plant 3D resulting in Placeholder bolts being inserted.*

When we specify the bolt lengths we will use metric units to enter the values.



The lengths we enter will correspond to our standard bolt lengths for the given flange thickness, see the example below.

The screenshot shows the 'Component Editor' window with the following data:

| Connection Port Properties | |
|---|-------------|
| <input type="checkbox"/> All Ports have the same properties | |
| Current Port: | Port 1 (S1) |
| Nominal Diameter: | 150 |
| Matching Pipe OD: | 168.275 |
| Wall Thickness: | |
| Engagement Length: | |
| Flange Thickness: | 25.4 |

| Piping Component Properties | |
|-----------------------------|----------------------------|
| Long Description (Size): | Metric Bolts, M20 x @@@ Lg |
| Item Code: | |
| Weight: | |
| Length: | 100 |
| Bolt Size: | M20 |
| Number In Set: | 8 |

However, because we had to define our bolt mapping standard in inches we need to consider conversion errors that occur when Plant 3D calculates bolt lengths and converts between metric and imperial values. To compensate for this and ensure that the correct metric lengths are selected, we will review in inches the standard bolt lengths we just entered and truncate them to 3 decimal places.

| Piping Component Properties | |
|-----------------------------|----------------------------|
| Long Description (Size): | Metric Bolts, M16 x @@@ Lg |
| Item Code: | |
| Weight: | |
| Length: | 3.93700787401575 |
| Bolt Size: | M16 |
| Number In Set: | 8 |

| Piping Component Properties | |
|-----------------------------|----------------------------|
| Long Description (Size): | Metric Bolts, M20 x @@@ Lg |
| Item Code: | |
| Weight: | |
| Length: | 3.937 |
| Bolt Size: | M20 |
| Number In Set: | 8 |

Our example bolt set is now complete and ready for use.

Isometric Configuration

Bolt lengths will now be calculated and displayed correctly in our Plant 3D model. However, bolt sizes will be displayed in imperial sizes on the BOM on any isometric drawing that we create and bolt lengths, although metric, may show rounding errors.

To correct the bolt size display we cannot simply change the <UNITS_BOLTS_DIA> tag in the PipelinesSettings.xml file of our isometric style configuration, as this tag is ignored for mixed-metric projects. Instead we must look elsewhere.

When Plant 3D generates an isometric drawing, it uses the BoltSizeMappings.xml file to determine the values that should be used for bolt sizes. In a mixed-metric project, if the bolt size in the model is specified as a metric value, the value to be used on the isometric is read from the **imperial** field of the corresponding tag within the BoltSizeMappings.xml file. For example, M20 bolts are reported as 3/4 inch on the BOM, the corresponding tag in the file is:

```
<BoltSizeMapping Imperial="0.75" Metric="M20"/>
```

The style in which bolt sizes are presented on the isometric drawing is determined by the BoltDiameterStyle tag in the IsoConfig.xml file.

```

<Style Name="Imperial" UnitFormat="Architectural" Precision="Precision5" Prefix="" Suffix="" Scale="1" Decimal="." />
<Style Name="ImperialSize" UnitFormat="Fractional" Precision="Precision5" Prefix="" Suffix="&quot;" Scale="1" Decimal="." />
<Style Name="ImperialPipeLength" UnitFormat="Architectural" Precision="Precision5" Prefix="" Suffix="" Scale="1" Decimal="." />
<Style Name="ImperialPipeLengthAlt" UnitFormat="Architectural" Precision="Precision1" Prefix="" Suffix="" Scale="1" Decimal="." />
<Style Name="Metric" UnitFormat="Decimal" Precision="Precision1" Prefix="" Suffix="" Scale="1" Decimal="." />
<Style Name="MetricSize" UnitFormat="Decimal" Precision="Precision1" Prefix="" Suffix="" Scale="1" Decimal="." />
<Style Name="MetricPipeLength" UnitFormat="Decimal" Precision="Precision1" Prefix="" Suffix="mm" Scale="1" Decimal="." />
<Style Name="MetricPipeLengthAlt" UnitFormat="Decimal" Precision="Precision2" Prefix="" Suffix="M" Scale="0.001" Decimal="." />
<Style Name="RefDimExtLineImperial" UnitFormat="Architectural" Precision="Precision5" Prefix="" Suffix="" Scale="0.2" Decimal="." />
<Style Name="RefDimExtLineMetric" UnitFormat="Decimal" Precision="Precision1" Prefix="" Suffix="" Scale="10" Decimal="." />
</Styles>
<!-- The dimension style used for formatting dimension values. -->
<DimensionsStyle Imperial="AdskIsoImperial" Metric="AdskIsoMetric" Rounded="false" />
<!-- The dimension style used for formatting coordinate values -->
<!-- For example, elevation and end coordinates annotations. -->
<CoordinatesStyle Imperial="Imperial" Metric="Metric" Rounded="false" />
<!-- The dimension style used for formatting size values -->
<!-- For example, bore size, and nominal diameters. -->
<SizeStyle Imperial="ImperialSize" Metric="MetricSize" Rounded="false" />
<!-- The dimension style used for formatting pipe length measurements -->
<!-- For Example, 'Quantity' in the BOM, or 'Length' in the Cut Piece List. -->
<PipeLengthStyle Imperial="ImperialPipeLength" Metric="MetricPipeLength" Rounded="true" />
<!-- The alternate dimension style used for formatting pipe length measurements -->
<!-- Set UseAlternateUnitsStyle='true' in the <AggregatedList> section to enable -->
<!-- alternate pipe length units for a data list. -->
<PipeLengthAltStyle Imperial="ImperialPipeLengthAlt" Metric="MetricPipeLengthAlt" Rounded="true" />
<!-- The dimension style used for formatting bolt diameter measurements -->
<BoltDiameterStyle Imperial="ImperialSize" Metric="MetricSize" Rounded="false" />
<!-- The dimension style used for formatting bolt length measurements -->
<BoltLengthStyle Imperial="ImperialSize" Metric="MetricSize" Rounded="true" />
<!-- The imperial or metric units that are appended to size or bolt measurements -->
<!-- If it cannot be formatted with a dimension style. -->
<LinearUnits Imperial="&quot;" Metric="mm" Rounded="false" />
<!-- The imperial or metric units that are appended to weight measurements -->
<WeightUnits Imperial="lb" Metric="kg" Rounded="false" />
<!-- The dimension style used for formatting reference dimension extension line values. -->
<RefDimExtensionStyle Imperial="RefDimExtLineImperial" Metric="RefDimExtLineMetric" Rounded="false" />
    
```

IsoConfig.xml file

In the example above, we see the default Style tags for a mixed-metric project. Bolt diameters are displayed using the ImperialSize Imperial style. So, if we were to create a new style, we could convert the bolt sizes back to metric values again.

We will define the following style tag to convert our imperial bolts sizes back to metric values with an “M” prefix:

```
<Style Name="MetricBoltSize" UnitFormat="Decimal" Precision="Precision1" Prefix="M" Suffix="" Scale="25.4" Decimal="." />
```

and assign this to the Imperial field of the BoltDiameterStyle tag.

Unfortunately, simply converting the imperial bolt sizes to metric does not produce standard metric bolt sizes. However, we can fix this by modifying the imperial values in the BoltSizeMappings.xml file to be the exact metric bolt diameters divided by 25.4 as shown in the example below:

```

<?xml version="1.0" encoding="utf-8"?>
<Mappings xmlns:xsi="http://www.w3.org/2001/XMLSchema" >
  <BoltSizeMappings>
    <BoltSizeMapping Imperial="0.226" Metric="M6"/>
    <BoltSizeMapping Imperial="0.394" Metric="M10"/>
    <BoltSizeMapping Imperial="0.551" Metric="M14"/>
    <BoltSizeMapping Imperial="0.630" Metric="M16"/>
    <BoltSizeMapping Imperial="0.787" Metric="M20"/>
    <BoltSizeMapping Imperial="0.945" Metric="M24"/>
  
```

BoltSizeMappings.xml File

We have now configured the isometric to display metric bolt sizes. All that remains is to fix any rounding errors that may occur with the bolt lengths, and we can do this by simply setting the value of the Rounded field to “false” in the BoltLengthStyle tag in our IsoConfig.xml file.

The example below shows all of the changes we have made to our IsoConfig.xml file.

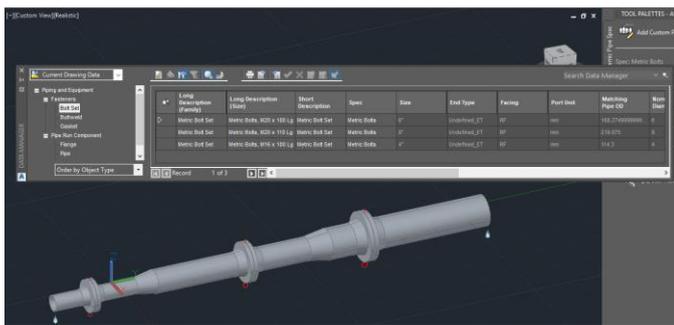


```

<Style Name="Imperial" UnitFormat="Architectural" Precision="Precision5" Prefix="" Suffix="" Scale="1" Decimal="." />
<Style Name="ImperialSize" UnitFormat="Fractional" Precision="Precision5" Prefix="" Suffix="&quot;" Scale="1" Decimal="." />
<Style Name="ImperialPipeLength" UnitFormat="Architectural" Precision="Precision5" Prefix="" Suffix="" Scale="1" Decimal="." />
<Style Name="ImperialPipeLengthAlt" UnitFormat="Architectural" Precision="Precision1" Prefix="" Suffix="" Scale="1" Decimal="." />
<Style Name="Metric" UnitFormat="Decimal" Precision="Precision1" Prefix="" Suffix="" Scale="1" Decimal="." />
<Style Name="MetricSize" UnitFormat="Decimal" Precision="Precision1" Prefix="" Suffix="" Scale="1" Decimal="." />
<Style Name="MetricBoltSize" UnitFormat="Decimal" Precision="Precision1" Prefix="M" Suffix="" Scale="25.4" Decimal="." />
<Style Name="MetricPipeLength" UnitFormat="Decimal" Precision="Precision1" Prefix="" Suffix="mm" Scale="1" Decimal="." />
<Style Name="MetricPipeLengthAlt" UnitFormat="Decimal" Precision="Precision2" Prefix="" Suffix="M" Scale="0.001" Decimal="." />
<Style Name="RefDimExtLineImperial" UnitFormat="Architectural" Precision="Precision5" Prefix="" Suffix="" Scale="0.2" Decimal="." />
<Style Name="RefDimExtLineMetric" UnitFormat="Decimal" Precision="Precision1" Prefix="" Suffix="" Scale="10" Decimal="." />
</Styles>
<!-- The dimension style used for formatting dimension values. -->
<DimensionsStyle Imperial="AdskIsoImperial" Metric="AdskIsoMetric" Rounded="false" />
<!-- The dimension style used for formatting coordinate values -->
<!-- For example, elevation and end coordinates annotations. -->
<CoordinatesStyle Imperial="Imperial" Metric="Metric" Rounded="false" />
<!-- The dimension style used for formatting size values -->
<!-- For example, bore size, and nominal diameters. -->
<SizeStyle Imperial="ImperialSize" Metric="MetricSize" Rounded="false" />
<!-- The dimension style used for formatting pipe length measurements -->
<!-- For Example, 'Quantity' in the BOM, or 'Length' in the Cut Piece List. -->
<PipeLengthStyle Imperial="ImperialPipeLength" Metric="MetricPipeLength" Rounded="true" />
<!-- The alternate dimension style used for formatting pipe length measurements -->
<!-- Set UseAlternateUnitsStyle='true' in the <AggregatedList> section to enable -->
<!-- alternate pipe length units for a data list. -->
<PipeLengthAltStyle Imperial="ImperialPipeLengthAlt" Metric="MetricPipeLengthAlt" Rounded="true" />
<!-- The dimension style used for formatting bolt diameter measurements -->
<BoltDiameterStyle Imperial="MetricBoltSize" Metric="MetricSize" Rounded="false" />
<!-- The dimension style used for formatting bolt length measurements -->
<BoltLengthStyle Imperial="ImperialSize" Metric="MetricSize" Rounded="false" />
    
```

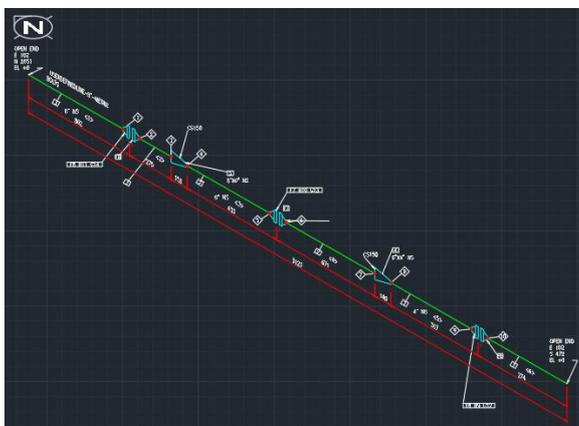
IsoConfig.xml File

The following simple example shows our metric bolt set in use in a mixed-metric project, three flange sets have been modelled as shown at different sizes.



Plant 3D Model

The isometric drawing and corresponding BOM produced are shown below.



Isometric drawing plus BOM

| FABRICATION ITEMS | | | | |
|-------------------|-----|---------|-----|---------------------------------------|
| ID | QTY | NO | SCH | DESCRIPTION |
| 1 | 1 | 4 | M20 | PERF. BEAMLESS, RC, AGMG B16.3 |
| 2 | 2 | 6 | RF | PERF. BEAMLESS, RC, AGMG B16.3 |
| 3 | 1 | 10 | RF | PERF. BEAMLESS, RC, AGMG B16.3 |
| 4 | 1 | 6 | RF | PERF. BEAMLESS, RC, AGMG B16.3 |
| 5 | 1 | 6 | RF | PERF. BEAMLESS, RC, AGMG B16.3 |
| 6 | 3 | 4 | 120 | FLANGE, MM, 120 LB, RF, AGMG B16.3 |
| 7 | 3 | 5 | 120 | FLANGE, MM, 120 LB, RF, AGMG B16.3 |
| 8 | 3 | 6 | 120 | FLANGE, MM, 120 LB, RF, AGMG B16.3 |
| ERECTOR ITEMS | | | | |
| ID | QTY | NO | SCH | DESCRIPTION |
| 9 | 8 | M16X100 | 120 | METRIC BOLT SET |
| 10 | 8 | M20X110 | 120 | METRIC BOLT SET |
| 11 | 8 | M20X110 | 120 | METRIC BOLT SET |
| 12 | 1 | 6 | 120 | FLANGE, 2MPC, 120 LB, JHK, RF, 120 LB |
| 13 | 1 | 6 | 120 | FLANGE, 2MPC, 120 LB, JHK, RF, 120 LB |
| 14 | 1 | 6 | 120 | FLANGE, 2MPC, 120 LB, JHK, RF, 120 LB |