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Connecting Piping Design in AutoCAD Plant 3D to Piping Fabrication Through Spoolgen

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Learning Objectives

- Tune AutoCAD Plant 3D isometric generation to create “clean” PCF’s
- Create error-free PCF’s
- Avoid Spool and Isogen pitfalls
- Follow a step-by-step process for customizing AutoCAD Plant 3D isometric creation to interface correctly to Spoolgen

Description

Many piping fabricators now receive pipe geometry information in digital format, preferably in Isogen PCF format. AutoCAD Plant 3D software creates PCF files that piping fabricators can use. But, if rules are not followed correctly, the interface between AutoCAD Plant 3D and SmartPlant® Spoolgen® will not work properly. This is not a problem fundamental to AutoCAD Plant 3D software; it’s a problem with how AutoCAD Plant 3D may have been customized. This class will focus on what you need to know to enable AutoCAD Plant 3D to interface to the Spoolgen software that is commonly used by piping fabricators. We will communicate the experience gained by working with the Hexagon Isogen®/Spoolgen Team through practical examples of what to do and what not to do while customizing AutoCAD Plant 3D Isometrics. This class will teach attendees how to manage the piping specs and catalogs to ensure compatibility with Spoolgen through the correct mapping of Skeys and End Types, as well as avoiding various “gotchas” that can cause Isogen and Spoolgen to fail.

Speaker(s)

Ian Matthew is using his experience in Plant Design Software to guide clients how to get the best out of AutoCAD Plant 3D. He offers training, customization guidance, project workflow guidance and works closely with his clients to get the best out of their users.

Ian specializes in supporting Autodesk’s AutoCAD Plant 3D software and has worked with a number of clients in the following areas:

- Basic and Advanced Product Training
- Project customization training
- Hands-on piping specs and catalogs customization
- Plant 3D technical support

Ian has over 35 years experience working in the field of Computer-Aided Design of process plant. Prior to forming Ian Matthew Consulting, Ian was employed by Autodesk in a Technical

Marketing and Sales Enablement management position primarily supporting AutoCAD Plant 3D, Process Plant Design and the Oil & Gas and Utilities industries.

Ian holds B.Sc.Tech in Chemical Engineering and Fuel Technology and M.Sc.Tech in Chemical Engineering and Fuel Technology degrees from Sheffield University, England.

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Introduction

Today, piping fabricators want to receive piping isometrics in digital form usually as PCF's (a file format which defines in text format the configuration of the piping spool). The PCF format is a 'de-facto' standard however, not all PCF's are equal and the information held in the PCF will be dependent on the plant design system being used to create the PCF.

Most Piping Fabricators that can receive piping information in the form of PCF's will probably have the Spoolgen software from Hexagon (previously Intergraph). This software is derived from the Isogen piping isometric software that used to be the de-facto piping isometric software. Spoolgen's interpretation of the PCF's is very rigid and therefore care has to be taken that the PCF complies with Spoolgen's requirements. Fortunately, Spoolgen has a pre-processor associated with it that can modify, to some extent, the incoming PCF to meet Spoolgen's requirements.

In this class we will describe the best practices that should be adopted in order to have a clean interface between PCF's generated by AutoCAD Plant 3D and Hexagon Spoolgen / Isogen.

Spoolgen Requirements

Spoolgen understands the piping configuration by reading the PCF and using the component 'END-POINT' coordinated to make 'connections'. It understands the piping components by reading the 'TYPE' and the 'SKEY' and it understands the connection type by reading the end type. TYPEs, SKEYs and end types are pre-defined and must have values that are recognized by Spoolgen. If any values are not recognized, Spoolgen will fail to create the isometric.

In Plant 3D, the TYPE, SKEY and end type are defined for each component in the piping catalogs. All components generated by Spoolgen are defined by a unique code called a symbol key (SKEY). SKEYs contain 2-4 characters; the first two characters define the type of component, and the last two characters define the end type, such as flanged, butt welded, or screwed.

End Types

The End Types recognized by Spoolgen are strictly defined and only those end types that Spoolgen recognizes can be used. **You cannot create your own end types.** Thus when customizing Plant 3D and adding new catalog components, if you define a new end type to be used in the Plant 3D model (and you are free to do this in Plant 3D) you must ensure the End Type part of the Skey uses only those that Spoolgen recognizes. We will discuss this further later in this document.

SKEYS

The Spoolgen Symbol Graphics are called SKEYs and define the component representation and the connectivity. SKEYs contain 2-4 characters; the first two characters define the type of component, and the last two characters define the end type, such as flanged, butt welded, or screwed.

Hexagon have issued a document "Isogen Symbol Key (SKEY) Definitions, Reference Guide" that define all the SKEYS currently supported by Isogen/Spoolgen. Below is an example taken from the document:

Hygienic Fittings

Description	SKEY	Shape	Plotted Isometric Shape	User-Definable	Flow Arrow / Flow Dependency	PCF Identification	IDF Record
Male part connector (Butt weld)	MPBW			Yes	No / No	CONNECTOR	111
Male part connector (Expanded)	MPEX			Yes	No / No	CONNECTOR	111
Clamp liner (Butt weld)	LCBW			Yes	No / No	CONNECTOR	111
Clamp liner (Expanded)	LCPEX			Yes	No / No	CONNECTOR	111

You cannot define your own symbols for Spoolgen, they must come from the document.

Plant 3D Isometric Generation

Plant 3D creates isometrics in a 2-stage process. The first is to create a pcf file and the second interprets the data in the pcf draws the isometric. Since the pcf file has become the “de-facto” standard for isometric, Plant 3D has attempted to be fully compatible. However, Plant 3D does allow more flexibility than Spoolgen/Isogen:

1. End types can be entirely user-defined. (The end types that are defined in the ‘out-of-the-box’ Plant 3D are in fact compatible with Spoolgen)
2. SKEYs can be entirely user-defined. The SKEY is used to define the AutoCAD blocks that are to represent the component in the piping isometric. Again, the ‘out-of-the-box’ SKEYs delivered with Plant 3D are compatible with Spoolgen.

The mapping of entypes and SKEYs to blocks are handled in the file ***IsoKeyAcadBlockMap.xml*** in the project sub-folder *Isometric*. Below is an example extracted from a typical project.

Note that the ‘??’ is used as a wildcard for endtype definitions allowing a multiple SKEYs to use the same AutoCAD block.

```
<?xml version="1.0"?>
<IsoKeyMap xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xsd="http://www.w3.org/2001/XMLSchema" Version="1" Name="Default">
  <!-- Begin: Fittings -->
  <KeyMap SKEY="EL??" AcadBlock="Elbow"/>
  <KeyMap SKEY="EB??" AcadBlock="Elbow"/>
  <KeyMap SKEY="ER??" AcadBlock="ElbowReducing"/>
  <KeyMap SKEY="PB??" AcadBlock="Bend"/>
  <KeyMap SKEY="BE??" AcadBlock="Bend"/>
  <KeyMap SKEY="PB" AcadBlock="Bend"/>
  <KeyMap SKEY="BE" AcadBlock="Bend"/>
  <KeyMap SKEY="MI??" AcadBlock="BendMitre"/>
```

```

<SkeyMap SKEY="EU??" AcadBlock="Elbow-180return"/>
<SkeyMap SKEY="BU??" AcadBlock="Bend-180return"/>
<SkeyMap SKEY="BU" AcadBlock="Bend-180return"/>
<SkeyMap SKEY="TE??" AcadBlock="Tee"/>
<SkeyMap SKEY="TY??" AcadBlock="Tee"/>
<SkeyMap SKEY="BT??" AcadBlock="TeedBend"/>
<SkeyMap SKEY="RC??" AcadBlock="ReducerConc"/>
<SkeyMap SKEY="CPBW" AcadBlock="ReducerConc"/>
<SkeyMap SKEY="CSBW" AcadBlock="ReducerConc"/>
<SkeyMap SKEY="ESBW" AcadBlock="ReducerEcc"/>

```

Customizing Plant 3D Projects

Although Plant 3D comes with a number of piping component catalogs and various instrumentation, piping support and specialty item catalogs, some projects will require additional components and some industry-specific connection will need to be handled using end types that may not be already defined in Plant 3D.

Planning Plant 3D customization with Spoolgen in mind

If you know that you will want to exchange piping spool configurations digitally, using the pcf file, and the fabricator is most likely already using Spoolgen, then you should follow these rules:

1. **Stick to end types that are supported by Spoolgen.** This is a rigid list and the end types supported by Spoolgen are defined in the SKEY definitions document. You can call the end types anything you want but select the 2-letter end type code from the list in the document.

Spoolgen End Type	End Prep	Plant 3D Default End Type
BW	Butt Weld	BW
CP	Compression	
SW	Socket Weld	SW
FL	Flanged	FL
SC	Screwed / Threaded	THDM
PL	Plain End	PL
LN	Liner Nut	
LC	Liner / Clamp	
LR	Reducing Liner / Nut	
MP	Male Part	MJM, THDM
PF	Push Fit	PFS
GL	Glued	PPL, PSW
CL	Clamped	TC, GRV
FA	Flared	FA
BS / SB	Ball and Socket (used on fixed length type pipe work)	
GF	Gland (used on fixed length type pipe work)	MJM, MJF, MJP

2. **Use SKEYs defined in the SKEY Definition Document.** Do not use ?? (or **) in the SKEY definition in the catalog. Since you know the end type of the component in the catalog, use the end type code as used in the component. If the component has two different end types (e.g. weld x threaded) select one of them for the SKEY code. (Spoolgen will recognize the other end type and will place the correct graphics) Here are some examples of SKEYS for Valves:

Valves							
Valves							
Description	SKEY	Shape	Plotted Isometric Shape	User-Definable	Flow Arrow / Flow Dependency	PCF Identification	IDF Record
Angle valve	AV**			Yes	Yes / No	VALVE-ANGLE	75/76
Relief/Vent angle valve	AR**			Yes	Yes / No	VALVE-ANGLE	75/76
Pressure reducing angle valve	AX**			Yes	Yes / No	VALVE-ANGLE	75/76
Basic valve	VV**			Yes	Yes / No	VALVE	130/0
Check valve	VC**			Yes	Yes / No	VALVE	130/0
Check valve (alternative)	CK**			Yes	No / Yes	VALVE	130/0
Ball valve	VB**			Yes	Yes / No	VALVE	130/0
Butterfly valve	VY**			Yes	Yes / No	VALVE	130/0

NOTE: The Symbol Keys can be found on various web sites, simply search for "Isogen Symbol Keys"

3. **Make sure your SKEY definition is valid when Customizing in Plant 3D Spec Editor.** The Iso Symbol Type should be "PCF Identifier" in the Symbol Keys document and the Iso Symbol SKEY should be taken from the SKEY column. Examine this example for a check valve:

Valves

Valves

Description	SKEY	Shape	Plotted Isometric Shape	User-Definable	Flow Arrow / Flow Dependency	PCF Identification	IDF Record
Angle valve	AV**			Yes	Yes / No	VALVE-ANGLE	75/76
Relief/Vent angle valve	AR**			Yes	Yes / No	VALVE-ANGLE	75/76
Pressure reducing angle valve	AX**			Yes	Yes / No	VALVE-ANGLE	75/76
Basic valve	VV**			Yes	Yes / No	VALVE	130/0
Check valve	VC**			Yes	Yes / No	VALVE	130/0
Check valve (alternative)	CK**			Yes	No / Yes	VALVE	130/0
Ball valve	VB**			Yes	Yes / No	VALVE	130/0
Butterfly valve	VY**			Yes	Yes / No	VALVE	130/0

Piping Component Properties

Material Code:

Short Description:

Design Std:

Design Pressure Factor:

Weight Unit:

Connection Port Count:

Valve Alignment:

Valve Detail:

Valve Body Type:

Flow Dependent:

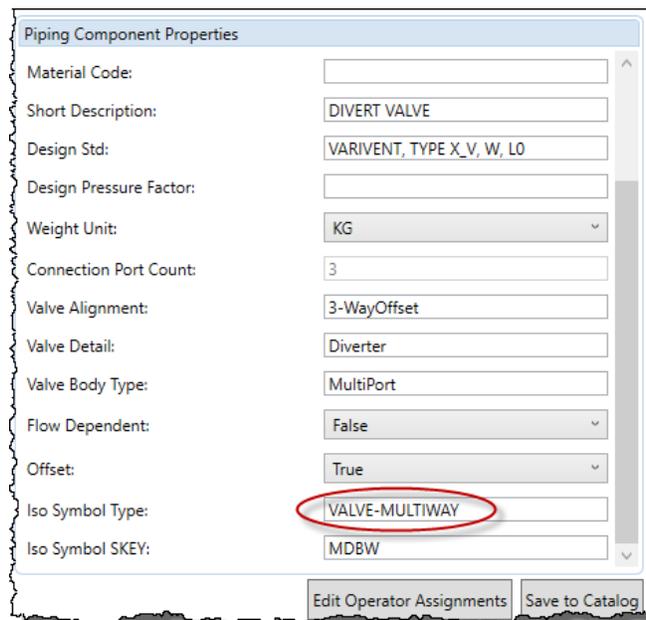
Offset:

Iso Symbol Type:

Iso Symbol SKEY:

NOTE: CK** was replaced with CKFL as CK** or CK?? Is an invalid Skey.

4. **Beware of the following Gotcha's!** Spoolgen has some rules that you need to adhere to:
- a. **INSTRUMENT GAUGE / DIAL** - These have only one connection and therefore the SKEY must be ID** (where ** equals the end type, e.g. Flanged – SKEY=IDFL)
 - b. **Inline Instrument**. The SKEY must be IN** for a standard inline instrument or select from the SKEY document for instrument valves, etc.
 - c. **MULTI-PORT Valves**. A multi-port valve is a valve that does not have a common centerpoint. One or more of the ports is in a different plane. For multi-port valves use SKEY = MD** or SKEY = MZ**. In both cases the symbol type **must** be “VALVE-MULTIWAY” Example:
 - d. **3-way / 4-way valves with common centerpoint**. If the valve has all three (or all four) ports on the same plane then select the appropriate SKEY from the SKEY definition document but the valve **must** have the Symbol Type set to “VALVE-3WAY” or “VALVE-4WAY” (Or for instruments, INSTRUMENT-3WAY or INSTRUMENT-4WAY)



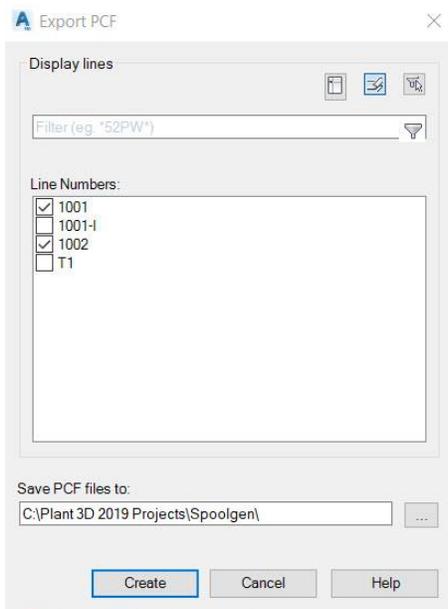
This example comes from the Tuchenhagen valves catalog.

Sending a PCF to Spoolgen

Once you have your isometrics ready to send to Spoolgen you use the command “PCF Export” in the “Isos” ribbon:



Which will pull up the following menu:



Select the lines to be created and then click “Create”
The pcf’s will be named *line number.pcf*

PCF Correction to be made

PCF’s created by Plant 3D all start as follows:

```
ISOGEN-FILES ISOCONFIG.FLS
UNITS-BORE INCH
UNITS-CO-ORDS INCH
UNITS-WEIGHT LBS
UNITS-BOLT-DIA INCH
UNITS-BOLT-LENGTH INCH
PIPELINE-REFERENCE 1001
DATE-DMY 10/29/18
ATTRIBUTE1 .....
```

Unfortunately, Spoolgen requires the first line to read:

ISOGEN-FILES ISOGEN.FLS

So the first line of every PCF will need to be edited for this change.

Handling pcf transfers where the above rules were not followed

So you customized Plant 3D before you knew all the gotcha's and you are ready to send pcf's and you have some SKEYs that are not in the SKEY document and you defined an end type that is not in the document, and you can't go back to make the changes to follow the rules – what then? Are you screwed? No, not quite – Spoolgen has a pre-processor that can fix some of the problems. You just need to know what they are.

The Spoolgen preprocessor accepts a text file (**.PPC) to define corrects to be made. All users of Spoolgen have access to the pre-processor and the commands are all documented. The following is an extract from the pre-processor manual:

SECTION 4

PCF Commands

The commands described in this section are used in the .ppc file to define the pre-processing of piping data in a PCF. You can use these commands to add attributes, and change, edit, or delete records so that the piping data file is imported successfully.

You can qualify most PCF commands with a **WHERE** statement followed by an expression. If the **WHERE** statement evaluates as **TRUE**, Isogen runs the command. You may include any of the following macros in the **WHERE** statement

- \$P.attribute\$
- \$C.attribute\$
- \$C.PCFTYPE\$
- \$C.Size1\$
- \$C.Size2\$
- \$C.Size3\$

where **attribute** is the name of the PCF attribute, **P** is the pipeline, **C** is the current component, and **PCFTYPE** is the current component type, such as flange, valve, or weld. **Size1**, **Size2**, and **Size3** represent the first, second, and third bores of the component.

Command Examples	Action on PCF
PCF ADD-UCI WHERE '\$PCFTYPE\$' = 'WELD'	Adds a unique component identifier.
PCF CHANGE-PROPERTY SKEY FLSW FLXX COMPONENT FLANGE WHERE '\$C.Size1\$ = 0.75'	Changes the property.
PCF DELETE-COMPONENT WELD WHERE '\$C.COMPONENT-IDENTIFIER\$ = 77'	Deletes the specified weld.

NOTES

- Enclose the 'expression' within single quotes ('). Strings in the expression must be delimited with double quotes (").
- The expression can also include VBScript-supported functions, such as `Left()` or `Instr()`.

And one example of a pre-processor command could be to correct and end type in the model “SO” for a ‘socket weld’ to change to “WW” for Spoolgen. The command would be:

```
PCF CHANGE-PROPERTY SKEY SO WW
```

Unfortunately not all errors can be corrected in the pre-processor!

Conclusions

A step-by-step process for customizing AutoCAD Plant 3D isometric creation to interface correctly to Spoolgen

Interfacing directly from Plant 3D to Spoolgen can be done. The following rules should be followed:

1. **Stick to end types that are supported by Spoolgen.** This is a rigid list and the end types supported by Spoolgen are defined in the SKEY definitions document.
2. **Use SKEYs defined in the SKEY Definition Document.**
3. **Beware of the following Gotcha’s!** Spoolgen has some rules that you need to adhere to:
 - a. **INSTRUMENT GAUGE / DIAL** - These have only one connection and therefore the SKEY must be ID** (where ** equals the end type, e.g. Flanged – SKEY=IDFL)
 - b. **Inline Instrument.** The SKEY must be IN** for a standard inline instrument or select from the SKEY document for instrument valves, etc.
 - c. **MULTI-PORT Valves.** A multi-port valve is a valve that does not have a common centerpoint. One or more of the ports is in a different plane. For multi-port valves use SKEY = MD** or SKEY = MZ**. In both cases the symbol type **must** be “VALVE-MULTIWAY
 - d. **3-Way / 4-way valves with common centerpoint.** If the valve has all three (or all four) ports on the same plane then select the appropriate SKEY from the SKEY definition document but the valve **must** have the Symbol Type set to “VALVE-3WAY” or “VALVE-4WAY” (Or for instruments, INSTRUMENT-3WAY or INSTRUMENT-4WAY)