Driving Tube and Pipe with the Master Sketch Design technique

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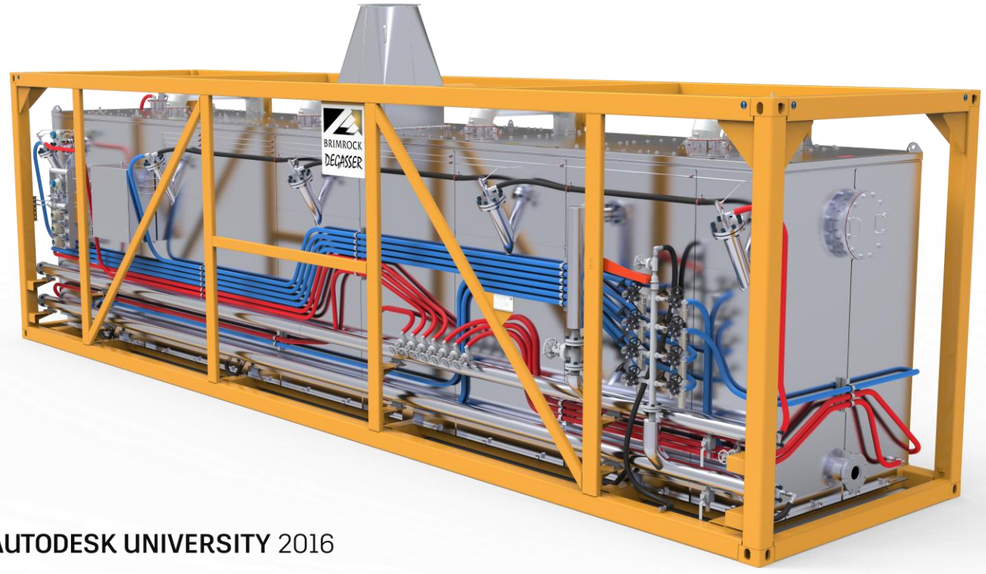
Class summary

- drive your Tube and Pipe assemblies with a master sketch.
- create and update routes, jacketed piping, piping insulation, drawings and assemblies for individual spools
- use custom content from the Content Center
- update and change your routes.
- document pipe spools in individual drawings
- create piping layout drawings
- nominalize hose lengths in your BOMs

Introductions

Cory McConnell

- Calgary Alberta Canada
- Used Inventor since 2002
- Designed pipeline inspection pigs, tooling, materials handling equipment, large scale sulphur processing equipment
- Use Master Sketch modeling (skeletal) technique



Introductions

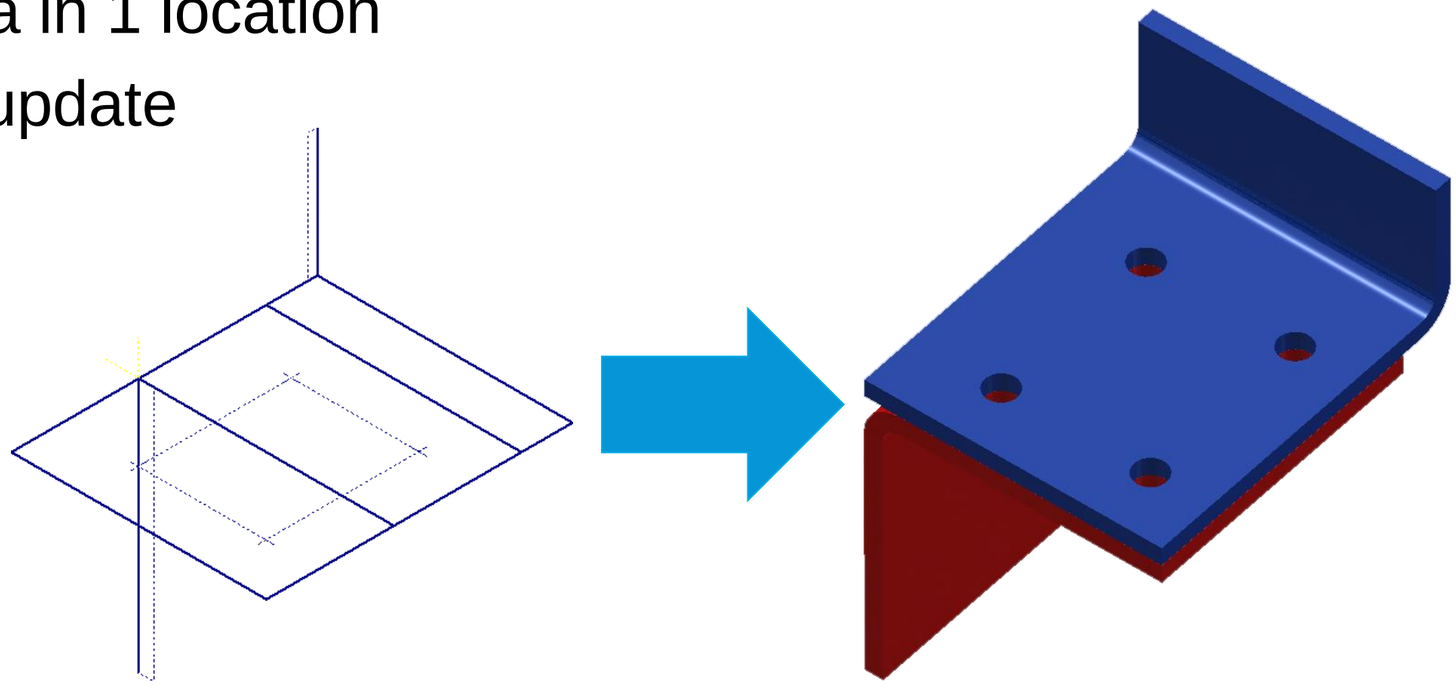
Autodesk Folks

Background

Master Sketch Modeling Technique

Purpose

- Uses Derive & Make Parts tools
- All (most) design data in 1 location
- Dependent features update



Tube & Pipe Module

Purpose

- Design/Route piping in Inventor
- Populate pipe routes with purchased content

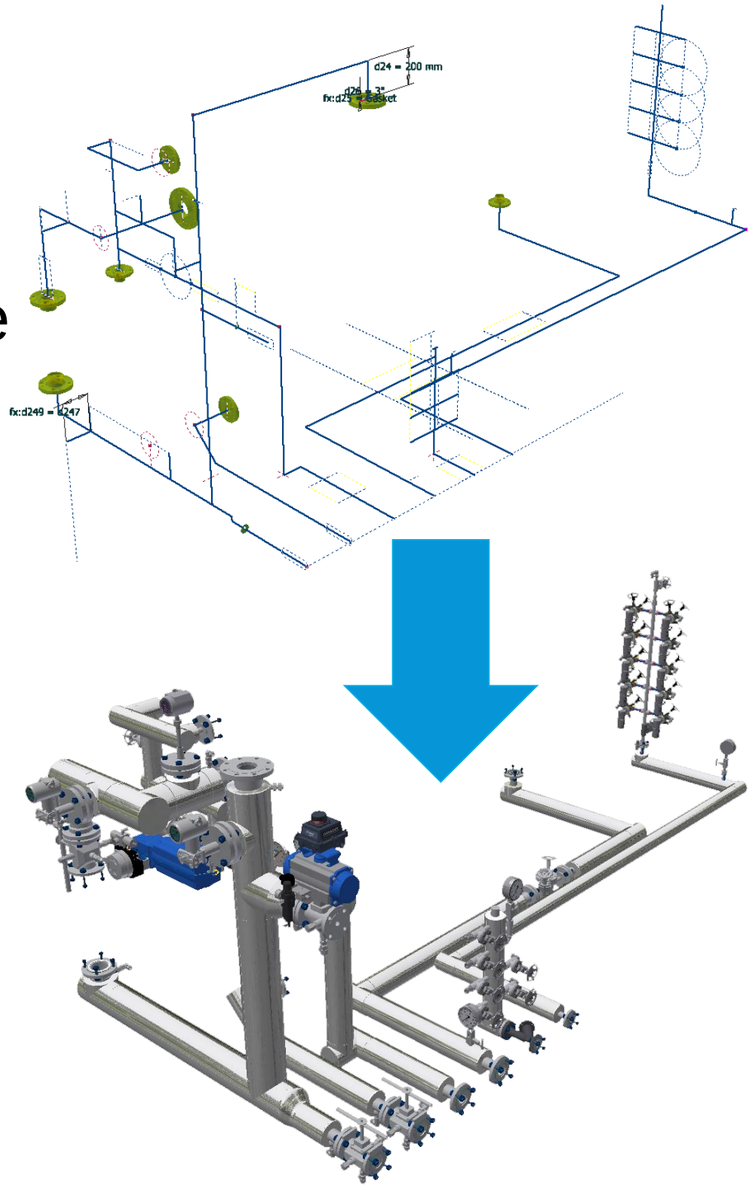
Drawbacks

- AutoRoute
- Piping is not structured in sub assemblies
- Coincident-Run (jacketed) piping is not possible
- Can’t be driven with a Master Sketch
- Branches and tie-ins are difficult

Master Sketch + Tube & Pipe =

Workflow

- developed to design and document jacketed pipe
- refined to work with all types of jointed piping



Results

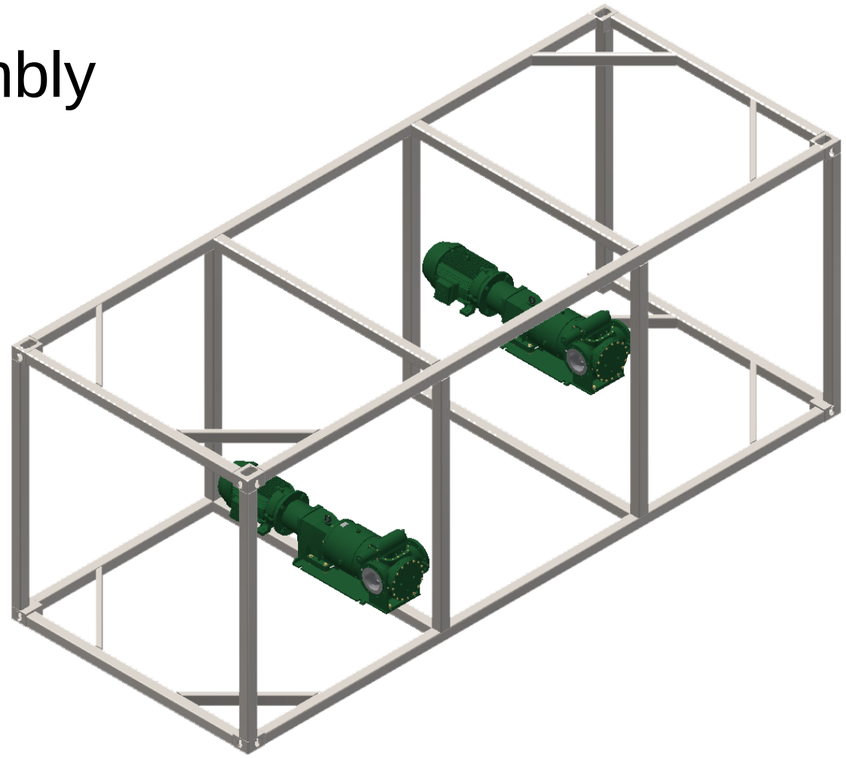
- Master Sketch driven routes
- Pipe spools are organized in subassemblies
- Coincident-Run (jacketed) piping is possible
- Does not use AutoRoute to place fittings
- Branches and tie-ins are easy

Drive Complex Tube and Pipe Routes with a Master Sketch

Create the Piping Master

Piping Master

- Drives piping
- Located at the origin of our equipment assembly



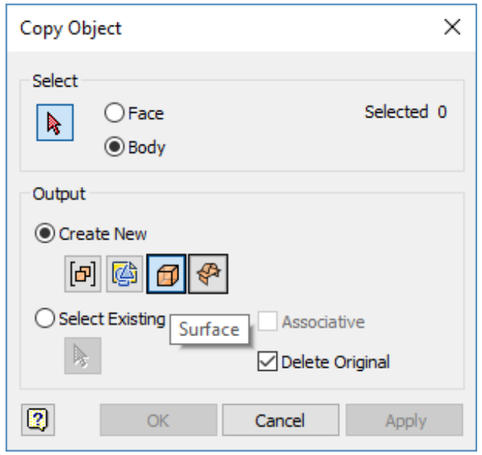
Piping Master Template

Piping Master Template

- Contains many parameters that are used many times
- Valve face to face dimension
- Gasket thickness
- Weld gap

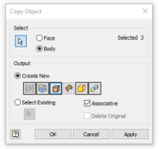
User Parameters		
Gasket	in	0.125 in
Gap	in	1/8"
LR_ELL_90_OFFSET_2	in	3 in
LR_ELL_90_OFFSET_3	in	4.5 in
LR_ELL_90_OFFSET_4	in	6 in
LR_ELL_90_OFFSET_6	in	9 in
LR_ELL_90_OFFSET_8	in	12 in
LR_ELL_90_OFFSET_10	in	15 in
SR_ELL_90_OFFSET_2	in	2 in
SR_ELL_90_OFFSET_3	in	3 in
SR_ELL_90_OFFSET_4	in	4 in
SR_ELL_90_OFFSET_6	in	6 in
SR_ELL_90_OFFSET_8	in	8 in
SR_ELL_90_OFFSET_10	in	10 in
ST_TEE_OFFSET_2	in	2.5 in
ST_TEE_OFFSET_3	in	3.38 in
ST_TEE_OFFSET_4	in	4.12 in
ST_TEE_OFFSET_6	in	5.62 in
ST_TEE_OFFSET_8	in	7 in
ST_TEE_OFFSET_10	in	8.5 in
ECC_RED_OFFSET_2X1	in	0.53 in
ECC_RED_OFFSET_3X2	in	0.5625 in
ECC_RED_OFFSET_4X2	in	1.0625 in
ECC_RED_OFFSET_4X3	in	0.5 in
ECC_RED_OFFSET_6X3	in	1.5625 in
ECC_RED_OFFSET_6X4	in	1.0625 in
ECC_RED_OFFSET_8X4	in	2.0625 in
ECC_RED_OFFSET_8X6	in	1 in
ECC_RED_OFFSET_10X4	in	3.125 in
ECC_RED_OFFSET_10X6	in	2.0625 in
ECC_RED_OFFSET_10X8	in	1.0625 in
FLG_RF_BB_150_2	in	0.753 in
FLG_RF_BB_150_3	in	0.943 in
FLG_RF_BB_150_4	in	0.943 in
FLG_RF_BB_150_6	in	1.003 in
FLG_RF_BB_150_8	in	1.123 in
FLG_RF_BB_150_10	in	1.193 in
FLG_RF_SO_150_3_Dia	in	7.5 in
FLG_RF_SO_150_3	in	1.183 in
VLV_FS_3x2x3_FtoF	in	8 in
FLG_RF_SO_150_6_Dia	in	11 in
FLG_RF_SO_150_6	in	1.563 in
FLG_RF_SO_150_2_Dia	in	6 in
FLG_RF_SO_150_2	in	1.003 in
VLV_FS_6x4x6_FtoF	in	10.5 in
VLV_FS_2x1x2_FtoF	in	7 in
FLG_RF_3_4_NPT_150_2	in	1.06 in
FLG_RF_SW_150_1	in	0.68 in
FLG_RF_SW_150_1_Dia	in	4.25 in
LR_ELL_SW_90_OFFSET_1	in	1.38 in
FLG_RF_SW_150_1_1_2	in	0.87 in
FLG_RF_SW_150_1_1_2_Dia	in	5 in
LR_ELL_SW_90_OFFSET_1_1_2	in	1.75 in
SWAGE_OFFSET_2X1_1_2	in	6.5 in
FLG_RF_SW_150_2	in	1 in
FLG_RF_SW_150_2_Dia	in	6 in
VLV_FS_4x3x4_FtoF	in	9 in

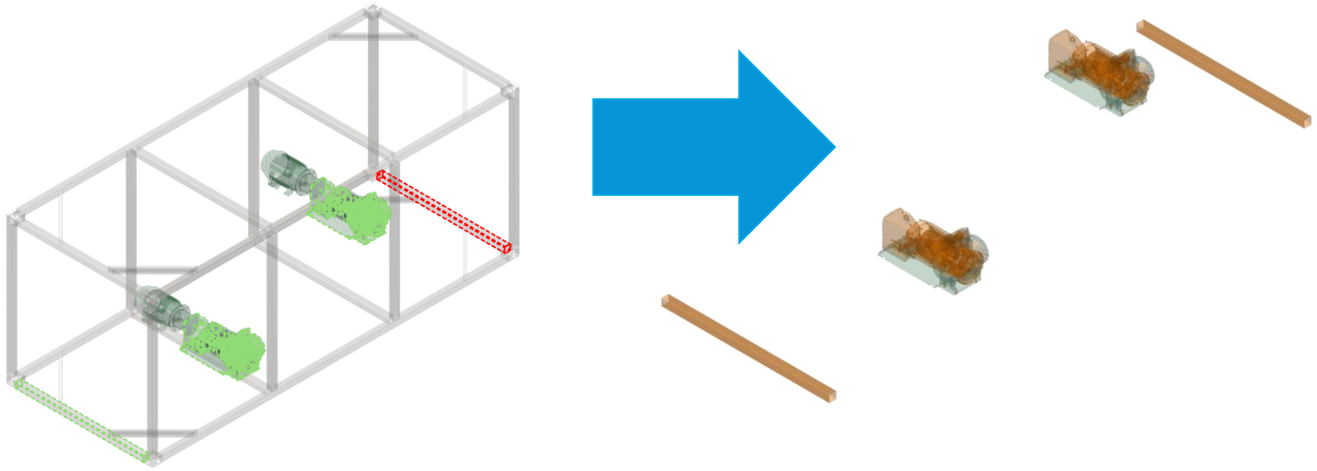
Copy Object Tool



Reference Geometry

- Copies geometry from assembly to part
- Robust, Adaptive relationship
- Easily updatable

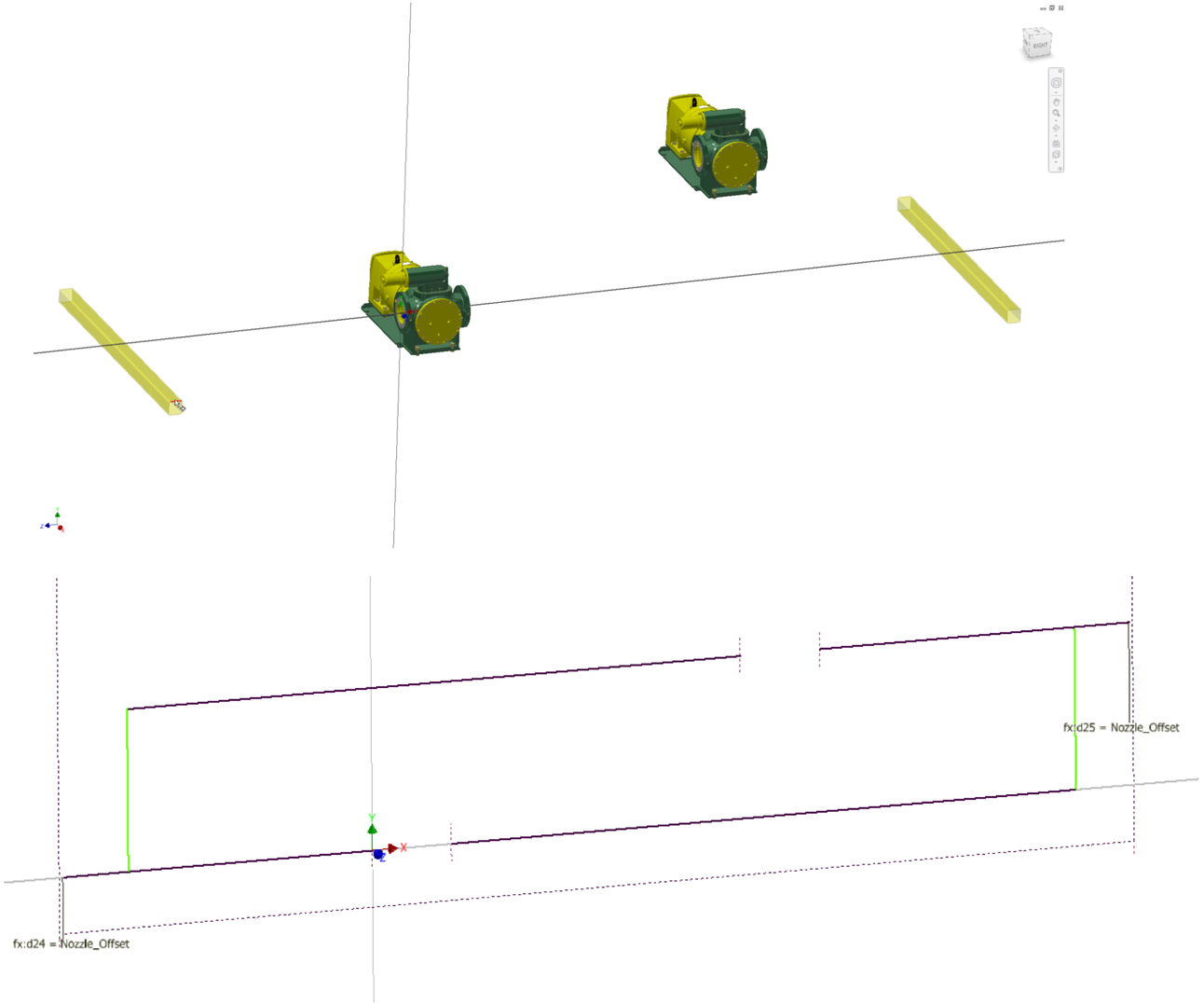




Sketching Routes

Routes

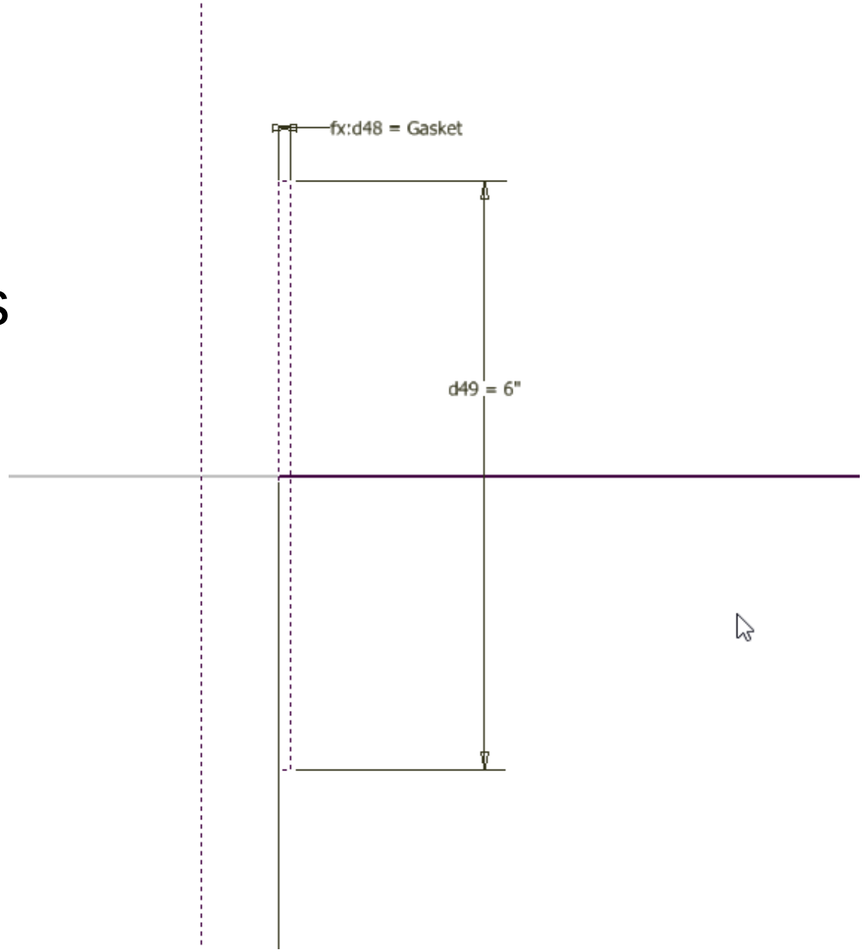
- 2D Sketches
- 3D Sketches
- Define pipe centerlines
- Locate valves and other inline equipment



Adding Room for Gaskets

Gaskets

- Locate gaskets at inlet and outlet
- Can be used to define flange connections in master
- Driven by parameter from template



Adding Valves and Other Inline Items

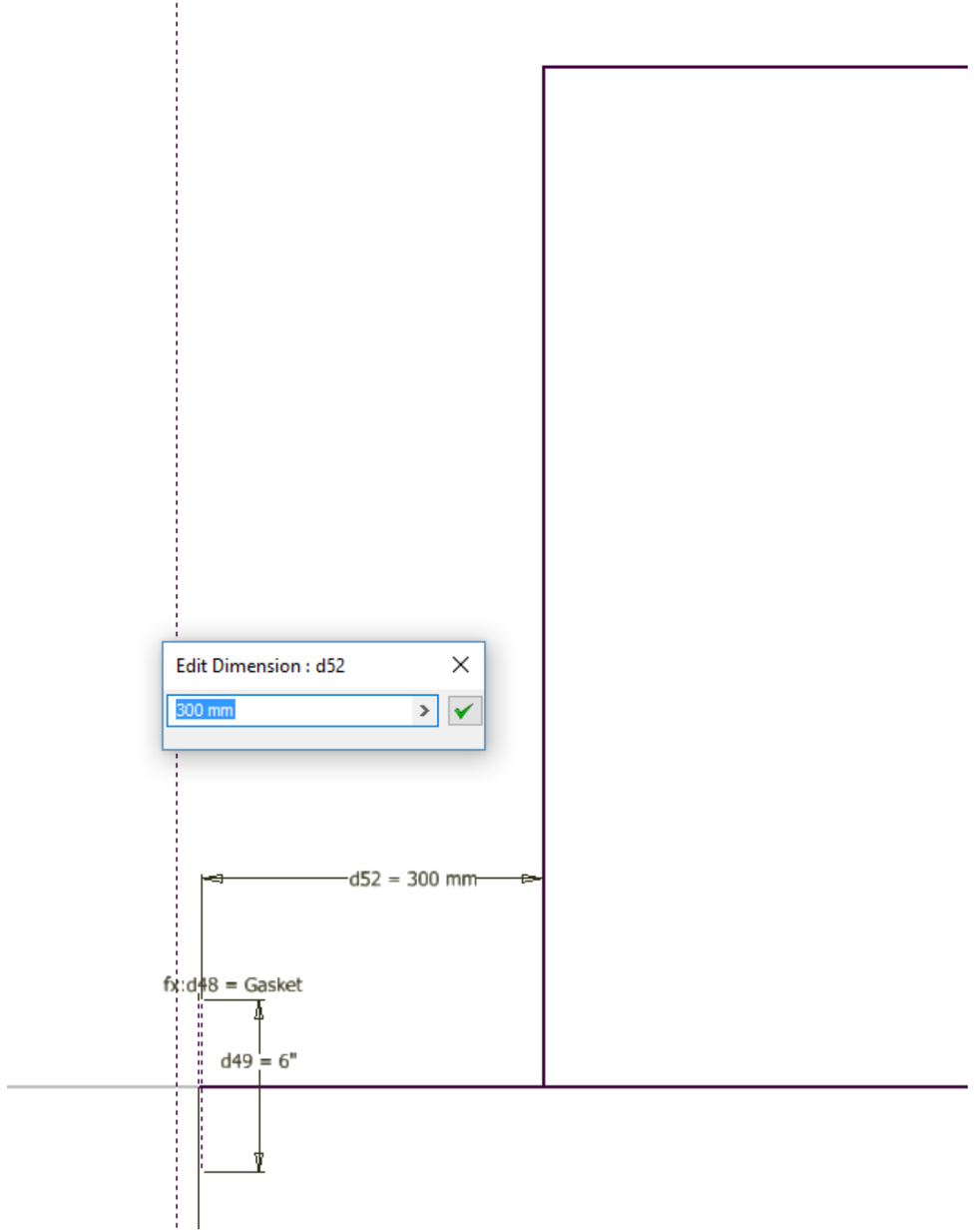
Valves

- Face to face dimensions
- Sketch on routes
- Y-Strainers, traps etc

Adding Branches

Piping Branches

- Can be in a separate sketch
- Dimensioned as required
- Can be adjusted as required

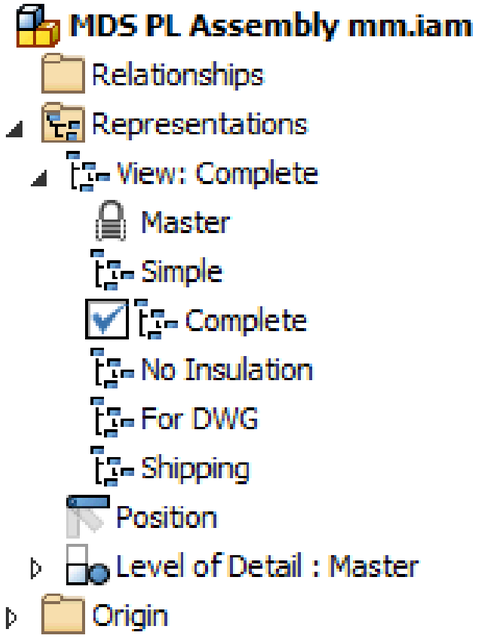


Create Individual Pipe Spool Assemblies

Piping Assembly Template

Templates

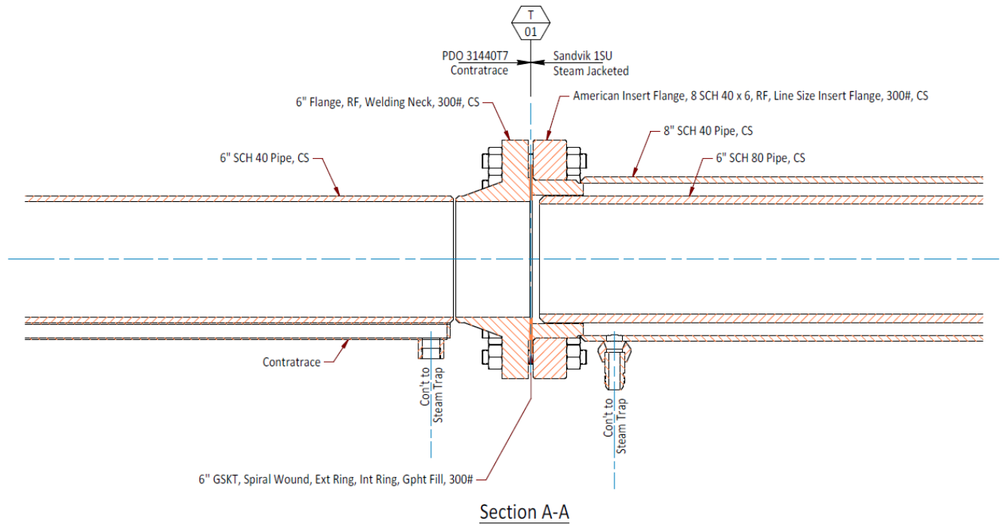
- View Reps for drawings
- Improves consistency



Jacketed Piping

Jacketed/Insulated Piping

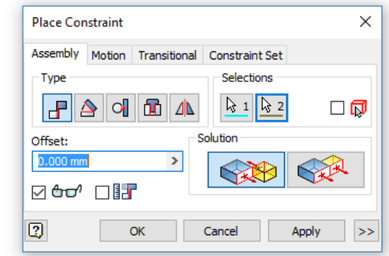
- Used to maintain product temperature
- Insulated, jacketed piping amounts to a pipe inside a pipe inside a pipe
- Coaxial pipe runs
- Complex, and difficult to fabricate

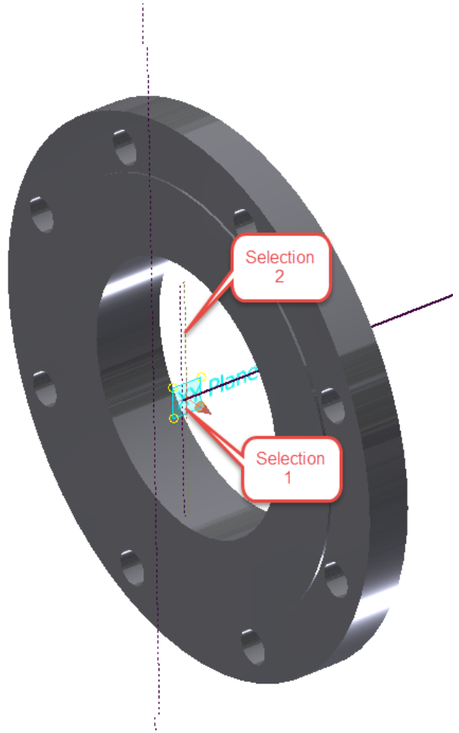


Adding Flanges

Flanges

- Constrained to route sketch
- Location and orientation controlled by Master

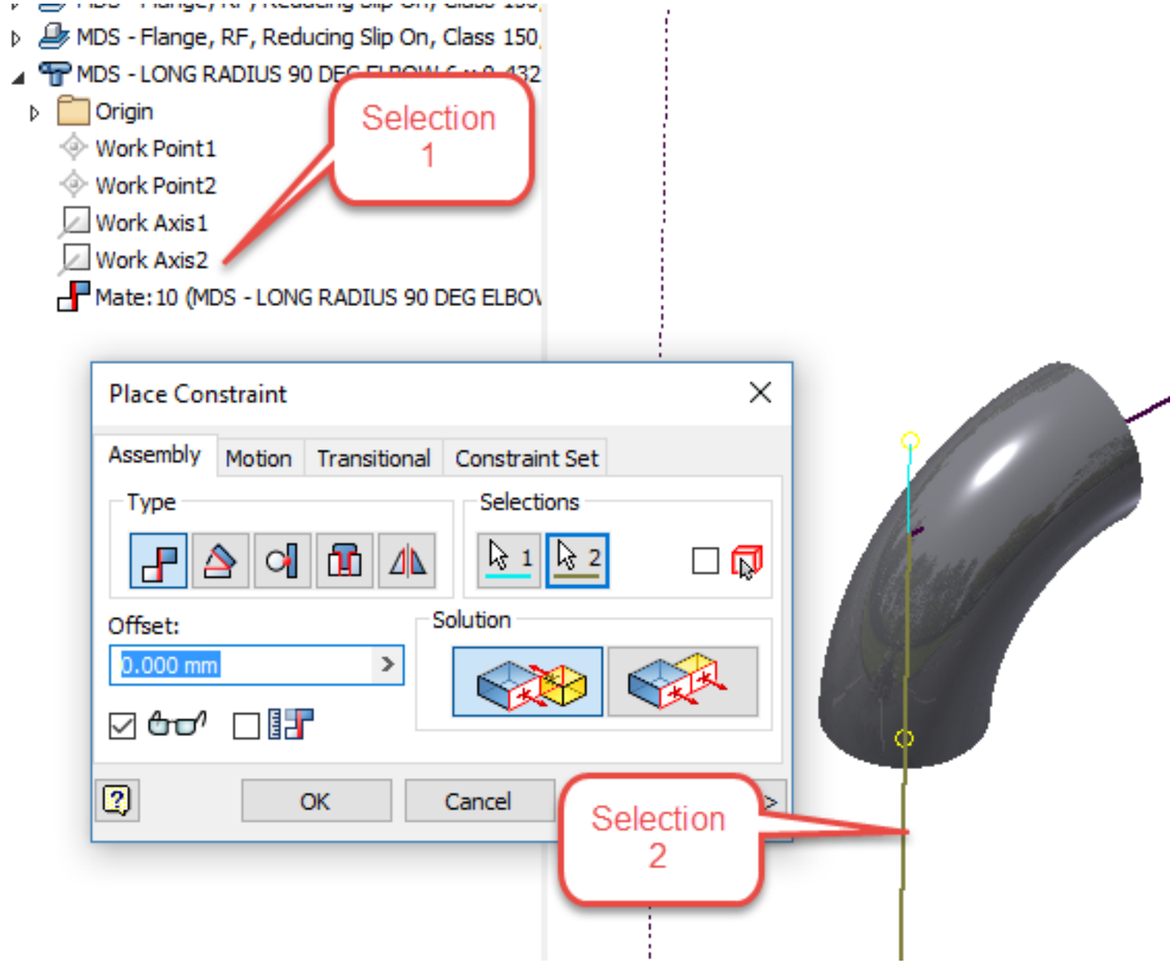




Adding Elbows

Elbows

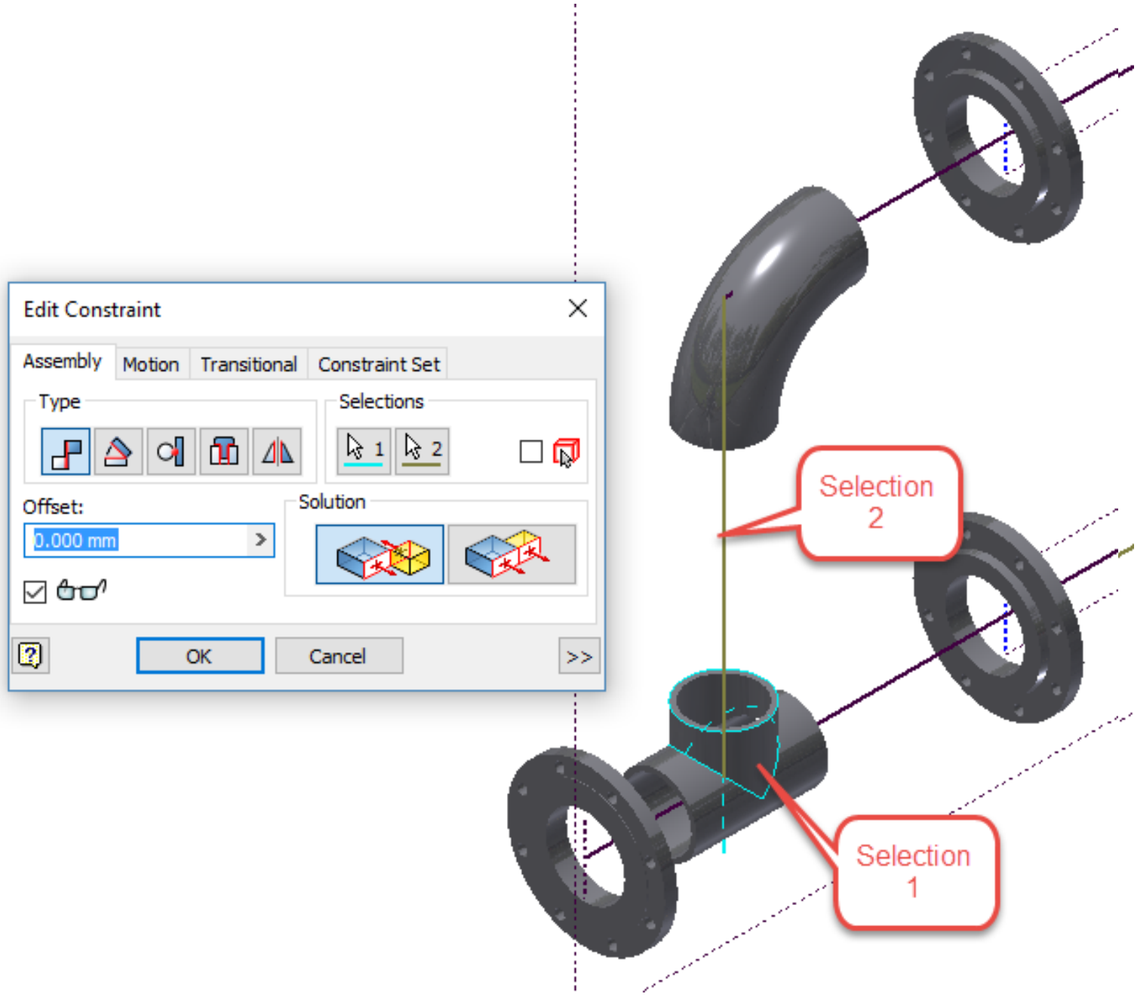
- Constrained to route centerline
- Location controlled by master



Adding Tees

Tees

- Constrained to route sketch
- Location and orientation controlle



Adding Pipe

Pipe

- Uses Tube and pipe toolset
- Driven by piping styles

Adding a Jacket or Insulation

Jacket

- SCH 40 pipe
- Coaxial with core
- Fittings are constrained to core fittings

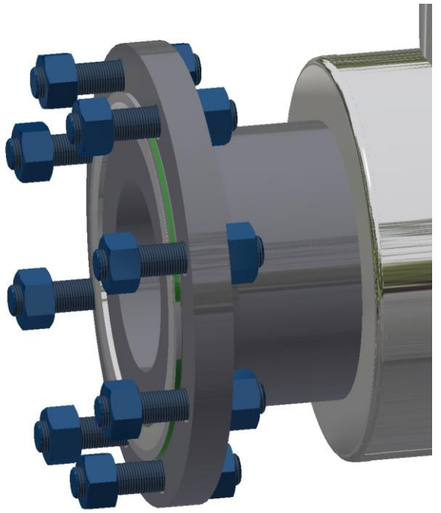
Insulation

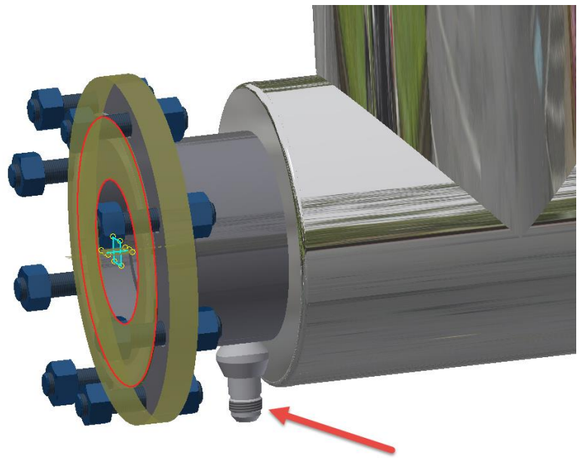
- Custom content
- Coaxial with jacket
- Fittings are constrained to jacket fittings

Adding Accessories

Piping Accessories

- Studs and Nuts
- Gaskets
- Labels
- Steam/Condensate Jumpers

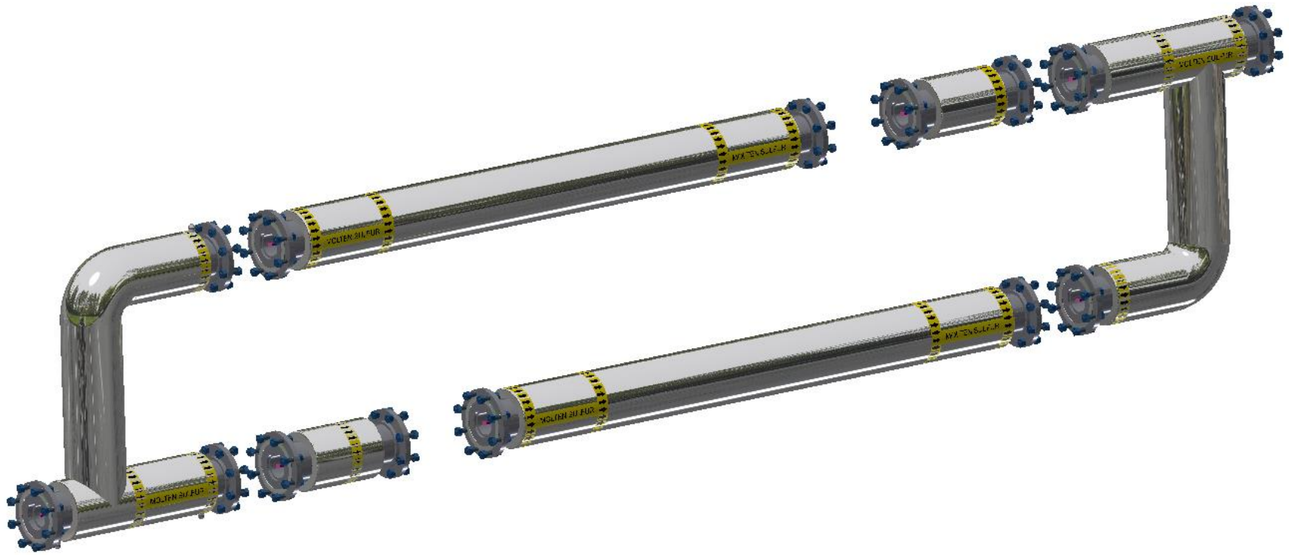




Bringing Your Spools Together

Piping Subassembly

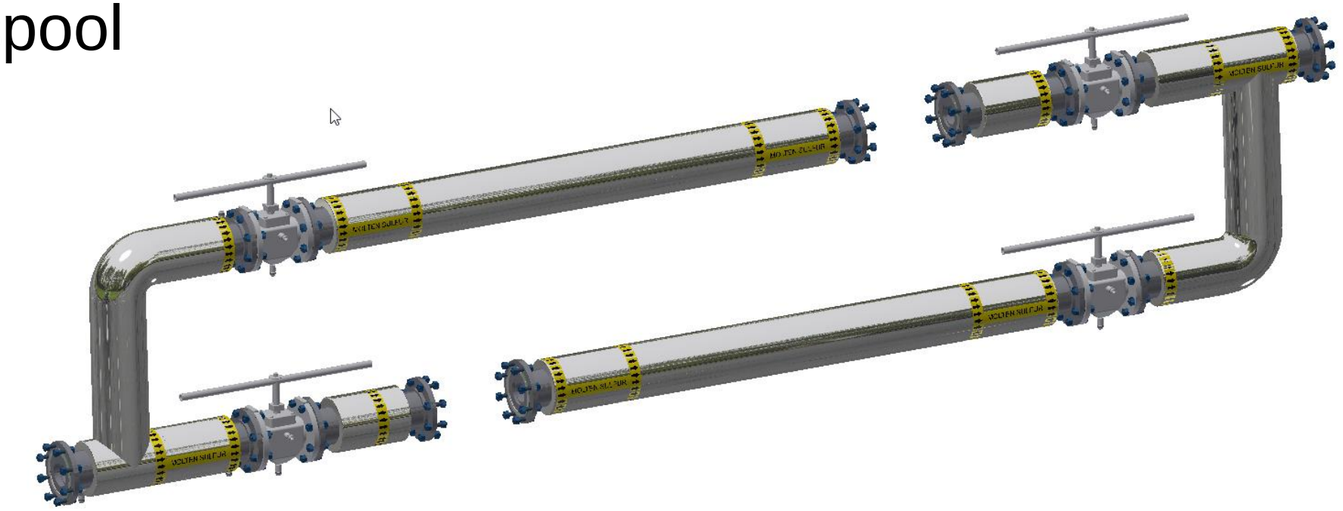
- Phantom assembly
- Collection of spools driven by common master
- Common master = common origin



Adding Valves

Valves

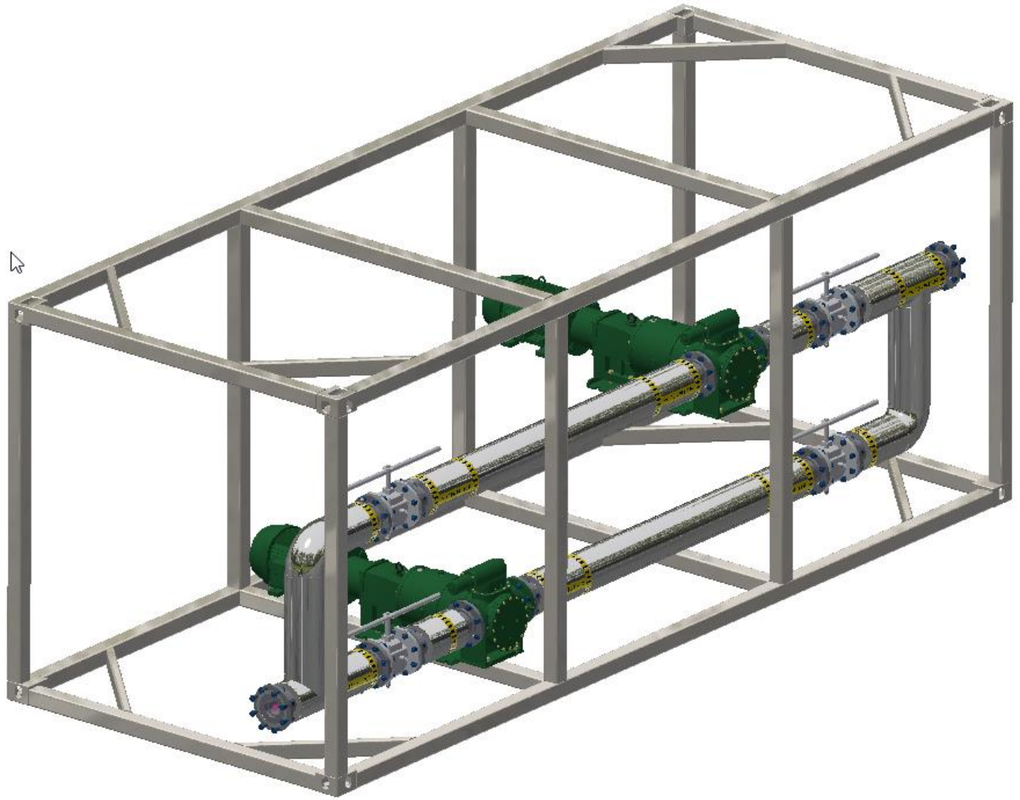
- Make use of subassemblies
- Constrained to upstream spool



Adding Your Piping to the Equipment Assembly

General Assembly

- Phantom piping assembly inserted and grounded at 0,0,0
- Copy object / master workflow locates pipe correctly

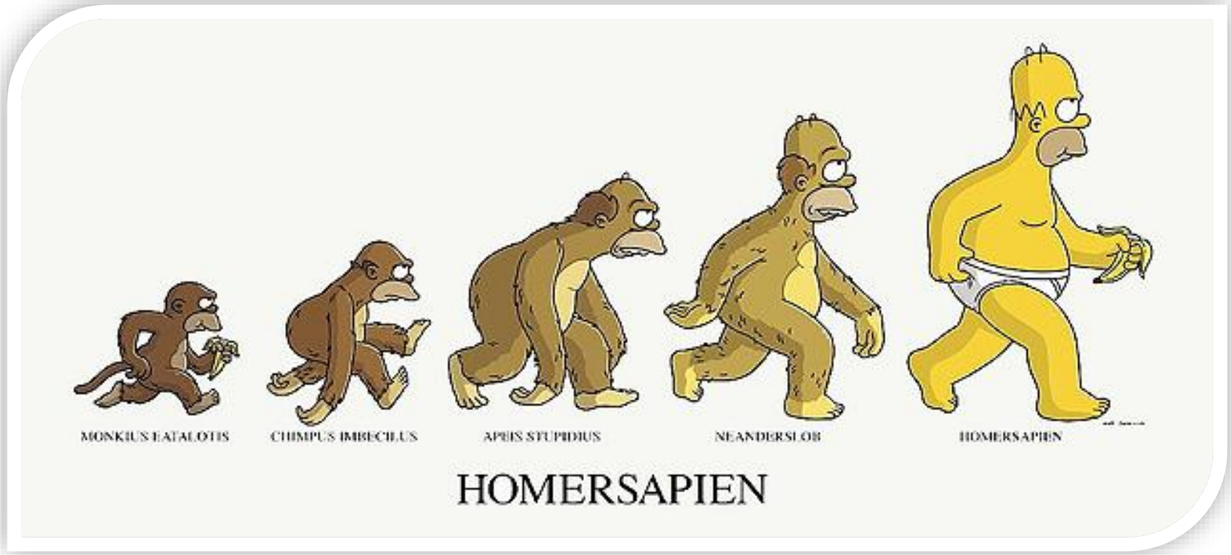


Questions?

Updating Your Routes and Spools

Changes

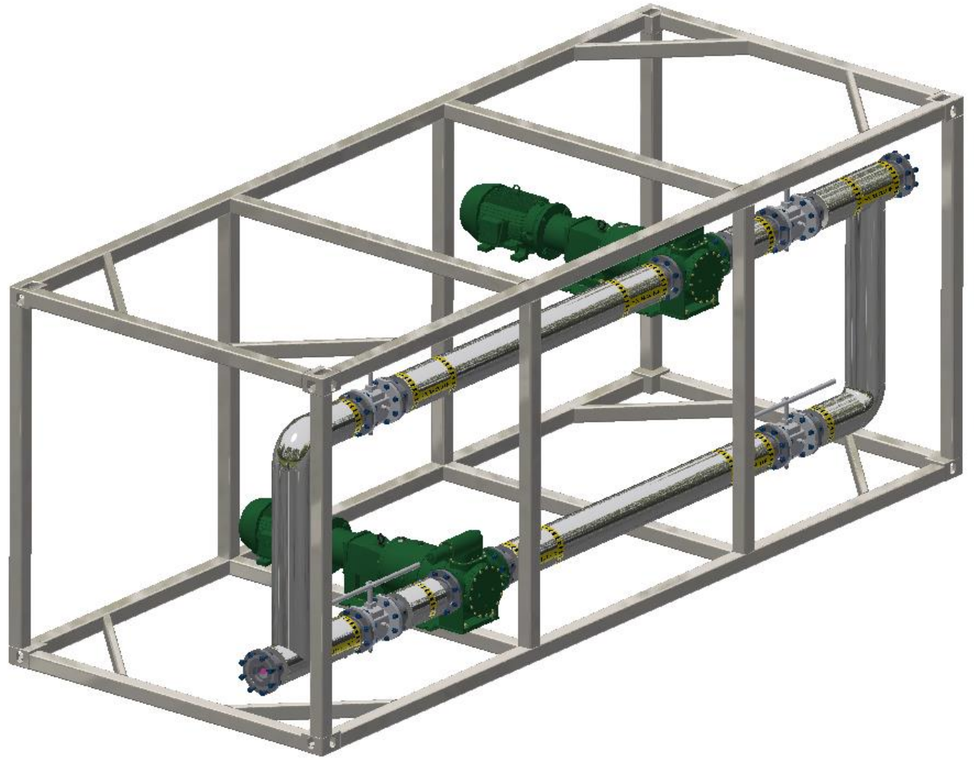
- Unavoidable
- 3 different types



Updating Your Routes and Spools

Level I

- Change to spool lengths only
- Equipment location is moved within plane of piping



Updating Your Routes and Spools

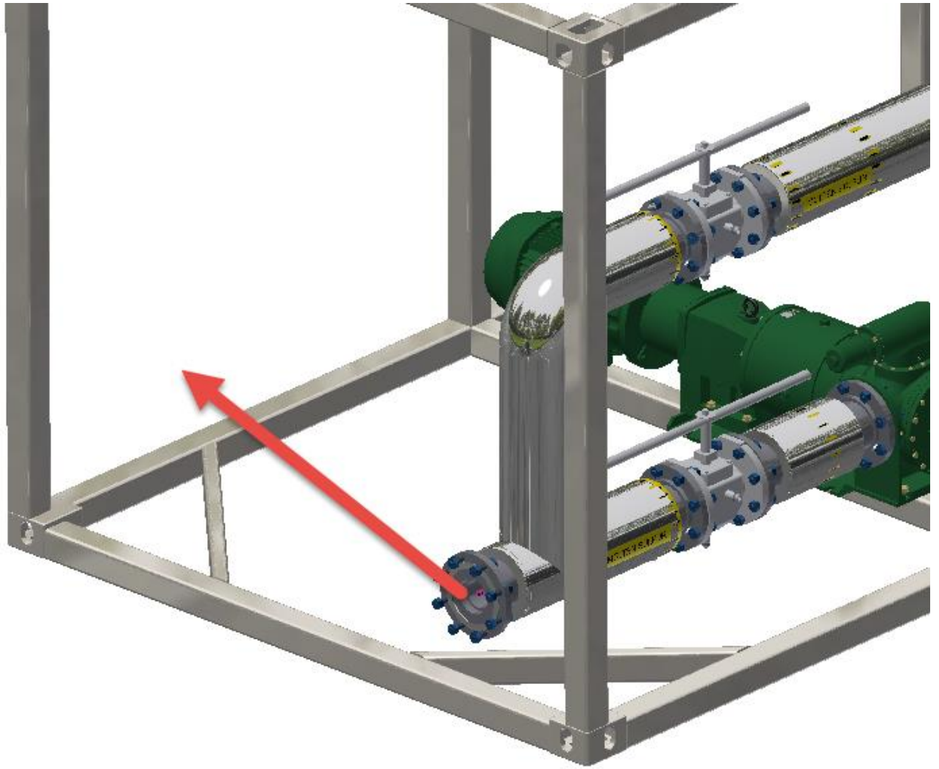
Level II

- Change in size of piping
- Fittings are replaced
- New style is selected

Updating Your Routes and Spools

Level III

- Change to routing of pipe
- Most complex



Questions?

Use Custom Content to Populate Routes

Types of Content

Content Center

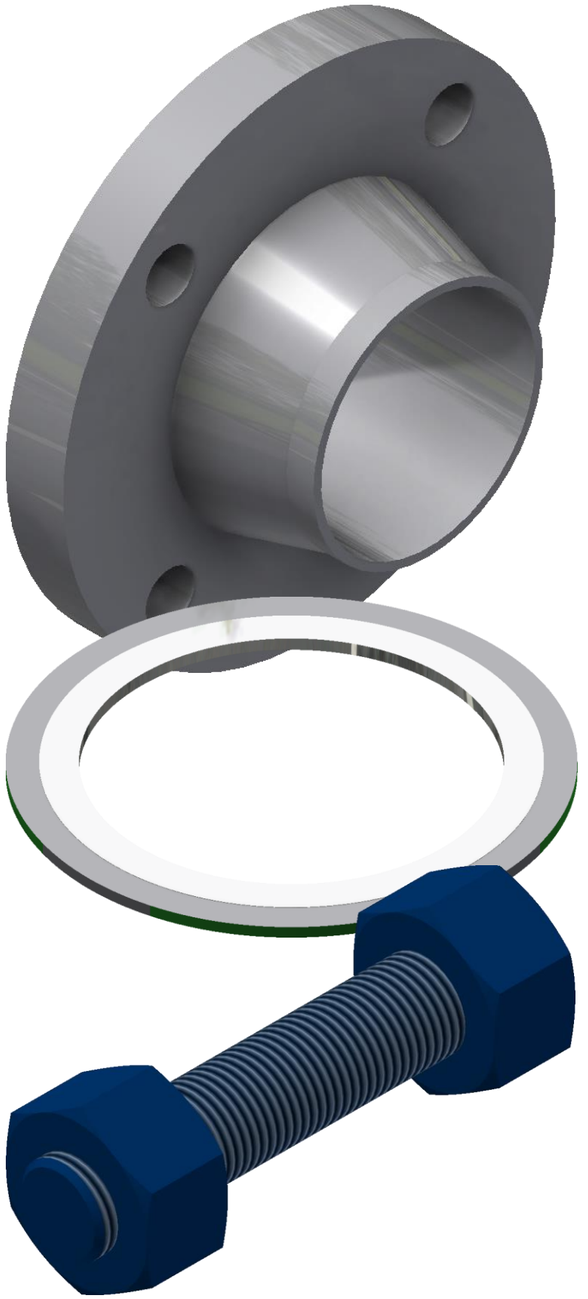
- Purchased parts that do not require drawings or flat patterns
- Easy to change sizes from the same family

iParts and iAssemblies

- Parts that need drawings or flat patterns
- Change sizes 1 at a time
- I do not use iAssemblies

Phantom Assemblies

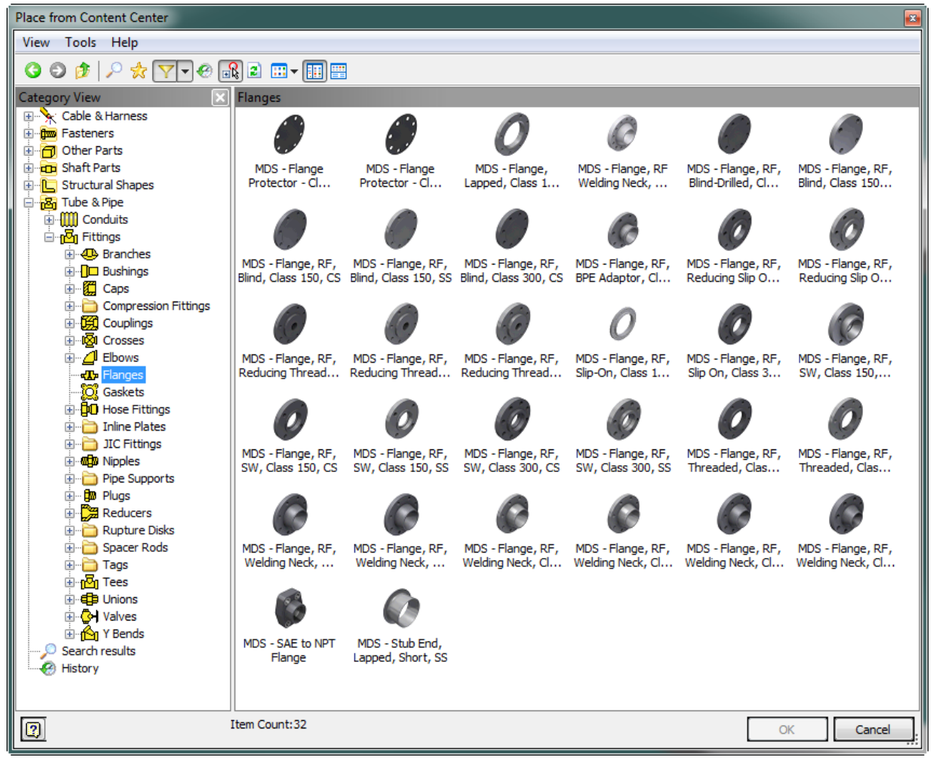
- A set of components used multiple times
- Parts bubble up in BOMs



Content Center

Custom Content

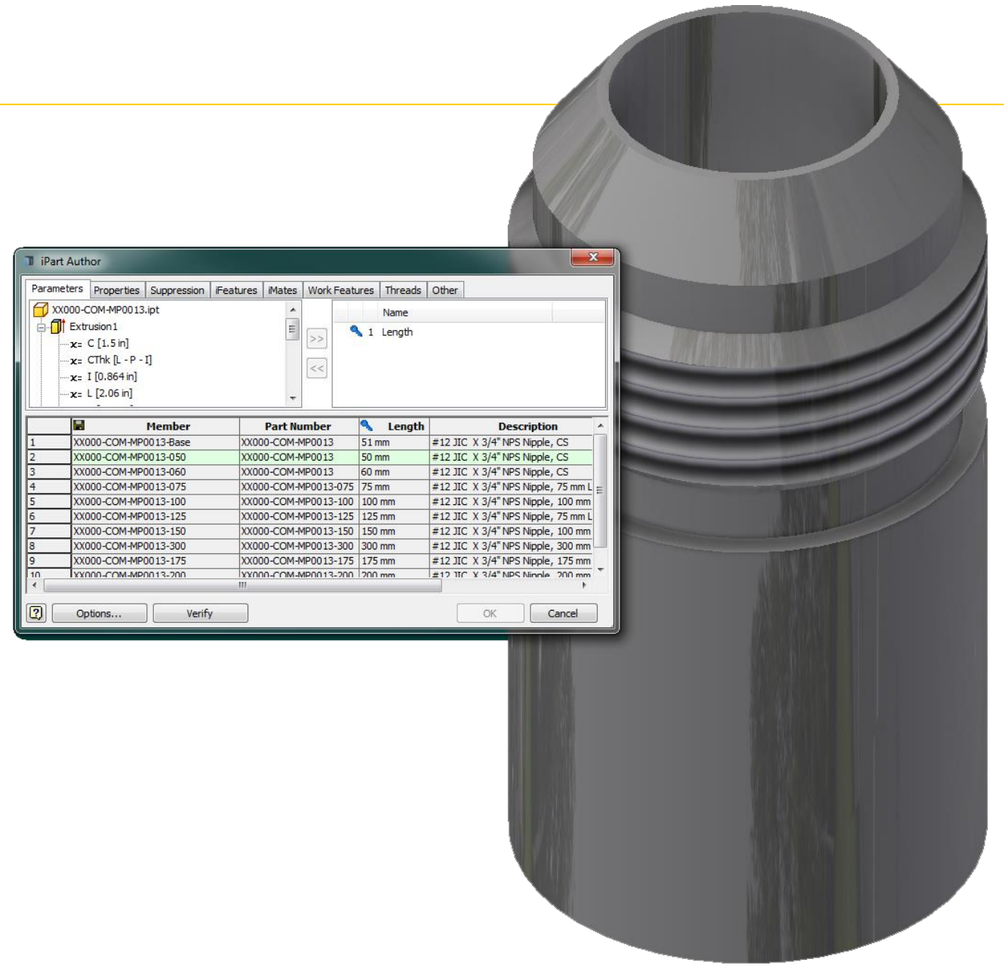
- Save Copy As
- Changes to Model geometry
- Changes to Connections
- Custom authored parts
- Updating parent assembly



iParts

iParts

- Creating iParts
- Modifying iParts
- Updating Parent Assembly



Phantom Assemblies

Phantom Assemblies

- Creating phantom assemblies
- Editing phantom assemblies
- Updating parent assembly

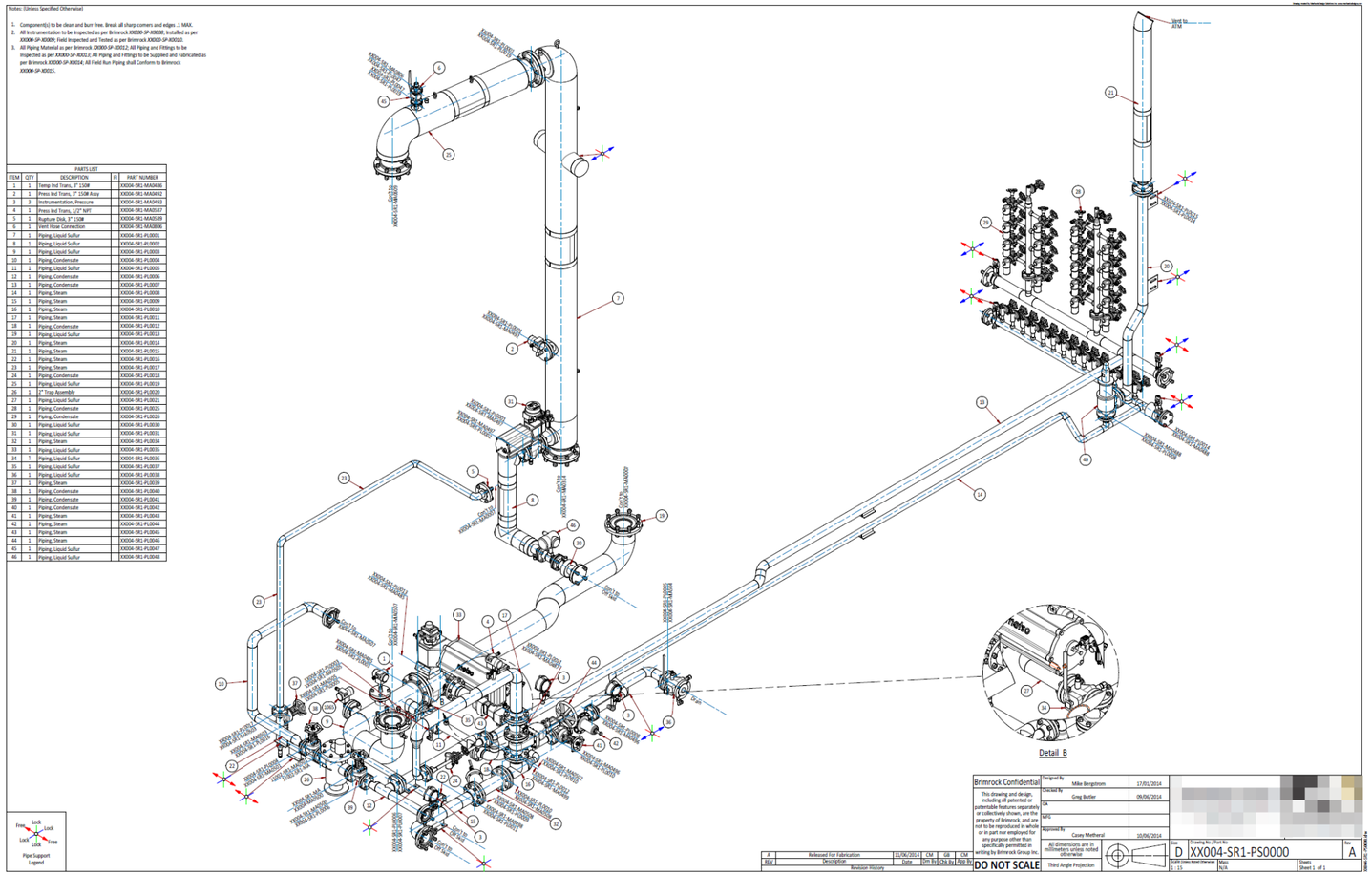
Questions?

Create Drawings of Individual Pipe Spools

Piping Layout Drawing

Only Piping

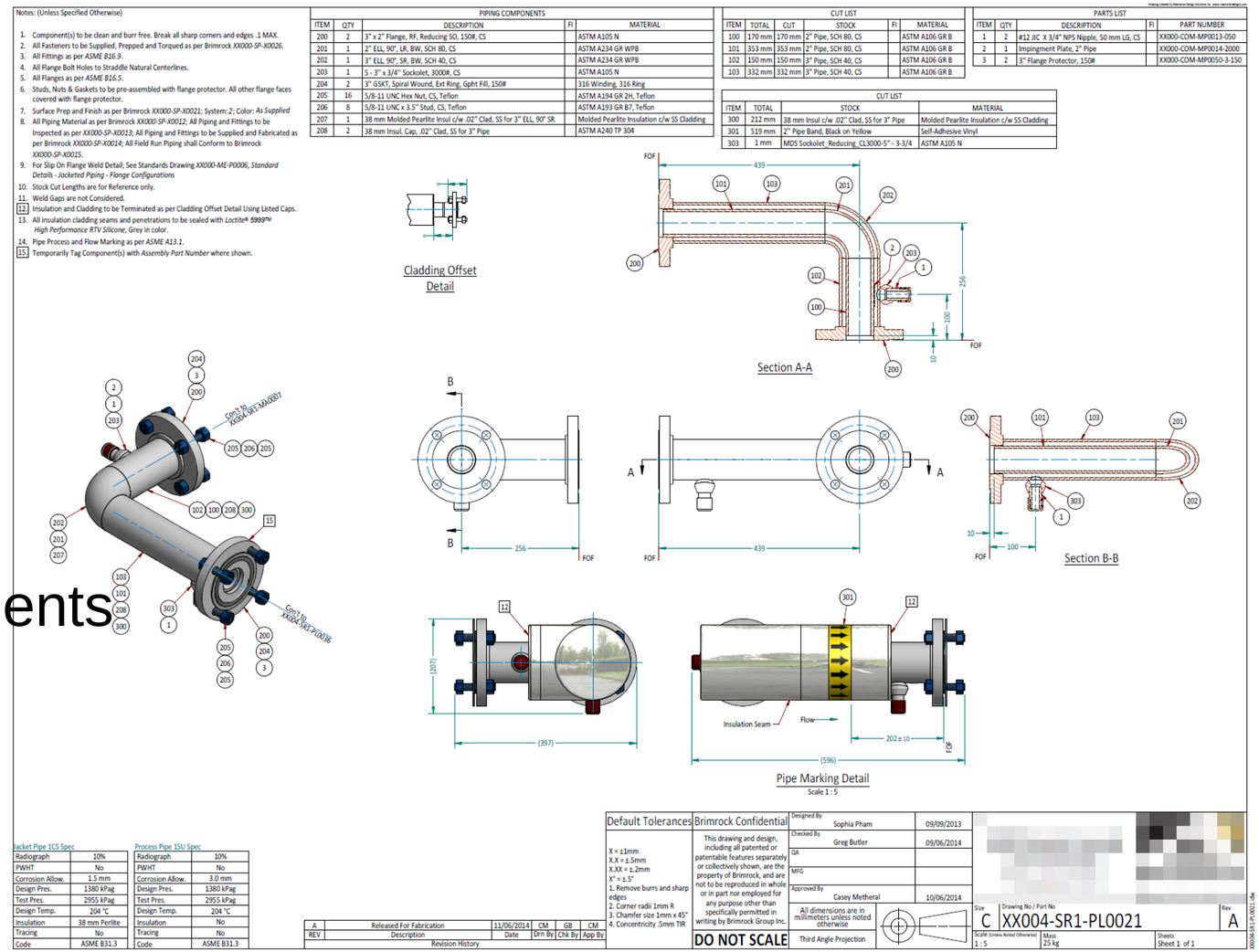
- No insulation
- Shows valves and inline instruments
- Used for troubleshooting of piping system



Pipe Spool Orthos

Requirements

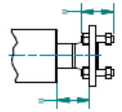
- Fabrication requirements
- Pipe cut list
- Purchased parts list
- Piping parts list
- Totaled cut list
- Insulation and labeling requirements
- Testing requirements
- Notes



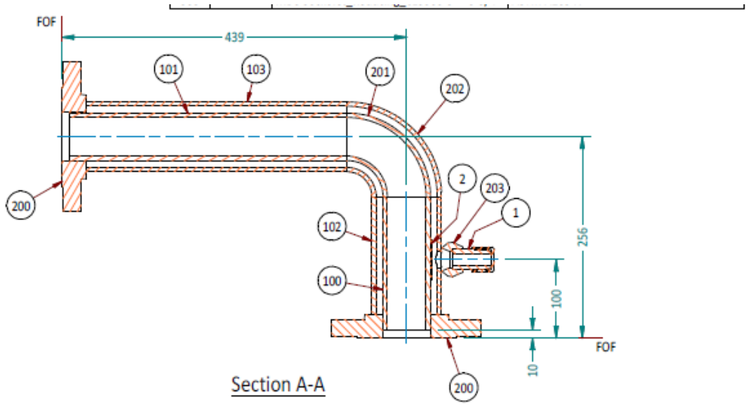
Fabrication Requirements

Fabrication

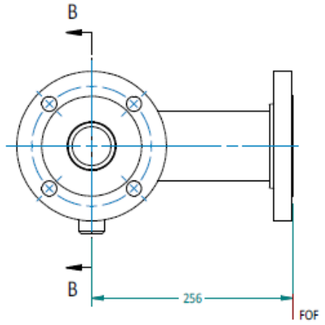
- Uses a View Rep
- Uses section views as req’d

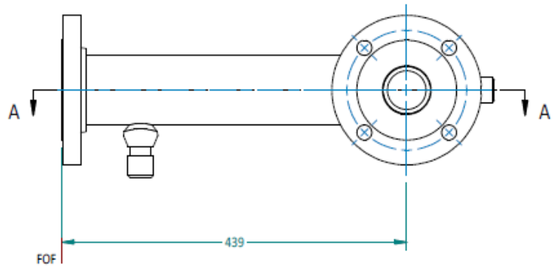


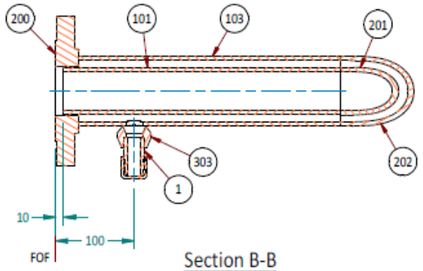
Cladding Offset Detail



Section A-A







Section B-B

Pipe Cut List

Cut List

- List of straight pipe lengths
- Part List filter
- Items from 100-199

CUT LIST					
ITEM	TOTAL	CUT	STOCK	FI	MATERIAL
100	46 mm	46 mm	4" Pipe, SCH 80, CS		ASTM A106 GR B
101	132 mm	132 mm	4" Pipe, SCH 80, CS		ASTM A106 GR B
102	180 mm	180 mm	4" Pipe, SCH 80, CS		ASTM A106 GR B
103	643 mm	643 mm	4" Pipe, SCH 80, CS		ASTM A106 GR B
104	1664 mm	1664 mm	4" Pipe, SCH 80, CS		ASTM A106 GR B
105	118 mm	118 mm	6" Pipe, SCH 40, CS		ASTM A106 GR B
106	127 mm	127 mm	6" Pipe, SCH 40, CS		ASTM A106 GR B
107	605 mm	605 mm	6" Pipe, SCH 40, CS		ASTM A106 GR B
108	1634 mm	1634 mm	6" Pipe, SCH 40, CS		ASTM A106 GR B

Purchase Parts List

Purchased List

- Specified by part number
- Part list filter
- Items from 1-99

PARTS LIST				
ITEM	QTY	DESCRIPTION	FI	PART NUMBER
1	3	#12 JIC X 3/4" NPS Nipple, 50 mm LG, CS		XX000-COM-MP0013-050
2	1	Impingment Plate, 4" Pipe		XX000-COM-MP0014-4000
3	3	#12 JIC Cap		XX000-COM-MP0016

Piping Parts List

Piping List

- Welded
- List material
- Items from 200-299

PIPING COMPONENTS				
ITEM	QTY	DESCRIPTION	FI	MATERIAL
200	3	6" x 4" Flange, RF, Reducing SO, 150#, CS		ASTM A105 N
201	2	6" ELL, 90°, SR, BW, SCH 40, CS		ASTM A234 GR WPB
202	2	4" ELL, 90°, LR, BW, SCH 80, CS		ASTM A234 GR WPB
203	1	4" Tee, BW, SCH 80, CS		ASTM A234 GR WPB
204	1	6" Tee, BW, SCH 40, CS		ASTM A234 GR WPB
205	3	6" x 3/4" Sockolet, 3000#, CS		ASTM A105 N
206	24	3/4-10 UNC x 4" Stud, CS, Teflon		ASTM A193 GR B7, Teflon
207	48	3/4-10 UNC Hex Nut, CS, Teflon		ASTM A194 GR 2H, Teflon
208	3	6" GSKT, Spiral Wound, Ext Ring, Gpht Fill, 150#		316 Winding, 316 Ring
209	2	38 mm Molded Pearlite Insul c/w .02" Clad, SS for 6" ELL, 90° SR		Molded Pearlite Insulation c/w SS Cladding
210	1	38 mm Molded Pearlite Insul c/w .02" Clad, SS for 6" Tee		Molded Pearlite Insulation c/w SS Cladding
211	3	38 mm Insul. Cap, .02" Clad, SS for 6" Pipe		ASTM A240 TP 304
212	2	Pipe Label, Molten Sulfur		Self-Adhesive Vinyl

Totaled Cut List

Total Stock

- Total length needed for estimation
- Items from 300-399

CUT LIST			
ITEM	TOTAL	STOCK	MATERIAL
300	2239 mm	38 mm Insul c/w .02" Clad, SS for 6" Pipe	Molded Pearlite Insulation c/w SS Cladding
301	2305 mm	2" Pipe Band, Black on Yellow	Self-Adhesive Vinyl

Insulation and Decal Details

Insulation and Decals

- View Rep
- Shaded view style

Design and Testing Requirements

Requirements Tables

- Sketched symbol
- Prompted entries
- Placed twice for jacketed piping

Jacket Pipe 1CS Spec	
Radiograph	10%
PWHT	No
Corrosion Allow.	1.5 mm
Design Pres.	1380 kPag
Test Pres.	2955 kPag
Design Temp.	204 °C
Insulation	38 mm Perlite
Tracing	No
Code	ASME B31.3

Process Pipe 1SU Spec	
Radiograph	10%
PWHT	No
Corrosion Allow.	3.0 mm
Design Pres.	1380 kPag
Test Pres.	2955 kPag
Design Temp.	204 °C
Insulation	No
Tracing	No
Code	ASME B31.3

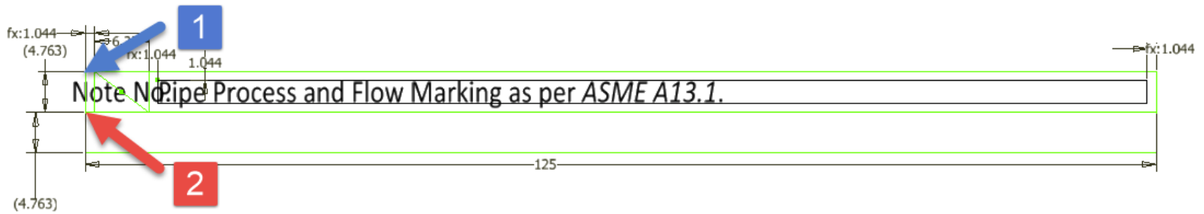
Notes

Note “Generator”

- Sketched Symbols
- Insert point
- Connection point
- Sketch geometry text frame

Notes: (Unless Specified Otherwise)

1. Pipe Process and Flow Marking as per *ASME A13.1*.
2. All insulation cladding seams and penetrations to be sealed with *Loctite® 5999™ High Performance RTV Silicone*, Grey in color.



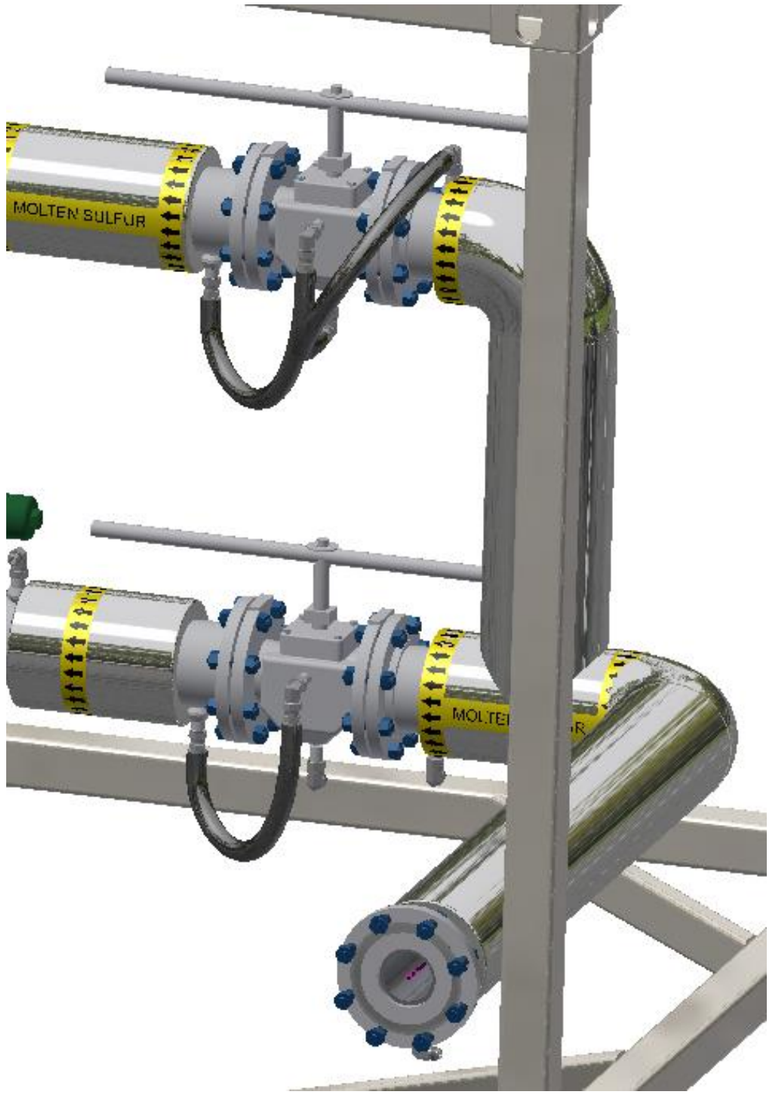
Questions?

Bonus: Modeling and Using Hoses

Hoses in Inventor

Routing Hoses

- Place connection fittings first
- Straight fittings
- Custom content with description and stock number
- Hose length allowance
- Hose length rounding



Hose Rounding in BOM

Excel Convertor

- RoPL Custom Column
- Adds allowance
- Rounds length
- Roll up hoses with common length
- Part list style and filter 400-499

HOSE LIST					
ITEM	QTY	DESCRIPTION	FITTING CONFIGURATION	FI	LENGTH
400	3	3/4" Microflex Flexible Hose, MSS362, Pyrotex PT20100-30 Insulation	3/4" Female JIC, Straight Swivel, SS x 3/4" Female JIC, Straight Swivel, SS		800 mm
401	1	3/4" Microflex Flexible Hose, MSS362, Pyrotex PT20100-30 Insulation	3/4" Female JIC, Straight Swivel, SS x 3/4" Female JIC, Straight Swivel, SS		900 mm
402	1	3/4" Microflex Flexible Hose, MSS362, Pyrotex PT20100-30 Insulation	3/4" Female JIC, Straight Swivel, SS x 3/4" Female JIC, Straight Swivel, SS		1000 mm
403	2	3/4" Microflex Flexible Hose, MSS362, Pyrotex PT20100-30 Insulation	3/4" Female JIC, Straight Swivel, SS x 3/4" Female JIC, Straight Swivel, SS		1100 mm

Questions?

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