16th STS-AIChE Southwest Process Technology Conference

Boosting Plant Design Efficiency with Auto Routing

Jinwoo Park

Arent Inc. / PlantStream

Sept 22-23, 2025, University of Houston

16th STS-AIChE Southwest Process Technology Conference

Jinwoo Park

Worked at JGC Corporation as a piping engineer for oil & gas plant projects. Currently at Arent Inc. and PlantStream as a Technical Consultant Manager leading DX and development in plant engineering.

Sept 22-23, 2025, University of Houston

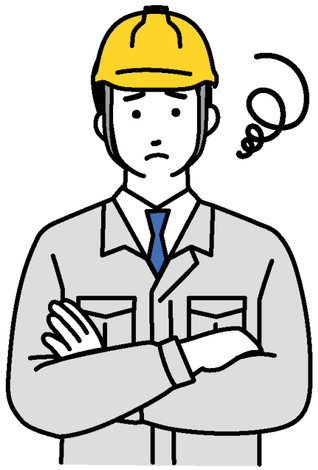
Agenda

1. Auto Routing
2. Routing Algorithms
3. Process Requirements
4. P&ID Interpretation for auto routing
5. Conclusion & Outlook

1. Auto Routing

Challenges of EPC Contractor

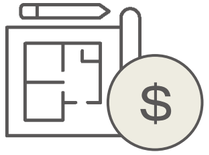
EPC Contractors



Time Consuming Piping Design

30% Of Plant Engineering Work

Cost Estimation from 2D Model

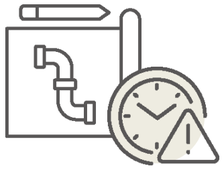


Low Accuracy of Cost Estimation

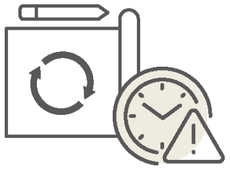
Cost Overrun

Frequent Design Change

Time Consuming Piping Design



Significant Time Required to Update Changes



Schedule Delay

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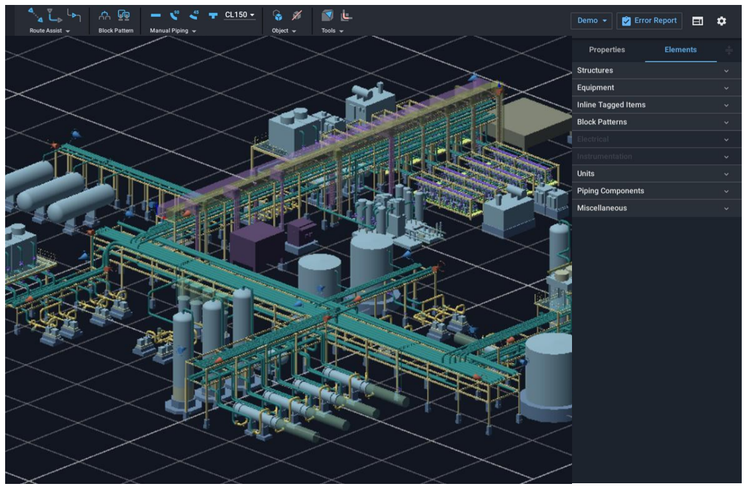
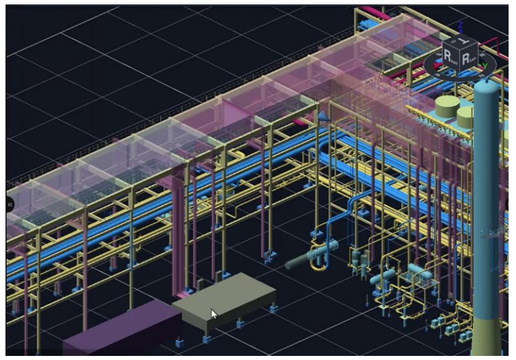
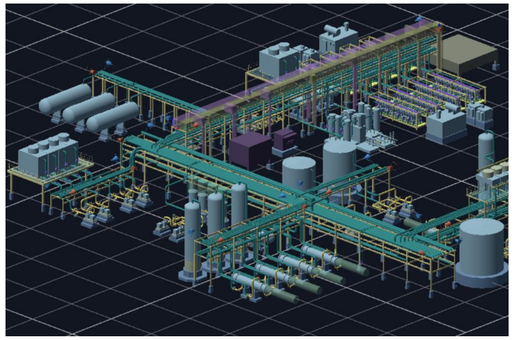
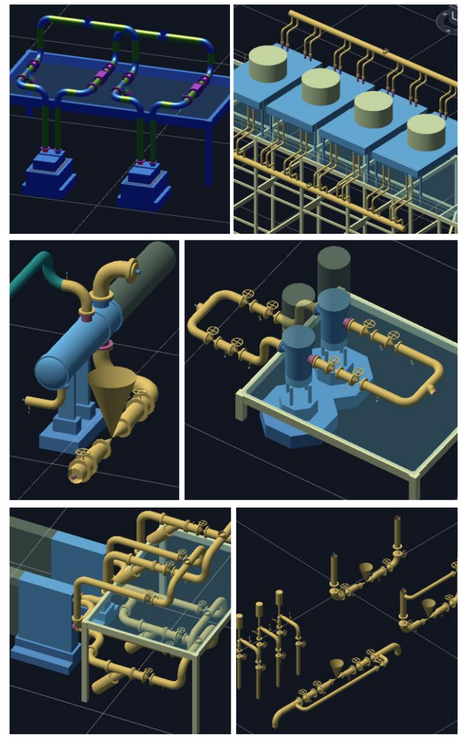


Auto Routing





Block Pattern



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Workflow with Auto Routing

Process Design PFD/UFD → Process / System Design P&ID/ UHD

Conventional Engineering Flow

FS → Pre-FEED → FEED → EPC

2D Design
Overall Plot Plan/ Unit Plot Plan General Route Study

3D Model Design
Basic Piping Design Manual

With Auto routing CAD

FS → Pre-FEED → FEED → EPC

Stage 1 :
Automatic (Route Assist) Plot Plan / General Route Study

Stage 2 :
Adjust auto routing Basic Piping Design

Stage 3 :
Detail design

Shortened Schedule

Auto routing CAD → Conventional CAD

With Auto Routing, by centralizing workflow, adjustment work for changes is remarkably reduced.
This enables about 75% cut in man-hours for initial 3D spatial design.

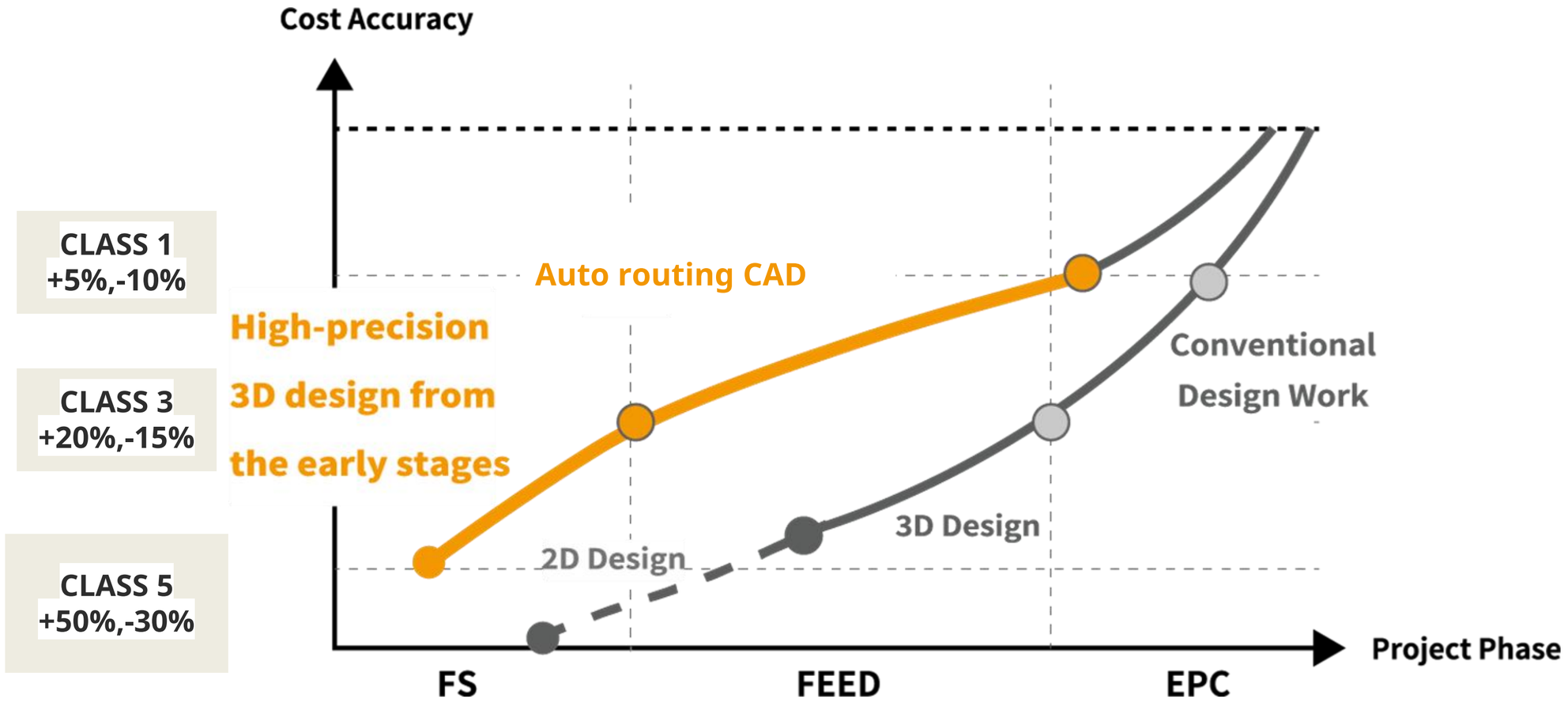
Actual PJ example

1 Petrochemical plant unit, 60 equipment pieces, 220 lines (FEED Level)

No	Tasks	QTY	General 3D CAD effort (Operator : Designer)	**Auto Routing CAD** (Operator : Administrative staff)
1	Equipment & Structure Model	60 equip	120 hours	30 hours
2	Pipe Model	220 lines	440 hours	110 hours
		Total	**560 hours**	**140 hours**

Up to 75% in Man Hours saved!

Improving the Estimation Accuracy of Initial Design



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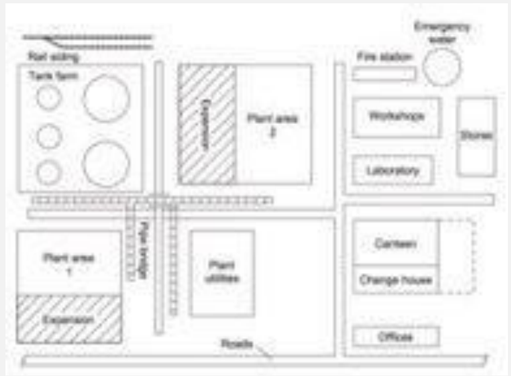
Conventional Engineering Flow

Only able to create one layout due to time constraints on FS or FEED.
No time to do further design study to consider cost reduction and better quality design.

Layout A



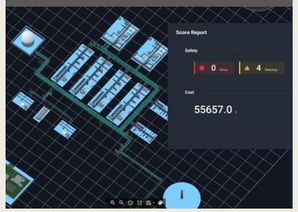
pipe weight (ton)
69,940
pipe rack weight (ton)
55,657

Total 125,597

With Auto Routing CAD

Easily create multiple layouts by using high speed-and-high accurate auto routing function with Auto Routing CAD.
Reduce the material cost of Plant by simulating multiple scenarios and choosing the best case.

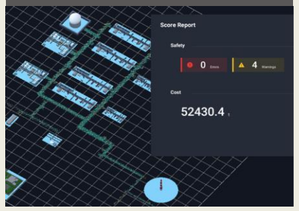
Layout A



pipe weight (ton)
69,940
pipe rack weight (ton)
55,657

Total 125,597

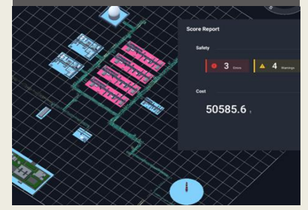
Layout B



pipe weight (ton)
68,740
pipe rack weight (ton)
52,430

Total 121,170

Layout C



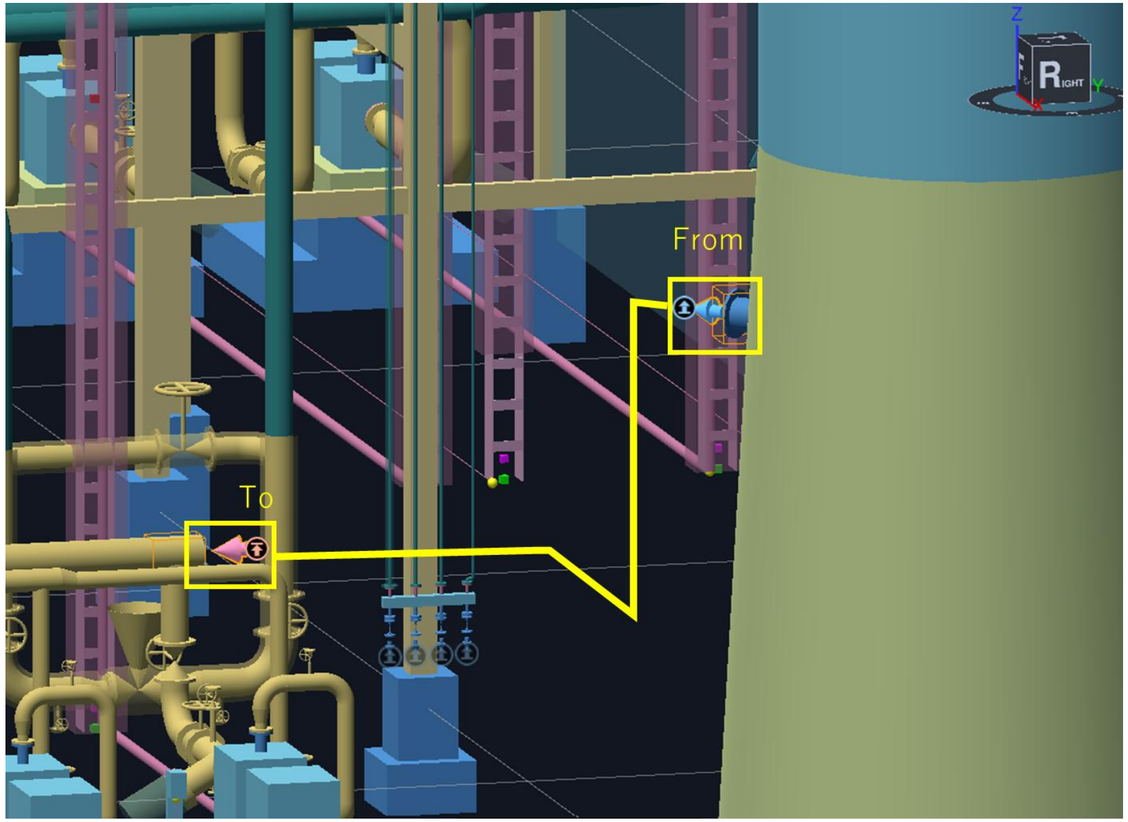
pipe weight (ton)
59,617
pipe rack weight (ton)
50,586

Total 110,203

Reduction of 15,394 ton

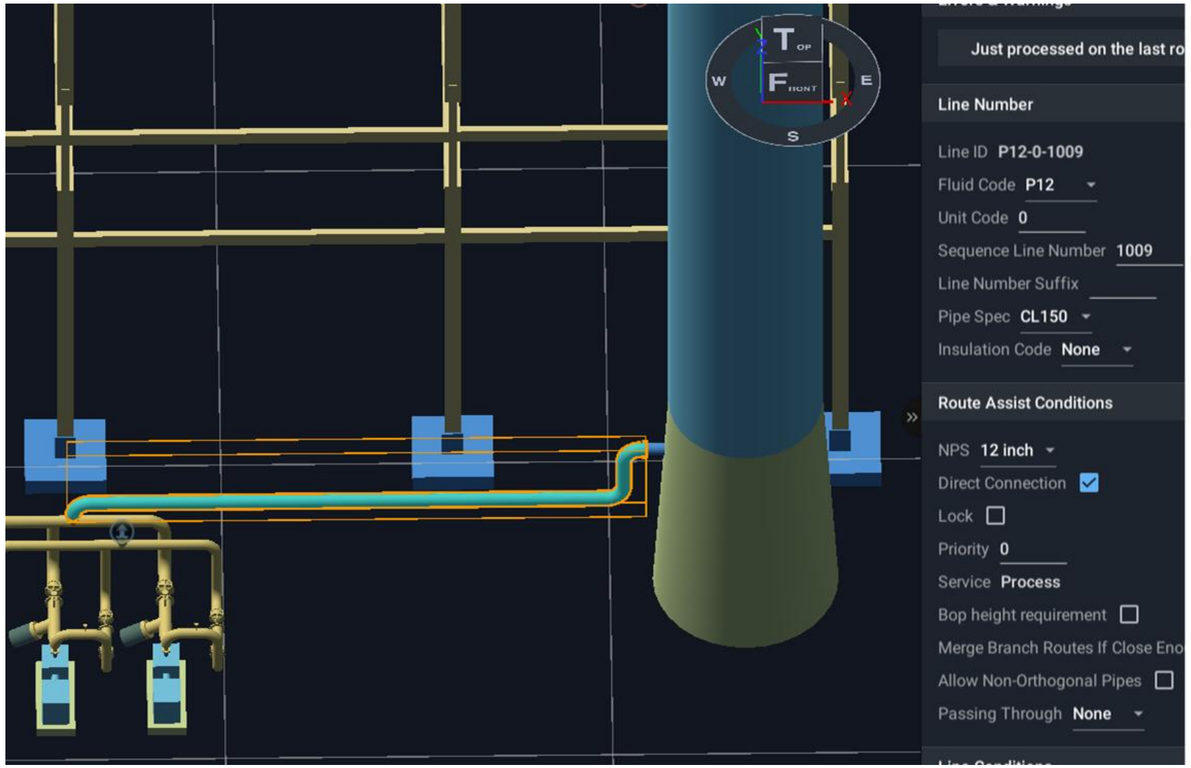
2. Routing Algorithms

Auto-Routing Basic Concept

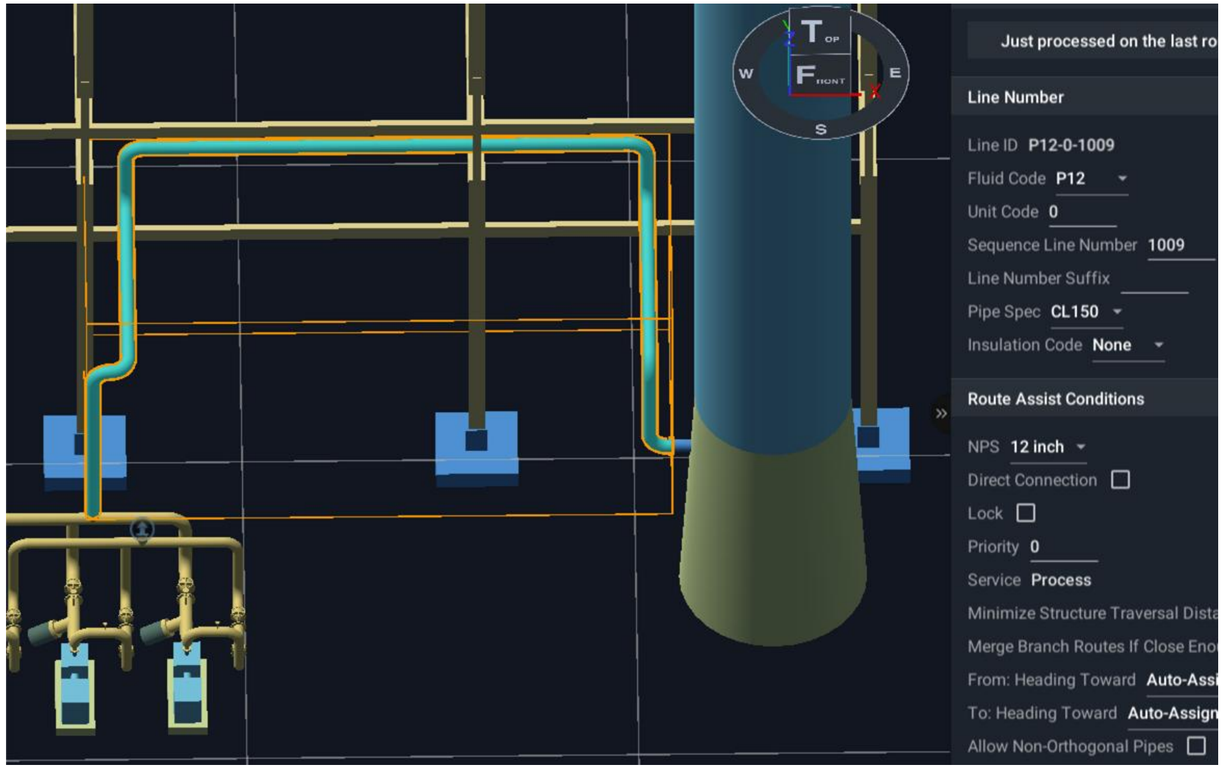


- A line is created and routed automatically, by connecting From&To points, such as nozzles or pipe rack battery limits.
- Line size is as per nozzle size, as default. If they are not consistent, smaller size and reducer are automatically applied.
- “All route” is the command to refresh all routings. “Re-route selected” can re-route only selected lines.

Direct Connection/ via Pipe Rack



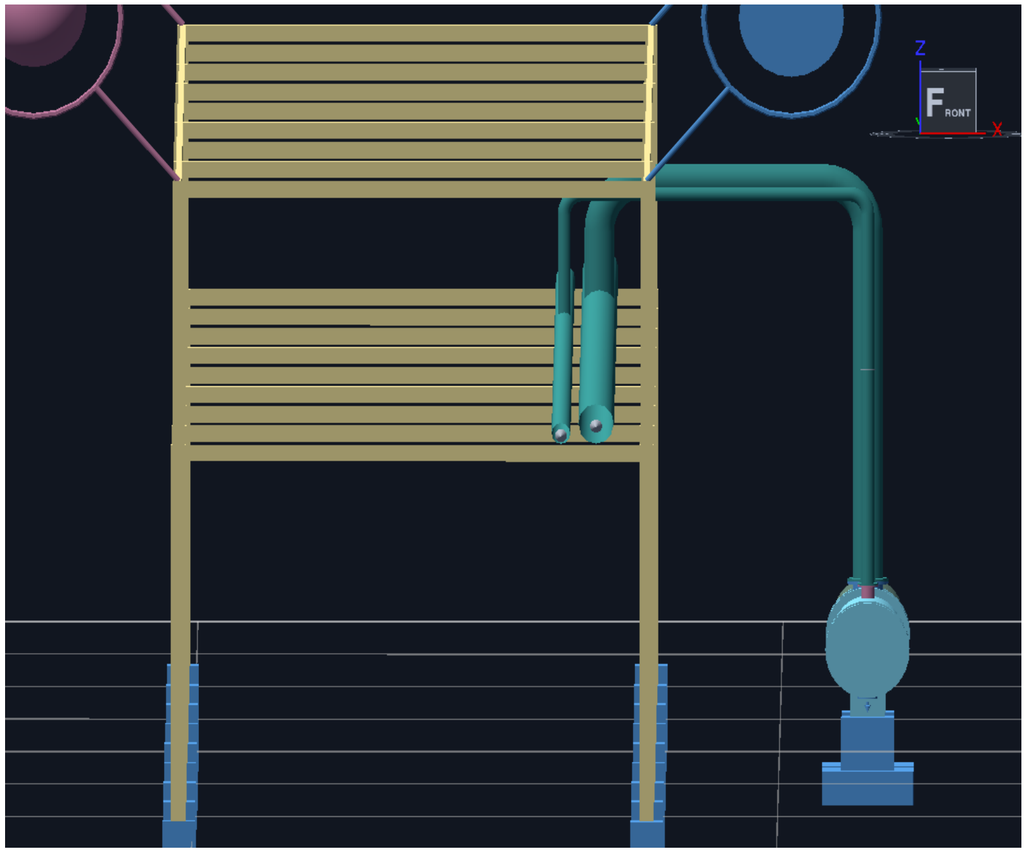
Direct Connection

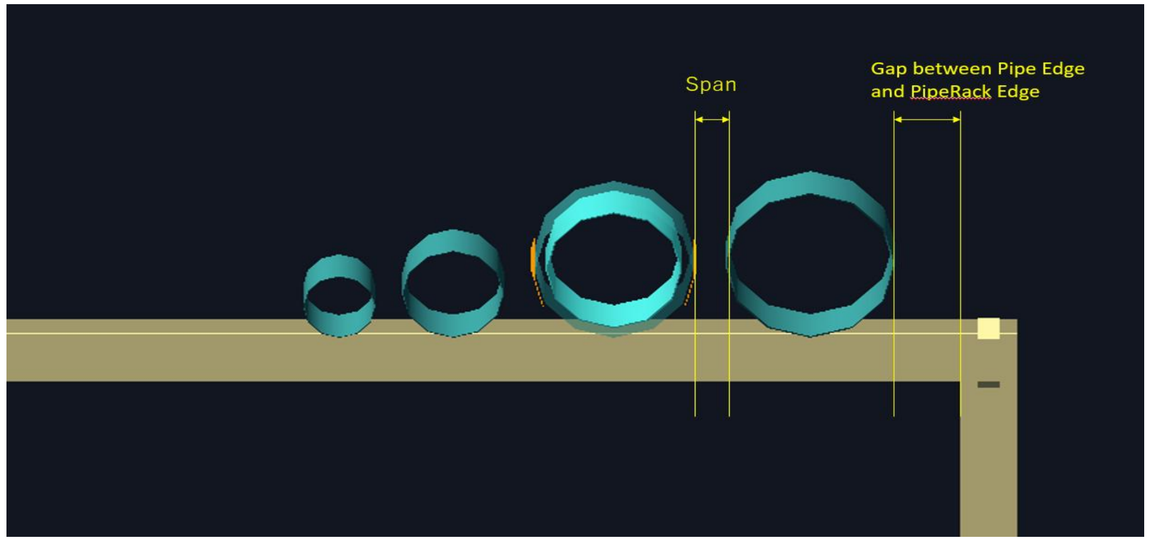


Via Pipe Rack

- With Direct Connection, From and To points are connected directly, in shortest and minimum elbows, without clashes.
- With via Pipe Rack condition, the line is forced to be routed on the nearest pipe rack.

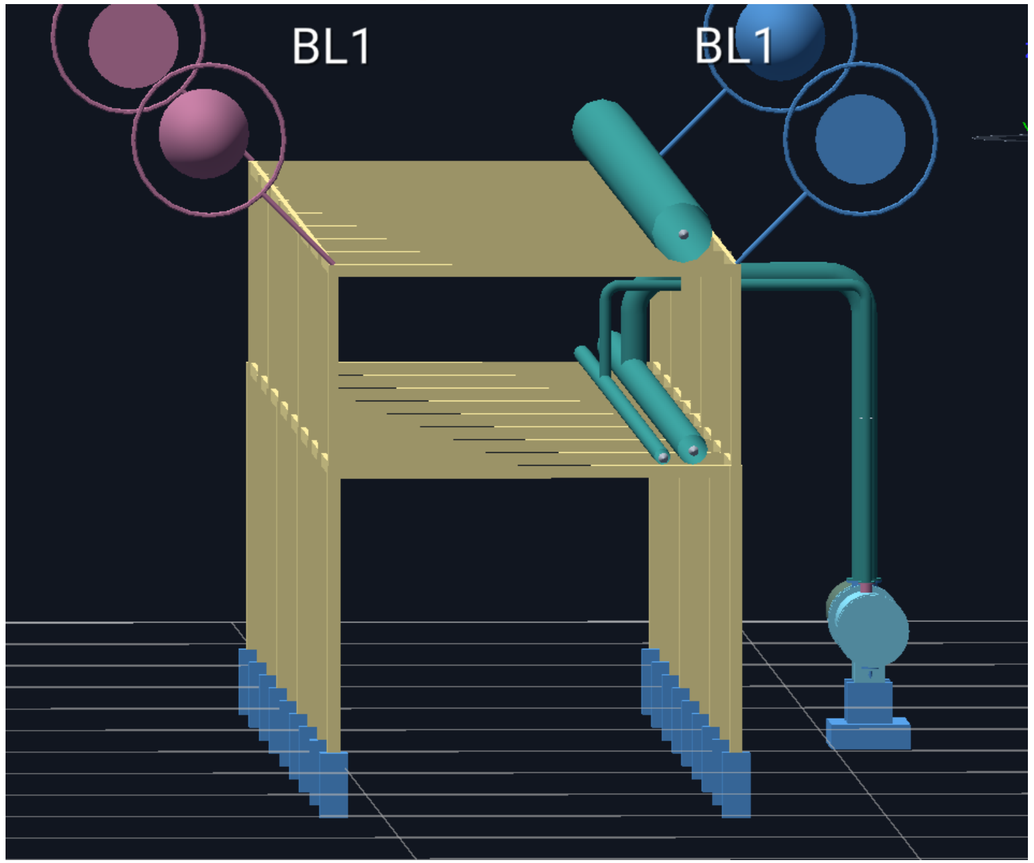
Place Piping on Pipe Rack

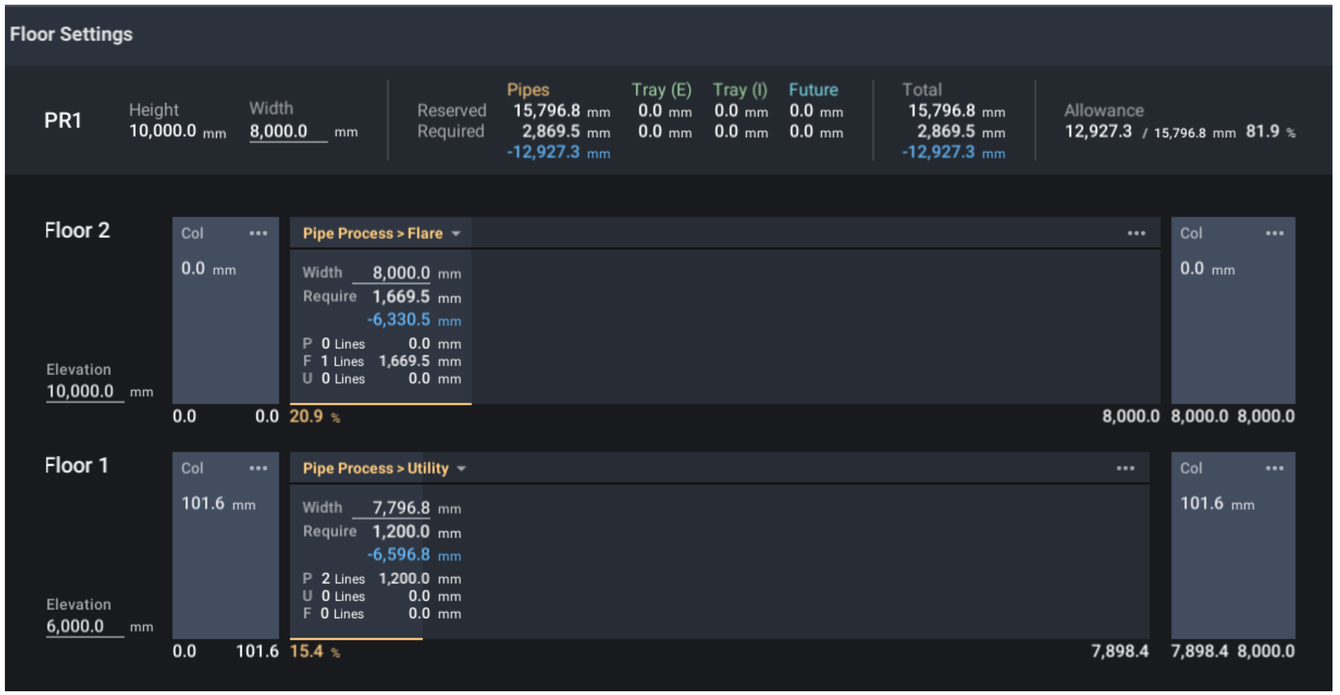




- Piping are routed ONE by ONE during auto-routing, from bigger bore lines to the smaller, filling from edge of pipe rack.
- Spacing and spans between pipes on pipe racks are automatically applied as per Preference or DataBase setting.
- The lines on the pipe rack is placed initially considering shortest pipe length including branch lines.
- Routing Priority, which goes initially from larger bore lines to smaller, can be changed in FromTo List.

Assign Layer on Pipe Rack

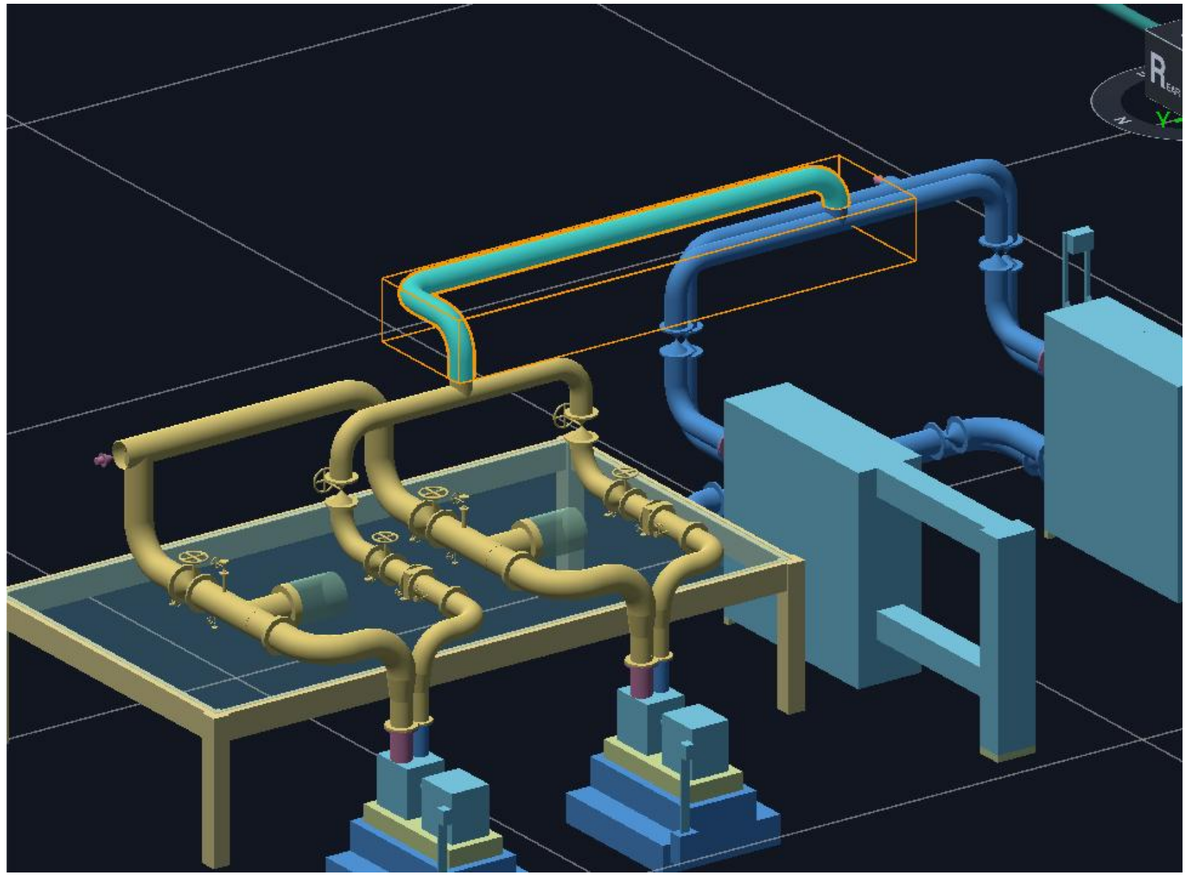


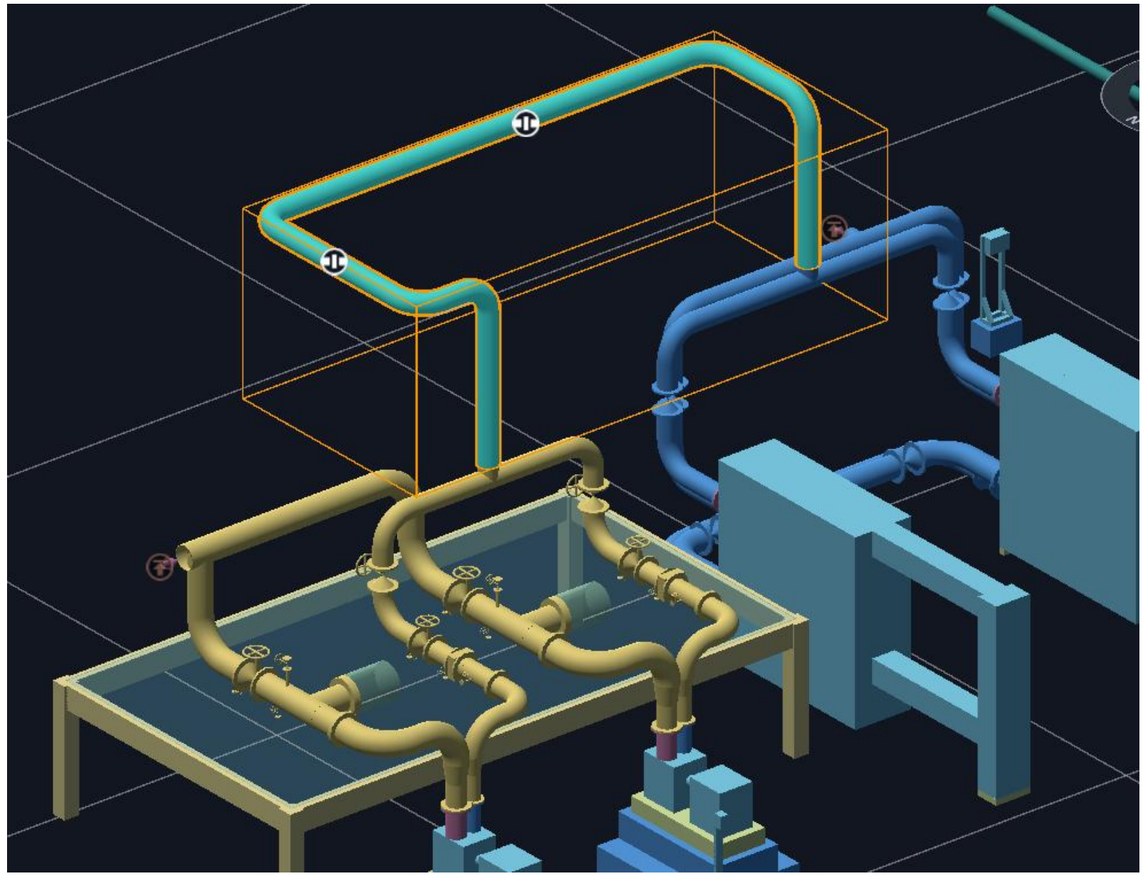


Floor Settings on a Pipe Rack

- Layer for each line on pipe racks is automatically assigned, based on “Floor settings”, process requirement, or space occupancy for each pipe rack, without any clashes with previously routed lines.
- In case there are some options, below layer is assigned first.

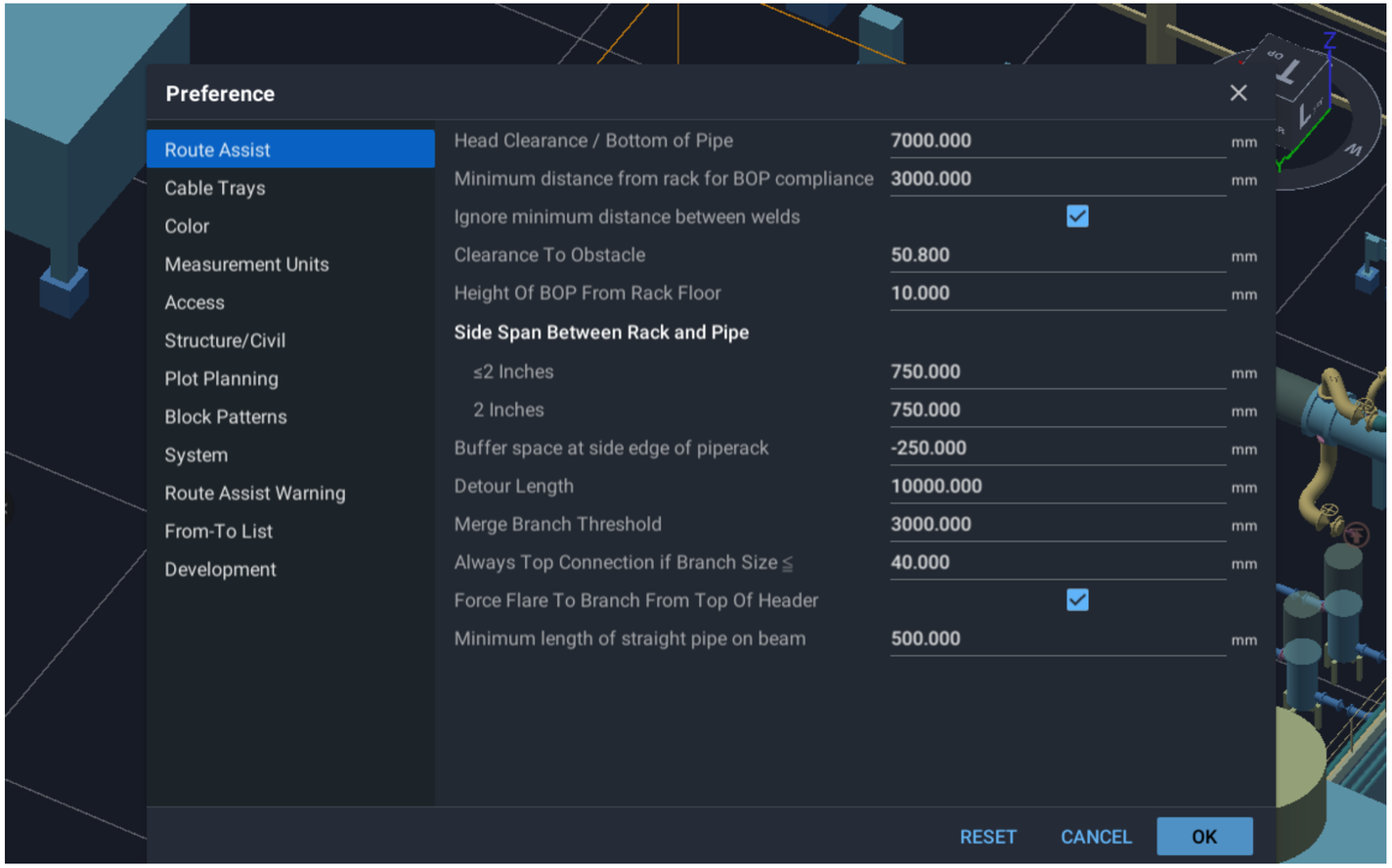
PassPoint





- With PassPoints for a line, the line is forced to be routed on the pass points, which allows users to create any piping configurations as per user's ideas.

User Routing Preferences



- General auto-routing conditions, such as BOP, head clearance, pipe spans on pipe racks, can be adjusted as per user's preferences or requirements, in Preference setting.

3. Process Requirements

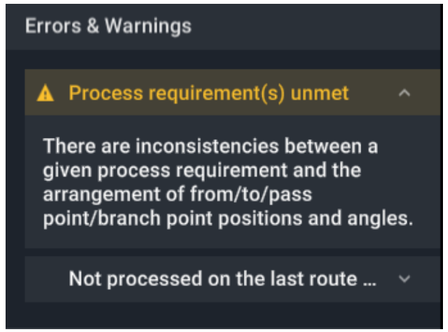
Process Requirements Setting method

Select each route to be set and set the process request as shown below.

- Select from the "Process Requirements" pulldown in Line Conditions.
- No Drain Pocket
- No Vent Pocket
- No Pocket
- Free Drain (Drain)
- Free Drain (Vent)
- None

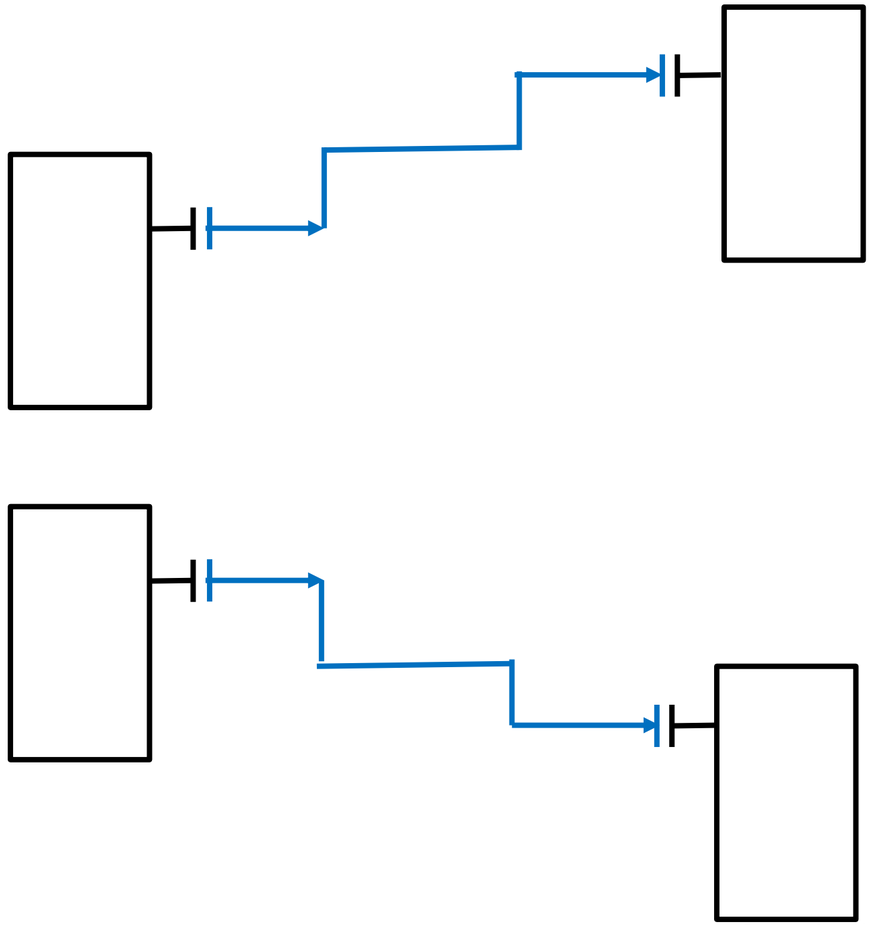
Each routing shape will be explained from the next sheet.

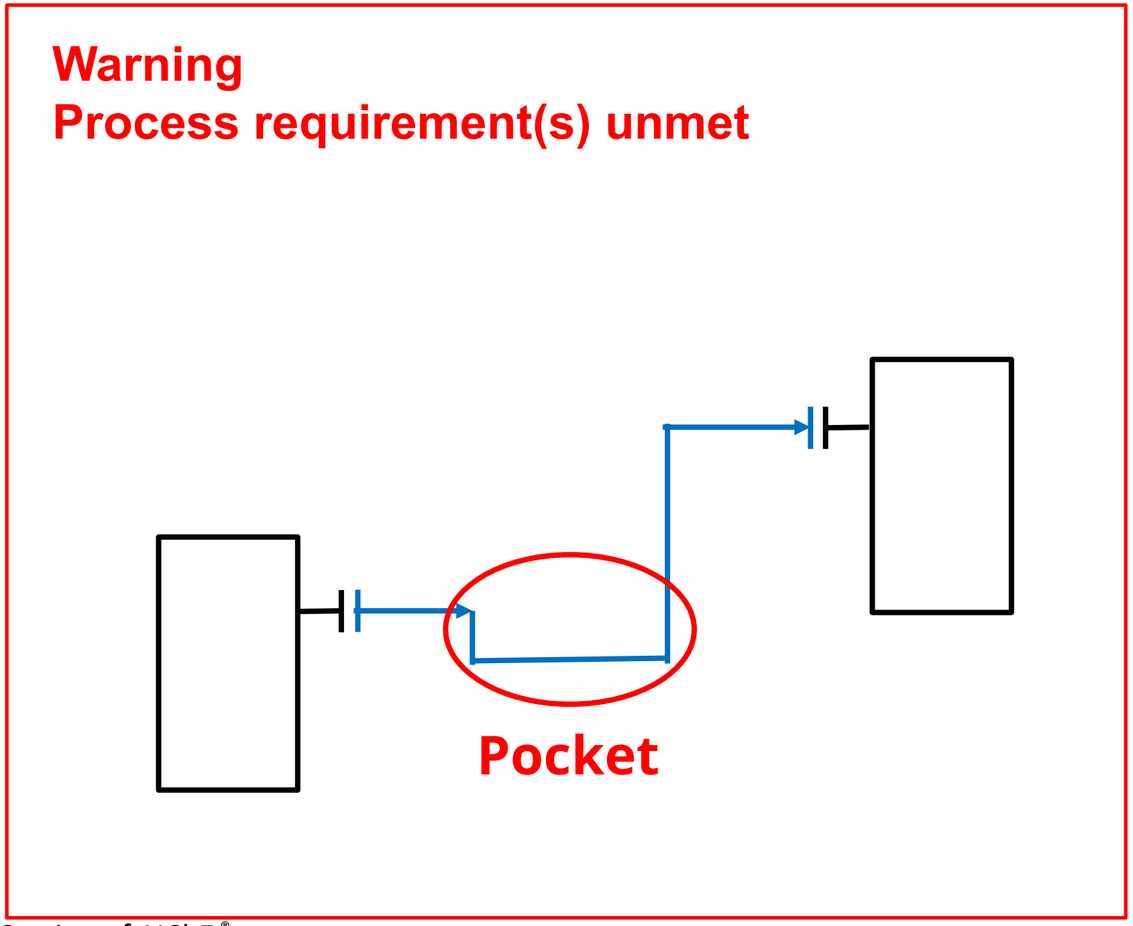
If the requested route cannot be achieved due to reasons such as the location of the rack or equipment model, a warning "Process requirement(s) unmet" will be announced as shown in the figure on the right.
The route shape that causes a warning is also listed on the next sheet.



① No Pocket

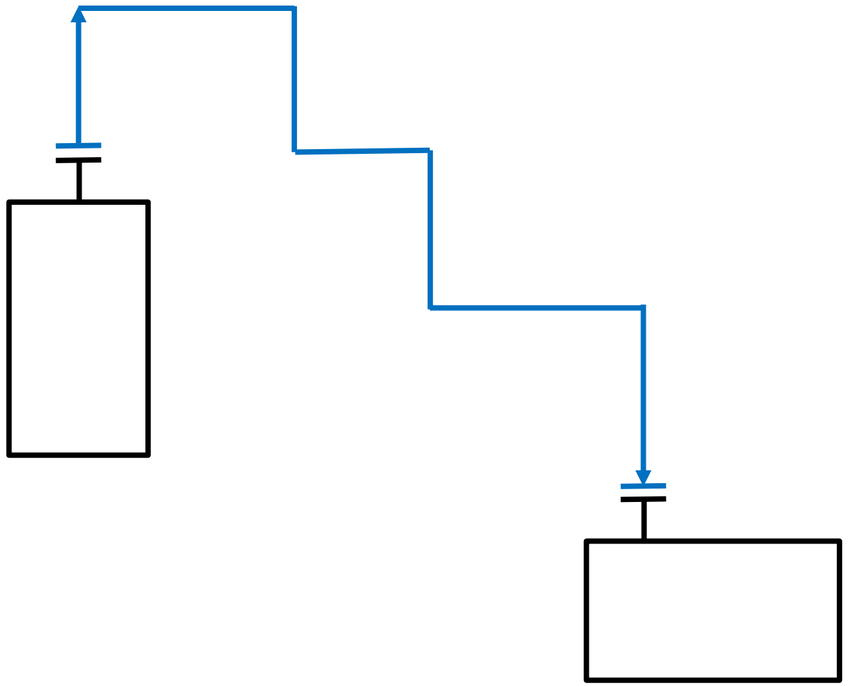
This is a route shape with no drain pocket or vent pocket.
If Pocket is on the route, a Warning announcement will be displayed as shown in the image on the right.

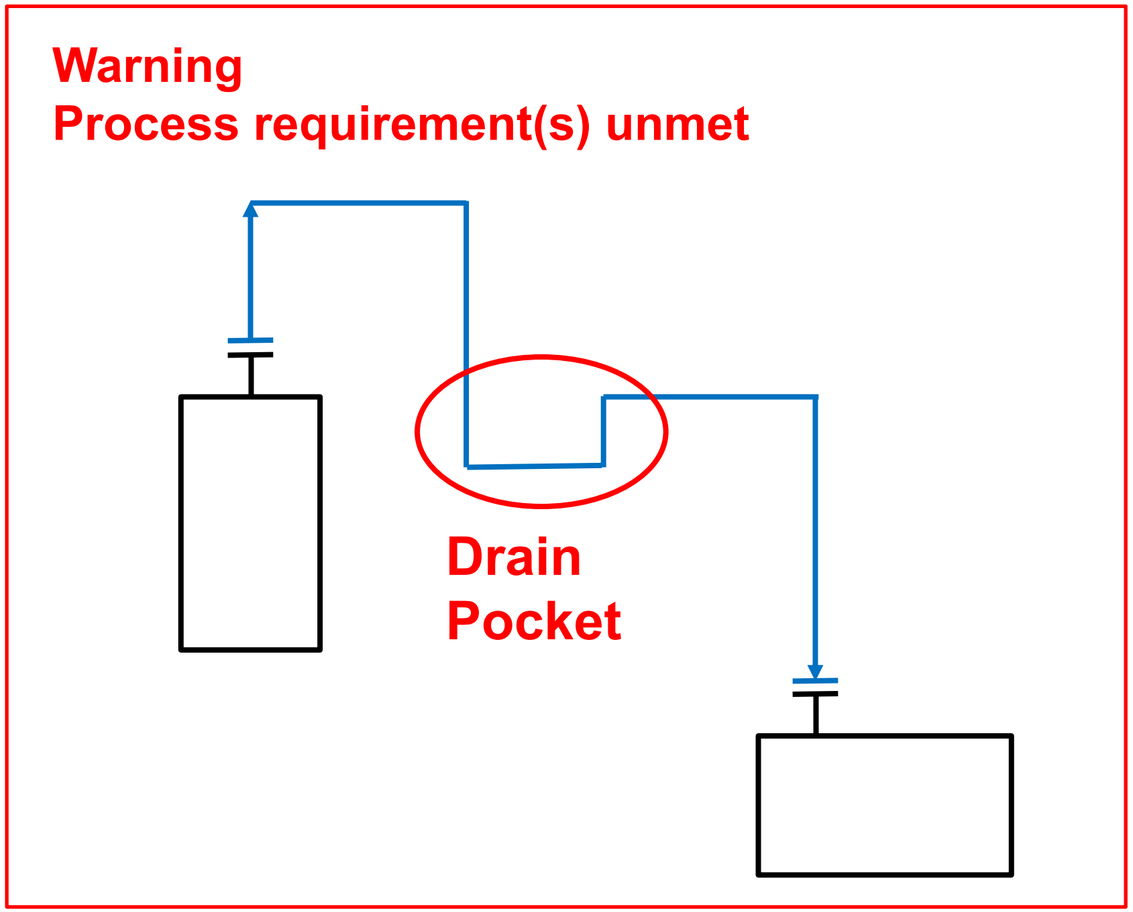




② No Drain Pocket

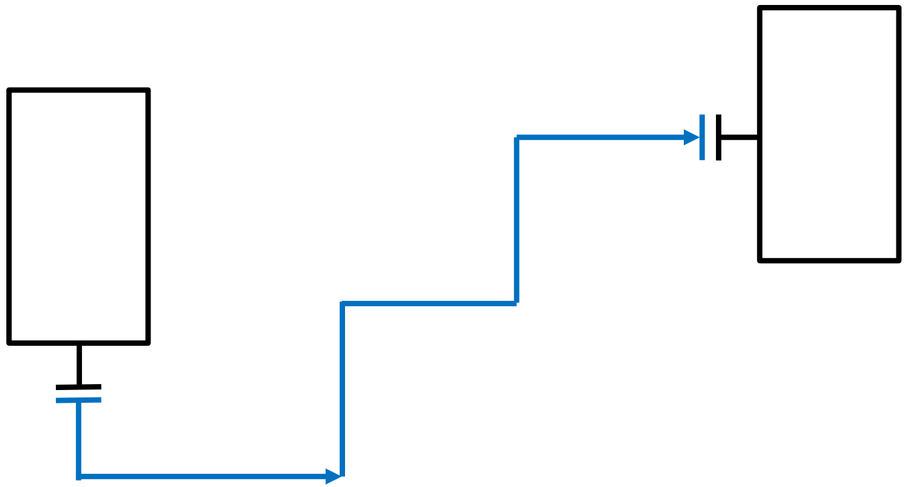
This is a route shape without a drain pocket.
If there is a Drain Pocket on the route, a warning announcement will be displayed as shown on the right.

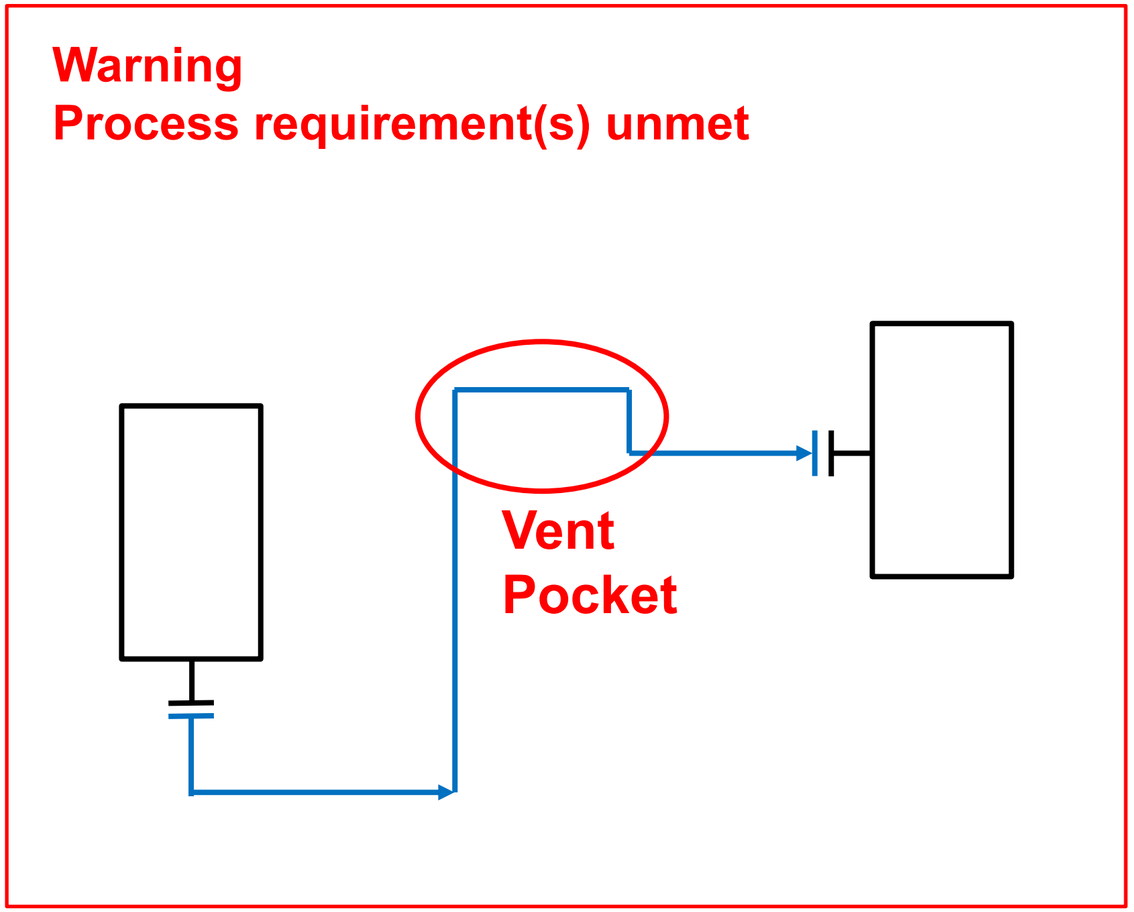




③ No Vent Pocket

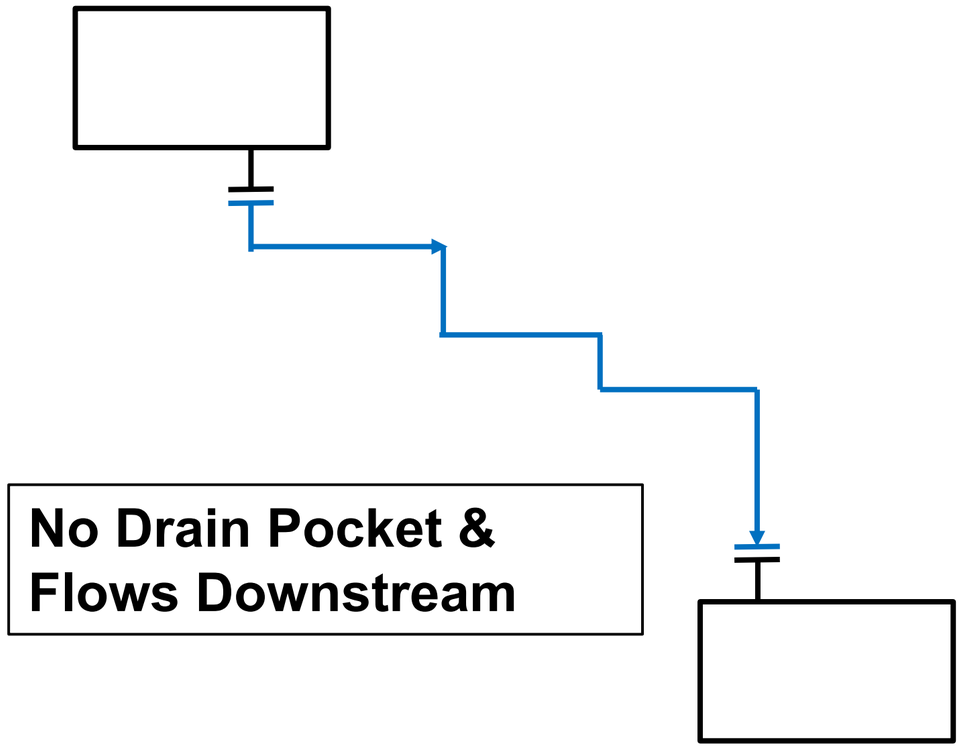
It is a route shape without a Vent Pocket.
If there is a Vent Pocket on the route, a Warning announcement will be displayed as shown in the image on the right.

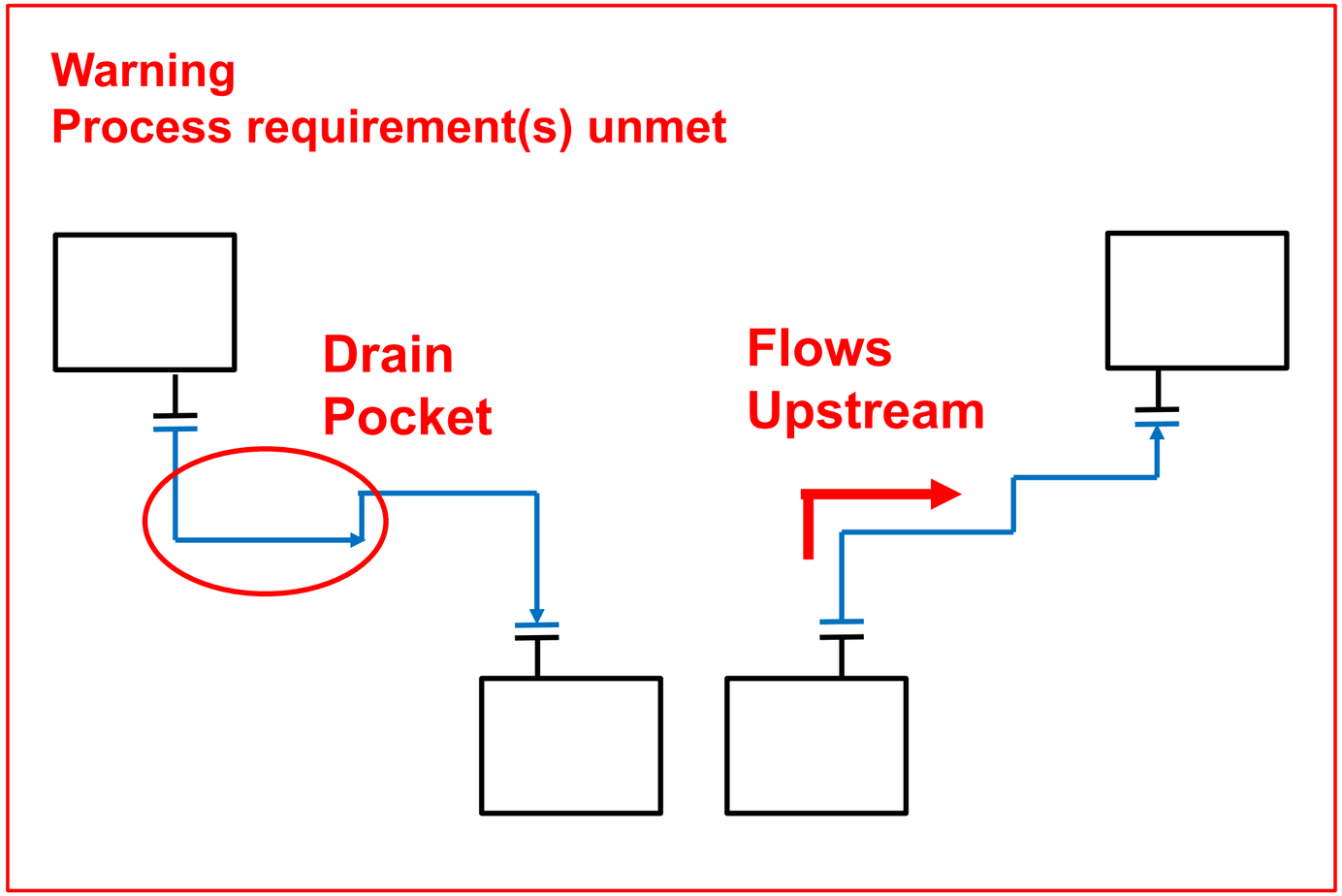




④ Free Drain (Drain)

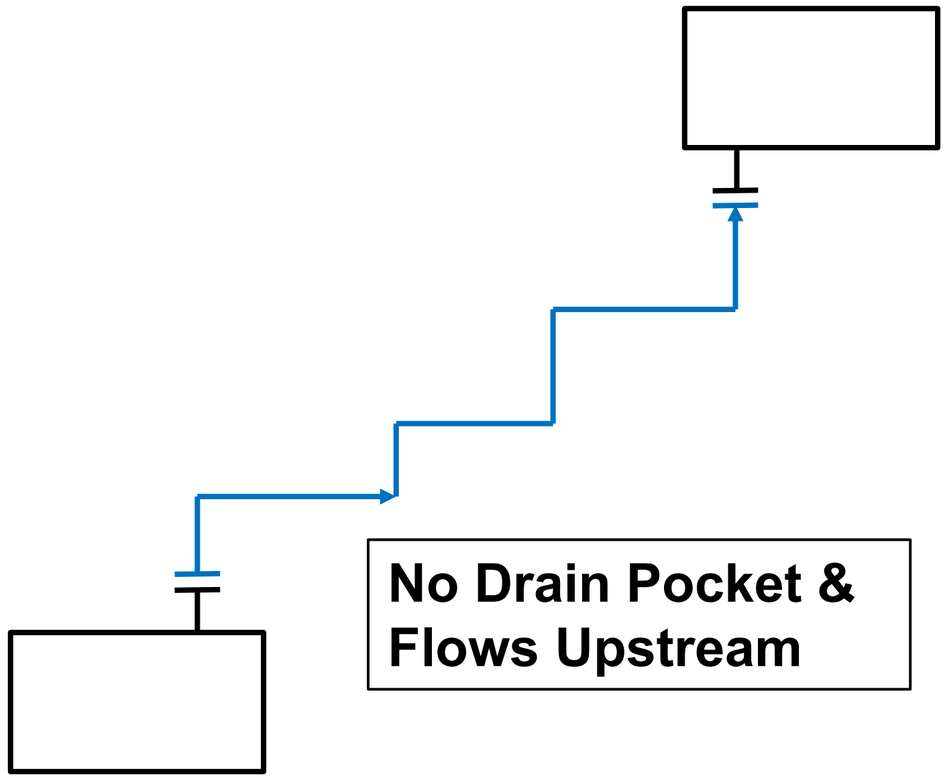
The route has no drain pocket and flows downstream.
If the route has a Drain Pocket or the route flows upstream, a warning announcement will be displayed as shown in the image on the right.

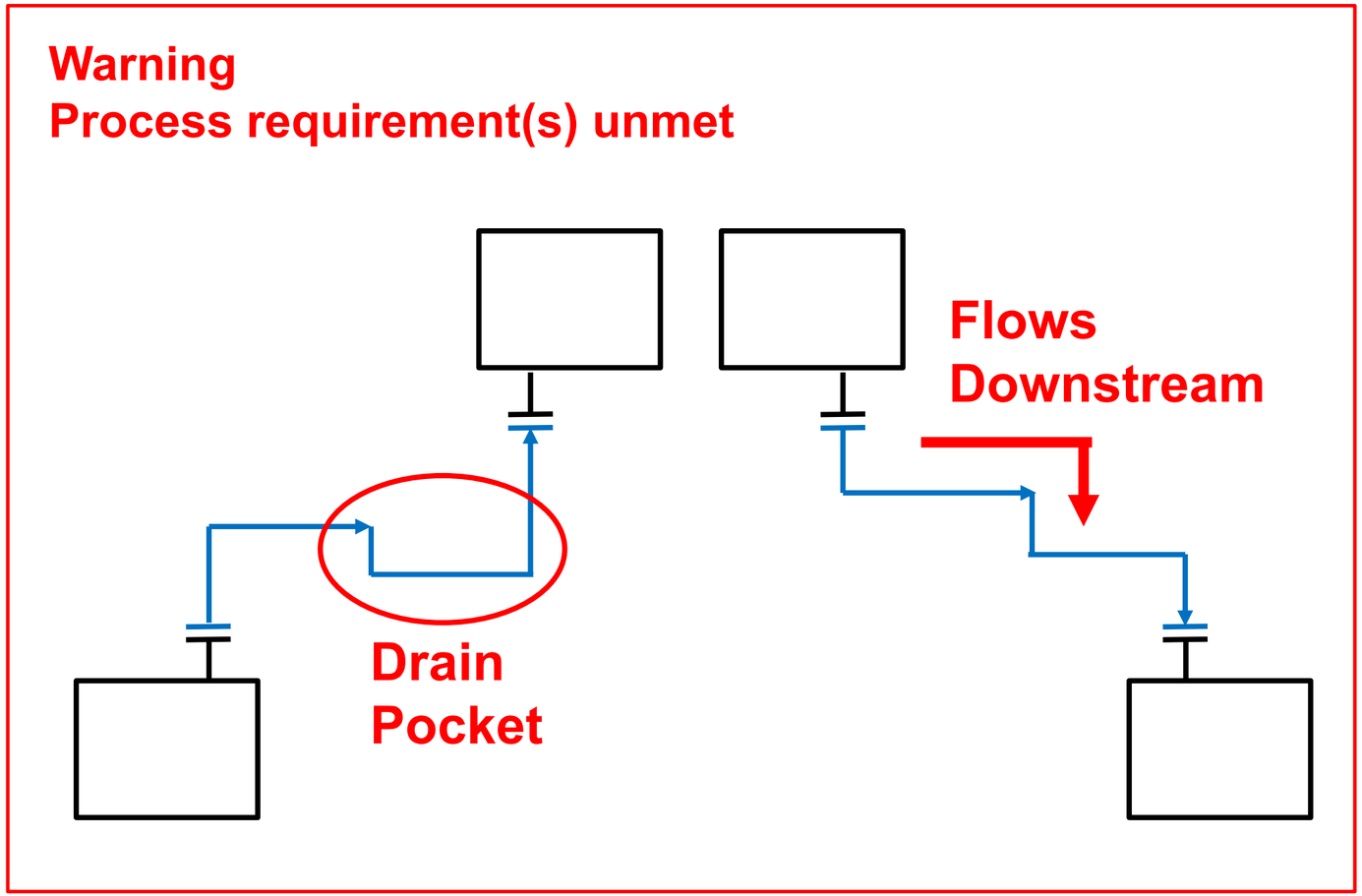




⑤ Free Drain (Vent)

The route has no drain pocket and flows upstream.
If the route has a Drain Pocket or the route flows in the downstream direction, a warning announcement will be displayed as shown in the image on the right.





4. P&ID Interpretation for Auto Routing

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Current Workflow

P&ID

Intelligent P&IDs

CSV

From-To List

Manual conversion work required!

Import

Auto Routing CAD

With AI:
Faster design process
Reduce human errors

Workflow with AI

P&ID Import → Run with AI → Line, Nozzle, Equipment Recognition → Check → From To List → Import to Auto Routing CAD → Auto Routing

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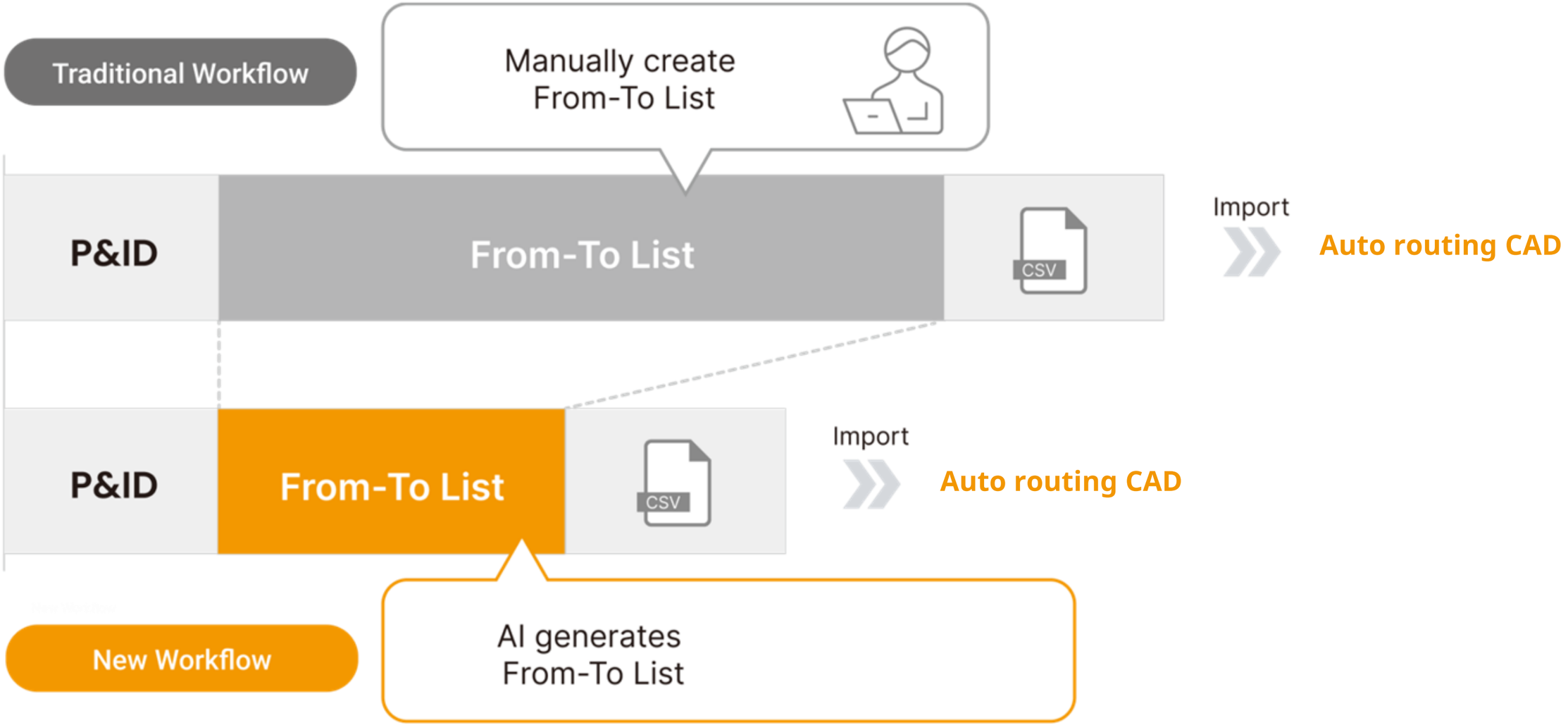

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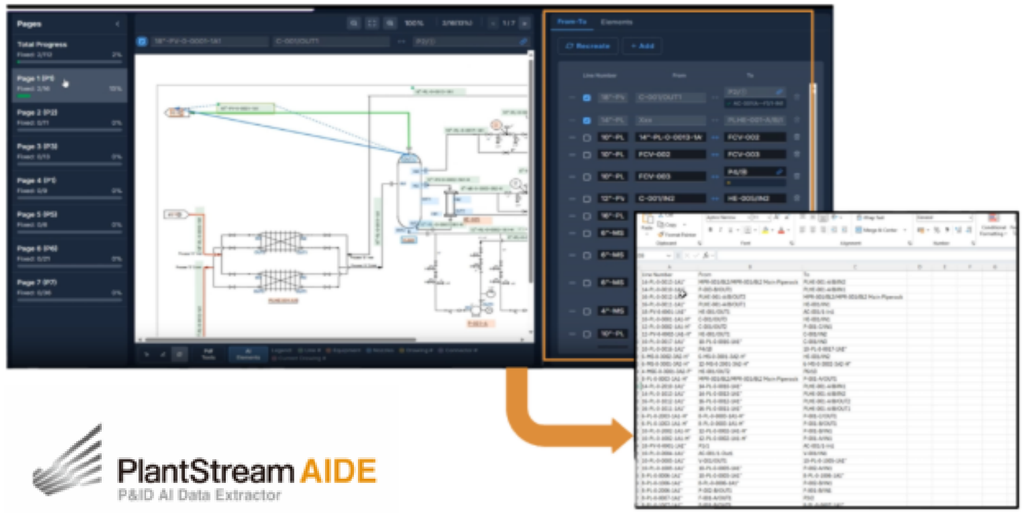
Eliminate Time-Consuming Manual Work with AI

AI extracts piping connection data and enables one-click generation of From-To Lists that can be imported directly into PlantStream.

From-To List Creation Man Hour
Maximum **50** % Reduction

Total Design Man Hour
Maximum **74** % Reduction

*According to our research



- AI analyzes P&ID diagrams and extracts line, nozzle, and equipment IDs
- Misidentified items can be easily reviewed and corrected with a single click
- Automatically generates From-To Lists for direct import into PlantStream
- Batch auto-piping design using the AI-generated From-To List and auto-routing feature
- Streamlines identification of changes when P&ID diagrams are updated

Implementation Benefits

Reduce Man Hour

by up to 74%

Significantly Reduce

Human Error

Reflect P&ID Changes Instantly

in the 3D Model

In near futures

1

From to List and P&ID

P&ID serves as the foundational reference for routing logic and connectivity.

- Line List extraction
- Cross-reference table between Line List and From-To List
- Marked-up P&ID for From-To List and Nozzle ID
- Support for P&ID Revisions

2

MTO (Material Take Off) and Cost Estimation

Automating MTO improves accuracy and efficiency across BM, BQ, and Cost Estimation.

- SP/ Instrument/ Equipment List
- Manual Valve MTO and Auto-Placement
- Enables accurate BM (Bill of Materials) and BQ (Bill of Quantity) calculations
- Integration with ACCE (Aspen Capital Cost Estimator)
- High-precision cost estimation by integrating MTO data with ACCE

AI-powered extraction of critical information from P&IDs to automate key tasks such as Auto Routing, MTO, and Cost Estimation!

5. Conclusion & Outlook

Conclusion & Outlook

- Auto-routing dramatically improves piping design efficiency, achieving man-hour savings in the initial 3D spatial design phase.
- High-speed routing allows multiple layout simulations, enabling material cost reduction and improved design quality through better scenario selection.
- Looking ahead, AI- and P&ID-driven integration will further bridge process and piping engineering, supporting a more connected and data-driven plant engineering workflow.

PlantStream

Thank You