Electrical Tutorial

Routing Cables

Version 2014

PART OF HEXAGON

INTERGRAPH®

Copyright

© 2002-2014 Intergraph® Corporation and/or its affiliates. All Rights Reserved.

Warning: This computer program, including software, icons, graphical symbols, file formats, and audio-visual displays; may be used only as permitted under the applicable software license agreement; contains confidential and proprietary information of Intergraph and/or third parties which is protected by patent, trademark, copyright and/or trade secret law and may not be provided or otherwise made available without proper authorization.

Restricted Rights Legend

Use, duplication, or disclosure by the Government is subject to restrictions as set forth in subparagraph (c) (1) (ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.227-7013 or subparagraphs (c) (1) and (2) of Commercial Computer Software -- Restricted Rights at 48 CFR 52.227-19, as applicable.

Unpublished - rights reserved under the copyright laws of the United States.

Terms of Use

Use of this software product is subject to the End User License Agreement ("EULA") delivered with this software product unless the licensee has a valid signed license for this software product with Intergraph Corporation. If the licensee has a valid signed license for this software product with Intergraph Corporation, the valid signed license shall take precedence and govern the use of this software product. Subject to the terms contained within the applicable license agreement, Intergraph Corporation gives licensee permission to print a reasonable number of copies of the documentation as defined in the applicable license agreement and delivered with the software product for licensee's internal, non-commercial use. The documentation may not be printed for resale or redistribution.

Warranties and Disclaimers

All warranties given by Intergraph Corporation about software are set forth in the EULA provided with the software or with the applicable license for the software product signed by Intergraph Corporation, and nothing stated in, or implied by, this document or its contents shall be considered or deemed a modification or amendment of such warranties.

Intergraph believes the information in this publication is accurate as of its publication date. Intergraph Corporation is not responsible for any error that may appear in this document. The information and the software discussed in this document are subject to change without notice.

Trademarks

Intergraph and the Intergraph logo are registered trademarks of Intergraph Corporation. Hexagon and the Hexagon logo are registered trademarks of Hexagon AB or its subsidiaries. Microsoft and Windows are registered trademarks of Microsoft Corporation. Other brands and product names are trademarks of their respective owners.

SESSION 9

Routing Cables

Objective

By the end of this session, you will be able to:

- Route a cable in SP3D.

Before Starting this Procedure

- Smart 3D Overview
- Smart 3D Common Sessions
- Electrical Overview
- Integration with SmartPlant Electrical (SPEL)

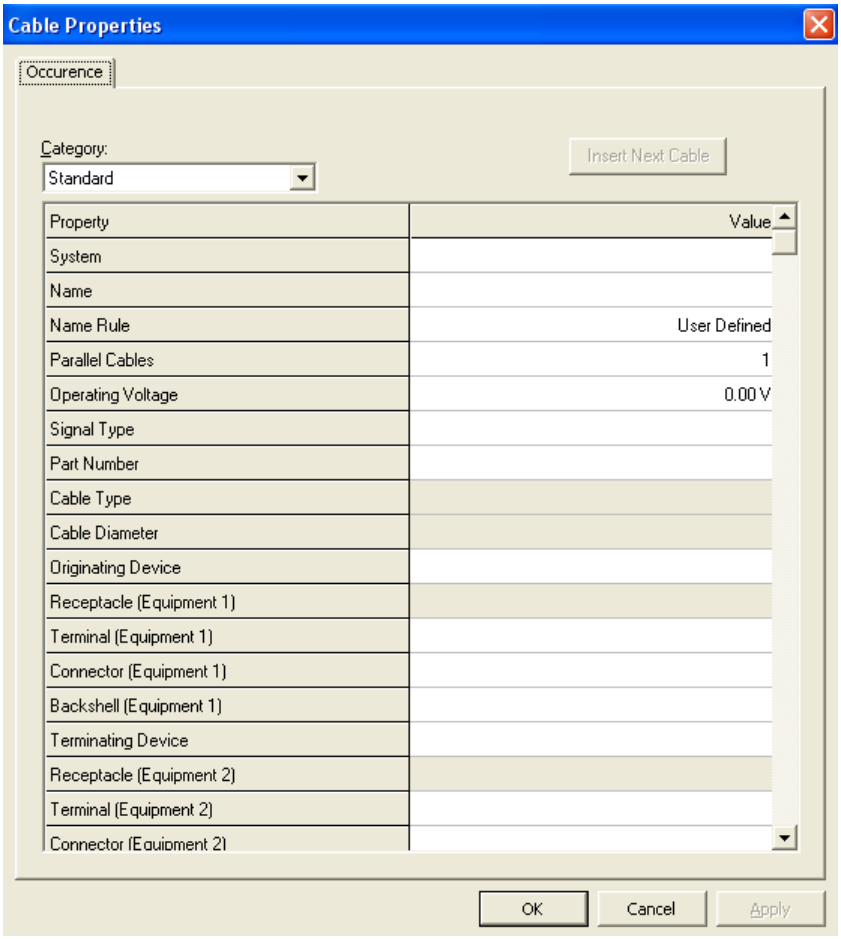
Overview

In the Electrical task, you can create cables and route them through the existing conduits and cableways. **Route Cable** allows you to define cable properties, such as the name, part number, and equipment to which the cable is connected. You can also use **Retrieve** to return cable definitions from SmartPlant Foundation that were defined by the SmartPlant Electrical. For example, you can choose an electrical cabinet and a motor pump to connect them with a cable in the model.

There are two primary workflows to route cables:

- Manual cable routing
- Auto cable routing

Before you start routing cables, you need to be familiar with how cables are created and displayed in the 3D model. The **Cable Properties** dialog box allows you to create a single cable or parallel cables in the model.



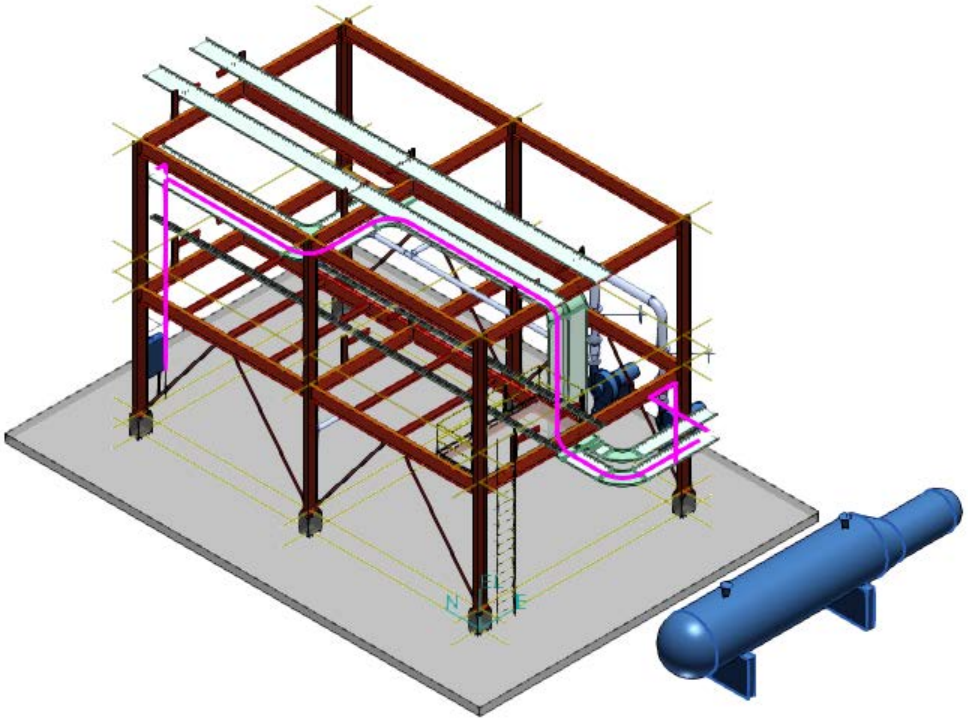
Cables do not have any persistent graphics of their own. Smart 3D uses temporary graphics to display the cable route generated from the path definition. When a cable is selected, a bold line shows the cable route in the selected color that traces the path of the cable as defined by the cable object. The path is along the centerline of the cableway and conduit and is a straight line from the cable exit point to the equipment terminal. A parallel cable is created by entering a number other than 1 in the **Parallel Cables** field.

This session covers the procedure for manual cable routing and auto cable routing.

Manual Cable Routing

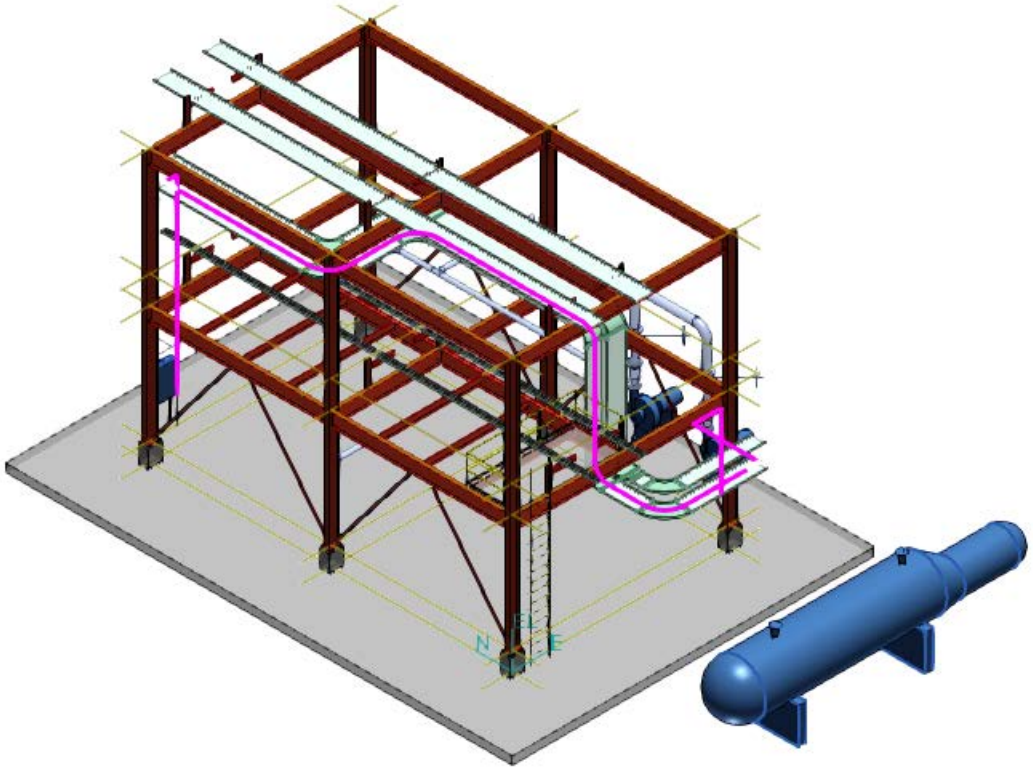
If you want to route a cable into a cable tray at some point along the length of the tray, you need to manually route the cable. For example, if you want to force the cable to go through a particular cableway or force the cable to detour a particular cableway, you manually route the cables. In this case, the cable needs to exit a conduit and then enter a cable tray. You can specify an entry point or exit point anywhere along a cable tray with **Set Entry Point** or **Set Exit Point**. You can also use **PinPoint** to assist in precise placement. One possible workflow for this example is to first branch the conduit out of the tray using **Route Conduit**. The software creates a connection between the conduit and cableway features. While routing the cable, you select the cableway that owns the tray and then do the same for the conduit run in the Select Cableways step. The software recognizes the connection between the two runs and makes the turn for you, trimming the path appropriately.

The highlighted portion below shows the cable path through the cable tray into the equipment terminals.



Manually Route Cables

Place a single cable, CC-001, from an electrical device to a pump in Unit U01 with **Edit Cable Path** .



Before beginning the procedure, define your workspace to display **Unit U01** and coordinate system **U01 CS**. Make sure that you are in the **Electrical** task and the **Active Permission Group** is set to **Electrical**.

1. Click **Insert Cable** .

   *The **Cable Properties** dialog box displays.*

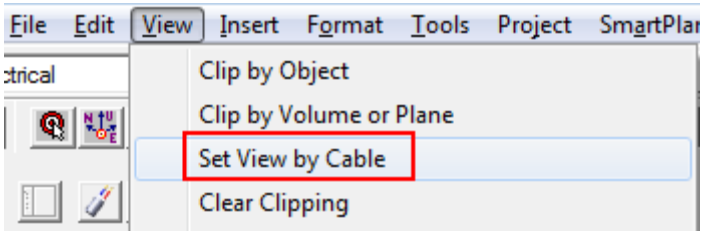
2. Define the following cable specifications, and click **OK**.

   System: A2\U01\Electrical\Low Voltage\Cables
   Name: CC-001
   Name Rule: User Defined
   Parallel Cables: 1
   Operating Voltage: 110.0 V
   Signal Type: Power
   Part Number: Cable\Cables\Power 0.6/1 KV (1 Conductor)\1 x1.5 mm^2 – 0.6/1KV XLPE 90 UA Cu

Originating Device: Electrical Device
Terminating Device: Pump-001

*The software automatically selects the created cable and opens the **Edit Cable Path** ribbon.*

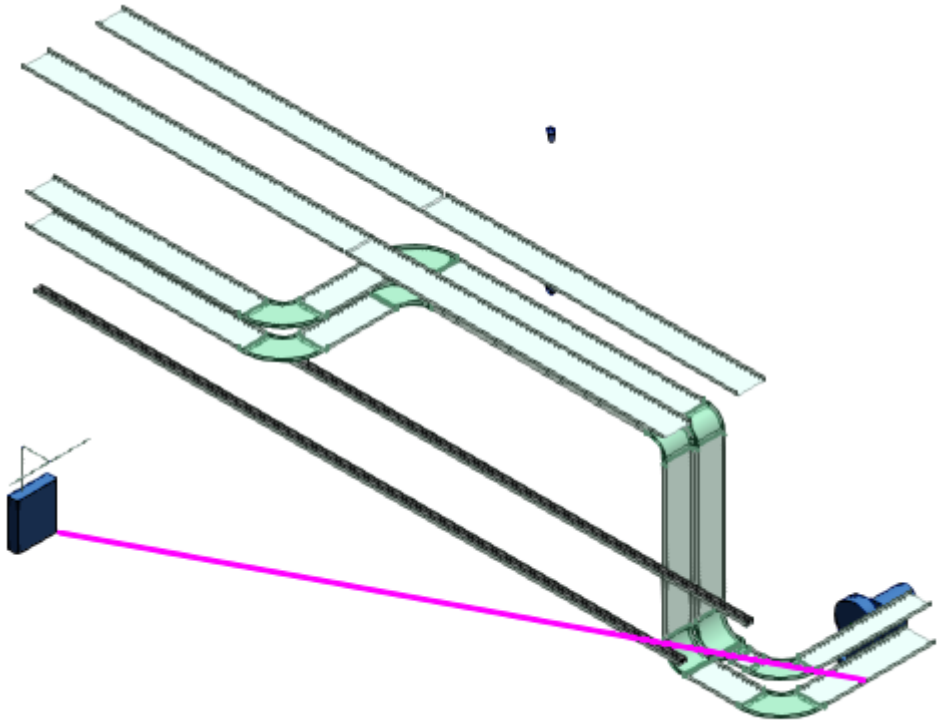
3. Select **View > Set View by Cable** to route cable by only showing the required objects and hiding the objects that are not required in the model.



In order to help you in determine the route, this command does the following:

- Hides structural, piping, HVAC, and other objects that you do not need.
- Hides all equipment not associated with the selected cable.
- Displays all conduit and cableways that are in the immediate vicinity of the equipment you are selecting. These objects are the most likely to be used for connecting the equipment with cable.
- Displays all conduits and cableways connected to those in the vicinity. As an extra measure to ensure that a viable cableway or conduit is not left out, the branches are included as well.
- Displays all conduits and cableways that the cable currently runs through.
- Shows hangers supporting these cableways and conduits. These hangers are important reference points for you during routing.
- Automatically zooms to view the volume of interest.

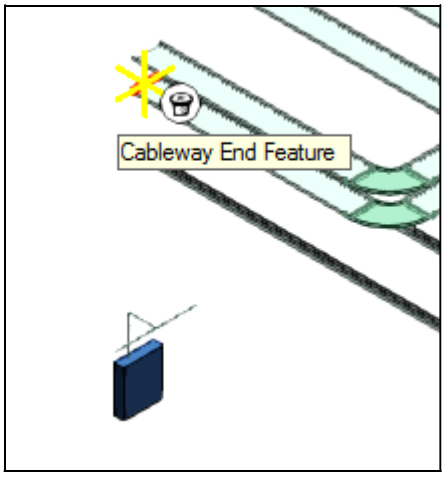
The selected cable is highlighted in the graphic view.



4. Click **Set Entry Point** .

   The system prompts for an entry point position on the cableway.

5. Select the cableway end feature of the bottom tray.



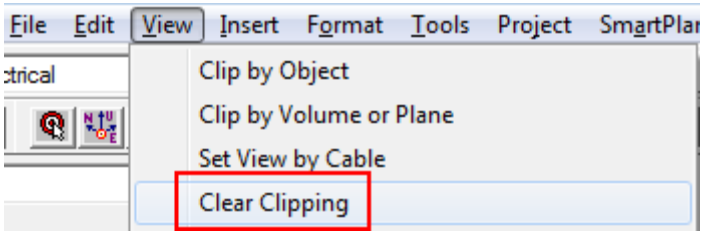
   The system shows the cableway path.

6. Ensure that the cable goes through the bottom tray, and click **Accept Selection** .
7. Click **Set Exit Point**

The system prompts for an exit point position on the cableway.

8. Select the cableway end feature at the other end of the bottom tray to specify the exit point.

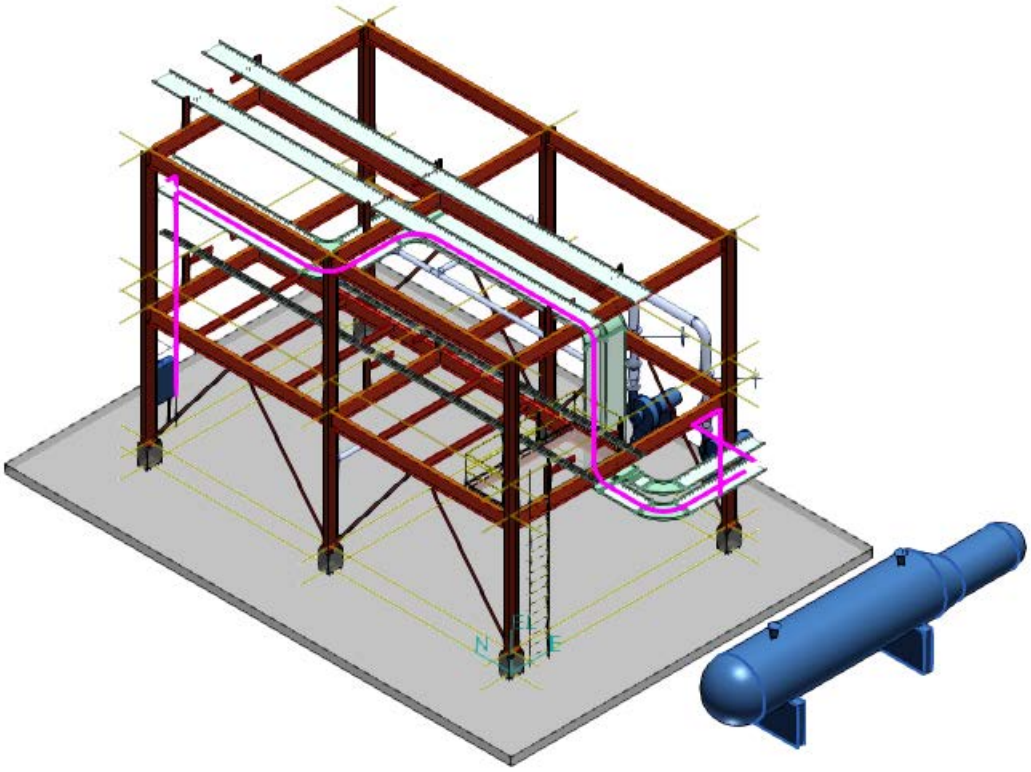
9. Click **Finish**.
10. Right-click cable **CC-001** in the **Workspace Explorer** and review its properties.
11. Select **View > Clear Clipping** to restore the graphic view to its original state.



TIP **Clear Clipping** displays any objects in the view that were hidden by **Clip by Volume** or **Clip by Object**. Use this command to restore the view before you define a new clipping volume or object.

12. Select **Tools > Show All**.

Your graphic view should resemble the below:



Parallel Cables

Cables that are routed together are called parallel cables. Using Smart 3D, you can create parallel cables when you need to route more than one cable together of the same specification. The software creates a parent object, called a parallel cable, and child objects, called paralleled cables. The parallel cables have the same part number, entry points, and exit points in and out of the cableway, and follow the same path in the cableway as the parent object.

Create Parallel Cables

Create two parallel cables in the model in Unit U01 of the following specifications with **Route Cable** .

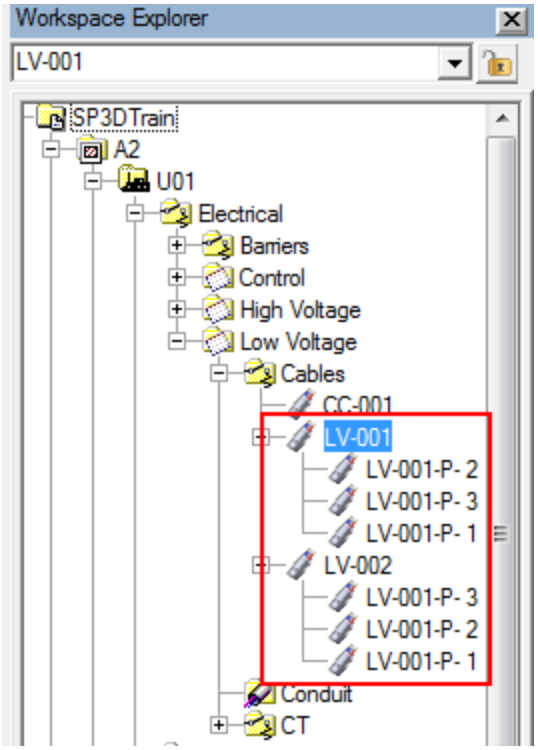
Parallel Cable 1:

System: A2 > U01 > Electrical > Low Voltage > Cables
Name: LV-001
Parallel Cables: 3
Operating Voltage: 110 V
Signal Type: Power
Part Number: LS3SJ- 16
Originating Device: Electrical Device
Terminating Device: Pump-001

Parallel Cable 2:

Name: LV-002
Parallel Cables: 3
Operating Voltage: 110 V
Signal Type: Power
Part Number: LS3SJ- 16
Originating Device: Electrical Device
Terminating Device: Pump-002

The view of your **Workspace Explorer** after defining the cable properties in the **Cable Properties** dialog box should appear as shown:



1. Define your workspace to show **Unit U01** and coordinate system **U01 CS**.

2. Click the **Insert Cable** .

   *The **Cable Properties** dialog box displays.*

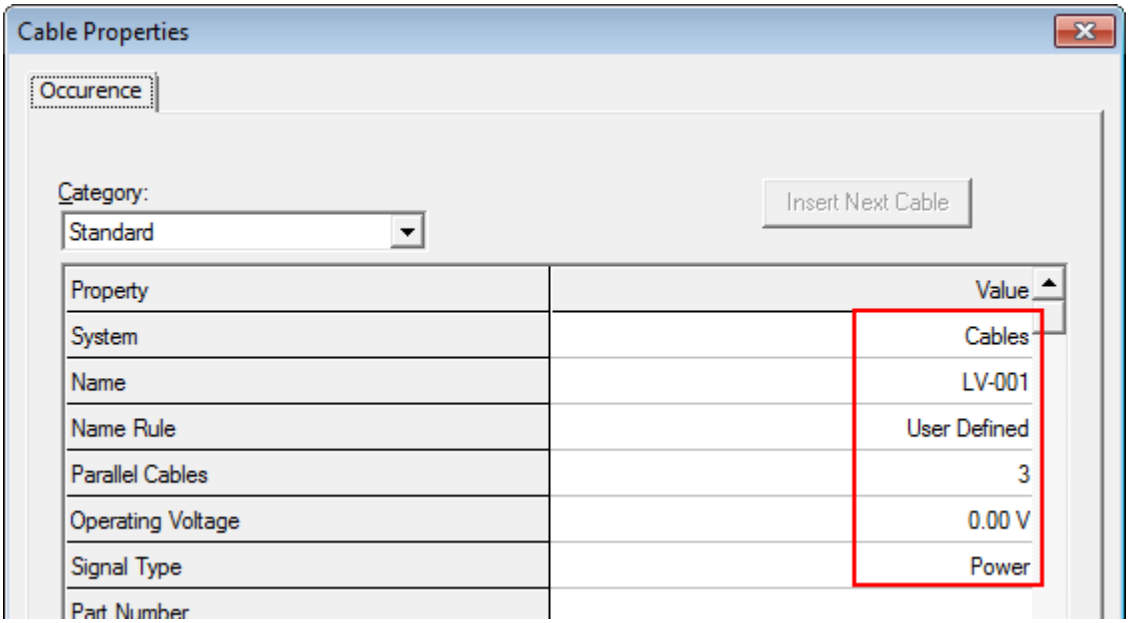
3. Under **System**, select **More…**.

   *The **Select System** dialog box displays.*

4. Select **A2 > U01 > Electrical > Low Voltage > Cables** and click **OK**.

5. Define the following properties:

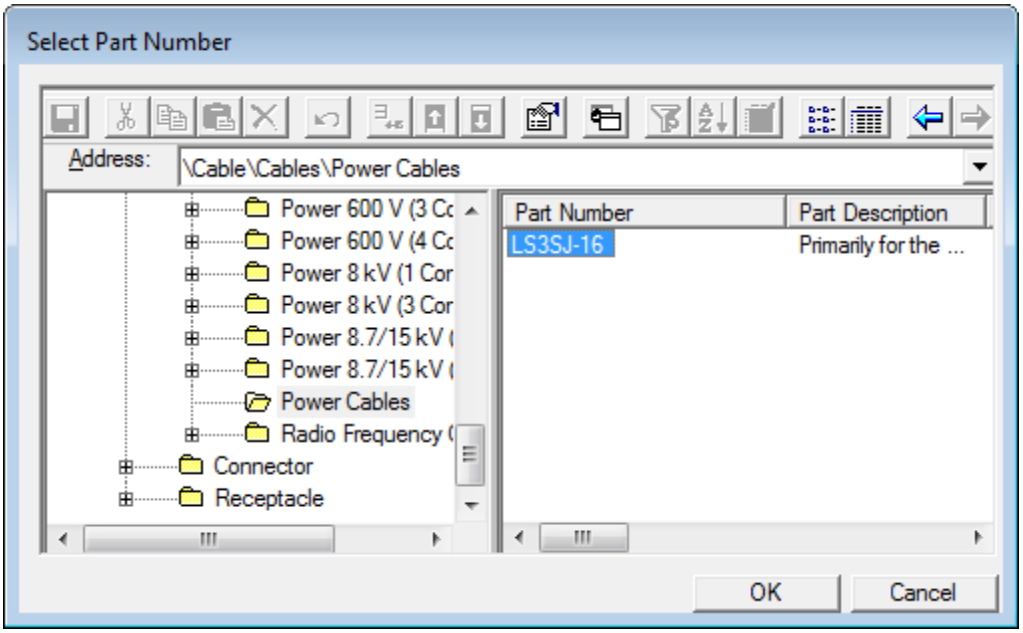
   Name: LV-001
   Parallel Cables: 3
   Operating Voltage: 110 V
   Signal Type: Power



6. Under **Part Number**, select **More…**.

   *The **Select Part Number** dialog box displays.*

7. Select **Cable > Cables > Power Cables > LS3SJ- 16**, and click **OK**.



8. Under **Originating Device**, select **More...**.

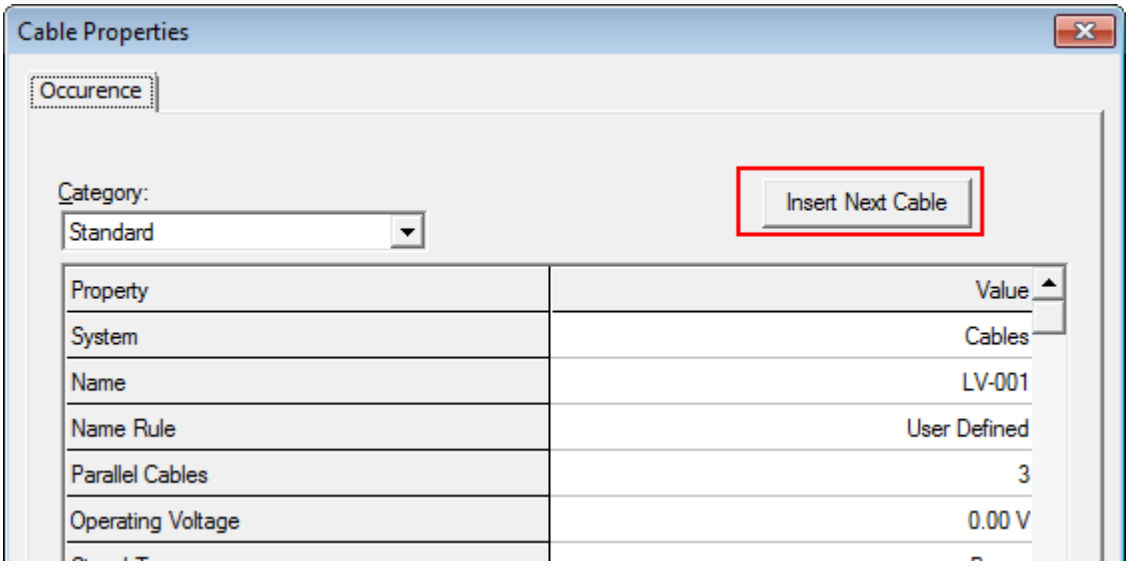
   *The **Select System** dialog box displays.*

9. Select **A2 > U01 > Equipment > Electrical Device**, and click **OK**.

10. Repeat the process for **Terminating Device**, selecting **A2 > U01 > Equipment > Pump-001** for the terminating device.

11. Click **Apply**.

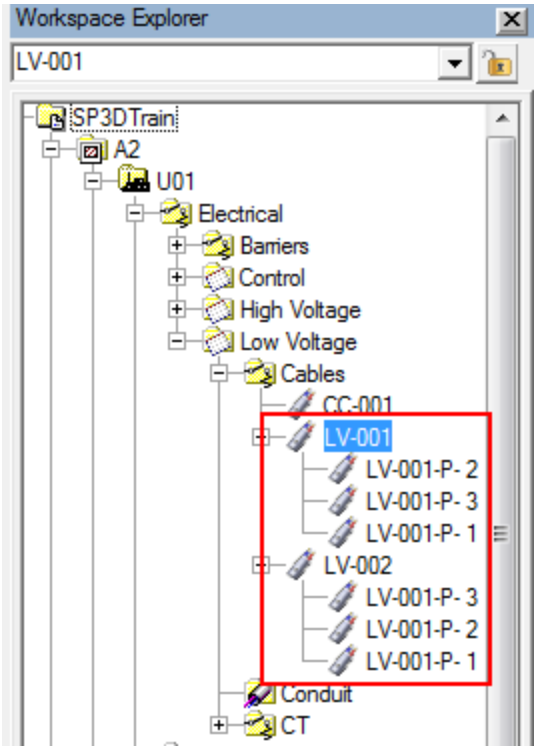
12. Click **Insert Next Cable** to specify the properties for the second cable.



13. Define the following specifications to create the second parallel cable, and click **OK**:

System: Cables
Name: LV-002
Parallel Cables: 3
Operating Voltage: 110 V
Signal Type: Power
Part Number: LS3SJ- 16
Originating Device: Electrical Device
Terminating Device:Pump-002

*The new parallel cables display in the **Workspace Explorer**.*



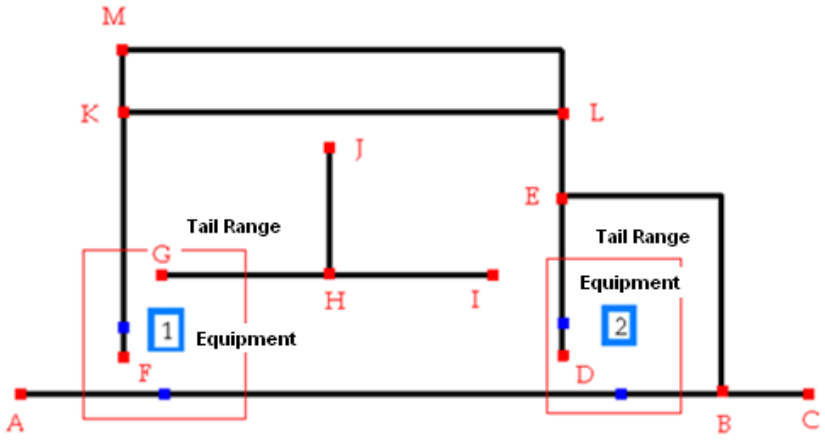
Auto Cable Routing

Smart 3D also provides auto-routing functionality, which routes the cable according to the shortest path from the start point to the end point on the cable tray or conduit. Routing is done through duct banks, connecting cableways, cable trays, and conduits that have their signal type already defined. You can modify the assigned auto-routed path by specifying additional must-include cable trays for the selected cable. During the auto-routing process, Smart 3D considers the cable tray fill. You can choose to allow overfilling of the cable trays or to allow real-time fill calculations during the routing process.

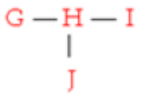
Auto-routing is turned off by default. Click **Auto-Route** on the **Edit Cable Path** ribbon to activate auto-routing. When **AutoRoute** is selected, the software builds one or more nodal networks representing all cableways in the workspace. Each end feature of the cableway, every branch on the cableway, and every cableway run change are nodes. Whenever there are more than two paths between any two nodes, a node is inserted at an arbitrary point (usually a turn) to

split one of the paths (see node M below). A connection is composed of the set of features that make up the path between two nodes. The total length of cableway is recorded for the connection along with the allowed signal types (read from the feature's parent cableway).

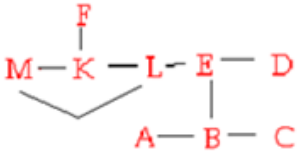
For example, two independent networks represent the following cableway model:



Network-1:

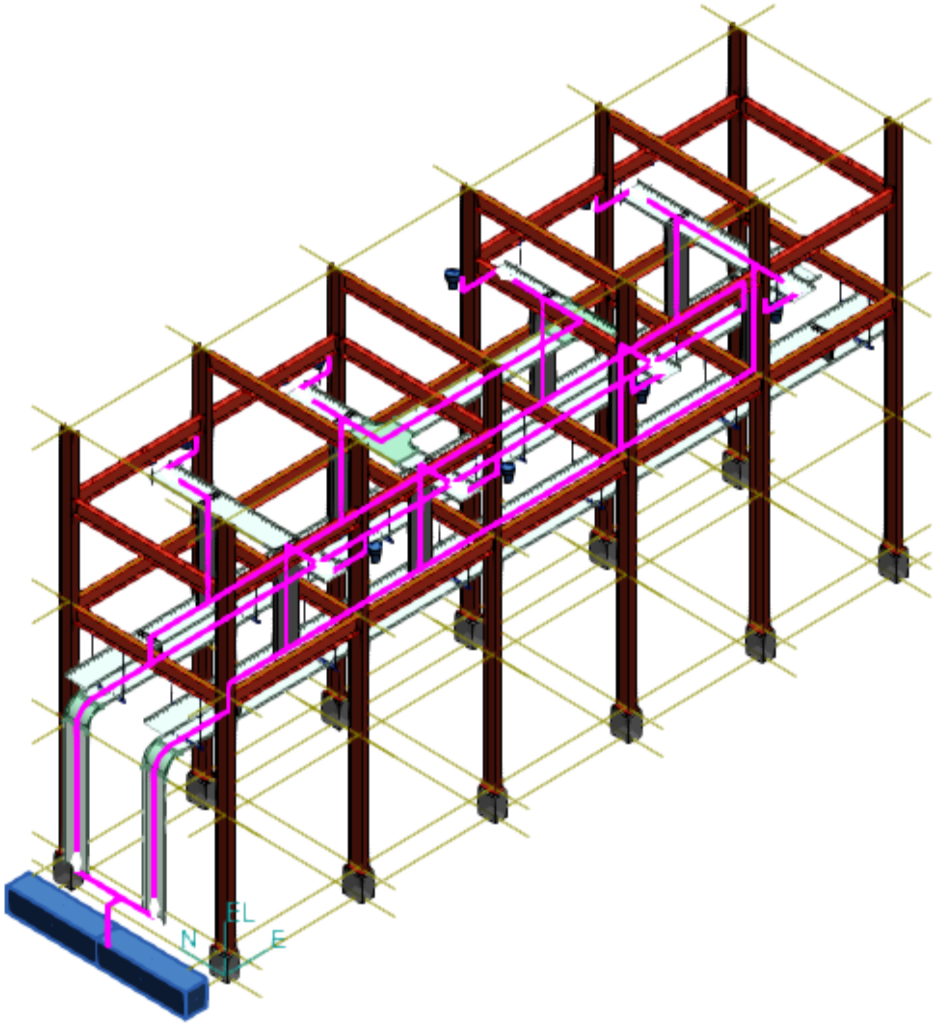


Network-2:



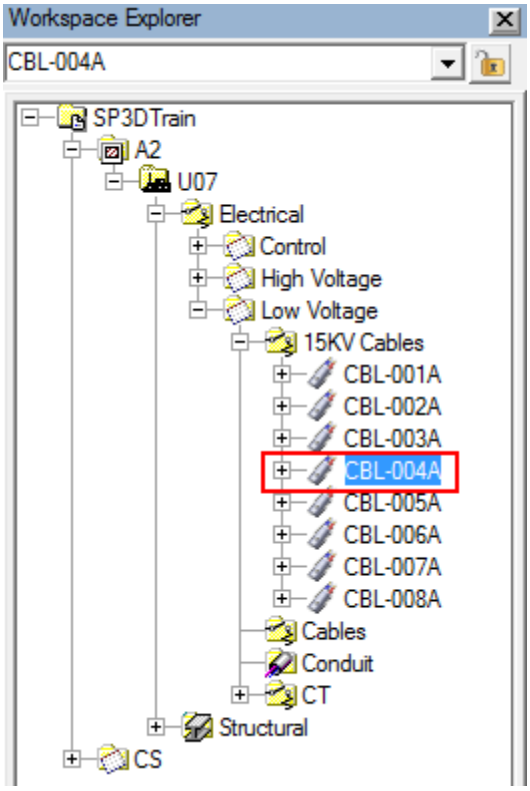
Auto Route Cables

Route cables in Unit U07 of your workspace by using **Auto Route** on the **Edit Cable Path** ribbon. After auto routing cables, the view of your model should be as shown:



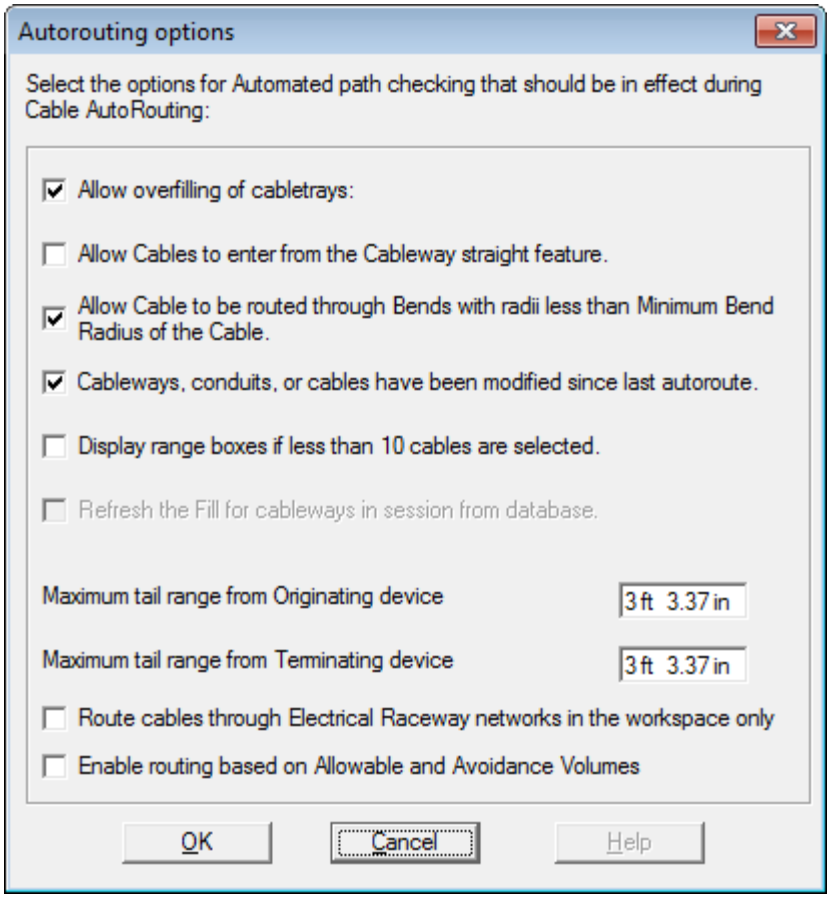
1. Define your workspace to show Unit **U07** and coordinate system **U07 CS**.
2. Under **Locate Filter**, select **Cables**.

3. In the **Workspace Explorer**, select **CBL-004A**.



4. Click **AutoRoute Options** on the **Cable Edit Path** ribbon to route the cable in the shortest path from the starting point to the ending point in the cable tray.

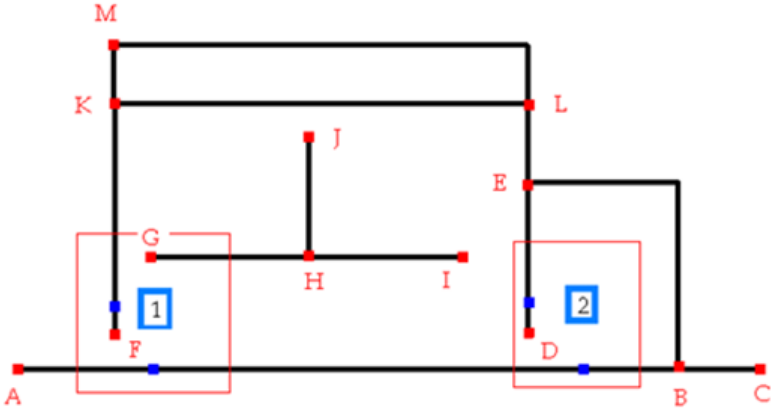
*The **Autorouting options** dialog box displays:*



The following options are available:

- **Allow Overfilling of Cable Trays** - Allows you to route cables through cable trays that can become overloaded. If **Allow Overfilling of Cable Trays** is not selected and a feature in a connection is full, connections between nodes are removed.

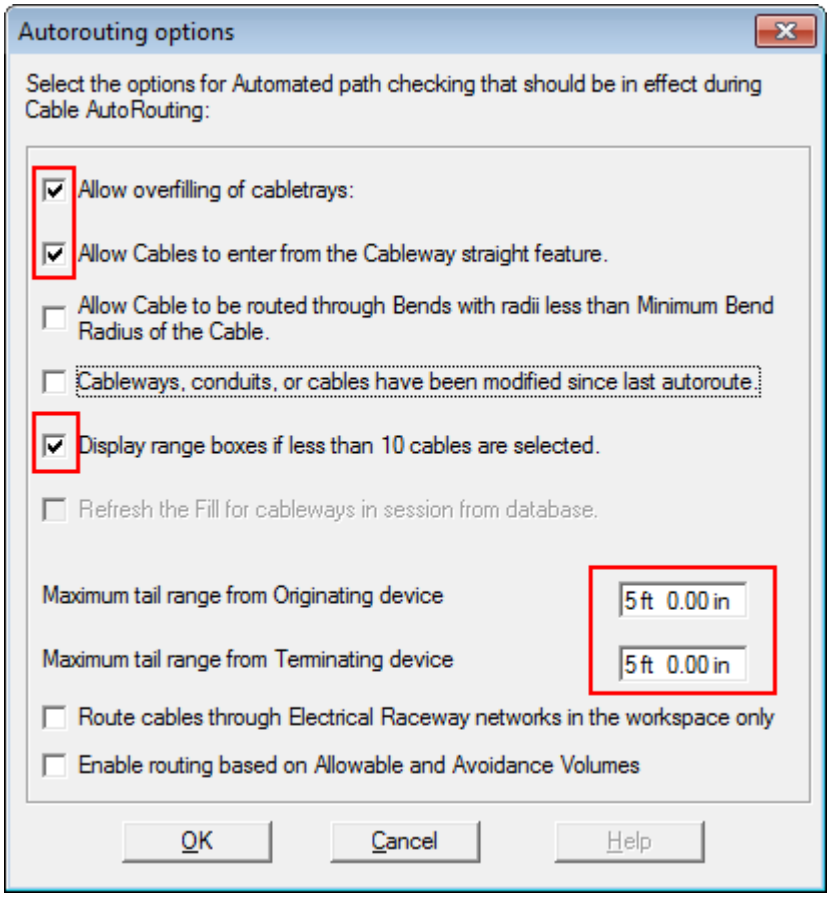
- **Allow Cables to enter from the Cableway straight feature** - Allows cables to enter from a cableway straight feature. If this option is selected, and the maximum equipment tail range is as indicated by the red boxes shown below, the blue dots are automatically selected as possible entry and exit points on each cableway network.



- **Allow Cable to be routed through Bends with radii less than Minimum Bend Radius of the Cable** - Allows you to route cable through bends that have a radius value less than the minimum bend radius value of the cable.
- **Cableway, conduits, or cables have been modified since last auto route** - Regenerates new cableway network layout data. If you do not select this option, the software does not regenerate the data, but uses cableway network data from the last auto-routed cable.
- **Display range boxes if less than 10 cables are selected** - Displays a range box around the cable connection location to the equipment, showing a graphical representation of the maximum tail ranges.
- **Maximum tail range from Originating device** - Allows you to set a specific maximum search distance from the originating device.
- **Maximum tail range from Terminating device** - Allows you to set a specific maximum search distance from the terminating device.
- **Route cables through Electrical Raceway networks in the workspace only** - Routes cables through the electrical raceway networks that are available in the Workspace, rather than through the entire electrical raceways available in the database. Check this option to route through the raceways available only in the workspace. Clear this option to include all the electrical raceways in the database.
- **Enable routing based on Allowable and Avoidance Volumes** - Routes cables through allowable volumes avoiding the avoidance volumes. If you check this option the software routes the cable only in the allowable volumes. However, this path might not be the shortest path. Clear this option to disable routing based on allowable volumes rule.

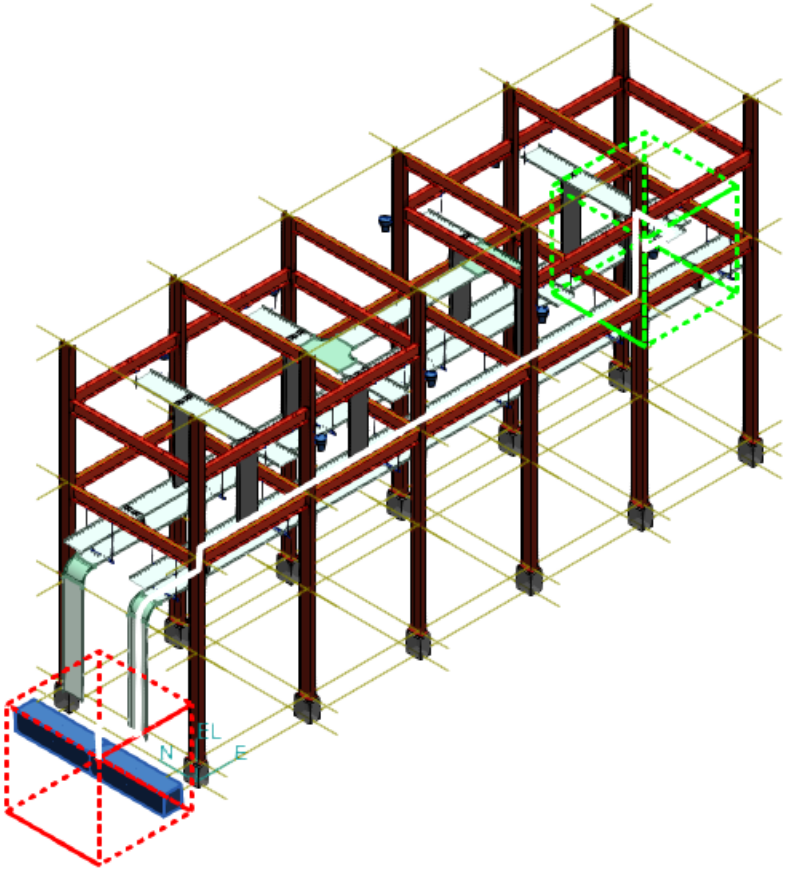
5. Select the following options in the **Autorouting options** dialog box, and click **OK**:

Allow Overfilling of Cable Trays
Allow Cables to enter from the Cableway straight feature
Display range boxes if less than 10 cables are selected
Maximum tail range from Originating device: 5 ft 0.00 in
Maximum tail range from Terminating device: 5 ft 0.00 in



6. Click **AutoRoute** .

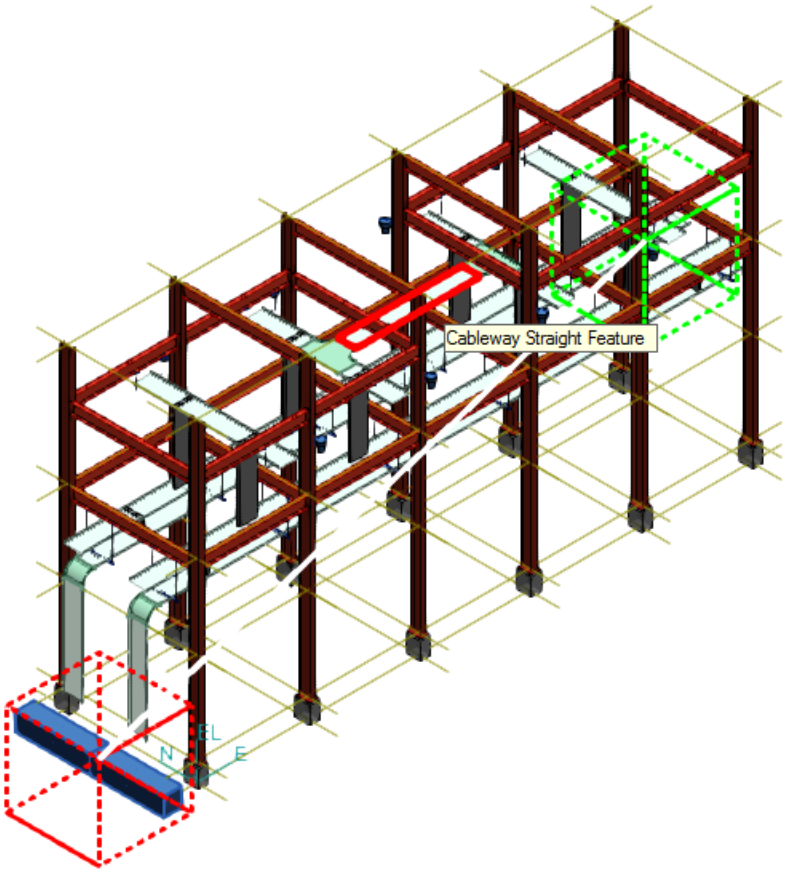
Smart 3D displays the proposed contiguous cable path for the cable in the model.



7. Click **Select** to cancel the proposed cable path.
8. Select **CBL-004A** in the **Workspace Explorer**.

   *The **Edit Cable path** ribbon displays, and Smart 3D highlights the cable in the active view.*

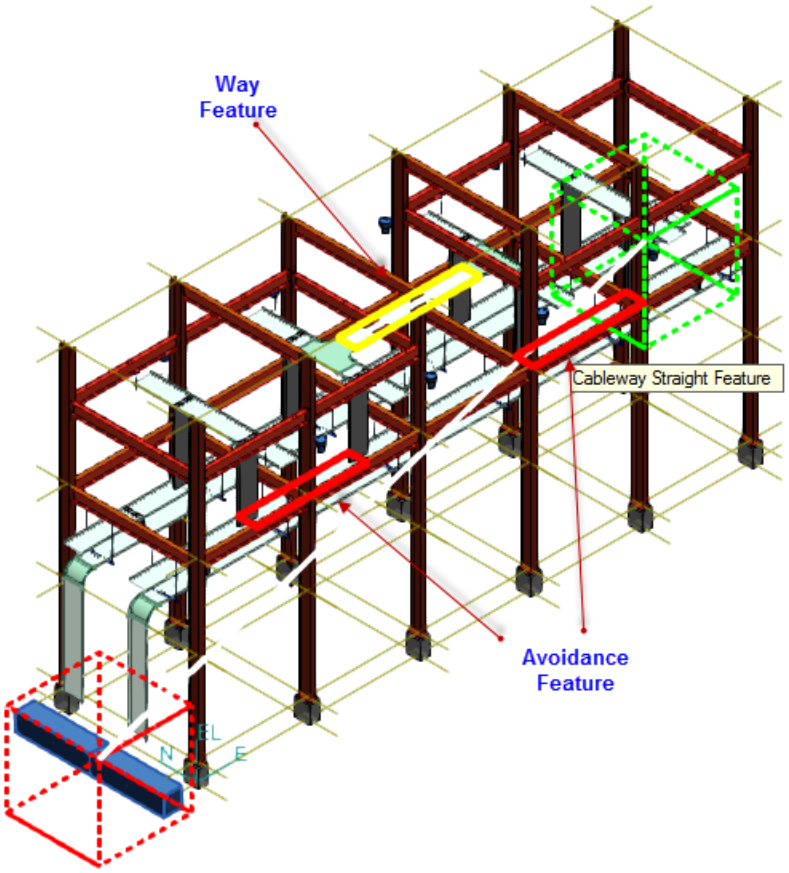
9. Click **Select Way Features** and select the cableway features or way points as shown below:



NOTES

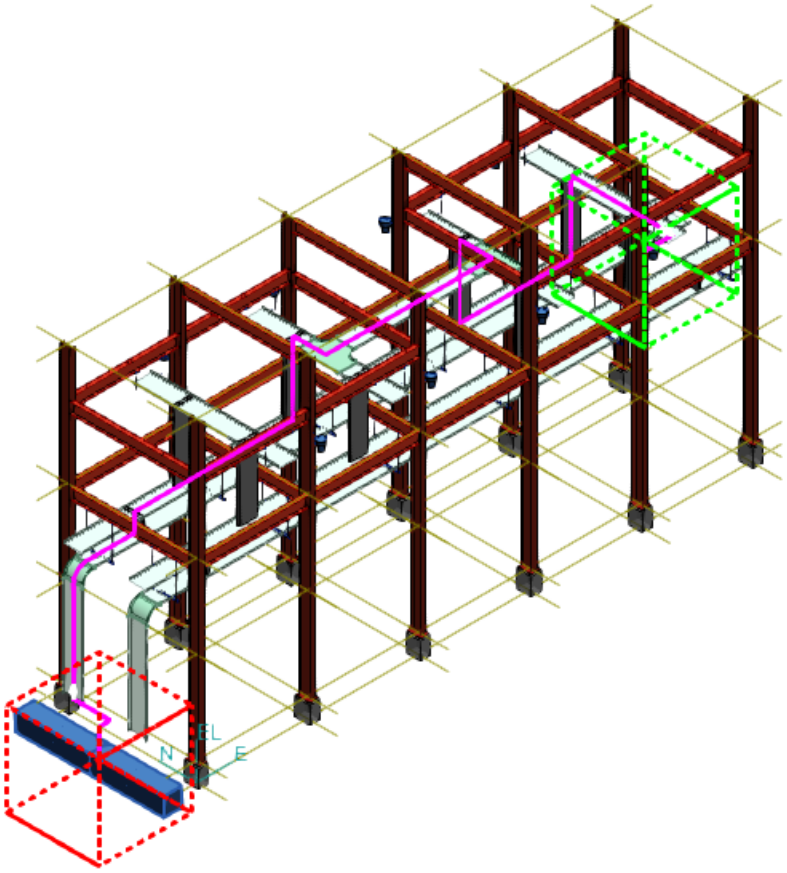
- Connections between nodes are removed if you pick a feature in a connection as a member-selected "avoidance point" feature.
- If only one "way point" feature is selected, and no path is possible between the entry and exit points that include the "way point" feature, then the autoroute fails and an error message is added to the log file.
- Connections between nodes are removed if the allowed signal type for the cableway of that connection does not match the signal type of the cable being routed.
- If any cableway feature is FULL and **Allow Overfill** is not selected, the connection containing the feature is removed from the networks.

10. Click the **Select Avoidance feature(s)** and select the cableway features or avoidance points in the model as shown below:



11. Click **AutoRoute** .

*Smart 3D displays the proposed continuous path for the selected cable from **PDB-101** to the light **LG-4** as shown below.*



NOTES

- Networks that have features, members of connections that have not been removed or trimmed by the above rules, within the "maximum tail length range" of both equipments are selected for autorouting between equipments 1 and 2.
- The minimum length path on the trimmed network is computed between each possible pair of entry and exit points. The path with the smallest length that includes the largest number of user-selected "way point" features is chosen.
- The computation of the minimum length path between each pair of possible entry and exit points is accomplished using the network definition and the location of the entry exit points on the network. Dijkstra's algorithm is used to process the network to find the minimum length path between them.

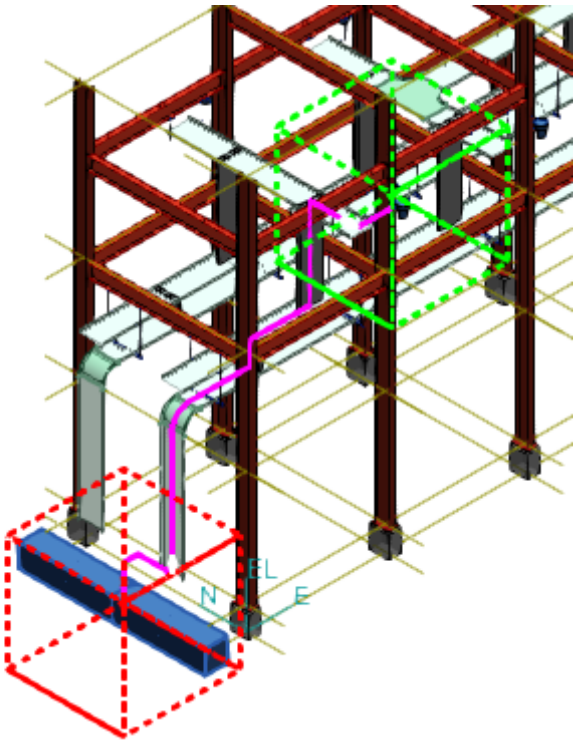
12. Click **Finish** to complete the cable path.

13. Select **CBL-001A** in the **Workspace Explorer**.

    *The **Edit Cable path** ribbon displays and Smart 3D highlights the cable in the active view.*

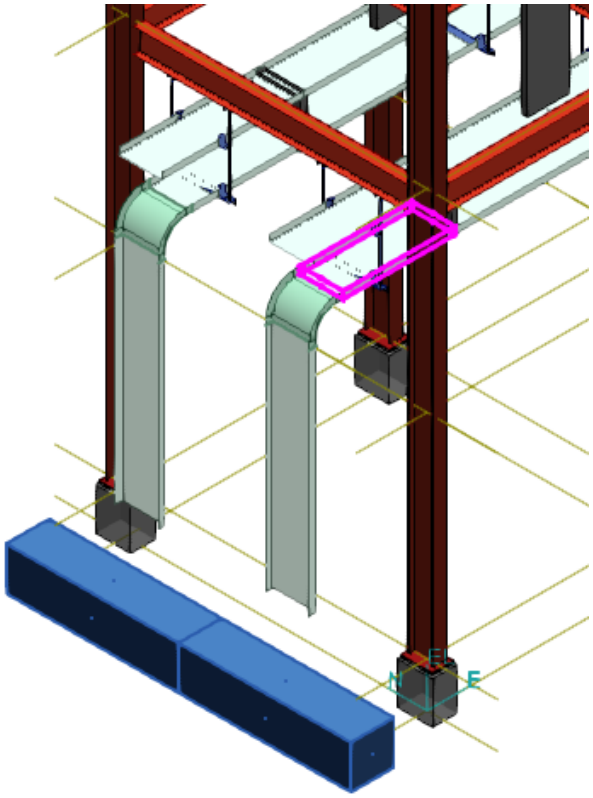
14. Click **AutoRoute** .

    Smart 3D displays the proposed contiguous cable path for the cable as shown:



15. Click **Finish** to complete the cable path.
16. Set the **Locate Filter** to **Cableway Features** to select the cableway features in the graphic view.

17. Select the cableway straight feature from the bottom cable tray, as shown:

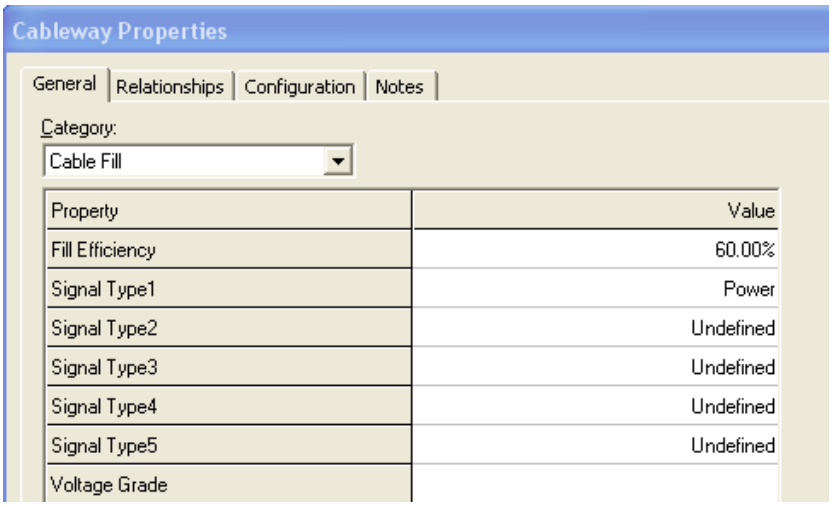


*The **Edit Cableway** ribbon shows **MaxFill** at 11.95%.*

NOTES

- The **Cable Fill** category on the cableway run consists of the following options:
  - **Fill Efficiency** - Displays or defines the efficiency of the stacking of cables in the cableway. You can enter a real number, integer, or percent. For example, type 0.9, 90, or 90%.
  - **Signal Type** - Displays or defines the cable usage, which is used in tray fill calculations.

- **Voltage Grade** - Displays or defines the voltage grade, which is used in determining the range of voltage that the cableway can carry.

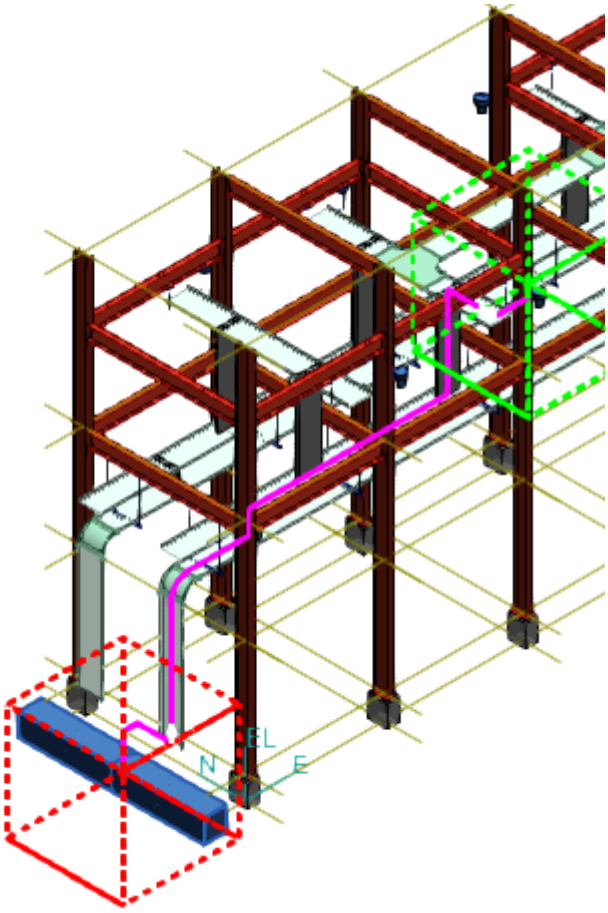


18. Select **CBL-002A** in the **Workspace Explorer**.

    *The **Edit Cable path** ribbon displays, and Smart 3D highlights the cable in the active view.*

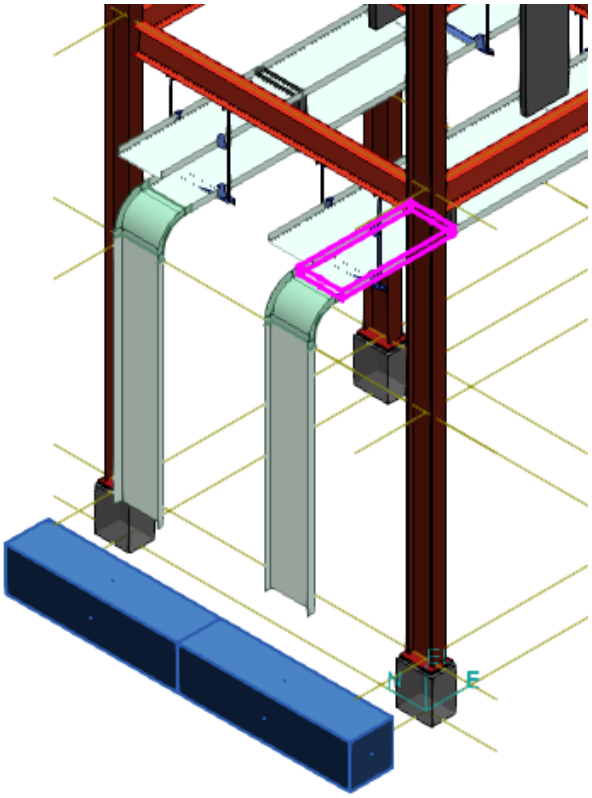
19. Click **AutoRoute** .

Smart 3D displays the proposed contiguous cable path for the cable as shown:



20. Click **Finish** to complete the cable path.

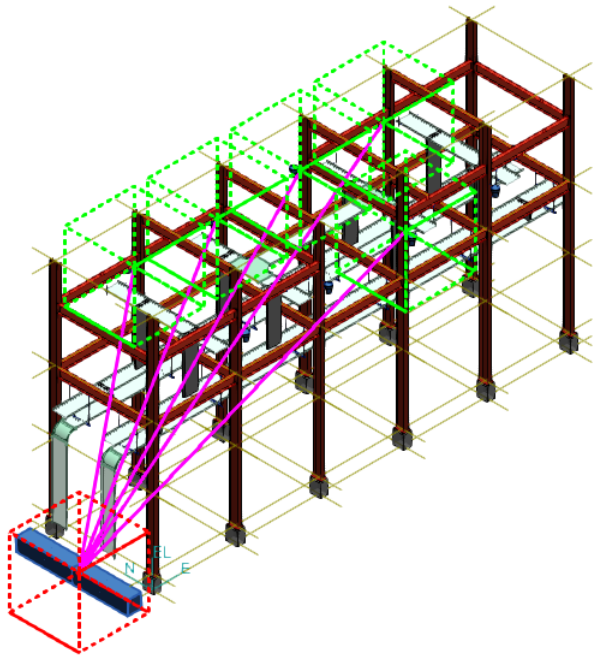
21. Select the cableway straight feature from the bottom cable tray, as shown:

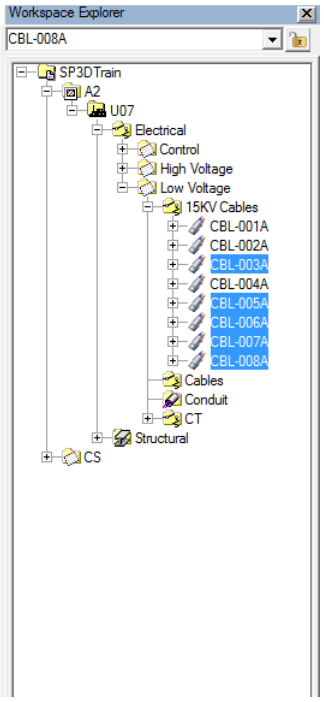


*The **Edit Cableway** ribbon shows **MaxFill** at 23.18%.*

22. Select **CBL-003A**, **CBL-005A**, **CBL-006A**, **CBL-007A**, and **CBL-008A** in the **Workspace Explorer**.

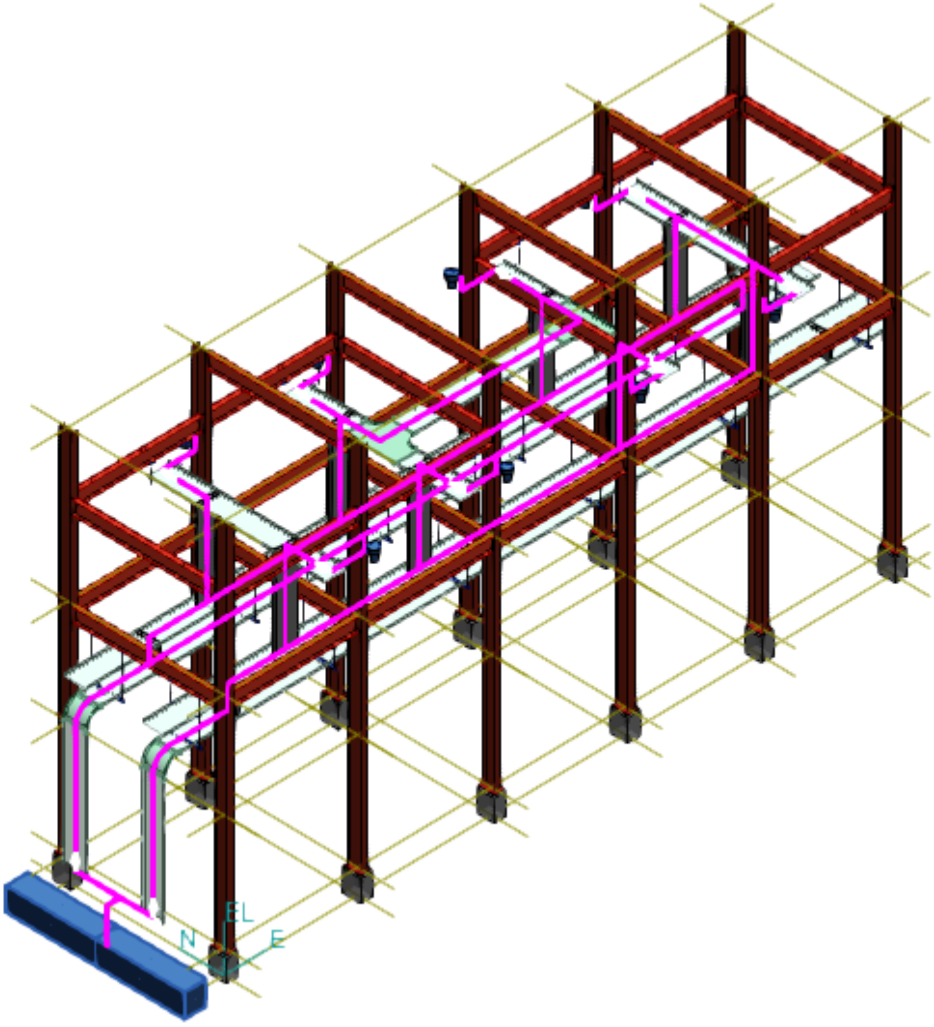
*The **Edit Cable path** ribbon displays, and Smart 3D the cables in the active view.*





23. Click **AutoRoute** to display the proposed continuous paths.

24. Click **Finish** to complete all cable paths.



For more information related to routing cables and cable properties,see *Routing Cables* and *CableProperties Dialog Box* in the *Electrical User's Guide*.