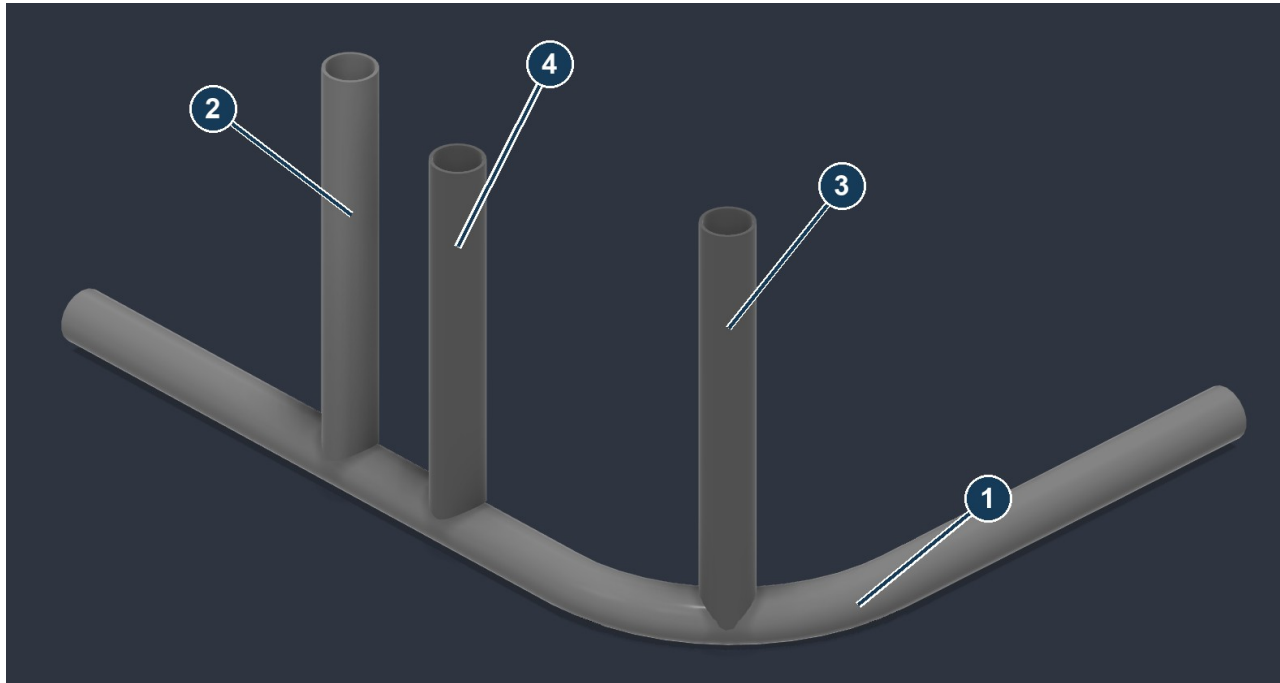


Tube Shop

Visual quick start

Build, edit, cope and export a four-tube practice model in Autodesk Fusion. Follow the pictures and numbered actions; use the reference only when you need more detail.



The finished practice assembly. Match the numbered tubes to the key below.

Picture	Tube	What you will do
1	H1 Bent host	Keep the imported R6 bend and use it as the coping host.
2	I1 Imported coped brace	Preserve its existing lower-end cut.
3	B1 Bend follower	Build a branch; review the unverified follow relationship.
4	B2 Straight joint	Move its upper point, then cope its lower end.

Example size: every tube is 1.500 in OD × 0.095 in wall. All exercise coordinates are in inches. R6 means a 6 in bend centerline radius.

Review draft for released Tube Shop 1.10.9. Reconciliation, host capture and bend conversion failed in this test. Those stops are marked on the relevant pages. The later fixed-point editing, coping and geometry exports were demonstrated.

Choose your starting point

Start from the STEP: use the supplied two-tube input and follow steps 1–10.

Practice the working edit and cope sequence: finish step 1, open **QS109_04_Point_built_branches.f3d**, then go to step 8. First complete the fixed-point setup given there; this path does not demonstrate host following.

Open: Fusion SOLID → APEX DESIGN → Tube Shop. Most commands below are in the palette's Actions → Design section.

Step	Task	Page	Demonstration result
1	Set up dies	3	Demo values saved; physical calibration not tested
2	Import and check scale	4	Verified
3	Reconcile or place points	5–6	Reconcile blocked; new points verified
4	Build the new branches	7	Verified
5	Review point hosts	8	Host capture blocked; fixed choices verified
6	Change one bend radius	9	Conversion blocked
7	Check branch following	10	Not verified
8	Move a point	11	Verified with fixed points
9	Cope and inspect	12–15	Digital examples verified; physical fit untested
10	Export and check files	16–17	Geometry reopened; TubePro receiving test pending

Keep these files handy

models/ holds the input and saved practice stages.

exports/developed/ holds the actual STEP, IGES and experimental ZX outputs.

reference/ holds the full procedure and verification record.

Extract the complete ZIP before opening files. Work on the disposable examples and use an isolated test die library/profile. A matching die name alone does not restore a saved die ID; review assignments if you recreate the demo dies.

About the pictures: all are genuine Fusion viewport captures. Native dialog images are unavailable, so the text gives the exact controls. The recorded commands were exercised through the installed add-in/API; a complete manual click-through remains pending.

[Scope and example files · detailed reference, pp. 2–3](#)

STEP 1 OF 10

Set up the demonstration dies

Save the stock and tooling you will use before building a tube. These practice values are **not measured calibration data**.

Open: Tube Shop → Dies → + New die

1. Create the two dies below in an isolated test library/profile. Use **Save die**, then reselect each row to check it.

Field	First die	Second die
Name	DEMO ONLY 1.5 x .095 R6	DEMO ONLY 1.5 x .095 R4.5
Material	DOM — illustrative	DOM — illustrative
Tube OD / wall	1.500 / 0.095 in	1.500 / 0.095 in
Nominal CLR	6.000 in	4.500 in
Calibrated CLR	Leave blank	Leave blank
Tube K	0.500 — illustrative	0.500 — illustrative
Measured tests	None	None

2. Check the header's **CLR** source. Nominal uses the die label; Calibrated uses a measured radius when present and falls back to nominal if blank.

Check: Both dies use the same stock. Only their nominal bend centerline radius differs. CLR is not the tube's outside radius.

For a real shop setup

Open: Dies → select saved die → Calibration → Open calibration wizard →

1. Cut and measure a test blank. Bend it; record the dial angle and the angle held after springback.
2. Measure **Legs to tangent**, or use **Tip to table** only for a held 90° test within 1°. Enter only measurements you actually made.
3. Review **Result**: solve CLR using a trusted K, or solve K using an independently known CLR. Apply, then verify a second physical test piece.

Cancel / Undo: Discard draft leaves an unsaved die unchanged. Close the calibration window before Apply to discard it. Saved library edits are not Fusion model Undo operations.

Image gap: the native die editor and calibration window were not captured.

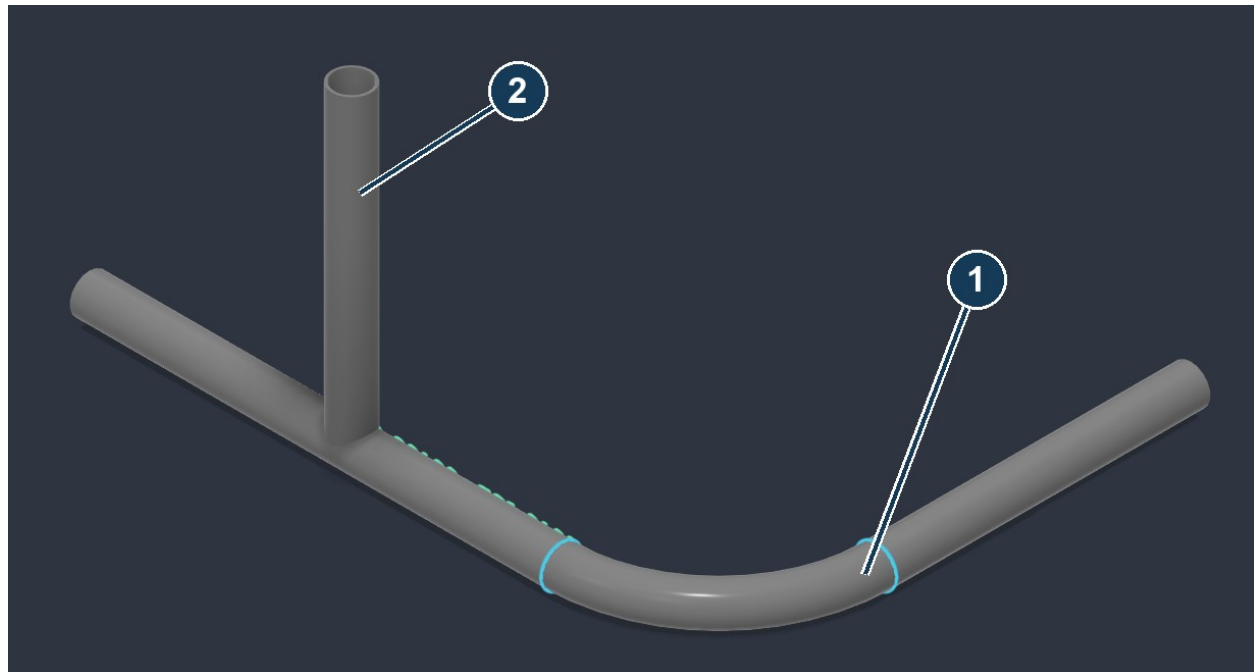
[Calibration measurements and recovery · detailed reference, pp. 4–5](#)

STEP 2 OF 10

Import and check the model

Start with two correctly scaled solids before adding editable points.

Open: Fusion Data Panel → Upload → models/QS109_Input.step



1 H1 bent host, with its original R6 bend. 2 I1 brace, already coped at the lower end.

1. Upload and open the STEP. Rename the bent member **H1 Bent host** and the vertical brace **I1 Imported coped brace**.
2. Set **Document Settings** → **Units** to inches. Measure OD **1.500 in** and H1 CLR **6.000 in**. H1 lies in XY; the brace rises along +Z.

Extract centerlines is optional: Actions → Design → Imported tubes → Extract centerlines makes independent, unfiled sketch lines. It does not link the existing solids to editable source points.

Starting a new design instead? Skip import and reconciliation. Place H1 at (0,0,0) → (24,0,0) → (24,18,0), then build through those points using R6. Continue with the four branch points on page 6. This complete new-H1 path was not demonstrated.

Check: Two solids, correct diameter, correct orientation. Changing display units does not change physical size.

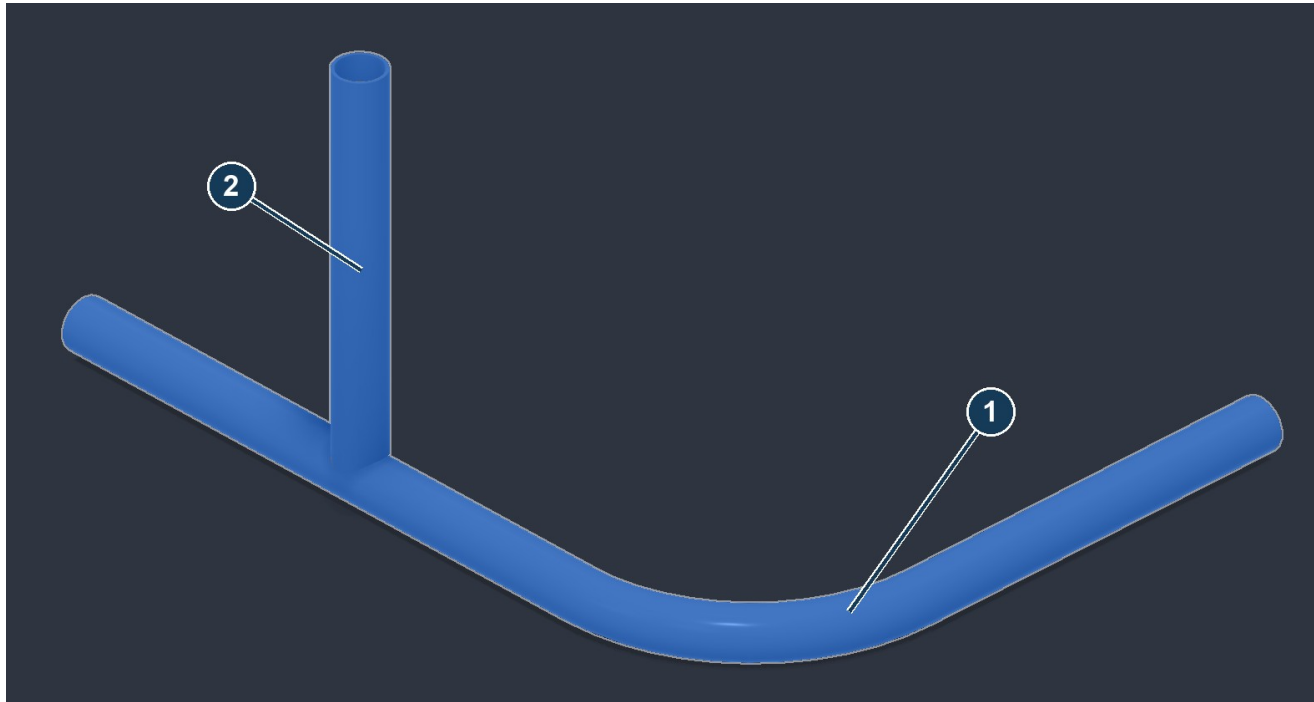
Cancel / Undo: Cancel optional extraction before accepting, or Undo the new sketches. If size differs by 25.4, inspect the import units before rescaling.

[Full procedure and recovery · detailed reference, pp. 6](#)

Link the existing imported solids

Reconciliation should add point identities while retaining the existing tube bodies and end cuts.

Open: Actions → Design → Imported tubes → Reconcile imported points



Select the existing solids: 1 H1 bent host and 2 I1 coped brace. This is the selection view only.

1. Select H1 and I1. Review the planned endpoints and bend-intersection points against the original bodies.
2. Use **Create point links** only when the review is valid. Do not rebuild an already reconciled solid with Tube through points.

Blocked in this example: the review reported “An analytic spine cannot carry both butt closure and a junction-return end relation.” No links were applied. The error repeated after a clean Fusion restart.

Check: On a successful model, check point order and identity, H1’s original radius, and I1’s existing cope. Cuts reaching bends or ambiguous geometry may be refused.

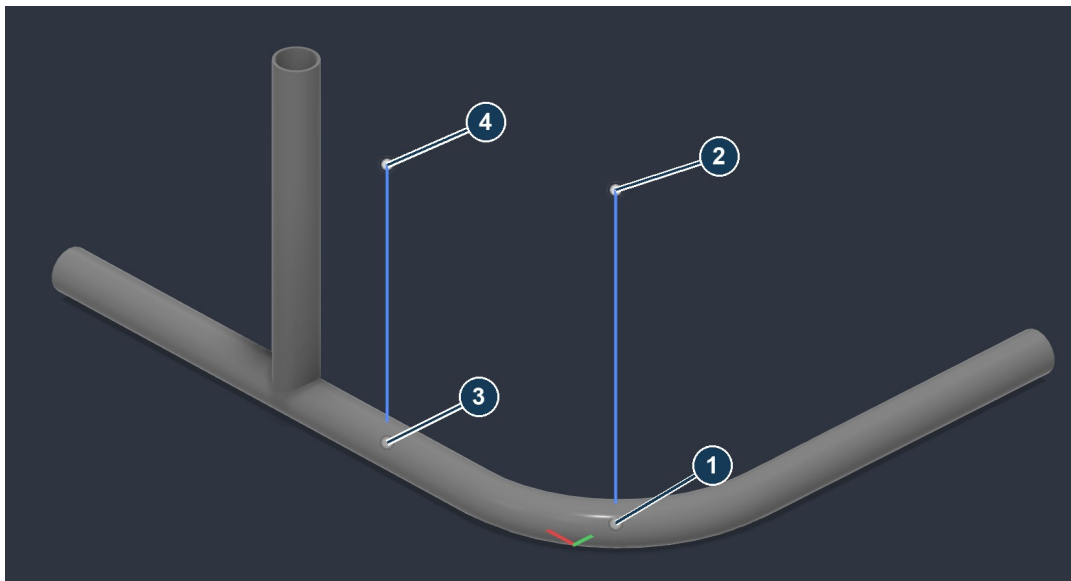
Cancel / Undo: Cancel a refused review and preserve the imported solids. Successful link creation and its Undo were not verified here.

Continue the practice: leave H1/I1 intact and add only the new branch points on the next page.

[Full procedure and recovery · detailed reference, pp. 7](#)

Place four new branch points

Open: Actions → Design → Place points | Native window: Place Points



Place each branch lower first, then upper. 1–2 belong to B1; 3–4 belong to B2.

Picture / point	X	Y	Z
1 B1 lower	22.242641	1.757359	0
2 B1 upper	22.242641	1.757359	12
3 B2 lower	14	0	0
4 B2 upper	14	0	10

1. Use the **design origin** as the reference and enter the four rows above. Leave mirror options off.
2. Inspect the preview, then choose **Keep points**. Pick source points, not circular tube rims.

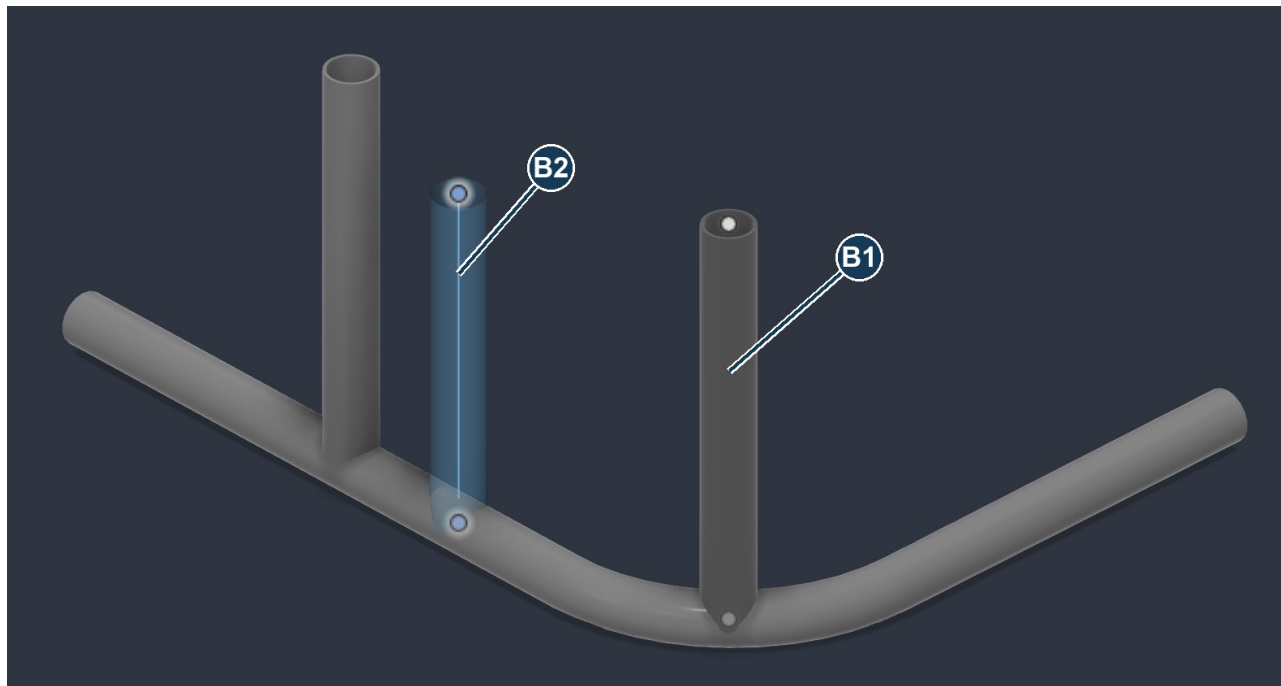
Check: Four new points appear in the Tube points sketch. Without a selected reference, XYZ is relative to the design origin; with one, the values are offsets. Check each row's Ref value.

Cancel / Undo: Cancel before Keep points, or Undo the committed set. For misplaced points, check the reference basis and units first.

[Full procedure and recovery · detailed reference, pp. 8](#)

Build the two new branches

Open: Actions → Design → Tube through points | Native window: Tube through Points



The two new branches after building. B1 is the bend follower specimen; B2 is the straight joint.

1. For **B1**, select lower point 1, then upper point 2 from page 6 in **Points, in run order**.
2. Choose the **R6 demo die**. Check OD **1.500**, wall **0.095 in**, and **Fillet corners at die CLR** on. Leave loop/mirror off. Choose **Build tube**; rename it B1 Bend follower.
3. Repeat for **B2**, lower point 3 then upper point 4. Rename it B2 Straight joint. Use the same die/fillet settings even though these branches are straight.
4. Open **Review bend dies**, choose H1's bend and the matching R6 die, then **Stage this bend** → **Apply choices**. The radius stays R6.

Check: Four solids total. B1 spans 12 in; B2 spans 10 in. Tube point coordinates lists their source points. Keep imported H1/I1 as existing bodies.

Cancel / Undo: Cancel a build preview or Undo a committed build. If duplicate solids appear, undo the second build; do not delete source points casually.

[Full procedure and recovery · detailed reference, pp. 9](#)

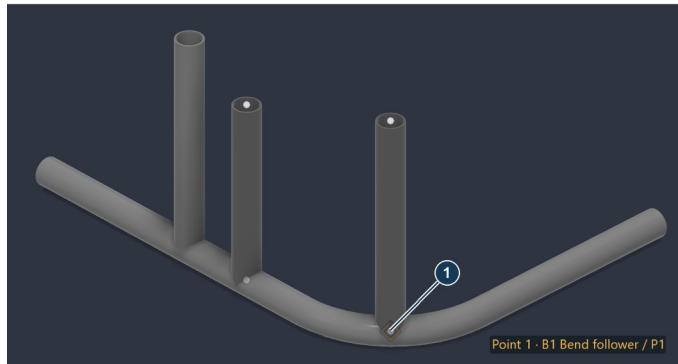
STEP 5 OF 10

Choose what each point follows

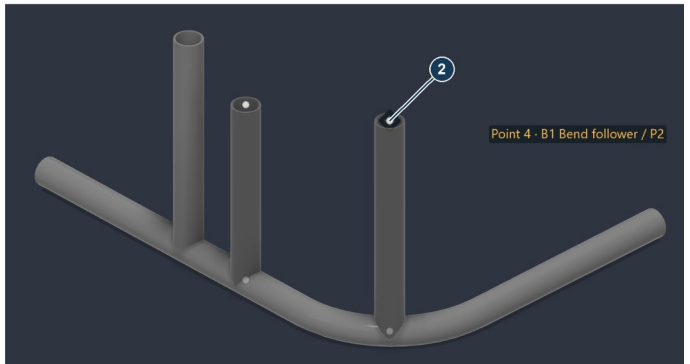
A point needs an explicit host relationship before it can follow a changing tube.

Open: Actions → Design → Review host points

LOWER POINT · INTENDED HOST



UPPER POINT · FIXED



Left: B1's lower point lies on H1's bend. Right: B1's upper point should stay fixed.

1. Select B1's lower **Source point**. Enter **Search radius = 0.125 in (3.175 mm)**. Confirm the highlight, then inspect nearby candidates.
2. For a valid candidate, choose **H1** in **Point follows**, inspect station/offset, then **Stage this choice**. Nearby capture may retain an offset.
3. Select B1's upper point. Choose **Fixed in space**, stage it, then review the queue before **Apply choices**.

Check: A host choice changes reference data; geometry should not move immediately. Reopen the review to confirm the saved driver. Avoid a cycle such as H1 following B1 while B1 follows H1.

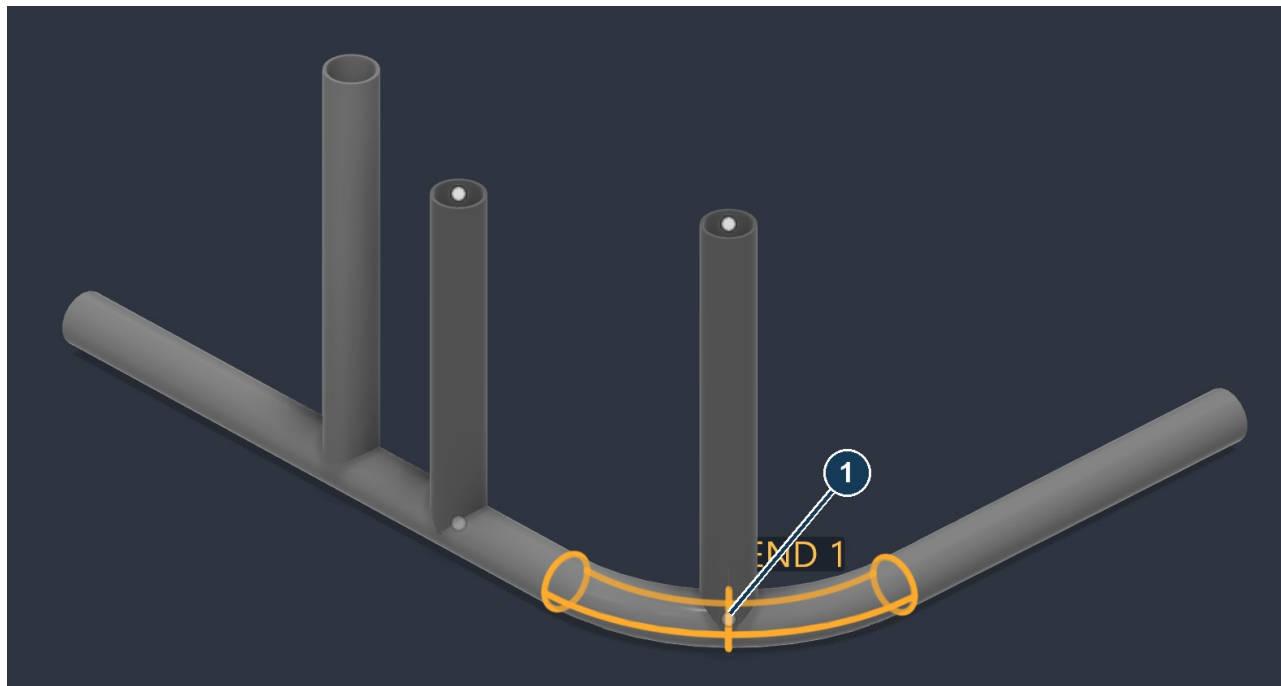
Blocked in this example: H1 candidate analysis failed. To test later editing and coping independently, all four new branch points were set **Fixed in space**. The supplied practice model has no verified B1-to-H1 follow link.

Cancel / Undo: Remove a queued choice or Cancel before Apply. Applied choices are intended as one native Undo step; successful host-capture Undo remains unverified.

[Full procedure and recovery · detailed reference, pp. 10](#)

Review a different bend radius

Open: Actions → Design → Review bend dies



Original geometry only: 1 marks H1's R6 bend. No converted R4.5 preview or after view was obtained.

1. Choose H1 under **Tubes (optional)**. Leave **Include assigned bends** on. Confirm the bend is R6 with OD 1.500 and wall 0.095 in.
2. Choose the **R4.5 demo die** under **Saved die**. If eligible, use **Stage this bend** → **Preview queued geometry**.
3. Inspect the whole preview before **Apply choices**. Check tangent lengths and neighboring bends; confirm the stock still matches.

Blocked in this example: R4.5 was offered, but the analytic-spine error prevented staging/applying it. H1 stayed R6. Matching R6 assignment did succeed.

Check: Review bend dies targets individual bend stations. **Change tube die** is a separate whole-tube die/stock change; use it only when that is your intention.

Cancel / Undo: If a replacement cannot fit, Cancel and keep the old geometry; choose another die or deliberately revise the run. Do not force Apply. Cancel an unwanted preview, or Undo a successful committed conversion.

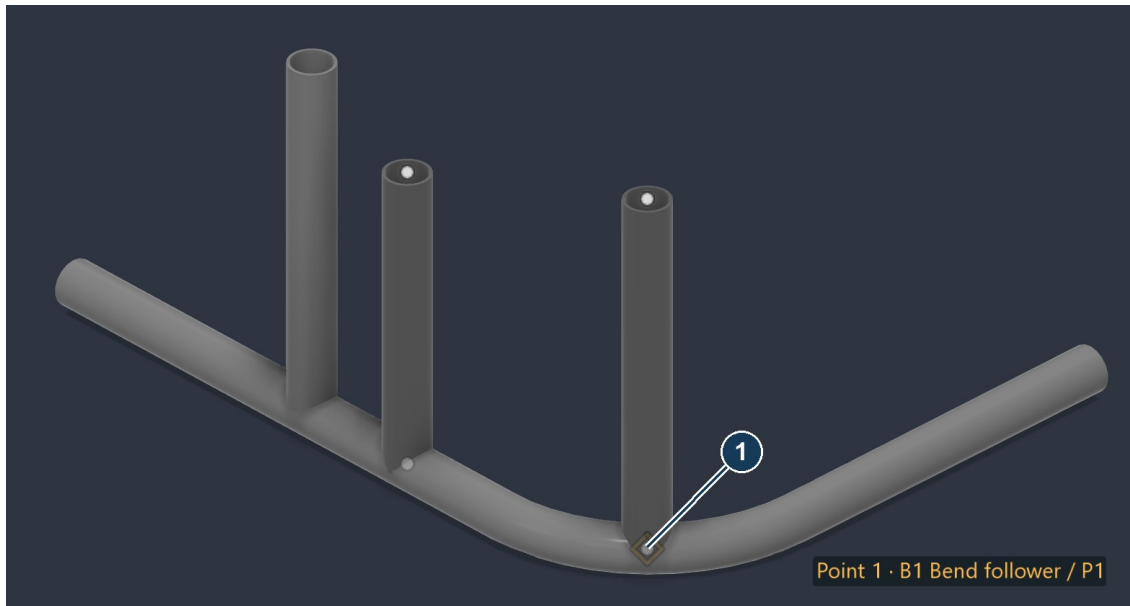
[Full procedure and recovery · detailed reference, pp. 11](#)

STEP 7 OF 10

Check that the branch follows

Run this check only after both the host link and radius conversion succeed. They did not succeed in the recorded example.

Open: Review host points → Review bend dies → Tube point coordinates



BEFORE ONLY. B1's lower point is at the middle of H1's R6 centerline arc. No verified after image exists.

B1 lower point	X	Y	Z
Observed R6 position	22.242641	1.757359	0
Calculated R4.5 target only	22.681981	1.318019	0

1. Before conversion, confirm the lower point follows H1 and the upper point is Fixed in space. Record both XYZ positions.
2. Preview and apply the eligible R4.5 conversion. Inspect the lower point on the new bend; verify the upper point has not moved.
3. Compare coordinates and branch shape. The branch should tilt when only its lower point moves; it should not translate as a rigid tube.

Check: The calculated target assumes unchanged H1 run intersections, half-arc station and zero offset. It is a reference calculation, not an observed result.

Cancel / Undo: Undo a successful conversion and recheck both points. If following fails, stop and review the saved host/station; do not manually move B1 to manufacture a passing result.

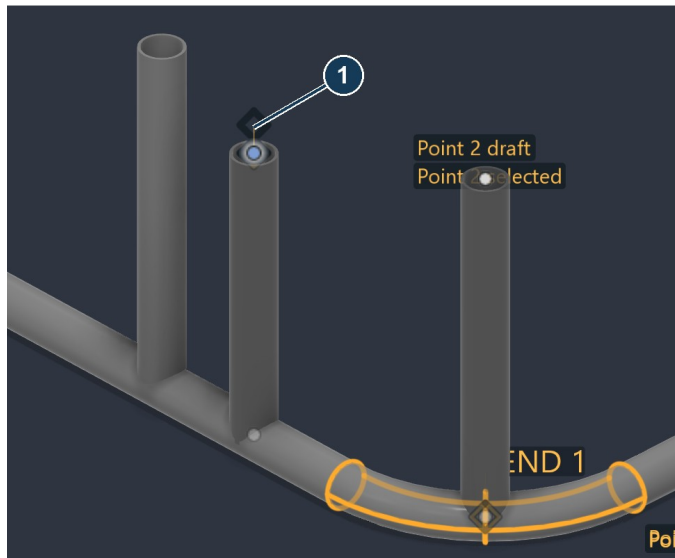
[Full procedure and recovery · detailed reference, pp. 12](#)

Move a point and update its tube

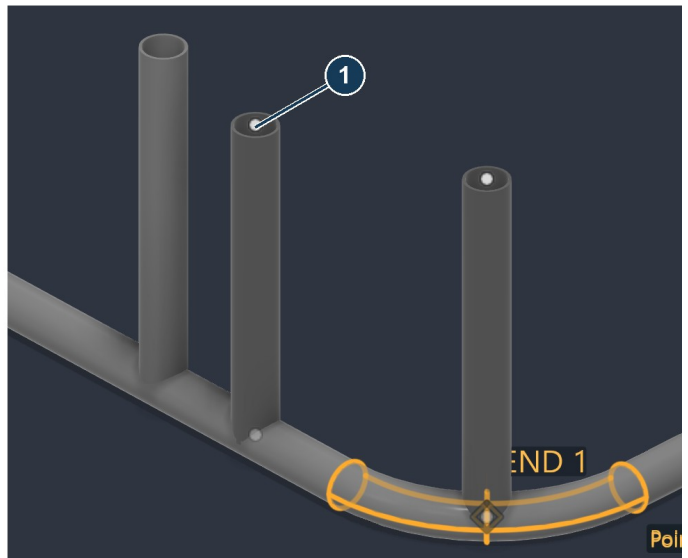
Practice from **models/QS109_04_Point_built_branches.f3d**. Complete the matching R6 assignment on page 7 if starting from this early snapshot.

Open: Actions → Design → Tube point coordinates

DRAFT · POINT AT Z 11



APPLIED · TUBE AT Z 11



1 highlights B2's upper point. In the draft the tube still ends at Z10; after Apply the tube reaches Z11.

1. First open **Review host points**. For each of the four new branch points, choose **Fixed in space** → **Stage this choice**, then **Apply choices**. This isolates the edit from host following.
2. Open **Tube point coordinates**. Pick **B2 upper**; confirm its highlight and design-root XYZ (**14, 0, 10**). Check the reference readout before editing.
3. Change only **Z to 11 in** and choose **Preview drafts**. Turn on **Update tubes on Apply**; it defaults off. Apply and reselect the point.

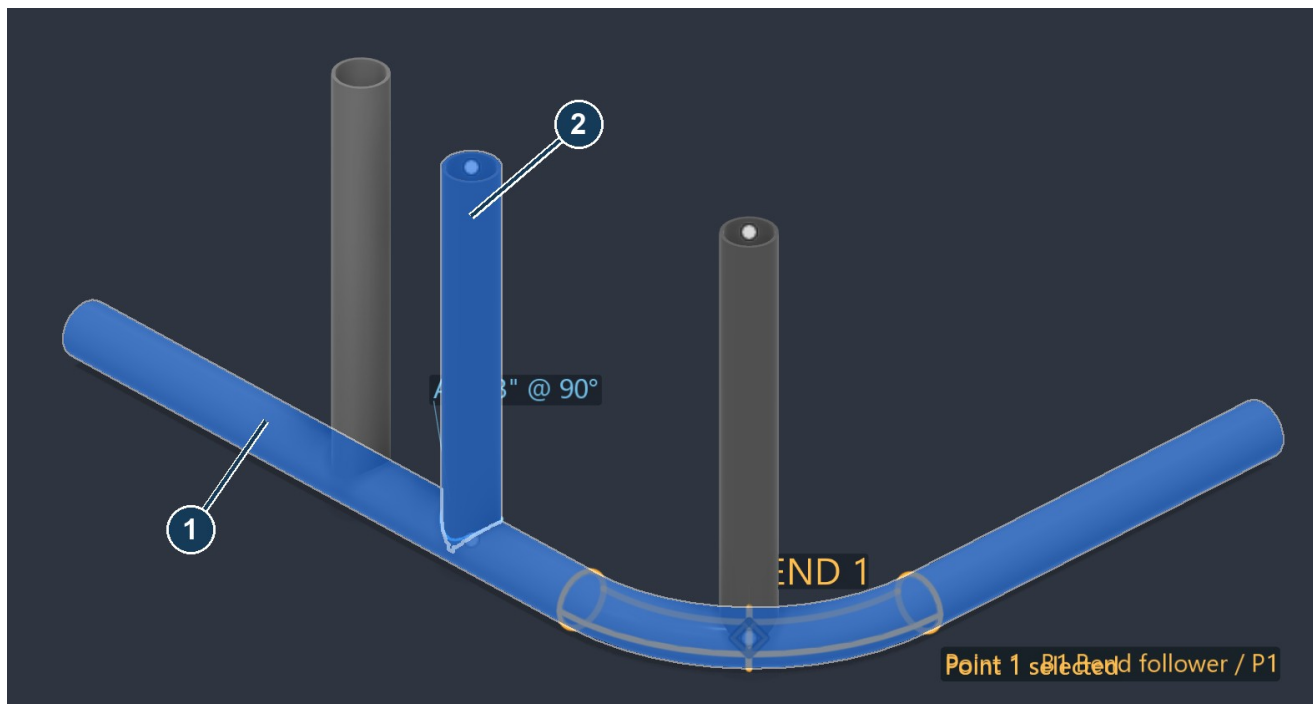
Check: The upper point is (14,0,11), the tube reaches it, and source-point IDs/die assignments remain. With the update option off, use Actions → Design → Update from points.

Cancel / Undo: Cancel discards drafts. Native Undo returned this test to Z10; Redo restored Z11. If an update fails, verify the point and tube rolled back together.

[Full procedure and recovery · detailed reference, pp. 13](#)

Choose the host and the tube to cut

Open: Actions → Design → Cope a joint | Native window: Cope Joint



1 H1 is the host to fit against. 2 B2 is the branch whose lower end will be cut.

1. Use the Z11 square-ended model from step 8, or open **QS109_08_Point_update.f3d**.
2. Choose joint mode **Notched / stationary**. Put H1 in **Fit against** and B2 in **Tubes to cut**. If reversed, use **Swap the two lists**.
3. Set the fit gap to **0** for this demonstration. Leave **Tab / slot joinery** off. Review the selections, then choose **Cope**.

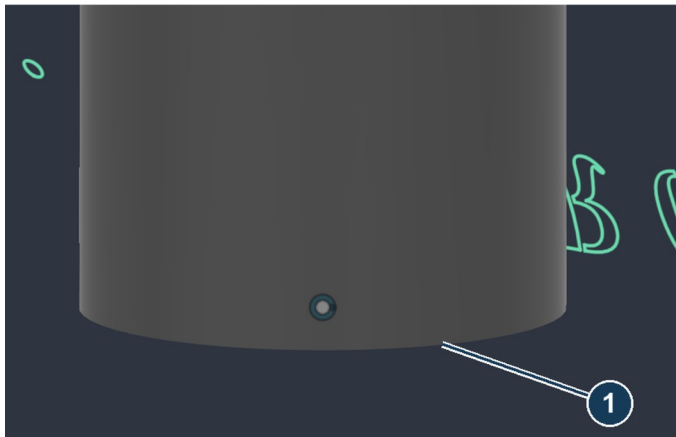
Check: B2 receives the saddle-shaped end cut. H1 remains the fitting surface and should not be cut in this ordinary-cope example. Inspect the result on the next page.

Cancel / Undo: Cancel before Cope to leave the model unchanged. Undo a committed cope to return to the square end.

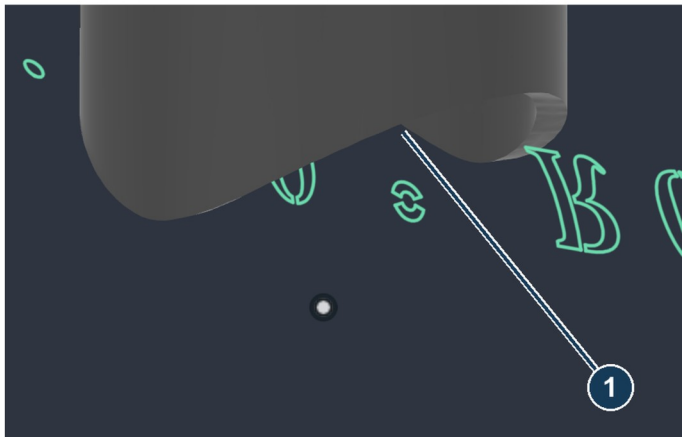
[Full procedure and recovery · detailed reference, pp. 14](#)

Inspect the cut and test an edit

BEFORE · SQUARE END



AFTER · COPE



B2's lower end with H1 hidden for inspection. The right-hand saddle is the completed ordinary cope.

1. Hide H1 temporarily to inspect B2's entire cut. Restore H1 and check the contact around the joint; confirm the intended end was cut.
2. Reopen **Tube point coordinates**. Change B2 upper Z 11 → 12 with **Update tubes on Apply** on, then Apply.
3. Verify that the tube updates and its cope is reapplied. Use **Undo** to return the example to **Z11** before exporting.

Check: The recorded edit updated one tube and reapplied one cope. The source IDs, die assignment and cut remained; Undo restored the original Z11 coped body.

If a cut looks stale: Actions → Design → Update copes can refresh saved cope relationships. Inspect the regenerated cut before continuing; use the reference for the recorded edit/Undo views.

Cancel / Undo: The cope and later point edit are separate actions. Undo the later edit first; Undo the cope only if you intend to return to a square end.

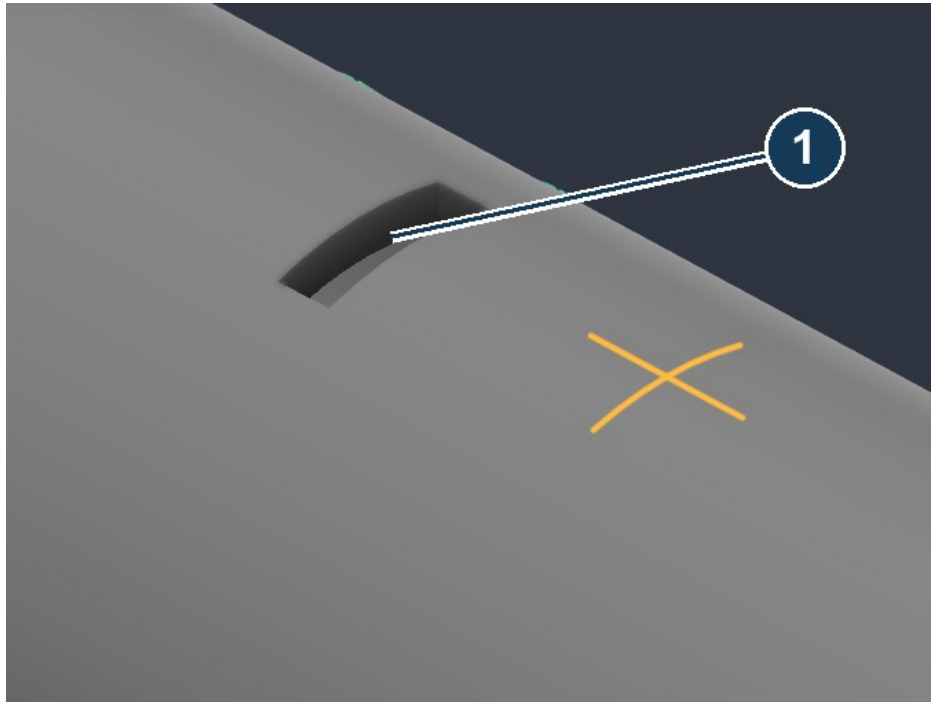
Save the ordinary result: QS109_09_Coped_job.f3d and QS109_Final_demonstration.f3d are supplied. The final example keeps H1 at R6 and all four new branch points fixed.

[Full procedure and recovery · detailed reference, pp. 15](#)

Try optional tabs on a copy

Use a separate copy of **QS109_08_Point_update.f3d**. Keep the ordinary coped model for the export exercise.

Open: Actions → Design → Cope a joint → Tab / slot joinery → Heel tabs + matching slots



The perpendicular test specimen. 1 points to the matching host slot. This view does not prove full tab engagement.

1. Use H1 as host and B2 as the tube to cut. Set width **0.375 in**, height **Auto through wall + 0.0625 in inside**, tolerance **0.005 in**, and minimum angle **45°**.
2. Cope, then inspect both the branch tab and the host slot. Check wall penetration, inside projection and clearance around the full perimeter.

Check: The digital specimen is saved as **QS109_Optional_tabs.f3d**. Physical fit and strength were not tested; a visible slot alone is not proof of a usable joint.

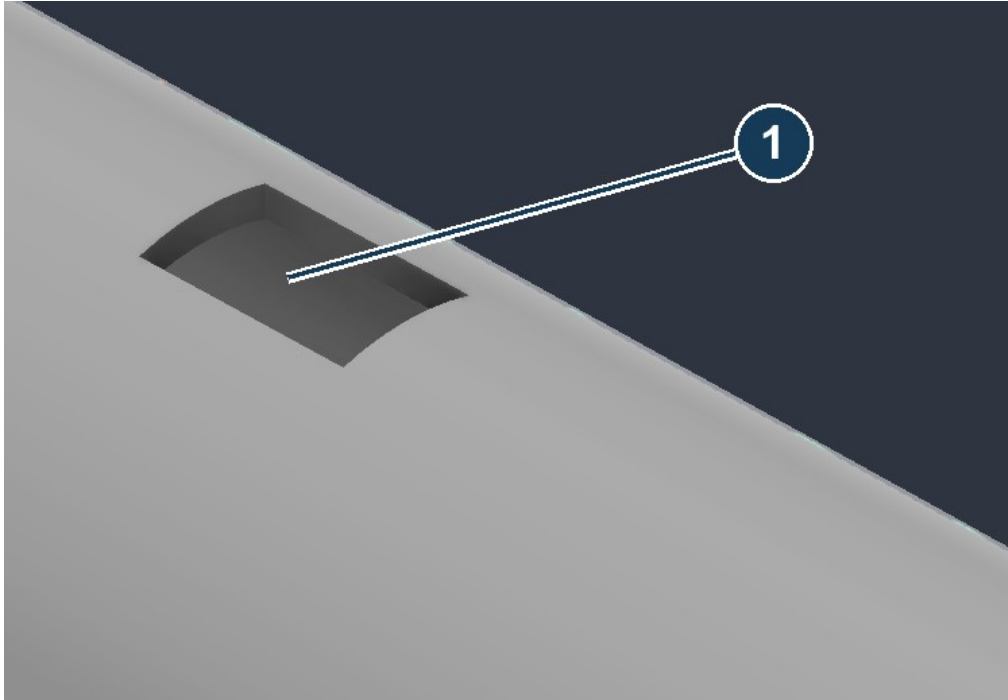
Cancel / Undo: Tab/slot options are session-only. Cancel before Cope or Undo the result. Reopen the ordinary coped model before the export steps.

[Full procedure and recovery · detailed reference, pp. 16](#)

Reject an impractical shallow joint

A shallow branch angle can stretch a tab slot along the host. Inspect the entire opening, not just the tab width.

Open: Actions → Design → Cope a joint → Tab / slot joinery



REJECTED EXAMPLE. 1 points to the host slot produced in the forced 20° tab test.

1. To inspect the saved result, open **QS109_Steep_angle_REJECTED_example.f3d**. The diagnostic branch runs from (14,0,0) to (4,0,3.639702).
2. Inspect the reported **0.418 × 0.669 in slot**, **0.375 × 0.7278 in tab**, and roughly **4.15 in cope depth**. The forced test lowered minimum angle to 0°; it is not a recommended setup.

Check: The command warned that the 20° angle is below 30° and weld access is marginal. Reject the forced setup for this exercise. No universal safe slot size or structural strength was established.

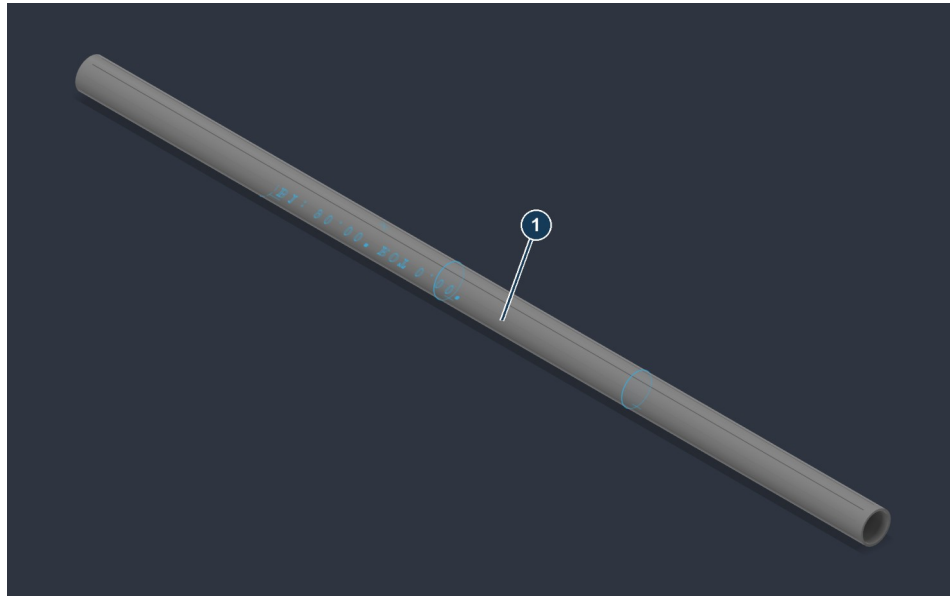
Cancel / Undo: Close this specimen and return to the ordinary model. Restore the normal 45° minimum, omit tabs, or redesign the joint. Do not export this diagnostic as approved work.

[Full procedure and recovery · detailed reference, pp. 17](#)

Export developed STEP and IGES

Export the ordinary coped four-tube model as straight blanks for the receiving workflow.

Open: Actions → Export tubes



Reopened developed H1. The bent host is now a straight blank; 1 identifies the exported geometry.

1. Select all four **Tubes to export**. Keep **Bending** on. Choose **Geometry** → **Developed (straight blank)** and **File format** → **STEP + IGES**.
2. Turn **Assembly file (all in one)** off; that option remains as-modeled. Leave **CAM G-code** and shop-document outputs off. Set a dedicated **Job folder (all outputs)** and run the export.
3. Open the four STEP and four IGES files from **exports/developed/blanks/**. Check part count, hollow section, end contours and orientation in the receiving software.

Check: All eight supplied files reopened in Fusion as one solid each. H1 is **39.424778 in** long. All ODs are **1.500 in = 38.100 mm**. Verify the receiver's units before any scaling.

Before machining: check contours and tolerances, nesting, process settings, leads, pierces, kerf and machine setup. Reopening geometry is not a machine-ready validation.

Cancel / Undo: Cancel before export. Fusion Undo does not remove written files; use a new job folder if you want to preserve an earlier export.

[Full procedure and recovery · detailed reference, pp. 18–19](#)

Review an experimental TubePro nest

This route writes a **.zx** nest for a separate receiving-system test. The supplied file was generated but was not opened or simulated in TubePro.

Open: Actions → Import to CAM → Tubes to nest → Advanced → Nest → Output stock → TubePro nest (.zx)

1. Use the ordinary final model and select all four tubes. Review the stock, chuck allowance, part spacing and process settings before nesting.
2. Choose **TubePro nest (.zx)** and generate the nest. Check the output folder and manifest for completion/errors.

Recorded result	Value
Selected parts / stocks	4 tubes / 1 stick
Recorded operations	13
Output file	QS109_Quick_start_demonstration_stick01.zx
Location	exports/developed/tubepro/
Manifest result	Complete; no recorded errors; experimental warning
Illustrative defaults	96 in stock; 2 in chuck allowance; 0.060 in kerf
Process used for the example	Plasma / GRBL defaults — not a validated laser setup

Check in the receiving software

1. Open the ZX in the intended TubePro version. Confirm units, four parts, stock size, positions and clamp/chuck clearance.
2. Separate cut from mark operations. Review their order, technology assignment, kerf, leads and pierces for the actual machine.
3. Simulate the complete job and follow the shop's receiving-machine validation process before cutting.

Check: A file on disk is the demonstrated result. TubePro compatibility, toolpaths and machine operation remain unverified.

Cancel / Undo: Cancel before generation. Keep this experimental output in its own job folder; model Undo does not delete export files.

Image gap: no native nesting dialog or TubePro receiving screen was captured.

[Full procedure and recovery · detailed reference, pp. 20](#)

Check the model before handoff

Use this as a handoff check, not a claim that every item passed. Mark blocked items as pending; keep the ordinary coped example separate from the optional joinery specimens.

Done	Stage	Check
☐	1 Dies	Correct stock and CLR; demo values distinguished from measured calibration.
☐	2 Import	Two solids at 1.500 in OD; H1 in XY and brace along +Z.
☐	3 Points	Existing solids retained; new points match the four-row coordinate table.
☐	4 Build	Four solids total; source-point IDs present; compatible dies assigned.
☐	5 Hosts	Driver/station/fixed choices reviewed. Host capture is blocked in this example.
☐	6 Radius	Before, preview and after checked. R4.5 conversion is blocked here.
☐	7 Following	Lower point follows bend and upper stays fixed. Not verified here.
☐	8 Edit	B2 upper Z10 → Z11; tube updates; Cancel and Undo behavior checked.
☐	9 Cope	H1 host, B2 cut; inspect cut and retained cope after edit. Return to Z11.
☐	10 Export	Eight geometry files checked. ZX receiving test remains pending.

Saved final state: H1 remains R6; four new source points are Fixed in space; B2 upper point is Z11 with its ordinary cope.

Pending before a complete release walkthrough: successful reconciliation, host capture, bend conversion and following; native dialog screenshots; physical calibration/fit; TubePro receiving and machine validation.

Use the right companion

[Printable one page checklist](#)

[One page troubleshooting](#)

[Full checklist, evidence and screenshot register · detailed reference, pp. 21–24](#)

The package retains 21 full-resolution screenshot originals and numbered copies, nine model/input files, and the actual exports. No personal recovery document is included.