SP3D CABLE TRAY FILL CALCULATION LOGIC

Based Upon: NFPA 70 National Electrical Code 2008 Edition

START

All Cables 2000 Volts or Below?

NO — NEC 392.12 — **All Cables 2001 Volts or Greater**

Add up the diameters for all cables (single conductor or multi-conductor): D_{TOTAL}

Retrieve cable tray width from catalog: W_{LOAD}

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (D_{TOTAL}/FE)/W_{LOAD}$$
Cables must be in a single layer - i.e., No Stacking

YES — **All Cables 2000 Volts or Less** — NEC 392.9 & NEC 392.10

Left branch (Single Conductor / NEC 392.10)

Single Conductor Cable?

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (A_{XS<1000}/FE)/(CS_{ALLOW-392.10(A)(2)} - 1.1\,Sd)$$

Add up the cross-sectional area for all cables less than 1000 kcmil: $A_{XS<1000}$

Use $W_{NOMINAL}$ to Retrieve the Allowable Cross-Section From Column 1 of Table 392.10(A): $CS_{ALLOW-392.10(A)(2)}$

Add up the diameters for cables >= 1000 kcmil : Sd

Retrieve nominal tray width from cableway run: $W_{NOMINAL}$

NEC 392.10 (A)(3)

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (A_{XS-ALL}/FE)/CS_{ALLOW-392.10(A)(2)}$$

Add up the cross-sectional area for all cables: A_{XS-ALL}

Use $W_{NOMINAL}$ to Retrieve the Allowable Cross-Section From Column 1 of Table 392.10(A): $CS_{ALLOW-392.10(A)(2)}$

Retrieve nominal tray width from cableway run: $W_{NOMINAL}$

NEC 392.10 (A)(2)

YES — NEC 392.10

Is the Cable Tray Ladder or Ventilated Trough?

Is Size 1000 kcmil or Greater for All Cables?

NEC 392.10 (A)(2)(3)(4)

YES — NEC 392.10 (A)(1)

Add up the diameters of all cables: D_{TOTAL}

Retrieve cable tray width from catalog: W_{LOAD}

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (D_{TOTAL}/FE)/W_{LOAD}$$
Cables must be in a single layer - i.e., No Stacking

Is Size for All Cables Between 250 and 900 kcmil?

NO

Is Size for Any Cable Between 1/0 and 4/0?

All Cables are Mixture of Cables >= 1000 kcmil and < 1000 kcmil

NEC 392.10 (A)(3)(4)

NEC 392.10 (A)(4)

YES

Add up the diameters for all cables: D_{TOTAL}

Retrieve cable tray width from catalog: W_{LOAD}

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (D_{TOTAL}/FE)/(W_{LOAD})$$
Cables must be in a single layer - i.e., No Stacking

Ventilated Channel decision

Is the Cable Tray Ventilated Channel? — **NO** — SP3D

NEC 392.9

NEC 392.9 (E)(F) branch

Is the Cable Tray Ladder, Ventilated Trough, or Solid Bottom?

NEC 392.9 (E)(F)

YES — NEC 392.9 (A)(B)(C)(D)

Is There a Mixture of Cables That Includes Power and/or Lighting?

NO

YES — NEC 392.9 (A)(C)

Are Any Cables AWG 4/0 or Greater?

All Cables are Smaller Than 4/0

YES — NEC 392.9 (A)(1)(3) NEC 392.9 (C)(1)(3)

Are All Cables AWG 4/0 or Greater?

All Cables are 4/0 or Larger

NEC 392.9 (A)(1) NEC 392.9 (C)(1)

NEC 392.9 (A)(3) NEC 392.9 (C)(3)

Add up the diameters for all cables greater or equal to 4/0 AWG: $S_{0-4/0}$

Sum the cross sectional area for all cables less than 4/0 AWG: $A_{XS<4/0}$

Is the Cable Tray Ladder or Ventilated Trough? — **Cable Tray is Solid Bottom**

NO

Use $W_{NOMINAL}$ to retrieve the allowable fill area from Column 3 of Table 392.9: $CS_{ALLOW-392.9(C)(2)}$

Retrieve nominal tray width from cableway run $W_{NOMINAL}$

NEC 392.9 (C)(3)

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (A_{XS<4/0}/FE)/(CS_{ALLOW-392.9(C)(2)} - S_{0-4/0})$$
4/0+ Cables must be in a single layer - i.e., No Stacking

YES — NEC 392.9 (A)(3)

Retrieve nominal tray width from cableway run $W_{NOMINAL}$

Use $W_{NOMINAL}$ to retrieve the allowable fill area area from Column 1 of Table 392.9: $CS_{ALLOW-392.9(A)(2)}$

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (A_{XS-4/0}/FE)/(CS_{ALLOW-392.9(A)(2)} - 1.2\,S_{0-4/0})$$
4/0+ Cables must be in a single layer - i.e., No Stacking

Add up the diameters of all cables: D_{TOTAL}

Retrieve cable tray width from catalog: W_{LOAD}

Is the Cable Tray Ladder or Ventilated Trough? — **NO**

NEC 392.9 (A)(1)

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (D_{TOTAL}/FE)/W_{LOAD}$$
Cables must be in a single layer - i.e., No Stacking

NEC 392.9 (C)(1) — **Cable Tray is Solid Bottom**

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (D_{TOTAL}/FE)/0.9W_{LOAD}$$
Cables must be in a single layer - i.e., No Stacking

Control/signal branch

Multi-Conductor Control and/or signal cables only

NEC 392.9 (B)(D)

Are the Cables Limited to a Mixture of Control and Signal Only? — SP3D

NO — Create ToDo Record: "Cable Signal Type is Not Handled by Fill Calculation Module - Check Signal Type(s) or Update VB Module."

NEC 392.9 (B)(D) — **Cable Tray is Solid Bottom**

Add up the cross-sectional area for all cables: A_{XS-ALL}

Is the Load Depth of Tray <= 6 in. (150 mm)?

YES — NEC 392.9 (B)(D)

NO — NEC 392.9 (B) — **Depth of Tray is Greater Than 6"**

NEC 392.9 (B)(D)

Set depth of Tray to 6 in: $D_{EFFECTIVE} = 6\ in\ (150\ mm)$

Retrieve cable tray load width from catalog (use smallest for varying port sizes): W_{LOAD}

Is the Cable Tray Ladder or Ventilated Trough?

YES — Set Derating Factor: $DR_{NEC\ 392.9(B)} = 0.5$

Calculate allowable area of cable tray:
$$CS_{ALLOW-NEC\ 392.9(B)} = DR_{NEC\ 392.9(B)}(W_{LOAD}\,D_{EFFECTIVE})$$

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (A_{XS-ALL}/FE)/CS_{ALLOW-NEC\ 392.9(B)}$$

NO — Is the Cable Tray Solid Bottom?

YES — Set Derating Factor: $DR_{NEC\ 392.9(D)} = 0.4$

Calculate allowable area of cable tray:
$$CS_{ALLOW-NEC\ 392.9(D)} = DR_{NEC\ 392.9(D)}(W_{LOAD}\,D_{EFFECTIVE})$$

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (A_{XS-ALL}/FE)/CS_{ALLOW-NEC\ 392.9(D)}$$

Depth > 6" path

NEC 392.9 (B)(D)

Is the Cable Tray Ladder or Ventilated Trough?

YES — NEC 392.9 (B) — Set Derating Factor: $DR_{NEC\ 392.9(B)} = 0.5$

Retrieve cable tray load width from catalog (use smallest for varying port sizes): W_{LOAD}

Retrieve cable tray load depth from catalog (use smallest for varying port sizes): D_{LOAD}

Calculate allowable area of cable tray:
$$CS_{ALLOW-NEC\ 392.9(B)} = DR_{NEC\ 392.9(B)}(W_{LOAD}\,D_{LOAD})$$

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (A_{XS-ALL}/FE)/CS_{ALLOW-NEC\ 392.9(B)}$$

NO — NEC 392.9 (D) — Is the Cable Tray Solid Bottom?

SP3D — **NO** — Create ToDo Record: "Cable Tray Type is Not Handled by Fill Calculation Module - Check Tray Type or Update VB Module."

YES — Set Derating Factor: $DR_{NEC\ 392.9(D)} = 0.4$

Retrieve cable tray load width from catalog (use smallest for varying port sizes): W_{LOAD}

Retrieve cable tray load depth from catalog (use smallest for varying port sizes): D_{LOAD}

Calculate allowable area of cable tray:
$$CS_{ALLOW-NEC\ 392.9(D)} = DR_{NEC\ 392.9(D)}(W_{LOAD}\,D_{LOAD})$$

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (A_{XS-ALL}/FE)/CS_{ALLOW-NEC\ 392.9(D)}$$

Multi-conductor / NEC 392.9(E)(F) branch

Is the Cable Tray Ventilated Channel?

NO — Create ToDo Record: "Cable Tray Type is Not Handled by Fill Calculation Module - Check Tray Type or Update VB Module."

Add up the cross-sectional area for all cables: A_{XS-ALL}

Retrieve nominal tray width from cableway run: $W_{NOMINAL}$

NO — Is the Cable Tray Solid Channel?

SP3D

YES — NEC 392.9 (F)

Is There Only One Cable in the Tray?

NEC 392.9 (F)(2) — **NO**

Using $W_{NOMINAL}$, retrieve the allowable cross-section from Column 2 of Table 392.9(F): $CS_{ALLOW-NEC\ 392.9(F)(2)}$

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (A_{XS-ALL}/FE)/CS_{ALLOW-NEC\ 392.9(F)(2)}$$

NEC 392.9 (F)(1) — **YES**

Using $W_{NOMINAL}$, retrieve the allowable cross-section from Column 1 of Table 392.9(F): $CS_{ALLOW-NEC\ 392.9(F)(1)}$

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (A_{XS-ALL}/FE)/CS_{ALLOW-NEC\ 392.9(F)(1)}$$

Is the Cable Tray Ventilated Channel?

NEC 392.9 (E) — **YES**

Is There Only One Multi-Conductor Cable in the Tray?

NEC 392.9 (E)(2) — **NO**

Using $W_{NOMINAL}$, retrieve the allowable cross-section from Column 2 of Table 392.9(E): $CS_{ALLOW-NEC\ 392.9(E)(2)}$

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (A_{XS-ALL}/FE)/CS_{ALLOW-NEC\ 392.9(E)(2)}$$

NEC 392.9 (E)(1) — **YES**

Using $W_{NOMINAL}$, retrieve the allowable cross-section from Column 1 of Table 392.9(E): $CS_{ALLOW-NEC\ 392.9(E)(1)}$

Calculate the Percent Cable Fill Using the Formula:
$$FILL_{CABLE} = (A_{XS-ALL}/FE)/CS_{ALLOW-NEC\ 392.9(E)(1)}$$