A building is being supplied by a 3 ϕ 4-Wire 120/208 60 Hz Wye system. Circuit 2 is feeding a 3-kW heater, circuit 4 is feeding a 0.2 H coil that has 7 Ω of resistance and circuit 6 is feeding a 0.4 H coil that has 15 Ω of resistance and a 20 μF capacitor.

Circuits 2, 4 and 6 all share a common neutral that is a #10 AWG R90. Is this acceptable?

Calculating the neutral current:

Circuit 2 (Phase A)

Purely Resistive

$P = IE$

$I = \frac{P}{E}$

$I = \frac{3{,}000}{120}$

I = 25 A @ 0°

Circuit 4 (Phase B)

Resistive / Inductive

$I = \frac{E}{Z}$

$R_{COIL} = 7\ \Omega$

$XL_{COIL} = 2\pi fL$

$XL_{COIL} = 2\pi(60)(0.2)$

$XL_{COIL} = 75.39822369\ \Omega$

$Z_{CCT} = \sqrt{R^2 + XL_{COIL}{}^2}$

$Z_{CCT} = \sqrt{7^2 + 75.39822369^2}$

$Z_{CCT} = 75.72246784$

$I = \frac{120}{75.72246784}$

I = 1.584734405

$PF_{COIL} = \frac{R_{COIL}}{Z_{COIL}}$

$PF_{COIL} = \frac{7}{75.72246784}$

$PF_{COIL} = 0.09244284$

$PF\angle_{COIL} = 84.69584243°$

I = 1.591549431 A @ 84.69584243°

Circuit 4 (Phase C)

Resistive / Inductive / Capacitive

$I = \frac{E}{Z}$

$R_{COIL} = 15\ \Omega$

$XL_{COIL} = 2\pi fL$

$XL_{COIL} = 2\pi(60)(0.4)$

$XL_{COIL} = 150.7964474\ \Omega$

$XC_{CAP} = \frac{1}{2\Omega fC}$

$XC_{CAP} = \frac{1}{2\Omega(60)(0.000002)}$

$XC_{CAP} = 132.6291192\ \Omega$

$X_T = XL - XC$

$X_T = 150.7964474 - 132.6291192$

$X_T = 18.1673282\ \Omega$

$Z_{CCT} = \sqrt{R^2 + X_T{}^2}$

$Z_{CCT} = \sqrt{15^2 + 18.1673282^2}$

$Z_{CCT} = 23.55953764\ \Omega$

$I = \frac{120}{23.55953764}$

I = 5.093478566 Ω

$PF_{COIL} = \frac{R_{COIL}}{Z_{COIL}}$

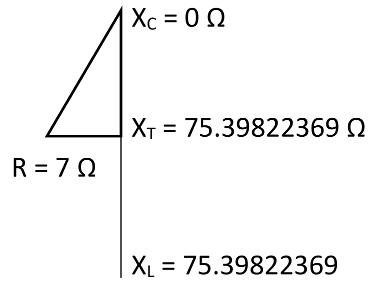
$PF_{COIL} = \frac{15}{23.55953764}$

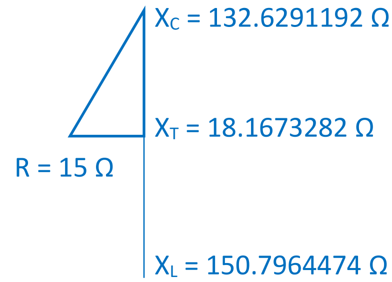
$PF_{COIL} = 0.63668482$

$PF\angle_{COIL} = 50.45494322°$

I = 5.093478566 A @ 50.45494322°

Power Triangle Not Necessary





Now that each phase has been calculated, we can calculate the Neutral Current.

I_A = 25 A @ 0°
I_B = 1.591549431 A @ 84.69584243° (LAG)
I_C = 5.093478566 A @ 50.45494322° (LAG)

We know that phases B and C have a lagging power factor because there is more inductive reactance in both when we calculated them out on page 1. Since Phase A is our reference at 0 (or 360)° then the origin angles for Phase B is 240° and Phase C is 120°. This tells us:

I_A = 25 A @ 360° - 0°
I_B = 1.591549431 A @ 240° - 84.69584243°
I_C = 5.093478566 A @ 120° - 50.45494322°

We are left with:

I_A = 25 A @ 360°
I_B = 1.591549431 A @ 155.3041576°
I_C = 5.093478566 A @ 69.54505678°

Plot Polar form to Rectangular Form

Phase	Horizontal	Vertical
I_A = 25 A @ 360°	25.000000000	0.000000000
I_B = 1.591549431 A @ 155.3041576°	-1.445983928	0.664951179
I_C = 5.093478566 A @ 69.54505678°	1.780021439	4.772320984
Totals	25.33403751	5.437272163

$I_N = \sqrt{25.33403751^2 + 5.437272163^2}$
I_N = 25.91095107 A

I_{Pf} = 25.33403751 ÷ 25.91095107
I_{Pf} = 0.977734759

$I\angle = 12.11324335$

I_N = 25.911 A @ 12°

As per Table 2 of the CEC, #10 AWG conductors have an allowable ampacity of 35 A at a 75°C temperature rating. This cable would be sufficient to carry the neutral load.