example problems

① what size dual element fuse is permitted to protect a 5HP, 230V 1Ø motor w/ SF 1.15 + nameplate current rating of 23.5 Amps from overloads and from SS + GFs.

a) size OLs per 430.32(A)(1) + 430.55

23.50A x 1.25 = 29.4 Amps

b) based on fuse sizes in 240.6(A) you should use a **25a fuse**

② which is highest rated motor:

a) 10hp 208v 3Ø 30.8 FLC (T430.250)

b) 3hp 208v 1Ø 18.7 FLC (T430.248)

(c) 3hp 115v 1Ø 34 FLC ← **highest rated** (T430.248)

③ what size conductors are required for a 1hp 1Ø 115v motor where terminals are rated @ 60°C

a) find FLC in Tbl 430.248. → answer = 16a

b) size conductor no less than 125% of motor FLC [16a x 1.25 = 20a]

c) check tbl 310.15(B)(16) → **12awg**

④ what size br ckt conductors are required for 7½ HP 3Ø 230v motor w/ nameplate FLA of 20a, rated for 5 min service, used for intermittent duty. Terminals 75°C

a) use motor nameplate FLA for non continuous duty cycle

- conductor must be @ least 85% of FLA [T430.22(E)]
- 20a x 0.85 = 17a

b) check tbl 310.15(B)(16) → **14awg**

⑤ Between what %'s can SC + GF protection be sized?

[430.52] between 150% and 300%

⑥ Between what % can overloads be sized

between 115% and 125%

Taps 210.19

240.21(A)

240.21(B)(1)-(5)

⑦ A 400a breaker protects a set of 500kcmil feeder conductors. There are 3 taps fed from the 500kcmil feeder that supply disconnects w/ 200a, 150a, & 30a OCPDs. what are the min size conductors for each of these taps

a) 200a disconnect - 3/0 AWG is rated 200a @ 75°C + is greater than 10% of rating of OCPD (400A)

b) 150a disconnect - 1/0 AWG is rated 150a @ 75°C & is greater than 10% of rating of OCPD (400A)

c) 30a disconnect - 8 AWG is rated 40a @ 60°C. The tap conductors from the 400a feeder to the 30a OCPD can't be less than 10% of rating of OCPD (400A) (10% = 40amps)

⑧ what size conductor & inverse time ckt brkr are required for a 7½ hp 230v 3Ø motor w/ terminals rated 75°C

a) Determine required br ckt conductor (125% of FLC) T310.15(B)(16)

sec 430.22 & T430.250 → 22a X 1.25 = 27.5a ✓ 10AWG rated 35 A @ 75°C

b) Determine branch ckt protection (250% of FLC) 240.6(A) 430.52(C)(1) Ex 1 & T430.250 → 22a X 2.50 = 55a, next size up = 60a

⑨ what size feeder protection + conductors are required for these 2 motors w/ terminals rated 75°C?

motor 1 = 10hp 460v 3Ø

FLC = 14a (T430.250)

motor 2 = 20hp 460v 3Ø

FLC = 27a (T430.250)

a) size feeder protection [430.62(A)] device so its no greater than largest branch ckt OCPD PLUS the other motors' FLC.

① Determine largest br ckt OCPD [430.52(C)(1) Ex 1]

10hp motor = 14a X 2.50 = 35a

20hp motor = 27a X 2.50 = 68 (next size up = 70a)

② Determine proper size feeder protection

not more than 70a + 14a = 84a, (next size down = 80a) [240.6(A)]

b) calculate feeder conductor size (based on 125% of FLC of highest rated motor in group plus 100% of all other motor FLCs on same phase [430.24]

(27a X 1.25) + 14a = 48a [110.14(C) & T310.15(B)(16)]

Questions always assume 1Ø and copper

① 8awg conductor is rated 50a @ 75° so... **80a breaker, 8awg conductor**

⑩ What size service conductors are required if the calculated load for a dwelling unit = 195a, + the service disconnect is rated 200a

a) 200a ckt. breaker X 0.83 = 166a

b) Tbl 310.15(B)16 → 2/0 awg conductor would work (175a @ 75°c)

⑪ What size neutral conductor is required if the calculated load for a dwelling unit = 195a, max unbalanced load = 100a, + service disconnect is rated @ 200a w/ 2/0 awg conductors?

a) Tbl 310.15(B)(16) → 3 awg good choice, its rated @ 100a @ 75°c

b) See 310.15(B)(7)(3) doesnt allow 83% deduction for neutral conductors

c) See 250.24(c) requires the neutral conductor to be sized no smaller than 4awg based on 2/0 service conductors in accordance w/ T250.102(c)

⑫ What size conductor and inverse time ckt brkr are required for a 2hp 230v motor? (75°)

a) T430.247 FLC = 12a ↓ / FLC x 125% = 15A

b) T310.15(B)(16) = 20a = 14awg

c) T430.52 = 250% of FLC = 30amps

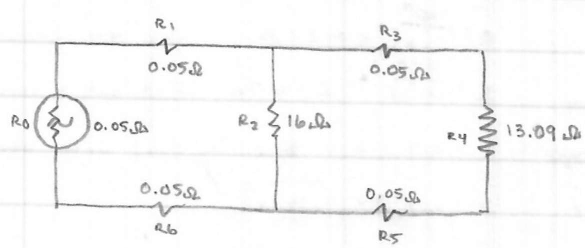
⑬ What is the neutral current for a 4-wire, 120/208v 3Ø ckt, if Line 1 = 100A, Line 2 = 100A and Line 3 = 50A

$I_N = \sqrt{[(100^2 + 100^2 + 50^2) - [(100 \times 100) + (100 \times 50) + (50 \times 100)]]}$ 22500 -

$I_N = \sqrt{(22500) - (20{,}000)}$

$I_N = \sqrt{2500} = I = 50a$ (neutral)

⑭ Calculate the total circuit resistance for the series-parallel circuit below



a) $R_3 + R_4 + R_5 = 13.19\Omega$

b) $R_{Tp} = \frac{(16 \cdot 13.19)}{(16 + 13.19)} = \frac{211.04}{29.19}$ 7.23

c) $R_0 + R_1 + R_2(\text{new}) + R_6 =$ **7.38Ω**

(15) What is the power consumed by a 9.6 kW heat strip rated 230v, connected to a 208v ckt?

$R = \frac{E^2}{P}$, $P = \frac{E^2}{R}$

a) $R = \frac{E^2}{P}$ $R_{230} = \frac{230^2}{9600}$ $R_{230} = 5.5\Omega$

b) $P = \frac{E^2}{R}$ $P = \frac{208^2}{5.5}$ $P = \boxed{7.85\ kW}$

(16) What is the conductor power loss in watts for a 10AWG conductor that has a voltage drop of 3% and carries a current flow of 24a? (240v ckt)

a) 240 x 3% = 7.2volts dropped

b) $P = E \cdot I \rightarrow P = 7.2 \cdot 24 = \boxed{172.8\ watts}$

(17) The total resistance of (2) 12awg conductors, 75' long is 0.30Ω, & the current through the circuit is 16a. What is the power loss of these conductors?

a) $P = I^2R \rightarrow P = 16^2 \cdot 0.30 = \boxed{76.8\ watts}$

(18) What is the line to neutral voltage drop over each line conductor of a balanced 4-wire multiwire branch ckt? · Each conductor is 12AWG, 75' long, supplying a 20a load - 120v

a) balanced load means neutral carries no current (phases cancel out)

b) $E_{vd} = I \cdot R$

c) R = (2ohms / 1000ft / 1000) x 75' x 1 wire R = 0.15 ohms

d) Evd = 20a x 0.15 ohm = $\boxed{3\ volts\ dropped}$

(19) A 3-wire 120/240v ckt supplies a 1200w, 120v hair dryer and a 600w, 120v TV. If the neutral conductor is interrupted it will cause the 120v TV to operate @ ____volts and consume ____ watts of power (instead of 600w) for only a few seconds and burns up.

a) $R = \frac{E^2}{P}$ Dryer : $R = \frac{120^2}{1200}$ $R = 12\Omega$ get Dryer resistance

b) $R = \frac{E^2}{P}$ TV : $R = \frac{120^2}{600}$ $R = 24\Omega$ get TV resistance

c) $I = \frac{E}{R}$ Both $I = \frac{240}{12+24} =$ $I = 6.7a$ find total new ckt current

d) $E = IR$ Dryer : $E = 6.7 \cdot 12 = 80v$ } find volts each

TV : $E = 6.7 \cdot 24 = \boxed{160v}$

e) $P = E \cdot I$ Dryer : $P = 80 \cdot 6.7$ $P = 536$ watts

TV : $P = 160 \cdot 6.7$ $P = \boxed{1072\ watts}$

(20) whats the apparent power (in VA) of a 1 HP, 115v motor that has a full load current of 16A.

115 x 16 = **1840 VA**

(21) Assuming 100% efficiency, whats the power factor for each ballast rated 0.75a @ 120v for a 2x4 fixture containing (4) 40w lamps (2 per ballast)

$PF = \frac{TP}{AP}$ $AP \cdot PF = TP$ $AP = \frac{TP}{PF}$

$AP = \frac{80}{120 \times 0.75}$ $AP = \frac{80}{90}$ $AP = 0.8\bar{8}$ or **89% PF**

(22) what is the true power of a 16a load rated 120v, w/ power factor of 85%?

$TP = AP \cdot PF$ $(120 \cdot 16)\, 0.85 =$ **1632 watts**

(23) whats the cost of power consumed per month (@ 0.09 / kwh) for a 120v ckt that's faulted to a ground rod w/ 25Ω resistance?

$P = \frac{E^2}{R}$ $P = \frac{120^2}{25}$ P = 576 watts or 0.576 kw

$0.576 \cdot (0.09) = 0.05184$ kwh

0.05184 kwh x 30 days = **$37.32**

(24) What size transformer is required for (48) 150w incandescent luminaires (noncontinuous load)?

$48 \cdot 150 = 7{,}200$ VA or 7.2 KVA

* (25) What size transformer is required for (48) 150w HID luminaires that have a power factor (non-cont) of 85%.

$48 \cdot 150 = 7200$ VA HID is inductive, so... $\frac{TP}{PF} = AP$ $\frac{7200}{.85} = 8470$ or 8.5 KVA

(26) How many 20a 120v circuits are required for (48) 150w incandescent luminairs (non-cont)

$48 \cdot 150 = 7200$ w

$20 \cdot 120 = 2400$ w/ea **3 ckts**

(27) How many 20a 120v ckts are required for (48) 150w HID luminaires (non-cont) that have 85% PF

$48 \cdot 150 = 7200$ w $PF = \frac{TP}{AP}$ $AP = \frac{TP}{PF}$ $AP = \frac{7200}{.85}$ AP = 8470.6 **4 ckts**

(28) if the output of a 5hp DC motor is 3,730w (746 · 5) and the input is 4800w (40a · 120v)

what is the efficiency of the motor?

$EFF = \frac{OW}{IW}$ $EFF = \frac{3730}{4800} = 0.777$ = 77.7% eff

(29) if the output is 250w & the equipment is 88% efficient, what's the input power rating (watts)?

$IW = \frac{OW}{EFF}$ $IW = \frac{250}{.88}$ IW = 284 watts

(30) what's the output watts rating of a 10HP, alternating current, 3Ø motor with an efficiency rating of 75% & a power factor of 70%?

Output W = 10hp × 746w output w = 7,460 w

★ PF & EFF have nothing to do with output watts! ★

(31) What's the secondary conductor power loss of a 75 KVA XFMR if the secondary current rating is 208A and the winding has a resistance of 0.0313 Ω?

$P = I^2 R$

$P = 208^2 \cdot 0.0313 = 1354.16\ w$

(32) whats the maximum primary and secondary line current @ full load for a 480/240v, 25kva, single phase XFMR?

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

$I_p = \frac{25,000}{480}$ I_p = 52.08a $I_s = \frac{25,000}{240}$ I_s = 104.16a

(33) what's the maximum primary and secondary line current @ full load for a 480v/208v, 37.50 kva three phase XFMR

$I = \frac{VA}{E\sqrt{3}}$

$I_p = \frac{37,500}{480 \cdot \sqrt{3}} = \frac{37,500}{831.38} =$ I_p = 45.12a

$I_s = \frac{37,500}{208 \cdot \sqrt{3}} = \frac{37,500}{360.27} =$ I_s = 104.09a

(34) According to T310.15(B)(16) what size THHN conductor is required for a 50a ckt where the equipment is listed for use @ 75°C

8 AWG is rated 50a @ 75°C

(35) what's the cross-sectional area of permitted conductor fill for trade size 1 EMT raceway 30" long containing 4 conductors?

ch. 9 Tbl 4 (EMT) – 40% column = $\boxed{0.346 \text{ in}^2}$

(36) What's the minimum size EMT raceway required for (3) conductors having an area of 0.25 in^2?

ch. 9 Tbl 1 + Tbl 4 – 40% column = $\boxed{\text{Trade size } 1"}$ (0.346 in^2)

(37) What size RMC nipple is required for (3) 3/0 THHN conductors, (1) 1 THHN conductor, and (1) 6 THHN conductor having a total cross sectional area of 1.0106 in^2?

Nipples – 60% column (24" or less)

ch 9 Tbl 4 – 60% column = Trade size $\boxed{1\frac{1}{2}"}$ (1.234 in^2)

(38) What's the minimum size schedule 40 PVC raceway required for (3) 500 kcmil THHN conductors, one 250 kcmil THHN conductor, and one 3 THHN conductor?

500 THHN = $0.7073 \text{ in}^2 \times 3$ wires = 2.1219 in^2

250 THHN = $0.3970 \text{ in}^2 \times 1$ wire = 0.3970 in^2

3 THHN = $0.0973 \text{ in}^2 \times 1$ wire = 0.0973 in^2

} 2.6162 in^2

ch9, tbl 1 = 40% fill – ch9 tbl 4 (PVC schedule 40) = Trade size $\boxed{3"}$

(39) How many 6 THW-2 compact conductors can be installed in trade size 1 EMT?

Annex C Tbl C.1(A) – $\boxed{\text{5 conductors}}$

(40) what's the smallest trade size PVC schedule 80 raceway that can be used for installation of a single 3/0 THHN as a grounding electrode conductor

Annex C Tbl C.9 – $\boxed{3/4" \text{ EMT}}$

(41) whats the max allowable conductor fill in sq in for a 6" x 6" wireway

wireway = 6 x 6 = 36 in^2

conductor fill = $36 \text{ in}^2 \times 0.20$ = $\boxed{7.20 \text{ in}^2}$ [376.22(A)]

I AM A PIECE
OF PAPER...
AND I AM SOOOO
TIRED OF YOUR FACE.

(42) What's the minimum size wireway required for (3) 500 kcmil THHN, (1) 250 kcmil THHN, and (4) 4/0 THHN conductors?

Ch 9 Tbl 5 - 500 kcmil THHN = $0.7073\ in^2 \times 3$ = $\underline{2.1219\ in^2}$

250 kcmil THHN = $\underline{0.3970\ in^2}$

4/0 THHN = $0.3237\ in^2 \times 4 = 3.8137\ in^2$

No more than 20% fill of wireway (376.22(A))

$3.8137\ in^2 \times 5 = \underline{19.07\ in^2}$ ← 20% = $\frac{1}{5}$, so multiply by 5 for required min wireway.

$6 \times 6 = 36\ in^2$, so [6x6] large enough.

(43) What 4" square outlet box containing (3) 12 THW and (6) 12 THHN conductors would be required?

* insulation types dont matter *

T 316.14(A) → 9 #12s fit in a [4" x 1½" square box.]

(44) What's the min depth 4" square outlet box required for on 14/3 w/ ground Type NM cable that terminates on a 3-way switch, and one 12/2 w/ ground type NM cable that terminates on a receptacle? The box has internal cable clamps.

(45) A round 4 x ½" box has a total volume of $7\ in^3$ and has factory installed internal cable clamps. Can this box be used with a luminaire that has a domed canopy? The branch ckt wiring is 14/2 w/ground NM cable, and the luminaire has (2) 16 AWG fixture wires and (1) 16 AWG ground.

1) # and size of conductors in box: 14/2 : (2), cable clamps : (1), ground wire : (1).

2) volume of the conductors [Tbl 314.16(B)] 14 AWG : $2\ in^3$

3) Add 'em up: 4 wires x $2\ in^3$ ea = $8\ in^3$. Box is only $7\ in^3$ [NO]

* Domed canopies are not counted ever (wires) *

(46) How many 14 AWG conductors can be added to a 4 x 2⅛" square box that has a plaster ring of $3.60\ in^3$ if the box already contains (2) receps, (5) 12 AWG conductors, and (1) 12 AWG EGC?

1) 4" x 2⅛" square box = $30.3\ in^3$

vol allowances use same in^3 as largest conductor. →

2) [2 receps = (4)] + [6 wires = (6) x 2.25 ea] = $22.5\ in^3$

3) total space (30.3) + mudring (3.6) = $\underline{33.9\ in^3}$ − $22.5\ in^3$ = $11.4\ in^3$

Room left for [5 conductors]

(47) According to T310.15(B)(16) what THHN conductor is required to supply a 150a Feeder?

T310.15(B)(16) 75°C column for over 100a

(48) According to T310.15(16)(B) what size Aluminum compact conductor to interconnect busbars protected by a 200a OCPD if all terminals are rated 90°C?

T310.15(B)(16) Aluminum, 90°, 200a = **4/0 AL**

(49) What's the ampacity of a 12 THHN conductor when installed in a location that has an ambient temperature of 50°F?

a) T310.15(B)(16) 90° = 30a

b) T310.15(B)(2)(a) 50°, 90° CF = 1.15

c) 30 × 1.15 = 34.5a

(50) What is the ampacity of 3/0 THHN conductors if the ambient temp is 108°F?

a) T310.15(B)(16) 3/0, 90° = 225a

b) T310.15(B)(2)(a), 108°, 90° CF = 0.87

c) 225 × 0.87 = **196 a**

(51) Whats the ampacity of an 8 THWN-2 conductor installed 3/4" above the roof, where the ambient temp is 90°F?

a) T310.15(B)(16) = 8 THWN-2 = 55a

b) T310.15(B)(3)(c) = 3/4" → 40°F added to ambient temp 90 + 40 = 130°

c) T310.15(B)(2)(a) → 130° = 0.76

d) 130° × 0.76 = **41.8a**

(52) Whats the adjusted ampacity of (4) #12 THWN-2 conductors in a raceway?

a) T310.15(B)(16) → 30a

b) T310.15(B)(3)(a) → 80%

c) 30a × 0.08 = **24a**

(53) whats the adjusted ampacity of 10 THHN conductors when 9 current carrying conductors are installed in a raceway?

a) T310.15(B)(16) → 10 THHN = 40a

b) T310.15(B)(3)(a) → 7-9 = 70%

c) 40 × 0.7 = **28a**

(54) Whats the ampacity of (4) 3/0 THWN-2 conductors in a raceway not exceeding 24" in length?

* ampacity adjustment for bundling doesnt count for raceway less than 24" *

225a - T310.15(B)(16) → 3/0 → 225a

(55) what's the ampacity of (4) current carrying 10 THWN-2 conductors installed in a raceway less than ½" above a rooftop, ambient temp 90°F?

a) T310.15(B)(16) → 40a

b) T310.15(B)(3)(c) → temp adder = 60°F

c) T310.15(B)(2)(a) → ambient temp = 90°F + 60°F = 150°F → 0.58

d) T310.15(B)(3)(a) → 4 conductors = 80%

e) 40 × 0.58 × 0.8 = **18.56a**

(56) what's the neutral current for (2) 16a 120v ckts w/ a common neutral? The system is a 120/208v 3Ø 4 wire wye connected system that supplies fluorescent lighting

a) $I_{neut} = \sqrt{(I_{L1}^2 + I_{L2}^2) - (I_{L1} \times I_{L2})}$

b) $I_{neut} = \sqrt{(512) - (256)} = \sqrt{256} = 16a$

(57) what's the ampacity of 8 THHN if there are (31) conductors in a cross-sectional area of a wireway?

a) T310.15(B)(16) → 55a

b) T310.15(B)(3)(a) → 31 conductors = 40%

c) 55 × 0.40 = **22a**

(58) what size OCPD will be required for a br ckt supplying a 45a continuous nonlinear load?

a) 45a × 1.25 = 56.25a, next size up **60a**

(59) What sized branch ckt conductor (THHN) is required for a 45a continuous nonlinear load that requires (3) ungrounded conductors and a neutral (4 ccc's)?

a) 45 x 1.25 = 56.25a , 4AWG conductor good @ 60°

b) T310.15(B)(16) 56a → 70a @ 60°C

c) 70 x 0.8 = 56a → **4AWG**

(60) What size feeder conductor (THHN) is required for a 200a continuous non-linear load @ an ambient temp of 100°F (4 ccc's)?

a) 200 x 1.25 = 250a (continuous) (OCPD size)

b) T310.15(B)(16) → 255a → 250 kcmil (75°C)

c) 250 kcmil 90°C column → 290a

d) 290 x 0.91 x 0.8 = 211a (211a feeds 200, but not ok on 250a OCPD

d) move up to 350 kcmil → 320a @ 90°C

e) 320 x 0.91 x 0.8 = **233a** ok for 200a, ok for 250a breaker

(61) Using the 10' tap rule, what's the minimum size conductor required to supply a 200a overcurrent device, if the tap is from feeder conductors protected by a 400a ckt breaker?

a) T310.15(B)(16) → **3/0** = 200a @ 75°C , $\frac{400}{10}$ = 40a min

(62) Using the 10' tap rule, whats the minimum size conductor required to supply a 150a OCPD, if the tap is from feeder conductors protected by a 400a ckt?

a) T310.15(B)(16) = **1/0** = 150a @ 75°C , $\frac{400}{10}$ = 40a min.

(63) Using the 10' tap rule, whats the minimum size conductor required to supply a 30a OCPD, if the tap is from feeder conductors protected by a 400a ckt?

a) T310.15(B)(16) = #10 = 30a @ 60°C , $\frac{400}{10}$ = 40a min → **#8** = 40a

(64) Using the 25' tap rule, whats the minimum size conductor required to supply a 200a OCPD if the tap is from feeder conductors protected by a 400a ckt?

a) T310.15(B)(16) = 200a → **3/0** , $\frac{400}{3}$ = $133.\bar{3}$ a min

(65) Using the 25' tap rule, whats the min size conductor required to supply a 150a OCPD, if the tap is fed from feeder conductors protected by a 400a ckt.

a) T 310.15 (B) (16) → [1/0] = 150a $\frac{400}{3} = 133.\bar{3}$ min.

(66) Using the 25' tap rule, whats the min size conductor required to supply @ 30a OCPD, if the tap is fed from feeder conductors protected by a 30a ckt.

a) T310.15 (B) (16) → #10 = 30a, $\frac{400}{3} = 133.\bar{3}$ a min ; [1/0] = 150a @ 75°

(67) what is the cross-sectional area of a 250 kcmil conductor?

[250,000 circular mils]

(68) what is the cross-sectional area of a 10 AWG conductor, and in what table is this information?

[10,380 cm]   [Ch. 9, Tbl 8]

(69) According to Tbl 8 of Ch.9 of the NEC, whats the DC resistance of 200' of 1/0 AWG Aluminum?

a) 1/0 Al = 0.201 @ 1000'

b) $\left(\frac{0.201}{1000}\right) \times 200'$ = [0.04 Ω]

(70) According to Tbl 8 of Ch 9 of the NEC, whats the DC resistance of 12 AWG @ 60°C when its resistance is approximately 2Ω @ 75°C.

a) R for Cu = Tbl R × {1 + [0.00323 × (Temp °C - 75°)]}

60°c = 2 × {1 + [0.00323 × (60 - 75)]}

60°c = [1.90 Ω]

(71) According to Tbl 9 Ch 9 of the NEC whats the AC resistance of 100' of 2/0 AWG installed in a steel raceway?

a) 2/0 AWG Cu = 0.10 Ω / 1000'

b) $\frac{0.10}{1000}$ × 200 = [0.010 Ω] @ 200'

(73) According to Tbl 9, Ch 9 in the NEC, what is the AC resistance of 1000' of 10 AWG in PVC conduit? **1.2 Ω**

(74) According to Tbl 9 Ch 9 in the NEC, what is the AC resistance of 100' of 2/0 AWG installed in a steel raceway?

a) $\frac{0.10}{1000} \times 100' =$ **0.010 Ω**

(75) What's the AC ohms-to-neutral resistance of 100' of 500kcmil aluminum conductors installed in an aluminum raceway?

a) Al wire in Al conduit 500 kcmil = 0.043 Ω

b) $\frac{0.043}{1000} \times 100 =$ **0.0043 Ω**

(76) What's the minimum NEC recommended operating voltage for a 115v rated load that's connected to a 120v source?

a) 120v × 0.05 = 6.0v (0.05 = 5% VD)

b) 120 − 6 = **114v**

(77) What's the voltage drop of two 12 AWG conductors that supply a 16A, 120v, single phase load located 100' from the power supply?

a) $E_{vd} = I \times R$ (remember 100' away means 200')

b) $E_{vd} = 16 \cdot \left(\frac{2}{1000} \times 200\right) =$ **6.4v**

(78) A 240v 24a single phase load is located 100' from the panelboard and is wired w/ 10 AWG. What's the voltage drop of the circuit conductors?

a) $E_{vd} = I \times R$ (remember 100' away means 200')

b) $E_{vd} = 24 \times \left(\frac{1.2}{1000} \times 200\right) =$ **5.76v**

(79) A 240v 24a single phase load having a length of 100' is located 100' from a panelboard and is wired with (2) 10 AWG conductors. What's the approximate voltage drop of the branch ckt conductors?

a) $Vd = \frac{2KID}{CM}$

b) $Vd = \frac{2 \times 12.9 \times 24 \times 100}{10,380}$

c) Vd = **5.97v**

(80) what's the voltage drop of 2/0 AWG aluminum conductors, that supply a 100a 208v three phase load located 100' from the power supply?

a) $Vd = \frac{1.732\,KIL}{Cm}$

b) $Vd = \frac{1.732\,(21.2)(100)(100')}{133{,}100}$ $Vd = \boxed{2.76\,v}$

(81) what size conductor should be used to limit the voltage drop to no more than 3% if the single phase continuous load of 26a @ 230v is located 100' from the power supply? The terminals are rated 75°C.

switch

a) $Cm = \frac{2KID}{Vd}$ ~~d vd = 2/~~

b) $Vd = 240 \times 0.03 = 7.2vd$

c) $Cm = \frac{2 \times 12.9 \times 26 \cdot 100}{7.2}$

d) 9316.6 cm = $\boxed{10\ awg}$

e) cont load = 26 × 1.25 = 32.5 (8 AWG)

f) breaker = 35a

(82) what size conductor should be used to limit voltage drop from exceeding 3% if the equipment nameplate indicates 18a continuous load @ 460v 3Ø, and its located 300' from the power supply?

a) $Cm = \frac{1.732\,KID}{Vd}$

b) $Vd = 480 \times 0.03 = 14.4v$ ~~13.8~~

c) $Cm = \frac{1.732\,K \cdot I \cdot D}{Vd}$

d) 8348 cm = $\boxed{10\ awg}$

e) cont load = 18 × 1.25 = 22.5 (10 awg

f) breaker = 30a

(83) what's the maximum distance a 240v 1Ø 10a continuous load can be located from the panelboard so the voltage drop doesn't exceed 3%? The load is wired with 12 AWG.

a) $D = (cmils \times VD) / 2KI$

b) $D = \frac{(6530 \times 7.2)}{2 \cdot 12.9 \cdot 10}$

d) $Vd = 240 \times 0.03 = 7.2v$

e) $\boxed{182.20'}$

(84) whats the max distance a 100a 208v 3Ø noncontinuous load wired with 1 AWG conductors can be located from the panelboard so the voltage drop doesn't exceed 3%?

a) $D = (cmils \times Vd) / (1.732\,KI)$

b) $Vd = 208 \times 0.03 = 6.24v$

c) cm for 1awg = 83690

d) $D = \frac{83690 \times 6.24}{1.732 \times 12.9 \times 100} = \frac{522225.6}{2234.28}$

e) $D = \boxed{234\ ft}$

(85) what's the max recommended continuous load that should be placed on 1/0 AWG Al conductors in a nonmetalic raceway to a panelboard located 200 ft from a 240v single phase power source so the NEC recommendation for voltage drop isn't exceeded?

a) $I = \frac{Cm \times Vd}{2 \cdot K \cdot D}$

b) 240 × 0.03 = 7.2 vd

c) $I = \frac{105600 \times 7.2}{2 \times 21.2 \times 200} = \frac{760,320}{8480} = 89.6$ or **90a**

(86) whats the max recommended ~~load~~ continuous load that should be placed on a 150a feeder containing 1 AWG copper conductors in an Aluminum raceway to a panelboard located 150 ft from a 208v 3Ø power source so the NEC recommendation for voltage drop isnt exceeded?

a) $I = \frac{Cm \times Vd}{1.732 \cdot K \cdot D}$

b) 208 × 0.03 = 6.24v

c) $I = \frac{83690 \cdot 6.24}{1.732 \cdot 12.9 \cdot 150} = \frac{522225.6}{3351.42} =$ ~~155.8a~~

d) 150a × 0.8 = 120a (load)

e) 130a (@75°c) × 0.8 = 104a (wire)

104a

(87) what size conductors are required for a 1 hp, single-phase, 115v motor, terminals rated 60°c,

a) T430.258 → 16a ⟶ b) 16 × 1.25 = 20a

c) T310.15(B)(16) → 60°c → **#12 AWG**

(88) what size branch ckt conductors are required for a 7½ hp, 3Ø, 230v motor, terminals rated 75°c

a) T430.250 → 22a ⟶ b) 22 × 1.25 = 27.5a

c) T310.15(B)(16) → 75° → **#10 AWG**

(89) what size branch ckt conductors are required for a 7½ hp, 3Ø, 230v motor, with a nameplate FLA of 20a, rated for 5min service, used for intermittant duty, terminals rated 75°c

a) FLA = 20a ⟶ b) 20 × 0.85 = 17a

c) T310.15(B)(16) → 75°c → **14 AWG**

(90) what size branch ckt conductors are required for a 7½ hp, 3Ø, 230v motor with a nameplate FLA of 20a, rated for 30min service, used for short-time duty, terminals 75°c.

a) FLA = 20a ⟶ b) 20 × 1.5 = 30a

c) T310.15(B)(16) → 75°C → **10 AWG**

(91) what size feeder conductors are required for a 5hp & 3hp, 1Ø, 230v motor, terminals rated 75°C?

a) T430.248 → 5hp = 28a, 3hp = 17a

b) 28a x 1.25 = 35a + 17a = 52a

c) T310.15(B)(16) → [6awg] = 65a @ 75°C

(92) what size feeder conductors is required for (2) 7½ hp, 3Ø, 230v motors, terminals rated 75°C?

a) T430.250 → 7½ hp = 22a

b) 22 x 1.25 = 27.5 + 22 = 49.5

c) T310.15(B)(16) = [8awg] = 50a @ 75°C

(93) what size feeder conductor is required for (2) 7½ hp & (1) 15hp, 3Ø, 230v motors terminals rated 75°C?

a) T430.250 → 42a @ 15hp, 22a @ 7½ hp

b) 42 x 1.25 = 52.5 + 22 + 22 = 96.5

c) T310.15(B)(16) → [3awg] = 100a @ 75°C

(94) If a dual-element fuse is used for overload protection, what size fuse is required for a 5hp, 230v, 1Ø motor, w/ a service factor of 1.15, if the motor nameplate current rating is 23.5a?

a) 23.5 x 1.25 = 29.38a

b) No more than 1.25, so [25a] fuse [240.6]

(95) A 25a dual-element fuse is used for overload protection of a 5hp, 230v, 1Ø motor w/ a service factor of 1.15 & the motor nameplate current rating is 23.5a. If the motor is unable to start, what's the max size overload allowed?

a) 23.5 x 1.4 = 32.9a

b) no more than 1.4, so [30a] fuse [240.6]

(96) If a dual element fuse is used for the overload protection, what size fuse is required for a 50hp, 460v, 3Ø motor with a temp rise of 39°C, & a motor nameplate current rating of 60a (FLA)?

a) 60 x 1.25 = 75a so per 240.6 (A) & 430.32 (A)(1) → **70a** fuse

(97) A 70a dual element fuse is used for overload protection for a 50hp, 460v, 3Ø motor, with a temp rise of 39°C, and a motor nameplate rating of 60a (FLA). If the motor is unable to start, whats the max size overload allowed?

a) 60 x 1.4 = 84a, so per 240.6(A) & 430.32(C) → **80a** fuse

(98) A motor has a nameplate that specifies the following: Service Factor 1.12, temp rise 41°C, & nameplate FLA 25a. What size dual element fuse is required when used for overload protection of this motor?

a) 25 x 1.15 = 28.75, per 430.32 (A)(1) + 240.6 (A) → **25a** fuse

(99) A 25a dual element fuse is used for overload protection for a 10hp, 230v, 3Ø motor, with a temp rise of 41°C, SF 1.12, & nameplate amps 25a. If the motor isn't able to start, what's the maximum overload protection allowed?

a) 25 x 1.3 = 32.5, so **30a** fuse

(100) For a 230v, 1Ø motor that doesn't use fuses for overload protection, overloads (heaters) must be installed in ______ to meet the minimum requirements of the code?

a) T430.37 → any 1 ungrounded conductor

(101) What size conductor and inverse time circuit breaker are required for a 2hp, 230v, 1Ø motor with terminals rated @ 75°C?

a) T430.247 → 2hp 1Ø = 12a

b) T430.52 → 250%

c) 12 x 2.5 = **30a** (breaker) 430.52 - 250%

d) 12 x 1.25 = 15a → # **14AWG** (wire) 430.22 - 125%

(102) What size conductor & inverse time ckt breaker are required for a 7½ hp, 230v, 3Ø motor, w/ terminals rated 75°C

a) 430.250 – 7½ hp 230v = 22a , 22a x 2.5 = 55a → 60a breaker

b) 22a X 1.25 = 27.5 10 AWG

(103) What size nontime-delay fuses are required for a 2hp, 230v 1Ø motor?

a) T430.248 → 12a

b) 12a x 300% = 36a , 40a

(104) What size time delay fuses are required for a 2hp, 230v, 1Ø motor?

a) T430.248 → 12a

b) 12 x 175% = 21a , 25a

(105) If an inverse time ckt bkr is used for SC/GF protection, what size ckt bkr & conductor is required for a 5hp, 230v, 1Ø motor having a nameplate current rating of 26a @ 75°C?

a) T430.248 → 28a

b) 28 x 2.5 = 70a

c) 28 x 1.25 = 35a 10awg

(106) What size dual element fuse is permitted to protect a 5hp, 230v, 1Ø motor w/ a S.F. of 1.15 & a nameplate current rating of 23.5a from overloads as well as SC/GF?

a) FLA = 23.5a

b) T430.32(A)(1) → 125%

c) 23.5 x 1.25 = 29.38a

d) no next size up for combo OCPD! 25a fuse

(107) What size dual element fuse is permitted to protect a ½ hp 230v 1Ø motor w/ a S.F of 1.20 and nameplate FLA of 4.9a @ 75°C from overloads & SC/GFs?

a) FLA = 4.9

b) 430.32 → 1.25%

c) 4.9 x 1.25 = 6.125a

d) no next size up for combo OCPD! 6a fuse

(108) What size feeder protection and conductors are required for the following (2) motors?

motor 1 - 10hp 460v 3Ø : FLC = 14a [T430.250]

motor 2 - 20hp 460v 3Ø : FLC = 27a [T430.250]

a) determine largest br ckt gf/sc OCPD:

10hp = 14a x 2.5 = 35a

20hp = 27a x 2.5 = 67.5a , next size up = 70a

b) determine size of feeder protection:

70 + 14 = 84a , next size down = 80a (not more then)

c) Feeder conductor size = (27 x 1.25) + 14 = 47.75a , 50a @ 75° = #8 [430.24]

(109) what are the output watts for a dual voltage, 1hp motor rated 115/230v?

1hp x 746w = 746watts

(110) whats the input VA for a dual voltage 1hp motor rated 115/230v 1Ø?

a) use FLC 115 x 16 = 1840VA ; 230 x 8 = 1840VA VA = I x E

(111) whats the input VA for a 5hp, 230v, 3Ø motor?

a) use FLC 430.250

b) VA = I · E · $\sqrt{3}$

c) VA = 230 x 15.2 x 1.732

d VA = 6055VA

(112) What size branch-ckt conductors are required for an adjustable speed drive system with a rated input of 25a when the terminals of the VFD are rated @ 60°C?

a) 25 x 1.25 [430.122(A)] = 31.25a

b) T310.15(B)(16) = 8 awg

(113) What size conductor is required for a 25hp 208v 3Ø fire pump motor?

a) 74.8 x 1.25 [T430.258] = 93.5a , 3AWG

(114) What size OCPD is required for a 25hp 208v 3Ø fire pump motor?

a) 404 a , 450a [T430.251(B)] , [240.6]

(115) what size conductor & short ckt + ground fault protection device is required for a multimotor compressor (nameplate: minimum ckt ampacity - 22.10a, min ckt breaker amps - 35a rated 60°C)

a) T310.15 (B)(16) → min 22.10 so 30a = #10

b) max breaker 35a

(116) what size ground fault short ckt ground fault protection is required for a 16.7a motor compressor with a 1.2a fan?

a) max SC/GF = (16.7 x 2.25) + 1.2 = 38.78 , so must be a 35a breaker

(117) what size SC/GF protection is required for a 23a motor compressor w/ a 1.3a fan?

a) max SC/GF → (23 x 2.25) + 1.3 = 53.05 , so 50a breaker

(118) what size conductor is required for a 16.7a motor compressor w/ a 1.2a fan @ 60°C?

a) max motor current = (16 x 1.25) + 1.2 = 21.2a , so #10

(119) what size conductor is required for a 23a motor compressor w/ a 1.3a fan @ 60°C?

a) max motor current = (23 x 1.25) + 1.3 = 30.05 , so #10

(120) what is the demand load for (2) 3kw cooking appliances in a dwelling unit?

a). T220.55 → column a , (2) units = 75% DF

b) 3,000 x 2 = 6000

c) 6000 x 0.75 = 4500 w or 4.5kw

(121) What's the demand load for (1) 6kw counter-mounted cooking unit in a dwelling unit?

a) T220.55 → column b, (1) unit = 80% DF

b) 6000 x 0.8 = 4.8kw

(122) what's the demand load for (2) 3kw ovens + (1) 6kw cooktop in a dwelling unit?

a) column A = 2 x 3kw = (6000 w x 0.75) = 4500 w

b) column B = 1 x 6kw = 6000 w x 0.8) = 4800 w

(123) What's the demand load for a 12kw range in a dwelling unit?

a) T220.55 → column C, (1) 12kw unit = **8kw**

(124) What's the demand load for a 13.6kw range in a dwelling unit?

a) T220.55 → Column C = 12kW → DF = 8kW

b) 5% for ea. kw or major fraction of a kw above 12 = (2) x 5% = 10%

c) 8kw x 1.10 = **8.8 kw**

(125) What size service conductors are required if the demand load for a dwelling equals 198A + the service disconnect is rated 200A?

a) svc conductor → 200a x 0.83 = 166a

b) T310.15(B)(16) → **2/0 cu** @ 175a / 75°C

(126) What size feeder conductors are required if the demand load for a dwelling unit equals 195a, the service disconnect is rated 200a, + the feeder conductors carry the entire load of the dwelling unit?

a) Feeder → 200a x 0.83 = 166a

b) T310.15(B)(16) → **2/0 cu**

(127) standard method - what size service is required for a 1500 sq ft dwelling unit containing the following loads;

- DW 1500VA
- Disp 1000VA
- WH 4500 VA
- Dryer 4000 VA
- Range 14,000VA
- AC 17A, 240VA
- HEAT 8000W

① 3VA x 1500 ft² = 4500 VA
② 1500 x 3 (laundry, sm app) = 4500 VA
} 9000VA

③ 9000VA → first 3000VA @ 100%, 6000 @ 35% → 3000 + 2100 = 5100VA

④ 1500 + 1000 + 4500 = 7000 VA

⑤ 4000VA Dryer = 5000VA

⑥ range - 14,000 VA = 12k @ 8k + 10% for remaining 2k = 8,800w

⑦ Heat = 8000 w

⑦ Total demand = 33,900 VA

⑧ 33,900VA / 240v = 141.25a **150A SVC** 150 x 0.83 = 124.5a, T310.15(B)(16) = **1 AWG cu**

OPT METHOD

(128) What size service is required for a 1500 sq ft dwelling unit containing the following loads?

- DW 1500VA　DRY 4000W　RANGE 14000W　AC 17A @ 240V
- Disp 1000 VA　HEAT 8000 W
- WH 4500 VA

① 3VA / sq ft = 4500VA
② 1500 + 1000 + 4500 = 7000 VA
③ sm app + laundry = 4500 VA
④ range = 14000 W
⑤ Dryer = 4000 W

} 34,000 VA

⑥ First 10 KVA @ 100%, remainder @ 40% = 10 KVA + (24 KVA x 0.4) = 19,600 (9,600)
⑦ HEAT = 8000 X 65% = 5200VA
⑧ 19,600 + 5200 = 24,800 VA
⑨ 24,800 / 240 = 103.3̄ a → 110a service　91.3a conductors = 3 AWG CU

(129) EXISTING DWELLING - What size service is required for a 1500 sqft dwelling containing:

- DW 1500VA　- DRY 4000W　- RANGE 14,000 W　AC 17A @ 240
- DISP 1000 VA　HEAT 8000W
- WH 4500 W

① 3VA x 1500 = 4500 VA
② 1500 x 3 = 4500VA
③ 1500 + 1000 + 4500 + 4000 + 14,000 = 25,000 VA

} + 4500 + 4500 = 34,000

④ HEAT = 8000W
⑤ 34,000 → 1st 8 kVA @ 100%, remainder @ 40% = 8,000 + 10,400 = 18,400 kVA
⑥ 18,400 + 8000 = 26,400 VA
⑦ 26,400 / 240 = 110 a svc　91.3a conductors = 3 AWG CU

Colorado cont...

(33) For an existing dwelling, what size 3 wire 1Ø, 240v feeder / service underground conductors are required for a 1500 sq ft dwelling unit that contains the following loads

- D/W	1200VA	W/H - 4500VA
- Disp	900VA	heat pump - 5HP w/ supp heat 7KW
- cooktop	6000VA	(28a) + 7,000w
- oven	3000 VA	6,720 + 7,000 = 13,720
- Dryer	4000VA	

a) 3 x 1500 = 4500VA lighting

b) 3 x 1500 = 4500VA sm app, laundry

c) 19,600va = all loads except AC

d) 19,600 + 4500 + 4500 = 28,600 va

e) First 8K @ 100 %, remainder @ 40% = 28,600 - 8,000 = 20,600 x 0.4 = 8,240

8,000 + 8,240 = 16,240

f) largest AC/Heat → 6,720 / 7,000 = 7,000 bigger

g) 16,240 + 7,000 = 23,240 VA

h) I = 96.8 amps

i) T310.15(B)(16) **4AWG**

(34) What size 4 wire 3Ø 120/208V svc is required for a multifamily bldg w/ (20) 1500 sq ft dwelling units where each unit contains the following loads:

- DW 1200VA	- Dry 4000VA	- Heat 7000VA
- W/H 4500VA	- cooktop 6000VA	- AC 5hp comp 6440VA
- Disp 900VA	- oven 3000VA	

a) connected load (ea) 1500 ft² x 3va / sq ft = 4500 VA

1200 + 4500 + 900 + 4000 + 6000 + 3000 = 19,600 VA + 4500 (laundry, sm app) = 24,100 + 4500 = 28,600

b) omit AC, heat = 7000VA

c) 28600 + 7000 = 35,600VA

d) DF T220.84 → 38% = (35,600 x 20) = 712,000 x .38 = 270,560VA

e) $I = VA/(E \cdot \sqrt{3})$ $I = 270,560/(208 \cdot \sqrt{3})$ $I = 750.99a$ (parallel set → $\frac{751}{2} = 376a$)

f) T310.15(B)(16) → [illegible]

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