CMGT 235 – Electrical and Mechanical Systems
Homework #24 – Single-Family Dwelling Service Entrance Calculation
Due: 12/4/2018
Points: 30

Name: Solution

1. Complete the attached Single-Family Dwelling Service-Entrance Calculations (Standard) Form for the following:
   Single-Family Dwelling – Service Entrance Calculations (Standard)

	3000 ft² of Living Floor Area	1	Garbage Disposal: ½ hp, 115V
3	Small-Appliance Branch Circuits	1	Trash Compactor: 10 AMPS, 120V
2	Laundry Branch Circuits	2	Attic Fans: 1/4 HP, 120V
1	Electric Dryer: 4.2 kW, 240V	1	Sump Pump: 1/3 HP, 120V
1	Wall-mounted Oven: 5 kW, 240V	1	Garage Door Opener: ¾ hp, 120V
1	Electric Range: 15 kW, 240V	1	Level 2 EVSE: 24A, 240V
1	Under-Cabinet Microwave Oven: 12A, 120V	1	Central A/C Unit: 28A, 240V
1	Dishwasher: 12 AMPS, 120V	1	Electric Baseboard Heat: 6 kW, 240V

2. Show Calculation for:
   Step 7. Electric Range, Wall-Mounted Ovens, Counter-Mounted Cooking Units
   Wall-mounted oven and Electric Range are supplied from a single branch circuit and located in the same room.

WALL-MOUNTED OVEN 5000 VA
Electric Range 15,000 VA

20,000 VA

20 KW exceeds 12 KW by 8 KW
8 KW × 5% = 40% increase

15 KW + 6 KW = 21 KW = 21,000 VA

Step 21. Raceway Size

QTY	GAUGE	TYPE	Cross-Section Area	
2	3/0	THWN	2 × 0.2679 in²	
1	1/0	THWN	1 × 0.1855 in²	EMT (70–680)
		Total Cross-Section Area	0.7213 in²	1 1/2 (40%)

SINGLE-FAMILY DWELLING SERVICE-ENTRANCE CALCULATIONS

1. General Lighting Load (*220.12*).

3000 ft² @ 3 VA per ft² = 9000 VA

Note: Included in this floor area calculation are all lighting outlets and general-use receptacles. Do not include open porches, garages, or unused or unfinished spaces not adaptable for future use. See *NEC 220.12*, *Table 220.12*, and *220.14(J)*.

2. Minimum Number of 15-ampere Lighting Branch Circuits.

$\frac{\text{Line 1}}{120} = \frac{9000}{120}$ = 75 amperes

then, $\frac{\text{amperes}}{15}$ $\frac{75}{15}$ = 5 15-ampere branch circuits

3. Small-Appliance Load [*210.11(C)(1)*, *220.52(A)*, and *210.52(B)*].

(Minimum of two 20-ampere branch circuits)

3 branch circuits @ 1500 VA each = 4500 VA

4. Laundry Branch Circuit [*210.11(C)(2)*, *220.52(B)*, and *210.52(F)*].

(Minimum of one 20-ampere branch circuit)

2 branch circuit(s) @ 1500 VA each = 3000 VA

5. Total General Lighting, Small-Appliance, and Laundry Load.

Lines 1 + 3 + 4 = 16,500 VA

6. Net Calculated General Lighting, Small-Appliance, and Laundry Loads (less ranges, ovens, and "fastened-in-place" appliances). Apply demand factors from *Table 220.42*.

a. First 3000 VA @ 100% = 3000 VA

b. Line 5 16,500 − 3000 = 13,500 @ 35% = 4725 VA

Total a + b = 7725 VA

7. Electric Range, Wall-Mounted Ovens, Counter-Mounted Cooking Units (*Table 220.55*). = 21,000 VA

8. Electric Clothes Dryer (*Table* ~~*220.51*~~ 220.54). = 5000 VA

9. Electric Furnace (*220.54*).

Air Conditioner, Heat Pump (*Article 440*).

(Enter largest value, *220.60*) = 6720 VA

10. Net Calculated General Lighting, Small-Appliance, Laundry, Ranges, Ovens, Cooktop Units, HVAC.

Lines 6 + 7 + 8 + 9 = 40,445 VA

11. List "Fastened-in-Place" Appliances *in addition* to Electric Ranges, Electric Clothes Dryers, Electric Space Heating, and Air-Conditioning Equipment.

Appliance		VA Load	
Water heater:	=	— VA	
Dishwasher:	=	1440 VA	12×120
Garage door opener:	=	1656 VA	13.8 A × 120 V =
Food waste disposer:	=	1176 VA	9.8×120 =
Water pump:	=	— VA	
Gas-fired furnace:	=	— VA	
Sump pump:	=	864 VA	7.2 ×120
Other: Trash Comp.	=	1200 VA	10×120
Micro-wave	=	1440 VA	12 × 120
Attic FANS	=	1392 VA	5.8 ×120 ×2
Level 2 EVSE	=	5760 VA	24× 240
Total	=	14,928 VA	

12. Apply 75% Demand Factor (*220.53*) if Four or More "Fastened-in-Place" Appliances. If Less Than Four, Figure @ 100%. Do not include electric ranges, electric clothes dryers, electric space heating, or air-conditioning equipment.

Line 11 Total: 14,928 × 0.75 = 11,196 VA

13. Total Calculated Load (Lighting, Small-Appliance, Ranges, Dryer, HVAC, "Fastened-in-Place" Appliances).

Line 10 40,445 + Line 12 11,196 = 51,641 VA

14. Add 25% of Largest Motor (*220.50* and *430.24*).

1656 × 0.25 (Garage Door Opener) = 414 VA

Note: The largest motor can be difficult to determine because nothing is in place when service-entrance load calculations are made. It might be an air-conditioning unit or a heat pump. If the dwelling is cooled by an evaporative cooler, the largest motor might be a water pump, a large attic exhaust fan, a large food waste disposer, or a sump pump. For simplicity in this example, the water pump was chosen. The additional 25% of the largest motor is a small portion of the total service-entrance load calculation.

15. Grand Total Line 13 + Line 14. = 52,055 VA

16. Minimum Ampacity for Ungrounded Service-Entrance Conductors.

$$\text{Amperes} = \frac{\text{Line 15}}{240} = \frac{52{,}055}{240} = 217 \text{ amperes}$$

17. Ungrounded Conductor Size (copper). 3/0 AWG

Note: *Table 310.15(B)(7)* may be used only for 120/240-volt, 3-wire, residential single-phase service-entrance conductors, service lateral conductors, and feeder conductors that serve as the main power feeder to a dwelling unit.

217 × 0.83 = 180 A

18. Minimum Ampacity for Neutral Service-Entrance Conductor, *220.61* and *310.15(B)(7)*. Do Not Include Straight 240-Volt Loads.

a. Line 6: = 7725 VA

b. Line 7: 21,000 @ 0.70 = 14,700 VA

c. Line 8: 5000 @ 0.70 = 3500 VA

d. Line 11: (Include only 120-volt loads.)

Dishwasher	1440	VA
Garage Door	1656	VA
Food Waste	1176	VA
Sump	864	VA
Trash	1200	VA
Total	9,168	VA

μwave 1440
ATTIC FANS 1392

e. Line d total @ 75% demand factor if four or more per *220.53*, otherwise use 100%.

9,168 × 0.75 = 6876 VA

f. Add 25% of largest 120-volt motor.

1656 × 0.25 = 414 VA

Total = 7290 VA

g. Total a + b + c + e + f. = 33,215 VA

$$\text{Amperes} = \frac{\text{Line g}}{240} = \frac{33{,}215}{240} = 138 \text{ amperes}$$

19. Neutral Conductor Size (copper)(*220.61*). 1/0 AWG

Note: *NEC 310.15(B)(7)* permits the neutral conductor to be smaller than the ungrounded "hot" conductors if the requirements of *215.2, 220.61*, and *230.42* are met. *NEC 220.61* states that a feeder or service neutral load shall be the maximum unbalance of the load determined by *Article 220*. When bare conductors are used with insulated conductors, the conductors' ampacity is based on the lowest temperature rating of the insulated conductors in the raceway, *310.15(B)(4)*. The neutral conductor shall not be smaller than the grounding electrode conductor, *250.24(C)(1)*.

20. Grounding Electrode Conductor Size (copper) (*Table 250.66*). 4 AWG

21. Raceway Size. 1½ Trade Size

Obtain dimensional data from *Table 1, Table 4, Table 5,* and *Table 8, Chapter 9, NEC.*

2 3/0 THWN CU — 2 × 0.2679 in²

1 1/0 THWN CU — 1 × 0.1855 in²

Total 0.7213 in²