CMGT 235 – Electrical and Mechanical Systems

In Class Activity #6 – Residential Service Entrance

WRITE NEATLY - Include all Names if working as a Group

Name	Solution
Name	
Name	

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

	2900 ft^2 of Living Floor Area	1	Trash Compactor: 15 AMPS, 120V
4	Small-Appliance Branch Circuits	4	Attic Fans: 1/4 HP, 120V
2	Laundry Branch Circuits	2	Garage Door Openers: ¾ hp, 120V
1	Electric Clothes Dryer: 7.2 kW, 240V	1	Air Handler (blower motor): 4 AMPS, 120V
2	Wall-mounted Ovens: 6 kW, 240V		Note: Blower for AC and Heater
1	Electric Range: 5 kW, 240V	1	AC Compressor: 18 AMPS, 240V
1	Under-Cabinet Microwave Oven: 10A, 120V	1	Condenser Fan Motor: 3 AMPS, 120V
1	Dishwasher: 15 AMPS, 120V	1	Electric Heater: 16kW, 240V
1	Garbage Disposal: ½ hp, 120V	1	Freezer: 6.2 A, 120V

2. Show Calculation for:

Step 7. Electric Range, Wall-Mounted Ovens, Counter-Mounted Cooking Units

Wall-mounted ovens and Electric Range are supplied from a single branch circuit and located in the same room. See: Table 250.55, Note 4

2 ovens $2 \times 6\,kW = 12\,kW$
1 Range $1 \times 5\,kW = 5\,kW$
$17\,kW$ } 1 appliance

$17\,kW - 12\,kW = 5\,kW$

$5\,kW \times 5\% = 25\%$ increase

$8\,kW + 8\,kW(0.25) = 10\,kW$

3. Show Calculation for:

Step 9. Electric Furnace. Air Conditioner, Heat Pump

Electric Heater (List Components)

Blower $4A \times 120V = 480\,VA$
Electric Heater $16000\,VA$
$16480\,VA$

Air Conditioner (List Components)

Blower $480\,VA$
compressor $18A \times 240V = 4320\,VA$
Condenser Fan $3A \times 120V = 360\,VA$
$5160\,VA$

4. Show Calculation for:
   Step 21. Raceway Size - Ungrounded Conductors and Neutral Conductor

QTY	GAUGE	TYPE	Cross-Section Area (4-decimals)	
2	3/0	THWN	0.2679 × 2 = 0.5358	
1	1	THWN	0.1562 × 1 = 0.1562	Trade Size EMT
			Total Cross-Section Area: 0.692 in^2	1½

5. Show Calculation for Raceway Size for Ungrounded Conductors, Neutral Conductor, and Bare Grounding Electrode Conductor.

QTY	GAUGE	TYPE	Cross-Section Area (4-decimals)	
2	3/0	THWN	0.2679 × 2 = 0.5358	
1	1	THWN	0.1526 × 1 = 0.1562	
1	2	Bare	0.0564 × 1 = 0.0564	Trade Size EMT
			Total Cross-Section Area: 0.7484 in^2	1½

CHPT 9
Table 5A

Bare 2 $d = 0.268$ in

$$A = \frac{\pi d^2}{4} = \frac{\pi (0.268\text{ in})^2}{4} = 0.0564\ in^2$$

NAME Solution

SINGLE-FAMILY DWELLING SERVICE-ENTRANCE CALCULATIONS

1. **General Lighting Load (*220.12*).**

   2900 ft² @ 3 VA per ft² = 8700 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.**

   $\frac{\text{Line 1}}{120} = \frac{8700}{120} = 72.5$ amperes

   then, $\frac{\text{amperes}}{15} \quad \frac{72.5}{15} = 4.83 = 5$ 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)

   4 branch circuits @ 1500 VA each = 6000 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 = 17,700 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 17,700 − 3000 = 14,700 @ 35% = 5145 VA

   Total a + b = 8145 VA

7. **Electric Range, Wall-Mounted Ovens, Counter-Mounted Cooking Units (*Table 220.55*).** = 10,000 **VA**

8. **Electric Clothes Dryer (*Table 220.51*).** = 7200 **VA**

9. **Electric Furnace (*220.54*).**

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

   (Enter largest value, *220.60*) = 16480 VA

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

    Lines 6 + 7 + 8 + 9 = 41,825 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:	= 1800 VA	15A × 120V
Garage door opener:	= 3312 VA	13.8A × 120V × 2
Food waste disposer:	= 1176 VA	9.8A × 120V
Water pump:	= — VA	
Gas-fired furnace:	= — VA	
Sump pump:	= — VA	
Other: Freezer	= 744 VA	6.2A × 120V
Microware oven	= 1200 VA	10A × 120V
Trash Compactor	= 1800 VA	15A × 120V
Attic Fans	= 2784 VA	5.8A × 120V × 4
Total	= 12,816 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: 12,816 × 0.75 = 9612 VA

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

Line 10 41,825 + Line 12 9612 = 51,437 VA

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

1800 × 0.25 (Trash Compactor) = 450 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. = 51,887 VA

16. Minimum Ampacity for Ungrounded Service-Entrance Conductors.

$$\text{Amperes} = \frac{\text{Line 15}}{240} = \frac{51,887}{240} = 216 \text{ A}$$

216 A × 0.83 = 179 A = 216 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.

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: = 8145 VA

b. Line 7: 10,000 @ 0.70 = 7000 VA

c. Line 8: 7200 @ 0.70 = 5040 VA

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

Dishwasher	1800 VA	Trash Compactor	1800 VA
Garage Opener	3312 VA	Attic Fans	2784 VA
Food waste	1176 VA		
Freezer	744 VA		
Microwave	1200 VA		
Total	12,816 VA		

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

12,816 × 0.75 = 9612 VA

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

1800 × 0.25 = 450 VA

Total = 10,062 VA

g. Total a + b + c + e + f. = 30,247 VA

$$\text{Amperes} = \frac{\text{Line g}}{240} = \frac{30{,}247}{240} = 126 \text{ amperes}$$

19. Neutral Conductor Size (copper)(*220.61*). 1 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*). 2 AWG

21. Raceway Size. 1½ Trade Size

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

SHOW ALL WORK FOR SIZING RACEWAY ON HANDOUT PROVIDED. DO NOT WRITE HERE.