

# Electrical Level 4



Load Calculations – Feeders and Services 26401-14



# Objectives

**When trainees have completed this lesson, they should be able to do the following:**

1. Size feeders and services in accordance with *National Electrical Code*<sup>®</sup> (*NEC*<sup>®</sup>) requirements.
2. Calculate loads and ampacities for single-phase and three-phase feeders.
3. Apply derating factors to size feeders.
4. Size feeder overcurrent protection devices (circuit breakers and fuses) for noncontinuous duty and continuous duty loads.
5. Apply tap rules.
6. Calculate loads for various residential and commercial applications.
7. Calculate loads for schools and other institutional projects.
8. Perform feeder and service calculations for farms.
9. Calculate the power and supply feeders for marinas and boatyards.
10. Calculate electric motor loads on feeders.

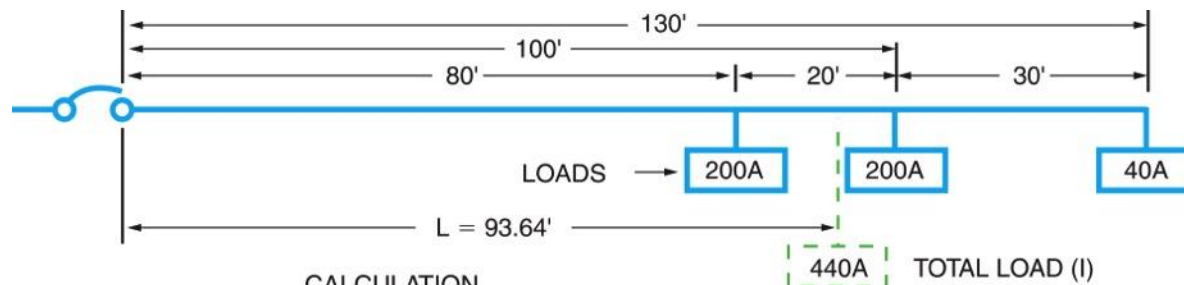
This is a knowledge-based module; there are no Performance Tasks.



# 1.0.0 – 2.7.0

## Introduction; Basic Calculation Procedures

- Electrical calculations can be divided into three sections: branch circuits, feeders, and services. The branch circuit load determines the feeder load, and the feeder load determines the service load.
- The voltage drop for feeders should not exceed 3% to the farthest outlet and 5% for the combination of branch circuits and feeders.



### CALCULATION

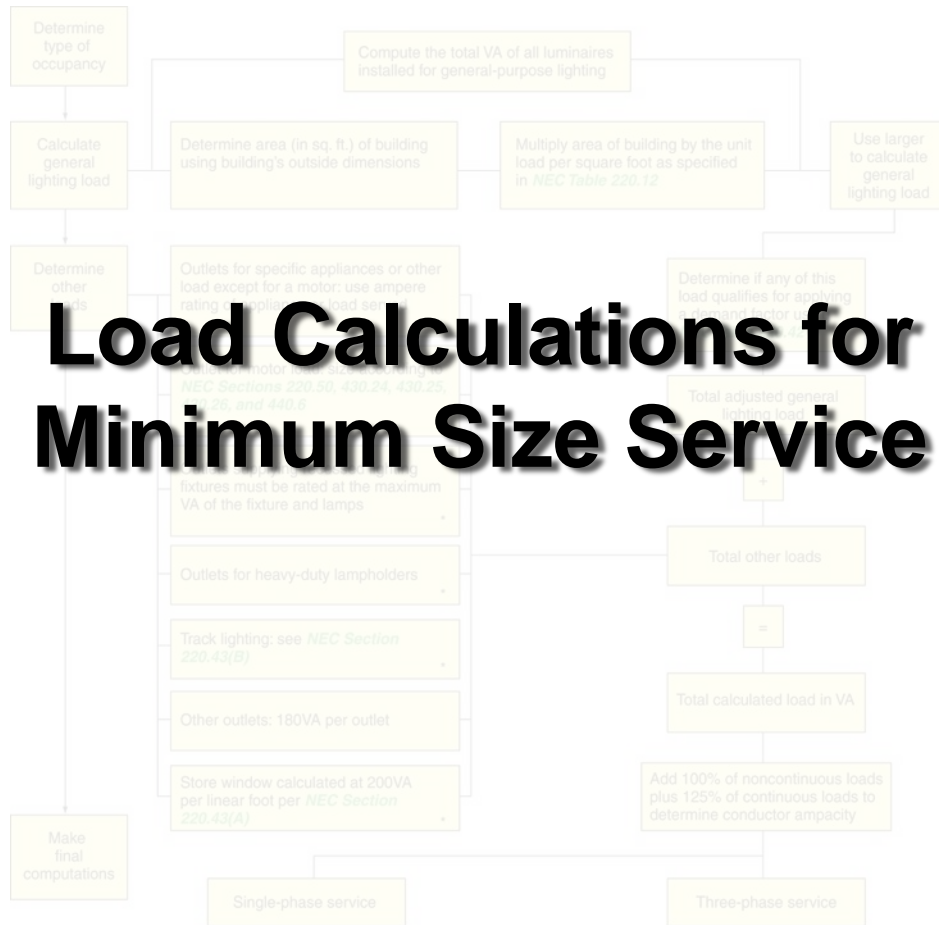
LOAD 1	$80' \times 200A =$	16,000
LOAD 2	$100' \times 200A =$	20,000
LOAD 3	$130' \times 40A =$	5,200
TOTALS	$440A$	$\sqrt{41,200} = 93.64'$ (LOAD CENTER LENGTH)

TOTAL LOAD (I) = 440A  
LOAD CENTER LENGTH (L) = 93.64'



# 1.0.0 – 2.7.0

## Next Session... Steps in a Load Calculation



\* Lighting not used for general illumination. Typical applications are task or display accent lighting.

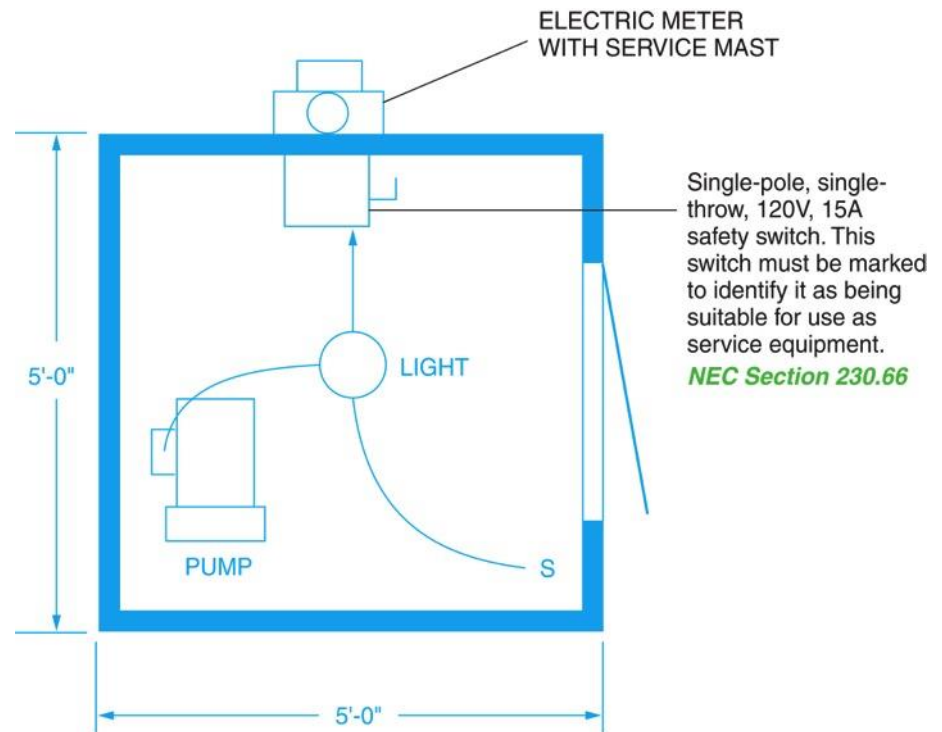
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## 3.0.0 – 3.3.2

# Load Calculations for Minimum Size Service

- This load calculation is for a small rural pump house requiring a separate service.
- The total loads on this facility include a shallow well pump with a  $\frac{1}{3}$ hp, 115V single-phase motor and one wall switch-controlled lighting fixture with a 60W lamp.



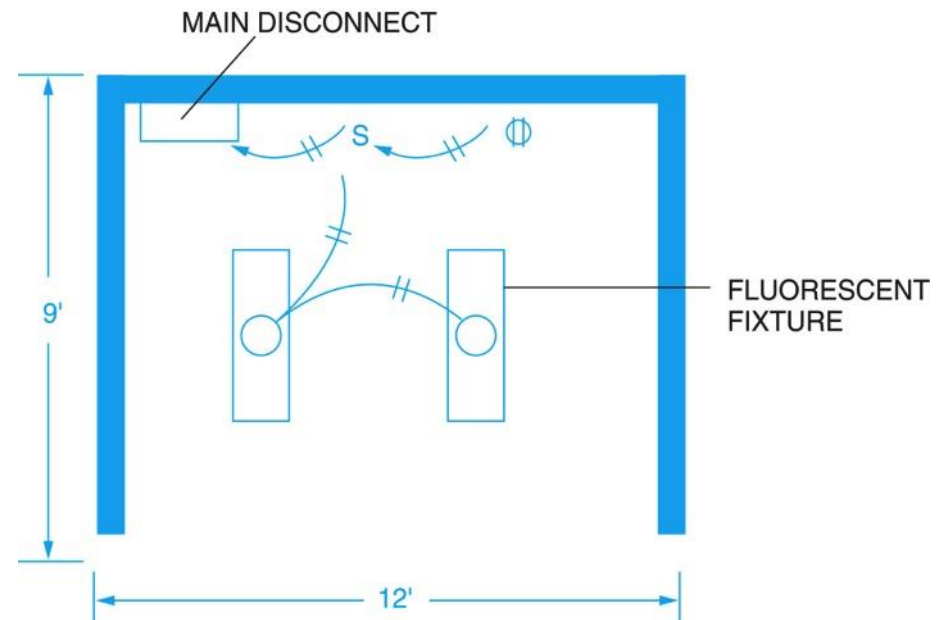
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## 3.0.0 – 3.3.2

# Roadside Vegetable Stand

- **NEC Section 220.14** is applied when making the calculations for this roadside vegetable stand.
- The loads include two receptacles powering a 12.2A refrigerator, a cash register at 300VA, and a calculator at 200VA, as well as two fluorescent fixtures, each with two 40W lamps.



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## 3.0.0 – 3.3.2

# Single-Family Dwelling

- **NEC Section 220.12** is applied when making the calculations for this single-family residence.
- The loads include a 12kW electric range, a 4.5kW water heater, and a 5.5kW dryer. The net living area (minus the carport) is 1,350 sq. ft.



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# 3.0.0 – 3.3.2

## Completed Calculation Form

General Lighting Load				Phase	Neutral
Square footage of the dwelling	[1] 1,350	× 3VA =	[2] 4,050		
Kitchen small appliance circuits	[3] 2	× 1500 =	[4] 3,000		
Laundry branch circuit	[5] 1	× 1500 =	[6] 1,500		
Subtotal of general lighting loads per <i>NEC Section 220.42</i>			[7] 8,550		
Subtract 1st 3000VA per <i>NEC Table 220.42</i>			[8] 3,000	× 100% =	[9] 3,000
Remaining VA times 35% per <i>NEC Table 220.42</i>			[10] 5,550	× 35% =	[11] 1,943
Total demand for general lighting loads =			[12] 4,943		[13] 4,943
<b>Fixed Appliance Loads</b> (nameplate or NEC FLA of motors) per <i>NEC Section 220.53</i>					
Hot water tank, 4.5kVA, 240V			[14] 4,500		
			[15]		
			[16]		
			[17]		
			[18]		
			[19]		
Subtotal of fixed appliances			[20] 4,500		
		If 3 or less fixed appliances take @ 100% =	[21] 4,500		[22] 0
		If 4 or more fixed appliances take @ 75% =	[23]		[24]
<b>Other Loads</b> per <i>NEC Section 220.14</i>					
Electric range per <i>NEC Table 220.55</i> (neutral @ 70% per <i>NEC Section 220.61</i> )			[25] 8,000		[26] 5,600
Electric dryer per <i>NEC Table 220.54</i> (neutral @ 70% per <i>NEC Section 220.61</i> )			[27] 5,500		[28] 3,850
Electric heat per <i>NEC Section 220.51</i>					
Air conditioning per <i>NEC Section 220.14(A)</i>		Omit smaller load per <i>NEC Section 220.60</i>	[29]		[30]
Largest Motor =	0	× 25% per <i>NEC Section 430.24</i> =	[31] 0		[32] 0
Total VA Demand =			[33] 22,943		[34] 14,393
VA/240V = Amps =			[35] 96		[36] 60
Service OCD and Minimum Size Grounding Electrode Conductor =			[37] 100		[38] 8 AWG
AWG per <i>NEC Table 310.15(B)(7)</i> and <i>Table 310.15(B)(16)</i> for neutral			[39] 4 AWG		[40] 6 AWG

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# 3.0.0 – 3.3.2

## NEC® Requirements for Multi-Family Dwellings

Standard Calculation: Feeder sized per *NEC Article 220, Part III*  
Optional Calculation: Per *NEC Section 220.84*, if each dwelling unit has:  
1. Single feeder  
2. Electric cooking equipment  
3. Electric space heating or air conditioning, or both



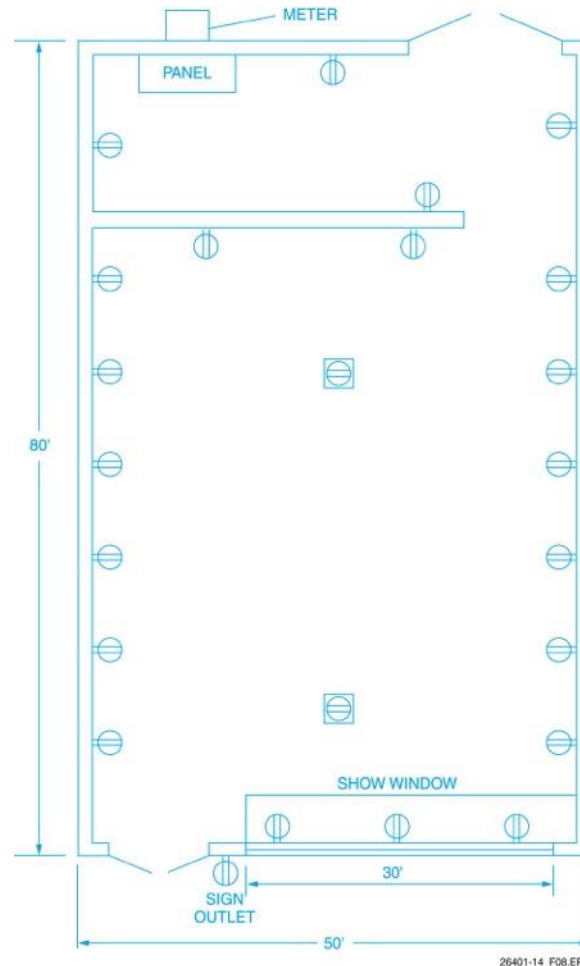
Standard Calculation: Feeder sized per *NEC Article 220, Part III*  
Optional Calculation: Use *NEC Section 220.84* if each dwelling unit has single 3-wire, 120/240V or 208Y/120V feeders with ampacity of 100A or greater.

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# 4.0.0 – 4.3.2

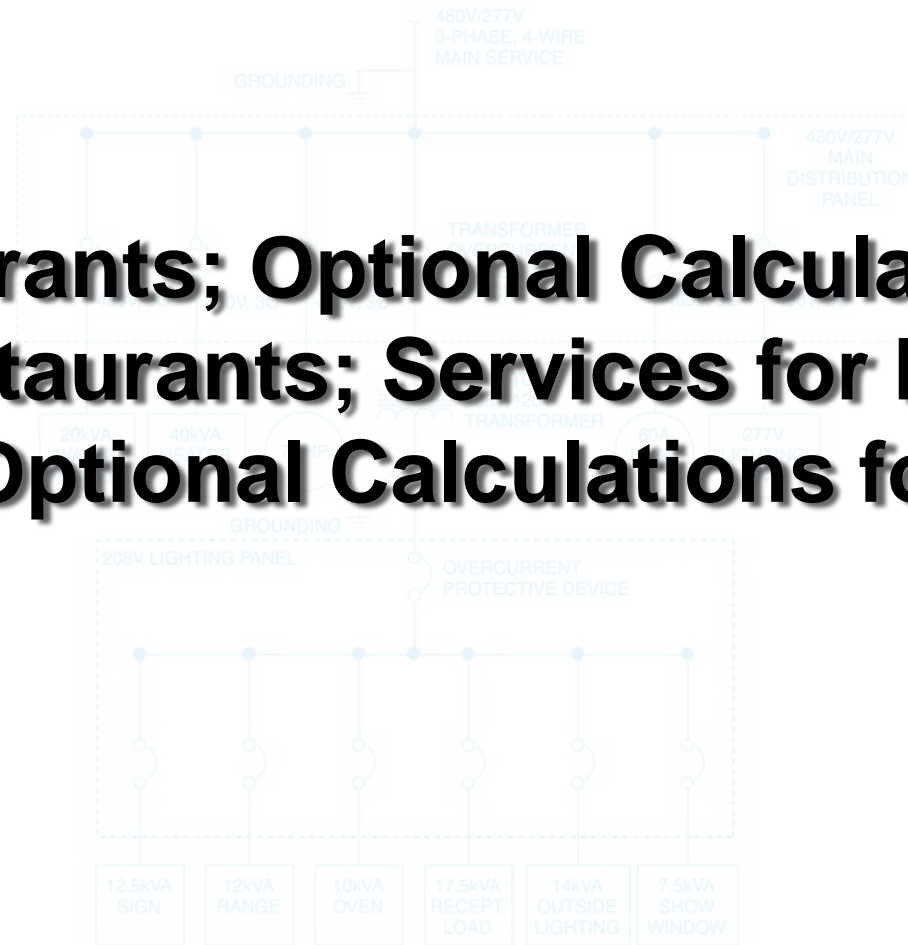
## Commercial Occupancy Calculations



# 4.0.0 – 4.3.2

## Next Session... Diagram of an Office Building

**Restaurants; Optional Calculations for New Restaurants; Services for Hotels and Motels; Optional Calculations for Schools**



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# 5.0.0 – 8.0.0

## Next Session... Optional Calculations for New Restaurants; Services for Hotels and Motels; Optional Calculations for Schools

# Shore Power Circuits for Marinas and Boatyards; Farm Load Calculations; Motors and Motor Circuits

Service Loads	Line A, C	Neutral	Line B
<i>Note: Unbalanced loads are calculated entirely on either phase A or C for a worst-case neutral (and conductor) load (NEC Section 250.67).</i>			
<i>Signaling = 200VA per 100VA per 100VA = 200VA</i>			
120V			
18			
B. Three-phase loads Kitchen equipment (5 or more units) =	144.3	0	144.3
C. 20A three-phase motor compressor Breaker rating = $1.75 \times 20A = 35A$ Use 35A (NEC Table 430.52)	20	0	20
D. Three-phase Shp fan (16.7A) (NEC Table 430.250) Breaker rating = $2.5 \times 16.7A = 41.75A$ Use 45A inverse-trip breaker (NEC Table 430.52)	16.7	0	16.7
E. 25% of largest motor load = $.25 \times 20A = 5A$	5	0	5
F. Sign circuit = $\frac{1,200VA}{120V} = 10A$ each $\times 2 = 20A \times 125\% = 25A$	25	25	0
	246.8A	60.8A	186A
Service Load NEC Table 310.15(B)(16) NEC Table 330.98 NEC Section 310.15(B)(5) NEC Section 230.90 NEC Section 240.6(A)	1. Conductors: Use No. 250 kcmil THHN copper at 75°C for ungrounded conductors; use No. 2 THHN copper conductor for neutral (neutral based on size of grounding electrode conductor). 2. Overcurrent protective device: Phases A and C = $45A$ (largest motor device) + $20.8A$ + $15.0A$ + $144.3A$ + $20A$ + $25A = 270.1A$ Use standard size 300A fuses. 3. Grounding electrode conductor required to be No. 2 copper.		

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# 9.0.0 – 11.0.0

## Next Session...

# Power Circuits for Marinas and Boatyards; Farm Load Calculations; Motors and Motor Circuits

Building No. 1 Feeder Load	240V Load	Neutral
Lighting (5kVA nondiverse load) = 5,000VA/240V	20.8	20.8
10hp motor = $1.25 \times 50A$	<u>62.5</u>	<u>-0-</u>
Total motor and nondiverse load	83.3	20.8
Other loads = 21,000VA/240V	87.5	87.5
<i>Application of demand factors</i>		
Motor and nondiverse load @ 75%	62.5	20.8
Next 60A of other loads @ 50%	30.0	30.0
Remainder of other loads (87.5 - 60) @ 25%	<u>6.9</u>	<u>6.9</u>
<b>Feeder Load</b>	<b>120.2A</b>	<b>57.7A</b>
<b>Building No. 2 Feeder Load</b>		
Lighting (2kVA nondiverse load) = 2,000VA/240V	8.3	8.3
Other loads = 15,000VA/240V	62.5	62.5
<i>Application of demand factors</i>		
Nondiverse load @ 100%	8.3	8.3
Remainder of first 60 (60 - 8.3) @ 100%	51.7	51.7
Remainder of other loads (62.5 - 51.7) @ 50%	<u>5.4</u>	<u>5.4</u>
<b>Total Farm Load</b>	<b>65.4A</b>	<b>65.4A</b>
<i>Application of demand factors</i>		
Largest load (Building No. 1) @ 100%	120.2	57.7
Next largest load (Building No. 2) @ 75%	<u>49.1</u>	<u>49.1</u>
Farm load (less dwelling)	169.3	106.8
Farm dwelling load	<u>100.0</u>	<u>100.0</u>
<b>Total Farm Load</b>	<b>269.3A</b>	<b>206.8A</b>

## Wrap Up

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# Wrap Up

## 3-2-1

- 3 – Write 3 important things learned during class
- 2 – Write 2 questions you have about the material
- 1 – Write 1 thought you had about the material



# Next Session...

## MODULE EXAM

Review the complete module to prepare for the module exam. Complete the Module Review as a study aid.

