

# ECET 4520

Industrial Distribution Systems, Illumination, and the NEC

# Feeder and Service Load Calculation Sizing Feeders and Panels

### Article 215 – Feeders

#### **215.2(A)(1)** – Minimum Rating and Size for $\leq$ 600V – General

Feeder conductors shall have an ampacity not less than required to supply the load as calculated in Parts III, IV, and V of Article 220. The minimum feeder-circuit conductor size, before the application of any adjustment or correction factors\*, shall have an allowable ampacity not less than the non-continuous load plus 125% of the continuous load.

#### **<u>215.3 – Overcurrent Protection</u>**

\* due to ambient temperature and/or number of current-carrying conductors in raceway

Feeders shall be protected against overcurrent in accordance with the provisions of Part I of Article 240. Where a feeder supplies ... any combination of continuous and non-continuous loads, the rating of the overcurrent device shall not be less than the non-continuous load plus 125% of the continuous load.

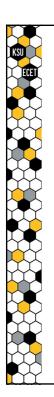
## Article 220 – BC/Feeder/Service Calculations

I. General

#### <u>220.1 – Scope</u>

This article provides requirements for calculating branch-circuit, feeder, and service loads. Part I provides for general requirements for calculation methods. Part II provides calculation methods for branchcircuit loads. Parts III and IV provide calculation methods for feeders and services. Part V provides calculation methods for farms.

Part II – Branch-Circuit Load Calculations (221.10 – 221.18) **Part III – Feeder/Service Load Calculations (221.40 – 221.61)** Part IV – Optional Feeder/Service Load Calculations (221.80 – 221.88) Part V – Farm Load Calculations(221.100 – 221.103)

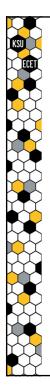


### Article 220 Part III – Feeder/Service Loads

#### <u> 220.40 – General</u>

The <u>calculated load</u> of a <u>feeder or service</u> shall not be less than the sum of the loads on the branch circuits supplied, as determined by Part II of this article, after any applicable demand factors permitted by Parts III or IV or required by Part V have been applied.

Note that, when determining the feeder or service loads as directed by Part II of Article 220 and applying any permitted demand factors as directed by Parts III and IV of Article 220, care must be taken to <u>separate the continuous loads from the non-continuous loads</u> since Article 215 requires that an additional scaling factor of 125% be applied to the continuous loads when determining the required ampacity of the circuit conductors and the rating of the circuit's overcurrent (short-circuit) protection device.



### **Article 220** Part III – Feeder/Service Loads

#### 220.42 - General Lighting

The demand factors specified in Table 220.42 shall apply to that portion of the total branch-circuit load calculated for general illumination.

The demand factors shall <u>not</u> be applied in determining the number of branch circuits required for general illumination.

	Portion of Lighting Load to Which Demand Factor	
Type of	Applies	Demand Factor
Occupancy	(Volt-Amperes)	(%)
Dwelling units	First 3000 or less at From 3001 to	100
	120,000 at Remainder over	35
	120,000 at	25
Hospitals*	First 50,000 or less at Remainder over	40
	50,000 at	20
Hotels and motels,	First 20,000 or less at	50
including apartment houses without provision	From 20,001 to 100,000 at	40
for cooking by tenants*	Remainder over 100,000 at	30
Warehouses (storage)	First 12,500 or less at Remainder over	100
	12,500 at	50
All others	Total volt-amperes	100

ating rooms, ballrooms, or dining rooms.



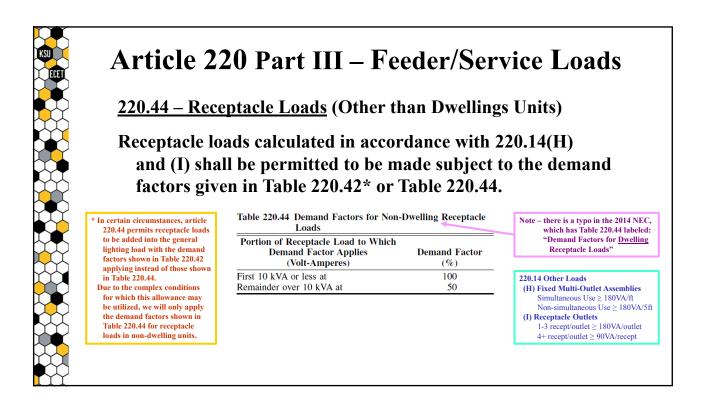
### Article 220 Part III – Feeder/Service Loads

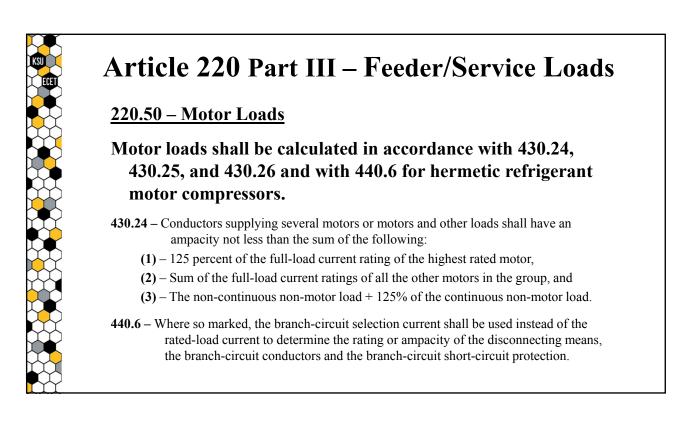
#### 220.42 - General Lighting

Note that the demand factors presented in Table 220.42 also apply to the installed lighting load (based on luminaire ratings) if it is known and greater than the minimum general lighting load based on Table 220.12.

	Portion of Lighting Load to Which Demand Factor	
Type of	Applies	Demand Factor
Occupancy	(Volt-Amperes)	(%)
Dwelling units	First 3000 or less at	100
	From 3001 to	
	120,000 at	35
	Remainder over	
	120,000 at	25
Hospitals*	First 50,000 or less at	40
	Remainder over	
	50,000 at	20
Hotels and motels,	First 20,000 or less at	50
including	From 20,001 to	50
apartment houses	100,000 at	10
without provision	Remainder over	40
for cooking by		
tenants*	100,000 at	30
Warehouses	First 12,500 or less at	100
(storage)	Remainder over	
	12,500 at	50
All others	Total volt-amperes	100

<sup>•</sup>The demand factors of this table shall not apply to the calculated load of feeders or services supplying areas in hospitals, hotels, and motels where the entire lighting is likely to be used at one time, as in operating rooms, ballrooms, or dining rooms.



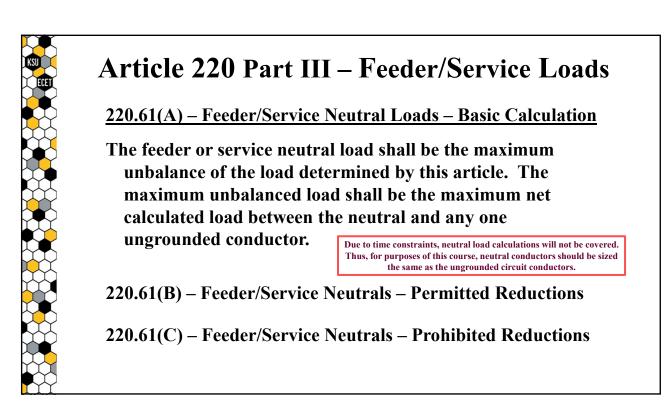


# Article 220 Part III – Feeder/Service Loads

<u>220.60 – Non-Coincident Loads</u>

Where it is unlikely that two or more non-coincident loads will be in use simultaneously, it shall be permissible to use only the largest load(s) that will be used at one time for calculating the total load of a feeder or service.

> Examples of loads that may possibly be considered non-coincident loads: • Electric Heating and Electric Cooling (Air Conditioning) Loads • Two circuits designed for the operation of a single welder, but at different locations within a facility.



### Article 220 Part III – Feeder/Service Loads

### Calculated Demand-Load

The calculated load of a feeder or service shall not be less than the sum of the loads on the branch circuits supplied, as determined by Part II of this article, after any applicable demand factors permitted by Parts III ...

Thus, to calculate the feeder (or service) load:

Apply any applicable demand factors to the loads that are supplied by the feeder (or the service), and sum up all of the adjusted and non-adjusted loads.

### Article 408 – Switchboards & Panelboards

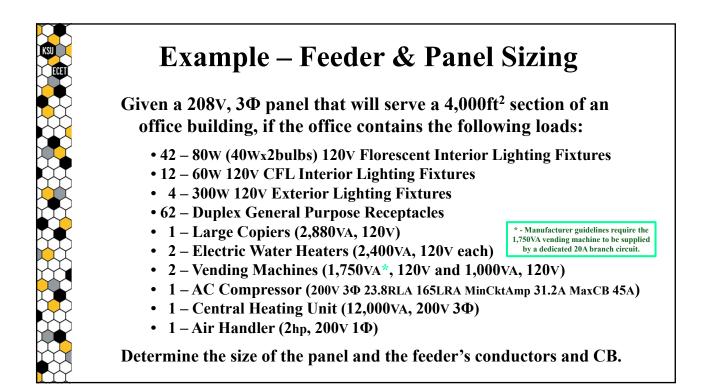
III. Panelboards

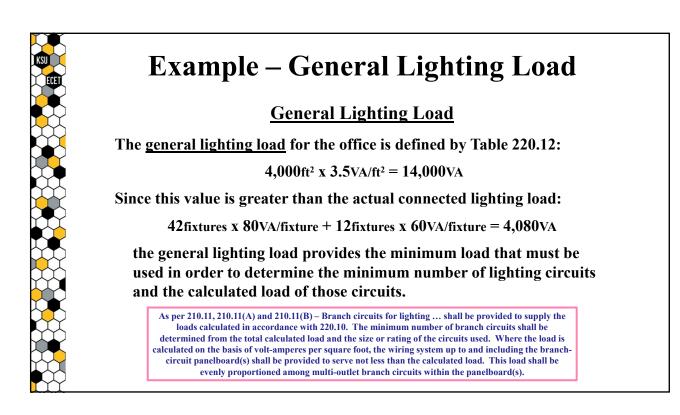
#### <u>408.30 – General</u>

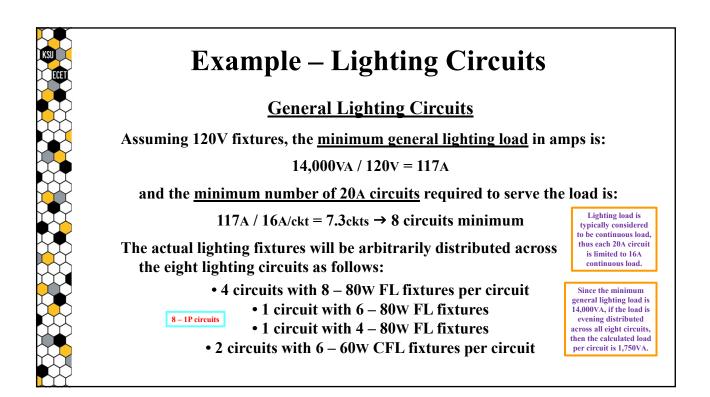
All panelboards shall have a rating not less than the minimum feeder capacity required for the load calculated in accordance with Part III, IV, or V of Article 220, as applicable.

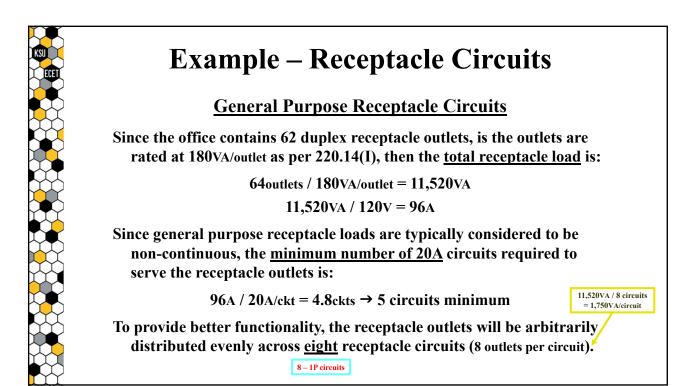
#### <u> 408.30 – General</u>

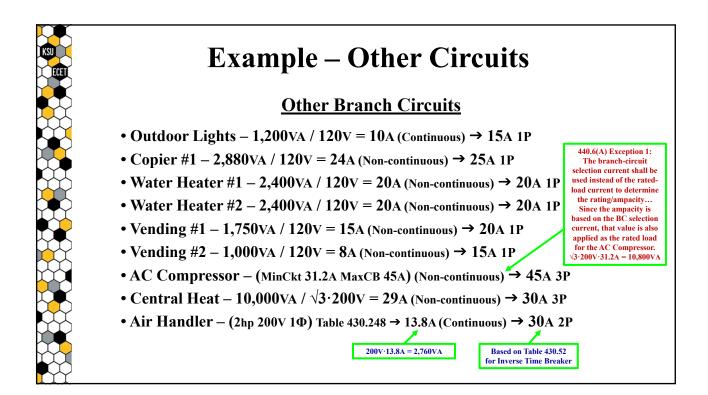
In addition to the requirement of 408.30, a panelboard shall be protected by an overcurrent protective device having a rating not greater than that of the panelboard. This overcurrent protective device shall be located within or at any point on the supply side of the panelboard.



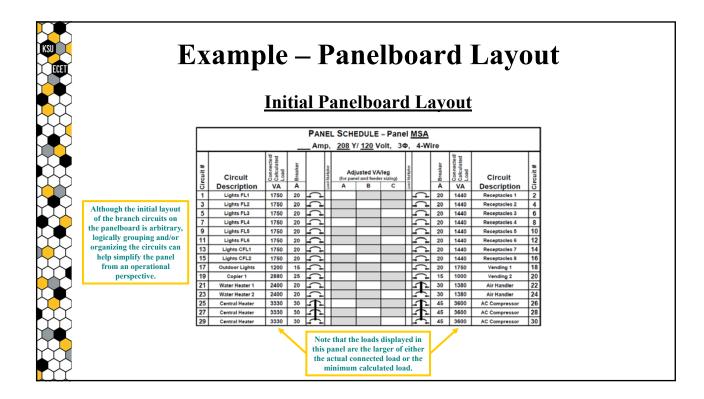


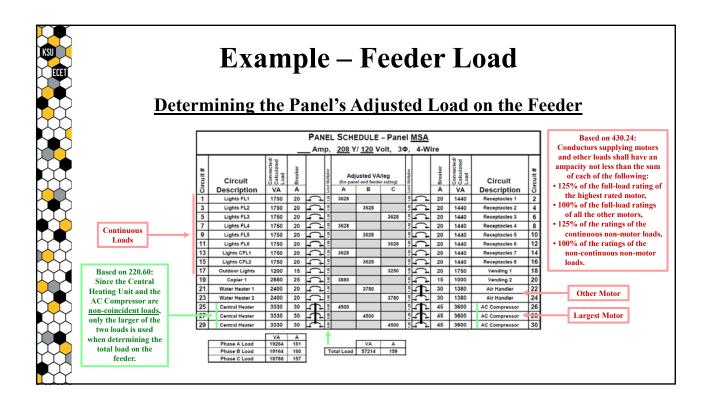


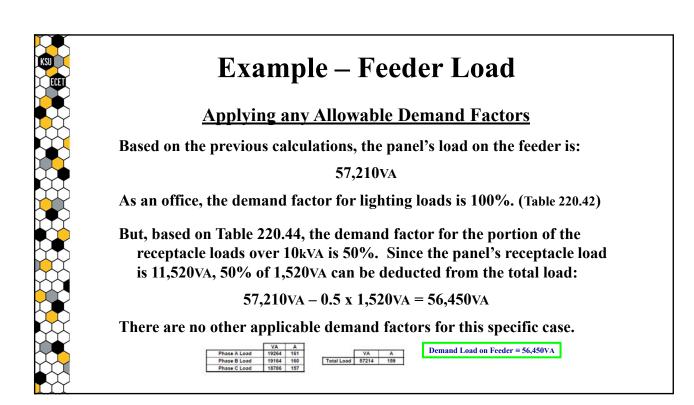


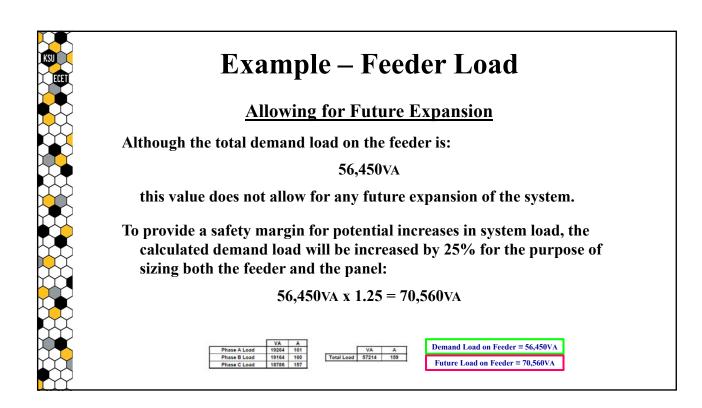


		<u>Common</u>	- Panelboard Select	tion
<mark>∖</mark> <u>≥</u>	_	<u>se, Three-Wire</u>		
<u>í</u>	Frame	Disconnect	Capacity	<u># of Poles Required</u> : Lighting Circuits – 8 Poles
<b>•</b>	<u>Size (A)</u>	<u>Rating (A)</u>	<u>(# of Poles)</u>	Receptacle Circuits – 8 Poles
$\hat{\mathbf{D}}$	100	100	8, 12, 16, 20	Other Circuits – 14 Poles
Γ, L	125	125	8, 12, 16, 20, 24	Required # Poles = <u>30 Poles</u>
Ĺ	150	150	20, 24, 30	Note that, although a panel
	200	200	20, 24, 30, 36, 40	with a larger number of
5			-) )) -	poles would be required to
ζ <u>1</u>	Three-Phas	e, Four-Wire I	Panelboards	allow for future expansion, a 30-pole panel will arbitrarily
	Frame	Disconnect	Capacity	be displayed in order to
	Size (A)	Rating (A)	(# of Poles)	maximize the size of the figures shown in this
5	100	100	16, 20, 24, 30	presentation.
ζ	125	125	20, 24	
r	225	225	24, 30, 36, 42	
	400	400	30, 42	
5				

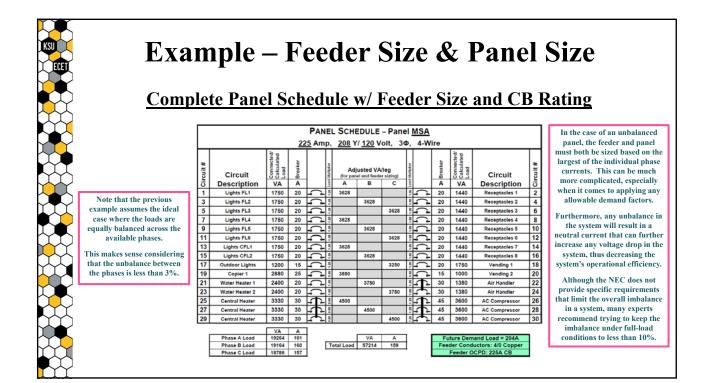








#### **Example – Feeder Size & Panel Size** Sizing the Feeder Conductors and the Panel Based on a future demand load of 70,560VA, the feeder conductors must have an ampacity that is not less than: 70,560VA / $(\sqrt{3} \cdot 200) = 204$ A Assuming that there are no required adjustments due to ambient temperature or # of conductors in the raceway, Table 310.15(B)(16) displays an ampacity of 230A for <u>4/0 copper conductors</u> at 75°C. Note that 430.62(B) allows the rating or setting of Furthermore, the next larger standard CB is 225A. the feeder overcurrent protective device shall be permitted to be based on the ampacity of the and the next large standard panel size is 225A. feeder conductors if the feeder conductors have an ampacity greater than required by 430.24. Demand Load on Feeder = 56,450VA VA A Total Load 57214 159 Future Load on Feeder = 70,560VA



	PANEL SCHEDULE – Panel MSA													
			22	<u>25</u> Am	p,	<u>208</u> Y	/ <u>120</u> V	olt, 3¢	Þ,	4-W	ire			
Circuit #	Circuit Description	Connected/ Calculated Load	<b>P</b> Breaker	-	Load Multiplier		usted VA el and feede B	-	Load Multiplier		<b>P</b> Breaker	Connected/ Calculated Load	Circuit Description	Circuit #
1	Lights FL1	1750	20	Ļ,	1.25	3628			1.00	;)	20	1440	Receptacles 1	2
3	Lights FL2	1750	20	(¦	1.25		3628		1.00	( <sup>ہ</sup>	20	1440	Receptacles 2	4
5	Lights FL3	1750	20	(¦	1.25			3628	1.00	( <sup>ہ</sup>	20	1440	Receptacles 3	6
7	Lights FL4	1750	20	(¦	1.25	3628			1.00	( <sup>ہ</sup>	20	1440	Receptacles 4	8
9	Lights FL5	1750	20	(¦	1.25		3628		1.00	;)	20	1440	Receptacles 5	10
11	Lights FL6	1750	20	(¦	1.25			3628	1.00	, ,	20	1440	Receptacles 6	12
13	Lights CFL1	1750	20	(°	1.25	3628			1.00	( <sup>ہ</sup>	20	1440	Receptacles 7	14
15	Lights CFL2	1750	20	(°	1.25		3628		1.00	°)	20	1440	Receptacles 8	16
17	Outdoor Lights	1200	15	(¦	1.25			3250	1.00	, ,	20	1750	Vending 1	18
19	Copier 1	2880	25	(¦	1.00	3880			1.00	, (	15	1000	Vending 2	20
21	Water Heater 1	2400	20	(¦	1.00		3780		1.00	ţ)	30	1380	Air Handler	22
23	Water Heater 2	2400	20	(¦	1.00			3780	1.00	Ĵ)	30	1380	Air Handler	24
25	Central Heater	3330	30	Ĵ	0.00	4500			1.25	÷)	45	3600	AC Compressor	26
27	Central Heater	3330	30	(°	0.00		4500		1.25	(°	45	3600	AC Compressor	28
29	Central Heater	3330	30	, ,	0.00			4500	1.25	¢,	45	3600	AC Compressor	30

	VA	Α
Phase A Load	19264	161
Phase B Load	19164	160
Phase C Load	18786	157

	VA	Α
Total Load	57214	159

Future Demand Load = 204A
Feeder Conductors: 4/0 Copper
Feeder OCPD: 225A CB

