Bulletin 8-3-13
Maximum circuit loading and demand factors
Rules 8-102, 8-106, 8-200, 8-202 and 8-304

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Scope

(1) Calculation of the minimum ampacity of service or feeder conductors for residential occupancies
  (a) Supplying one single dwelling unit (as defined in Section 0);
  (b) From a main service supplying two or more single dwelling units such as row-housing, triplex and quadruplex stacked units;
  (c) Supplying one dwelling unit (as defined in Section 0) such as apartment unit; and
  (d) From a main service supplying two or more dwelling units
(2) Classification of different types of row-housing
(3) Smoke alarm and carbon monoxide alarm loads on branch circuits
(4) Additional loads to a single dwelling unit
(5) Use of demonstrated load – Who is a "qualified person"?
(6) *Maximum number of LED luminaires on an existing circuit*

(1) Calculation of the minimum ampacity of service or feeder conductors for residential occupancies

The intent of this section of the bulletin is to clarify the code requirements to calculate the minimum ampacity of the service required to one dwelling unit. This section also elaborates on the correct determination of the minimum ampacity of service or feeder conductors from a main service supplying two or more of these dwelling units.

The following examples show the method for calculation carried out for single dwelling units (as per Rule 8-200) versus apartment units (as per Rule 8-202). The ampacity calculations are based on single phase, 120/240 V service.

(a) Supplying one single dwelling unit (as defined in Section 0)

Assuming a single dwelling unit with total living area of 140 m^2 (1500 sq.ft.)*and other loads as described below:

Rule Ref.	Load Designation	Calculated load (W)
8-200 1) a) i)	Basic load for the first 90 m^2	5000
8-200 1) a) ii)	Basic load for additional area	1000
8-200 1) a) iii), 62-116	Electric space heating (N/A in this example)	4000
8-200 1) a) iii)	Air conditioning (4 kW @100% = 4000 W)	
8-200 1) a) iii) 8-106 4)	The greater of electrical space-heating and air conditioning loads above	
8-200 1) a) iv)	Electric Range (rated up to 12 kW)	6000
8-200 1) a) v)	Electric tankless water heaters (N/A)	0
8-200 1) a) vi)	Electric vehicle supply equipment – Level 2 (32 A, 240 V @100% = 7680W)**	7680

Rule Ref.	Load Designation	Calculated load (W)
8-200 1) a) vi)	Other loads @ 25% : - Clothes Dryer (5000W) - Electric storage water heater (4500 W)	2375
	Total Calculated load for the unit	26055
	The calculated min. ampacity (A) of the service (240 V, single Phase)	108.5 A
8-200 1)	The required min. service rating after applying Rule 8-200 1) b) i)	125 A***
4-004(23) & Table 39	**The required min. size 3-wire 120/240V service conductors for this dwelling unit**	**# 2 AWG(Cu) or # 1/0 AWG(Al)**
14-104	**The selected overcurrent protection for this service**	**125 A**

(*) Determination of total living area shall be based on Rule 8-110
(**) The calculation does not account for electrical vehicle energy management system
(***) Consult with local building officials for the required minimum service required for new single dwelling units

(b) From a main service supplying two or more single dwelling units such as row-housing, triplex and quadruplex stacked units

As per Rule 8-200 2), the minimum ampacity of a service or feeder conductors from a main service supplying six (6) of the above single dwelling units in a row-housing installation together with an assumed 3 kW of common area lighting (outside of the single dwellings):

- The minimum ampacity of each unit feeder conductor, obtained from Subrule 8-200 1), less the electrical heating and air conditioning loads = 108.5 A - (4000/240) = 91.9 A; plus
- Rule 8-200 2) a) references the application of Rule 8-202 3) a) i) to v):

8-202 3) a) i)	100% of the load of first unit (A)	= 91.9 x 100%	**91.9 A**
8-202 3) a) ii)	65% of the load of the next 2 units (A)	= 91.9 x 2 x 65%	**119.47 A**
8-202 3) a) iii)	40% of the load of the next 2 units (A)	= 91.9 x 2 x 40%	**73.52 A**
8-202 3) a) iv)	25% of the load of the next 3 units (A)	= 91.9 x 1 x 25%	**22.9 A**

- Adding other loads as per Rule 8-200 2) b) which references Rule 8-202 3) b), c) and d)

8-202 3) b)	Total electrical space heating loads (A)	N/A	**N/A**
8-202 3) c)	Total air conditioning loads (A)	= (4000/240) x 6 x 100%	**100 A**
8-202 3) d)	Other loads outside of the dwelling units at 75% (exterior lighting, etc.)	= (3000/240) x 75%	**9.38 A**
		Total Calculated load for six units (A)	**417.2 A**

The next standard size for service equipment and feeder conductors for the above six units row-housing is 500 A.

(c) Supplying one dwelling unit (as defined in Section 0) such as apartment unit

Assuming an apartment unit with total living area of 140 m^2 (1500 sq.ft)* and other loads as described below:

Rule Ref.	Load Designation	Calculated load (W)
8-202 1) a) i)	Basic load for the first 45 m^2	3500
8-202 1) a) ii)	Basic load for the second 45 m^2	1500
8-202 1) a) iii)	Basic load for additional area	1000
8-202 1) a) iv), 62-116	Electric space heating (N/A in this example)	4000
8-202 1) a) iv)	Air conditioning (4kW @100%)	
8-202 1) a) iv) 8-106 4)	The greater of electrical space-heating and air conditioning loads above	
8-202 1) a) v)	Electric range (rated up to 12 kW)	6000
8-202 1) a) vi)	Electric tankless water heaters (N/A in this example)	-
8-202 1) a) vii)	Other loads @ 25% : - Clothes dryer (5 kW)	1250
	Total Calculated load for the apartment	17250
8-202 1) a)	The calculated min. ampacity (A) of the service (240 V, single Phase)	71.87 A
8-202 1)	The required min. service ampacity after applying Rule 8-202 1) b)	71.87 A
4-004 22) & Table 39	**The required min. size 3-wire 120/240 V service conductors for this dwelling unit**	**#4 AWG(Cu) or #2 AWG(Al)**
14-104	**The selected overcurrent protection for this service**	**100 A**

(*) Determination of living area shall be based on Rule 8-110

(d) From a main service supplying two or more dwelling units

Applying Rule 8-202 3) a) to calculate the minimum ampacity of a service or feeder conductors from a main service supplying eighteen (18) of the above dwelling units in a building, with an assumed 3 kW of common area lighting (outside of the dwelling units):

- Calculated ampacity, obtained from Subrule 8-202 1) a), less the electrical heating and air conditioning loads = 71.87 A - (4000/240) = 55.2 A.

- Applying Rule 8-202 3) a) i) to v)

8-202 3) a) i)	100% of the load of first unit (A)	= 55.2 x 100%	**55.2 A**
8-202 3) a)(ii)	65% of the load of the next 2 units (A)	= 55.2 x 2 x 65%	**71.76 A**
8-202 3) a) iii)	40% of the load of the next 2 units (A)	= 55.2 x 2 x 40%	**44.16 A**
8-202 3) a) iv)	25% of the load of the next 3 units (A)	= 55.2 x 13 x 25%	**179.4 A**

- Adding other loads as per Rule 8-202 3) b), c) and d)

8-202 3) b)	Total electrical space heating loads (A)	N/A	**N/A**
8-202 3) c)	Total air conditioning loads (A)	= (4000/240) x 18 x 100%	**300 A**
8-202 3) d)	Total electrical vehicle supply equipment Level-2 at 90% (A)$^{+}$	= 32 x 7^{++} x 90%	**201.6 A**
8-202 3) e)	Other loads outside of the apartment units at 75% (exterior lighting, etc.)	= (3000/240) x 75%	**9.4 A**
		Total Calculated load for eighteen units (A)	**511.0 A**

(+) The calculation does not account for electrical vehicle energy management system. Demand factor determined as per Table 38
(++) Assuming seven parking spots dedicated for electrical vehicles in this building

The next standard size for service equipment and feeder conductors for this building is 600 A.

Note
The result in case of this building is different from the single dwelling calculation example above because it is required to use the calculated ampacity for one unit obtained from Rule 8-202 1) a) in determining the minimum ampacity of building main service.

(2) Classification of different types of row-housing

Background
A question had been asked about the classification of different types of row housing for the purpose of applying Rules 8-200 and 8-202.

Question 1
When cities and townships define a block of back-to-back townhouses and/or stacked townhouses as "Apartment", does the OESC concur with these definitions for the purpose of applying Rules 8-200 and 8-202 to size the main service feeder supplying two or more of those units?

Answer 1
No. The units of a block of back-to-back townhouses fall under the OESC definition of “single dwelling” as a form of row housing. Rule 8-200 shall be used to determine the minimum ampacity for the main service feeder supplying two or more of those units. The same concept applies to stacked townhouses with individual ground access.

Rationale 1
The OESC defines a single dwelling as “a dwelling unit consisting of a detached house, one unit of row housing, or one unit of a semi-detached, duplex, triplex, or quadruplex house.”

Back to back row housing units which do not have back yards and instead share a common rear wall are still considered as row housing (single dwelling units) for application of the OESC. Stacked units of row housing with individual ground access will also be considered as row housing.

(3) Smoke alarms and carbon monoxide alarms loads on branch circuits

Question 2
In dwelling units, how many smoke/carbon monoxide alarms can be connected to a branch circuit?

Answer 2
- For branch circuits where the load is unknown (such as circuits that supply a mix of lighting and general purpose receptacles), each smoke alarm shall be counted as one outlet.
- For branch circuits where the load is known (such as a circuit with only lighting and no receptacles):
    - Rule 8-304 3) permits more than 12 outlets to be connected to a single branch circuit provided that the total connected load does not exceed 80% of the overcurrent protection rating. When more than 12 smoke alarms are required to be installed on the same circuit, the total load shall not exceed 80% of the overcurrent device.

Rationale 2
Smoke alarms with a visual component (strobe) may have a current rating of up to 1 A; therefore each of these alarms shall be counted as one outlet for the application of Rule 8-304.

Notes
1. Overall length of branch circuit wiring feeding alarms (up to the furthest point on the circuit) is required to comply with voltage drop requirements in Rule 8-102 and bulletin 8-6-*.
2. A manufacturer may limit the number of interconnected smoke alarms on a circuit, refer to manufacturer installation instructions

(4) Additional loads to a single dwelling unit

Questions have been asked if a service upgrade is required when additional loads, such as a hot tub or electrical vehicle supply equipment, are added to the existing service of a single dwelling unit.

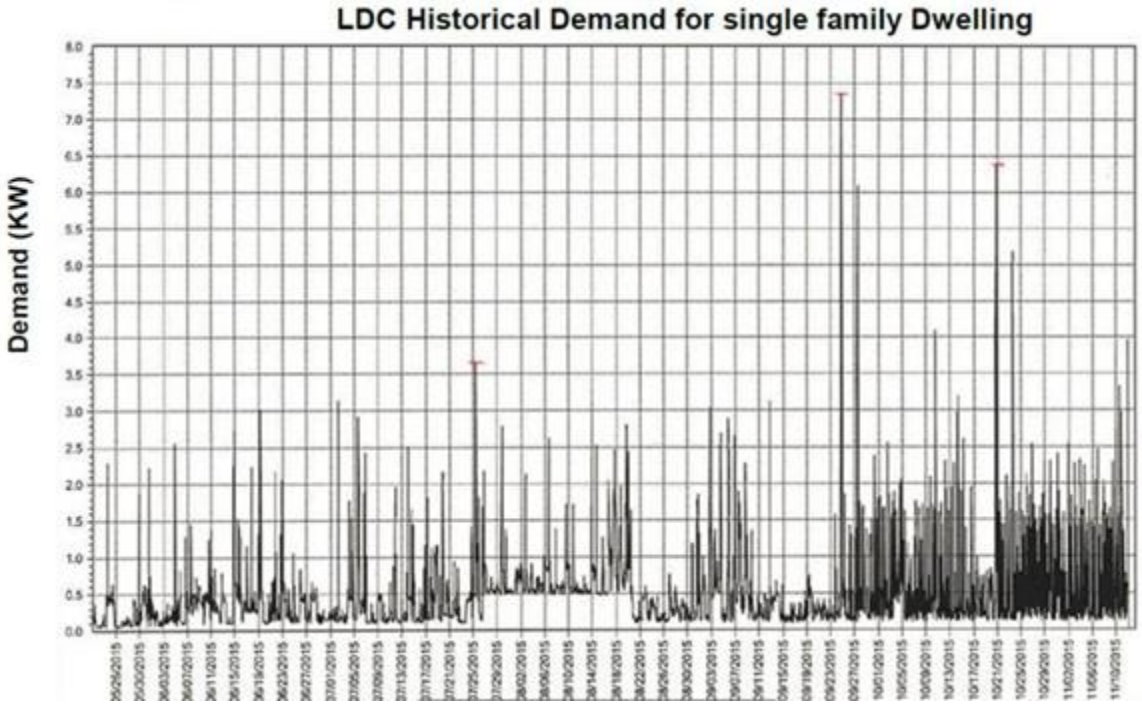
A typical service calculation using Rule 8-200 for an average 2500 ft^2 dwelling (without electric heat) containing a range, an air conditioner and a dryer results in a demand load of 85 A. It has been found that the actual demand for this typical dwelling is below the calculated load, as per Rule 8-200.

Question 3
When is it permitted to connect a hot tub to an existing 100 A service without increasing the service size?

Answer 3
Based on Rule 8-106 8), it is permitted to use a detailed load (demonstrated load), as obtained from the local distribution company (LDC), indicting the existing peak demand over the last 12 months (see Diagram B1 for example), plus the hot tub nameplate rating to calculate the new demand. The existing 100 A service should be sufficient if the new calculated demand does not exceed 89 A when conductors are # 4 AWG Cu or 95 A when # 2 AWG Al.

Calculation
Peak Demand Ampacity + Hot Tub Nameplate Ampacity ≤ 89 A (for # 4 AWG Cu)

Diagram B1 – Example, LDC Historical Demand over the last 12 months for single-family dwelling



Question 4
What is the peak power demand when peak energy demand is supplied for a residential dwelling unit?

Answer 4
In order to assist users in determining the maximum demand, the following shall be permitted in performing peak demand calculations.

Max Amps = ((highest LDC supplied value in a hourly interval kWh) X 125%) X 1000 / 240V
Note: The inclusion of 25% is to make provision for diversity that might occur during the hour.
Example 100A service for a single dwelling unit
Max kWh = 9.99 kWh X 1.25= 12.49
Max Amps = 12.49 X 1000 = 1249 ÷ 240 = 52.04 A
100 A Service – 52.04 A= 47.96 A for future loads.

Hourly Usage for Sunday October 1, 2017 - Wednesday October 31, 2018

Date	Time	Rate Type	Consumption (kWh)	Cost
07/29/2018	5:00 PM	Off-Peak	9.99	0.65
07/29/2018	4:00 PM	Off-Peak	9.75	0.63
08/18/2018	3:00 PM	Off-Peak	8.98	0.58
07/21/2018	1:00 PM	Off-Peak	8.93	0.58
04/15/2018	10:00 PM	Off-Peak	8.89	0.58
07/27/2018	8:00 PM	Off-Peak	8.87	0.58
07/21/2018	6:00 PM	Off-Peak	8.76	0.57
07/15/2018	5:00 PM	Off-Peak	8.72	0.57
04/22/2018	9:00 PM	Off-Peak	8.67	0.56
07/15/2018	4:00 PM	Off-Peak	8.46	0.55

(5) Use of demonstrated load - Who is a "qualified person"?

Background
Rules 8-106 5) and 8-106 9) of the OESC permit a "qualified person" to determine the demand factors for air conditioning or motor loads, and to use demonstrated load (as defined in Section 8) for feeder and service calculations for facilities other than residential.

This bulletin intends to address some questions related to the application of Rule 8-106.

Question 5
For the purpose of application of Rules 8-106 5) and 8-106 9), who can be considered a "qualified person"?

Answer 5
ESA will consider a person such as a professional engineer, designer, licensed electrical contractor, facility operator/ owner or other representative as the qualified person to:

- use different demand factors for motor or air conditioning loads (based on knowledge of the process and sequence of operation of these loads), as per Rule 8-106 5); or
- utilize historical demonstrated load for a facility, as per Rule 8-106 9).

An individual that chooses to use a demonstrated load and/or uses demands factors for motor or air conditioning loads not stated in the OESC, is responsible for any undesired consequences of system(s) malfunction or nuisance service interruption to these feeders.

Question 6
Does ESA require the submission of a deviation request to use different demand factors for motors and air conditioning loads?

Answer 6
No. Notwithstanding Rule 8-106 5), a deviation request is not required to be submitted to ESA for the application of Rule 8-106 5).

(6) Maximum number of LED luminaires on an existing circuit

Background:
Rule 8-304 permits a maximum of 12 outlets (lighting and/or receptacles) on a 2-wire branch circuit, considering each outlet to be 1 A.

With more efficient lighting such as LEDs, questions have been raised regarding the application of Rule 8-304 3), where medium base socket luminaires are replaced with low watt LED luminaires and additional low wattage LED luminaires are installed. Subrule 3) permits the maximum number of outlets to exceed 12, if the connected load is known, to a maximum of 80% of the overcurrent protecting the circuit.

Direction
Notwithstanding Rule 8-304 1), it shall be permitted to replace a medium base socket luminaire with multiple LED luminaires, provided the combined wattage of the newly installed LED luminaires does not exceed:

1. *The wattage of the replaced luminaire (the number of devices is permitted to exceed 12 as required by Rule 8-304 1)); and*
2. *The wattage specifically allowed by the switch controlling those LED lights (e.g. dimmer switch). See Photo B1*

LEDs have inrush current and repetitive peak current that differ from incandescent and halogen lamps. The connected load of LEDs shall not exceed the maximum rating of the switch (e.g. dimmer switch).

Where mixing of lighting types will occur, follow manufacturers direction for the wattage limits of LEDs/CFLs and Incandescent/Halogens.

Note: The LED luminaire can be a recessed type or any other type that have the LEDs integral with luminaire.

Photo B1 – Example of Wattage Ratings marked on a dimmer switch