Impact of proposed modifications in draft NEC 2017 on Premises Powering of Communications Equipment over Communications Cables

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Supporters

Name	Company

Name	Company

NEC Update

- Draft NEC 2017 is under development
- A new Section is proposed to be added to address: “Premises Powering of Communications Equipment over Communications Cables”
- Cables with an “LP” marking are to be used to support conductor ampacity values that exceed 802.3af, 802.3at, and proposed Type 3 802.3bt values

The concern

- Proposed text lists “Power over Ethernet” as an example premise powering application that is addressed in the new Section

VI. Premises Powering of Communications Equipment over Communications Cables

Informational Note: This Part addresses types of circuits intended to provide power over coaxial cables and communications wires and cables to remote equipment, including systems such as Power over Ethernet (PoE). These premises-powering systems do not include circuits such as those that provide plain old telephone services (POTS), traditional CATV services and similar legacy communications services.

The concern

- It is not clear in sub-sections (C) and (D) that IEEE 802.3 PoE applications do not require cables with an “LP” marking for safe operation

(C) Installations of New Cables. New cables installed for carrying both communications and power, where the maximum adjusted ampacity of conductors exceed the values in Table 840.160(A), shall be Type CMP-LP, CMR-LP or CM-LP, as applicable.

(D) Using Cables Without the “LP” Marking for Supplying Premises Power and Communications. New and existing cables without the “LP” marking shall be permitted to connect to communications equipment that supplies communications and power in accordance with the voltage and power limitations of Table 11(B) in Chapter 9 for voltage sources up to 60 V dc, provided that the maximum current supplied by the power source is less than the adjusted ampacity of conductors in Table 840.160(A). For ambient temperatures other that 30°C (86°F) ampacity shall be permitted to be adjusted per Table 310.15(B)(2)(a).

Table 840.160(A), Communications Conductor Ampacity Based on Copper Conductors at Ambient Temperature of 30°C (86°F), Conductor Temperature 60° C (140° F)

The solution

- Develop a liaison to NEC requesting that:
  - Power over Ethernet be removed as a reference application in the Section VI Informational Note
  - The following text be added to both sections (C) and (D):

Cables with "LP" markings are not required for support of applications compliant with IEEE Std. 802.3-2012 Clause 33 “Power over Ethernet” (including IEEE Std. 802.3af-2003, IEEE P802.3at-2009), or any application consistent with the current limits in the referenced and published IEEE 802.3 Power over Ethernet standards, when used over the cabling specified in IEEE 802.3 for these applications (i.e., ANSI/TIA-568-C category 5 or better horizontal cabling). This includes Type 3 applications under consideration in the proposed amendment under development in IEEE P802.3bt.

Moving forward

- Additional information may be required to make a statement about Type 4 operation
- Address this by including the following text in the liaison to NEC:

Considerations for IEEE P802.3bt Type 4 operation, up to 480mA/conductor, are currently under study, and because this is close to the limits proposed, IEEE 802.3 would appreciate any technical information that the committee could forward. The IEEE 802.3 working group has repeatedly considered the limitations of 100VA per eight-conductor cable as a limiting condition for Power over Ethernet applications and currently has no proposals which exceed those limits.

Annex A – NEC Global Input

- Ballot comment NEC **4643-NFPA 70-2015**

First Revision No. 4643-NFPA 70-2015 [Global Input]

VI. Premises Powering of Communications Equipment over Communications Cables

Informational Note: This Part addresses types of circuits intended to provide power over coaxial cables and communications wires and cables to remote equipment, including systems such as Power over Ethernet (PoE). These premises-powering systems do not include circuits such as those that provide plain old telephone services (POTS), traditional CATV services and similar legacy communications services.

840.160 Powering Circuits. Communications cables, in addition to carrying the communications circuit, shall also be permitted to carry circuits for powering communications equipment. The communications cables and the powering circuits shall comply with 840.160(A), (B) and (C), as applicable.

(A) Power Limitations. The power circuits shall comply with the requirements of Table 11(B) in Chapter 9 for voltage sources up to 60 V dc.

Informational Note: The 100 VA (100 W) power source maximum nameplate rating in Chapter 9, Table 11(B) is the same as the maximum power rating for network-powered broadband communications systems in Table 830.15, the communications industry standard in ATIS-0600337.2010 and UL 60950-21.

(B) Ampacity. The maximum current carried by each communications conductor shall conform to Table 840.160(A).

Informational Note: The ampacity of the small wire gauges used in communications cables are not included in the ampacity tables in Article 310.

(C) Installations of New Cables. New cables installed for carrying both communications and power, where the maximum adjusted ampacity of conductors exceed the values in Table 840.160(A), shall be Type CMP-LP, CMR-LP or CM-LP, as applicable.

(D) Using Cables Without the "LP" Marking for Supplying Premises Power and Communications. New and existing cables without the "LP" marking shall be permitted to connect to communications equipment that supplies communications and power in accordance with the voltage and power limitations of Table 11(B) in Chapter 9 for voltage sources up to 60 V dc, provided that the maximum current supplied by the power source is less than the adjusted ampacity of conductors in Table 840.160(A). For ambient temperatures other that 30°C (86°F) ampacity shall be permitted to be adjusted per Table 310.15(B)(2)(a).

Table 840.160(A), Communications Conductor Ampacity Based on Copper Conductors at Ambient Temperature of 30°C (86°F), Conductor Temperature 60° C (140° F)

Supplemental Information

File Name	Description
840_160A_FR4643_final.docx	Table 840.160(A)

Submitter Information Verification

Submitter Full Name: CMP 16
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 16 08:02:42 EST 2015

Committee Statement

Committee Statement: The new Part VI accommodates power over Ethernet (PoE) and other powering systems that provide power over the data communications cables. PoE is widely used with communications circuits and

Table 840.160(A) Communications Conductor Ampacity Based on Copper Conductors at Ambient Temperature of 30°C (86°F), Conductor Temperature 60°C (140°F)

Conductor Size (AWG)	Ampacity of Each Conductor in a Single 4-Pair Multipair Communications Cable Installed Separated from All Other Cables	Ampacity of Each Conductor in a Multipair Communications Cable when More than One Cable Is Installed Together or the Multipair Cable Is Larger than 4 Pairs
26	0.8	0.4
24	1.3	0.6
23	2.0	1.0
22	3.1	1.5

Informational Note: The conductor size of existing communications cable, including "category X" type cables, can be as small as 26 AWG.

each successive revision of the PoE standards delivers more power to the powered devices raising concern about overheating of the cables. Bundling and bunching of cables carrying power to communications equipment can result in heating. No conductor (or cable) should be used in such a manner that its operating temperature exceeds the maximum temperature it was rated for. Sections 770.179 and 800.179 require that optical fiber cables and communications cables have a temperature rating of not less than 60°C (140°F). Where cables carrying communications and power are installed, cables rated for temperatures above 60°C (140°F) may be required. How much higher is dependent on many factors, including ambient temperature, spacing and ventilation among cable bundles and bunches, wire gauge and power being dissipated in the cables.

The new Part VI provides for the use of new cables with properties chosen to be safe in worst-case installation conditions. The listing requirements for these cables are in 840.170. Similar to CMP-CI, CMR-CI and CM-CI cables, the new cables are marked Types CMP-LP, CMR-LP and CM-LP. These cables are listed to have adequate ampacity (wire gauge) and temperature rating for worst-case ambient thermal conditions e.g., a hot attic, and worst case heating produced by the maximum permissible current being carried by the cables.

The Part VI also permits for the use of new non-LP marked cables and previously installed cables provided the current is limited so that the cables do not overheat.

Ampacity values in Table 840.160(a) were derived based on review of Reference Data for Engineers: Radio, Electronics, Computer and Communications, 7th Ed., and NFPA 79, 12.5.1. Adjustments were made considering Article 522 of the NEC, and other sources

CMP-16 chooses not the include Information Note No. 2 with reference to http://wiki.xtronics.com /index.php/Wire-Gauge_Ampacity as provided by the submitter. Data does not necessarily add value to the data in Table 840.160(A). Changes made by CMP-16 meet the intent of the submitter.

Response Message:

Public Input No. 1861-NFPA 70-2014 [New Section after 840.154]

Ballot Results

✔ **This item has passed ballot**

17 Eligible Voters
0 Not Returned
14 Affirmative All
2 Affirmative with Comments
1 Negative with Comments
0 Abstention

Affirmative All

Bish, George
Brunssen, James E.
Dawson, Fred C.
Dorna, Gerald Lee
Jensen, Robert W.
Johnson, Steven C.
Lawrence, Eric
McNamara, Jack
Moore, Thomas E.
Murphy, Michael F.
Ohde, Harold C.
Parrish, Thomas J.

Pirkle, W. Douglas
Zieman, Leo

Affirmative with Comment

Ivans, Randolph J.

We agree with the addition of this new section in Article 840. However, the structure and wording of 840.160 are confusing. For example, except for the temperature adjustment information, "(D)" is just a repetition of "(A)" and "(B)". "(B)" says you have to meet current limits then "(C)" says you don't. In addition, there needs to be current limitations included for the type –LP cables even though they may be higher than permitted by Table 840.160(A). Finally, since Chapter 9, Table 11(B) has limitations for maximum power and current and rated power and current, these need to be identified in the text. Suggested revisions are as follows: 840.160 Powering Circuits. Communications cables, in addition to carrying the communications circuit, shall also be permitted to carry circuits for powering communications equipment. The communications cables and the powering circuits shall comply with 840.160(A), (B) and (C). (A) Maximum Power and Current Limitations. The maximum power (VAmax) and current (Imax) limitations of the powering circuits shall comply with the Class 2 requirements of Table 11(B) in Chapter 9 for voltage sources up to 60 V dc. (B) Rated Power. The maximum rated power of the powering circuit shall comply with the Class 2 requirements of Table 11(B) in Chapter 9 for voltage sources up to 60 V dc. Informational Note: The 100 VA (100 W) power source maximum nameplate rating in Chapter 9, Table 11(B) is the same as the maximum power rating for network-powered broadband communications systems in Table 830.15, the communications industry standard in ATIS-0600337.2010 and UL 60950-21. (C) Rated Current. The maximum rated current of the power source that may be carried by each communications cable conductor shall conform to 840.160(C)(1) or 840.160(C)(2). Informational Note: The ampacity of the small wire gauges used in communications cables are not included in the ampacity tables in Article 310. (1) Installations of New Cables. New cables type CMP-LP, CMR-LP or CM-LP, as applicable, installed for carrying both communications and power, shall be supplied by a power source with a maximum current rating that is less than the maximum adjusted ampacity of the conductors in Table 840.160(XX). For ambient temperatures other that 30°C (86°F) ampacity shall be permitted to be adjusted per Table 310.15(B)(2)(a). (2) New and Existing non-LP Cables. New and existing cables without the "LP" marking shall be permitted to connect to communications equipment that supplies communications and power provided that the maximum current supplied by the power source is less than the adjusted ampacity of conductors in Table 840.160(A). For ambient temperatures other that 30°C (86°F) ampacity shall be permitted to be adjusted per Table 310.15(B)(2)(a).

McCoy, William J.

Table 840.160(A) is missing from the FR. Also, The ampacities for other than 30?C temperature ratings need to be addressed and requires additional research. Definition of separation and wiring methods must be addressed as part of the ratings. Applications will be such that temperatures other than 30 degrees C will be encountered.

Negative with Comment

Prezioso, Luigi G.

While there is a potential issue with the overheating of cables that are powering network devices, there was no evidence of an existing safety hazard presented, and therefore no justification for an entirely new cable listing. The development of the requirements is not based on solid evidence and needs further investigation prior to being made part of the Code. The requirement to use the "LP" in new installations "New cables installed for carrying both communications and power, where the maximum adjusted ampacity of conductors exceed the values in Table 840.160(A), shall be Type CMP-LP, CMR-LP or CM-LP, as applicable." requires the infrastructure designers to determine "the maximum adjusted ampacity of conductors" at the time the infrastructure design is completed. This is potentially years before the network design has been completed and possibly before a new, future networking solution has even been identified.

Table 11(B)

Table 11(B) Class 2 and Class 3 Direct-Current Power Source Limitations

Power Source		Inherently Limited Power Source (Overcurrent Protection Not Required)					Not Inherently Limited Power Source (Overcurrent Protection Required)			
		Class 2				Class 3	Class 2		Class 3	
Source voltage V_{max} (volts) (see Note 1)		0 through 20*	Over 20 and through 30*	Over 30 and through 60*	Over 60 and through 150	Over 60 and through 100	0 through 20*	Over 20 and through 60*	Over 60 and through 100	Over 100 and through 150
Power limitations VA_{max} (volt-amperes) (see Note 1)		—	—	—	—	—	250 (see Note 3)	250	250	N.A.
Current limitations I_{max} (amperes) (see Note 1)		8.0	8.0	$150/V_{max}$	0.005	$150/V_{max}$	$1000/V_{max}$	$1000/V_{max}$	$1000/V_{max}$	1.0
Maximum overcurrent protection (amperes)		—	—	—	—	—	5.0	$100/V_{max}$	$100/V_{max}$	1.0
Power source maximum nameplate rating	VA (volt-amperes)	$5.0 \times V_{max}$	100	100	$0.005\times V_{max}$	100	$5.0 \times V_{max}$	100	100	100
	Current (amperes)	5.0	$100/V_{max}$	$100/V_{max}$	0.005	$100/V_{max}$	5.0	$100/V_{max}$	$100/V_{max}$	$100/V_{max}$

Table 11(B) continued

*Voltage ranges shown are for continuous dc in indoor locations or where wet contact is not likely to occur.
For interrupted dc or wet contact conditions, see Note 4.

Notes for Tables 11(A) and 11(B)

1. V_{max}, I_{max}, and VA_{max} are determined with the current-limiting impedance in the circuit (not bypassed) as follows:

V_{max}: Maximum output voltage regardless of load with rated input applied.

I_{max}: Maximum output current under any noncapacitive load, including short circuit, and with overcurrent protection bypassed if used. Where a transformer limits the output current, I_{max} limits apply after 1 minute of operation. Where a current-limiting impedance, listed for the purpose, or as part of a listed product, is used in combination with a nonpower-limited transformer or a stored energy source, e.g., storage battery, to limit the output current, I_{max} limits apply after 5 seconds.

VA_{max}: Maximum volt-ampere output after 1 minute of operation regardless of load and overcurrent protection bypassed if used.

2. For nonsinusoidal ac, V_{max} shall not be greater than 42.4 volts peak. Where wet contact (immersion not included) is likely to occur, Class 3 wiring methods shall be used or V_{max} shall not be greater than 15 volts for sinusoidal ac and 21.2 volts peak for nonsinusoidal ac.

3. If the power source is a transformer, VA_{max} is 350 or less when V_{max} is 15 or less.

4. For dc interrupted at a rate of 10 to 200 Hz, V_{max} shall not be greater than 24.8 volts peak. Where wet contact (immersion not included) is likely to occur, Class 3 wiring methods shall be used, or V_{max} shall not be greater than 30 volts for continuous dc; 12.4 volts peak for dc that is interrupted at a rate of 10 to 200 Hz.

Table 310.15(B)(2)(a)

Table 310.15(B)(2)(a) Ambient Temperature Correction Factors Based on 30°C (86°F)

For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate correction factor shown below.

Ambient Temperature (°C)	Temperature Rating of Conductor			Ambient Temperature (°F)
	60°C	75°C	90°C	
10 or less	1.29	1.20	1.15	50 or less
11–15	1.22	1.15	1.12	51–59
16–20	1.15	1.11	1.08	60–68
21–25	1.08	1.05	1.04	69–77
26–30	1.00	1.00	1.00	78–86
31–35	0.91	0.94	0.96	87–95
36–40	0.82	0.88	0.91	96–104
41–45	0.71	0.82	0.87	105–113
46–50	0.58	0.75	0.82	114–122
51–55	0.41	0.67	0.76	123–131
56–60	—	0.58	0.71	132–140
61–65	—	0.47	0.65	141–149
66–70	—	0.33	0.58	150–158
71–75	—	—	0.50	159–167
76–80	—	—	0.41	168–176
81–85	—	—	0.29	177–185

Annex B – Supporting analysis

- Ballot cycle of draft NEC 2017
- Review of ballot comment NEC **4643-NFPA 70-2015** with new cable requirements
- Referenced codes and standards
- What is the problem ?
- Additional issues with article 840.160 Part 6
- Why should IEEE 802.3bt be concerned ?
- What should we do about this new code ?

Ballot Cycle of draft NEC 2017

- Ballots on first draft discussed and resolved in January 2015
- Resolved ballots posted in April 2015
- Public input to posted comments open till September 2015
- Next meeting is November 2015 to review comments received during public input

Referenced codes and standards

- UL 60950-21 Information Technology Equipment - Safety - Part 21: Remote Power Feeding
- ATIS 0600337.2010 Requirements for Maximum Voltage, Current, and Power Levels in Network-Powered Transport Systems

NOTE: No references to IEEE 802.3 standards, ISO/IEC TR 29125, or TIA TSB 184-A

New cable requirements in draft NEC 2017 article 840.160 Part 6

- **(C) Installations of New Cables.** New cables installed for carrying both communications and power, where the maximum adjusted ampacity of conductors exceed the values in Table 840.160(A), shall be Type **CMP-LP**, **CMR-LP or CM-LP,** as applicable.

- **(D) Using Cables Without the "LP" Marking for Supplying Premises Power and Communications.** New and existing cables without the "LP" marking shall be permitted to connect to communications equipment that supplies communications and power in accordance with the voltage and power limitations of Table 11(B) in Chapter 9 for voltage sources up to 60 V dc, provided that the maximum current supplied by the power source is less than the adjusted ampacity of conductors in Table 840.160(A). For ambient temperatures other that 30°C (86°F) ampacity shall be permitted to be adjusted per Table 310.15(B)(2)(a).

Table 840.160(A) Max current per conductor at 30 C

Table 840.160(A) Communications Conductor Ampacity Based on Copper Conductors at Ambient Temperature of 30°C (86°F), Conductor Temperature 60°C (140°F)

Conductor Size (AWG)	Ampacity of Each Conductor in a Single 4-Pair Multipair Communications Cable Installed Separated from All Other Cables	Ampacity of Each Conductor in a Multipair Communications Cable when More than One Cable Is Installed Together or the Multipair Cable Is Larger than 4 Pairs
26	0.8	0.4
24	1.3	0.6
23	2.0	1.0
22	3.1	1.5

What is the problem ?

- Table 840.160(A) clearly does not apply to the currents being contemplated in IEEE 802.3bt 4PPoE (except for 26 AWG) so what is the problem ?
- The primary basis and justification for the development of article 840.160 Part 6 is:
  - *"This Part addresses types of circuits intended to provide power over coaxial cables and communications wires and cables to remote equipment, including systems such as Power over Ethernet (PoE)."*
  - *"each successive revision of the PoE standards delivers more power to the powered devices raising concern about overheating of the cables"*
- So even if table 840.160(A) may not be applicable, the perception is that when new cables are installed they should be **CMP-LP, CMR-LP, or CM-LP**
- This **limitation will restrict the adaption and growth of PoE**

Additional issues with article 840.160

- Table 840.160(A) does not match the more detailed information by Category and bundle sizes in draft ISO TR 29125 Ed2 and TIA TSB-184-A and is therefore a source of confusion
- Most of the current detailed work on remote powering has been done in IEEE 802.3, TIA TR42 and ISO/IEC TR 29125 but this body of expertise or useful information is not referenced, dangerously isolating NEC NFPA in its own world
- The current levels specified are applicable to bundle sizes from 2 and above (could be infinity !!). This is dangerous as we know that temperature rise increases significantly with bundle size
- There is no upper limit of current for **CMP-LP, CMR-LP, or CM-LP** cables, again posing dangerous assumptions of ampacity

Why should IEEE 802.3bt be concerned about all this?

- NEC codes are referenced widely and are the law taking precedence over all other standards
- They are a big part of the eco-system and serve as a baseline for many of our standards activities.
- It is in the interest of all standards bodies including IEEE 802.3 to have a friendly eco-system that reflects care, accuracy, and harmonization to build confidence in the market place

What should we do about this ?

- IEEE 802.3 should review activities in NEC NFPA 70 related to its standards and offer constructive feedback that will create the best eco-system for all SDOs
- The objective is to avoid conflicts and confusion that generally leads to a cautious market worried about investing in new solutions
- IEEE should send a liaison letter to NEC NFPA 70 with input to clarify and improve the new Clause 840.160 Part 6
- If possible, a executive member or their delegate of IEEE 802.3 should attend the next NEC NFPA 70 meeting in November 2015 where public input will be discussed and resolved