



**Verizon NEBS™ Compliance: Network
Equipment Power Termination and
Cabling Requirements**
Verizon Technical Purchasing Requirements
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1.0 Purpose

The purpose of this Verizon Technical Purchasing Requirement document is to address DC power termination guidelines for network equipment that Verizon Wireline will be evaluating and approving. The document establishes the minimum power termination and cabling requirements of all network end equipment, rack fuse/breaker panels and cable whips / connectors provided by the equipment manufacturer for use with their equipment that will be deployed in the Verizon Wireline technical facilities. This document provides the necessary information for equipment manufacturers to design the power terminations at the network equipment such that the power cabling to the device will meet Verizon Standards and other applicable codes.

2.0 Scope

This document is to be used for all DC powered network elements regardless of function to be deployed in Verizon Wireline facilities (i.e. CO, CEV, etc.).

3.0 References

GR-63-CORE	NEBS™ Requirements: Physical Protection
GR-78-CORE	Generic Requirements for the Physical Design and Manufacture of Telecommunications Products and Equipment
GR-347-CORE	Generic Requirements for Telecommunications Power Cable
GR-357-CORE	Generic Requirements for Assuring the Reliability of Components Used in Telecommunications Equipment
GR-513-CORE	Power Requirements in Telecommunications Plant
GR-1217-CORE	Generic Requirements for Separable Electrical Connectors
GR-1275-CORE	CO/Network Environment Equipment Installation/Removal
GR-1502-CORE	CO/Network Environment Detail Engineering Generic Requirements
All Applicable Standards	National Electric Code (NEC)
All Applicable Standards	Underwriters Laboratory (UL)
All Applicable Standards	American National Standards Institute (ANSI)
All Applicable Standards	Institute of Electrical and Electronic Engineers (IEEE)



4.0 Acronyms

AWG	American Wire Gauge
CO	Central Office
CEV	Controlled Environmental Vault
GR	Generic Requirements
OEM	Original Equipment Manufacturer

5.0 General Information

- 5.1 The network equipment and components shall comply with all the requirements herein to the fullest extent possible. Verizon will, at its sole discretion, consider equipment that does not comply 100% with the specific requirements of this specification for deployment in the network, however certain requirements in this document will be considered mandatory. Verizon will address these items with the equipment manufacturer as issues arise.
- 5.2 Equipment that does not comply with the requirements in this document will require a written waiver with Director Level (minimum) approval before the product can be deployed in the Verizon network. The waiver process shall include various groups internal to Verizon based upon the nature of the non-compliant item. It is mandatory that Verizon Facility Power Standards group be involved with the waiver process. Other groups that may be involved are Installation Standards, Network Planning, Quality Assurance, Operations and so on.
- 5.3 The requirements of this document and subsequent issues apply to new equipment being developed after the release of the specific revision of this document. Previously approved products do not need to be upgraded in the field or immediately redesigned just to meet this standard, unless specifically required by Verizon. Previously approved products can remain “as is” till new configurations of the make and model are prepared for released at which time the product shall conform to the most current revision of this document.
- 5.4 Verizon reserves the right to revise this document for any reason, including but not limited to conformity with standards promulgated by various state and federal agencies, utilization of new advances in technology, or to reflect changes in the design of equipment or services described herein. Liability for difficulties arising from technical limitations is disclaimed.
- 5.5 This document does not represent any commitment by Verizon to evaluate or purchase any product for use in Verizon, whether or not it provides the described power



termination characteristics. The products to be evaluated and or selected for deployment are completely up to Verizon's discretion. Verizon will use the criteria as specified in this document in evaluating equipment that potentially may be deployed in the Verizon network to insure compliance with standards and codes.

- 5.6 In addition to the standards and guidelines outlined in this document, the Equipment Provider shall consult and adhere to the most current Verizon Wireline practices, including, but not limited to Flashes, Technical Aids, etc.
- 5.7 This practice was prepared solely for the use of Verizon Wireline and its designated representatives. It shall be used only by its employees when requesting bids for equipment, when performing network compliance evaluations of the products (internal or external lab testing), or by the end equipment manufacturers when designing their equipment so it meets Verizon Wireline standards. Any other use of this practice is forbidden. The information contained in this practice might not be applicable in all circumstances and is subject to change without notice. By using this practice the user agrees that Verizon Wireline has no liability (to the extent permitted by applicable law) for any consequential, incidental, special or punitive damages that might result.

6.0 Requirements for DC Power Cabling and Terminations at Network Element

- 6.1 All power cabling supplied by Verizon and any power cabling supplied by the equipment manufacturer such as whips and cords that Verizon must interface with, must meet Verizon standards and the requirements of the National Electric Code (NEC) from where it originates (typically the BDFB/ BDCBB or Powerboard) all the way to the cable terminations at the end equipment (Typically the rack fuse / breaker panel or the equipment shelf).
- 6.2 Power cabling that originates and terminates in the equipment bay that is supplied by the equipment manufacturer and is part of a UL listed assembly, does not technically need to meet the requirements of the NEC and Verizon standards in all regards. However, this power cabling should be designed to meet Verizon standards and the NEC wherever possible. The equipment manufacturer supplied/provided cabling and terminations will still be subject to evaluation by Verizon for safety and reliability and may result in the equipment being disapproved if the power issue is not corrected and Verizon feels the issue warrants and requires it.

6.3 Equipment Protection Versus Overcurrent Protection



6.3.1 Equipment manufacturers will provide overcurrent protection for their equipment (generally this is internal to the equipment). Protection of internal components of the end equipment is the sole responsibility of the equipment manufacturer.

6.3.2 Verizon will provide overcurrent protection for the cabling providing power to the equipment only. Verizon's overcurrent protection will be in the form of industry standard breakers or fuses. Generally the breakers are equipped with a 52 delay and the fuses are Bussman Telepower type (TPS, TPA, TPL etc.) or equivalent. Verizon will not accept equipment manufacturers specifying the overcurrent protection device type (breaker/fuse) or trip delay setting (long or short) for any device under Verizon control for the protection of their equipment.

6.4 Cable Type and Ratings

6.4.1 The cable type provided by Verizon to power the device/equipment will be RHH/RHW for 14 AWG and larger. ALL power terminations at the device or equipment shall be designed for RHH/RHW type cable with Code or B stranding. The power terminations shall not require the use of flex or super flex type conductors to make the final terminations at the equipment. The terminations provided by the equipment manufacturer at their equipment shall be designed so as to prevent Verizon from having to tap or splice the code or B strand cable to a flex type cable for termination at the shelf.

Note: Cabling provided by the equipment manufacturer that originates and terminates internal to the rack or cabinet that is part of a UL listed assembly that utilizes cable other than RHH/RHW or uses a finer stranding than Code or B type strand is permissible (with Verizon approval), as long as any Verizon provided cabling and terminations are completely separated from the equipment manufacturer provided cabling. Verizon will review the internal cabling and terminations to insure safety and reliability as needed.

6.4.2 Tables 1 and 2 below provide the minimum cable size for the given breaker or fuse size required to power the equipment and the maximum cable ampacities as specified by the National Electric Code for RHH/RHW cable. Verizon will size its provided cabling to be terminated at the device/equipment per these tables. The manufacturer of the equipment shall design the equipment terminations to accommodate these cable sizes as required.

6.4.3 The values in Table 1 and 2 below are based upon the 2008 National Electric Code (NEC) Table 310-16 at the 75 degree C rating. Terminations for cabling at the device/equipment rated for temperatures above 75 degree C are not permitted regardless if the cable insulation is rated for a higher temperature such as 90 degree C. The 2008 NEC code is used instead of more recent versions of the NEC, as it will be the prevalent version adopted by local authorities and AHJs.



Cabling provided by the equipment manufacturer such as whips and cords that Verizon will interface with directly (splice or tap) shall also be sized in accordance with the requirements in Table 1 and 2. All cabling in the path of the same upstream overcurrent protection device must meet these minimum requirements.

Note: Internal power connections (Cable originating and terminating in the rack or cabinet) provided by the equipment manufacturer that are part of a UL listed assembly that have terminations rated at higher than 75 degrees C will be considered by Verizon on a case by case basis for acceptance, but should be avoided when designing the device or equipment.

Table 1: CB/Fuse Size and Minimum RHH/RHW Cable Size at the 3 Conductor 75 Degree C Rating

SECONDARY POWER CB/Fuse Size (AMPS)	MINIMUM ALLOWED Conductor Gauge (AWG)
15	14
20	12
25	12 (Note 1)
30	10
35	10 (Note 1)
40	8
50	8 (Note 1)
60	6
70	6 (Note 1)
75	4
80	4
90	4 (Note 1)
100	2
125	2 (Note 1)
PRIMARY POWER CB/Fuse Size (AMPS)	MINIMUM ALLOWED Conductor Gauge (AWG/MCM)
150	1/0
200	2/0 (Note 1)
225	4/0



250	4/0 (Note 1)
300	350 MCM
400	500 MCM (Note 1)
500	750 MCM (Note 1)
600	(2) 350 MCM per polarity
800	(2) 500 MCM per polarity (Note 1)
Feeds > 800	Note 2
<i>Note 1: Cable sized per 2008 NEC Article 240-4(B) allowance</i>	
<i>Note 2: Where battery disconnects or bulk feeds are required and sized for greater than 800 amps, the minimum cabling shall be calculated using the 75 degree C rating of the RHH/RHW cable and shall meet the fuse clearing requirements of the NEC. Verizon voltage drop requirements shall additionally be met.</i>	

Table 2: Cable Size and Maximum Allowable Ampacity for RHH/RHW at 3 Conductor 75 Degree C Rating

GAUGE	AMPACITY	GAUGE	AMPACITY
14	15	1/0	150
12	20	2/0	175
10	30	4/0	230
8	45	250	255
6	65	350	310
4	85	500	380
2	115	750	475

6.4.4 Where twisted pair cable is provided for DC power feeds by Verizon or the equipment manufacturer for applications 10 amp / 16 AWG and smaller, the following maximum cable ampacity ratings shall apply and the upstream fuse or breaker that powers circuits shall not exceed the ampacity rating of the conductor sizes as stated below. The maximum ampacity of these paired conductors is as follows:

- a) #16 AWG = 10 amps
- b) #18 AWG = 7 amps
- c) #20 AWG = 3 amps



- d) #22 AWG = 2 amps
- e) #24 AWG = 1-1/3 amps

6.4.5 Where twisted pair cable is provided, each fuse position/circuit (battery and return) shall have a dedicated twisted pair cable ran to it for all power feeds to end equipment (alarm wiring can use multi-pair wire/cable); using multi-pair conductors in a common jacket is not permitted for powering Verizon network equipment. These paired conductors do not need to include a braided or foil shield unless required by the application/equipment manufacturer.

6.4.6 Color coding of DC power cable is not required. Where cable is color coded (RHH/RHW or Twisted Pair type cable), the following shall apply:

- Red (RHH/RHW), Red or Red W/Black Stripe for Twisted Pair: -48V conductors
- Blue: +/-24V conductors
- Black: 48V or 24V battery returns.

6.5 Sizing of Upstream Overcurrent Protection and the Necessary Cable

6.5.1 Power terminations provided at the device/equipment shall be designed so as to allow Verizon to provide an upstream overcurrent protection device (fuse or breaker) and cabling sized to 125% of the worst case input load of the device/equipment at the cutoff voltage of the equipment. Cable terminations at the device/equipment designed for a minimum cable size rated at 100% of worse case load at cutoff voltage are not permitted.

Note: Cabling provided by the equipment manufacturer such as whips and cords that Verizon will interface with directly (splice or tap) shall also be sized in accordance with this requirement as well.

6.5.2 Power terminations provided at the device/equipment shall additionally be designed to allow Verizon to run up to two (2) standard cable sizes (not breaker or fuse sizes) larger than the minimum conductor based upon the upstream overcurrent protection device (fuse or breaker) per Table 1 to accommodate voltage drop. Standard cable sizes for RHH/RHW cable are shown in Table 2. Note: Not all gauge sizes possible are considered “standard” or readily available with RHH/RHW cable. Ex: The device requires a 60 amp breaker or fuse upstream which is sized at 125% of the worse load at cutoff voltage. The minimum conductor size per Table 1 for a 60 amp OCP device is 6 AWG. The device / equipment power terminations shall be designed to accommodate the minimum conductor size of 6 AWG, plus conductors sized up to 2 AWG (two sizes larger than 6 AWG).



- 6.5.3** Power terminations at the equipment shall not be designed to require the need for tapping down to parallel conductors (two smaller conductors from 1 larger one) per polarity using a “Y” tap, so they can be terminated at the equipment. (Ex: The equipment requires a 60 amp overcurrent protection device installed upstream. As such, a 6 AWG cable minimum per polarity should be run to the equipment. The equipment shall be designed to terminate the 6 AWG minimum (plus two standard sizes larger or 2 AWG) and not require the 6 AWG to be tapped to two (2) parallel 10 AWG’s per polarity so the cables can be physically terminated at the equipment. Note: This requirement is based in part upon 2008 NEC Article 310.4 (A) (B) conductors in parallel.
- 6.5.4** Power terminations at the equipment shall not be designed so as to require parallel conductors to be ran to the device or equipment where a single conductor could have been used per 2008 NEC Article 310.4 (a) (B) conductors in parallel. (Ex: If the device requires a 100 amp feed (OCP device size). The terminations at the device / equipment shall be designed to accommodate the minimum size conductor which is a 2 AWG, (plus the next two standard cable sizes up), not be designed where parallel conductors of 6 AWG are required.
- 6.5.5** Input power terminations provided at any equipment manufacturer provided rack fuse or breaker panels that are provided to power the device / equipment in the rack or cabinet, shall be designed and sized, at a minimum, to allow Verizon to provide an upstream overcurrent protection device (fuse or breaker) sized to 100% of the rack fuse or breaker panel bus rating minimum (125% is preferred) as specified by the panel manufacturer. (Ex: a fuse or breaker panel that is rated for two (2) 100 amp inputs for load A & B shall be designed to allow Verizon to provide two (2) 100 amp feeds with cable sized per Table 1 (2 AWG for use with the 100 amp breaker or fuse upstream). The input terminations shall additionally be sized to allow cable two (2) standard sizes larger than the minimum to be terminated to accommodate voltage drop to the rack fuse or breaker panel. Note: Verizon may not supply overcurrent protection and cabling for the 125% rating of the fuse or breaker panel bus, but the equipment should be able to accommodate it if necessary.

6.6 Mechanical Connector Limitations and Crimp/Compression lug requirements

- 6.6.1** The equipment shall not be designed with spring loaded/ push in type power terminations for use in Verizon.
- 6.6.2** Mechanical terminations (pressure, saddle clamp, screw, Phoenix block, etc.) are non-preferred for all terminations sizes and should be avoided where possible



when designing the device or equipment. However, Verizon will permit approved mechanical terminations for DC feeds less than 15 amps and/ or less than 14 AWG cable if used. Note: See Section 6.10 for locking plug assemblies such as Molex or Amphenol requirements.

- 6.6.3** Solid type cable, not stranded, shall be used where mechanical terminations are permitted and provided. Solid cable will not compress or loosen like stranded cable.
- 6.6.4** Power terminations rated for 15-amperes and larger and/or 14 AWG and larger, shall provide for use of compression/crimp lugs.
- 6.6.5** All compression / crimp type lugs used by Verizon, or provided loose by the equipment manufacturer for Verizon use (will be crimped onsite), that will be used to terminate to the equipment shall be Verizon approved Burndy or Thomas and Betts (T & B) type lugs. The use of Panduit or other compression/crimp type lugs that are not approved by Verizon is prohibited. Terminations shall not be designed to exclusively accept only the dimensions of a Panduit or any other unapproved lug.

Note: Compression/Crimp type lugs used for internal power connections (Cable originating and terminating in the rack or cabinet) provided by the equipment manufacturer that are part of a UL listed assembly do not need to be Burndy or T & B type lugs as long as they do not require to be crimped in the field by Verizon.

- 6.6.6** Compression/crimp type lugs from Burndy and T & B shall be plated copper lugs with inspection windows. (Example Burndy YA series standard/short barrel lugs or Burndy YAZ series long barrel lugs or T & B equivalent).
- 6.6.7** The equipment shall be designed to accommodate long barrel lugs in the required cable size range (minimum gauge plus two sizes larger). This is so the equipment can be used in all seismic applications. The equipment must be designed to accommodate the long barrel lugs without interference or blocking of other connections or cabling.

Note: Compression/Crimp type lugs used for internal power connections (Cable originating and terminating in the rack or cabinet) provided by the equipment manufacturer that are part of a UL listed assembly do not need to be long barrel but it is preferred that long barrel is used due to the higher pullout rating.

- 6.6.8** All lugs will be crimped using the UL approved tools and dies for the given lug. The lug and tooling shall provide a UL approved crimp/connection. The tools and dies shall emboss the lug with the die information so as to allow inspection to insure the crimps are in compliance with specifications.



- 6.6.9** Compression / crimp type lugs shall be crimped using “U” type dies and hydraulic crimping tools to make any necessary crimps where possible. With the “U” dies, a single crimp per activation of the crimping tool is required. Lug shall be designed and banded to accept the correct quantity of crimps and/or be the correct barrel length (short or long) to comply with Verizon requirements.
- 6.6.10** Terminations shall be designed such that narrow tongue lugs or special order lugs such as split tongue type shall be avoided.
- 6.6.11** The lug terminations should be designed to accommodate the following NEMA or IEEE lug hole patterns and sizes. Metric lugs shall not be used.
- A) 5/8” centers #10 bolt minimum (non-preferred). (Up to 2 AWG Wire)
 - B) 5/8” centers, 1/4” bolt (Preferred) (Up to 2 AWG Wire)
 - C) 1” centers, 3/8” bolt (2 AWG and Above)
 - D) 1-3/4” centers 1/2” bolt (2 AWG and Above)
- 6.6.12** Compression lugs should be two-hole type where possible (space permitting) for 14 AWG cable and larger.
- 6.6.13** Single-hole crimp lugs may be used in applications up to and including DC feeds utilizing a 30 amp overcurrent protection device (OCP device) upstream. For DC feeds larger than 30 amps, compression connections shall be designed for two-hole lugs.
- 6.6.14** Ring type lugs (Sta-Kon type or Burndy equivalent) can be used for DC feeds below 15 amps (based upon OCP device size) AND for wire gauges smaller than 14 AWG. Ring lugs should be used only where a regular crimp type lug is not available.
- 6.6.15** The use of spade/fork lugs for small gauge wire (below 14 awg) should be avoided wherever possible. Ring type lugs should be used instead. Where terminations are designed for spade/fork type lugs, they should be converted to ring lugs where possible (where the bolt is not captive on the equipment), or the spade/fork type lug used must be flanged to help prevent pullout.
- 6.6.16** All standard compression type lugs and uninsulated ring lugs provided by the equipment manufacturer at the equipment should be equipped with clear heat shrink for inspection of the crimps and embossed die information. Heat shrink is not required with insulated ring lugs.



6.6.17 All crimp type lug connections at the equipment or any equipment manufacturer provide rack fuse or breaker panel shall be designed to operate at no more than 75 degree C when operating at worse case load (i.e.: equipment cutoff voltage).

6.7 Physical Termination Requirements and Restrictions

6.7.1 Equipment input rating should be limited to a maximum of 125 amperes at low end operating voltage. If higher power is required for a chassis, the power supplies/power entry modules should provide for multiple lower amperage inputs. Current requirements higher than 125 amperes require the equipment be powered from the main power boards and this means there will be no power disconnect in the immediate vicinity of the equipment.

6.7.2 Equipment shall be designed so that the wire/cable SHALL NOT obstruct access to other power terminals.

6.7.3 All termination methods used must produce a UL listed connection at a minimum and comply with Verizon standards.

6.7.4 The equipment shall be designed with barriers between the terminations of both opposite and like polarities. (e.g. such as barrier term strips) Hard barriers are preferred over fiber paper barriers. Plug assemblies shall also provide barriers at a minimum between opposite polarity terminals to prevent shorts if a pin was to become bent.

6.7.5 The equipment shall be designed such that the power terminations are sized to avoid fuse or breakers in parallel. Fuse or breakers in parallel are prohibited by the 2008 NEC Article 240.8. Parallel OCP devices are where two (2) individual OCP devices (breakers or fuses) are powering / terminated to a common bus or device internal or external to the equipment. (Ex: using two individual single pole 60 amp breakers or fuse devices to power a load versus using a single 125 amp OCP device, or using two (2) 60 amp OCP devices to the same power supply for N + 1 redundancy of the DC input feeds). Using parallel OCP devices and feeds of a smaller size to reduce the cable size and required termination landings at the equipment is not prohibited, but must be properly designed. Parallel fusing can be avoided in two ways: A) Use the larger single OCP device and design the power terminations to accommodate the larger cabling lugs, or B) provide electrical isolation between the paralleled fuses or breakers. Electrical isolation can consist of the individual feeds terminating to a separate bus / power paths at the equipment (the two DC inputs are never tied to a common bus internal or external to the equipment) or provide diode isolation of the two DC feeds at the equipment.



- 6.7.6 Dual lugs back to back under one set of studs is not permitted at the equipment. Back to back lugging on busbar (one lug on either side of the busbar) with through bolts is permitted.
- 6.7.7 Bolting hardware shall not be used to carry current. The current carrying portion of the lug or conductor must be mated to a flat current carrying surface of the terminal provided.
- 6.7.8 All the terminations (bolting hardware size and quantity of bolts) shall be mechanically/physically sized to meet ANSI /IEEE/NEMA standards so as to properly retain the conductor and or conductor/lug for the size termination required and must withstand the normal stress / torque that may arise when the conductor is landed and secured. (e.g. # 6 studs should not be provided for termination of a 4/0 cable)

6.8 Minimum Bend Radius for DC Power Feeds

- 6.8.1 Equipment shall be designed such that minimum bend radius of the power cables is not exceeded. The minimum bend radius will apply to the largest cable required to meet the minimum cable size plus two requirements as identified in Item 2.3.3 above. See Table 3 and Figure 1 Below for required minimum bend radiuses.

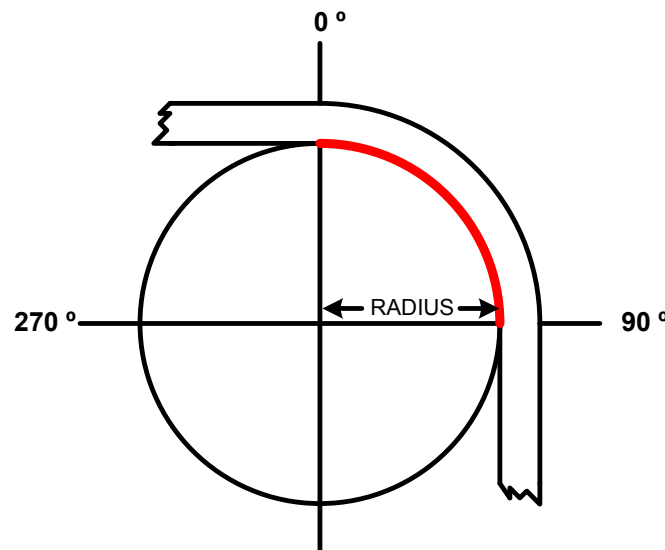
Table 3: RHH/RHW Minimum Bend Radius and Cable Characteristics

Wire Size	Circular Mills	Weight Per Foot (LBS)	Diameter Over Insulation (Inches)	Minimum Bend Radius (Inches)
14	4110	0.026	0.19	0.95
12	6530	0.035	0.21	1.05
10	10380	0.049	0.24	1.2
8	16510	0.084	0.31	1.55
6	26240	0.126	0.4	2.0
4	41740	0.19	0.45	2.25
2	66360	0.275	0.51	2.55
1/0	105600	0.443	0.63	3.15

2/0	133100	0.54	0.68	3.4
4/0	211600	0.814	0.75	3.9
350 MCM	350000	1.31	0.98	4.9
500 MCM	500000	1.815	1.12	5.6
750 MCM	750000	2.7	1.34	6.7

Figure 1: Definition of minimum bend radius.

Minimum bend radius is defined as the smallest radius to which a **cable** may bend.



6.9 Whips/Cords provided by the Equipment manufacturer

6.9.1 Equipment manufacturer provided DC power whips shall be sized with conductors no less than the minimum conductor size as specified in Table 1 for the overcurrent protection device size that will be required upstream of it to power the equipment. Additionally the whip or cord shall be designed to facilitate Verizon terminating (splice, tap or other termination method) up to two (2) cable sizes larger to accommodate voltage drop.

6.9.2 Any inline splices or H-taps that will be required to interface equipment manufacturer provided whips or cords from the equipment with the Verizon provided DC input cable, will be standard Verizon approved T&B or Burndy, plated copper inline splices or H-taps.



6.10 Plugs and Connectors

- 6.10.1** All separable electrical plugs or connectors used at the equipment shall be keyed to prevent incorrect mating and must provide a dual locking connection. The locking mechanism can be screw, bayonet type plug or similar. Velcro straps are not considered adequate to be considered a locking mechanism.
- 6.10.2** All plugs/connectors used at the equipment should be designed to carry the worst-case load of the equipment at a temperature rating of no greater than 90 degree C. 105 degree C terminations shall be avoided even if the plug assembly is rated for this temperature as long term operation at elevated temperatures can cause operational problems over time.
- 6.10.3** All plugs/connectors used at the equipment shall be designed to accommodate the wire size required for feeding the equipment Per Table 1.
- 6.10.4** All plugs and connectors shall meet Telcordia and Verizon NEBS requirements for connection tension, heat and so on.
- 6.10.5** The design of power and ground connections for equipment assemblies shall be such as to ensure that there is no risk of the connections becoming loose because of vibration or accidental mechanical shocks or seismic activity. As a minimum, screw-down power and ground connections shall be fitted with some type of locking feature (e.g., lock washers) that both prevent rotation and maintain clamping forces, or shall be designed to be immune from the effects of shock and vibration. Positive methods to prevent rotation are preferred, e.g., two-hole lugs and terminals.

6.11 Miscellaneous Requirements

- 6.11.1** Protective covers, while not required in all applications, will be provided where there is possibility of anything dropping onto the terminations, or where anything can make contact with the terminations from the rear/front (based upon where the terminations are located) that may result in damage or short.
- 6.11.2** Power terminal protective covers, where supplied, will provide adequate space/clearance for long barrel lugs with two (2) crimps minimum or four (4) crimps for larger cable without interfering with other cabling, blocking airflow to the shelf or blocking access to any components or termination hardware in the shelf.



- 6.11.3 Barriers, covers, heat shrink, insulators and so on shall be made of a flame retardant material that is UL 94V-0 or UL 94V-1 and LOI \geq 28%.
- 6.11.4 Per the National Electric Code the grounding conductor(s) to the shelf or shelves is required to be sized to clear the largest upstream overcurrent protection device (breaker or fuse). The grounding conductor only needs to clear one of the upstream devices, not all of them at a given time. (Ex: A device that requires (4) 60 amp DC inputs shall have its grounding conductor sized to clear only (1) of the 60 amp OCP devices. The grounding conductor does not need to be sized to clear all (4) 60 amp OCP devices (240 amps) at one time.
- 6.11.5 The equipment shelf/shelves shall provide a termination point for grounding the shelf to the rack or cabinet. The termination point shall accommodate up to a 6 awg crimp lug. A stud for a single hole 1/4" bolt lug minimum is required. Preferably, where space on the chassis is available, arrangements shall be made for a two hole compression lug to be landed with 1/4" holes on 5/8" centers. Verizon will most likely use a 6 awg conductor to ground the given equipment shelf or shelves in the rack or cabinet regardless if a smaller conductor could be used. The following table shows the **minimum** cable gauge/size that is required for the OCP device rating.

Table 4: 2008 NEC Table 250.122 Minimum Size Equipment Grounding Conductor for Grounding Raceway and Equipment. Cable Size and Maximum Allowable Ampacity for RHH/RHW at 3 Conductor 75 Degree C Rating

Rating of setting of single OCP upstream of equipment (not to exceed amps)	Size AWG of Copper Cable
15	14
20	12
30	10
40	10
60	10
100	8
200	6

- 6.11.6 Grounding of the individual DC power supplies shall not be required to make it or the shelf operational, functional or safe. The power supplies shall be individually grounded internally to the chassis and not require a dedicated ground to each power supply. The grounding should be achieved by the mating process of the



power supply to the shelf/chassis. It is not a Verizon, Verizon NEBS, NEC or Telcordia standard to require individual grounding of the DC power supplies. Historically individual grounds on DC power supplies were never provided and equipment that would require it poses an implementation problem. The manufacturer can provide a grounding terminal on the individual power supplies for customers that may want to do this, but Verizon will not terminate individual grounds to the DC power supplies unless necessary. Note: AC power supplies will be grounded vial the ACEG of the AC input.

- 6.11.7** It is not a specific Verizon requirement that each individual power supply module is to powered with N + 1 redundancy of the DC input feeds in telecom applications (IE: dual fed where the power supply module only required (1) DC input to be operational to its full rated capacity). This is even though N + 1 redundancy of the DC input feeds to each individual power module, does provides additional redundancy / reliability in some applications. N + 1 redundancy on the power feeds to each power module takes up too many breaker positions in our secondary distribution bays (BDFB and BDCBB's) and requires twice the cabling and labor to install. Larger rated power supplies may require two DC inputs feed to accommodate their full capacity, but redundant feeds (N + 1) is not required. Verizon does not prohibit redundant (N +1) power feeds to each power supply; they are just not preferred where they are not required. Note: Requirements for equipment designed for Data Center applications may vary though.