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COMMERCIAL CUSTOMER PREMISES AND CARRIER HOTELS ELECTRONIC EQUIPMENT ENVIRONMENTAL SPECIFICATIONS AND INSTALLATION GUIDE

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NOTICE

This document describes the Environmental and Installation Requirements, as well as the Powering and Grounding options for CenturyLink Telecommunications Equipment to be placed on the Customers' Premises. This document applies only to services that require the placement of CenturyLink digital multiplexing and/or switching equipment. The space may be wholly owned by the customer, leased by CenturyLink, or owned by the building owner or another tenant.

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1. Introduction

1.1 General

This document describes the Environmental and Installation Requirements, as well as the Powering and Grounding options for CenturyLink telecommunications equipment to be placed on the Customers' Premises and in Carrier Hotels. This document applies only to services that require the placement of CenturyLink digital multiplexing/IP and/or switching equipment for the service of end customers in or near the building. The space may be wholly owned by the customer, leased by CenturyLink, or owned by the building owner or another tenant.

1.2 Scope

There are many services sold by CenturyLink where the economical option for delivering these services is to place telecommunications equipment on the Customers' Premises or in Carrier Hotels. (This publication covers business-type customer premises equipment, such as multiplexers, digital loop carrier, routers/servers, DWDM, ROADM, etc. It does not cover residential CPE, such as DSL modems placed in a computer, telephones, etc.). It also does not cover leased facilities primarily used for CenturyLink infrastructure rather than serving end customers. Sometimes the end-user customer of the CenturyLink services owns the space outright, but allows CenturyLink to place its equipment there in order to serve them. Other times CenturyLink leases the space from the customer or a third party. In other cases the equipment is allowed to be placed in space owned by a third party for use by CenturyLink customers. Some of this telecommunications equipment comes in pre-packaged lockable cabinets that can be placed in many locations in a building. In other applications it is mounted in relay racks in an equipment or mechanical room, or may even be wall-mounted equipment. Sometimes it will share rooms with other telecommunications equipment providers, or with the telecommunications equipment owned outright by customers (e.g., PBX).

This document does not cover Customer Premise E-911 PSAP installations (since the 911 equipment is typically owned by the governmental agency, even if CenturyLink is contracted to do the maintenance. A similar Tech Pub (77339) applies to PSAPs. Some of these sites may have both types of installations: a traditional Customer Premises entrance point (that may be covered by this Tech Pub 77368), and then E-911 equipment covered by Tech Pub 77339.

In all cases, decisions must be made up front about items such as backup Power, Alarms, Distributing Frames, Equipment floor space, Equipment Environment, etc. All of this requires the coordinated effort of the various CenturyLink Marketing groups, Designed Services group, Engineering, Installation/Construction and the Customer. Coordinated effort by these groups in adherence to the requirements and guidelines of this document will ensure that the customer receives safe and reliable telecommunications services from CenturyLink.

1.3 Reason For Reissue

This publication is being re-issued primarily due to the absorption of Qwest into CenturyLink and the need to standardize policies and procedures to simplify deployment of services to commercial customers.

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2. General

2.1 Safety and Reliability

As mentioned in the introduction, proper up-front coordination between Marketing and the various Engineering Centers can ensure that many of the standards contained in this document are met. Engineering, field forces, and/or CenturyLink-approved contracted installation vendors are then responsible for installing the equipment on the Customers' Premises according to the standards of this document. Finally, CenturyLink Local Network installations may be randomly audited by CenturyLink Quality Inspectors to ensure conformance to the requirements and guidelines of this document, and CenturyLink Standard Configurations and other technical documents. In CenturyLink National Network sites, field operations personnel are responsible for filling out an acceptance checklist.

Reliability of the telecommunications Network on the Customer's Premises increases CenturyLink's chances of retaining the customer(s), and selling additional services. Also CenturyLink does not suffer lost revenue due to outages. Reliability increases the customers' ability to serve their customers; thereby increasing their revenues. Safe telecommunications equipment safely installed in a safe environment, with safe backup power, will ensure that neither the customer, their customers, nor CenturyLink personnel are harmed by potential hazards.

For example, if the guidelines of Section 5 are followed, and the DC rectifiers serving the CenturyLink telecommunications equipment are fed from an AC source backed up by a building standby generator, service is much more likely to remain available during prolonged commercial AC power outages. If two-hole lugs are used for power and grounding connections, as suggested in Sections 6 and 7, the connections are much less likely to become loose. Loose connections can result in short or open circuits, impairing service from the equipment fed by that circuit. Proper configuration and end-end testing of housekeeping and network element alarms per Section 8 will ensure response.

When telecommunications equipment is properly grounded (Section 6), not only will it be more reliable, but it will protect personnel from shock. Proper installation practices (Section 7) will prevent sharp edges that can cut, as one small example. Proper implementation of the environmental and power guidelines (Sections 4 and 5) will prevent abnormal battery venting.

By taking the extra time and spending a little more money to ensure the requirements and guidelines of this document are followed, there are short- and long-term monetary benefits to the customer and CenturyLink. The reliable service produced from adherence to these requirements also fosters an incalculable good will that will help ensure a long term relationship between the two parties. These gains (both monetary, and in customer confidence) far outweigh any small added costs that adherence to these standards cause. This document is beneficial to both the customer and CenturyLink.

As mentioned, requirements and guidelines for Customer Premises equipment space cannot be as strict as those applied to CenturyLink-owned space, simply because CenturyLink does not own the space. For purposes of this document the following terms denote whether a requirement is absolute (must be met) or not:

- SHALL, MUST — denotes requirements which must be adhered to for basic personnel safety and basic reliability
- SHOULD, ADVISABLE, DESIRABLE — guidelines which would improve reliability and safety, but do not have to be absolutely followed (suggestions)

Equipment reliability and safety can be ensured by 3rd party testing to Ericsson/Telcordia's NEBS documentation: GR-63-CORE, GR-1089-CORE, and SR-3580. NEBS Level 1 indicates that equipment is "safe" (i.e., not flammable, and will not radiate harmful levels of electro-magnetic wave interference — RF, EMI or EMF — among other things). NEBS Level 2 additionally indicates that the equipment will function. NEBS Level 3 additionally indicates that equipment will be reliable under non-standard circumstances (e.g., stand up to earthquakes expected in Zones 3 and 4 — see Section 4.5 for more information on earthquake zones and ratings). In addition, there are "other NEBS criteria", which primarily cover environmental issues. CenturyLink does not require that equipment placed on the Customer Premises be NEBS-compliant (we do require that our equipment placed on Customer Premises meet the NEC and applicable UL (or other approved Listing agency) specifications (like UL 1950/60950). However, it is a good idea that CenturyLink equipment at least be designed to NEBS specifications. If the Customer has additional equipment certification requirements (for example, CSA standards in Canada, or IEC standards in Europe), this should be negotiated in the contract (see Chapter 9)

Customer-signed waivers for environmental and power exceptions are mentioned several times in this document in Chapters 4 and 5, and some of the mentions include hyperlinks to the appropriate standardized form. Those who should keep a copy (preferably stored electronically in CenturyLink internal multi-user systems) of signed waivers include: the project manager, wholesale contract administration, the service delivery representative (as part of the order records), Network Planning and Engineering (to be stored with other job packet documents), the service center tester, and the billing coordinator.

2.2 Types of Customer Premises and Carrier Hotel Installations

This document deals with all types of Customer Premises and Carrier Hotel installations. Sometimes the terms Carrier Hotel and Data Center are used interchangeably. For purposes of this document, DataCenters refer to non-CenturyLink Data Center collocation facilities. Carrier Hotels refer to meet-me points, typically where we provide backhaul facilities to multiple Carriers who reside in the building.

For purposes of this document, Customer Premises and Carrier Hotel installations are divided into three types of sites, regardless of the ownership or lease status of the property.

Some Customer Premises applications that involve telecommunications equipment that can fit into one or two relay racks may come pre-packaged in a lockable cabinet (using a CenturyLink standard key). Most of these cabinets sit on the floor, although some may be mounted to walls. In some cases, when more than two relay racks full of equipment are needed to serve the customer, multiple cabinets are placed.

These cabinets can be placed in many different locations in a building, and are unobtrusive, as the equipment inside cannot be seen when the doors are locked. However, these cabinets should not be placed just anywhere. Particular attention should be paid to the environmental requirements of Section 4 (as well as some physical attributes covered in Section 3). As an example, these cabinets generally contain batteries, which need a good environment to remain safe, maintain capacity, and not overload the floor with their weight. The cabinets also contain circuit packs, which need a relatively clean environment that is not too hot. Otherwise the circuit packs will fail before their life cycle is complete.

In some cases where there is a need for more than two relay racks of equipment, the equipment is placed in standard telecommunications relay racks (typically with 23" wide standard mountings). This is the second type of site. Because the telecommunications equipment is "exposed" to view, most of these types of installations are in equipment or mechanical rooms in a building. Again, care must be taken in the selection of the location for this equipment, especially with regard to the environmental requirements of Section 4, such as heat, and floor loading.

In Carrier Hotels / Data Centers, the relay racks and/or cabinets may be located in a locked/caged area.

As equipment density increases, more and more bandwidth is capable of being provided in a smaller package. Because of this, more and more Customer Premises installations are wall-mounted.

The requirements and guidelines that follow in this document apply to wall-mount, cabinet, and relay rack installations.

In a multi-tenant building or campus, multiple customers can be served from one or more installations anywhere in the building or on the campus. However, CenturyLink must either lease the space(s) outright from the building owner, or procure space for the placement of equipment from said owner in all Customer Premises installations. If the spaces are owned by a common owner it is best to keep all of the spaces under one common contract, even if the spaces are "procured" at different times. When more than one contract exists, the terms should be copied as much as possible, and the contracts linked together. For the most complex types of multi-tenant arrangements, the CenturyLink Engineering department may wish to use the internal services of the CenturyLink Real Estate department that handles commercial Customer Premises leases. This can add time to the process, but due to Real Estate's familiarity with leasing and other building arrangements, can result in a more favorable economic and contractual outcome and a more reliable environmental setup.

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3. Site Survey Check List and Site Selection

The assistance of other engineering groups may be necessary to assure that the site will be ready prior to the digital equipment start date. The building owner's building Engineers may need to be consulted if any building work is required on the Building/Owner or Customer's property for Non-Leased Floor Space. For leased space, a CenturyLink Real Estate Engineer may be consulted.

Many of the items in the checklists of this section are explained in greater detail in subsequent sections. In fact, similar tables are found in Section 10 of this document for use by Marketing. These Tables in this Section have enough detail to provide good checklists for Field Engineers, and they can refer to Sections 4 through 7 for greater detail. They are intended for use after an initial agreement has been reached with the Premises owner/customer. The Tables in Section 10 are simplified for up front use by CenturyLink Marketing organizations.

3.1 Unsuitable Customer Premises Locations

Some locations which may be offered by Premises owners, are unsuitable for the installation of CenturyLink telecommunications digital equipment. These types of locations/rooms are as follows:

- Near flammable materials including easily ignitable dusts and gases
- Corrosive atmospheric or environmental conditions
- Projections into work areas, passageways or other hazardous locations
- Upper areas requiring access by ladder
- Humid, moist or flood-prone areas
- Near main AC switchgear and/or transformers
- Near moving machinery
- Heat, direct sunlight
- Boiler rooms
- Washrooms
- Janitor's closet
- Any place that contains: Steam pipes, Drains, Clean-outs

In areas that CenturyLink considers hazardous or inaccessible to its employees, the customer will be required to make the appropriate changes to the space or CenturyLink will not place telecommunications equipment.

3.2 Floor Space and Clearance Requirements

For leased space, extra space is needed outside of the leased area for Network Interfaces (NIs).

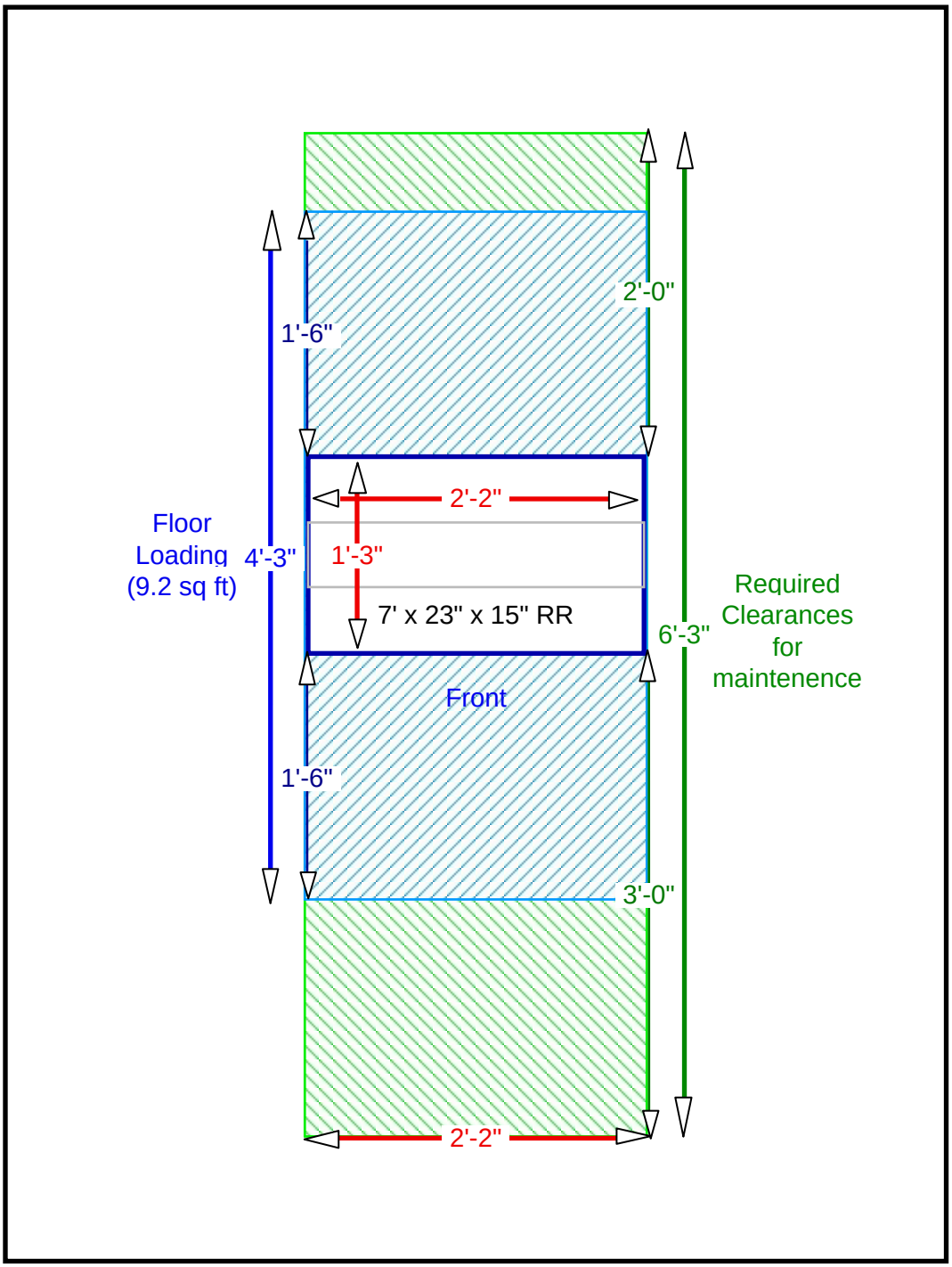

Figure 3-1 Maintenance and Floor Loading Clearances

As a general rule, there should be three feet of clearance in front of relay-rack mounted equipment for maintenance (per the NEC), and two feet behind the equipment (see Figure 3-1). Up to eighteen inches around the relay rack may be used for floor loading calculations (see Section 4.4 for exceptions to this rule, and more information on floor loading) when there is no equipment located behind this bay. Customer Premises cabinets require three feet of maintenance clearance on both sides of the cabinet (see Figure 4-1), unless additional space is needed for heat dissipation or cooling for high power density bays.

If it is desired to place relay racks against a wall, all of the equipment and wiring mounted in those racks should be 100% accessible from the front (this could be accomplished through the use of hinges). Ensure that for seismic reasons or rear heat release reasons (check the equipment manufacturer documentation), that minimum clearance is maintained from the wall (typically 3-6" for cabinets and relay racks, and sometimes minimum space is needed for heat release even for direct backboard-mounted equipment). Some Customer Premises cabinets may be mounted against a wall if there is three feet of space in front of all cabinet doors.

For relay rack lineups that exceed twenty feet in length, the end aisle clearance on both ends should be at least 28 inches (per the Life Safety Code) for existing construction. This is a good idea even if the lineups do not exceed twenty feet. For new construction, or any facility where the ADA applies, this must be 36 inches.

3.3 Customer Premises Environment and Space Pre-Site Checklist

Table 3-1 contains a quick reference checklist for some of the items specified in much greater detail elsewhere in this section or in sections 4 and 7. This checklist should be used by the CenturyLink Engineer (formally or informally interviewing the Customer) before engineering and installation activity begins in a site. Some of the items found in this pre-site survey may cause re-evaluation of the space selected for installation of CenturyLink digital telecommunications equipment, or will drive an upgrade of the selected site.

CenturyLink may also desire additional floor space (convenient to where the equipment will be located) to permit secure storage. If so, ensure that the appropriate CenturyLink Marketing Group becomes involved to negotiate this with the customer.

Drop-dead issues (if not met CenturyLink will not place equipment in the space) are identified with an asterisk in the checklists of this chapter (and in Chapter 10).

If the conditions of Tables 3-1 and/or 3-2 are not met, determine if the building owner is willing to make needed improvements? (For non-leased space, if the owner is not willing to do this, CenturyLink won't place digital electronics. For leased space CenturyLink can make the upgrades a condition of lease, or contract the improvements). A customer-signed waiver absolving CenturyLink of liability is also a possibility (see Chapter 4 for more details on waivers).

Table 3-1: Field Engineer's Customer Prem Pre-Site Environmental & Space Checklist

Requirement	Notes/Description	Response
1. Temperature*	Are HVAC systems sufficient to preferably maintain a 55-85 °F room temperature (95° F maximum if batteries are in the room and 104°F maximum if the installation does not include batteries), including when the ultimate heat load of the CenturyLink equipment is added?	
2. Asbestos*	Is the room free of asbestos (ask the customer)?	
3. Ventilation* (min 0.5 ach)	Is ventilation sufficient so air is changed with external air at least once every 2 hours (this requirement will be met if the space is ventilated for human occupancy) – necessary if batteries are in the room*?	
4. Air Filtration	Is the room air filtered?	
5. Humidity	Is the Operating Relative Humidity between 5% and 55%?	
6. Size of Equipment area	Are width, length, and height of area available to CenturyLink large enough to place equipment? The space should also be large enough to accommodate anticipated growth. (Refer to appropriate Configuration to determine the floor space requirements of equipment being placed).	
7. Floor loading	The building owner should state what the floor is capable of supporting in terms of lb/ft². For raised floors, point loading may also be important, and it may be necessary to anchor to the base floor.	_____ lb/ft²
8. Sealed Floor	Is the floor sealed or covered? (Asphalt tile, linoleum tile, static free carpet, or sealed concrete are acceptable floor coverings).	
9. Walls	Are the walls at least 8'6" (102 inches) tall?	
10. plywood backboard	Is there space for NIs and other wall-mount equipment? (A minimum 4' x 4' space - or 4' x 8' - with a ¾" fire-retardant plywood backboard, no higher than 7', with 36"front-clearance, is usually required).	
11. Batten Boards	Are 2"x 8" batten boards installed with the lower edge at 6'9" (81") for mounting cable rack? (See section 7.2 of this document for further info. and guidelines on the installation of cable rack and framing.)	
12. Fire detector and extinguisher	Is fire safety equipment there? (It's preferable not to place equipment under sprinklers — see Section 4.6 for further info. on fire systems.) Equipment area should have fire detection and a fire extinguisher.	
13. Fire Stopping	Are cable openings into equipment space fire stopped? (CenturyLink will fire stop any opening they use to cable to the digital equipment).	
14. Lighting	Is there sufficient lighting in room? (Intensity of 50 ft-candles at 3 feet above floor level is recommended. Ensure lighting is not obstructed).	
15. Access	Does CenturyLink have 24 hr, 7 day a week access? If not, can CenturyLink obtain keys or other access methods to gain this access?	
16. Security	Is room secure? Is CenturyLink sole service provider in room? (Where CenturyLink is not sole occupant, locked cabinets are recommended).	Secure:___ 1 Occupant:_
17. Earthquake zone issues	If in Earthquake Zone 3 or 4 (see section 4.5), and building is over 2 stories, must check with bldg owner to see if any floors have post-tensioning cables. If so, or if unsure, must X-ray before making cable holes, or placing ceiling supports or floor anchors. If in Zone 3 or 4 on a raised floor, it may be necessary to anchor the bays to the subfloor underneath the raised floor.	
18. Concrete thickness for anchors	Concrete should be at least 4" thick to allow imbedded anchors. If not, building owner must suggest proper anchoring method and anchors for the floor type.	

3.4 Customer Premises Power and Grounding Pre-Site Checklists

Tables 3-2 and 3-3 contain quick reference checklists for some of the items specified in much greater detail in Sections 5, 6, and 7. This checklist should be used before engineering and installation activity begins in a site. Some of the items found in this pre-site survey may cause re-evaluation of the space selected for installation of CenturyLink digital telecommunications equipment, or will drive an upgrade of the selected site.

Table 3-2: Field Engineer's Customer Premises Pre-Site Power Checklist

Requirement	Notes/Description	Response
1. AC Power	Is AC Power available? (Refer to the appropriate Configuration to determine the voltage, breaker size, the quantity of feeds necessary, and the type of receptacle required to feed the equipment being placed). Determine from Chapter 5 if NEMA locking receptacles and/or dedicated AC circuits are required. Any receptacles must be within reach of the standard AC cord provided with the CenturyLink rectifier or equipment AC power supply.	
1.1	What is the Nominal Voltage and Phase? (120 V 1-Ø, 240 V 1-Ø, 120/240 V 1-Ø, 208/120 V 3-Ø, or 480 V 3-Ø).	_____ Volts
1.2	Is the customer providing Essential AC Power (AC backed up by a standby engine-alternator), and/or Protected AC power (backed up by a UPS). Either of these situations is desirable. If the power is not provided through a UPS, is it protected by a TVSS (surge arrestor)?	
1.3	Can CenturyLink equipment be powered directly from AC (no DC plant needed). This is only allowed if the customer provides Protected AC power, and the customer agrees to not hold CenturyLink liable for power outages; or is allowed where backup is not needed (see section 5.4). The CenturyLink Planner/Engineer should refer to internal PEG documents for more information.	
1.4	If power strips are to be used, were calculations run to ensure the upstream breaker would not be overloaded with all of the loads to be plugged in (existing and future) to that strip	
2. -48 VDC Power	What are the total forecasted List 1 and List 2 drains of the equipment to be served. Ensure that a DC Power plant and batteries are provided to meet these drain needs. (Customer Premises standard cabinet configurations often come pre-configured with an appropriately sized DC power plant and batteries.)	
2.1	Is the customer supplying the -48 VDC power? If so, refer to the appropriate Configuration to determine the DC current drain, and the quantity of feeds necessary to feed the equipment being placed, and procure these from the Customer. (Procuring -48 VDC power from the Customer is allowed only under certain circumstances specified in Section 5.3.)	____ # of feeds ____ Amps/feed

Table 3-3: Field Engineer's Customer Premises Pre-Site Grounding Checklist

Requirement	Notes/Description	Response
1. Building Ground*	Does the equipment room have a ground bar that is connected to a building ground source by a stranded (preferred, with green insulation) or solid #6 AWG minimum (see section 6.1 for cable sizing based on distance) copper wire? (Recommended building ground sources in order of preference are: driven ground system, metallic water pipe, continuous and bonded building steel, ACEG, or power company's MGN — see Section 6.2 for further information — it is most preferable to have at least two of these sources). Ground source leads should not be run in ferrous conduit. Where they are they must be end-bonded to the conduit at both ends with a minimum #6 AWG conductor.	
If ground is not available	Is the building owner willing to make the necessary improvements? (In the case of non-leased space, if the building owner is not willing to provide a good ground to CenturyLink, then CenturyLink will not place digital electronics. In the case of leased space CenturyLink can make the upgrades a condition of the lease, or Real Estate can contract an electrician to make the necessary improvements).	

3.5 Conduit Cable Entrance Concerns

For many commercial Customer Premises installations with indoor equipment, CenturyLink fiber or copper cable enters the facility or room through customer-provided conduit (negotiations with the customer may require that CenturyLink provide the conduit). If there is pre-existing conduit or innerduct that has no cable in it, that is the first choice, or a new conduit may be placed depending on the termination location. If it is desired to use an existing conduit or innerduct that already contains cable, the success of that option depends on many factors, including, but not limited to: size (inside diameter) of the existing conduit/innerduct, the length of the pull, the number of bends in the run, the size (outside diameter) of the existing cable, the size (outside diameter) of the new cable to be pulled in, the accessibility to the conduit for placing/pulling equipment and operations, and the general condition of the conduit structure with particular reference to silt accumulation. Where an existing innerduct (or conduit without innerduct) already contains two or more cables, no attempt should be made to place more cables in that innerduct or conduit. The final decision on the potential for success, and the go ahead to attempt placing a second cable in existing occupied conduit or innerduct is up to the CenturyLink Construction Field Engineer or Construction Contract Work Inspector.

The CenturyLink selection order for placing the proposed new cable to a commercial property should be prioritized in the following order:

- New, existing, unused, customer-provided conduit
- New, existing, unused, CenturyLink-provided conduit
- Placement of a new customer-provided conduit prior to cable placement
- Placement of a new CenturyLink-provided conduit prior to cable placement
- Placement of a Micro Duct/Fiber configuration in an area where CenturyLink has Micro Duct/Fiber placing equipment
- Placement of a new facility (copper or fiber cable) in a conduit with an existing facility
- A duct (or a conduit without innerduct) that contains two or more cables shall be considered unavailable for additional cable placement

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4. Environmental Requirements

The environment in which Digital Technology Equipment resides must be maintained to proper conditions in order to minimize service outages and economically optimize the usable life of the equipment. These conditions encompass the construction of equipment space, installation or removal of equipment, and ongoing maintenance. Digital Equipment contains a high number of components on the circuit boards. For purposes of this Technical Publication, all equipment placed on the Customers' Premises is classified as Digital Equipment.

The standards of this section shall be read as absolute requirements for all CenturyLink owned or leased space that houses Digital Equipment. They shall also be fully applicable when equipment is placed in a customer's residence. Vigilance is needed in these cases because residential homes are not generally built to the same environmental standards as work/equipment buildings.

When Digital Equipment owned by CenturyLink is located in Non-Leased equipment floor space, this Document should be used as an Environmental Recommendation to the Customer or Building Owner for optimal equipment operation.

CenturyLink has recognized the need for a cleaner and more protective environment in the operating envelopment within which Digital Technologies are deployed. Many operational problems, circuit failures and service outages have been attributed to poor environmental conditions. These must be managed to minimize failure of Digital Technology Equipment. For optimal customer equipment operation, the requirements of the succeeding subsections should be met.

4.1 Temperature and Humidity Guidelines

Low levels of humidity can increase the probability of Electrostatic Discharge (ESD) from personnel not using ESD-protection techniques. High levels of humidity can result in electrolytic corrosion, and can also result in electrical leakage when there is also dust, corrosive chemicals, and chemical corrosion products in the environment.

High Temperature ranges and rapid variations can cause thermal shock to components. Constant circulation of filtered air reduces hot spots and minimizes rapid temperature changes.

The customer must understand that temperature and ventilation requirements are 7x24x365 (they must be maintained continuously, even during "off-hours").

Environmental requirements for optimal equipment operation are described in Table 4-1 below:

Table 4-1: Environmental Requirements For Optimal Operation

Normal Operating Temperature Limits (can be tighter)	55˚ to 85˚ F
Maximum Rate of Temperature Change	2.5˚ F per 10 minutes
Short Term Temperature Limits	40˚ to 120˚ F
Normal Equipment Extended Operability Temperature	40˚ to 104˚ F
Operating Relative Humidity	5% to 55%
Short Term Relative Humidity	5% to 90%
Lead-acid Battery Extended Temperature Limits	40° to 95° F
Lead-acid Battery Short-Term Temperature Limits	30° to 122° F

Notes:

1. "Short Term" is defined as not more than 72 consecutive hours and a total of not more than 15 days in 1 year.
2. The Digital Equipment CenturyLink places in Customer Premises equipment space is designed to operate between the Normal Equipment Extended Operability Temperature ranges of 40˚ to 104˚ F. However, the equipment (especially the batteries) will last longer and pose fewer safety dangers if the equipment is operated in a room where ambient is maintained between the Normal Maximum Operating Temperature Limits of 55˚ to 85˚ F (and even tighter if possible). Ambient temperature should be measured at a height of 5 feet above the floor, and 15 inches out from the equipment (or in the center of the aisle if it is narrower than 30 inches). These ambient temperatures must be maintained regardless of equipment heat dissipation. If the building owner needs CenturyLink equipment heat dissipation information, the Design Engineer shall provide it. Note that enclosed spaces may need separate temperature control in order to maintain 55-85 °F.
3. Although the lower humidity guideline of 5% comes from Ericsson Telcordia's NEBS (GR-63-CORE), this assumes that technicians are wearing their wrist straps (or practicing other ESD-dissipation techniques) when working on Digital Equipment. Wrist straps are the most cost-effective method of controlling ESD. Humidification is very costly and does not totally eliminate ESD events (although it does reduce their severity) if wrist straps are not worn. However, if humidification equipment is used in the site, it should ensure a minimum indoor relative humidity of 20% (humidification up to 40% is even more effective, but up to 10 times more costly).
4. If all electronic equipment is "hardened" (designed for operation from -40 to +65 degrees C), and Nickel-based batteries are used (or no batteries are used), the normal equipment operating range can be extended to 0-122 degrees F.
5. In some NNS applications, the upper operating temperature range may be extended to 95 degrees F.

Temperature and high humidity are generally controlled with the HVAC (Heating, Ventilation and Air-Conditioning) system. The owner of the Premises is responsible for HVAC systems which can ensure that temperature and humidity meet the guidelines of Table 4-1.

To achieve maximum reliability in the installation, it is wisest for the customer to use more than one HVAC unit or system to meet the load needs. This is wise engineering practice, which protects against outages. As an example, there may be two units, each sized to handle 60% of the load. Multiple system components should be designed in such a way that if one component fails, the remaining component(s) should be able to maintain the short-term temperature, humidity, and temperature rate of change guidelines of Table 4-1.

In order for a building owner or their engineer to determine if their HVAC system is adequate, they must know the approximate heat releases of the CenturyLink equipment.

The building HVAC system should easily be able to handle average NEBS heat spread release of 35 W/ft^2. This is equivalent to about 500 W per standard front and rear equipment relay rack, 300 W per front-access only relay rack, and 650 W per Customer Premises 2-sided cabinet. The higher NEBS heat release level (which requires notification of the customer, and potential upsizing of the HVAC for the room), is 80 W/ft^2. This is equivalent to about 1200 W per standard front and rear aisle relay rack, 700 W for front access only relay racks, and about 1500 W for a Premises cabinet. Heat release above 1200 W per rack or 1500 W per cabinet must not only be communicated to the Customer by the CenturyLink Engineer, but a waiver absolving CenturyLink of responsibility for heat-related outages is preferable if the Customer accepts the higher heat release(s).

Average heat release information is given by the vendors of the equipment and power plant. If this cannot be obtained, it can be estimated from List 1 (average) power drains given by the equipment vendors:

$$P_{DC} = I \times V$$

Where I is the List 1 drain in Amperes (Amps), and V is the voltage (normally about -54.5 in a Customer Prem DC plant). The result, P (Power) will be in Watts (W).

Sometimes, the vendor will only give List 2 (peak) power drains. A rough estimate of List 1 drains is 30-40% of the List 2 drain.

If none of the above can be obtained, the rawest estimate can be done using the size of the power plant. Using the formula above, I (the Amps) would be represented by the total capacity of the rectifiers minus one rectifier. For example, if there were five 15 A rectifiers, 5 x 15 = 75, and 75 - 15 = 60 Amps.

Besides Watts, commonly used units for HVAC sizing are BTUs/hr, and tons of air-conditioning. The following conversion factors can be used.

1 W = 3.41 BTUs/hr

1 ton of air-conditioning = 12,000 BTUs/hr

Cabinets, relay racks, or battery stands containing batteries should be placed relatively close to air-conditioning distribution vents. Batteries are more susceptible to high temperatures than other components.

After a power outage, care should be taken to slowly reintroduce cooling or heating in such a manner that rapid temperature changes are avoided (to maintain the guidelines of Table 4-1).

4.2 Ventilation Guidelines

Constant circulation of filtered air reduces hot spots and minimizes rapid temperature changes.

Ventilation with outside air must be periodically accomplished to relieve buildup of toxic and explosive gasses, and for human safety. For occupied buildings, local codes, the Uniform and International Building Codes (UBC and IBC), and ASHRAE Std. 62 specify minimum air change requirements for human occupancy (typically between 2-6 ach). When telephone equipment is placed on the portions of the Customer's Premises that were designed for human occupancy, ventilation of any potential harmful gasses is practically assured. However, when the Customer Premises space was designed as an equipment or mechanical room, care should be taken to ensure that gasses are ventilated. The lead-acid batteries normally used to back up the telecommunications equipment are capable (under high temperature and/or shorted cell conditions) of venting explosive gasses. Even under normal charge conditions these batteries can and will ventilate small amounts of Hydrogen. Lithium-based or NaNiCl batteries are an option for unventilated confined space, since they are truly sealed and don't gas.

Along with the Building Codes and ASHRAE Standard 62, Ericcson Telcordia's predecessors wrote two standards (BR 781-810-885 and BR 760-550-102) which govern ventilation for Central Offices. Although these standards were designed for Central Offices, many of the principles therein can be put to use when designing adequate ventilation systems for telecommunications equipment rooms on the Customers' Premises. In addition, IEEE and ASHRAE have a collaborative standard (IEEE 1635 / ASHRAE 21) specific to ventilation and thermal management of battery rooms/areas/compartments.

Although the above-referenced standards and the following formulae should be used, when calculation simplicity is desired normally unoccupied telecommunications equipment space on a Customer's Premises can be designed for a minimum air change rate of 0.5 ach (NFPA 111 requires a minimum ach of 2, when that standard is in effect in a jurisdiction). CenturyLink Equipment cabinets are designed to ventilate at a rate of at least 0.5 ach to the surrounding space. Airflow in these cabinets is from bottom to top, since batteries are traditionally placed at the bottom, and they should receive the coolest air possible.

Even if ventilation fails, unless a chamber/room is completely sealed, exfiltration (the flow of air through porous materials and around door and window frames, etc.) in a typical building or chamber, plus diffusion (Hydrogen diffuses rapidly as the smallest and lightest molecule), usually ensure that a buildup of gasses will not become explosive for several days, if ever.

Calculations and standards specify the minimum amount of outside air that must be used. However, care must be taken to ensure that excessive outside air is not introduced in climates that have temperature, humidity, and air quality extremes.

Outside air ventilation can also be used for cooling, but the environmental control system must temper this use to ensure that the humidity and air quality guidelines of Sections 4.1 and 4.3 are also being met.

For more detailed calculations, the most troubling gas that must be ventilated is Hydrogen produced by the batteries. IEEE standards recommend no greater than 2% concentration (since Hydrogen begins to be flammable at 4%) in air (Hydrogen becomes truly explosive at about 17%, but for purposes of the fire code, the LFL and the LEL are the same —the lower limit of 4%). The NFPA and other Fire Codes state that buildup can't exceed 1%. If Hydrogen sensing is used (not recommended for Customer Premises due to the high frequency of maintenance required for the sensors), OSHA recommends pre-alarming at 0.4 to 0.5% concentration (10% of the LEL) in air. For calculation purposes, most Customer Premises Buildings will be under the auspices of the Building and Fire Codes, so the 1% figure should probably be used (limiting to the 1% figure also has the additional advantage of allowing air discharge from the battery room into other areas of the building, per the Mechanical Code; whereas if the concentration exceeds 1%, the gasses must be ventilated to the outdoors).

Note that all formulas in this section have been greatly simplified. For more complex and completely accurate formulas, refer to the IEEE/ASHRAE 200 standard on battery room ventilation. The formulas from which those below are derived incorporate temperature, pressure, and other factors. However, the results will not be different enough with the temperature and other ranges we are dealing with to significantly change the results; so the formulas have been simplified to assume STP — standard temperature (25 C or 77 F) and pressure (1 atm ≈ 1 bar ≈ 100 kPa ≈ 14.7 psi), and 1% Hydrogen concentration. Note also that the formulas use SI (metric) units for calculation simplicity. Conversion factors are given where necessary.

Maximum Hydrogen evolution by lead-acid batteries (after the battery reaches full charge) can be calculated from the following formula:

$$0.46 \times C \times I \quad \text{liters/hr}$$

Where C is the number of cells (24 lead-acid per nominal -48 VDC string), and I = the float charging current. Note that the total float charging current must be split between parallel strings. Each cell in the string receives an equal amount of current (they are in series), which is the string current.

Liters per hour can be converted to m^3/s by dividing by 3,600,000. Liters per hour can be converted to cm^3/hr (cm^3 is often signified by the abbreviation "cc") by multiplying by 1000. Liters per hour can be converted to ft^3/min (cfm) by dividing by 1,700.

As an aside, the Oxygen vented is approximately half of the Hydrogen vented.

The Hydrogen can be exhausted in one of two ways: diffusion (natural convection), or forced air (fans); or a combination of the two.

If 100% diffusion is to be used, the following formula will compute the Area of the vent opening(s) to maintain 1% Hydrogen concentration (if 2% concentration is the limit the vent opening area need be only half of this amount; or double the amount for 0.5% concentration).

$$A = 0.0355 \times V \times L$$

Where A is given in cm^2, V is the volume of gas produced in cc/hr, and L is the length (depth) of the vent opening in centimeters.

There are 2.54 centimeters for every inch. Square centimeters (cross-sectional) area can be converted to square inches by dividing by 6.45, or to square feet by dividing by 929.

If fans are to be used, the formula to compute the fan size (to maintain 1% Hydrogen concentration) is:

$$F_s = V \times 100$$

The units used for volume of gas produced will compute the fan size in those units. For example, if the volume of gas produced is given in cc/hr, the result of the formula will be cc/hr. If fan sizes are normally given in cfm, the cc/hr would have to be converted to cfm. Note that this formula assumes maintaining 1% Hydrogen concentration. If 2% is the desired level, the fan cfm output needed is halved. If 0.5% is the desired concentration, the fan size is doubled.

Note that the worst case charging current (after a commercial AC outage) is the total Amps of the rectifiers minus the load. For example, if there are five 15 A rectifiers, and a total List 1 equipment drain of 36 Amps, the maximum recharge current is 75-36 = 39 Amperes. However, as noted earlier, only the float current produces gassing. While the batteries are charging, more than 99% of the current is going into the desulfation of the plates, with only a very minimal amount electrolyzing the water in the electrolyte into Hydrogen and Oxygen.

Normal float charge current at room temperature is very low (about 1 mA/Amp-hr [0.3 mA/W/cell] for VRLA batteries and about 0.1 mA/Amp-hr [30 mA/kW/cell] for flooded batteries).

The first formula in this section gives the H_2 evolution rate for all lead-acid batteries. This will be released into the air for flooded/wet cells when on float charge.

Fire Codes can be interpreted as requiring that ventilation rates be calculated at the boost charge current rate. Normal boost charge currents (plant voltage is usually raised so that the cell voltage increases no more than about 0.1 V) for flooded battery strings are no more than 0.2 mA/Amp-hr [60 mA/kW/cell] (this goes to about 2 mA/Amp-hr [0.6 A/kW/cell] if we assume the maximum temperature listed in Section 4.1 — float current and gassing doubles for every 15 degrees F above 77 F).

The most common type of battery used in Customer Prem locations is the VRLA AGM (also called "gelled", "sealed", or "maintenance free"; none of which are accurate). Under normal use, almost all (95%+) of the Hydrogen and Oxygen electrolyzed by excess charge current recombines (to water) inside the cell (so less than 5% is released through the pressure valve into the room air). As an example, testing of various manufacturers' VRLA products have shown that gassing at normal float voltage is around 0.5 cc/hr per Ampere-hour for nominal -48 V strings, where the Amp-hour rating is the 8-hr rate (C_8 to 1.75 V/cell at 25 degrees C). For example, a plant with 3 strings of 100 Amp-hr batteries will normally gas about 3 x 100 x 0.5 = 150 cc/hr = 0.005 ft^3/hr.

Note, however, that during a valve failure, or an overcharge condition such as thermal runaway, a VRLA will gas just as much as a flooded battery. VRLA batteries are not normally boost-charged, but it may be wise to calculate the Hydrogen release as if they were, in case of an improper float voltage, shorted cells, or a thermal runaway situation.

For ventilation calculation worst-case scenario purposes, assume a failed open valve, with the "failure mode" boost charging regime, and the highest temperature from Section 4.1 (120 degrees F). This yields a string current of about 10 mA/Amp-hr (3 mA/W/cell), and the formula at the top of the previous page can be used to calculate the Hydrogen evolution. Using the previous example of 3 each -48 V nominal strings at 100 Amp-hrs each, this yields about 33 L/hr = 0.02 cfm. To meet the maximum 1% concentration requires air exchange of 2 cfm. This is a very small amount, even assuming all the worst case conditions.

4.3 Air Quality Guidelines

Accumulation of airborne contaminants on circuit boards can result in bridging of electrical and electronic circuits leading to circuit faults or intermittent failures. Contamination may be introduced by dust, textile fibers, human debris, soil contributions, products of combustion, etc.

Normal air quality operating conditions for digital equipment should be **Class 100,000**. This means that there should not be more than 100,000 particles of 0.5 microns or greater per cubic foot of air. This can normally be easily obtained by 85% ASHRAE efficiency filtration (pre-filters are probably advisable, depending on the quality of the outdoor air in the city). Short-term (see Note 1 to Table 4-1 for a definition of "short-term") guidelines are **Class 150,000**.

Proper filtration to achieve the efficiencies mentioned above should be left to the building owner. Local air qualities will determine the amount of filtration needed, and 85% may be excessive. Also, the ASHRAE dust spot ratings may be changing in the near future.

If the customer wishes to determine particle counts in an equipment area, they may refer to Ericsson Telcordia GR-63-CORE for further information.

Sometimes, positive pressurization of an equipment area with the ventilation system will reduce contamination.

4.4 Floor Loading Guidelines

Customer Premises cabinets and relay racks often contain lead-acid batteries. Lead is a heavy element, and care must be taken to ensure that floor loading is adequate for the space where batteries are to be placed. In addition, the cabinet or relay rack used must be rated for the weight. The CenturyLink Engineering department is responsible for ensuring that the frame / relay rack or cabinet is rated to support the weight of the equipment mounted therein (including batteries).

Typically, Customer Premises types of sites (human-occupancy buildings) are designed for floor loading of 75 lbs/ft² (psf). However, raised computer floors may not be able to support more than 50 lbs/ft² (although they can be designed to support 300 lbs/ft² or more if the floor underneath is rated for that). Standard CenturyLink Customer Premises cabinets are generally designed for 75 lbs/ft² floors with adequate spacing to the front and rear of the cabinet (see Figure 4-1). If the cabinet is to be placed on a 50 lb/ft² floor the weight of the cabinet and each of its individual components (especially the batteries) must be considered. In these cases it may not be possible to fully load the cabinet with equipment. However, if space is provided to the right and left of the cabinet (as well as in front and back), more equipment may be loaded into the cabinet.

Bottom basement slabs or ground floor on grade slabs typically have much higher floor loading capabilities (around 300 lbs/ft²), but this must be verified with the building owner. For concrete floors, individual point loading may exceed the average floor load allowed. However, the total floor load in a building bay (between support beams/walls) cannot exceed the limits for that bay. This is not true of raised floors, where point loading must be taken into consideration.

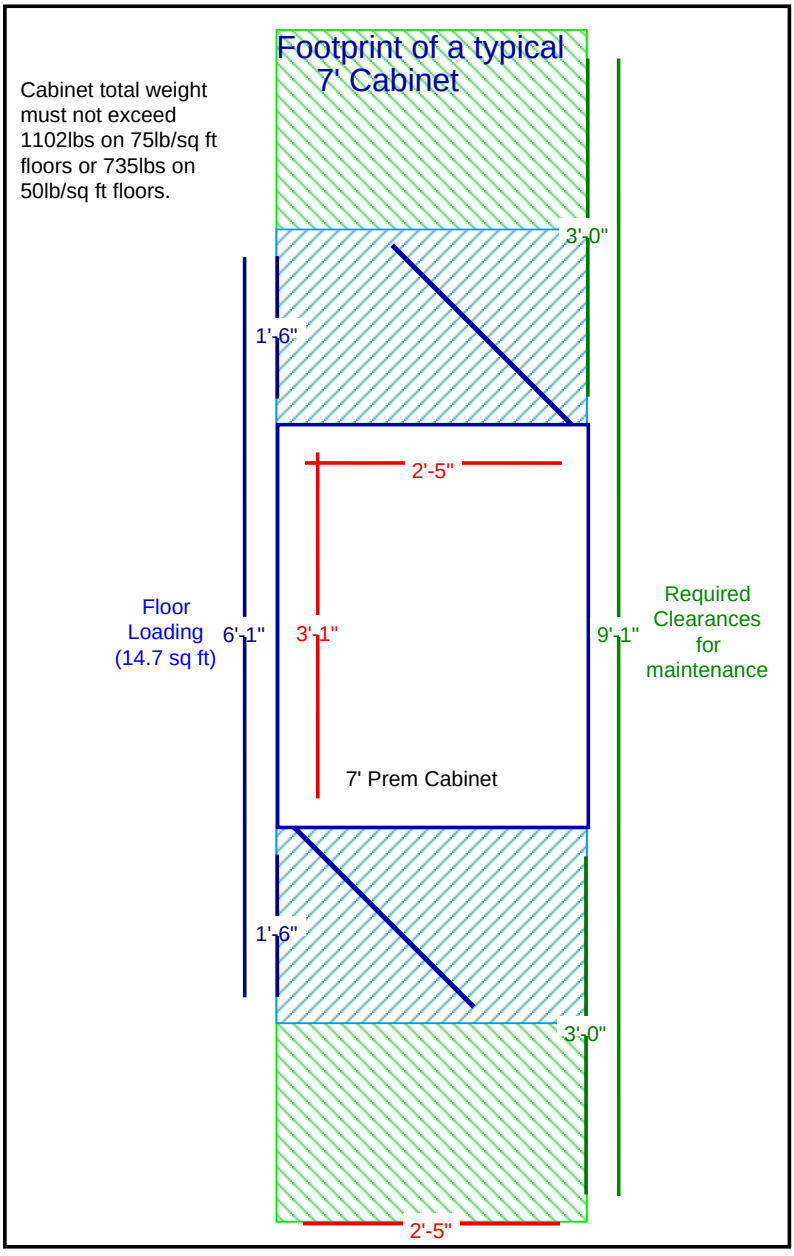

Figure 4-1 Floor Loading Example

Figure 4-1 serves as a good example of how to properly perform floor loading computations. The cabinet itself is approximately 2'5" ft. x 3'1" ft. (7.45 ft²). However, equipment is generally placed in the front and back of the cabinet, accessible from doors on either the front or back. Generally, the area in front and in back of the cabinet is kept clear to allow the doors to open and shut. Up to 18 inches of this free space in front of and in back of the cabinet can be used for the floor loading calculation. If we also assume that equipment is placed on both sides of the cabinet, there is no free space on either side to use for the floor loading calculation. The total floor loading space for the cabinet is then 2'5" ft. x 6'1" ft. (14.7 ft²). Assuming the total equipment, cabinet and battery weight is 1100 pounds, we can then compute the total floor loading of the cabinet:

$$Total\ Floor\ Loading = \frac{1100\ lbs}{14.7\ ft^2} = 74.83\ {}^{lbs}\!/_{ft^2}$$

The preceding calculation shows that the cabinet will work on a 75 lb/ft² floor; however, some equipment will have to be removed from the cabinet, or spacing provided around the sides of the cabinet to ensure that it will not damage a floor designed for 50 lbs/ft².

Relay rack type Customer Premises installations are a bit more tricky. In these cases, the power load is generally higher, requiring larger (therefore heavier) batteries. Typically the batteries will be in their own relay rack (sometimes with rectifiers or other power equipment) or on a separate battery stand. Unless the floor is designed for telecommunications Central Office floor loading standards of 150 lbs/ft² (most battery stands and relay racks are designed to fall under this 150 lb/ft² standard), calculations similar to the example just given should be performed. Because of the generally larger size of these batteries, often extra free space must be allocated around the battery stand to provide adequate floor loading.

There should be three feet of clearance in front of relay-rack mounted equipment (or a battery stand) for maintenance, and two feet behind the equipment (see Figure 3-1). Up to eighteen inches of this front space can be used for floor loading calculations. Up to eighteen inches of the rear space may also be used for floor loading calculations, provided that no other equipment backs up to it. If other equipment is on the other side of the rear aisle, only half of the aisle space (up to eighteen inches) may be used for floor loading calculations. For front-accessible equipment (equipment that backs up to a wall) only, the few inches behind the relay rack may be used for floor loading calculations. If there is free space around the relay rack on either the right or the left, up to eighteen inches on either (or both) side(s) may be used for floor loading calculations. (Please refer to Figure 3-1 for an example.)

The Customer must tell CenturyLink Communications personnel what the floor loading of the space under consideration is. This information can generally be gleaned from the architectural and mechanical drawings of the building. If this information cannot be obtained, the following worst case floor loading capacities may be assumed:

- 150 lbs/ft2 for basement (or bottom floor) concrete floors
- 100 lbs/ft2 for concrete floors on other levels
- 50 lbs/ft^2 for raised floors
- 75 lbs/ft^2 for all other floors.

In some instances, Customer Premises cabinets are wall-mounted. In these cases care must be taken to ensure that the wall can support the weight of the cabinet(s).

4.5 Earthquake Zones and Equipment Ratings

In telecommunications Central Offices care has always been given to ensuring that telecommunications equipment is properly braced to withstand the rigors of an earthquake. The reasons for this are threefold: 1) proper earthquake bracing helps ensure uninterrupted telephone service during a disaster such as an earthquake, and this is when communications services are most needed; 2) proper earthquake bracing helps keep potentially dangerous materials (e.g., batteries) from spills, leaks, etc., which would make them hazardous, and potentially toxic to humans; 3) proper earthquake bracing keeps equipment in place to prevent it from falling on humans.

Although traditionally not as much care has been given to ensuring that equipment in Customer Premises applications is earthquake-braced, the same reasons for having the bracing apply in this environment, and perhaps with added urgency due to the importance of the telecommunications services and numbers of personnel at a typical Customer Premises installation.

Ericsson Telcordia's GR-63 NEBS document (as well as the UBC and IBC) adequately covers earthquake bracing and conformance. Equipment manufacturers who are NEBS Level 3 certified have their equipment tested to these standards (note that NEBS testing is not required for Customer Premises electronic equipment, but is desirable — UL 60950 is the minimum level of testing required for Customer Premises electronic equipment). Figure 4-2 shows the Earthquake Zones within the U.S., in conformance with NEBS and the UBC (the IBC does not use a zone system, and the Applied Technology Council uses a Zone system of 1-7). Zones 0 and 1 are the areas least likely to suffer an earthquake of any significance at all. Zone 2 denotes areas that could potentially suffer a mild earthquake. Zones 3 and 4 are for areas that could suffer violent earthquakes. Equipment designed to each of these standards is braced accordingly.

The aforementioned Uniform Building Code (UBC, which is slowly being supplanted in most jurisdictions by the International Building Code — IBC) not only covers standards for equipment bracing, but also for building bracing. In Zones 3 and 4, high rise buildings are often built with post-tensioned floors. This means that there are cables imbedded in the floor which help hold the building together during an earthquake. These cables are tensioned. In buildings taller than 2 stories in earthquake zones 3 and 4, it is imperative that CenturyLink and the building owner work together to determine if there are post-tensioned floors. If it is determined that there are post-tensioned floors, the building owner should X-ray the floor prior to any cable hole or anchor bolt drilling. If the building owner is uncooperative, and there is a probability of post-tensioned floors, CenturyLink will need to hire someone to do the x-raying. The CenturyLink Real Estate Department should have contractors qualified to do this work. Drilling into a post-tensioning cable can result in severe building structure failure consequences.

Many CenturyLink Standard Customer Premises equipment cabinets are designed to Zone 4 as a standard (but it's only required that the cabinet be Zone 4 in Zones 3 and 4). However, relay rack type installations must take earthquake zoning into consideration. Standard CenturyLink relay racks, equipment, and battery stands or trays are available for both heavy (Zones 3 and 4) and light (Zones 0, 1, and 2) earthquake zones. The CenturyLink Engineers will take earthquake zones into account when placing the equipment. Engineers may refer to CenturyLink Tech Pubs 77350, 77351 or Ericsson Telcordia's NEBS documents if greater map detail (latitude and longitude lines) is desired than that given below. Another good earthquake bracing reference is ANSI/ATIS-0600329. For existing installations, where retrofit to earthquake bracing standards is desired, Ericsson Telcordia SRs 2432, 2498, and 2536 may be used.

CenturyLink should not generally place its equipment into Customer-owned relay racks/cabinets, nor share it's relay racks with other telecommunications providers (this prohibition on sharing includes CenturyLink's Regulated and Un-Regulated business units). The prohibition is necessary to ensure that the equipment and its framework meets load rating, seismic requirements, heat release requirements, and floor loading requirements. If this policy is not followed (the customer insists that equipment be placed in their rack/cabinet), a written waiver from the Customer absolving CenturyLink of liability for problems related to heat release, floor loading, or shaking is the best policy (especially in earthquake Zones 3 and 4 — see Figure 4-2). However, if the customer refuses to sign the waiver, CenturyLink is still absolved of responsibility for rack/cabinet failure. Any time, a customer rack is used, the Engineer, Sales personnel and Customer must ensure that the CenturyLink equipment required for the job fits in the rack. Most CenturyLink equipment is designed for mounting in relay racks with 23" wide mountings, while many Customer-owned equipment racks (including those in cabinets) have 19" wide mountings.

The aforementioned waivers also apply in Earthquake Zones 3 and 4 when floors or overhead support structure are not seismically braced.

Conversely, customers may place equipment in CenturyLink racks with written agreement between the parties. However, all equipment placed in CenturyLink racks must be NEBS Level 1 compliant and/or Listed to UL 60950-1 or the older UL 1950.

Raised floors may pose a problem regardless of the bracing of the equipment (unless the equipment rack or cabinet is mounted to the subfloor). If equipment is to be placed on a raised floor, special care should be taken to ensure that the floor will hold up to earthquakes of the magnitude suggested by the Zone (see Figure 4-2) in which it is geographically located. Typically, equipment installed in heavy earthquake zones on raised floors should be anchored to the subfloor.

When other equipment in a Customer Premises site is in the same area as CenturyLink equipment, the building owner may want to ensure that the rest of the equipment is adequately braced for the proper earthquake zone to ensure that it cannot adversely affect the telecommunications services in the event of an earthquake.

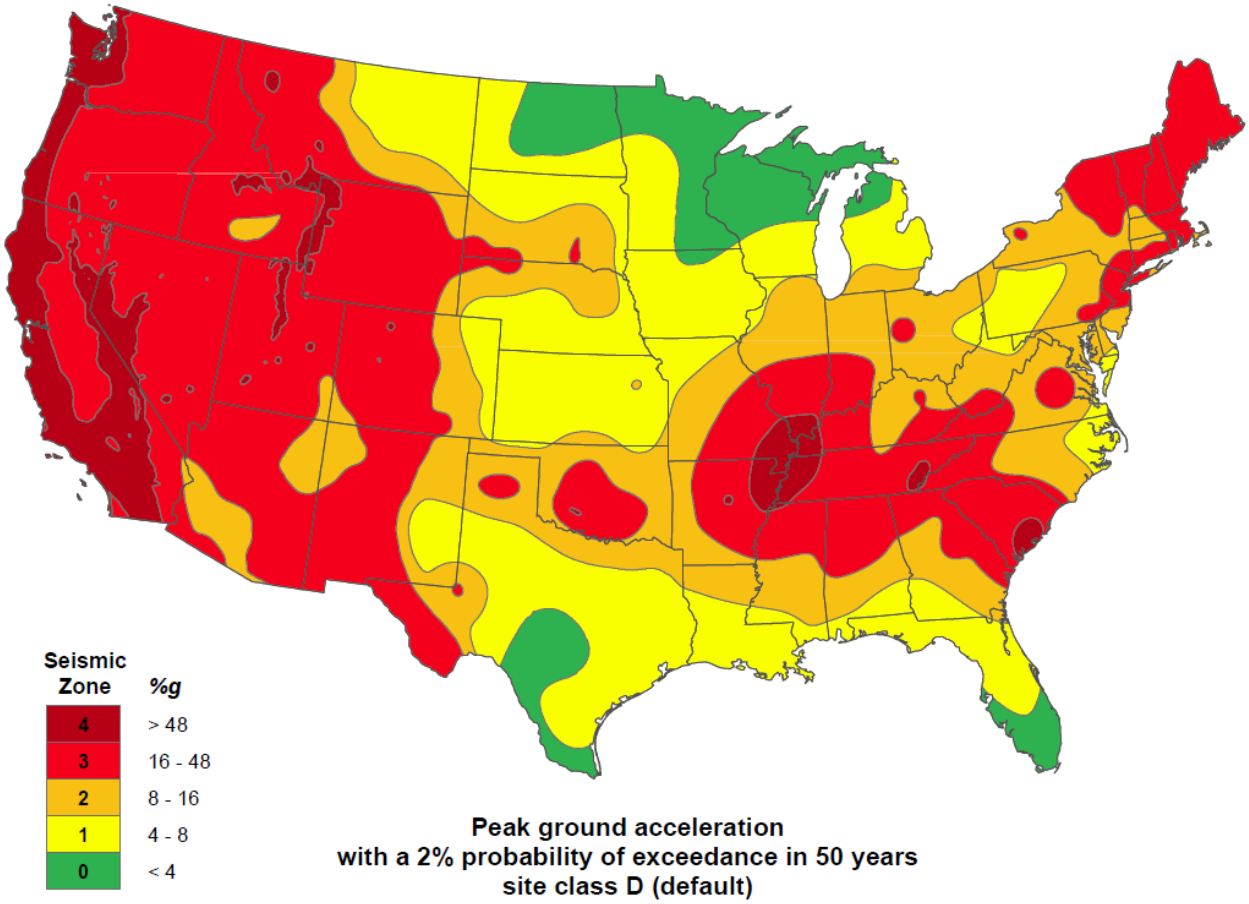

Figure 4-2 Earthquake Zone Map of the United States

4.6 Fire Systems

The Equipment Floor Space must meet the local Fire Codes. The walls, floors, and doors should be a minimum of one-hour fire-rated. Fire detectors and alarms should be present. Usually none of this is a problem in Customer Premises spaces because these are generally designed for human occupancy, and had to meet codes when built.

Although there is often not a choice in Customer Premises installations, if possible, space with a CO_2 fire suppression system is much preferred over halon (or it's modern replacements such as HFC-227) or sprinklers. Obviously water can harm the electrical components of telecommunications equipment. If sprinklers exist, see if it is a dry or non-pressurized system. If it is wet or pressurized, the first option is to try to place CenturyLink equipment in CenturyLink-approved Customer Premises equipment cabinets. If relay racks are used, an attempt should be made to keep the equipment (especially power bays) out of the direct "line of fire" of the sprinklers. Halon leaves a fine dust coating on everything, which must then be cleaned.

4.7 Fire Stopping

Fire-rated openings (as defined by the Customer and/or building/fire inspector) through which CenturyLink passes its cable (whether pre-existing or opened by CenturyLink in the installation process) in getting from the outside of the building to the inside **will be fire-stopped** by CenturyLink (fire stop procedures, if needed, can be found in CenturyLink Technical Publication 77350). The initial fire-stopping of new-unused conduits is the responsibility of the customer.

CenturyLink will not normally fire stop cable openings beyond the Network Interface. It would probably be wise for the building owner, his agents, or assignees to fire stop holes they might create for their own cables to limit the spread of fire between rooms. If agreement between the Customer and CenturyLink calls for CenturyLink to install cabling beyond the demarcation point (that cabling is the responsibility of the customer, but they may hire CenturyLink to do it), CenturyLink will reseal any fire-stopped openings that they open. If the opening was not previously fire-stopped CenturyLink will assume that that passage does not constitute a compartmentation penetration per the locally adopted Fire Code

When firestopping new cable penetrations, an attempt should be made to utilize the Premises owner's preferred materials, provided they meet or exceed CenturyLink standards. When the cost for the Premises owner's preferred materials exceeds the cost of CenturyLink-provided firestopping materials, CenturyLink materials should be used. Where existing cable penetrations are disturbed, they must be re-sealed with like materials. Mixing of firestop materials is prohibited.

4.8 Asbestos Management

If CenturyLink is to construct in an asbestos-contaminated area in order to place its telecommunications equipment, the building owner shall let CenturyLink know of this issue beforehand. If this is the case, it is the responsibility of the building owner to either remove the asbestos, or put in place an asbestos-management plan that will conform to local and national codes. The CenturyLink Environmental, Health, and Safety (EHS) group may be contacted if help is desired with this problem.

4.9 Water/Flood Management

As mentioned in Section 4.6, telecommunications equipment does not function well in a wet environment. For this reason, if possible, space where there are sprinkler systems or water pipes above the potential equipment location should be avoided. If equipment is placed in a basement, all penetrations into the basement from outside the building should be properly sealed. It is also preferable in a basement installation that sump pumps and/or drains be present.

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Chapter and Section **Page**

5. Powering Guidelines

This Section on Power addresses the general powering philosophy for Customer Premises sites. For specific installation guidelines for power, see Section 7.7 of this document.

5.1 Power Requirements for CenturyLink Power Plants

All CenturyLink DC Power Plant and UPS Standards are contained in CenturyLink Technical Publication 77385. Not only are the requirements of this document applicable to CenturyLink DC Plants, but if CenturyLink is to use a Customer DC Plant or a Customer UPS, those components should also meet the requirements of Tech Pub 77385. In the following paragraphs of this subsection 5.1, a few of the more salient DC Plant requirements from Pub 77385 are excerpted.

Eight hours of DC Plant backup battery reserve (sized at the List 1 or average drains of the served equipment) are required when the AC feeding the rectifiers (see Section 5.2) is not backed up by a permanent standby engine-alternator. Only four hours of backup is required if the rectifiers are backed up by a permanent standby set, or for CenturyLink-provided UPS systems for AC-powered equipment. For exceptions to these rules, see Section 5.4. CenturyLink standard configurations for Customer Premises equipment cabinets always provide for eight hours of battery backup because it is often unknown if the AC service to the rectifiers will be backed up by an engine. (Because this Essential AC feed to CenturyLink rectifiers is not standard from site to site, CenturyLink is only responsible for maintaining power to their equipment for the first eight hours of a commercial AC failure.)

Most Customer Premises installations use VRLA (Valve-Regulated Lead-Acid) batteries. That is because most Customer Premises loads are small, and space is often limited (VRLA batteries are more energy-dense, can be placed in strange positions, have less stringent Hazardous Materials regulations, and come in smaller sizes than flooded batteries). However, for larger installations where the -48 VDC load exceeds 100 Amperes, serious consideration should be given to the use of traditional flooded (wet cell) batteries. Flooded batteries last much longer (up to 20 years or more in the right environment, as compared to 9 years or less for most monobloc VRLA), and are less prone to the dangerous gassing and fire hazard condition of thermal runaway than are VRLA batteries. However, flooded batteries do require more space, and have certain Code requirements not applicable to VRLAs (such as spill containment and compartmentation). Flooded batteries might be a good choice for loads over 100 Amperes in critical applications, such as FAA and airport sites? Where lead-acid batteries are not desirable by the Customer; or space, weight or ventilation limitations preclude their use, Century-Link approved Nickel-based or Li-based batteries may be used, with due consideration given to their higher initial cost.

When VRLA cells are used, the served equipment must be able to tolerate a maximum voltage of -54.8 VDC. Most equipment should easily work at this voltage (the ANSI/ATIS and NEBS upper voltage limits for equipment design are -56.0 VDC for normal operability, with a short term maximum of -60.0 VDC). If there is equipment that will not function at -54.8 VDC, flooded batteries must be used.

When VRLA batteries are used, due to their increased risk of failure, a minimum of 2 strings are required. This requirement is waived when there are 96 or fewer DS-0 or POTS circuits. If the service provided is at a higher level than DS-0 (e.g., DS-1, DS-3, etc.) the 2 string minimum is required.

VRLA batteries should be used with temperature-compensated rectifiers or a charge current-limiting circuit to greatly reduce the probability of dangerous thermal runaway. The settings or thresholds for these devices should agree with the ranges specified in Chapter 13 of CenturyLink Tech Pub 77385. Temperature sensors for temperature-compensated rectifiers should be placed on the batteries if possible. VRLA batteries also need adequate airspace into which they can release any heat generated during charging. This should be a minimum of 0.5 inches between batteries. It greatly helps in reducing thermal runaway.

Redundant rectifiers (n+1 at 125% minimum of equipment manufacturer List 1 drains) are required for more than 96 DS-0 or POTS circuits, or for any higher digital signal rate services. This same n+1 redundancy requirement applies to bulk ringing and tone supplies, and converter plants, if they are needed.

It is generally more cost-efficient in the long run if Customer Premises installations only have a single bulk DC power plant. However, this decision is at the discretion of the engineer due to unavailability of future forecasting and the inability to grow some DC plants. The Engineer should be aware that some Customers limit the number of AC feeds they will provide to CenturyLink (thus limiting the number of DC plants).

Rectifiers and converters in relay rack types of Customer Premises installations should be designated with voltage and group number.

CenturyLink installations in our own buildings and outdoor cabinets are outside the scope of the NEC (see Article 90.2B4), although CenturyLink adheres to the intent of the Code. However, this is not the case with Customer Premises installations. Depending on the interpretation of the Code by the AHJ (Authority Having Jurisdiction — typically a fire marshal or electrical inspector), manual or electrically-operated battery disconnects and EPO (Emergency Power Off) switches may be required in accordance with Articles 645 and 230. These may be connected to the fire alarm and/or HVAC system controls. In cases where CenturyLink supplies shunt-trippable battery disconnect breakers that are connected to an EPO switch, CenturyLink should obtain a written waiver from the Customer absolving CenturyLink of liability for outages related to operation of the EPO switch by non-CenturyLink personnel.

5.2 Essential AC Power from the Customer

In telecommunications Essential AC power is defined as power that is backed up by a standby engine-alternator. Essential AC power is not uninterruptible. There will be a delay of several seconds to several minutes between the loss of commercial AC and the time the engine-alternator comes up to speed and assumes the load.

The customer must provide AC feeds from an AC power panel to CenturyLink's rectifiers (or to their own rectifiers if their DC Power Plant is being used) or UPS. For larger relay-rack mounted installations or installations of more than one cabinet, at least two feeds should be run in conduit or raceway by a licensed electrical contractor in accordance with the NEC, with separate breakers and circuits feeding each rectifier. It is desirable that the AC circuits be sourced from separate AC panels if possible. In most installations these AC feeds should be 240 V or 208 V 1-Ø, or 120 V 1-Ø. If 208 V 3-Ø, or 480 V 3-Ø are being provided, and the DC Power Plant is CenturyLink's, the customer must inform the CenturyLink Engineer so the proper rectifiers can be supplied to operate from the given voltage and phase configuration.

Individual feeds to each rectifier are not required (although they are desirable) for an individual Customer Premises cabinet, since these are typically smaller AC loads than the relay rack type of installations.

The customer is responsible (as a minimum) for providing one or two nearby standard 240 V, 208 V, or 120 V, 1-Ø, 15, 20, or 30 Ampere NEMA locking outlet/receptacles (each outlet fed from a dedicated circuit breaker). (If locking receptacles are not provided [other than for wall-mount cabinets, or equipment plugged directly into the back of a UPS, or into a rack-mount PDU in the same bay], the Customer must sign a written waiver absolving CenturyLink of financial responsibility for the loss of power due to the power cords being unplugged). Small wall-mount power cabinets with direct runs to outlets along walls (the cord doesn't cross aisles or overhead or under floors) may be exempted from the locking receptacle or screw-down requirement (equipment plugged directly into the back of a UPS or into a rack-mount PDU in the same bay is also exempt from the locking plug requirement); but if so, they must be labeled on / next to the receptacle to not remove because they feed telecommunications equipment. CenturyLink usually provides one or two 30 foot AC cords equipped with NEMA locking plugs for connection to the customer-provided receptacles. The CenturyLink Engineer and the customer shall work together jointly to determine the proper type of plug/receptacle or AC service needed.

It is highly desirable to both CenturyLink and the customer (for service reliability) that the AC power panel(s) that feeds the rectifiers be an Essential AC panel. This means that the panel is ultimately fed from an AC source that is backed up by a standby engine-alternator. The standby Engine-Alternator should meet the requirements of NFPA 37 and possibly also NFPA 110.

If so-desired, additional reliability can be achieved (depending on the UPS configuration and the maintenance of the UPS) by feeding the DC plant rectifiers from a power board that is fed by a customer UPS, which in turn is backed up by a standby engine-alternator (see Section 5.3 for further information).

If no standby engine-alternator or Essential AC feed is available, feeding the rectifiers from an AC power panel fed by a UPS with a static transfer switch may be preferable over a plain Non-Essential AC feed (see Section 5.3 for further information).

The building AC service entrance should have lightning/surge protection. If this is not presently installed, CenturyLink should request it of the building owner. Not only will it protect CenturyLink equipment, but all equipment in the building that uses electricity. Secondary protection on the feeds to the rectifiers is optional.

When DC power plants are added (especially larger ones), the building owner should be notified of the total power capacity (in Watts or kW) of the rectifier plant in order to ensure that engine-alternator, house service panel, or AC subpanel capacity is not being exceeded with the added load(s). If capacity triggers are exceeded, growth of the AC infrastructure is the responsibility of the customer.

The customer should also give strong consideration to ensuring that at least some of the HVAC system components are backed up by Essential AC power in order to ensure that the temperature, humidity, air quality, and temperature rate of rise guidelines of Section 4 can be met, even in the event of a commercial AC power outage.

All circuit breakers (or fuses) feeding CenturyLink equipment must be properly labeled.

Unless otherwise specified in the contract, the customer is responsible for the electric bill.

5.3 Shared Power Supplies

Some products that CenturyLink sells (e.g., SHARP/SHNS, SST, etc.) have standard contracts which promise the customers rebates or free service should telecommunications services fail and not be restored within certain time frames. With other customers, individual contracts may specify rebates for service interruptions. There is equipment (mainly add/drop muxes) that may be a pass-through point, rather than an end-point The most critical Customer Premises sites are those that support FAA circuits, 911 circuits, or airports. For all these types of services, CenturyLink must provide its own DC power plant, backed up by a minimum of eight hours of battery reserve (with a customer engine, if space does not allow eight hours of backup, with the concurrence of the customer and the CenturyLink Power Tech Support engineer, this backup time can be reduced to four hours). In these cases also, the guidelines of Section 5.2, encouraging AC feeds backed up by an engine-alternator and/or UPS, become even more important.

Generally, when a single customer is served in a building, the customer pays the electric utility bill for any AC they provide us (whether that be directly to our equipment, to our rectifiers, or indirectly through their UPS or DC plant). If the telecommunications services we install in a building serve multiple customers, it is wise to negotiate for space and power with the building owner so that there is one common point of power provisioning. In some multi-user cases, we may enter into arrangements with the building owner where we are separately metered, and/or are responsible for our own environmental controls, and/or have our own portable genset receptacle.

If the desire is to use the customer's DC Power Plant, the customer must specify (preferably in writing —see Section 9) that rebates and free service rights are waived for power outages (this waiver is not to be used for pass-through [fiber ring] sites — it should only be used at sites where the only customer that would be affected by an outage is the one providing the power).

In some cases, CenturyLink equipment is placed in an area that already contains other telecom equipment (e.g., PBX, etc.) owned by the customer. Often this equipment is powered from a traditional telecom -48 VDC plant. In these cases, for services other than those mentioned above, it may be advantageous to both CenturyLink and the customer, from a space and cost perspective, to provide power to the CenturyLink equipment from the customer's pre-existing DC Plant. The CenturyLink engineer shall contact the customer representative to determine if this can and/or should be done. If it is done, the customer's plant should meet the guidelines of CenturyLink Tech Pub 77385, especially, the items pointed out in Section 5.1 of this document. The capacity of the DC plant bus bar, distribution bays, rectifiers, and batteries must be looked at and increased if necessary before adding these new loads. It should also be recognized that the best scenario for these DC plants is that only CenturyLink and the customer are powered from these plants. If other telecom vendors are allowed to connect to this DC plant, the chances for unnoticed load additions and outages increases greatly, and a waiver is required. This affects all of the above-mentioned capacities, and backup powering capacities become difficult to manage, potentially endangering telecommunications services. The CenturyLink Engineer shall inform the customer of the protector (fuse or breaker) size(s) needed, the distance to the CenturyLink fuse panel(s), and the number of feeds needed. It is preferable that the customer run the feeds and tie them down on both ends, so that CenturyLink will not have the opportunity to accidentally knock down other services provided from this plant. However, if the customer is unwilling or incapable of running these feeds, CenturyLink will do the work with a customer-signed MOP, and customer coverage during the "cut".

CenturyLink-provided AC power strips, UPS or DC power plants shall not be used to power other telecommunications providers' equipment (even temporarily, such as to power test sets and tools) because this could compromise the reliability of the service provided. The only exception to this policy is if the Customer provides a written waiver absolving CenturyLink of liability for outages deemed to have been caused by such an arrangement (dispute arbitration procedures shall be provided in the contract). In addition when existing power strips are being used to power DC rectifiers, if the CenturyLink Engineer is adding more AC-powered equipment to that power strip, they must run calculations to ensure that the rating of the power strip and upstream breaker feeding it are not exceeded.

Please note that -48 VDC power is not the only telecommunications DC powering voltage. If 130 VDC or 24 VDC power is needed by CenturyLink equipment, and the customer provides these voltages from primary DC plants or DC-DC converters, the same rules apply as in the previous paragraph. However, if the customer's primary DC power or DC-DC converter plant(s) are at a voltage and polarity different from that needed by the CenturyLink equipment, CenturyLink is still free to use that power, but must provide its own DC-DC converter plant.

There are some cases where a customer buys telecommunications services from CenturyLink that are not required to work when the customers' computers are not functioning (see Section 5.4 for more information). In some of these cases the customer's computers may be backed up by UPS. Some CenturyLink equipment can be AC-powered, or may be DC-powered but fed by rectifiers only (not backed up by batteries). In these cases where the customer does not require any more backup time for telecommunications services, it is permissible to power the telecommunications services from the customer's UPS (the same one backing up their computers) only if they are the only customer that would be affected by an outage. This rule can be waived if the AC power provided by the customer is from a Tier III or Tier IV Data Center with n+1 redundancy on engines, the AC-fed equipment is at least dual-corded from separate UPS that are not loaded to more than 40%, and all customers served by the CenturyLink transport equipment are aware of the special powering circumstances (in writing, in the contracts). It may be wise to advise the customer to have dedicated AC feeds for their UPS that feeds our equipment if they do not already have those.

Any powering or backup powering equipment provided by CenturyLink will be maintained by CenturyLink. Maintenance of DC Power Plants, Standby Engine-Alternators, UPS, and the AC infrastructure owned by the customer will be the responsibility of the customer. In these cases the Customer may wish to make arrangements with CenturyLink regarding the cost of this maintenance (see Section 9 for further information on Contracting).

Both CenturyLink and the customer should ensure that regular preventive maintenance (CenturyLink recommends every 6 months for DC Plant maintenance, and monthly engine runs) routines are being performed on power equipment, regardless of the owner. If the property owner is performing maintenance on their own DC plants and/or engines, they may wish to use Ericsson Telcordia BR 790-100-672 (or the appropriate IEEE battery specification — see the Reference section of this document for a list of applicable IEEE publications) for battery routines, The rectifier/charger manufacturer's manual for rectifier routines, and NFPA 37 for engine routines. CenturyLink has their own maintenance procedures, which generally meet or exceed the recommendations of Ericsson Telcordia, the IEEE, and the NFPA. CenturyLink technicians will determine, in accordance with their "Maintenance Window" guidelines, the proper time to perform proactive maintenance routines on their power plants and other equipment. If the customer desires that the routines are done at specific times of day, week, or month; they must so specify.

When CenturyLink equipment is located in the same room as a customer UPS which uses flooded batteries, and the voltage of the flooded battery string(s) exceeds nominal 48 VDC, CenturyLink may request that the Customer clearly mark their battery stand(s): "WARNING HAZARDOUS VOLTAGE" (a -48 V plant floating at -54.5 V still qualifies as a nominal 48 V plant and does not require special warnings).

5.4 Operation without Backup Power

As stated in the previous section, there are some cases where a customer buys telecommunications services from CenturyLink that are not required to work when the customers' computers are not functioning. As an example, a telemarketing company might be using computer modem autodialers and a database. When these computers go down, many of their phone lines or their internet connection(s) are not needed. If this customer has a desire to cut some backup powering costs or has a lack of space to place a DC power plant, they may desire that their telecommunications services do not have to be up when their computer systems are not up. Another example might be secondary line service (most state regulations require that primary lines be backed up for E-911 functionality). DSL and ethernet service are other example of a service not legally required to be backed up (but the customer may want the backup). The customer and the CenturyLink Engineer must work closely together when traditional backup powering is not required. If this is done, both CenturyLink and the customer must clearly understand the implications (that the telecommunications services may be lost when the AC source is lost), and there must be no penalties to CenturyLink as a result of AC failure (see Section 9). Note that this type of powering arrangement can only be used when the Customer waiving the requirement for backup is the only customer served by the affected equipment.

Some equipment CenturyLink uses for telecommunications services (e.g., some routers) comes in both AC and DC-powered versions. In that case, when traditional backup powering is not needed, the telecommunications equipment can be equipped with AC powered cards, and fed directly (if the equipment is dual AC-corded, it is wise to have the two AC feeds on separately breakered circuits, and in some cases, at least one of the two AC circuits is backed up by an essential engine-backed circuit and/or a protected UPS-backed circuit). For direct-AC-powered equipment using standard NEMA 5-15R or 5-20R receptacles (see section 5.2 for more details on when this is allowable), while it is desirable that these outlets be fed from dedicated circuit breakers, it is not absolutely required if the service is "best effort" that doesn't require payment of rebates for lost service.

Much telecommunications equipment is provided only in DC-powered versions. When this is the case, and traditional backup is not needed, CenturyLink can provide DC rectifiers with the appropriately filtered DC output (to not introduce DC ripple noise greater than 35 dBrnC into the equipment — which is usually filtered by the batteries). These rectifiers are fed by AC power of course, but they are not backed up by batteries. These rectifiers then supply the DC power needed by the load, and when the AC source is lost, telecommunications equipment fails.

The CenturyLink Engineer shall take special care to ensure that when traditional backup powering is not used, that the telecommunications equipment can quickly auto-initialize and resume telecommunications services after AC power returns.

As mentioned in Sections 5.2 and 5.3, the AC source can be Essential AC backed up by an engine-alternator, and/or fed from the customer's UPS. This is highly advisable if the customer's computers are fed from either or both of these AC sources.

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Figure

6. Grounding Guidelines

This Section on Grounding addresses general grounding principles. For specific installation guidelines for grounding (including some thoughts around isolated ground planes), see Section 7.8 of this document.

6.1 General Grounding Information

Grounding of telecommunication equipment and its feeding power sources is done for the following reasons:

- Personnel Safety (proper grounding protects personnel from high voltages and currents that could be introduced by lightning or other transients)
- Equipment Safety and Telecommunications Reliability (proper grounding helps ensure equipment circuit packs will not be damaged by the aforementioned transients)
- Equipment ESD Protection (grounded equipment frames provide a safe place for the safe and proper discharge of static electricity from the human body — when the human is using ESD protection techniques such as wrist straps — before that person touches a circuit pack)
- Electrical Noise Abatement (properly grounded equipment can bleed away unwanted AC noise components that can be introduced by magnetic induction or other EMF effects — if left to its own devices this noise can severely disrupt digital and analog transmissions)

The reasons just given make it clear why proper grounding is important. Unfortunately, Customer Premises grounding is often not sufficient to meet Code nor protect people and equipment. The following sections bring out some of the more salient points regarding Customer Premises grounding from Tech Pub 77355, the CenturyLink Grounding Standard. However, all of the relevant portions of Pub 77355 apply.

The following sections give some guidelines on minimum ground wire sizes. Ultimately it is most desirable to keep impedance as low as possible among internal grounding cables to facilitate the flow of electrons back to ground and limit voltage differentials during a lightning strike or power fault to ground. The desirable limit for any internal grounding path back to the building SPGP is 0.03 ohms (up to 0.01 ohms on any one branch). The following distances show the 0.01 ohm limit for the given stranded (preferred, with green insulation) or solid copper cable size: #6 AWG < 20 ft.; #2 AWG < 50 ft.; 1/0 AWG < 80 ft.; 2/0 AWG < 100 ft.; 4/0 AWG < 160 ft.; 350 kcmil < 260 ft.; 500 kcmil < 375 ft.; and 750 kcmil < 575 ft.

6.2 Ground Sources

A ground source is a point from which electrical current will see a low impedance (resistance in the case of DC only) to ground. Per the National Electrical Code, this impedance should not exceed 25 Ω. CenturyLink Tech Pub 77355 prefers that it be lower than 5 Ω, although this is not always possible, depending on soil conditions, etc. The following sources usually qualify as good ground sources for Customer Premises locations. They are listed in priority order (but are probably in reverse order of the simplicity to obtain):

- Driven Ground System (As an example, this might be driven ground rods connected in an exothermically welded ring, or a ground well, or a ground mat field, etc. This field can be extended via copper cables to ground bars in a building.)
- Water Pipe (It must be ensured that this pipe is connected to the city water system using metallic pipe only. If there is any PVC, rubber, silicone, or other non-metallic pipe in the system it cannot be used as a ground source. A bond strap across the water meter is required. Water valves and pipe unions should be within the bond.)
- Building Steel (Usually building steel is connected in many places, and is ultimately sunk into the ground, connected to the rebar of the base concrete — which constigates a Ufer ground, or connected to a driven ground system as described above.)
- ACEG (The AC Equipment Ground is defined by the NEC as the "green-wire" ground run with AC circuits which is connected to the AC Neutral — and therefore to the electric company's multi-grounded neutral — at the AC service entrance or House Service Panel. If the ACEG is used as the ground source, the connection should be made as close as possible to the HSP or nearest separately derived source. Failing that, the ACEG in the nearest AC panel will suffice.)

CenturyLink requests that the customer extend at least one of these ground sources (with a cable sized according to the NEC, at a minimum of #6 AWG — see Section 6.1 for cable sizing requirements based on distance) to a customer-provided ground bar in the telecommunications equipment room (as close to CenturyLink's equipment as possible, preferably within 6 ft.), to which CenturyLink may tie its equipment. It is also Code-required that the grounding cables running to the bar (both from the customer side and the CenturyLink side) have a green-colored insulation. The ground source from the Customer should not be run in ferrous metal conduit. If it is, it should be end-bonded at both ends of the conduit with a #6 AWG minimum. Typically, CenturyLink will collect all of its grounds to a single collection point (see section 6.3). From this point, a cable (appropriately sized per Tech Pub 77355, depending on the size of the installation) should be run between CenturyLink's ground collection point and the ground bar that represents the extended building ground source. Failing the presence of a ground bar that is an extension of one of the ground sources, CenturyLink should tie its collection bar to one of the ground sources mentioned above. Standard CenturyLink Customer Premises cabinets usually come equipped with 30 feet of #6 AWG copper wire for connection to the nearest ground source. If possible, this should be upgraded to a minimum of a #2 AWG stranded, insulated copper conductor.

If a copper entrance facility (cable) is used, the Building Entrance Terminal must be located as close as possible to the Main House Service Panel and grounded to the Building Grounding Electrode (a requirement of the NEC). The Customer Premises equipment should also be grounded there to eliminate the possibility of differences in electrical potential between the grounds. Equipment misoperation and/or damage may result from the differences in potential. Naturally, if a fiber entrance is used, this requirement is not necessary.

It is desirable that the ground source used be labeled as the telecommunications ground source. For example, it may be labeled as the TMGB (Telecommunications Master Ground Bar).

6.3 Telecommunications Ground Collection Point

As mentioned above, CenturyLink prefers to collect all of its grounds to a single collection point before connecting that point to the chosen ground source. Preferably (especially for larger installations), this is a bar, instead of simply a conductor to which all grounds are H-tapped . Figure 6-1 is one example of a suitable bus bar.

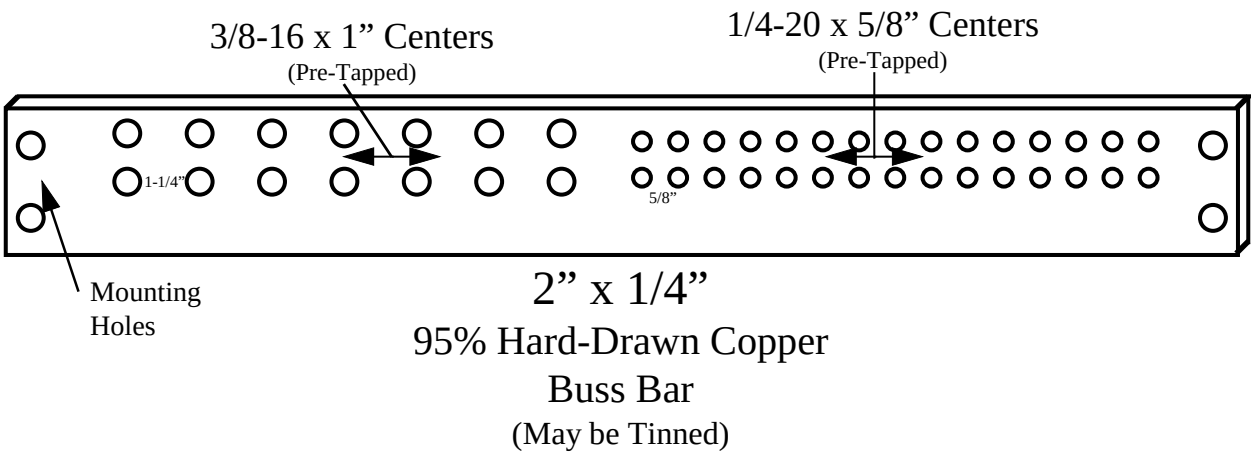

Figure 6-1 Customer Premises Ground Bar

The bar could vary greatly in size and number of holes, depending on the size of the installation. The bus bar above is suitable for a 200-Ampere DC power plant. The bar may be mounted inside the cabinet, above a relay rack, in a relay rack, hanging from cable rack (and insulated from it), mounted in the space under a raised floor (if that floor is not a plenum, or if the room meets the requirements of Article 645 of the NEC), or mounted on a wall (perhaps inside an electrical cabinet). The customer will normally provide the bar.

Note that the bar is built for 2-hole lugs. Two-hole irreversible crimp compression lugs are required for all power and grounding connections except for small wall-mount power plants or connections internal to a bay or shelf where the manufacturer's design is for single-hole. When single-hole irreversible crimp compression lugs are used, they must use a star washer to prevent loosening of the connection.

Regardless of whether the power plant return bus bar is used or a separate bar is provided, the following grounds should be connected to this "telecommunications equipment ground collection point":

- Power Plant Battery Return Bus Bar (connected to the telecommunications ground collection bus with a minimum #6 AWG copper wire. If it is a relay rack type (larger) installation, this connection should be a #2 AWG.)
- Equipment Cabinets (Rails, walls, and doors of equipment cabinets shall be electrically bonded to each other, and then a connection shall be made from each cabinet to the ground collection point directly with a #6 AWG, or indirectly to a #2 AWG stringer run from the collection bar.)
- Relay Racks (Equipment relay racks should be connected to the collection point. If there are multiple relay racks and/or lineups, it may be wise to run a #2 AWG stringer above each lineup. A splice with a #6 AWG can be made to each relay rack frame from this stringer.)
- Splice Cases (The shields of cables entering the space (sometimes through a cable entrance facility called a TEF) from the Outside Plant feeding CenturyLink digital equipment should be bonded to a splice case ground point, which is in turn connected to the collection point with a #6 AWG. If there are metallic cables entering the space that do not feed CenturyLink digital equipment, their sheath grounds should be tied to the customer's ground bar, as opposed to the CenturyLink single-point collection bar.)

  If the entrance is copper cable, each metallic pair in the cable must be protected, using a listed protector unit. The ground for the protector should also be connected to the collection point, if they are in the same room. The NEC requires that the protector ground be bonded back to the building grounding electrode, so care must be exercised in equipment placement.
- Appliance Outlet ACEGs (The ACEGs of any appliance outlets in the telecommunications equipment space may be optionally extended to the collection point. As above, this is not necessary if the ACEG or AC Neutral is the ground source.)
- Other Telecommunications Equipment Providers Bays and Cabinets located within 7 feet of CenturyLink equipment bays or cabinets should be bonded to the bar to avoid potential differences and resulting shock hazard to personnel.
- Other Metallic Cabinets (any other metallic bays, cabinets, or other metal objects in the telecommunications equipment area may be bonded directly to the collection point with #6 AWG, or connected to the collection point through "stringers" as described above. This is especially helpful in reducing ESD problems for cabinets that are used as storage for circuit packs.)

6.4 Isolated Grounding

In rare cases, CenturyLink will place a remote Class 5 Local circuit switch in a Customer Premises location. Most of these switch manufacturers require an isolated ground plane. If this is the case (or if there is other equipment requiring an isolated ground plane — check with the equipment manufacturer), the requirements of CenturyLink Tech Pub 77355, Chapter 8 (which essentially mirrors Ericsson Telcordia GR-295), or Chapter 9 (for PANI type systems), must be followed (see also section 7.8.3 of this document for further information).

There is another type of isolated grounding used in the computer industry. This type of grounding is explained in CenturyLink Tech Pub 77355, Chapter 11. If CenturyLink Telecommunications equipment is placed in a computer room environment that uses a computer room isolated grounding scheme, a separate integrated ground plane area (separated from any isolated ground plane metal by at least 6 feet), ground source, and ground bar may be needed.

Sometimes the space the customer gives CenturyLink to place telecommunications equipment has a PBX. The PBX manufacturer may require an isolated ground plane. Normally, this does not affect the CenturyLink integrated ground plane equipment. However, if located within 6 feet of the isolated ground plane, CenturyLink equipment may be FOG bonded. Whether the Customer performs this FOG bonding, or CenturyLink does is open to negotiation (CenturyLink is not required to determine the need for FOG grounding).

In the case of some local governmental PSAP 911 facilities (typically covered by Tech Pub 77339), or other sites, the customer may purchase an OEM PBX from CenturyLink. Depending on the recommendations of the PBX manufacturer, an isolated ground plane may be required or desired. Some PBXs are DC-powered. In those cases, the guidelines of Chapter 8 should be followed in setting up an isolated ground plane where the PBX manufacturer requires it. For AC-powered PBXs, the equipment manufacturer grounding recommendations are the rules. Typically, when an isolated ground plane is required for an AC-powered PBX, the equipment manufacturer recommends the use of the ACEG bus (in the AC panel feeding the switch) as the MGB.

6.5 Chassis Grounding

Individual equipment shelves are grounded in differing ways depending on manufacturer design and fault current testing.

DC-powered equipment that has been NEBS-tested has been tested with or without chassis ground wires (self-tapping screws to the frame, along with external-tooth lockwashers may be sufficient). If the equipment shelf manufacturer specifies to use a separate chassis ground lead, and provides a wire gauge, do what they recommend. If they provide a chassis ground lug landing point, but don't provide a wire guage, use Table 5-5 from Technical Publication 77355 to appropriately size the chassis ground wire. If they do not provide a chassis ground lug landing point, assume that the equipment is sufficiently grounded to the relay rack or cabinet mounting framework via the use of self-tapping screws and external-tooth lockwashers.

AC-powered equipment shelves are often chassis grounded via the ACEG, which is part of the power cord. Assume this is the case if there is no chassis ground lug landing point. If there is a chassis ground lug landing point, check the manufacturer documentation to see if it is required to be used or is optional for use.

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7. Installation Guidelines

Installation requirements and guidelines for Customer Premises equipment space cannot be as strict as those applied to CenturyLink-owned space, simply because CenturyLink does not own the space. For purposes of this section (and the entire document), the following terms denote whether a requirement is absolute (must be met) or not (these same definitions can be found in Section 2.1):

- SHALL, MUST — denotes requirements which must be adhered to for basic personnel safety and basic reliability
- SHOULD, ADVISABLE, DESIRABLE — guidelines which would improve reliability and safety, but do not have to be absolutely followed (suggestions)

7.1 General Installation Guidelines and Requirements

This document provides Service Suppliers with the general requirements affecting non-CenturyLink-owned nor leased building facilities and their care, the installation and removal of telecommunications equipment, and related service requirements to be met prior to such activities. For purposes of this document, the term "Service Supplier" shall include any contractor or contracted agent doing work on a Customer's Premises in behalf of CenturyLink (this includes CenturyLink's own Installation forces).

This document also provides key material and workmanship requirements for Engineering and Service Suppliers and shall be a basis for audit and evaluation of a job. The workmanship items described in this section are both generic and specific in nature and may be applicable to all installation and removal operations. In addition, the Service Supplier shall adhere to the specific installation (new or reuse), removal, and operational standards established in applicable equipment specifications as well as all handbooks and technical information required to successfully complete installation or removal of the equipment and associated cabling. Service Suppliers shall also adhere to any applicable guidelines of the Service Level Agreement (SLA or contract) with the Customer owner.

Service Suppliers doing business with CenturyLink for a product type shall show a level of expertise in that technology, based on history, training, or related work experience. Service Suppliers shall be required to comply with all suppliers', manufacturers', and CenturyLink Standards and configurations. Lack of documentation or information is not an acceptable reason for noncompliance with this Standard. Service Suppliers shall not deviate from Standards outlined in this Technical Publication without written permission of the CenturyLink Design Engineer. Standards for Earthquake protection or Fire Life Code Safety cannot be given a waiver by the CenturyLink Design Engineer without the concurrence of the appropriate PEG Engineer.

The Service Supplier shall be responsible for providing all tools and expendable materials necessary to complete the job.

When a Service Supplier becomes aware of a preexisting defective condition, that impacts the work on the job they are installing or removing; the Service Supplier shall contact the CenturyLink Design Engineer and take corrective action if authorized. This activity shall be documented in the job log.

Any questions not answered by this section, the job specifications, drawings/records, etc. shall be referred to the CenturyLink Design Engineer for resolution and documented in the job log by the Service Supplier.

7.1.1 Facility Access and Security

The amount of space and its location for administrative purposes shall be a matter of agreement between the Service Supplier, CenturyLink, and the Premises owner prior to the start of services. Every attempt shall be made to locate this area outside the room or compartments containing equipment. In those cases where this cannot be accomplished, the area should be set as far away as possible from the equipment locations. Combustible materials should not be stored in an equipment area and should be stored in a packing/unpacking storage room or in a trailer outside of the installation location. Drawings, documentation, and all other flammable materials used in and around equipment and cable racks during the work shift should be removed at the end of each shift and stored in a fire resistant container/environment.

With the concurrence of the Premises owner, temporary trailers or structures may be provided for installation related work or storage room if space is not available at the work location.

Service Suppliers and their hired personnel shall wear a valid company picture identification (above the waist, and visible from the front) at all times while working in behalf of CenturyLink at Customer Premises locations. This identification shall show: the company name, employee name, and current photograph of the employee.

The Service Supplier shall be in the facility only during authorized scheduled work hours as agreed to and defined in the MOP and/or Change Management ticket. Depending on the location, Service Suppliers may also need to inform or obtain permission from the Premises owner (or their authorized representative, such as a guard or building maintenance personnel) each time they enter or leave a facility. The Service Supplier shall determine these requirements with the Premises owner before beginning installation activity.

The Service Supplier shall be responsible for the security of job provided materials and equipment.

The Service Supplier shall be responsible for the security of their personal valuables, tools, materials, and the parking of private and company vehicles.

Unauthorized equipment or devices such as cameras, recording equipment, metal ladders, etc., shall not be permitted in Customer Premises locations without the permission of the Premises owner or their representative.

The Service Supplier shall not bring alcohol, drugs, firearms, weapons, or explosives into any Customer Premises facility.

7.1.2 Facility Environmental Conditions, Upkeep, Storage, and Handling

If environmental concerns are being ignored, CenturyLink personnel may temporarily halt a job. The Premises owner (or their representative) may also halt a job if they have environmental concerns. Should a job be halted by either of the above for the stated reasons, the CenturyLink Design Engineer and/or Project Manager should be contacted immediately.

All building construction or alterations, within the areas requiring Service Supplier occupancy, shall be completed before the scheduled start of the installation or removal activity. Any exceptions shall be subject to agreement between the Service Supplier, Customer Premises representatives, and CenturyLink representatives.

The Service Supplier and CenturyLink Design Engineer shall negotiate with the Premises owner to provide suitable openings in buildings to allow material to be placed in position. The same process applies for necessary openings and ducts for cable and conductors in floors and walls as required. The Service Supplier shall not create nor subcontract the making of unauthorized holes and openings in the facility (unless authorized to do so under rare circumstances by the Premises owner). When equipment is removed, the building owner should be contacted again (by the Design Engineer) about filling any unused holes. With the permission of the building owner and the Design Engineer, the Service Supplier may fill floor and ceiling bolt/anchor holes with an approved fibrous mortar/cement filler compound.

The Service Supplier and CenturyLink shall negotiate with the Premises owner to provide the necessary ceiling inserts, embedded ceiling channel, or appropriate fastening arrangements in areas in which the equipment requires ceiling fastening.

Refer to Section 4.7 of this document for information on fire-stopping responsibilities.

Electric power, heat, and general illumination for the equipment work area is the responsibility of the Premises owner. The Service Supplier may negotiate directly with the Premises Owner if these services are not adequate, or may ask the CenturyLink Design Engineer to serve as an intermediary. Temporary lighting provided by Service Suppliers shall be removed at the end of the job.

The Service Supplier shall not adjust or disable any Heating, Ventilation, Air Conditioning (HVAC) or humidity control, or building alarm system. Any necessary adjustments should be requested through the Premises Owner's representative.

The Service Supplier shall provide fire retardant protection for floors, walls, and equipment when necessary to prevent damage. Walls constructed for temporary purposes during an installation or removal should be constructed with fire retardant materials such as UL Listed lumber meeting FR-S 15P3/AWPA C-20 or U1 requirements.

The Service Supplier shall be on site to receive and ensure proper storage of all material associated with their jobs. Failure to comply with CenturyLink "Fire Combustible Policy", any time during a job shall result in serious disciplinary actions. All equipment and materials shall be unpacked and cleaned outside of the facility or in the facility's authorized unpacking area. Equipment and materials shall be free of contaminates prior to being brought into the work area.

The cutting, filing, drilling, and milling or painting of auxiliary framing, cable rack, etc. should be done outside of the equipment area whenever possible. When drilling equipment or structures that cannot be removed from a facility, proper protection, and the use of a High Efficiency Particulate Arrester (HEPA) vacuum shall be required.

General cleaning of the equipment facility or storage area in which work is being done is to be performed by the Service Supplier during the entire installation or removal process. Care shall be taken to generate a minimal amount of airborne dust.

The Service Supplier should use only a HEPA vacuum, capable of filtering particles larger than 0.3 microns in size, and equipped with a static dissipative hose, to capture dust and chips from the drilling of floors, walls, ceiling, ironwork, and equipment during the uncrating process, and while cleaning cable racks and equipment.

The Service Supplier shall be aware of conditions that may result in equipment thermal shock (failure or degraded service brought on by a rapid change in temperature) and notify the Design Engineer of any such condition (the Design Engineer is responsible for contacting the Premises owner for potential equipment placement changes or HVAC system changes).

At the completion of a job, the Service Supplier shall arrange for the disposal of remaining job-generated trash; removal of temporary floor, wall, column, and equipment protection placed by the Service Supplier; and removal of the Service Supplier's tools and property. The Service Supplier shall arrange for the turnover of all CenturyLink-owned, and Customer owned materials. All equipment manuals and documentation shall be turned over to the CenturyLink Operations representative for proper storage. Combustible material shall not be left in or near the equipment.

The Service Supplier should establish and maintain documented procedures for the handling, storage, packaging, preservation, and delivery of products.

The Service Supplier should provide methods of handling product that prevent damage or deterioration.

7.1.3 Environmental, Safety, and Health

CenturyLink has area safety personnel that have been assigned responsibilities for environmental, safety, and health conditions. When questions arise concerning these topics, the appropriate individual may be reached through UNICALL at (800) 654-2525 by requesting the Environmental or Safety Manager for the state.

The Service Supplier shall perform a walk through of the work area, specific to their job, before the start of the installation or removal activity to identify any hazardous conditions and to become familiar with the location of emergency equipment. Any hazardous conditions existing in the work area shall be documented and reported to the Design Engineer and the Premises owner, and recorded in the job log.

At the completion of the job, the Service Supplier shall again walk through the area and ensure that all their tools, equipment, protective materials, and trash, etc. has been removed and that no hazardous conditions have been created.

Hard hats shall be used when performing overhead removal work, and when working in a mandated hard hat construction area.

It is the Service Supplier's responsibility to instruct their employees in the appropriate safety procedures and practices, the operation and safe use of tools and equipment, and to ensure employee adherence to these procedures and practices.

For any work in a building that requires the use of Radiography x-ray (or similar EMF generating) techniques by contractors, building owners, or vendors for the purpose of locating building structural members and verifying core drill locations, the following shall be part of the contractor's specifications, and part of their MOP document for the work at hand.

1. Prior to starting work, the Contractor must post warning signage on exterior doors or at safe perimeter distances from the exposure area to warn personnel. Example: "WARNING - X-ray equipment is in use"
2. During each radiographic operation the contractor shall maintain continuous direct visual surveillance of the operation to protect against unauthorized entry into a high radiation area.
3. Certain equipment (for example, magnetic tape storage devices, etc.) may be susceptible to the electro-magnetic fields produced by an X-ray machine. In order to ensure that sensitive equipment is protected, the location of the radiography must be cleared with the Premises owner. If a particular location cannot be x-rayed due to the sensitive nature of nearby equipment, other, less-intrusive techniques which don't create potentially harmful electro-magnetic fields must be used; or another location to place penetrations must be found.

Service Suppliers employee(s) shall assess the workplace to determine if there are hazards that require the use of personal protective equipment (for example, head, eye, face, hand, or foot protection). The Service Supplier shall ensure that their employees or contracted labor are trained/instructed on the proper use of safety equipment.

Protective goggles or face shields shall be provided and worn where there is any danger of flying particles or corrosive materials. Approved safety glasses shall be worn at all times in equipment areas, when working with tools or any other areas where there is a risk of eye injuries such as punctures, abrasions, contusions or burns could occur. Personnel, who need corrective lenses (glasses or contacts) in working environments having harmful exposures, are required to wear approved safety glasses, or protective goggles.

Appropriate foot protection is required where there is the risk of foot injuries from hot, corrosive, or poisonous substances; falling objects; and/or crushing or penetrating actions.

Protective gloves, aprons, shields, or other means shall be provided and required where employees could be cut or where there is reasonably anticipated exposure to corrosive liquids or chemicals (batteries, for example).

Food or beverages shall not be consumed on the Premises within the area of the telecommunication equipment.

Supplier shall provide protection against the effects of occupational noise exposure when sound levels exceed the OSHA noise standard.

All tools and equipment (both company and employee owned) used by employees at their workplace shall be in good condition. Note: If tools requiring calibration are on site, these tools shall have the date of calibration attached to that tool. Tools with an expired calibration date shall not be used.

Hand tools such as chisels and punches, which develop mushroomed heads during use, shall be reconditioned or replaced as necessary. Broken or fractured handles on hammers, axes and similar equipment shall be replaced promptly. Worn or bent wrenches shall be replaced regularly. Appropriate handles shall be used on files and similar tools. Tools should be insulated in some manner when working with "electrically hot" equipment, and they must be manufactured as insulated tools (not taped or dipped) when working on power plants.

Jacks, hoists or other lifting devices shall be checked periodically to ensure they are in good operating condition. Hoisting equipment available and used for lifting heavy objects shall have hoist ratings and characteristics appropriate for the task.

Tools' cutting edges shall be kept sharp so the tool will move smoothly without binding or skipping.

Grinders, saws and similar equipment shall be equipped with appropriate safety guards.

Cord-connected, electrically operated tools and equipment shall be effectively grounded or be of the approved double-insulated type.

Portable fans shall be provided with ½" opening or less full guards or screens.

Personnel that operate powder-actuated tools shall be trained in their use and carry a valid operator's card. A Powder-actuated tool shall be stored in its own locked container when not being used. A sign at least 7 inches by 10 inches with bold face type reading "POWDER-ACTUATED TOOL IN USE" shall be conspicuously posted when the tool is being used. Powder-actuated tools shall be left unloaded until they are actually ready to be used. Powder-actuated tools shall be inspected for obstructions or defects each day before use. Powder-actuated tool operators shall have and use appropriate personal protective equipment such as hard hats, safety goggles, safety shoes and ear protectors.

7.1.4 Electrostatic Discharge (ESD)

A wrist strap connected to an appropriate ground terminal shall be worn when removing, inserting, or handling devices and components not in static dissipative packaging. The wrist strap shall be snug fitting and make contact with the skin.

The Service Supplier should test each of their wrist straps daily (on days when they are going to use them) with either a pass/fail wrist strap test set or by using a Volt-Ohm meter. The reading shall be 1MΩ ± 15%.

The Service Supplier shall maintain a static safe environment for the handling of circuit packs and other electronic equipment. All containers or packing materials used shall be marked with ESD warning labels. The Service Supplier shall minimize the handling of circuit packs. Devices and components shall be stored in their static dissipative packaging prior to insertion in the equipment. Package and transport all circuit packs, including those presumed defective, in an approved protective static dissipative container. When removing a circuit pack from service, the pack shall be immediately placed in an anti- static, protective container. The correct size container shall be used to adequately contain and physically protect the individual circuit pack.

Circuit packs shall be handled by their front face plates. If additional support is required, use the outermost top and bottom edge, being careful not to touch any components or conductive paths.

Keep synthetic fibers, plastics, foams, etc., which are not anti-static, out of the environment where circuit packs are being handled.

7.1.5 Fire Protection Policy

The first few moments after a fire has started and/or is discovered are of extreme importance. Upon discovery of fire or smoke, immediately call the Fire Department, and notify other building occupants.

Combustible materials should be brought into the equipment areas only when necessary to perform work and will be removed from the area when the work is completed. Manuals, papers, computer printouts, drawings, circuit pack boxes, plastic parts bags or any other combustible material should not be stored or left in or around equipment. These items should be stored in metal cabinets, desks or lockers when not in use.

When cardboard boxes, wooden crates, and other combustible packing materials cannot be placed in a separate area from the equipment room, the following guidelines should be adhered to as closely as possible.

1. Storage area should be as far as possible from working equipment.
2. Area is not adjacent to, near or below AC or DC power equipment, battery strings, fuse or breaker panels, AC panels, bus bars, cable racks carrying power cable, or other similar equipment.
3. Area is not adjacent to heating units, registers or radiators.
4. Area does not create a safety hazard or block access to exits, doors, light switches or any other areas that need to remain accessible to personnel.
5. Area is maintained to the minimum size necessary for daily operation.
6. Combustibles are kept to an absolute minimum and items are stored or stacked neatly on a daily basis and maintained in this manner for the entire cycle of the job.
7. Small items are stored in boxes, metal or plastic containers, or mobile "parts cart".
8. All items will be removed from this area when no longer needed.
9. Small quantities of solvents and paints for use on the job shall be properly stored in their original, labeled containers.

All wood materials used for construction of temporary walls and equipment or terminal mounting boards must be either UL listed fire retardant pressure treated and factory marked with the UL label or be completely coated with a fire retardant paint.

Nothing shall be placed on top of a unit of equipment that interferes with the airflow necessary for the cooling of that equipment.

Fire doors and internal security doors shall not be blocked open or have lock assemblies impeded or disabled.

The administrative area to be used by a Service Supplier shall be agreed upon with the Premises owner. This area should be located out of the equipment area if possible, with similar requirements as the equipment storage area. Documentation, drawings and other combustible administrative items needed for daily use should be removed from equipment areas daily or stored in metal containers This applies only to the time that the Service Supplier is performing work related to the job. If the Service Supplier temporarily closes down work for more than 48 hours for any reason, the storage and administrative areas should be cleared of all combustible material until work is restarted.

CenturyLink personnel or Premises personnel may point out all violations of CenturyLink combustible policy to the Service Supplier, and ask them to comply.

During acceptance of a job, the CenturyLink personnel shall assure that the Service Supplier has left the area free of combustibles and has properly sealed all cable holes.

Adherence to this policy will allow the Service Supplier to perform work efficiently and maintain cost effectiveness while not placing CenturyLink at undue risk to the safety hazards, economic and service penalties associated with fires in the building. It is the Service Suppliers responsibility to adhere to this policy.

Smoking is not permitted in areas with digital equipment (unless the Premises owner specifically allows it in an administrative area where digital equipment is collocated).

Automatic fire suppression and alarm systems should be impaired (work will need to be coordinated with building management and possibly even fire departments) prior to anything that can produce smoke, or heat shrink gun use. Brazing and cutting operations that produce sparks should not be done in rooms with fire detection and/or suppression systems if at all possible.

7.1.6 Equipment Performance Tests

Performance tests should be conducted on newly installed and/or modified equipment by the Service Supplier (unless the test and acceptance work is specifically assigned to a CenturyLink work group) to assure the equipment performance meets manufacturers' and CenturyLink requirements. CenturyLink may provide an observer(s) on the job to ensure that the tests are performed and that conditions causing unacceptable test results are corrected. The test record summary, indicating tests performed and troubles found and cleared, should be forwarded to the CenturyLink Operations representative before acceptance of the job and a copy shall be left in the job package, and a copy forwarded to the CenturyLink Design Engineer.

Where a functional performance test is not performed, a continuity test shall be made on all conductors run and connected by the Installer.

7.1.7 Maintenance Window

A Maintenance Window is a predetermined period of time during each day when specific planned maintenance and infrastructure provisioning work activities should be performed. The purpose of scheduling work during specific times is to minimize the risk of disruption to the CenturyLink network. Although load and service conditions vary by site, nighttime is generally the time of least traffic in most CenturyLink sites. Therefore the generic Maintenance Window is: midnight to 6 am.

The CenturyLink Operations Manager can adjust maintenance window hours to minimize the risk of disruption to the CenturyLink network. In addition, there are some Customer Premises locations where access at night is not as readily obtained. In Customer Premises locations, the maintenance window should be worked out with the Premises owner, and the customers being served.

Work performed in the "Maintenance Window" generally only applies to "in-service" or "hot" equipment; or the specific times when "dead" equipment is being connected to "live" equipment. As a minimum, the following qualify as maintenance window activities:

- Any work on the main DC power distribution panel(s) while it/they is/are "hot" (running/live/energized).
- Any connection or disconnection of equipment to the DC power plant buswork while it is "hot" (running/live/energized). Closing a breaker or inserting a fuse is not generally considered "hot" work.
- Any work that could be hazardous to the network (e.g., synchronization/timing cuts) should be done in the maintenance window unless otherwise approved through the CenturyLink change management process.

7.1.8 Letters of Deviation

There are occasional cases where following the standards contained in CenturyLink Technical Publications are not possible because of specific, identified conditions within the structure. In a few of these cases, it is possible for a Letter of Deviation detailing the condition, and the method used to provide a safe, reliable and well engineered alternative where the standards cannot be met. This letter application shall be written by the requestor, with the CenturyLink Design Engineer authorizing the alternative, who is ultimately responsible for its success.

Letters of deviation are not valid for wholesale or economic concerns. Each instance of deviation shall be documented with an individual letter. These letters are not to be used in continuing non-standard practices that may have been applied in the past, or where new standards have superseded the old, (i.e. Earthquake bracing upgrades caused by seismic zone changes). A copy of the Letter of Deviation shall be provided as part of the Job Package by the installation forces. The original shall be filed in the engineering job folder and stored as part of the permanent record.

The CenturyLink Letter of Deviation form and processes are documented in Technical Publication 77350.

7.2 Assembly and Ironwork

The location of auxiliary framing, cable racks, frames, relay racks, bays, cabinets, and other equipment should conform to any particular plans, drawings, records, and specifications for each installation that are provided by the engineer. If equipment must be placed in a different position than that shown in the drawings, the Service Supplier shall note the "as-built" configuration on the drawings, and send these to the CenturyLink Design Engineer.

All assemblies and ironwork referred to in this section should be installed to meet Seismic zone requirements for the area in which they are installed. Further information on earthquake zoning and bracing can be found in Sections 4.5 and 7.2.4 of this document.

Overhead clearance in all aisles and equipment areas should typically be maintained at a minimum of 7 feet. This includes auxiliary framing, cable rack, cableway systems and lighting.

Typically in Customer Premises installations, auxiliary framing (if used at all) and cable racking is run across the room, supported from batten boards which are run around the edges of the room. The batten boards are typically 2" x 8" boards anchored to the wall (in Heavy Earthquake Zones, they are specially anchored to the wall), with the bottom of the boards at 6'9". Installation of these batten boards is usually the responsibility of the Premises owner. Information on attachment to these boards and the support of auxiliary framing and cable rack can be found in CenturyLink Technical Publication 77351.

7.2.1 Auxiliary Framing

All pairs of auxiliary framing channel or bars shall be of uniform length, aligned per job specification or drawing and closed with end caps or finishing clips when bars or channels extend more than three inches beyond a clip or support. Finishing clips may be omitted where ends of bars or channels extend to within three inches of a wall, column, or other vertical surface.

Maximum distance between supports should not exceed six feet (standard spacing is five feet). Distance between last supports and auxiliary framing bar ends should not exceed 30 inches. Auxiliary framing bars shall be flush with the end of support clips at a minimum.

All splices, junction details, brackets, and hangers shall be secure and installed per standard convention.

Cantilevered auxiliary framing bars should not be used to support vertical loads.

All auxiliary framing splices in the same aisle of adjacent pairs of auxiliary framing shall be avoided. In no case shall two adjacent pairs of auxiliary framing be spliced in the same aisle.

Captive split nuts and slotted clips may be used (but only in "light" earthquake zones) to secure additional layers of auxiliary framing bars that are added above existing auxiliary framing where disassembly of the existing auxiliary framing is not practical.

7.2.2 Bolts, Nuts, Screws, and Threaded Rods

All bolts, nuts and screws used to secure any part or unit shall be plated to prevent corrosion (exceptions are copper, silicon-bronze and stainless hardware). They shall also be tight, free of damage, and meet specific/manufacturer's torque requirements where required.

All threads of a nut must be used. Bolts/screws may protrude beyond the nut, but not to the extent that they would create a safety or service hazard. Maximum allowable protrusion, where exposure may create a safety or service hazard, shall not exceed the diameter of the threaded unit.

Both ends of bolts, screws or threaded rods shall be free of sharp edges.

Threaded rod splices may be used only under the following conditions:

- The splice has jam nuts installed top and bottom.
- The splice has an inspection hole in the center of the splice to permit visual confirmation that the two rod sections are fully inserted and meet in the center of the splice.
- Where no practical alternative exists for the installation of non-spliced thread rod of the correct length.
- Only one splice may be used.

The tips of all cotter pins shall be bent back and rest against the rod or bolt to prevent injury by projecting ends.

7.2.3 Cable Racks

All cable racks shall be of the proper size and type, and located, leveled and aligned per job specification and drawing.

All sections of cable rack shall have both stringers supported at a minimum of one point, regardless of length. An exemption is made for short transition racks or vertical/horizontal bends. Vertical cable rack shall be supported with a minimum of two supports. Stringer splices do not constitute a support.

Cable rack runs consisting of one piece of rack require a minimum of two points of support for each stringer.

Maximum distance between supports should not exceed six feet (standard spacing is 5 feet). Distance between last supports and cable rack ends should not exceed three feet. Sections of cable rack four feet or less in length may be supported by two corner clips at each end. Transition cable racks do not need to be supported, unless they are longer than 6 feet. Supporting shall be accomplished by drilling the sides of the cable rack, and installing an angled drop rod bracket on each side.

Open and protruding ends of ladder type cable rack shall be finished with closing details or protective rubber caps.

All splices, junction details, brackets, and hangers shall be secure and installed per standard convention.

All cable rack shall be of the solid bar or channel stringer type.

All panned cable racks should have cable horns installed on both sides, alternating sides every other cross strap. Cable racks should be horned when they contain cables that are not to be secured (horns are not required when the cable is secured).

It is preferred that cable rack be placed above the front aisle, but not to where it excessively impedes air-conditioning flow. Where this is not possible, consideration should be given to heat dissipation, size of the cable rack (loading), and installer access.

7.2.4 Earthquake Bracing

When the CenturyLink engineers determine that special earthquake or disaster bracing is required, they shall so advise in their job specifications. (See Section 4.5 of this document for further information on Earthquake Bracing.)

Auxiliary framing, battery stands, equipment frames, etc. shall be located no closer than 6 inches to exterior walls. In earthquake zones 3 and 4 (“heavy”), this 6” minimum also applies to interior walls and columns. Columns shall not be boxed.

All auxiliary framing and cable rack parts shall be equipped with external tooth lock washers in “heavy” earthquake zone installations.

Splices in the same aisle of adjacent pairs of auxiliary framing shall be avoided. In no case shall more than two adjacent pairs be spliced in the same aisle. Splices shall be staggered at least one aisle apart or approximately five feet (on centers). Only drilled-through, bolted splices shall be permitted.

Auxiliary framing bars extending 3" or less beyond the last support shall be through-bolted with a ⅜ inch bolt, spacer, external tooth lockwasher and nut. This requirement is for Heavy earthquake areas only.

Where extension of auxiliary framing bars is possible, the ends of the bars shall be drilled for future splices.

Earthquake bracing with ⅝" threaded rod shall be limited to 10" or less. Flat bar $^{3}/_{16}$" can be used in lengths up to 18", and ⅜ angle type supports shall be used for lengths longer than that.

In seismic zone light, two bottom supports are required per bay (not in a lineup). In seismic zone "Heavy, there shall be four bottom floor supports. Frames, bays, or cabinets that use an approved bottom support earthquake strategy may be free standing and are exempt from top support requirements.

Top supports (if used at all) made with threaded rods or bolts may not exceed 8 inches in length. Top junctioning materials shall not constitute a top frame support. A top support shall establish a fastening point to a supportive member other than the frame, bay, or cabinet.

All battery stands shall be floor secured, meet manufacturers' recommendations, and should comply with CenturyLink minimum requirements for the Earthquake Zone in which the stands are installed.

For seismic reasons, relay racks should be welded (not bolted), and be constructed from iron or steel (not aluminum).

7.2.5 Equipment Removal For Reuse

The Service Supplier shall make a visual inspection of the equipment being removed for reuse to identify and document physical defects or missing parts (broken or bent terminals, broken or warped circuit pack shelves, missing hardware, etc.). The inspection and agreed-to repairs shall be completed prior to the equipment being shipped, documented in the job log, and notification of completion of the repairs sent to the CenturyLink Design Engineer.

The Service Supplier shall utilize the proper tools and methods and procedures to ensure that the equipment being removed, as well as remaining equipment, is not damaged during the removal process. If the equipment is damaged during the removal activity, the Service Supplier shall notify the CenturyLink Design Engineer.

Care shall be taken not to damage or remove any shop wiring.

All installers' wiring shall be removed and terminals cleaned unless otherwise instructed by the CenturyLink Design Engineer.

The Service Supplier shall utilize the proper packing assemblies when preparing to ship equipment removed for reuse. All equipment shall be packed and secured per job specification or manufacturer's instructions to safeguard against possible equipment damage during shipment.

System circuit packs and plug-in units shall be secured in place and remain with equipment shelves, unless otherwise noted by the Design Engineer. When it is necessary to protect the structure of the equipment, circuit pack and plug-in units shall be packaged separately in approved ESD containers and identified with the circuit pack or plug-in number on the outside of the container before shipment. ESD control measures shall be practiced if circuit pack removal is required (see Section 7.1.4).

7.2.6 Fiber Optic Protective/Distribution Systems

All covers and devices used to maintain fiber cable/jumpers within their protective systems shall be in place and secure.

Fiber optic cables and jumpers shall be run on dedicated racks or in dedicated cable ways whenever possible.

A dedicated cable slot/hole/sleeve should be used for fiber cable entering the equipment facility from the CEF with provisions for approved fire/smoke and gas stopping.

7.2.7 Frames, Bays, Cabinets, and Stands

Locate all frames, bays and piece parts per job specification and drawing/record. All frame parts shall be free of defects, secure, and aligned.

All adjacent frames shall be bolted together where possible.

Relay Racks are preferred to have 23" mounting width (instead of 19") with 1" or 1-$^{3}/_{4}$" mounting holes, unless the equipment being installed dictates otherwise. (19" equipment can be installed in 23" relay racks with appropriate reversible or alternate ears, but 23" equipment cannot be squeezed into 19" mounting width racks.)

The vertical alignment of all frameworks should be plumb within the allowable deviations shown below:

Table 7-1: Framework Alignment and Clearances

Vertical Alignment (Maximum Allowable Deviation From Plumb)	
Height	**Maximum Deviation**
4′6″ or Less	1/16″
Over 4′6″ and less than 7′	1/8″
7′ to 9′ inclusive	3/16″
Over 9′	1/4″

Horizontal Alignment
Should Be Level

Aisle Spacing				
Equipment Type	**Standard Front Aisle**	**Min Front Aisle**	**Standard Rear Aisle**	**Min Rear Aisle**
Relay Racks and Cabinets	3'	2'6"	2'6"	2'
Front Access Eqpt in Relay Racks	3'	2'6"	6"	
Battery Stand	3'	2'6"	6" (from wall)	
Equipment with AC Power	3'6"	3'	3' (if accessible) 6" (if rear not accessible)	
Main Aisles and Egress Routes	4'	4'	N/A	

Joined sides of frames shall be properly aligned both vertically and front to rear.

Frame bases, end guards, and spacers shall match and be in alignment. Transition plates or guards shall be installed where this cannot be accomplished.

Cabinets on casters or rollers shall have the rolling system disabled or removed and be anchored to the floor.

The uprights of all frames or cabinets (7 feet high or taller) where the flanges align will be junctioned together. Equipment frames 7 feet high require a minimum of three junction plates. Taller equipment frames require a minimum of four junction plates.

The distance between the TOP of a pipe stand and the BOTTOM of the supported ironwork shall not exceed 2 inches.

7.2.8 Framework Parts

All piece parts (i.e., ironwork, framework, threaded rod, miscellaneous details, etc.) should be installed per equipment drawings/records and shall be secure, aligned, plumb, and free from defects, sharp burrs, points, etc.

All splices on cable racks, auxiliary framing bars or junction bars shall be butted together or butted against junctioning hardware. Gaps shall not exceed $^1/_8$".

All surfaces of equipment and ironwork parts should be free of rust, dirt and contaminants. If corrosion is apparent on equipment or parts, they should be cleaned and painted.

All cut ends of cable rack auxiliary framing, threaded rods, and other unprotected metal parts should be plated or painted.

End guards are not required, but are permissible.

7.2.9 Mounting of Shelves/Equipment

When mounting positions are identified in inches or in fractions of inches, these measurements are from the lowest mounting position to the uppermost mounting position.

All units of equipment, including cabling and brackets, shall be installed, aligned and secured in accordance with job specifications and drawings.

All installer mounted units shall be secured with a minimum of four screws in the upper and lower most available mounting holes on each side of the unit. Units exceeding 8 inches in height require 1 additional mounting screw on both sides for each additional 8 inch interval. Additional screws may be required for heavier units or as required by manufacturers' specifications.

All units of equipment should not extend beyond the front or rear edges of the base or guardrail of the frame. The installer shall notify the Design Engineer when this cannot be accomplished and provide a detailed description in the job log. The Design Engineer must approve the deviation.

Mounting space adapters shall be used where hole spacing is incorrect for the equipment being mounted in the frame, bay, or cabinet. The frame, bay or cabinet shall not be drilled to accommodate equipment mounting.

When bays are up against a wall or back up to other equipment in a cabinet so that rear access is near impossible, every effort should be made to install only front-accessible equipment.

Where equipment is wall mounted, it generally should not be mounted above 7'.

7.2.10 Building Envelope Drilling Procedures

All drilling of the equipment building envelope, consisting of floors, walls, ceiling, or any wall or separation therein, should be accomplished in a safe and environmentally sound manner, which captures and contains any debris using proper HEPA vacuum and protective materials.

Before drilling into any basement floor or basement wall, it shall be the installer's responsibility to determine from the CenturyLink Design Engineer and the Premises owner whether waterproofing has been provided. Usually this is covered on job drawings or in job specifications. When waterproofing is used, CenturyLink shall decide the method for securing the frames. Drilling in waterproofed floors, where authorized, is limited to depths not exceeding three inches. If the waterproofing cannot be temporarily broken to accept anchors, the "poured concrete block" method should be considered; however, some frames cannot be secured in this manner (see CenturyLink Technical Publication 77351 for more information on the "poured concrete block" method). Frames equipped with pull out units, where an appreciable amount of the weight may be shifted outward, shall not be fastened with the "poured concrete block" method.

Procedures for Dry Drilling, Wet Core Drilling, Floor Tile Punching, and Floor Tile Drilling with a HEPA Vacuum should be used whenever the Service Supplier is performing an installation that involves drilling through floor tiles that contain asbestos or if the Service Supplier is unsure of the asbestos content of the floor tiles. These procedures are outlined in Section 3.20 of Tech Pub 77350. (See CenturyLink Safety and Loss Prevention Program manual or a CenturyLink EHS Representative for further information.)

7.2.11 Floor Anchors and Installation Instructions

CenturyLink Standard configuration documents will contain the presently approved floor anchors. Those are preferred. If floor depth or equipment design problems are encountered, the Service Supplier should contact the Design Engineer who will contact the PEG representative and the Premises owner for resolution. The service supplier should document the resolution in the Job Log, and obtain a letter of deviation from the Design Engineer.

Floor Anchor Installation Instructions are provided by the manufacturer, and shall be followed.

On raised or other floors, where floor tile drilling and/or punching are required, see Tech Pub 77350, Chapter 3. When mounting frames, bays, and cabinets on raised floor environments, the floor manufacturer's instructions for mounting shall be followed, and the appropriate number of anchors should be used for the seismic zone in which the equipment is located.

In raised floor environments where the space underneath the floor is used as an air plenum, all cables placed in this space must be plenum-rated (or placed in fire-resistant conduit), or the room must be classified as "IT" space (with accompanying special restrictive requirements), per Article 645 of the NEC. Some Premises locations require plenum-rated cable regardless of the classification of the room.

Further information on floor anchoring can be found in Technical Publications 77350 and 77351.

7.3 Cabling: Forming, Running, and Securing

Note that additional specific requirements for power cabling are found in Section 7.7.

The requirement for cable routing and segregation shall be per job specification and records/drawings, except where manufacturers' requirements, critical routing, and/or critical lead lengths shall take precedence.

Route cables to avoid pileups and blocking of cable runs. All cables shall be run within the confines of the cable rack stringers. Do not run cables on existing cable racks where cable pileup exceeds the top of cable horns. Cable horns are limited to a maximum usable length of twelve inches. See Section 7.3.4, "Cable Pileup."

Cables shall be run directly, from point to point, with only a maintenance loop of slack (not to exceed 4 feet) stored on the cable rack. Although not generally encouraged, it is permissible to run cable between two adjacent bays/cabinets without going above or below the rack (where done, the cable must be properly secured and protected from abrasion). In "Heavy" Earthquake Zones, cabling between equipment elements that are secured to different earthquake planes (i.e. floor and ceiling) shall require additional slack between the cable break off and the equipment frame. Typically an additional 9 inch slack loop shall be provided.

Cable spanning horizontal planes shall not exceed 9 inches without additional support. Vertical cable rack offsets of greater than 9 inches in parallel planes shall be made using fixed degree edge clamps. Where it is not practical to use fixed degree edge clamps for vertical offsets, adjustable clamps may be utilized.

Remove all cable running tags and binder grouping material after the completion of testing. Exception: When requested by CenturyLink Operations personnel, and the CenturyLink Design Engineer concurs with a letter of deviation, on a per job basis, the tags may be left in place if those tags are made of a fire resistant material.

Cable and cable management systems shall be a distance sufficient to maintain a maximum cable enclosure temperature of 115° F. At a minimum, the distance shall be no less than six inches clearance from steam pipes, or other environmental hazards.

If any cable mining must be done, refer to Tech Pub 77350, Section 5.2, for guidelines.

7.3.1 Bending and Forming

Sharp bends in cables shall be avoided to prevent damage to insulation and conductors. Minimum bending radii should be as follows:

- Switchboard and ABAM cables — A minimum radius 3 times the cable diameter.
- Armored (BX), and Flex Steel cables — 5 times the diameter of the cable.
- Coax, Shielded, and Twin Conductor cables — 10 times the diameter of the cable.
- Power and Grounding cables — 9 times the cable or wire diameter (8" minimum for grounding wires).
- Fiber Optic cable and jumpers — 10 times the cable diameter (but always ≥ 1½")

7.3.2 Cable Protection and Storage

Protect all cables and wires against damage at all locations where they come in contact with sharp edges or threaded rod, using fiber sheet, plastic edge guard, and/or protective tubing as appropriate.

Store and protect all cabling and wiring identified as "future" in a manner that shall allow for future access.

All cables identified for future use shall be identified at both ends with the far end location of the other end and near end location. All cables shall be stored in a manner that allows for future access. Cables run (extended), but not yet connected, shall be coiled, banded, and stored (outside the rack) in a safe manner.

Plastic electrical tape or heat shrinkable tubing shall be used to wrap/protect the butt location of ABAM and shielded cables.

All cables shall have their exposed ends covered (taped) during the running process (and until they are terminated) to protect existing equipment.

All types of cable rack that have threaded rod(s) in contact with the cable rack, shall have the threaded rod(s) protected with protective tubing.

Provide protection using fiber sheathing on inverted ladder-type cable rack in a horizontal or vertical plane where the wire and cable are in contact with the flange side of the cross straps.

Power wires fastened to the underside of channel type cable rack straps shall be protected.

Cables on distributing frames that are butted at the traverse arm require fiber protection or fanning rings.

Fanning rings shall be required when wires are fanned under transverse arms.

All soft rubber insulated cables require protection when secured with 9-cord, or equivalent. Cable insulation that will not cold flow is exempt from this requirement. Cold flow is a condition where insulation thins or flows away from an impingement point.

All exposed ends of power or ground cables shall be protected with rubber insulating tape and plastic electrical tape or heat shrinkable end caps. This requirement applies specifically to common feeders serving multiple bays or cables that have been dead ended.

7.3.3 Securing and Supporting

All switchboard cables and wires not in basket type or pan rack are to be sewn with No. 9 cord (twine, waxed polyester, 9 ply) or equivalent. Horizontal runs are to be sewn every sixth strap and when necessary to keep cable in the cable rack or from sagging through the cable rack. Vertical runs (and waterfall rack) are sewn on every alternate strap. Installer may leave securing cord provided that ending stitch is made and cord is properly stored for future use. No more than two square inches of cable shall be secured under a single stitch. Band between cable rack break-off and first frame support is exempt from the two square inch requirement. See Section 7.3.10, "Securing Tables."

All cables shall be tied with 9 cord, or equivalent, at cable rack break-off points, banded or tied between the cable rack and first support (where this distance exceeds eighteen inches), and banded or tied at the first support on a frame, bay, or cabinet. Where cables extend from a ceiling supported racking system to equipment frames that are floor supported only, or not physically connected to the feeder rack, then an additional 9 inch slack loop shall be provided. Where no vertical cable support bracket exists, the Service Supplier may secure cabling using the rear relay rack upright mounting holes to meet the eighteen-inch requirement provided that cable bending radius and strain relief tolerances are maintained. At the point of break-off the cable rack stringer (side of the cable rack) shall be protected with cable rack sheet fiber paper or equivalent.

All non-fiber cables and wires should be secured at intervals not to exceed three feet in protected ducts or eighteen inches in open ducts and at all turns or junctions within the frame, bay, or cabinet.

Secure and support all cables before, at, and after turns or junctions of horizontal runs in other than pan, basket, and horned racks.

Cable should not be unsupported for a distance greater than three feet, measured from the last support on the cable rack or waterfall to the first support on the frame, bay, or rack, except where otherwise specified in specifications or drawings.

Grounding conductors 1/0 AWG and smaller may be secured directly to the side of cable racks (see Section 7.3.10).

Grounding conductors larger than 1/0 AWG should be suspended on and secured to cable hangers. Cable hangers should be placed at maximum eighteen inch intervals.

Individual p-wire (16-26 AWG) alarm leads may be sewn on the outside of the rack or to the outside of hangers.

7.3.4 Cable Pile-up

The maximum pile-up of switchboard, coax, ABAM, etc. is given in the following table.

Table 7-2: Switchboard/ABAM Cable Pile-up on Horizontal Cable Rack

Width of Cable Rack	Maximum Pile-up Height	
	Supports on 5′1″ Centers	Supports on 6′0″ Centers
12″ or less	equal to width of Rack	
15″ to 25″	12″	10″
30″	10″	7″

Vertical runs of Switchboard/ABAM are limited to 12 inches of pile-up.

The maximum pile-up on combined vertical and horizontal cable rack shall not exceed seven inches for Power cable.

The maximum width of horizontal and vertical dedicated power cable rack shall not exceed twenty inches.

The maximum pile-up on cable hangers or "T" bars shall be limited to their width, or the manufacturer's weight restriction for the hanger (whichever is more stringent).

7.3.5 Coaxial Cables

Coaxial cables may be run with other types of cable. Where possible, coaxial cables should be bundled and segregated to increase protection.

Care shall be taken, when sewing or banding, not to indent or collapse coaxial cables. Fiber sheet or protective-tubing protection may be required.

7.3.6 Fiber Optic Cable

Fiber optic cable and jumpers shall not be pulled, kinked or twisted during installation. Manufacturers' guidelines shall be followed.

Slack on fiber optic cable should be stored in a designated storage cabinet. Fiber jumper slack (if any exists) shall be stored on reels, trays, or in fiber protective systems. Fiber cable slack in the trough system or on cable rack is not desirable, and where done shall not exceed the maintenance loop (4 foot) maximum length (coiling or storing excessive slack in a cable rack or trough is strictly prohibited).

Cable ties shall not be used for banding or securing fiber optic cables/jumpers.

Fiber optic jumpers and cables shall be protected from metal work and lacing twine by wrapping with 1 layer of sheet fiber, 3 layers of fiber paper tape, or protective tubing.

Metallic members of fiber optic cables shall be grounded. Components include: protective cable covering, cable sheath and/or any metallic inner strength members.

Fiber optic cables and jumpers should be run on dedicated racks or in dedicated cable ways. Fiber optic cable, which qualifies for support by ladder type cable rack, must meet several design specifications. All dielectric construction shall provide ElectroMagnetic Interference (EMI) immunity. For the detailed specifications on fiber optic cable approved for use within CenturyLink central offices and buildings, contact the CenturyLink representative for fiber cable standards or Product Selection.

In order to minimize the possibility of incorrect fiber optic cable / jumper termination, the Service Supplier will perform a basic continuity test on installed fiber optic cables & jumpers with an Optical Loss Meter. This device is also referred to as a "light meter." The results of this test are typically documented on RG 47-0157. Loss shall not exceed the EIA/TIA 568 standards for fiber optic cable.

The fiber optic cables (fiber patch cords or jumpers) not equipped with a heavy protective sheathing (rated OFNR and meeting GR-409 riser requirements) leaving the Fiber Distribution Frame (FDF) shall be continuously protected within an approved Fiber Protection System (FPS) until they are terminated on the fiber equipment bays. This totally enclosed protection system shall be equipped and installed with covers on all fittings and straight sections, both horizontal and vertical. FPS systems shall maintain a minimum 12" clearance when located above cable rack. End caps are required on the end of all horizontal or vertical sections. Running fiber optic cables or patch cords with any other type of cable is strictly prohibited unless specified in CenturyLink Standard Configurations documents.

Hook and loop fastening systems shall be permitted for the banding and securing of fiber optic cables/jumpers.

Fiber ribbon type cables shall not generally be run on cable racks. Dedicated cableways should be utilized, unless the ribbon type cable has specifically been approved for cable rack use by CenturyLink Technology Selection and Configurations.

Fiber optic cable troughs are used to support OFN fiber cable patchcords/jumpers or small quantities (10 or less) of OFNR 1-to-12 fiber cables. All covers and devices used to maintain fiber cable/jumpers within their horizontal and vertical protective duct systems shall be in place and secure. The use of "split flex" tubing is **only** approved for short transition (24 inches or less) applications from horizontal solid duct to vertical slotted duct on equipment frames. Horizontal runs of split flex tubing are strictly prohibited. Horizontal sections of fiber trough shall be supported as follows: 2"x 2" slotted = 18 inches; 2"X 2" solid = 24 inches; 4" X 4" solid = 5 feet.

7.3.7 Repair of Damaged Cables

Damaged outer jackets of Polyvinyl Chloride (PVC) covered cables shall be repaired with electrical tape and/or heat shrink tubing. The tape shall be applied in two half-lapped layers with the final two wraps applied without tension and overlapping. The tape shall extend a minimum of two inches past the damaged section.

Seriously damaged sections of outer jackets of PVC covered cables shall be repaired by removing the damaged section and replacing it with the covering from a similar cable. Apply a single half-lapped layer of electrical tape over the new section, extending two inches either side of the repaired section, to secure it in place.

Damaged power cable insulation shall be repaired with an insulation equivalent to that of the original, or with an insulating device identified for the purpose (heat shrink tubing is acceptable).

A run of cable shall be replaced if the number of damaged conductors exceeds five percent of total conductors.

7.3.8 Splicing Cables, and Mated Connectorized Cables

Multiconductor cable shall be rerun if the number of spliced conductors exceeds five percent of the conductors in the cable. Under certain conditions, this requirement may be deviated from with permission of the CenturyLink Design Engineer. A letter of variance shall be required and the reason shall be documented in the job log.

Splicing of non power or grounding cables shall be kept to a minimum and, if required, shall generally be done in the vertical duct of frames, bays or cabinets, or at the equipment shelf or a splice shelf. All splices shall be protected (grounding splices are not required to be insulated, and are only required to be protected if they have sharp edges in a position to cut other cables or are position where personnel may come in contact with them).

Mating of connectorized cables shall be kept to a minimum and if required shall be done at the equipment shelf, or in the vertical duct on the splice shelf of frames, bays, or cabinets, or on dedicated rack. Mated connectorized cables shall be mated and secured by using twine, tie wraps, hook and loop systems, screws, spring clips, etc.

Spliced or mated cables shall be protected, designated, and accessible for maintenance.

Protective covers or caps shall be installed on unused connectors to protect contacts from mechanical or ESD damage.

7.3.9 Use of Nylon and Plastic Cable Ties

Cable ties are never approved for use within NNS. Within CenturyLink LNS, cable ties are not approved for securing fiber optic cables and jumpers.

Cable ties used for banding and securing of cable, fiber fish protection, PVC protection etc. shall be of an adequate size, type, strength, etc. for the particular application, and shall not be overtightened such that they can damage the cable.

Cable ties shall be trimmed at the locking head with a flush cutting device that provides automatic tensioning. Under no circumstances shall cable ties have sharp or jagged cut ends protruding from the locking head. A cable tie is considered to have sharp or jagged ends when it is sharp to the touch.

The locking head of reusable cable ties shall be positioned so as not to interfere with the installation or removal of apparatus or equipment (i.e, towards the outside or bottom of a rack, brace, etc.)

Reusable cable tie tails shall be positioned so as not to present a personnel hazard.

Existing cable ties shall be removed where the heads of tie wraps interfere with additional cable or wires that are superimposed.

Where cable or wire forms are secured to cable securing brackets, the locking head of the cable tie shall be positioned on the side of the bracket opposite the side on which the cables or wires are run.

7.3.10 Securing of Cables

Table 7-3: Cable Securing Requirements

Size of Wire	Sew at Strap	# Twine Strands	Ultimate # of Layers	Cables per Stitch
Sewing Horizontal Resting Runs On Dedicated Power And Switchboard Cable Racks				
400 kcmil or larger	Every 4th	4	Limited only by section 7.3.4 (Cable Pile-up)	2
250-374 kcmil		2		
4/0 and Smaller				4
Fiber cable (wrapped with fiber sheeting)				1
Switchboard Cable	Every 6th			6, not to exceed 2 in^2
Sewing Vertical Or Inverted Horizontal Runs On Power and Switchboard Racks				
250 kcmil or larger	Every Strap	4	Limited only by section 7.3.4	1
4/0 - #4		2		2
#6 and Smaller				not to exceed 2 in^2
Switchboard Cable	Alternate Strap			4, not to exceed 2 in^2
Sewing on Horizontal Runs of Cable Hangers Spaced at 18" Intervals				
250 kcmil or larger	Every Hanger	2	Limited by section 7.3.4	1
4/0 and smaller				2, not to exceed 2 in^2

There are two general methods of securing cables: sewing and tie wraps. Sewing of cables has historically been done with high quality standards. For drawings showing proper sewing methods, refer to CenturyLink Tech Pub 77350, Figures 5-1 through 5-9.

Unfortunately, the same standards of quality have not been as evident when securing is done with cable tie wraps. Ensure that the rules of Section 7.3.9 are followed.

7.4 Wiring

Wire shall be of the type, color, and gauge specified in the drawings/records and/or manufacturer's specifications and instructions.

Wire shall be dressed in such a manner as to avoid congestion, to ensure accessibility, and to maintain clearance between terminals.

All spare and unused wire shall be placed in fiber/protective tubing or secured to the existing form or equipment. Individual bare wire ends shall be insulated.

Where a functional performance test is not performed, a continuity test shall be made on all conductors run and connected by the Installer. Functional performance and continuity testing shall be recorded in test records. A Copy of the test records shall be left in the Job Packet.

Wires shall be run as directed in the specification and records/drawings.

Wire dress shall be sufficient to provide for one additional skinner length without splicing the conductor.

All wiring shall be protected from hazardous conditions such as sharp edges, excessive strain, etc.

All installation cable running tags shall be removed prior to job completion and turnover. Factory-installed shop wiring and verification tags designed for proper interconnection of bay equipment are not considered cable running tags and will not be removed at the completion of testing and turn-up.

7.4.1 Fanned and Unsewed Forms

Fanning rings shall be placed as provided in job specifications prior to wiring operations. Loose wires not held in place by rings or other similar retaining devices shall be banded at each point of breakout.

7.4.2 Sewed Forms

Sewed forms shall be secured in a manner that affords access to the equipment. All wiring added to existing forms shall be properly secured. All ending stitches shall be trimmed of excess twine. Forms designed for hinged equipment shall be capable of accomplishing movement without twisting or damage to the form.

7.5 Connecting

Additional AC power, DC power, and grounding connecting requirements are specified in Sections 7.7.1, 7.7.2 and 7.8.1.

All DC wire connections terminated under screw heads shall be made with an approved connector (e.g., ring or flanged fork connectors). Exception: threaded compression connections specifically designed for bare wire insertion.

All terminals, lugs, and connection points shall be free of contamination and previous connecting materials (i.e., corrosion, paint, grease, dirt, etc.)

Plated surfaces, such as silver, tin, or lead-plated copper, etc., are plated to prevent oxidation and reduce contact resistance and, therefore, shall not be sanded or abraded. If cleaning is required, wipe with a dry cloth.

All types of connections shall be secure (tight) and shall conform to manufacturer's torque requirements where specified.

For connectorized cables, connectors shall be properly mated and secured with an approved method (i.e., clips, screws, tie wraps, hook and loop systems, etc.).

7.5.1 Coaxial Connections

Correct crimping practices and components shall be used as specified by the manufacturers' of the connector components and crimping tools for coaxial connections. A CenturyLink-approved or manufacturers'-specified crimping tool shall be used. Components shall be crimped once only, multiple crimps shall not be allowed. Field testing of all field fabricated coax connections should be performed by using the manufacturers specifications (or the specs in Tech Pub 77350, Section 7.2.1), and results of tests recorded on RG 47-0157 (or other appropriate form), and left in the job packet.

Center conductors shall crimped.

7.5.2 Crimp Compression Connectors, Splices, and Taps

Aluminum connectors and lugs are not authorized for use in CenturyLink indoor installation locations. Copper or tinned copper connectors and lugs shall be used.

All crimp compression connections using the various types of approved commercial connectors shall be properly made with the number of crimps being determined by the manufacturers' requirements pertaining to the wire gauge, type of wire, type of lug, and the crimp compression tool used. The lug specified or used shall determine the crimp compression tool and die set combination required.

Wires shall be inserted to the full depth of lug. The wire shall be inserted to within ⅛" of the inspection hole for wire sizes #2 AWG and smaller and within ¼" for wire sizes 1/0 AWG and larger.

Space between wire insulation and the body of solderless connectors and power lugs shall be kept to a maximum of one eighth of an inch. If necessary, field prepared connections may use clear (transparent) heat shrink tubing when insulation is necessary to protect the connector from shorting.

All connections shall be accessible for inspection. Power conductor H taps shall be taped with plastic electrical tape (unless the cover is clear), have covers applied, and the covers secured with 9 ply cord. (Ground connection C-tap and H-taps do not require covers or taping.)

Butt or reducing splices for power connections (hot or return) are required to have at least one layer of clear thick heat shrink tubing (that is what typically comes in the kit), or 2 layers of thin (standard) heat shrink tubing. Butt or reducing splices for grounding connections are not required to have heat shrink applied.

All connections shall be free of sharp edges, fins, or burrs caused by the crimping process.

Crimps shall not extend onto the tang area.

Individual crimps may not be recrimped after initial application.

Only one wire shall be crimped in a connector barrel.

Compression crimps shall be permitted on solid wire, #16 AWG and smaller, and on larger copper conductors where the connector has been specifically Listed for use on solid wire of that size. Crimp tools used on solid wire #8 AWG and larger shall be specifically intended for use on solid wire.

Parallel connectors (H-taps or C-taps) shall not be located on cable rack stringers or any other metallic object that will cause pressure to be exerted on its protective cover.

7.5.3 Quick Clip/Slotted Beam Connections

Quick clip terminations shall be made with the correct tool, properly inserting the wire into the working portion of the terminal, and shall be secure.

Only one wire of the proper size and type shall be engaged in each terminal slot. Wire ends from previous connections shall be removed.

Textile (cloth) covered insulated wire shall not be terminated in slotted beam terminals.

Conductors shall not be placed on deformed terminals.

Previously terminated wire ends shall not be reterminated; use new wire ends.

Clearances for Quick Clip Connecting Slotted Beam Type are as follows:

- Wire ends shall clear metallic parts by one thirty-second of an inch, minimum
- Wire ends shall protrude one sixteenth of an inch beyond the edge of a clipped terminal

7.5.4 Wire Wrapped Connections

The Figures in this section represent established standards, and compliance to these standards is recommended.

Wire-wrapped connections shall be secure and shall have a minimum of 5 consecutive conforming turns/wraps (Figures 7-1 through 7-4 in Tech Pub 77350 provide further guidelines).

All connections not meeting the minimum requirement shall be reterminated using the correct wire-wrapping technique. This may require:

- Complete reskinning of the existing lead
- Running a new lead

Some examples of wire wrapping deficiencies are as follows:

- Overlaps
- Excessive separations
- Excessive shiner (+⅛″)
- Excessive tail (+⅛″)
- A lead that has been previously terminated

A minimum clearance of 1/32″ shall be maintained between adjacent connections or connections and metal work.

Separations between adjacent wraps shall not exceed 0.005″ for 20-26 AWG wire; and 0.003″ for 28 and 30 AWG wire.

Wire end projections shall not jeopardize minimum clearances and shall be less than ⅛″ in length.

Insulation shall be within ⅛″ of the terminal. (Exception: 28 and 30 AWG wire shall have one full wrap of insulation before wire wrapping begins. This requires the use of a bit designed to provide a "modified" wrap. The turn of insulated wire shall not count as 1 of the minimum consecutive conforming turns.)

7.6 Equipment Designations

Note that Power and Grounding designation rules are contained in Sections 5, 7.7 and 7.8.

All designations should be accurate, permanent, legible, visible, aligned, secure, the proper color, at the prescribed location, complete, and conform to the existing equipment designation pattern. The labels in Figures 7-1 and 7-2 serve as examples of labels that could be used on a frame base or upright. If a frame, bay, or cabinet is fully equipped with like equipment, then a single label for the equipment may be used. Labels should be located on the part of the frame, bay, or cabinet that is not normally removable by maintenance personnel and which shall remain fully visible.

Stamping or approved labeling is required on painted or plated surfaces. Generally, the specifics of labeling requirements are specified in other CenturyLink standards accessible by the installers (such as Technical Publication 77350); however, if the customer has a labeling standard (or prohibition) for their room, CenturyLink will work with them to come up with a mutually agreed-upon labeling standard for the site.

Designation tags, cable sheaths, connectors and approved designating labels (for items such as cross-connects) may be designated by hand lettering, using a fine point, permanent, black ink marker, or a standard labeling device that prints labels.

Generally, use black ink on white surfaces, red ink on caution notices.

Pwr/Fuse RR _____ Load A _____ Load B _____
Ringing _____ Frame Location _____
DSX-1 RR _____ Shelf _____ Jacks _____
DSX-3 RR _____ Shelf _____ Jacks _____
FDX RR _____ Shelf _____ Jacks _____
Timing RR _____ Card/Terminals _____
Alarms RR _____ Shelf/Terminals _____
X.25/IP RR _____ Panel _____ Links _____
Drawing/Manual #_____
Other _____

Figure 7-1 Example Base Plate or Cover label

Designate connectors on connectorized cables as identified in the specification or drawing/record. All connectorized cables that could be removed and improperly replugged shall be identified with connector or jack number. Where connectorized cables are formed and stitched to prevent connecting errors, numbering is optional. A label or fine point, permanent, black ink marker may be used to accomplish these designations on either the cable or the connector.

Mark all assignment changes on drawings/records as applicable.

It is useful to know the CenturyLink systems' site identifiers (site base CLLI Code). This information should be found on each end of a lineup (or where there is only one relay rack or cabinet, on that frame). This information does not have to be on the bottom of the Frame/Upright Label, but that is a convenient placement. Each intelligent shelf (such as a mux) should be marked with it's 11-character equipment CLLI (this is not necessary if this CLLI is found on the tags to the circuits feeding the shelf).

Designate all frames, bays, and cabinets, with frame type (PBD, RR, etc.) and number on the front and rear.

- The recommended locations are: first choice — frame base; second choice — mid-frame to eye level left frame upright, or as the existing office convention dictates.
- The designations shall be readily visible.

Designate each shelf, unit, or position on the front and rear or as instructed in the detailed installation specification and drawings/records. When a shelf or unit of equipment is designated by “Equipment Location” EQL such as plate number, the lowest occupied plate number for the shelf or unit shall be referenced.

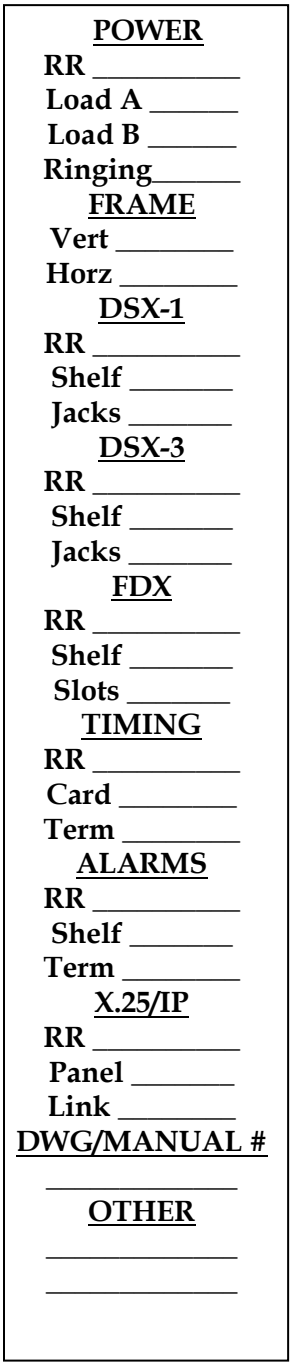

Figure 7-2 Example Frame Upright Label

The recommended convention for numbering of shelves, units, and positions in the same frame are found in Tech Pub 77351. Shelf, panel, bank, and fuse panel numbers shall consist of two digits, starting with 01, and be unique within a given frame; i.e., there shall be only one shelf, panel, bank, or fuse panel 01, 02, 05, 19, etc. Typical single frame designations formats could be as follows: SH-01, BK-02, PN-03, FP-04, etc. Units should have an electrical connection (power, fiber, frame, timing, alarm, etc.) in order to be designated. Cooling fans may or may not be designated. Frame filler plates, heat deflectors, and cableways should not be given a shelf number.

Circuit numbers associated with shelves, units, or panels shall be provided when indicated in the specifications or where they are part of the manufacturer's or CenturyLink's standard design.

Designate equipment drawing number and circuit equipment description (if not apparent) for units in frames, bays or cabinets.

In the rare cases where distributing frames might exist in a Customer Premises environment, designate them as described in Technical Publication 77350.

7.7 Power and Battery Installation Requirements and Guidelines

7.7.1 DC Power Connections

Contact surfaces shall be cleaned so that direct metal to metal contact is made. Remove non-conductive coatings (such as paint, lacquer and enamel). Copper bars may require the use of low abrasive pads to remove oxidation.

Plated surfaces, such as silver-plated or lead-plated copper, are plated to prevent oxidation and reduce contact resistance; and therefore, should never be sanded or abraded. If cleaning is required, wipe with a dry cloth.

Mating surfaces shall be flat to ensure maximum cross-sectional area contact.

An anti-oxidizing agent free from metallic particle "conduction improvement" compounds shall be applied to inhibit corrosion on all indoor grounding, battery and battery return connections. Because this agent is not conductive, only a thin film should be applied.

Pressure or clamping devices shall be tight.

All DC/Grounding wire connections terminated under screw heads shall be made with an approved connector. (e.g., Ring or flanged fork connectors shall only be used with stranded wire of the correct size). Stranded wire shall be tinned prior to being inserted into a threaded compression connector.

Lock washers are advisable to ensure secure connections for DC power and return (except for connections to the batteries). Double or locking nuts also meet this intent. Shake-proof (star) lock washers under mounting screws, and split-ring lock washers with bolts and nuts are best. Lock washers should not be placed between the connecting terminal and the contact surface. Connections that require annual retorquing routines are not acceptable.

Generally only one connector should be attached with the same mounting screw or bolt (i.e., stacking of lugs onto each other on the same side of a bar is generally prohibited, unless a spacer specifically designed and Listed for that purpose is used). Any connector drilled with two holes shall be secured using both holes.

Stranded cables or wires shall not be stripped of strands at the termination point to fit a specific lug of the wrong size onto the cable.

Irreversible crimp compression connections are strongly preferred for DC power and grounding connections (self-threading Listed screw-on lugs are allowed for solid wire grounding connections). The integrity and quality of an irreversible crimp compression connection is dependent on:

- The correct size of connector for the particular wire size(s) involved.
- Insulation removal so that the wire extends the full length of the barrel or groove.
- The wire end and connector being properly prepared.
- A non-oxidizing agent is used on the wire and connector as required.
- Full insertion of the wire into the connector. The wire shall be inserted to within ⅛″ of the inspection hole for wire sizes #2 AWG and smaller, and within ¼″ for wire sizes 1/0 AWG and larger.
- Compression of the connector the correct amount and in the proper sequence using a tool and die set that has been tested and Listed for that lug (i.e. a Listed circumferential crimp)
- Use of a pre-bent 45° or 90° factory lug when an angled lug is needed.

7.7.2 AC Circuit Installation Considerations

This subsection applies to AC circuits run to serve CenturyLink equipment, such as those feeding the rectifiers. It does not specifically apply to general electrical outlets and lighting on the Customers' Premises that do not directly serve CenturyLink equipment, although if CenturyLink finds NEC violations, they may point these out to the customer.

All connectors, wiring, conduit, fixtures, etc. shall meet the requirements of the NEC, NEMA, UL, and CSA, and any local codes and ordinances that vary from these standards. AC circuits should be installed by licensed electricians. The Service Supplier shall purchase and pay for electrical permits, licenses, and inspections, if they are required.

AC electrical work done in CenturyLink facilities shall be done in compliance with OSHA/NEC for all contract electrical work. Employees who regularly work on or around energized AC electrical equipment or lines shall be annually instructed in the cardiopulmonary resuscitation (CPR) methods.

Multiple AC plug adapters are prohibited for CenturyLink equipment (even test equipment) when fed from for standard NEMA 5-15R or 5-20R receptacles, except for power strips up to 8 outlets (but they shall not be daisy-chained). Much larger outlet strips can be used if they are fed from a NEMA locking receptacle.

If electrical equipment or lines are to be serviced, maintained or adjusted, necessary switches shall be opened or wires disconnected whenever possible. When this is done, OSHA procedures for locking out and or tagging out the circuit at the source shall be followed in order to mitigate against the possibility of someone energizing the circuit when it is being worked on. No work shall be performed on LIVE/ENERGIZED AC CIRCUITS by other than a Licensed Electrician (journeyman title or higher). Any installation supplier shall be aware of the power work safety guidelines contained in CenturyLink EHS safety practices.

Exposed wiring and cords with frayed or deteriorated insulation shall be repaired or replaced promptly. Flexible cords and cables shall be free of splices or taps. Clamps or other securing means provided on flexible cords or cables at plugs, receptacles, tools, equipment, etc., shall be securely held in place. All cord, cable and raceway connections shall be intact and secure.

Metal measuring tapes, ropes, handlines or similar devices with metallic thread woven into the fabric shall be prohibited where they could come in contact with energized parts of equipment or circuit conductors.

Use of metal-frame ladders shall be prohibited in areas where the ladder or the person using the ladder could come in contact with energized parts of equipment, fixtures or circuit conductors.

All disconnecting switches and circuit breakers shall be labeled to indicate their use or equipment served.

Interior wiring systems shall include provisions for grounding metal parts of electrical raceways, equipment and enclosures. Electrical raceways and enclosures shall be securely fastened in place.

All energized parts of electrical circuits and equipment should be guarded against accidental contact by approved cabinets or enclosures. Unused openings (including conduit knockouts) in electrical enclosures and fittings shall be closed with appropriate covers, plugs or plates.

AC circuits serving an isolated ground plane shall not be extended to serve an integrated (non-isolated/neutral) ground plane.

Exposed ACEG conductors shall be green in color, bare copper, or taped at all appearances with green tape (sometimes, the green conductor may have a yellow stripe. Green conductors should not be used by CenturyLink or its contracted installation vendors for any purpose other than an ACEG conductor, interior ring ground, or other types of grounding conductors (although not desirable, green insulation is permissible in manufacturer intrabay and intrashelf wiring).

An ACEG should be run with each AC circuit (including temporary and permanent extension cords, which are also required to be GFCI-protected), and should be enclosed in the same conduit or raceway with the phase and neutral conductors.

Compression connections are preferred for AC terminations. Mechanical and single-hole connectors are permitted where allowed by the NEC, and where they are accessible for inspection. Connectors shall be the proper size specified by the manufacturer for the wire gauge and type, copper or tin-plated copper, and the correct hole size for the mounting hardware.

Wire nut connections should be placed so as to be accessible for maintenance and inspection, and should be made in an approved enclosure (i.e., junction box, conduit box, or pull box). When used, wire nuts shall be of the correct size for the wire gauge and number of conductors being joined.

For circuits where the nominal rms voltage exceeds 130 VAC, for personnel safety reasons it is desirable that receptacle cover plates be marked with the appropriate voltage (e.g., 208 VAC, 240 VAC, etc.).

AC circuits should be labeled with the location from which they are fed.

7.7.3 DC Power Conductors

DC Power and Grounding conductors shall be XHHW, traditional RHH-RHW with cotton braid, non-halogen thermoset cross-linked RHH-RHW, or DLO RHH-RHW (the latter is only allowed if it is fibered at all tie points and points of impingement). If placed under a raised floor that serves as an air plenum (and the space is not classified as IT space subject to NEC Article 645), conductors must be enclosed in fire-resistant conduit, or be MIC, or sealed-sheath MC type. Since the publication and local adoption of the 2014 NEC, red is no longer allowable for use going forward as a conductor color for either polarity of a -48 VDC system.

Unfused cable may be run between cabinets/bays (without traveling on overhead cable racking) when the batteries and/or plant are in no more than two adjacent bays or cabinets, but it must be done at the same level, and the conductors must be paired and protected from abrasion.

Separate cable racks for DC power conductors are not required, but it is advisable to run DC power cable on the horns or hangers of switchboard rack, or segregate it from switchboard and fiber cable as much as possible.

Cable tap connections should be accessible for inspection. Connections that are taped and have covers are considered accessible. Connections covered with heat shrink tubing, other than clear, are not considered to be accessible.

Bus bars should be free of sharp edges, burrs, corrosion, etc.; and should be copper or tin-plated copper. Bus bars should be properly supported, and insulated from surrounding metalwork, especially if they are closer than 3 inches from metal of a differing electrical potential.

For relay rack type Customer Premises installations, the equipment end termination of battery and battery return leads should be identified as to their source frame plate or panel, and fuse or breaker position; i.e., BDFB, PBD, etc. Identification may be accomplished by adding the information on a visible, small fiber or plastic tag attached to the cable with twine or nylon tie. If the fiber tag is equipped with a small metallic ring, this ring shall be removed in areas where it may contact electrically hot conductors.

Equipment fused from power sources outside its common equipment frame shall have its battery and battery return leads designated with the frame, plate or panel, and fuse or breaker position of the source end. Equipment fused within the same frame does not require designation tags on the load end.

All bus bars should be designated as to their potential and group designation in an area on or adjacent to the bar (i.e., -48 Volts, Load A, etc.)

Remote battery return bars associated with power frames and BDFBs should be designated with the potential and associated frame(s).

Shunts shall have their amperage rating and millivolt drop value designated and visible.

7.7.4 DC Distribution Panels, Fuses, and Circuit Breakers

All fuses and circuit breakers shall be of the proper type and capacity for the application (e.g., DC fuses for DC circuits, etc.).

When manufacturers specify that their loads have multiple feeds (i.e., A and B), they should be fused from separate primary power distribution. When separate feeders are not available, diverse cable routing or fuse assignment separation is advisable.

All cartridge, knife-type fuses, and fuse reducers being installed should be cleaned and lightly coated with a non-oxidizing agent. This also applies to fuse ferrules, blades, and the contact area of their associated clips.

Dummy fuses should be installed where fuse holders depend on the dummy fuse as a tensioning agent. Dummy fuses are not required for unassigned fuse locations.

Unequipped fuse or breaker block positions or panels should have blank panels installed for safety reasons.

When power cables are tapped down in size for entry into an equipment bay or shelf power lug, the taps shall be placed within six feet of the entry point. Taps should be staggered to prevent pileups (reducing splices are not required to be staggered).

Alarm fuses shall be installed or an alternate system provided to indicate when a feeder fuse has opened. It is advisable to pre-connect all fuse alarms when installing a fuse panel/board whether the fuse locations are fused up or are spare.

Power should be disconnected whenever possible from switches, fuses, clips, or connections before work begins on them. If the potential cannot be removed (due to the need to keep service working), attempt to protect adjacent parts of differing potential with insulating materials.

Where applicable, all PBDs, Battery Distributing Fuse / Ciruit Breaker Boards (BDFB/BDCBB) and miscellaneous fuse and breaker panels shall be clearly designated both front and rear as to frame, panel, row, plate, fuse locations, voltage, and load so as to coincide with equipment and assignment drawings/records. The fuse or breaker position number shall be considered adequate on the rear of each position and does not require tags where each fuse position number is designated on the rear.

It is desirable to designate fuse and breaker panels with voltage designations front and rear.

Designate all locations associating alarm fuse with discharge fuse.

For relay rack types of Customer Premises installations, it is desirable to designate DC distribution fuses with frame number, equipment type, and location associated with the distribution fuse. Example (RR 102.35 FP-07).

It is desirable to designate all fuse and breaker panels with row designations (letters and/or numbers). If this is done, designate each fuse or breaker with:

- Position number front and rear.
- GMT, 70 type, and miniature cartridge fuse panels shall be designated by first, every 5th, and last position.

- Capacity on the front of the fuse or breaker panel, or install a fuse designation pin, disc, or paint/adhesive dot. Where this is not possible, the fuse record sheet or book assigned to the panel should be designated.
- Circuit breakers and switches should be designated to show the "ON" position.
- All designation pins for fuses that are not assigned, should be removed or assigned "DNA" on the fuse assignment record. (Exception: This is not required where fuse designation pins are factory installed for guard fuse positions, or where the manufacturer specifies specific fuse values for each position, such as in ringing plants.)

Fuse panel detachable assignment records should be designated with frame, bay, or cabinet number, equipment type, and shelf or mounting location.

List all new or added circuits on fuse or breaker panel sheets (blue or black ink). Update all fuse and breaker record sheets, or drawings/records with changes, additions or removals. When changes are necessary, correction tape is better than white-out fluid or crossing through old designations.

7.7.5 VRLA Battery Installation Guidelines

Most Customer Premises installations use Valve-Regulated (VRLA) batteries to provide the DC backup. A UPS system, if present, is also likely to use VRLA batteries. These batteries are used in Customer Premises installations due to their lack of free-flowing liquid electrolyte and relatively small size. This allows them to be placed in small space-saving configurations. Follow the guidelines below when installing VRLA batteries.

Battery gasses, which are present during a charge or which remain near the cell at the completion of a charge, can exist in sufficient concentration to explode. Sufficient ventilation should be provided for the battery area, as described in Section 4.2. This is true even for VRLA cells. Even though these batteries are often referred to as "sealed" (this is a misnomer), they actually have a one-way pressure release valve that will release Hydrogen gas periodically during float operation, when there are shorted cells, when the float voltage is set too high, or when cell temperatures are high in plants where temperature compensation is not employed.

Due to this Hydrogen gas, before working on a battery cell, discharge static from yourself by touching a grounded surface.

For personal protection and protection of clothing, use chemical safety goggles, rubber gloves, coveralls and/or aprons as required.

Do not lift cells by means of intercell connectors or cell posts.

Cells from different manufacturers, and cells of different sizes shall not be placed in the same string.

Remove any shipping compound that might exist from battery posts and apply a non-oxidizing agent before installation.

VRLA batteries shall have the install date placed on each cell or monoblock, if the manufacturer has not provided the manufacture date of the battery on the case.

Connections to battery posts/lugs shall be torqued to the manufacturer specification.

VRLA batteries should not generally be boost-charged, equalized, or given an initial charge, due to the ability of the excess charge current to possibly drive weak cells into dangerous thermal runaway. If any of this type of charging is done, it should strictly follow the battery manufacturer's guidelines, which generally do not allow it for more than 24 hours, and under close supervision during those 24 hours.

VRLA batteries in -48 VDC Plants generally float between -53.8 and -55.2 VDC (consult the battery manufacturer's literature for exact levels; also the rare 23-cell VRLA strings, or low specific-gravity VRLA strings will float lower). Voltages should not be higher than this. If voltages are lower than -53.8 VDC, it may be because the power plant is equipped with temperature compensation. Temperature compensation lowers the float voltage as room and battery temperatures rise to prevent thermal runaway. However, if battery temperatures do not exceed 85˚ F, and the batteries are being floated below -53.8 VDC, adjust the voltage to at least this minimum. Temperature compensation should be inspected/adjusted at initial installation and at battery replacement to ensure that the slope of compensation falls within CenturyLink (see Tech Pub 77385, Chapter 13) and manufacturer guidelines.

After installation, ensure that the normalized temperature of the room does not exceed 85˚ F. If the room temperature exceeds 85˚ F report this fact to the Premises owner for correction. High room temperatures will severely reduce battery life and could lead to potentially dangerous thermal runaway. If the room temperature does not exceed 85˚ F, but the batteries do, and are more than 5˚ F hotter than room ambient, ensure that it has been at least 72 hours since initial installation to allow the batteries to become fully normalized. If battery temperature still exceeds 90˚ F 72 hours after installation (and there are no room temperature problems), there is probably a problem with the batteries that should be corrected.

7.7.6 Additional Considerations for Batteries

Flooded (or vented) batteries are superior in performance and lifetime to VRLA cells, but because of their size and liquid electrolyte (spill potential) are not generally used in Customer Premises installations. In the rare instances where they are used in Premises installations, consult Technical Publications 77385 (Chapter 3) and 77350 (Chapter 10).

Lithium-based batteries may be used in Customer Premises installations, but only if they are Listed to UL 1973. Even if Listed to that standard it is preferable that they be of a Li-ion phosphate chemistry for safety reasons. They do not require ventilation, weigh less, use less space, and will usually last longer than VRLA batteries; however, they are costly and can be more of a safety hazard, and require greater Fire Code precautions.

7.8 Proper Grounding Methods

Bonding and grounding must be done properly. Improper connections can loosen, corrode, etc. Lack of adherence to the standards found in Technical Publication 77355 can adversely affect digital equipment (by adding noise, allowing ESD damage, etc.). The rest of this section points out some of the more salient grounding methods and rules garnered from Pubs 77355, and 77350. However, all of Tech Pub 77355 is applicable.

7.8.1 DC Grounding Connections

All connections to bus bars, relay racks, cabinets, etc., should be made with irreversible crimp connectors (see Figure 7-3), and coated with a thin film of anti-oxidant. The 2-hole crimp connector should be copper or tinned copper.

Connections between cables may be an exothermic weld or an approved mechanical crimp (e.g., C-tap or H-tap).

Contact surfaces should be cleaned so that direct metal to metal contact is made. Non-conductive coatings (such as paint, lacquer and enamel) on equipment should be removed to assure good electrical continuity. Copper bars may require the use of low abrasive pads to remove oxidation.

Plated surfaces, such as silver- or lead-plated copper, etc., are plated to prevent oxidation and reduce contact resistance; and therefore, should never be sanded or abraded. If cleaning is required, wipe with a dry cloth.

Mating surfaces shall be flat to ensure maximum cross-sectional area contact.

Pressure or clamping devices shall be tight.

Lock washers are advisable to ensure secure bonding and grounding connections. Double or locking nuts also meet this intent. Shake-proof (star) lock washers under mounting screws, and split-ring lock washers with bolts and nuts are best. Lock washers should not be placed between the connecting terminal and the contact surface. Connections that require annual retorquing routines are not acceptable.

Generally only one connector should be attached with the same mounting screw or bolt. Any connector drilled with two holes shall be secured using both holes.

Stranded cables or wires shall not be stripped of strands at the termination point to fit a specific lug of the wrong size onto the cable.

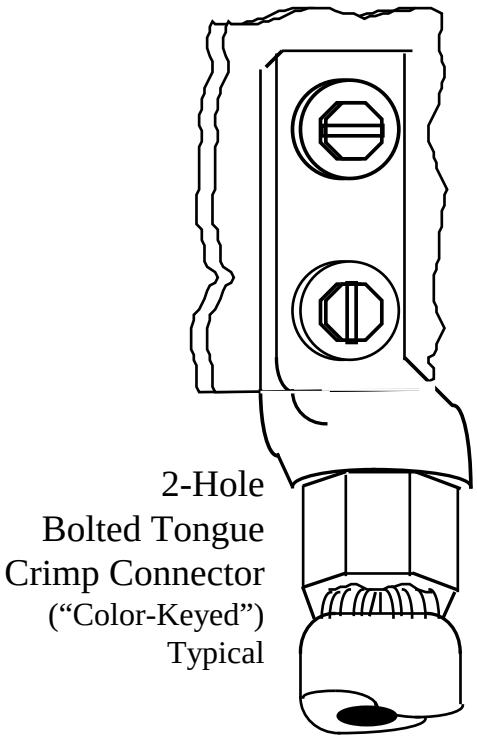

Figure 7-3 Two-Hole Crimp Connector

Grounding conductors, bonds and taps to ground conductors should be arranged to flow fault currents in the direction of the ground source (this does not apply to busbars).

All chassis, shield, and equipment ground bonds may be made using a solderless wrapped connection (wire-wrapped), or a single-hole ring-type crimped connector mounted to a properly prepared surface of the frame, bay, or cabinet with suitable hardware and a shakeproof lock washer.

7.8.2 DC Grounding Conductors

The minimum bending radius of a grounding conductor is 8 inches. 180 degree bends in grounding conductors are not permitted without a straight section.

A grounding conductor shall not be secured or supported by metallic clamps that completely encircle the conductor. Grounding conductors shall not be run in metallic conduit unless they are end-bonded at both ends.

It is desirable that grounding conductors be traceable in order to find grounding problems that could be causing electrical noise or compromising personnel safety. For this reason they are not generally run in cable racks; instead they are secured to hangers or to the side of the racks. If grounding conductors are run in cable racks or trays, they would be easier to trace if they were marked differently than the other cables (e.g., colored green, etc.).

It is desirable that identification tags be affixed to each end of all equipment bonding and grounding cables. Either or both sides of a tag may be used for designations. The information on the identification tags should contain the location where the opposite end of the cable is terminated. Short lengths of bonding or grounding cables, #6 AWG and smaller, which are entirely visible, and shall remain so for their entire expected life, are exempted from this rule and are not required to be designated.

It is desirable to place "Do Not Disconnect" tags on all removable grounding electrodes and all terminating locations of main ground reference conductors.

7.8.3 Ground Plane Considerations

In most Customer Premises installations, all of the grounding is integrated (also known as non-isolated or neutral in a PANI system). In some rare cases, installations will have switching equipment that requires an isolated ground system. In these cases, the isolated and integrated ground planes must be properly designed, installed and maintained to provide adequate protection of personnel, equipment and service in accordance with CenturyLink Tech Pub 77355 and the National Electrical Code.

When other telecommunications equipment (owned by the customer or other companies), or other metallic objects in a room will be placed within 7 feet of the CenturyLink equipment, they should also be ultimately grounded to the same ground source (e.g., bar) that CenturyLink is using. This will avoid potential differences between equipment that can be hazardous to personnel and/or damage equipment. This is the responsibility of the customer.

All bars that constitute the ground window in sites using such a design shall be designated "GROUND WINDOW" once, adjacent to the bars and visible from the floor. The individual bars (or portions of bars) shall be designated for "ISOLATED" and "INTEGRATED" areas and each separate bar designated with its appropriate title. i.e. Main Ground Bus (MGB), Single Point Ground (SPG), etc.

Designate deliberate bond points made through surface contact, for Foreign Object Grounding (FOG) paths with "GRD" in ⅜" or 36 point font. Designations shall be placed so that they are visible from the floor.

7.9 Hazardous Material Handling

Hazardous materials are those materials that are potentially hazardous to human health and the environment. The handling, packaging, storage, transportation and disposal of these materials are governed and regulated by various federal, state, and local laws that are very specific and restrictive on the handling of such materials. Violations can lead to fines and/or imprisonment for employees, Service Suppliers, and subcontractors for the illegal disposition of a regulated material. CenturyLink is responsible for hazardous materials from cradle to grave, and tracking (with such items as Bills of Lading, HazMat Manifests, etc.) is very important.

Hazardous Material and Waste Handling Guidelines for CenturyLink contractors and customers are covered in Chapter 12 of Tech Pub 77350. CenturyLink employees should be able to contact their Environmental Health and Safety (EHS) representative with questions, and there is an internal environmental health and safety manual available behind the firewall (on the company intranet) for CenturyLink employees.

The Service Supplier shall comply with Local, State, and Federal Regulations involving hazardous waste and/or materials. On jobs requiring dismantling of equipment or removal of equipment containing hazardous materials, the Service Supplier shall contact the CenturyLink representative before starting any removal work. The U S Environmental Protection Agency (EPA) has published regulations pertaining to the management and disposal of hazardous waste materials in compliance with the Resource Conservation and Recovery Act (RCRA).

In Customer Premises telecommunications locations, the following hazardous materials might be found:

- Relays using Mercury (Hg)
- Circuit Packs with components containing Mercury (Hg)
- Ballasts and transformers containing PCBs
- Radioactive Tubes
- Asbestos Resistors
- Asbestos Floor Tiles
- Lead-Acid Batteries (and possibly their intercell connectors) containing Lead (Pb) and Sulfuric acid (H_2S0_4), and capable of producing Hydrogen Gas (H_2) and Hydrogen Sulfide Gas (H_2S)
- Cable and Sleeves containing Lead (Pb)
- Cleaning supplies which might contain Solvents and CFCs
- Paint with hazardous materials such as Lead (Pb), etc.

7.10 Installation Documentation

7.10.1 Commonly Used Installation/Removal Forms

The Service Supplier shall be responsible for the proper filling out and distribution of, all applicable forms and documents. Applicable CenturyLink Installation and Removal Forms for LNS locations (RG forms and 820 series Test and Acceptance Forms in the attached table) are mostly found in Technical Publication 77350. For NNS locations, applicable forms (00 series Forms, as detailed in Table 7-5) are available to installation suppliers through the CenturyLink Engineer.

In the following table, forms and labels specifically stated as NNS forms are thus marked, and the same applies to LNS forms. If they are not designated as either LNS or NNS, then they can be used for either type of site.

Table 7-4: Common Installation/Removal Forms

Form Number	Name/Description
RG 33-0017	Straight Bill of Lading
RG 33-0043	LNS Document and Material Disposition Form
RG 41-0046	Installation Job Log
RG 41-0170	LNS Installation Alarm Assignment and Capacity Sheet
RG 41-0173	LNS Alarm/OSS Testing Incompletion Tag
RG 47-0002	Installation Revised/Completion Notice
RG 47-0004	Job Information Memorandum
00132	Method of Procedure
RG 47-0009	LNS Report of Equipment Disconnected from Existing Plant
RG 47-0013	LNS Service Interruption/Degradation Report
RG 47-0132	LNS Cable Hole Open Label
RG 47-0133	Fire Stopped Cable Hole Label
RG 47-0157	LNS Test Record
RG 47-0166	LNS Job Site Material Inventory for Missing Items
RG 47-0169	Letter of Deviation
RG 47-0170	LNS Installation Alarm Assignment and Capacity Sheet
827	LNS OSP site Test and Acceptance Checklist
00171	NNS Electronics Test and Acceptance Form
002368	NNS DC Power Acceptance Form
RG 51-0083	Job Packet Envelope

7.10.2 Job Packet and Job Log

The Service Supplier should use a Job Packet Envelope for all installation or removal activities where documentation and job papers are to be turned over to CenturyLink.

The Job Packet may contain, but is not necessarily limited to:

- Design Work Package or Engineering Document Package (Detailed Job Specification)
- All Methods Of Procedure (MOPs) related to the job (see document 00132)
- Completion Notice (RG 47-0002) or completion date noted on the outside of the Job Packet
- Job Log (RG 41-0046)

- Test Records
- Bills of Lading (RG 33-0017)
- Job Information Memorandums (RG 47-0004)
- Drawings/Records ("installer marked" shall be identified)
- Letters of Deviation (if issued)
- Alarm Assignments
- Material Inventory of Missing Items
- Service Interruption report if problem occurred

The RG 41-0046 Job Log mentioned above will typically include, but not be limited to the following:

- Deviations from the Specification or Standards approved by the Design Engineer
- Material shortages and impact on job progress
- Engineering changes
- Communications with Design or Detail Engineers, Installation Quality, CenturyLink Operations, the Customer, Tech Support personnel, etc.
- Security or Safety Problems

7.10.3 Job Completion or Extension Reporting

The Service Supplier shall report the completion of a job on the day the job completes to CenturyLink. Service Suppliers should obtain CenturyLink Operations' acceptance before sending a final Completion Notice to the Design Engineer. Advanced or partial completion of the job shall also be reported.

Where possible, the Service Supplier should obtain a "CenturyLink Representative" signature on the job completion notice prior to the distribution of copies. The CenturyLink representative shall mark the job completion notice as "Accepted" or "Not Accepted", with appropriate comments.

7.10.4 Job Information Memorandum (JIM)

A JIM (RG 47-0004) is a formal publication issued by the Engineer (based on communications with the installer) to explain and correct differences between actual job conditions and the engineering information provided.

A JIM must include a specific detailed description of each additional work effort associated with an installation job. The JIM must include the exact number of hours required to complete each specific work effort.

7.10.5 Service Interruption/Degradation Report

When a Service Interruption/Degradation Report is required the Service Supplier shall notify the CenturyLink site manager and Design Engineer. A copy of the report shall be sent to the CenturyLink Operations manager, Design Engineer, Job Packet, and Network Strategic Sourcing Construction Team Lead: 7800 E. Orchard, Ste. 450, Englewood, Colorado 80111 (FAX 303-224-1023). Another copy shall be sent to the Regulatory Analysis and Interface Group, 700 West Mineral Ave., Room NEE29.22, Littleton, Colorado 80120 (FAX 303-707-2229) within 24 hours of the occurrence. The service supplier shall obtain the Nil Notification Report of Major Service Failure or Occurence, and Change Management ticket numbers from the CenturyLink person that was notified, and include it in the report.

7.10.6 Returning Material

When the Services Supplier needs to return excess material, they shall complete an MRF (Material Review/Return Form). This can be provided to them by a CenturyLink employee, who can obtain it from the Asset Recovery and Disposition (AR&D) intranet website (where the entire process is detailed), or the Supplier can obtain it by emailing: Asset_RecoveryandDistribution@CenturyLink.com.

When shipped material is damaged in transit or items are missing, clearly write any damage or shortage on the delivery receipt. This includes damage such as "boxes crushed, punctured, wet, or damaged".

For claims, the following minimum documentation is required (other documentation may also be required):

- Copy of the delivery receipt
- Copy of the packing slip
- Statement concerning the circumstances

Damages, overages, and shortage may require using the material return process. .

To file a claim for common system material that is incorrect upon receipt of shipment, complete the "Report of Unsatisfactory Shipment" on the back of the packing slip. Call the NPC expediter to reorder material and arrange for material return.

To order common systems material, the Service Supplier shall coordinate with the Design Engineer.

A Service Supplier shall not scrap material without approval from the Design Engineer, or instructions in the DWP. Once authorization has been obtained, locate the MRC for your area (see the process for AR&D above), and call the SMC (877-879-7447) to make transportation arrangements.

7.11 Installation Methods of Procedure (MOPs)

This section speaks to the minimum requirements for the preparation of a Method Of Procedure (MOP) required for all work operations performed on equipment being added, removed or modified in any manner, in CenturyLink equipment facilities. The MOP is a written document which details installation and removal procedures and operations that shall be followed in their entirety.

The Service Supplier shall be responsible for the writing of the MOP before the start of any installation activity. Where possible, a CenturyLink Representative, a designated member of the Operations organization , should review and concur in its content. That individual may or may not have specific work related activities detailed on the MOP. Responsibility for work functions and operations are indicated on the MOP. While CenturyLink personnel signatures are normally required on MOPs for installation activity in CenturyLink facilities, it is recognized that this will not always be possible in Customer Premises installations. However, even though it is not an absolute requirement, the Service Supplier should make an effort to meet with a CenturyLink Operations representative, have them review the MOP, and sign off on it. Whether CenturyLink signatures are obtained or not, a MOP shall be posted for all installation activities.

The Service Supplier Representative responsible for the preparation of the MOP (in NNS, when CenturyLink Operations will be performing the install, the Engineer may be the creator of the MOP) should be knowledgeable in the proper use and completion of the MOP form and in the specific work operations involved, and familiar with CenturyLink standards.

The Service Supplier shall send a copy of the MOP to the Engineer and the CenturyLink Operations representative (where possible).

A properly written MOP is intended to prevent the occurrence of costly service interruptions and to assure that work is performed in a safe and secure manner. It is the responsibility of the supplier preparing the MOP to clearly and accurately represent all work to be performed and to detail all required steps, procedures and locations where work is to be performed. Every effort shall be made by the Service Supplier and CenturyLink representative to work cooperatively to assure that no degradation of equipment or service will occur.

During the installation process, a copy of the MOP shall be posted in a convenient location, preferably near the actual equipment being installed, modified, or removed. Completed MOP forms shall be included with job documentation.

It shall be understood by all parties that the content of individual MOPs shall be used to help affix responsibility for work operations, procedural errors, service outages and accidents that may occur during the exercise of the detailed procedures. It is in the interest of all involved parties to assure that each MOP is complete and accurate.

Entries on the MOP form found in CenturyLink document 00132 are to appear in their proper respective fields and be legible and understandable. The form is designed to be utilized in computer word processor type systems.

A MOP, written to install, remove or modify equipment, shall be prepared for each order number and location.

Extended breaks (greater than 30 days) in installation activity require cleanup and abandonment of the area and a new authorized MOP upon restart of the activity.

The details of the MOP are most important when work is to be performed on live equipment. This includes any work on equipment that is in an area where potential hazards to equipment or personnel exist. The work description section of a detailed MOP defines each step of the process and, in effect, is the step-by-step procedure under which the activity shall be performed. This includes all precautionary steps before, during and after each work effort. For service-affecting work, the MOP should also include backout procedures. Success of the particular activity depends highly on the accuracy and completeness of this form.

Before installation/removal activity begins, the CenturyLink technician may need to pre-apply for a Change Management ticket.

Any document referenced in the step-by-step procedure should be on site and readily available for use.

The Service Supplier shall collect all essential information available for the job and confer (where possible) with the CenturyLink Representative regarding the proposed sequence of work operations. An initial MOP walk-through, if needed or requested, shall be conducted at the work site, to identify potential hazards and special conditions that may effect work operations. Those items shall include such considerations as building and equipment conditions, customer service, safety issues, corrective measures and security procedures.

The work description portion of a detailed MOP shall be completed by the installer who will be responsible for the work operation. The Service Supplier representative shall be familiar with MOP procedures, and CenturyLink Installation Standards as defined in various applicable publications; and be qualified to perform the work operations detailed within the MOP, regardless of whether they will actually perform each step of the procedure themselves.

An installer's qualifications for involvement in the MOP writing process and work procedures shall be the responsibility of the Service Supplier. Each Supplier shall accept the responsibility for the work performed by their employees and their subcontractors.

The work description portion of a MOP may be prepared by a representative of the Service Supplier provided that person is familiar with the generic equipment type and activity represented in the job detail specification.

The work description in the MOP shall include all steps necessary to perform the work. Each step shall be numbered, and appear in the order in which they will occur in the work operation.

The Work Description Details portion of the MOP shall contain narrative references to all applicable steps. The check lists entitled "Have You Considered" or "Question your Work" are intended purely to enhance the completeness of the narrative write-up. Examples of write-up considerations are (note that this list is not all-inclusive):

- **Equipment Added**, including all frames, bays, units and apparatus
- **Equipment Removed**, including all frames, bays, units and apparatus tagged or identified
- **Equipment Compatibility** with existing units and circuits
- **Affected Working Circuits** not listed as added or removed on this work specification.
- **Restricted Work Hours —** to be listed in the MOP header information (this could be a maintenance window; or there are other opportune times for certain types of installation work, often depending on the particular loads and needs of that site)
- **Work Area Protection** to adjacent equipment and building
- **Special Tools/Materials**, such as circuit pack pullers, hoists, ungrounded drills, HEPA vacuum, etc.
- **Tool Insulation**, including inspection of all insulated tools
- **Safety Considerations**, including goggles, floor clutter, rubber gloves and aprons, insulated power blankets, etc.
- **Emergency Equipment and Procedures Available**, including first aid, hazardous material, fire, etc.
- **Procedures Available** that are manufacturer or product specific
- **Fuse Alarm Operation** checked for added and affected circuits
- **Location of Spare Fuses —** has been checked for availability
- **Records Correction** where existing information has been altered
- **Hazardous Material Handling and Storage** policies, labeling, storage supplies and required paperwork available
- **Personnel Experience** considered for both work effort and MOP responsibility
- **Before and After Tests —** to be performed on applicable circuits
- **Backout Procedures —** covered in the eventuality that hardware, software errors or time restrictions preclude service restoration by the designated COMPLETION TIME

- **Referenced Documents** should be on site and readily available for use
- **Technical References** are available and understood
- **Required CenturyLink Support** has been discussed and is available (if necessary)
- **Emergency Restoration Plans** have been discussed and are in place for any eventuality
- **Fuses and Leads Tagged** for identification purposes, including any AC circuits under LOCKOUT condition
- **Office Records/Drawings Available** on site when necessary
- **Supplier Drawings Available** on site when necessary, as well as installation instructions and manuals
- **MOP Referenced Documents —** on site and available for use

Following the preliminary MOP write-up, the Service Supplier Personnel who will be performing the work operations and, if possible, the CenturyLink Operations person who will be responsible for coverage (if needed), should conduct a dry run of the detailed procedures. At this time, any shortcomings or omissions in the write-up shall be addressed.

The signing authority for each MOP appears at the end of the form. The Service Supplier and all signing parties are responsible for verification that their particular copy of the MOP is complete in all its pages.

The Service Supplier Representative may be the person performing the actual work activity. This person may be a Service Supplier's supervisor or any duly appointed personnel in the suppliers analysis center. The CenturyLink Representative field may be signed by the CenturyLink Operations supervisor and/or any duly appointed CenturyLink technician where possible. (It will not always be possible for the Service Supplier to conveniently find CenturyLink Operations personnel. In the cases where CenturyLink is the Service Supplier, the installer may sign in any or all of the fields.)

If CenturyLink, or the contracted Installation Service Supplier is making connections to a Customer-owned DC plant distribution panel or bus, it would be wise to get the Customer's signature (somewhere near the signature section, since there's no specific line for it) on the MOP for this work.

7.12 Service Interruptions

If a service interruption occurs during installation or removal activity, service must be restored quickly. The Operations personnel and the Service Supplier personnel shall work cooperatively to ensure that actual outage time is kept to a minimum.

CenturyLink **UNICALL (1-800-654-2525)** shall be called immediately and informed of the outage and of the actual or expected term of the outage. In addition the appropriate alarm management center shall be notified. For LNS sites, call the NROC Network Management Center at (800) 879-1200. For legacy OnFiber NNS sites, call (866) 663-4237. For all other NNS sites, call (800) 860-6485.

All particulars that led to the service outage shall be documented on CenturyLink Service Interruption Form RG 47-0013 and presented to the CenturyLink Representative within 24 hours of the outage. (Further procedures for processing this form are outlined in Section 7.10.5.)

In order to minimize service interruptions, CenturyLink has a Change Management process. The purpose of these processes is to formally register work activities (by the Service Supplier with a CenturyLink representative) that have the potential to impact or cause an outage or network service disruption.

The Change Management tool used by CenturyLink for planned outages is controlled specifically by CenturyLink personnel (Refer to the list below for examples of planned network activities requiring registration). The Service Supplier has no direct access, but must enlist the assistance of the CenturyLink representative to file for a Change Management ticket. The process of opening such a ticket will vary based on location and CenturyLink geography. In any event, the Service Supplier will document, in the Method of Procedure (MOP), all of their steps to register their planned network activity (including the Change Management number associated with their specific work).

If the work activity goes according to plan, and no outage occurs, the Service Supplier will perform all required testing to insure that the work is completed correctly. The Service Supplier will verify and update any applicable databases (access permitting) for accuracy based on the completed work. The Service Supplier will call the appropriate CenturyLink Alarm Center to ensure that the network is in a stable condition. When validated and confirmed by the CenturyLink Technician overseeing the work, the Change Management ticket for this work may be closed.

In the event an OUTAGE DOES OCCUR, the Service Supplier will work with all available resources to rectify the condition and document all activity in the installation Job Log. Not until verified and confirmed by the CenturyLink center, will the condition be considered resolved. Only at that time may the Change Management ticket be closed.

The following activities in a Customer Premises location require a Change Management ticket.

- Power to Customer Premises
- Replacement or upgrade of fiber common equipment boards
- Any maintenance work on equipment that involves FAA or 911 circuits

- PCNs for CenturyLink maintained Customer Premises equipment, and multiplexers
- Reference Rearrangements
- Any vendor, Inter-Exchange Carrier activity
- Cable & Fiber section throws
- Transport network element growth
- Transport network element conversion
- Decommissioning of transport equipment, cable mining, etc.
- NNS site access for non-CenturyLink personnel
- Any other planned maintenance window activity; specify

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Tables

8. Alarming

CenturyLink Communications, or their authorized Installation vendor, is responsible for ensuring that equipment, power, and some environmental alarms are remotely connected and tested to the appropriate CenturyLink Network (Reliability &) Operations Center (NROC/NOC), or Business and Government Services (BGS) / Designed Services centers (for SHARP/SHNS or government services alarms), or to the DSL Operations center for DSL/Ethernet SNMP trap alarms. These CenturyLink centers are responsible for proper alarm monitoring, analysis and dispatch.

The customer is responsible for ensuring that CenturyLink technicians have access to the telecommunications equipment 7 days a week, 24 hours a day to perform reactive and proactive maintenance for remotely alarmed equipment.

CenturyLink Engineering is responsible for determining the alarm requirements, and the method of alarm transport.

Alarm transport methods are varied. For SONET-based equipment, its equipment alarms are transported back to the "A end" over dedicated channels within the SONET bandwidth. At that point there must be a connection (typically an X.25 or IP circuit) between the headend and the alarm system. And the alarms must be databased with the NMA database group for proper messaging and routing. Finally, alarms should be tested for continuity with a CenturyLink center technician.

Some other non-SONET equipment also has dedicated alarm channels. For example, some Digital Loop Carrier (DLC) systems will allocate a portion of their overhead transport bandwidth back to the central office for the transmission of alarms. At the central office end, these alarms must generally be picked off the Central Office Terminal (COT), and connected to an alarm monitoring system (for example, an e-telemetry device such as Dantel®). These alarms must also be tested for continuity.

Some equipment is less intelligent, and requires another alarm transport medium to get back to the "A end". Power equipment, such as rectifiers and fuse panels are good examples of this. Some transmission equipment also does not have its own alarming. And environmental alarms (such as high temperature, fan failures, etc.) need an alarm transport medium for their failures. The most common type of alarm transmission system for these "housekeeping" alarms is the overhead bitstream of the fiber multiplexer. (This method of transmission is described in greater detail further on in this Section.) If the site does not have a multiplexer, nor spare alarm channels on the transmission equipment, another alarm transmission device (e.g., a small e-telemetry system) must be installed for the housekeeping alarms. Whether a fiber mux overhead or another transmission medium is used, alarms must still be ultimately connected at the "A end", and tested for continuity to the appropriate CenturyLink alarm center.

For provisioning and testing of LNS alarms going to NMA, the following contacts can be used. For e-Telemetry and X.25/IP databasing, the phone number is: (763) 536-3888; and the fax number is: (763) 536-3799. For X.25/IP circuit provisioning and turnup, the phone number is: (763) 536-2441; and the fax number is: (763) 536-3799.

The LNS NMA Database groups require the following information: ETEL number, remote address, and display number (for e-telemetry points); the X.25 circuit ID (for X.25 points); plus the assigned alarm points, and BVAPP number.

For provisioning and testing of SNMP trap alarms (see Table 8-2) for Ethernet type services (such as MOE), use the DSL Ops Center (800-229-6751) for turnup and testing.

For NNS locations, the appropriate alarm center will help with provisioning and testing (866-663-4237 for legacy OnFiber sites; and the ECC [Environmental Control Center] at 800-860-6485 for all other NNS locations). The test and acceptance for NNS site alarms will probably be handled by a CenturyLink Tech Support Engineer, but they can be contacted via the ECC.

No network element shall be turned up for service without alarms, unless the service is specifically tariffed and/or the contract with the Customer allows for non-remote-alarmed service. The Service Supplier and/or CenturyLink Operations personnel shall list all alarms and any reason any of them cannot be tested at job closure in the Job Log. The Service Supplier and/or CenturyLink Operations personnel shall be responsible to correct any problems associated with the installed product alarms. The Service Supplier shall negotiate with the Design Engineer for any additional alarm testing effort required, because of CenturyLink caused delays or problems. The supplier and/or CenturyLink Operations personnel shall record all test results for LNS sites on RG47-0157 and/or RG47-0170 and place a copy in the job package. For NNS sites, the appropriate alarm testing forms are found in the appendices of document 00690, which is available to service suppliers through their CenturyLink Engineer. When existing muxes carrying housekeeping alarms are removed/replaced, the CenturyLink Engineer must ensure that any existing housekeeping alarms are transferred to a device that can carry overhead bitstream alarms. If this cannot be done, they must keep the old mux up, or add a device that can carry the housekeeping alarms.

Alarms that are equipped for future use, and require software translations or cross-connections, which are to be made in the future do not require an ETEL number or X.25 circuit ID. The Installer shall be required to perform standard continuity and power verifications on these circuits.

When alarm testing is complete, the NMA group or Tech Support Engineer will provide a confirmation log number to the Service Supplier. This log number shall appear in the Job Log, and for LNS sites on the Installation Revised Completion Notice (Form RG 47-0002). For NNS sites, alarm test records are kept on the forms from the appendices of document 00690.

Fire, humidity, air-conditioner failure, and other similar building alarms will not normally be monitored by CenturyLink, and are the responsibility of the building owner. However, high temperature may be monitored by CenturyLink, and if detected, the Premises management will be informed and asked to correct the problem immediately.

If the DC power plant of the site is owned by the customer, the customer is responsible for monitoring that plant, unless specifically negotiated otherwise with CenturyLink.

Fiber multiplexers, which are installed in many Customer Premises locations, are capable of carrying housekeeping alarm data in a portion of their overhead bandwidth. This is known as the overhead bitstream, and as noted is to be used for alarms that are not carried on the normal SONET equipment channels. Most of these muxes allow contact open or contact closure connections, and there are usually between 4 and 18 points, depending on the multiplexer. These overhead bitstream alarms are given text names and descriptions through programming of the mux. These alarms are transmitted back over the overhead bitstream to a central location mux (such as might be found at a CO or TI site). If this "A end" mux is then connected to a packet network, the names and descriptions given the alarms can then pass through to the CenturyLink alarm monitoring system, NMA, given that NMA is properly programmed to accept these points. (If the "A end" mux is not connected to a packet network, the alarms must be pulled off of it and placed on another alarm transmission device as simple binary alarms. These must then be programmed to NMA in the traditional way for that alarming device.) The packet connection is the preferred method. Ericsson Telcordia and CenturyLink have jointly developed standard TL1 messages to be programmed into the muxes at LNS sites for eventual transmission to NMA over the X.25 circuit. The minimum set of standard overhead bitstream TL1 messages used by CenturyLink in LNS locations is given in Table 8-1. Some muxes are only capable of accepting the messages defined in Ericsson Telcordia GR-833, Appendix F. The ALMTYPEs (Condition Types) for these messages are marked in the table below with an asterisk, and the description in quotations. This TL1 condition type for these messages must totally describe the event within the 10 character limit (the messages are limited to 10 characters because some of the muxes used by CenturyLink will only allow that many characters for a condition type). (Most muxes also have an additional 40 character open text field for each alarm with which to further describe it.)

The generic building alarms shown in the following Table 8-1 (BLDGMJ and BLDGMJCR) may use replacements for the acronym "BLDG", depending on the site type. For example, there could be a CPEMJ, or a CPECABMN alarm. There may also be other derivations from the messages given below. All of this housekeeping alarm wiring and programming work is to be done by CenturyLink or their hired installers. Note that this table (and Table 8-2) are applicable to CenturyLink LNS installations.

For alarming requirements for NNS Premises and Carrier Hotel locations, installation suppliers shall refer to CenturyLink document 00690, available to them through their CenturyLink Engineer. Table 8-3 provides a summary listing of all of the alarms for Premises locations found in NNS documents (including 00690), but more specific details about which alarms apply to which sites are in the documents themselves.

Note that the messages listed in Table 8-3 are not possible to program word-for-word in every device (in fact, some of the muxes only allow the Ericsson Telcordia GR-833 Appendix F messages that are found in Table 8-1, marked with an asterisk). The guidance is to choose wording as close as possible to that found in Table 8-3.

Table 8-1: CenturyLink Standard Power and Environmental TL1 Condition Types for Overhead Bitstream Transmission on Premises (Page 1 of 2)

CONDTYPE (ALMTYPE)	**NTFCN CODE**	**Description of Condition Type** (some of this may be used in the 40-character **ALMMSG** field)
BATTDISC BATTERY *	MJ	battery disconnect breaker manually or automatically operated or "battery failure"
BATTTEMP	MJ	high (or low) battery temperature
BLDGMJ CPMAJOR *	MJ	any building environmental major — used when points are limited generic "environmental major"
BLDGMJCR	MJ	any environmental major or critical — used when points limited
COMLACFAIL POWER *	MJ	"commercial" AC "power failure"
CRITICAL or CR	CR	system critical (may have other characters before or after in ALMTYPE)
DIFFTEMP	CR	high differential temperature between the batteries and the ambient
DISTFUSE FUSE *	MJ	power distribution "fuse" or breaker "fail"/operation
CKTBRKR	MJ	any breaker operated
ERR	MN	bit error rate in transmission (may have other characters before/after in ALMTYPE)
EXC	MJ	excessive error rate
EXPLOSIVE EXPLGS * GASDETECT	CR	combustible/"explosive gas" alarm or gas detector failure
CLFAN * FAN VENTILATE VENTN *	MJ	ventilation/circulation/"cooling fan" or "ventilation system failure"
FE	MN/MJ/CR	far end alm (may have other characters before or after in ALMTYPE)
FIRE	CR	fire or smoke alarm
HITEMP * HILOTEMP TEMP	MJ	"high" or "low" site "temperature"
LWTEMP *	MN	
HILOVOLT	MJ	high or low DC plant voltage
HIVOLTAGE RECTHI *	MJ	high DC plant voltage or "high rectifier voltage"

Table 8-1: CenturyLink LNS Standard Power and Environmental TL1 Condition Types for Overhead Bitstream Transmission on Premises (Page 2 of 2)

CONDTYPE (ALMTYPE)	NTFCN CODE	Description of Condition Type (some of this may be used in the 40-character **ALMMSG** field)
ILC *	MN	insufficient link capacity
LOS	MJ	loss of signal (may have other characters before or after in ALMTYPE)
LFD *	MN	loss of frame delineation
BATDSCHRG *	MJ	"low battery"/plant "voltage" — "battery on discharge"
LOVOLTAGE		
LWBATVG *		
LVDDISC	CR	low voltage disconnect switch operated
LVDFAIL	CR	low voltage disconnect device has failed
MAJOR or MJ	MJ	System/"equipment fail/major" (may have other characters before or after in ALMTYPE)
CPMAJOR		
MINOR or MN	MN	system/"equipment minor" (may have other characters before or after in ALMTYPE)
CPMINOR *		
MISCn *	MN/MJ	"miscellaneous" alarm on overhead point #n — describe in the ALMMSG field
HKAn		
N48B1MJ	MJ	any "centralized power plant major" alarm combined on this point
CPMAJOR		
N48B1MJCR	MJ	power major or critical — used when there aren't enough points to separate
N48B1MN	MN	any "centralized power plant minor" alarm combined on this point
CPMINOR		
N48B1CR	CR	any power critical alarm combined on this point
PWR-48 *	MN/MJ/CR	"-48 V power supply alarm" or combination of alarms (may append criticality)
NE	MN/MJ/CR	near end alm (may have other characters before or after in ALMTYPE)
OPENDOOR	MN	"open door (intrusion alarm)"
INTRUDER *		
OPENDR *		
PMI *	MN	payload missing indication
PTM *	MN	payload type mismatch
RECT *	MN/MJ	DC plant "rectifier failure" (minor for 1 rectifier, major for multiple rectifier fails) or "rectifier low voltage"
RECTFAIL		
RECTLO *		
TLCR *	MJ	receive (Rx) total loss of capacity
PLCR *	MN	receive (Rx) partial loss of capacity
RINGFUSE	MJ	ringing distribution fuse operated
RINGMN	MN	ringing plant generic minor (e.g., one ring generator failed, etc.)
RINGMJ	MJ	ringing plant generic major (e.g., both ringing generators have failed, etc.)
RPTR	MN/MJ/CR	repeater alarm (may have other characters before or after in ALMTYPE)
SQM *	MN	loss of sequence
SYNC	MJ	synchronization/timing alarm; possibly a clock failure
DATASYNC LOS *	MJ	loss of data synchronization
TLCT *	MJ	transmission (Tx) total loss of capacity
PLCT *	MN	transmission (Tx) partial loss of capacity
VHILOVOLT	CR	very high or very low voltage

Table 8-2: CenturyLink LNS Premises Standard Power and Environmental SNMP Traps

SEVERITY	SNMP Trap (Condition Description)
Major	AC Failure
	Power Failure
Major	Battery on Discharge
Minor	boostOn
Major	Cabinet Failure
Critical	communicationLost
Minor	Door Open
Major	Cabinet Fan
	Fan Board
	Fan Failure
Major	Fuse Failure
Critical	lowBattery
Major	Power Major
Minor	Power Minor
Minor	Power Shed
Major	upsBypass
Major	upsBypassacabnormal
Major	upsBypassacnormal
Major	upsBypassFreFail
Critical	upsDiagnosticsFailed
Critical	upsDischarged
Critical	upsOnBattery
Critical	upsOverload
Major	upsRebootStarted
Major	upsRecroterror
Major	upsScheduleShutdown
Major	upsSleeping
Major	upsTemp
Major	upsTest
Major	upsTurnedOff

Table 8-3: CenturyLink NNS Standard Premises Power and Environmental Alarms

Condition	Description
Commercial AC Fail (Alarm)	AC input voltage to the rectifier decreases below a threshold
Battery on Discharge (Alarm)	indicates that the batteries are supplying the load
Low Voltage Alarm	DC plant voltage decreases below a threshold
Battery Failure	a battery cell/module, string, or plant has failed
High Voltage Alarm	DC plant voltage increases above a threshold
Max Capacity Alarm	the DC plant load has exceeded its preset capacity threshold
Door Open	a cabinet, room, or site door is open
Open Door CenturyLink	
Tech on Site CenturyLink	
Door Alarm	
Site/Cage Door Opened	
Battery Fuse Alarm	a distribution fuse in the DC plant has opened
Distribution Fuse	
Primary Fuse Breaker Trip	a breaker has tripped or a fuse has opened in the DC plant
Fuse Panel Minor Alarm	a fuse has opened in a miscellaneous fuse panel or BDFB
Module Fuse	
Fuse (Panel Fail) A Side (Alarm)	
Fuse (Panel Fail) B Side (Alarm)	
Secondary Fuse Breaker Trip	A tripped breaker or an open fuse in a BDFB/BDCBB
High Temperature (Bldg #)	the temperature has exceeded the threshold
Low Voltage Disconnect Alarm	batteries disconnected because the DC voltage dropped below a preset threshold
Battery on Disconnect	
M13 Mux	an alarm on a DS-1/DS-3 mux
Critical Power Failure	any DC plant critical alarm has occurred
DC Major (Alarm)	any DC plant major alarm has occurred
Major Power Alarm	
Major Power Failure	
DC Minor (Alarm)	any DC plant minor alarm has occurred
Minor Power Alarm	
Minor Power Failure	
Rectifier Minor (Alarm)	one rectifier has failed
Rectifier Fail	
N+1 Redundancy	
Rectifier Major	more than one rectifier has failed
Symmetry Fail	loss of redundant path

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9. Customer Responsibilities and Agreement

Individual Agreements/Contracts with Customers are negotiated by the appropriate CenturyLink Marketing Groups, possibly with the help of the CenturyLink Contracting Organization. These agreements or contracts should generally include the following provisions related to environment, power, grounding, and installation. Many of these provisions are taken from state tariffs, BIC policy, Cable Wire and Service Termination Policy, MPOP Policy, and/or New Construction Policy (CenturyLink personnel can refer to these documents if further information is required).

- The space provided shall comply with the UBC, NEC, and any other relevant local, state, or national codes
- The Customer shall allow employees or agents of CenturyLink free access to the Premises and facilities where the digital equipment is located on a 7 x 24 basis. This is necessary to ensure timely alarm response, reliable service, and to enable CenturyLink to meet the service guarantees of selected service offerings.
- All operations at the Customer's Premises will be performed at the expense of the customer and will be required to conform to whatever rules and regulations that CenturyLink may adopt as necessary to maintain a proper standard of service.
- The customer is required to provide adequate building space, lighting, and atmospheric control (humidity, temperature, and ventilation) for the proper installation, operation and maintenance of the telephone equipment on the Customer's Premises.
- When CenturyLink equipment installed on the Customer's Premises requires power for its operation, the customer is required to provide such power. The customer is required to provide adequate commercial power, wiring and the electrical outlets necessary for the proper operation of the telephone equipment on their Premises. The customer should also extend a suitable ground source to the telecommunications equipment area.
- CenturyLink requires 36" of floor space in front of all wall mounted equipment, Bay mounted equipment, and cabinet mounted equipment. CenturyLink requires 24" of floor space behind bay mounted equipment unless all equipment is front access only. If there are multiple equipment bay line-ups, the 36" of space can be shared by Bays that face each other, in other words front aisles can be a minimum of 36". Rear aisles can be a minimum of 24". Equipment floor space requirements reflect OSHA and BICSI standards. Where applicable, provide a sufficient amount of clear-wall surface or floor space for mounting of any equipment according to manufacturer's guidelines.
- Where concealed telephone wiring is required on the customer's Premises, the customer shall furnish, install and maintain the necessary outlet boxes and conduit.
-

- Any special structural work required for the supporting telephone facilities on the Customer's Premises shall be provided at the expense of the customer.
- Items to be negotiated may include: Building Alteration, Earthquake bracing, Environmental Alarms, sharing of power sources (see Section 5.3 for further information) and frames/racks/cabinets (see Section 4.5 for further information), etc. If the Customer desires that CenturyLink perform maintenance on non-CenturyLink equipment (such as the customer's DC power plant), this must be negotiated in the contract. A dispute resolution method shall also be provided.
- As stated in Section 5.1, CenturyLink provides 8 hours of battery backup for sites that are not backed up by an engine (rectifiers backed up by an engine is known as Essential AC feed). Because this Essential AC feed to CenturyLink rectifiers is not standard from site to site, CenturyLink is only responsible for maintaining power to their equipment for the first 8 hours of a commercial AC failure. In other words, if lost service calls for rebates, rebates shall only be granted if the service failure occurs within the first 8 hours during a commercial AC failure. Outages not related to commercial AC failures are liable to rebate regardless of time frame. Also, if primary backup power is provided from a Customer's power supply (either -48 VDC power plant, or an AC UPS), CenturyLink shall be exempted from any lost service rebates due to the failure or malfunction of these Customer power supplies.
- In some cases, the customer may not desire backup power (see Section 5.4 for further information). The customer and the CenturyLink engineer should work together closely in order to provide the appropriate configuration. If this is done, CenturyLink shall be exempted from any lost service rebates due to the failure of commercial power.

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Tables

10. Marketing Checklist(s)

According to the guidelines given in Sections 3 to 6 of this document, certain things should be ensured with the customer before a deal for Customer Premises services is closed. The checklists of this section provide a simple method for the various marketing arms of CenturyLink (e.g., Business and Government Services, Small Business, etc.) to ensure adherence to this document. This will provide telecommunications services that are more reliable and safe. The various CenturyLink Marketing groups may pass these checklists on to internal Engineering, which will provide the Engineer with valuable information to help them make decisions when engineering the site.

10.1 Location and Environment Checklist

The checklist on the following page summarizes some of the more important environmental issues that need to be broached with the customer before an agreement is ever made. They include temperature and ventilation, floor loading, space size and access, fire systems, and a few other things.

Some of the environmental requirements in Table 10-1 are not applicable in the rare instances where the equipment is not backed up by a DC battery plant or a UPS (see Section 5.4). There are also other requirements that are not applicable to all situations. These exceptions will be noted in the Notes/Description column of the Table.

10.2 Powering Checklist

The checklist on the following page summarizes some of the more important power and grounding issues that need to be broached with the customer before an agreement is ever made. They include Essential AC power provided by the customer, use of a customer DC power plant, availability of a ground source in the equipment area, and a few other things.

There are some requirements in the following table that are not applicable to all situations. Those exceptions will be noted in the Notes/Description column of the Table 10-2.

Drop-dead issues (if not met CenturyLink will not place equipment in the space) are identified with an asterisk in the checklists. When the customer is not willing to meet all conditions, but is willing to absolve CenturyLink of liability, a waiver may be used (see Chapters 4 and 5 for more details on waivers and when they may or may not apply).

Table 10-1: Marketing Checklist for Equipment Location and Operating Environment in Customer Premises Installations

Requirement	Notes/Description	Response
1. Temperature*	Are HVAC systems sufficient to preferably maintain a 55-85 °F room temperature (95° max if batteries are in the room and 104° max if batteries are not included), including when the ultimate heat load of CenturyLink equipment is added?	
2. Air Changes*	Ensuring ventilation is sufficient so that the air is changed with external air at least once every 2 hours will avoid battery Hydrogen buildup, and will help prevent overheat and possible shutdown of transmission equipment.	
3. Size of equipment area	The width, length, and height of the area available helps the engineer decide how much service and how much backup power can be provided. If a building alteration is needed, this must be negotiated with the customer. The space should also be large enough to accommodate anticipated growth. The ceiling should be at least 8'6" (102") high.	
4. Avoid raised computer floors	In most cases, raised floors should be avoided, due to their weakness, battery weight, and poor earthquake bracing. If a raised floor cannot be avoided, the floor loading capacity of that floor should be obtained, and calculations should be run in accordance with Section 4.4 of this Pub 77368.	
5. Post-Tensioned Floors X-Rayed Prior to Drilling	In buildings over 2 stories in heavy earthquake zones, the building owner must identify if the floor/ceiling of planned equipment area has post-tensioning cables. If so, the exact location of these cables must be identified (typically by X-Ray) before floors or ceilings are drilled for anchoring bays.	
6. Elevator or hoist access to space	Equipment must be able to be brought to the area where it is to be installed. Access openings should be min. 36" x 48".	
7. Walls	A few customer prem cabinets are of the "wall-mount" type. The wall should be sturdy enough to support the equipment in these cases. For mounting of terminations, a minimum 4' x 4' wall space, with a ¾" fire-retardant plywood backboard, with 36" clearance in front of it (and the top of it no higher than 7'), is desired. (More space and plywood – e.g. 4' x 8' – may be needed depending on the terminations and/or wall-mount equipment required to be mounted.)	
8. Fire detectors	The equipment area should have adequate fire detection.	
9. Avoid sprinklers and halon	Areas with sprinklers and halon fire systems should be avoided if possible because they'll damage the equipment, and can go off inadvertently. Areas with water pipes above the equipment should also be avoided for similar reasons.	
10. 7 x 24 access with contact info	CenturyLink needs 24 hour a day, 7 day a week access to the equipment area to be able to respond to alarms, minimize service outage lengths, and ensure safe and reliable service.	
11. Asbestos*	Space that has asbestos should be avoided. If it cannot be avoided, the customer must have an asbestos abatement/ management plan before the work begins, per the EPA.	

Table 10-2: Marketing Checklist for AC and DC Power Issues in Customer Premises Locations

Requirement	Notes/Description	Response
1. AC source backed by engine	It is preferable that the AC source provided to power CenturyLink's rectifiers or equipment shelves be on the Essential bus (backed up by the customer's or building engine). This will extend the life of the batteries and greatly increase reliability by shortening discharge duration.	
2. AC source backed by UPS	If the customer owns a UPS, it is preferable that they feed CenturyLink's rectifiers from this UPS. More preferable is a UPS backed by an engine as the AC source. This will extend the life of the batteries and greatly increase reliability by shortening discharge duration.	
3. Twist-Lock™ type outlets available	Standard NEMA locking receptacles or "ground screw-down" connector(s) are within a maximum of 30 feet of the space where CenturyLink pre-packaged equipment cabinets will be placed (and may need to be closer depending on the maximum cord length available for the equipment being powered). For relay rack type installations, a nearby AC service cabinet with spare capacity is to be provided to feed rectifiers. See Section 5.2 for more detail.	
4. Proper AC voltage available	For relay rack installations, CenturyLink rectifiers or direct AC-powered equipment shelves may work from nominal single-phase 120, or 208 or 240 VAC. For pre-packaged Customer Premises cabinet installations, the appropriate configuration should be consulted to determine the nominal voltage, breaker size, and quantity and type of outlets required.	
5. Customer DC plant available	If the customer has a well-maintained existing DC plant with 8 hours of battery backup (or 3-4 or more hours of battery backed by a permanent on-site auto-start auto-transfer engine-alternator), and there are no penalties to CenturyLink for outages, money and space can be saved by powering relay rack type installations from the customer's DC plant.	
6. Ground source in equipment area*	The customer should extend a reliable ground source (not in metal conduit) to the equipment area, preferably with a #2 AWG or larger (#6 AWG minimum), and terminate it on a customer-provided ground bar . (See Section 6.2 of this Pub 77368 for further detail on appropriate ground sources.) A good ground source will protect personnel and equipment from power and lightning surges, and help avoid noise on the telecommunications circuits.	
7. Customer requires backup	In most cases CenturyLink will provide a DC plant with 8 hours of battery reserve. If the customer does not require telecommunications during power outages, and there are no penalties to CenturyLink for outages, arrangements can be made for UPS-only backup or no backup at all. See Sections 5.3 and 5.4 for more detail.	

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11. References

11.1 Acronyms and Definitions

A	Amp/Ampere/Amperes (a measure of electric current)
AC	Alternating Current (electricity from the power utility; typically available at 120/240 V, single-phase, or 120/208 V, three-phase in a Customer Premises location)
ACEG	AC Equipment Ground (commonly known as the "green-wire" ground run with most AC circuits)
ach	air changes per hour
ADA	Americans with Disabilities Act
AGM	Absorbed Glass Matte (fiberglass plate separators in a certain type of VRLA battery that immobilize/hold all the electrolyte)
AHJ	Authority Having Jurisdiction to enforce a Code
aka	also known as
AMC	CenturyLink standard Architectures, Models, and Configurations group (now known as PEG)
AMMS	Automated Material Management System (an internal CenturyLink miscellaneous material ordering system)
ANSI	American National Standards Institute
AR&D	Asset Recovery and Distribution
ASCII	American Standard Code for Information Interchange (standard computer codes representing text characters and symbols)
ASHRAE	American Society for Heating, Refrigeration, and Air-conditioning Engineers
ATIS	Alliance for Telecommunications Industry Solutions
atm	atmospheres (measure of pressure — 1 atmosphere is the air pressure at sea level)
AWG	American Wire Gauge (wire size standard)
AWPA	American Wood Protection Association
BDFB	Battery Distribution Fuse Board/Bay
BGS	CenturyLink Business and Government Services division
BICSI	Building Industry Consulting Services International
BTU	British Thermal Units (a measure of heat energy)

BVAPP	Billing Verification And Payment Process (a number or numbers assigned to CenturyLink engineering jobs for use in internal billing systems' tracking)
C	Celsius or Centigrade (temperature)
cc	cubic centimeter, equal to 1 millimeter (ml)
CFC	Chloro-FlouroCarbon (an ozone destroying chemical used as a propellant or coolant)
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CLLI™	Common Language Location Identifier (Ericsson Telcordia Trademark)
cm	centimeter
CO	Central Office
COT	Central Office Terminal (CO end of a remote terminal, whether it be DLC, a mux, etc.)
CPE	Customer Premises Equipment (common catch-all for equipment such as telephones, modems, etc., usually owned by the customer, which connect to the CenturyLink [or other telecomm carriers'] Network).
CPR	Cardio-Pulmonary Resuscitation
CSA	Canadian Standards Association
DC	Direct Current (electricity normally used by telecommunications equipment; rectified from AC, typically to -48 V)
dBrnC	decibels referenced to Noise Level C (an audible noise measurement of the AC ripple component of a DC voltage or current)
DLC	Digital Loop Carrier (a fiber or T-1 based digital multiplexing transmission system to transport multiple channels closer to the customer on a few copper pairs or fiber)
DNA	Did Not Assign
DS-0	Digital Signal level 0 (a 64 kbps digital circuit/channel; the digital equivalent of POTS)
DS-1	Digital Signal level 1 (a 1.544 Mbps digital circuit/channel; which may be subdivided into 24 DS-0 circuits)
DS-3	Digital Signal level 3 (an approximately 51 Mbps digital circuit/channel; which may be subdivided into 28 DS-1 circuits plus an overhead)
DSL	Digital Subscriber Line (high-speed data service)

DWDM	Dense Wave-Division Multiplexing
DWP	Design Work Package (the CenturyLink LNS job number — formerly known as a TEO, or Telephone Equipment Order)
E-911	Emergency 911
ECC	Environmental Control Center (one of the major NNS NOCs)
EDP	Engineering Design Package (NNS equivalent to a DWP package)
EHS	Environmental, Health, and Safety (an internal CenturyLink group)
EIA	Electronics Industry Association
EMF	Electro-Magnetic Fields (frequencies in the air or on nearby conductors which can induce unwanted currents and voltages into telecommunications equipment, disrupting normal communications)
EMI	Electro-Magnetic Interference (see EMF)
EMT	Electrical Metallic Tubing (a type of conduit used for AC circuits)
EPA	Environmental Protection Agency
EPO	Emergency Power Off switch/button
ESD	Electro-Static Discharge (discharge of accumulated static electricity from the human body)
F	Fahrenheit
FCC	Federal Communications Commission
FDF	Fiber Distribution Frame
FOG	Foreign Object Ground
FPS	Fiber Protection System
FRC	Field Reporting Code (Account Codes used to classify telecommunications capital investments)
ft	foot
GFCI	Ground Fault Circuit Interruptor
GMT	a 0-20 Amp small fuse type used for power and alarming
HazMat	Hazardous Material (as defined by the EPA)
HEPA	High Efficiency Particulate Arrestor (specially rated filters and devices that remove most of the dust and particulates from the air)
HFC	hydroflourocarbon
hr	hour
HSP	House Service Panel (at the commercial AC service entrance to a building)
HVAC	Heating, Ventilation and Air-Conditioning

I	symbol in electrical formulas for current (Amperes)
ICBO	International Conference of Building Officials
ICC	International Code Council
IEC	1) Inter-Exchange Carrier (long-distance company)
	2) International Electro-Technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IFCI	International Fire Code Institute
in	inches
INE	Intelligent Network Element
IP	Internet Protocol
IT	Information Technology
JIM	Job Information Memorandum (form sent to Engineering to indicate necessary changes to a job and/or additional material must be ordered)
kbps	kilobits per second (digital transmission frequency/speed)
kHz	a measure of thousands of sound waves per second
kPa	kilo-Pascals (standard measurement of pressure)
kVA	kilo-Volt-Amperes (a measure of total electrical power used or provided)
kW	kiloWatts (thousands of Watts)
L	Liters (sometimes abbreviated with a cursive ℓ)
lbs	pounds
LEL	Lower Explosive Limit
LFL	Lower Flammability Limit
LEWIS	Loop Electronics Warehouse and Installation Services Center
Li-ion	Lithium ion battery
LNS	Local Network Services (CenturyLink's Local Network)
LMP	Lithium Metal Polymer battery
m	meter
Mbps	Megabits per second (one Megabit = 1000 kilobits)
min	minute
ml	milliliter
MOE	Metro Optical Ethernet
MOP	Method of Procedure (a detailed plan for installation/removal work)

MPOP	Main/Minimum Point of Presence (the main point of interface/demarcation between CenturyLink and the Customer)
MRC	Material Reclamation Center (CenturyLink's old Salvage Yards — CenturyLink often uses vendor warehouses or their own LEWIS Centers for portions of this)
MRF	Material Review/Return Form
mux	fiber multiplexer (combines several signals/channels/circuits into one larger bandwidth signal)
NAVL	North American Van Lines
NEBS	Network Equipment — Building System (see the Ericsson Telcordia references in Section 11.3 of this document)
NE	Network Element
NEC	National Electrical Code (NFPA 70)
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers' Association
NFC	CenturyLink Network Facilities Alarm Monitoring Center
NFPA	National Fire Protection Association
NI	Network Interface (the point of demarcation between CenturyLink equipment, and the copper or fiber plant owned by the customer)
Ni-Cad or NiCd	Nickel-Cadmium battery
NMA	Network Monitoring and Analysis (an Ericsson UNIX program and computer system used for gathering and analyzing remote alarms)
N(i)MH	Nickel Metal Hydride battery
NNS	National Network Services (CenturyLink's long-haul Network)
NOC	Network Operations Center
NPC	Network Procurement Center (an internal CenturyLink group responsible for cutting Purchase Orders and procuring material for installation jobs, among other things)
NTC	National Traffic Center (former U S WEST designation for the new SMC)
OEM	Outside Equipment Manufacturer
OFN(R)	Optical Fiber Non-conductive (Riser) Cable
Ω	Ohms (the Greek letter Omega, signifying the impedance or resistance in an electrical circuit)
Ops	Operations

OSHA	Occupational Safety and Health Administration (Division of U.S. Dept. of Labor)
OSP	OutSide Plant (all telecommunications locations outside the CO, including Customers Premises
P	Power (measured in Watts)
PANI	Producers, Absorbers, Neutrals, and Isolateds (ground bar designation)
PB or PBD	Power Board (the main DC plant distribution bays/panels)
PBX	Private Branch Exchange (a small switch owned by customers)
PDB	Power Distribution Bay
PDF	Portable Document Format (a common electronic format for literature of all types, which can be read by Adobe's free "Acrobat Reader")
PEG	Planning and Engineering Guidelines (internal CenturyLink group, formerly known as AMC)
Ø	Phase (the Greek letter Phi, denoting the number of electrical phases of power, which directly correlates to the number of wires)
POTS	Plain Old Telephone Service (a 3.4 kHz minimum analog voice channel)
PCB	PolyChlorinated Biphenyls (a hazardous material)
PCN	Product Change Notice (initiated by an equipment supplier to make changes to their equipment — may be the same as a CN where CN is a specific term used by the suppliers, and PCN is the generic term used by CenturyLink and Ericsson Telcordia)
PID	Product IDentification number
PSAP	Public Service Access Point (911 call center)
psf	pounds per square foot
psi	pounds per square inch
Pub	abbreviation of Publication (as in CenturyLink Technical Publication)
PVC	Poly-Vinyl Chloride (a plastic tubing pipe commonly used as water pipe)
RC	Responsibility Code (internal accounting codes assigned to CenturyLink employees for the internal tracking and cross-charging of expenses)
RCRA	Resource Conservation and Recovery Act
RF(I)	Radio Frequency (Interference) — see EMF
rms	root mean square (a method of obtaining the AC sine wave voltage or current constant equivalent value — as opposed to the peak voltage — this is the effective level that a person will feel, and is used in computations)
ROADM	Remote Optical Add/Drop Multiplexer

RT	Remote Terminal (remote end — closest to the customer — of a multiplexing system used to provide service to the customers)
s or sec	second
SA	former name of CenturyLink Communications NROC (see above)
SAT	Service Assurance (alarm center) Technician
SHNS	Self-Healing Network Services (a redundant fiber ring service)
SHARP	Self-Healing Alternate Route Protect (a fiber service with alternate routing)
SI	Système International d'Unités (metric system)
SME	Subject Matter Expert
SMC	AIMS Logistics' CenturyLink Shipment Management Center
SNMP	Simple Network Management Protocol
SONET	Synchronous Optical Network (a transmission standard to which most modern telecommunications equipment is built and communicates)
SPGP	Site Principal Ground Point
SST	Synchronous Service Transport
T-1	T-carrier 1 (a basic telephone multiplexing scheme of 24 x 64 kbps channels, for a total 1.544 Mpbs bitstream — T-1 is the architecture to carry a DS-1)
TCP	Transmission Control Protocol (used to send IP packets)
Tech	abbreviation of Technical (as in CenturyLink Technical Publication)
TEF	Telecom Entrance Facility
Telecom	telecommunications
TEO	Telephone Equipment Order (the new term is DWP)
TIA	Telecommunication Industry Association
TL1	Transaction Language 1 (a standard set of ASCII text alarm and command messages developed by Ericsson Telcordia/Bellcore, and expanded by CenturyLink, which are sent over X.25 or IP packet links)
TMGB	Telecommunications Master Ground Bar
UBC	Uniform Building Code
UFC	Uniform Fire Code (previously published by the WFCA and IFCI, and the former name of NFPA 1 - which is now known simply as the Fire Code)
Ufer	A term for a grounding system using concrete — derived from the last name of a man who proved that rebar-reinforced concrete in good contact with soil provides good electrical continuity, unless the concrete is coated
UL	Underwriters' Laboratories

UNIX	a powerful, workstation- and server-based operating system invented by Bell Labs in the late '60s, but still highly popular today for complex computing tasks
UPS	Uninterruptible Power Supply (a commercially available assembly of rectifiers, batteries and inverters — or in rare cases a motor-generator set and a flywheel — which ensures that clean AC power is available, and on loss of commercial AC, usually provides 15-30 minutes of backup — it is available in various kVA sizes)
V	Volts or Volume
VAC	AC rms Voltage (a measure of the strength of the electrical "pressure")
VDC	DC Voltage
VRLA	Valve-Regulated Lead-Acid (a type of battery commonly used in the OSP)
W	Watts (a measure of "real" electrical power used or produced)
WFCA	Western Fire Chiefs Association
WMC	CenturyLink's installation Work Management Center (formerly known as the Installation Control Center [ICC])
X.25	a packet data network transmission protocol, used by CenturyLink for alarm transmission to their NMA system

11.2 CenturyLink Documents

FOPS-00243	NNS Field Operations Site Power Safety Reference, Issue 11, June 2005
NNS-00690	Alarm Standards, Issue 8, April 2011
Pub 77324	Qwest DS3 Service, Issue F, January 2005
Pub 77339	Enhanced 911 (E-911) Public Service Access Point (PSAP) Environmental Specifications and Equipment Installation Guidelines, Issue B, January 2010
Pub 77346	Synchronous Service Transport (SST), Issue V, August 2015
Pub 77350	Telecommunications Equipment Installation and Removal Guidelines, Issue N, December 2006
Pub 77351	Engineering Standards General Equipment Requirements, Issue H, April 2015
Pub 77355	Grounding - Central Office and Remote Equipment Environment, Issue I, July 2015

Pub 77375	1.544 Mbit/s Channel Interfaces, Issue G, June 2008
Pub 77385	Power Equipment and Engineering Standards, Issue K, July 2015
Pub 77411	Metro Ethernet, Issue P, January 2013
Pub 77419	Specifications for Placement of Qwest Equipment in Customer-Owned Outdoor Cabinets, Issue B, June 2011

11.3 Ericsson Telcordia Documents

BR-101-170-005	Quality and Reliability — Electrostatic Discharge, Issue 3, June 1996
BR 760-550-102	Building Ventilation, Issue 3, October 1981
BR 781-810-885	Central Office Ventilation, Issue 1, August 1987
BR 790-100-672	Battery Maintenance Practices for Flooded and Valve-Regulated Lead-Acide Batteries, Issue 1, December 1993
GR-26-CORE	Generic Requirements for CEVs, Issue 1, December 1994
GR-27-CORE	Generic Requirements for Environmental Control Systems for EEEs, Issue 1, November 1994
GR-63-CORE	Network Equipment — Building System (NEBS) Requirements: Physical Protection, Issue 4, April 2012
GR-295-CORE	Isolated and Mesh Bonding Networks: Definition and Application to Telephone Central Offices, Issue 1, November 2004
GR-409-CORE	Generic Requirements for Premises Fiber Optic Cable, Issue 2, November 2008
GR-833-CORE	Operations Application Messages — Network Maintenance: Network Element and Transport Surveillance Messages, Issue 7, December 2010
GR-1089-CORE	Electromagnetic Compatibility and Electrical Safety — Generic Criteria for Network Telecommunications Equipment, Issue 6, May 2011
SR-TSY-000963	Network Switching Element Outage Performance Monitoring Procedures, Issue 1, April 1989
SR-NWT-002432	Earthquake Retrofit Bracing Guidelines for Qwest Battery Stands, Issue 1, August 1992
SR-NWT-002498	Earthquake Retrofit Bracing Guidelines for Qwest Network Equipment (Phase I), Issue 1, October 1992
SR-NWT-002536	Earthquake Retrofit Bracing Guidelines for Qwest Network Equipment (Phase II), Issue 1, November 1992

SR-3400	Economic Impact of Increasing the Operating Temperature Range Within Telecommunications Central Offices: The Wideband Study, Issue 1, November 1994
SR-3580	Network Equipment — Building System (NEBS): Criteria Levels, Issue 5, May 2012
SR-3700	Economic Impact of Humidifying Telecommunications Central Offices: The Humidity/ESD Study, Issue 1, September 1995
TA-NWT-001360	Generic Requirements for Power Systems Messages at the OS/NE Interface, Issue 1, January 1993

11.4 Other Documents

ANSI/ATIS 0600003	Battery Enclosure and Rooms/Areas, 2012 reissue
ANSI/ATIS 0600318	Electrical Protection Applied to Telecommunications Network Plant at Entrances to Customer Structures or Buildings, 2010 Issue
ANSI/ATIS 0600329	Network Equipment Earthquake Resistance, 2014 Issue
ASHRAE Std. 62.1	Ventilation for Acceptable Indoor Air Quality, 2013 Issue
AWPA U1	User Specification for Treated Wood, 2016 Issue
C&D 41-6739	Gassing and Ventilation, October 1995 Issue
C&D 41-7329	Life Expectancy and Temperature, May 1999 Issue
CFR28 Part 36	Nondiscrimination on the Basis of Disability in Public Accomodations and Commercial Facilities
Enersys Section 58.00	Safety, Storage, Installation, Operation, and Maintenance Manual for Heritage Series Flooded Lead Acid Battery Systems, 2000 Issue
IBC	International Building Code, published by the International Code Council (ICC), 2015 Edition
IFC	International Fire Code, published by the International Code Council (ICC) and the International Fire Code Institute (IFCI), 2015 Edition
IEEE Std 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book), 2007 Edition
IEEE Std 450	IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications, 2010 Edition
IEEE Std 484	IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications, 2008 Edition

IEEE Std 485 IEEE Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations, 2010 Edition

IEEE Std 1184 IEEE Guide for the Selection and Sizing of Batteries for Uninterruptible Power Systems, 2006 Edition

IEEE Std 1187 IEEE Recommended Practice for the Design and Installation of Valve-Regulated Lead-Acid Storage Batteries for Stationary Applications, 2013 Edition

IEEE Std 1188 IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid Batteries for Stationary Applications, 2005 Edition

IEEE Std 1189 IEEE Guide for the Selection of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications, 2006 Edition

IEEE 1578 IEEE Recommended Practice for Battery Electrolyte Spill Containment and Management, 2006 Edition

IEEE1635/ASHRAE21 Guide for the Ventilation and Thermal Management of Stationary Battery Installations, 2012 Edition

NECA/BICSI-607 Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings, 2011 Edition

NFPA 1 Fire Code, 2015 Edition

NFPA 37 Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, 2014 Edition

NFPA 70 National Electrical Code (NEC), 2017 Edition

NFPA 70HB NEC Handbook, 2017 Editon

NFPA 101 Life Safety Code, 2015 Edition

NFPA 110 Standard for Emergency and Standby Power Systems, 2016 Edition

NFPA 111 Standard on Stored Electrical Energy Emergency and Standby Power Systems, 2016 Edition

OSHA 29 CFR Standard 1926.417, Lockout and Tagging of Circuits

RUS 1751F-805 Electrical Protection at Customer Locations, Issue 9, May 1995

TIA/EIA 568 Optical Fiber Cabling Components Standard, 2014 Issue

TIA/ANSI J-607-B Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, 2011 Edition

Uniform Building Code (UBC) Vols. 1-3, published by the International Conference of Building Officials (ICBO), 1997 Edition

Uniform Fire Code	Vols. 1-2, published by the Western Fire Chiefs Association (WFCA), 1997 Edition
UL 723	Standard for Test for Surface Burning Characteristics of Building Materials, Issue 10
UL 60950-1	Safety of Information Technology Equipment – Safety – Part 1: General Requirements (*replaced UL 1950*), Issue 3

11.5 Ordering Information

All documents are subject to change and their citation in this document reflects the most current information available at the time of printing. Readers are advised to check status and availability of all documents.

American National Standards Institute (ANSI) documents from:

American National Standards Institute
11 West 42nd Street
New York, NY 10036
Phone: (212) 642-4900
Fax: (212) 302-1286
Web: www.ansi.org

ASHRAE Documents may be obtained from:

American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.
1791 Tullie Cir. NE
Atlanta, GA 30329
Fax: (404) 321-5478
Phone: (800) 527-4723
Web: www.ashrae.org

ATIS Documents may be obtained from:

Alliance for Telecommunications Industry Solutions
1200 G St. NW
Washington D.C. 20005
Fax: (202) 393-5453
Phone: (202) 628-6380
Web: www.atis.org

AWPA Documents may be obtained from:

American Wood Protection Association
PO Box 361784
Brimingham, AL 35236
Fax: (205) 733-4075
Phone: (205) 733-4077
Web: www.awpa.com

C&D Dynasty Documents may be obtained from:

C&D Technologies Dynasty Division
900 E. Keefe Ave.
Milwaukee, WI 53212
Fax: (414) 961-6506
Phone: (800) 396-2789
Web: www.dynastybattery.com

CenturyLink Technical Publications may be obtained from:

Web: www.centurylink.com/techpub

The non-proprietary portions of other Century Link documents may be obtained from a CenturyLink representative by companies whose contract contains the necessary non-disclosure provisions

Enersys Documents may be obtained from:

Enersys Inc.
2366 Bernville Rd.
Reading, PA 19605
Fax: (610) 372-8457
Phone: (610) 208-1991
Web: www.enersysreservepower.com/products.asp

Ericsson Telcordia documents may be obtained from:

Ericsson Telcordia Customer Relations
8 Corporate Place, PYA 3A-184
Piscataway, NJ 08854-4156
Fax: (908) 336-2559
Phone: (800) 521-CORE (2673) (U.S. and Canada)
Web: www.telcordia.com

Federal Regulations may be obtained from:

Web: www.access.gpo.gov/nara/cfr/index.html

International and Uniform Building and Fire Codes may be obtained from:

International Code Council
5203 Leesburg Pike, Ste. 600
Falls Church, VA 22041
Fax: (703) 379-1546
Phone: (703) 931-4533
Web: www.intlcode.org

IEEE Documents may be obtained from:

Institute of Electrical and Electronics Engineers, Inc.
345 East 47th Street
New York, NY 10017-2394
Fax: (732) 981-1721
Phone: (732) 981-0060
Web: www.ieee.org

NECA documents from:

National Electrical Contractors Association
3 Bethesda Metro Center, Ste. 1100
Bethesda, MD 20814
Phone: (301) 657-3110
Fax: (301) 215-4500
www.necanet.org

NFPA Documents may be obtained from:

National Fire Protection Association
1 BatteryMarch Park
Quincy, MA 02269-9101
Fax: (617) 770-0700
Phone: (617) 770-3000
Web: www.nfpa.org

RUS documents may be obtained from:

United States Department of Agriculture Rural Development
1400 Independence Ave. SW
Washington, DC 20250-0107
Phone: (202) 720-8674
www.rurdev.usda.gov/RDU_Bulletins_Telecommunications.html

TIA Documents may be obtained from:

Telecommunications Industry Association
2500 Wilson Blvd., Ste. 300
Arlington, VA 22201
Fax: (703) 907-7727
Phone: (703) 907-7700
Web: www.tiaonline.org

UL Documents may be obtained from:

Underwriters Laboratories
333 Pfingsten Rd.
Northbrook, IL 60062-2096
Fax: (847) 272-8129
Phone: (847) 272-8800
Web: www.ul.com

11.6 Trademarks

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