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Technical Publication

SPECIFICATIONS FOR THE PLACEMENT OF QWEST EQUIPMENT IN CUSTOMER-OWNED OUTDOOR CABINETS

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NOTICE

This document describes the environmental (including electromagnetic compatibility), power, and grounding requirements for customer-owned outdoor cabinets in order to allow the placement of Qwest-owned equipment inside these cabinets for the provision of high speed services to the customer. When these requirements are not attainable by the Customer cabinet, Qwest equipment must be placed external to the cabinet in an enclosure suitable to the equipment. When these requirements are not maintained, Qwest is absolved of equipment and service outage damages.

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1. Introduction

1.1 General

This document describes the environmental and electromagnetic compatibility (EMC) requirements, as well as the power and grounding requirements, for customer-owned outdoor equipment cabinets, in order to allow the placement of Qwest equipment within said cabinet for purposes of serving the customer. When these requirements are not attainable by the customer cabinet, Qwest equipment must be placed external to the cabinet in an enclosure suitable for the equipment. When these requirements are not maintained, Qwest is absolved of equipment and service outage damages.

1.2 Scope

There are services sold by Qwest where the economical and/ or space-efficient option for delivering these services is to place telecommunications equipment in the customers' outdoor cabinet. While Qwest equipment is robust, the customer's cabinet (and their equipment within that cabinet) must meet certain power, grounding, temperature, air quality, and electromagnetic compatibility requirements in order to ensure reliable service from Qwest. This requires the coordinated effort of the Qwest Marketing, Engineering and Construction groups, in conjunction with 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 Qwest.

1.3 Reason For Reissue

This document is being revised primarily to clarify Customer responsibilities and liabilities.

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2. General

2.1 Safety and Reliability

As mentioned in the introduction, proper up-front coordination between Marketing, Engineering, and the customer can ensure that the standards contained in this document are met. Engineering and field forces, in conjunction with the customer, are then responsible for installing the equipment in the Customers' outdoor cabinet.

Reliability of the telecommunications Network on the Customer's Premises increases Qwest's chances of retaining the customer(s), and selling additional services. Also Qwest does not suffer lost revenue due to outages. Reliability increases the customers' ability to serve their customers; thereby increasing their revenues. Telecommunications equipment safely installed in a safe environment, with safe backup power, will mitigate potential harm to personnel.

For example, if the guidelines of Chapter 5 are followed, and the customer's DC plant maintains the proper voltage levels at all times (even during high load periods, such as a DC air-conditioner compressor startup), the Qwest equipment will continue to work. If the cabinet is properly grounded, as per Chapter 6, the metallic cabinet will serve as a Faraday cage, shielding both Qwest and customer equipment from harmful magnetic, and electric fields, including lightning.

Additional effort and time to ensure that the requirements and guidelines of this document are followed will result in both short-term and long-term monetary benefits to the customer and Qwest. 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 Qwest.

Requirements and guidelines for Customer Premises equipment space cannot be as strict as those applied to Qwest-owned space, simply because Qwest 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 Telcordia's NEBS documentation: GR-63-CORE and GR-1089-CORE, or GR-2934/ 3108. NEBS Level 1 (see Telcordia SR-3580) certification 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). Listing to UL specifications 1950 or 60950 essentially ensures the same things. Qwest equipment to be placed in customer-owned cabinets will have been 3rd-party certified to at least NEBS Level 1. It is not required that the customer equipment be certified to a minimum of NEBS Level 1 or Listed to UL 1950/ 60950; however, if it is not, it must meet the electromagnetic compatibility guidelines of this document detailed in Chapter 7.

A cabinet compliant to Telcordia GR-487 (another document in the NEBS family) will safely and reliably support all temperature-hardened equipment placed within it, provided that the heat release of the equipment does not exceed the heat exchange capacity of the given cabinet for the equipment configuration. Again, Qwest does not require that the customer's cabinet be GR-487 compliant, but if it is not, it must be able to maintain the environmental criteria detailed in Chapter 4 of this document, given the added heat release of the Qwest equipment.

It is important to note that the customer's environment/ cabinet/ enclosure not only meet the cerifications at time of installation, but also be maintained periodically to ensure all requirements are met while Qwest provides said services. Failure to maintain environmental conditions, power and/ or grounding inside the enclosure will increase the risk of permanently damaging equipment and/ or disrupting service.

Some Qwest equipment is temperature-hardened and water-resistant. Subsequently, such equipment can withstand a minimal amount of moisture and dirt, but needs to be in a rainproof enclosure, such as a NEMA/ UL 3, 3S, 4, 4X, 6, or 6P (or relatively equivalent IEC IP55, IP66, IP67, or IP68 rating) enclosure that is properly grounded per Chapter 6.

Some Qwest equipment is not temperature-hardened and/ or water-resistant, thus requiring additional protection from dirt and moisture. For locations requiring Qwest non-temperature hardened equipment, the customer must provide an enclosure sufficient to meet the environmental cabinet requirements outlined for air conditioned cabinets in Section 4 (in addition to the other requirments outlined in this Technical Publication). Such enclosures must meet a minimum of NEMA/ UL 4, 4X or GR-487 as well as include additional temperature, humidity and air-quality controls to ensure the Qwest equipment is not compromised.

Finally, some Qwest equipment is not only temperature-hardened, but sealed (impervious to water and dust intrusion, and has its own Faraday cage that makes it EMI-resistant as long as it is properly grounded). This equipment may or may not need an enclosure for security reasons. When it does need an enclosure, it is typically a "pedestal"-type enclosure. If the pedestal is compliant to Telcordia GR-13, it is definitely suitable for the placement of Qwest hardened and sealed equipment as long as it can dissipate the heat generated by the Qwest equipment. Lacking such compliance, the customer enclosure may still be suitable, but would need to be a NEMA/ UL or IEC-type enclosure, such as a NEMA/ UL 3R or IEC IP24, or any of the types listed in the preceding paragraphs.

2.2 Types of Outdoor Customer Cabinets that May be Suitable for Qwest Equipment

This document deals with all types of outdoor customer cabinets that may be suitable for Qwest equipment (depending on the given Qwest equipment). For purposes of this document, customer cabinets that may be suitable are divided into 4 general categories: 1) sealed equipment chambers with air-conditioning; 2) sealed equipment chambers with a heat exchanger that limit the equipment temperature to no hotter than 10° C (18° F) above the outdoor ambient.; 3) water and dust-resistant NEMA/ UL/ IEC enclosures; and 4) pedestals. For future reference in this document, these will usually be referred to as Cabinet Environmental Types 1, 2, 3, and 4.

Type 1 and 2 cabinets typically have two parallel ETSI mid-mount or front-mount mounting rails with nominal mounting widths of 19 or 23 inches, and the ETSI standard hole pattern. Type 3 and 4 cabinets may have mounting rails, and if they do, the hole pattern and mounting width should meet the 19 or 23" ETSI standards. If there are differing mounting widths and hole patterns, Qwest and the Carrier will have to jointly ensure that this is specified so that mounting ears can be made and ordered when there is variation from the ETSI standards. Type 3 and 4 NEMA/ UL/ IEC cabinets may have a plywood backboard for surface-mounting of equipment.

Regardless of the cabinet type, it must be able to dissipate the heat generated by both the Carrier's equipment and Qwest equipment and still be able to maintain the temperature requirements specified in Chapter 4.

If the Qwest equipment is not going to be placed in a customer cabinet, Qwest may request an "H-frame" or stub-pole mounting location for its equipment. In those cases, a meet point must be designed for service handoff.

When the customer cabinet is used, Qwest must have access to the cabinet (preferably not via key since those can be easily lost).

Space and power for Qwest equipment inside the Customer's cabinet should be provided at the Customer's expense. From a cost and space perspective, the arrangement of placing Qwest equipment in a customer cabinet is mutually beneficial to both parties without the need for additional construction charges or recurring fees. Any deviation from this cost model must be negotiated and be in writing.

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Tables

3. Site Survey Check List and Cabinet Selection

The site owner may need to be consulted/ involved if any construction work is required on the property to accommodate the arrangement (this would be rare when the Qwest equipment is going into the Carrier's cabinet).

Many of the items in the checklists of this section are explained in greater detail in subsequent sections. These Tables in this Section have enough detail to provide good checklists for Engineers and Marketing teams, and they can refer to Sections 4 through 7 for greater detail.

3.1 Unsuitable Customer Cabinets

Some cabinet locations which may be offered by Carriers, are unsuitable for certain types of Qwest telecommunications digital equipment. These types of cabinets are as follows:

- Ungrounded and/ or non-metallic cabinets
- Cabinets that allow excessive dust intrusion when the Qwest equipment is not "sealed"
- Cabinets that allow water intrusion when the Qwest equipment is not "sealed"
- Cabinets that are incapable of dissipating the combined heat generated by Carrier and Qwest equipment
- Cabinets without adequate NEC™ access clearances in front of the equipment to facilitate safe work
- Cabinets that Qwest cannot access 24x7x365 in order to maintain its equipment
- Cabinets that are not routinely maintained to ensure adherence to the environmental, power, and grounding requirements of this document

If the cabinet does not meet the above-mentioned requirements, the Carrier Customer will be required to make the appropriate changes to the space or Qwest will not place telecommunications equipment in the cabinet (another arrangement for the site with a meet point for handoff of services may be agreed upon instead).

3.2 Space and Clearance Requirements

Per the Electrical Code, there should be three feet (approximately 91 cm) of clearance and at least 30 inches (approximately 76 cm) of width in front of the cabinet's equipment access opening(s). This access should also exist from the ground to a height of at least 6½ feet (approximately 2 meters). If the cabinet opening is a hinged door, it should open to at least 90 degrees without obstruction. Preferably, any hinged door will have a "locked" open position (often accomplished with a slide bar mechanism) so that it doesn't have to be held in place by a person while work is occuring.

Most Qwest equipment will be front access. If rear access is necessary for connections, it will be so noted and negotiated.

As previously noted in this document, Qwest equipment will usually be designed to mount to a standard ETSI 19 or 23" nominal width parallel rail system, or is designed to be mounted to a plywood backboard. The mounting ears may be at the front of the equipment chassis/ shelf, mid-mount, or at the rear. In some cases, mounting ears are adjustable for multiple positions and either mounting width. If this is the case it will be so noted by marking multiple configurations on the checklist that follows.

Special attention needs to be payed to sites located near or "in" electric utility "high voltage" sites, which include: substations, generating stations, and transmission towers. In each of these cases, due to voltages and currents injected into the earth during a fault, a Qwest high voltage protection engineer must be involved in the project to ensure that facilities are properly isolated from the "ground potential rise". Qwest Technical Publication 77321 serves as the reference material for this "Special High Voltage Protection".

Table 3-1: Carrier Cabinet Space and Clearance Checklist

Requirement	Notes/Description	Qwest Needs	Carrier Response
1. Front Clearance Depth	Does the Carrier cabinet have unobstructed clearance of at least 36" in front of equipment access openings?		
2. Access Width	Does the Carrier cabinet have an unobstructed clearance width of at least 30" in front of equipment access openings?		
3. Clearance Height	Does the Carrier cabinet have an unobstructed clearance height of at least 78" in front of equipment access openings?		
4. Rear Access	Is rear access needed/ available for the equipment?		
5. Equipment Mounting Width	Equipment mounting width availability (mark all that apply) is nominally (ETSI standard): *Note: If the equipment is to be backboard mounted note the mounting width next to backboard*	19" ☐ 23" ☐ other____ backboard__	19" ☐ 23" ☐ other____ backboard__
6. Hole Spacing	The ETSI hole spacing on the mounting rails needs to be / can be (mark all that apply): *Note 1: 1¾" standard ETSI hole spacing has holes at alternating intervals of 1¼" and ½".* *Note 2: 1" hole spacing is often referred to as 2" mounting, but there are typically holes every inch.*	1¾" ☐ 1" ☐ other____ N/A ☐	1¾" ☐ 1" ☐ other____ N/A ☐
7. Shelf Mounting Ear Position	The shelf mounting ears are positioned at (mark all that apply, or are available): *Note: Backboard mounts will typically be rear.*	front ☐ mid ☐ rear ☐ N/A ☐	front ☐ mid ☐ rear ☐ N/A ☐
8. Shelf Depth and Airflow Space	List the shelf depth (including airflow space needed in front and behind) and whether this can be accommodated in the cabinet: *Note: If the shelf is turned vertically for mounting (typically on a backboard) this would be the same as the shelf height of a horizontal mount.*	_____"	
9. Mid-Mount position	List the mid-mount ear position from the front of the shelf (include necessary airflow space in front of the shelf) and whether this can be accommodated:	_____" N/A ☐	
10. Shelf Height and Airflow space	List the total height of all shelves to be installed (including any airflow space above and below) *Note: If the shelf is turned vertically for mounting (typically on a backboard) this would be the same as the shelf depth for a horizontal mount.*	_____"	

3.3 Cabinet Environment Checklists

Tables 3-2 through 3-5 contain quick reference checklists for some of the items specified in much greater detail elsewhere in this section or in chapters 4 and 7. The appropriate checklists (see the next paragraph to determine which one is appropriate for the environment) should be used by the before a contract is signed, and long before engineering and installation activity begins at a site. Some of the items found in this pre-site survey may cause re-evaluation of the cabinet selected for installation of Qwest telecommunications equipment.

As specified in Section 2.2, there are up to 4 types of cabinets that may be suitable for Qwest equipment, depending on the equipment: 1) sealed equipment chambers with air-conditioning; 2) sealed equipment chambers with a heat exchanger; 3) water and dust-resistant NEMA/ UL/ IEC enclosures; and 4) pedestals. Each of these cabinet types has its own environmental checklist, dependent on the equipment Qwest needs to place. Typically only one of the following four checklists would be used.

The following checklist should be used for equipment normally designed for installation in a Central Office or Customer Premises indoor environment (although in this particular case it will be going in an air-conditioned cabinet).

Table 3-2: Air-Conditioned Carrier Cabinet Environmental Checklist

Requirement	Notes/Description	Response
1. Temperature	The cabinet is capable of maintaining a temperature range of 5 to 40° C around the Qwest equipment, given an outdoor ambient range (measured in the shade and not including wind chill) of -40 to 50° C (with intake air temperatures up to 60°C), when the Qwest equipment has the following average heat release in Watts: ___ W *Note 1: Failure of Qwest equipment due to failure of the air-conditioning system will absolve Qwest of outage liability.* *Note 2: The Carrier must add Qwest equipment heat release to the heat release (including future plans) of its own equipment in the cabinet.*	
2. Sealed Equipment Chamber	The cabinet equipment chamber is sealed (including cable passages) to prevent dust and water intrusion (equipment heat is released via an air-conditioned heat exchange system that maintains the seal of the equipment chamber).	
3. Air Filtration	Are there filters for the air-conditioning system; and if so are they periodically (at least every 3 months) maintained/ replaced? *Note: It is preferable that the air-conditioning system be designed such that it does not require filters.*	
4. Electro-Magnetic Compatibility	No carrier equipment located inside the cabinet may exceed the FCC Part 15 Subpart B criteria for radiated electric and magnetic fields. *Note: Failure of Qwest equipment due to collocated carrier equipment with radiated emissions above the noted FCC criteria will absolve Qwest of outage liability.*	

The following checklist should be used for temperature-hardened Qwest equipment typically designed for installation in a GR-487 compliant cabinet.

Table 3-3: Heat Exchanger Carrier Cabinet Environmental Checklist

Requirement	Notes/Description	Response
1. Temperature	The cabinet is capable of maintaining a temperature range of -40 to 65° C around the Qwest equipment, given an outdoor ambient range of -40 to 51.7° C (with intake air temperatures up to 60°C), when the Qwest equipment has the following avg. heat release in Watts: ___ W *Note 1: Failure of Qwest equipment due to failure of the heat-exchange system will absolve Qwest of outage liability.* *Note 2: The Carrier must add Qwest equipment heat release to the heat release (including future plans) of its own equipment in the cabinet.*	
2. Sealed Equipment Chamber	The cabinet equipment chamber is sealed (including cable passages) to prevent dust and water intrusion (equipment heat is released via a heat exchange system that maintains the seal of the equipment chamber).	
3. Air Filtration	Are there filters for the heat exchange system; and if so are they periodically (at least every 6 months) maintained/ replaced? *Note: It is preferable that the heat exchange system be designed such that it does not require filters.*	
4. Electro-Magnetic Compatibility	No carrier equipment located inside the cabinet may exceed the FCC Part 15 Subpart B criteria for radiated electric and magnetic fields. *Note: Failure of Qwest equipment due to collocated carrier equipment with radiated emissions above the noted FCC criteria will absolve Qwest of outage liability.*	

For Qwest equipment that dissipates only a small amount of heat, and is temperature-hardened and water-resistant (this means that it can withstand a little moisture and dirt, but needs to be in a rainproof enclosure, such as a NEMA/ UL or IEC 3, 3S, 4, 4X, 6, 6P, IP55, IP66, IP67, or IP68 enclosure), use the following checklist.

Table 3-4: NEMA Carrier Cabinet Environmental Checklist

Requirement	Notes/Description	Response
1. Temperature	The cabinet is capable of maintaining a temperature range of -40 to 70° C around the Qwest equipment, given an outdoor ambient range of -40 to 51.7° C (with intake air temperatures up to 60°C), when the Qwest equipment has the following avg. heat release in Watts: ___ W *Note: The Carrier must add Qwest equipment heat release to the heat release (including future plans) of its own equipment in the cabinet.*	
2. NEMA/ UL/ IEC Type	The cabinet is one of the following NEMA or IEC types: 3, 3S, 4, 4X, 6, 6P, IP55, IP66, IP67 or IP68; or is Telcordia GR-487 compliant	
3. Air Filtration	Are there air filters on the cabinet; and if so are they periodically (at least every 12 months) maintained/ replaced? *Note: It is preferable that the cabinet be designed such that it does not require filters.*	
4. EMC	No carrier equipment located inside the cabinet may exceed the FCC Part 15 Subpart B criteria for radiated electric and magnetic fields.	

As noted previously in section 2.1, some Qwest equipment is not only temperature-hardened, but sealed (impervious to water and dust intrusion, and has its own Faraday cage that makes it EMI-resistant as long as it is properly grounded). This equipment may or may not need an enclosure for security reasons. When it does need an enclosure, that enclosure is typically a "pedestal"-type enclosure. If the pedestal is compliant to Telcordia GR-13, it is definitely suitable for the placement of Qwest hardened and sealed equipment as long as it can dissipate the heat generated by the Qwest equipment. Lacking such compliance, the customer enclosure may still be suitable, but would need to be a NEMA/ UL or IEC-type enclosure, such as a NEMA/ UL 3R, IP24 or any of the types listed in the preceding paragraph.

Table 3-5: Carrier Pedestal Environmental Checklist

Requirement	Notes/Description	Response
1. Temperature	The cabinet/ pedestal is capable of maintaining a temperature range of -40 to 70° C around the Qwest equipment, given an outdoor ambient range of -40 to 51.7° C (with intake air temperatures up to 60°C), when the Qwest equipment has the following average heat release in Watts: ___ W *Note: The Carrier must add Qwest equipment heat release to the heat release (including future plans) of its own equipment in the cabinet.*	
2. Enclosure Type	The pedestal is compliant to Telcordia GR-13, or is one of the following NEMA/ UL or IEC types: 3, 3R, 3S, 4, 4X, 6, 6P, IP24, IP55, IP66, IP67, or IP68	
3. Electro-Magnetic Compatibility	No carrier equipment located inside the pedestal/ cabinet may exceed the FCC Part 15 Subpart B criteria for radiated electric and magnetic fields.	

3.4 Carrier Power and Grounding Pre-Site Checklists

Tables 3-6, 3-7, and 3-8 contain quick reference checklists for some of the items specified in much greater detail in chapters 5, 6, and 7. These checklists 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 Qwest digital telecommunications equipment, or will drive an upgrade of the selected site.

For AC-powered Qwest equipment, use Table 3-6. For DC-powered Qwest equipment, use Table 3-7.

Note that the use of Qwest AC-powered equipment will be rare (unless the Carrier Customer and Qwest have agreed that backup power is not necessary) because no backup is usually provided.

Table 3-6: Carrier Cabinet AC Powering Checklist

Requirement	Notes/Description	Qwest Needs	Carrier Response
1. Backup?	Is backup power required during an AC outage? *Note: If the answer to this question is Yes from either party, then DC powered equipment is suggested.*		
2. Voltage	Mark the nominal single-phase AC voltage(s) needed/ available	120 ☐ 208 ☐ 240 ☐	120 ☐ 208 ☐ 240 ☐
3. AC Noise	Voltage THD reflected towards the source from the AC feed(s) provided to Qwest shall not exceed 15%, and current THD shall not exceed 30%.		
4. Feeds	List the number of hard-wired AC feeds needed/ available		
5. Breaker Size(s)	List the size of AC feed breaker(s) needed/ available *Note: The ampacity of the cables (as determined by NEC Table 310.15B16) shall equal or exceed the breaker size.*		
6. Meet Point	Jointly with the customer, determine the meet point for splicing of AC feeds.		
7. Breaker Access	Qwest shall have 24x7x365 access to the breaker enclosure feeding their equipment in order to restore service. The breaker enclosure shall not be locked with a key. Combination lock codes shall be provided to Qwest if combination locks are used.		
8. Average Drain	List the average draw of the equipment in Watts *Note: Lacking other information, this would be the same as the heat release.*		
9. TVSS	Are the AC feeds provided to Qwest protected by a functional TVSS? *Note: Failure of Qwest equipment due to failure of the TVSS will absolve Qwest of outage liability.*		

Note that the main purpose of providing DC to the equipment from the Carrier's cabinet DC power plant is so that the run time on backup for the carrier equipment and the Qwest transport equipment is the same, since either is essentially useless without the other. Note also, that the added List 1 (average) DC drain of Qwest equipment will reduce the battery backup time of all the equipment in the cabinet unless the batteries are upgraded.

If a DC source is provided to Qwest equipment from outside the cabinet in which the equipment is located(this is not the preferred configuration), it must have grounded, working TVSS protection (designed to fire at a voltage level no greater than 45% above nominal DC voltage) at the point it enters the cabinet with the Qwest equipment. The owner of this TVSS may need to be negotiated between Qwest and the Carrier.

Table 3-7: Carrier Cabinet DC Powering Checklist

Requirement	Notes/Description	Qwest Needs	Carrier Response
1. Voltage	Mark the nominal DC voltage(s) needed/ available	+24 ☐ -48 ☐	+24 ☐ -48 ☐
2. Voltage Tolerance	The normal operating voltage provided to Qwest equipment shall be between -41.65 and -56.00 VDC for a nominal -48 VDC source; or between 20.00 and 28.00 VDC for a nominal +24 VDC source. *Note 1: These voltage windows apply at all times except for after complete battery drain during an AC outage.* *Note 2: Failure of Qwest equipment due to voltages outside of these operating windows will absolve Qwest of outage liability.*		
3. Noise on the DC Source	The DC source provided to the Qwest equipment shall have less than 400 mV peak-peak and less than 50 dBrnC of AC ripple noise.		
4. Feeds	List the number of hard-wired DC feeds needed/ available *Note: Most DC fed equipment is A and B fed, typically meaning 2 feeds per equipment shelf*		
5. Fuse/ Breaker Size(s)	List the size of DC feed fuses or breaker(s) needed/ available *Note 1: Typically, DC fuses or breakers are sized at a minimum of 125% of the List 2 (peak) drain of the shelf (assuming one redundant feed size is down and the other is carrying all of the start-upcurrent at minimum operating voltage).* *Note 2: The ampacity of the cables (as determined by NEC Table 310.15B16) shall equal or exceed the fuse/breaker size.*		
6. Outside Source of DC Power	If DC Power is provided to Qwest equipment externally from the cabinet containing the equipment, all feeds must be protected by grounded TVSS (with a clamping voltage no more than 45% above the nominal voltage) at the entrance point to the cabinet containing the Qwest equipment. *Note: Qwest shall be absolved of any outage liability caused by a voltage spike on an external DC source of power.*		
7. Meet Point	Jointly with the customer, determine the meet point for splicing of DC feeds.		
8. Fuse/ Breaker Access	Qwest shall have 24x7x365 access to the fuse/ breaker panel/ enclosure feeding their equipment in order to restore service. The fuse/ breaker panel/ enclosure shall not be locked with a key. Combination lock codes shall be provided to Qwest if combination locks are used.		
9. Average Drain	List the average draw of the equipment in Watts *Note 1: Lacking other information, this would be the same as the heat release.* *Note 2: Average DC drains are often given by equipment manufacturers in List 1 Amps. Where this is the case, simply multiply the List 1 Amps by the nominal Voltage (24 or 48) to determine average Watts. Or if List 1 current is required by the Carrier, simply divide average Watts by the nominal Voltage.*		

Table 3-8: Carrier Cabinet Grounding Checklist

Requirement	Notes/Description	Response
1. Site Ground	Does the Site have one or more grounding electrode fields that are tied together?	
2. Cabinet Ground	Is the cabinet containing the Qwest equipment bonded to the site ground?	
3. MGN Bond	Is the site grounding system bonded to the power companies neutral or ACEG buss, and is the ACEG bus bonded to the neutral bus at the site power service entrance?	
4. Fence Bond	Is any metallic fencing within 6 feet of the cabinet(s) that will contain Qwest equipment bonded to the site grounding system?	
5. DC System Ground Reference	The DC source provided to Qwest shall be referenced to the cabinet ground system at the positive bus for nominal -48 VDC systems, or at the negative bus for nominal +24 VDC systems.	
6. Faraday Cage	Except for the cases when the Qwest equipment is the completely sealed pedestal-type, the cabinet meant to contain the Qwest equipment shall be made of metal (or provide an equivalent Faraday cage for protection of the equipment from EMF).	
7. Bonding Continuity of Mounting Rails	The equipment racking rails shall have continuity to the cabinet ground bar, and shall not be painted on the mating surface so that when Qwest equipment is mounted, it will be bonded to the cabinet ground. Lacking such continuity, at least one connection point shall be available to Qwest on the cabinet ground bar for chassis bonding.	
8. Involvement of a Qwest High Voltage Protection Engineer	If the site is to be located near a substation, generating station, or transmission tower, a Qwest High Voltage Protection Engineer must be consulted to determine if special measures need to be taken.	

3.5 Miscellaneous Carrier Cabinet Concerns

Table 3-9 is a quick reference checklist for other miscellaneous items (besides those already covered in this chapter) that Qwest and the Carrier Customer must agree on before the project can proceed.

Table 3-9: Carrier Cabinet Miscellaneous Items Checklist

Requirement	Notes/Description	Response
1. GFCI for Test Sets	Is there a spare GFCI outlet in the cabinet that will contain Qwest equipment (or within 6 feet of the cabinet) for Qwest to plug portable test equipment into? *Note: The GFCI will not permanently power equipment.*	
2. Access	The cabinet and any fenced gate shall not be locked with a key. Combination lock codes shall be provided to Qwest if combination locks are used. Cabinet entry shall be via standard telecommunications slotted pin hex/ allen wrenches and/ or can wrenches. Qwest shall have 24x7x365 access to the cabinet in order to repair service.	
3. Protectors for Metallic Services Leaving the Cabinet	Cabling between Qwest equipment and carrier equipment shall be confined to the cabinet. If not, overvoltage protectors suitable to the service (and grounded to the cabinet ground) shall be provided (at or near the point of exit/ entrance from the cabinet containing the Qwest equipment). *Note 1: The owner of these protectors and their clamping voltage levels may need to be negotiated. Involve a Qwest Electrical Protection (ICEP) Tech Support Engineer if necessary.* *Note 2: Fiber cabling is exempt from this requirement, except that any metallic strength members in a fiber cable should be bonded to the cabinet ground.*	

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4. Environmental Requirements

The environment in which telecommunications equipment resides must be maintained to proper conditions in order to minimize service outages and economically optimize the usable life of the equipment.

Qwest has recognized the need for a cleaner and more protective environment in the operating envelopment within which most 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 the telecommunications equipment. For optimal customer equipment operation, the requirements of the succeeding subsections should be met.

4.1 Temperature Guidelines

High Temperature ranges and rapid variations can cause thermal shock to components that are not designed for it (those that are designed for thermal extremes are typically referred to as temperature-hardened).

As noted in the preceding two chapters, there are essentially 4 types of equipment environmental requirements for equipment that could be deployed in a Carrier's outdoor Cabinet. From a temperature perspective, these can be distilled down to two temperature environments: 1] non-temperature-hardened (cabinet Type 1, per section 2.2); and 2] temperature-hardened (cabinet types 2, 3, and 4).

The customer must understand that temperature and ventilation requirements are 7x24x365 (they must be maintained continuously, even during "off-hours"), and that Qwest is absolved of outage liability when the temperature is not maintained within the guidelines set forth in the following two tables. In order to help achieve this reliability objective, the Carrier Customer would be wise to alarm their air-conditioning system (where applicable), and/ or fans, or for temperature extremes. In addition, fans should be used that have an MTBF of at least 40,000 hours.

For any cabinet with fans, that are accessible to personnel, the fans should be equipped with guards to prevent injury.

For non-temperature-hardened equipment that must go in an air-conditioned (or similarly cooled) cabinet, the environmental requirements for optimal equipment operation are described in Table 4-1:

Table 4-1: Environmental Requirements for Air-Conditioned Carrier Cabinets

Normal Operating Temperature Limits	40˚ to 104˚ F
Maximum Rate of Temperature Change	2.5˚ F per 10 minutes
Short Term Temperature Limits	5˚ to 120˚ F
Operating Relative Humidity	5% to 65%
Short Term Relative Humidity	5% to 95%

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 Qwest places in an air-conditioned outdoor Carrier Cabinet is designed to operate between the Normal Equipment Operability Temperature ranges of 40˚ to 104˚ F. However, the equipment will last longer if it is operated within a tighter operating window (ensure that the window is not so tight that failure or return of the air-conditioning does not cause the maximum rate of temperature change to be exceeded (thermal shock to circuit packs). The air temperatures noted in the Table must be maintained around the equipment in its chamber taking into account the total equipment heat dissipation and solar loading, when the outdoor ambient in the shade can range from -40° to 125° F, and the air-conditioning intake air temperatures from the outdoors can range from -40° to 140° F.
3. Cooling of the equipment chamber below ambient outdoor air-temperature can be accomplished by traditional air-conditioning, thermo-electric cooling, passive thermo-siphoning black-body-radiation, etc. Each has their own advantages and disadvantages relative to cost, maintenance, efficiency, and cooling capacity. Qwest does not care which technology is used by the Carrier for their cabinet, as long as the appropriate technology is chosen for the overall heat load and maintenance is kept up to ensure long-term operation of the cooling system.
4. Although the lower humidity guideline of 5% is in accordance with 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.

For temperature-hardened equipment that goes into Carrier Cabinets (Cabinet Types 2, 3, and 4, as described in Chapter 2) that are not air-conditioned (or otherwise cooled below the maximum ambient temperature), the temperature requirements of the air inside the cabinet equipment chamber are described in Table 4-2:

Table 4-2: Temperature Requirements for Other Carrier Cabinets

Normal Operating Temperature Limits	-40˚ to 149˚ F
Short Term Temperature Limits	-40˚ to 158˚ 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 temperature-hardened digital equipment Qwest places in an outdoor Carrier Cabinet is designed to operate between the Normal Equipment Operability Temperature ranges of 40˚ to 149˚ F. However, the equipment will last longer if it is operated within a tighter operating window. The air temperatures noted in the Table must be maintained around the equipment in its chamber taking into account the total equipment heat dissipation and solar loading, when the outdoor ambient in the shade can range from -40° to 125° F, and heat exchanger or ventilation intake air temperatures from the outdoors can range from -40° to 140° F.

In order for a Carrier to determine if their cabinet air-conditioning system, heat exchange system, or cabinet ventilation design is adequate, they must know the approximate average heat release of the Qwest equipment (given by the Qwest Engineer in chapter 3 Tables), and add to that the average heat release of their own equipment; and take into account solar loading and the worst case intake air temperatures of Note 2 to Tables 4-1 or 4-2. Cabinet color and reflectivity, along with placement, can have a big impact on the solar loading.

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).

Air-conditioning can be sized based on Watts, BTUs/ hr, and/ or tons. The following conversion factors can be used.

1 W = 3.41 BTUs/ hr

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

For air-conditioned cabinets or any cabinet with fans, DC-powered components will best ensure that the temperature guidelines of Tables 4-1 or 4-2 are met. However, due to the large locked rotor startup currents of compressor motors, special care must be taken to ensure that any DC-powered motor startup current does not depress the voltage below the equipment operating levels given in Chapter 5 or Table 3-7.

If there are cabinet surface temperatures, or Carrier equipment in the same equipment chamber as the Qwest equipment that may have temperatures capable of causing personnel burns; such equipment or surfaces should be marked with a warning label regarding hot surfaces.

4.2 Ventilation Guidelines

Constant circulation of air reduces hot spots and minimizes rapid temperature changes. Most cabinets of Type 1 or 2 (see section 2.2) will constantly circulate air inside the equipment chamber. For those cabinets that do not constantly circulate air, equipment fan shelves may be provided. After viewing the heat release numbers, the Carrier shall inform the Qwest Engineer as to whether an equipment fan shelf may be needed to maintain the temperature guidelines around the Qwest equipment. It may be negotiated between the Carrier and Qwest as to who provides this equipment fan shelf.

For Type 3 or 4 cabinets (especially Type 4 cabinets/ pedestals), the possibility of excessive dust intrusion into the equipment space (since, unlike Type 1 or 2 cabinets, the equipment space is not usually "sealed") usually precludes the use of ventilation fans. These cabinet/ pedestal types must usually make use of convective airflow and strategically designed and placed vents to dissipate equipment heat generated and still maintain the temperature guidelines of Table 4-2.

Any cabinet design with air filters is prone to higher equipment failure rates unless periodic maintenance of the filters can be assured. For this reason, cabinets with air filters are typically not preferred (other strategic designs of ventilation openings can help minimize dust and water intrusion without requiring filters).

VRLA and Ni-Cd Batteries provided by the Carrier Customer in their cabinet should have adequate ventilation due to the Hydrogen gas they release. Qwest is absolved of liability and must be reimbursed for equipment and repair costs if Customer batteries cause a fire or explosion.

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.

For equipment designed for Type 1 or 2 Carrier Cabinets (as defined in Section 2.2), maintenance of the air quality around the equipment is via a sealed equipment chamber. Not only must there be a heat exchange mechanism for these types of cabinets that does not break that seal, but openings between the equipment chamber and other chambers (such as a battery chamber or splice chamber must also be sealed via the use of rubber grommets or other sealing methods.

In addition, any equipment chamber door/ cover seal/ gasket for Type 1 and 2 cabinets should be designed from materials that can stand up to weathering (retain the seal) and not be corrosive to the metal of the cabinet or the equipment inside.

Thermal weatherability can be determined with a thermal cycling test between -40 and 70° C for a minimum of 7 days, with a minimum of 9 cycles between the extremes. Following the test (after a return to room temperature), there should be no visible deterioriation, deformation, melting, or cracking, and the gasket should not be hard (as determined by hand flexing). In addition, after this test, the gasket/ seal shall continue to properly adhere to the metal cabinet.

Some cabinets will be in coastal areas and/ or consistently exposed to high humidity. In those cases, part of their weatherability can be tested with salt fog exposure (see ASTM B 117-A). The standard test for salt fog exposure is 30 days followed by an inspection of the seals.

The gaskets/ seals for the equipment chamber should not allow water intrusion. This can be determined by two tests: wind-driven rain, and lawn sprinkler testing. The wind-driven rain test is performed per MIL-STD-810F, Method 506.3, Procedure 1. The lawn sprinkler test is performed by positioning a spray head on the ground 6 feet from the cabinet and aiming the spray (30 psi for 15 minutes on each seal surface/ side) upwards at a 45 degree angle).

Finally, the gaskets/ seals for the equipment chamber should not allow dust intrusion. This can be determined by a wind-driven dust test conducted with the cabinet in an enclosure with a minimum of 18 inches of clearance on all sides. 2 pounds of 325 mesh alumina silicate (or equivalent) should be blown against all door operings/ seals, etc. with an air velocity of 60 mph.

Hinged doors for equipment chambers should be equipped with a door alarm remoted to a NOC so that when a technician leaves the site and accidentally leaves the equipment door open, it can be corrected.

The heat exchange equipment areas of a Type 1 or 2 cabinet may allow some water and dust intrusion, but ventilation openings for these shall be designed to minimize such intrusion (and drain any accumulated water), so that the heat exchange equipment enjoys a long useful life. These areas may also be subjected to the dust and water intrusion tests mentioned in the preceding paragraphs, with the caveat that some water and dust intrusion is allowed. As noted in the previous section, it is highly desirable that the ventilation openings for these heat exchangers not be equipped with filters requiring maintenance and/ or replacement. If such filters are necessary, they must be on a periodic maintenance schedule (by Carrier personnel or a Carrier contractor) appropriate for the climate and site.

Equipment designed for use in Type 3 cabinets can withstand some minimal dust and water intrusion. No additional testing is necessary beyond use of a cabinet rated NEMA/ UL 3, 3S, 4, 4X, 6, or 6 P (or IEC IP55, IP66, IP67, or IP68), since those manufacturing guidelines will ensure the minimal water and dust intrusion allowed by the equipment. Equipment designed for Type 3 cabinets can also obviously be placed in the sealed equipment chambers of a Type 1 or 2 cabinet.

Any battery chamber of a Type 1, 2, or 3 cabinet may also allow water and dust intrusion. However, battery terminals and connectors should be protected with an anti-oxidant coating in order to ensure that dust in the battery chamber does not affect the continuity of the connections. Water accumulation in a battery chamber can be minimized by the use of drains. If less than 1 inch of water accumulates during the water testing described in preceding paragraphs, the drains are probably sufficient.

Equipment designed for use in Type 4 cabinets/ pedestals is hermetically sealed and technically does not need any cabinet or pedestal to protect its equipment from water and dust intrusion, so it may go into any of the previous cabinet types mentioned, a NEMA/ UL 3R cabinet (or IEC IP24), or a common metallic telecommunications pedestal. However, drains should be provided to prevent excessive water accumulation.

As noted in the previous section, it is highly desirable that the ventilation openings for Type 3 and 4 cabinets not be equipped with filters requiring maintenance and/ or replacement. If such filters are necessary, they must be on a periodic maintenance schedule (by Carrier personnel or a Carrier contractor) appropriate for the climate and site.

Any screens on ventilation openings (or any filters if used) should be resistant to fire and corrosion (including corrosion from salt fog that may occur in coastal areas).

4.4 Vibration Resistance

Many cabinets are near roads where passing trucks can cause fairly significant vibration. Winds can also cause vibration. Qwest equipment has been tested to withstand such normal vibration (and is typically also tested to withstand even earthquake vibrations. However, the Qwest equipment is mounted in a cabinet that may or may not be susceptible to vibration. If Qwest equipment is made inoperable because the cabinet is not resistant to vibration, Qwest is absolved of responsibility for outages. If Qwest equipment is damaged by the cabinet or other equipment in it due to vibration, the Carrier will reimburse Qwest for the cost of the equipment in addition to absolving Qwest of responsibility for outages.

Carriers wishing to ensure that their cabinet is resistant to normal vibration induced by wind, trucks, nearby industrial processes, etc. would probably ensure that their Cabinet model and equipment had been tested to the ETSI EN 300 019, 1-4 Office Vibration test procedure stress levels using random vibration protocols for IEC DS/ EN 60721-3-4+A1 mechanical Class 3M5 locations. Equipment Listed to UL 60950 (or the older UL 1950) will also be resistant to some normal vibration.

For cabinets located in earthquake-prone areas, the Carrier may wish to ensure that their equipment and cabinet has been tested for the appropriate seismic zone or forces expected for that locale per the applicable Building Code, or per ATIS 0600329, or per Telcordia GR-63.

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5. Powering Guidelines

This Section on Power addresses the general powering philosophy for Qwest equipment placed within Carrier Customer Premises cabinets.

Most of the time, the Carrier Customer will provide DC power to the Qwest equipment. There are rarer circumstances where the Carrier will provide AC power circuits to Qwest, and in some of those circumstances, Qwest may even place their own power plant.

5.1 Powering from Carrier Customer DC Power Supplies

Because the service provided by the Carrier Customer is typically dependent on the transport provided by the collocated Qwest equipment, it is wisest that they have the same amount of backup power. The easiest way to ensure this, and minimize use of space in the cabinet is to provide the Qwest equipment with a feed from the Customer's DC plant (typically at nominal +24 or -48 VDC).

Some Qwest equipment can be powered from either a nominal +24 (grounded negative bus) or -48 (grounded positive bus) VDC feed, but some requires one voltage or the other. Some Carrier Customers can only provide one of these nominal voltages, while some can provide both. In cases where the nominal DC voltage available from the Carrier Customer does not match the nominal voltage range of the Qwest Equipment, either Qwest or the Carrier can provide a DC-DC converter (who provides it is open to negotiation) shelf. If Qwest provides the converter plant, we will always ensure that there are n+1 converters (at least one converter more than the List 3 peak average DC load). We suggest that the Carrier do the same if they are providing the converter plant.

Note that the Qwest equipment drain will reduce the backup time for all equipment in the cabinet, so if the reduction (based on adding the average equipment drain provided by Qwest in response to item 9 in Table 3-7 to the existing average equipment drain of the Carrier equipment) drops the battery reserve below what the Carrier Customer considers acceptable, the Carrier may decide to add additional battery strings or upsize the existing battery strings. In addition, the Carrier should probably also ensure that the added List 1 drain(s) of the Qwest equipment do not cause their total average load to exceed the n-1 capacity of their rectifier plant. If it does, they should add more rectifiers.

Normally, because the Qwest equipment is there solely to support the Carrier Customer's service(s), there is no charge to Qwest for the space, the power feeds, or the electrical power consumed. However, this is a matter that is open to negotiation. In cases where it is determined that Qwest must pay for consumed power, it should be based on the sum total List 1 average Ampere draw of all of the Qwest equipment (and not the peak List 2 drains or fuse/ breaker sizes).

For a nominal -48 V feed, the Qwest equipment requires a source that operates (including during battery discharge) between -41.65 and -56.00 VDC. For +24 VDC sources, the supplied voltage at all times (including during compressor motor startup, if applicable) should be between 20.00 and 28.00 VDC. In addition, the source voltage should have AC ripple below 400 mV peak-peak with an electrical noise measurement less than 50 dBrnC. Qwest is not liable for its own equipment outages when DC power quality provided by the Customer falls outside of these ranges.

Most Qwest equipment requires dual DC feeds to each equipment shelf. Qwest will specify to the Carrier Customer the size and number of DC breakers or fuses. If Qwest requires more than two breakers or fuses, Qwest and the Carrier Customer may decide that Qwest needs to place a miscellaneous fuse panel to further break down the feeds for individual equipment shelves. Note however, that this panel will take up more room in the Carrier's cabinet. The ampacity (as defined by NEC Table 310.15B16) of the DC feeder wires shall equal or exceed the Ampere rating of the feeder fuse or breaker.

Most of the time where the Carrier Customer provides DC power to Qwest equipment, it will be from a DC plant contained in the same cabinet. In the rare cases where it is provided from a DC source external to the cabinet where Qwest's equipment is placed, special electrical protection measures are necessary. Such feeds should be in grounded metallic conduit. For any run exceeding 6 feet, at the point they enter the outdoor cabinet containing the Qwest equipment, each feed must be connected to a grounded DC surge arrestor (with a clamping voltage no greater than 70 V for a nominal -48 VDC protector, or a clamping voltage no greater than 35 V for a nominal +24 VDC protector) rated for at least the Amps represented by the feeding fuse or breaker size. The only exception to this rule would be for cases where a DC-DC converter is used in the cabinet containing the Qwest equipment, and the converter model has been tested to withstand the surges specified in ATIS 0600315 and IEC 61000-4-11. The provider (Qwest or the Carrier Customer) of DC surge protection (where required), at the entrance to the Carrier Customer Cabinet containing the Qwest equipment, is open to negotiation. In these cases where the external DC feed run exceeds 6 feet, Qwest also suggests that the Carrier protect their own DC plant (at the feed source end) from induced or direct surges by use of DC surge arrestors and/ or DC-DC converters. Even with surge protection and/ or DC-DC converter plants, a close enough lightning strike can cause equipment damage; therefore, when Carrier Customer DC power feeds to Qwest equipment come from a source external to the Carrier Customer Cabinet in which the Qwest equipment is located, Qwest is absolved of liability for outages.

When DC feeds come from a source external to the cabinet, the entrance seal for the conduit should be weathertight.

Especially for externally-sourced DC feeds, a meet point (e.g., junction box) between any Qwest-run power wires and customer power wires must be negotiated, as well as coordination of "fuse up" (or breaker "turn on"). It is preferable that meet point be within a cabinet, but if the meet point is external to a cabinet, it must be in an appropriate weather-resistant electrical enclosure. For many feeds, the customer will simply leave a specified length of cabling (negotiated) that Qwest can "lug" and terminate on their own equipment shelves; or if Qwest has already placed the equipment shelves, and they desire that the Carrier make the terminations to the Qwest equipment themselves, this can also be negotiated.

Regardless of whether the DC feeds originate internal to the Carrier Customer Cabinet containing the Qwest equipment, or external to this cabinet, Qwest must have 7x24x365 access to the feeder fuse or breaker panel in order to restore service, as well as a posted Carrier Customer NOC or Tech Support number to call. In addition, the circuits feeding Qwest shall be well-labeled. The feeding fuse or breaker panel and any cabinet within which it is contained shall not be locked with a key. If combination locks are used, the codes shall be provided to Qwest. In case of an inaccessible fuse or breaker panel or lack of labeling, Qwest shall not be liable for any additional delay in service restoral beyond the time the Qwest technician arrives on site. It is permissible for the Carrier Customer technicians to replace fuses or re-close breakers feeding Qwest equipment without the permission of an on-site Qwest technician or Qwest Tech Support personnel on the phone, but not to open them (unless the breaker is already tripped).

When Qwest equipment is located in the same Carrier Customer Cabinet with exposed DC exceeding 75 V, such exposure shall be clearly labeled with a red or yellow label (or a white label with red lettering) so that a Qwest employee is warned against contact. Note that this requirement does not apply when the relatively higher Carrier Customer DC Voltage is behind grounded metal panels or insulating covers.

5.2 AC Power from the Carrier Customer

While it is usually wisest to feed the Qwest equipment from the same backed up DC source as the customer, there may be circumstances that preclude that, or other reasons to power the Qwest equipment from Customer-provided AC power. Note that a permanent on-site engine feeding AC loads does not constitute uninterruptible power unless there is a UPS or battery-backed DC plant-fed inverter for "ride-through". There will be a delay of several seconds to several minutes between the loss of commercial AC and the time an engine-alternator comes up to speed and assumes the load.

While not absolutely required, it is suggested that the customer have a means of providing portable genset power (through a Listed transfer switch/ breaker assembly) to their cabinets not backed by a permanent engine-alternator for long-term commercial AC outages.

Most Qwest equipment (including rectifier shelves) that requires AC power can be powered from single-phase nominal 120 V, or from single-phase nominal 208 or 240 V. Qwest and the customer simply need to negotiate to ensure that the AC Voltage provided by the customer matches the AC Voltage range of the Qwest AC-fed equipment (see Table 3-6, Requirement 2).

Generally, direct AC-fed equipment is not backed up. However, if the AC feed from the Customer is provided by an inverter or UPS, the Qwest equipment drain will reduce the backup time for all equipment backed up by that source; so if the reduction (based on adding the average equipment drain provided by Qwest in response to item 8 in Table 3-6 to the existing average AC equipment drain of the Carrier equipment) drops the battery reserve below what the Carrier Customer considers acceptable, the Carrier may decide to add additional battery strings or upsize the existing battery strings. In addition, the Carrier should probably also ensure that the added AC drain(s) of the Qwest equipment do not cause the inverter or UPS to be loaded to greater than 80%. If the AC feed is backed up by an engine-alternator, the Carrier Customer should ensure that the added Qwest AC load does not exceed the capacity of the engine-alternator, the transfer switch, or the genset receptacle.

If the Qwest equipment requires AC power, but Qwest and the Customer desire backup, either the Customer or Qwest can provide (open to negotiation) an inverter shelf (preferably n+1) fed by the Customer's battery-backed DC plant. Less desirable is placement and use of a UPS by either party due to the additional battery maintenance and the poor battery life and reliability of UPS batteries as opposed to those of nominal 24 or 48 VDC plants. If Qwest provides the UPS, it will need to receive an AC feed from the customer.

As noted in the previous section there is normally no charge to Qwest for the space, the power feeds, or the electrical power consumed. However, this is a matter that is open to negotiation. In cases where it is determined that Qwest must pay for consumed power, it should be based on the average draw of all of the Qwest equipment (see the response to Requirement 8 in Table 3-6).

For a nominal 120 VAC feed, the Qwest equipment requires a source that operates between 90 and 136 VAC rms. For nominal 208 or 240 VAC single-phase sources, the supplied voltage should be between 176 and 264 V rms. In addition, the source voltage should have THD less than 15%, and the source current should have a THD less than 30%. Qwest is not liable for its own equipment outages when AC power quality provided by the Customer falls outside of these ranges.

Qwest may require or desire two AC feeds. Qwest will specify to the Carrier Customer the size and number of AC breakers or fuses. If Qwest requires more than two breakers or fuses, Qwest and the Carrier Customer may decide that Qwest needs to place a power strip to further break down the feeds for individual equipment shelves. Note however, that this panel will take up more room in the Carrier's cabinet. The ampacity (as defined by NEC Table 310.15B16) of the AC feeder wires shall equal or exceed the Ampere rating of the feeder fuse or breaker.

When AC power is provided from a source external to the cabinet where Qwest's equipment is placed, such feeds should be in grounded metallic conduit. For any run exceeding 10 feet, at the point they enter the outdoor cabinet containing the Qwest equipment, each feed must be connected to a grounded surge arrestor (TVSS) with indicating lights so that it may be determined when it has sacrificed itself. The provider (Qwest or the Carrier Customer) of AC surge protection (where required), at the entrance to the Carrier Customer Cabinet containing the Qwest equipment, is open to negotiation. In these cases where the external AC feed run exceeds 10 feet, Qwest also suggests that the Carrier protect their own equipment (at the feed source end) from induced or direct surges by use of TVSS.

Even with surge protection (and the GR-1089 NEBS-qualified surge withstand capability of Qwest AC-powered equipment), a close enough lightning strike can cause equipment damage; therefore, Qwest is absolved of liability for outages caused by AC surges.

A Listed meet point (e.g., junction box) between any Qwest-run AC power wires and customer power wires must be negotiated, as well as coordination of breaker "turn on". It is preferable that meet point be within a cabinet, but if the meet point is external to a cabinet, it must be in an appropriate weather-resistant electrical enclosure. For many feeds, the customer will simply leave a specified length of cabling (negotiated) that Qwest can "lug" and terminate on their own equipment shelves; or if Qwest has already placed the equipment shelves, and they desire that the Carrier make the terminations to the Qwest equipment themselves, this can also be negotiated. For meet points, plugs should generally not be used because receptacles in outdoor locations are required by Code to be GFCI-protected. GFCIs are a nuisance tripping hazard. If the customer insists on feeding AC-fed Qwest equipment via a GFCI-protected receptacle, Qwest is not liable for outages due to GFCI tripping.

While Qwest does not want its equipment permanently fed from a GFCI-protected AC circuit, it prefers that such an outlet be available in the cabinet for plugging in temporary test equipment.

Regardless of whether the AC feeds originate internal to the Carrier Customer Cabinet containing the Qwest equipment, or external to this cabinet, Qwest must have 7x24x365 access to the Listed feeder fuse or breaker panel in order to restore service, as well as a posted Carrier Customer NOC or Tech Support number to call. In addition, the circuit(s) feeding Qwest shall be clearly labeled. The feeding fuse or breaker panel and any cabinet within which it is contained shall not be locked with a key. If combination locks are used, the codes shall be provided to Qwest. In case of an inaccessible or unlabeled fuse or breaker panel, Qwest shall not be liable for any additional delay in service restoral beyond the time the Qwest technician arrives on site. It is permissible for the Carrier Customer technicians to re-close breakers feeding Qwest equipment without the permission of an on-site Qwest technician or Qwest Tech Support personnel on the phone, but not to open them (unless the breaker is already tripped).

When Qwest equipment is located in the same Carrier Customer Cabinet with exposed AC exceeding 50 V rms, such exposure shall be clearly labeled with a red or yellow label (or a white label with red lettering) so that a Qwest employee is warned against contact. Note that this requirement does not apply when the relatively higher Carrier Customer AC Voltage is behind grounded metal panels or insulating covers.

All AC circuits are required to be run with an ACEG.

For reliability purposes, it is suggested that the Carrier Customer remotely alarm the commercial AC fail for the site.

5.3 Qwest DC Rectifier Plants in Outdoor Carrier Cabinets

All Qwest DC Power Plant Standards are contained in Qwest Technical Publication 77385. In the following paragraphs of this subsection, a few of the more salient (for this application) DC Plant requirements from Pub 77385 are excerpted.

In the rare cases where Qwest provides a DC rectifier plant for placement within an outdoor Carrier Cabinet in order to power Qwest's own equipment, the redundancy and backup time of that design is often subject to negotiation between the Carrier and Qwest.

The exception to that rule is for equipment supporting lifeline regulated telephony services. In those cases, the AC feeds supplied from the Customer must be from an inverter supplied by the Carrier's battery-backed DC power plant; or Qwest must provide eight hours of battery reserve (sized at the List 1 or average drains of the served equipment); unless the AC feeds are backed by a permanent auto-start auto-transfer engine-alternator, in which case only four hours of backup is required.

Qwest can only provide lead-acid batteries if the batteries are contained inside a Type 3 enclosure (see Section 2.2).

In those Type 3 enclosures, only certain rectifier shelves may be used (the Qwest Engineer should consult their internal Power AMC contact to determine if there is a rectifier shelf that will work in that situation). Otherwise, Qwest rectifier shelves must go into a Type 1 or 2 Cabinet.

Redundant rectifiers (n+1 at 120% minimum of equipment manufacturer List 1 drains) will be provided when Qwest supplies the rectification, and a regulated service with an overall bandwidth greater than a DS-2 level is provided by Qwest to the Customer. Qwest rectifier heat release (at the equipment List 1 average drain) will be provided along with equipment heat release to the Carrier Customer.

When VRLA batteries are used in association with a Qwest-provided rectifier shelf, temperature-compensated charging will be used to reduce the probability of thermal runaway. One temperature sensor will be placed per VRLA string, and compensation will be as specified in Tech Pub 77385.

Qwest lead-acid batteries cannot go into the sealed equipment chamber of a Type 1 or 2 Cabinet because these batteries release hydrogen. The Carrier customer may give Qwest space in the battery chamber of a Type 1 or 2 cabinet for placement of lead-acid or Ni-Cd batteries (Ni-Cd batteries are a much more expensive option), or Qwest can place expensive Li-ion batteries in the sealed equipment chamber.

When VRLA batteries owned by Qwest are used to back up Qwest equipment supporting regulated lifeline telephony, a minimum of 2 strings are required for reliability reasons. This requirement is waived when the overall service bandwidth provided by Qwest to the Carrier Customer is equal to or below a DS-2 level, or is also waived for Li-ion or Ni-Cd battery technologies.

Qwest transport equipment must support at least two housekeeping alarms in order to allow placement of Qwest-owned DC plants and Li-ion batteries in Carrier Customer outdoor RT cabinets.

Any powering or backup powering equipment provided by Qwest will be maintained by Qwest. 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 Qwest regarding the cost of this maintenance (see Section 9 for further information on Contracting). Both Qwest and the customer should ensure that regular preventive maintenance (Qwest recommends at least annual routines for DC Plant maintenance, including batteries; and monthly engine runs where applicable) 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 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.

Qwest has their own maintenance procedures, which generally meet or exceed the recommendations of Telcordia, the IEEE, and the NFPA. Qwest 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.

5.4 Miscellaneous Power Installation Requirements

A thin film of anti-oxidant grease should be applied to DC power connections prior to tightening. 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 for nuts and/ or bolts are best. Lock washers should not be placed between the connecting terminal and the contact surface. Irreversible crimp compression connections are strongly preferred for DC power.

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). Any connector drilled with two holes should be secured using both holes.

All AC connectors, wiring, conduit, fixtures, etc. shall meet the requirements of the NEC, NEMA, and UL, and any local codes and ordinances that vary from these standards. Generally, the Carrier Customer shall purchase and pay for electrical permits, licenses, and inspections, if they are required; unless otherwise negotiated with Qwest.

If AC-fed equipment or AC circuits greater than nominal 24 VAC are to be serviced, maintained or adjusted, necessary switches shall be opened or wires disconnected whenever possible. No work shall be performed on LIVE/ ENERGIZED AC CIRCUITS by other than a Licensed Electrician (supervised by a journeyman title or higher).

Metallic AC or DC circuit meet-point boxes external to the cabinet containing Qwest equipment shall contain provisions for attachment of a grounding conductor to the box (any grounding conductor then passing through the box is required to be bonded to this point). If such a metallic meet-point box is internal to the cabinet containing the Qwest equipment, it must have a secure, conductive metallic connection to the cabinet metal, or be otherwise bonded to the cabinet or cabinet grounding system. Unused openings (including conduit knockouts) in cabinets and external meet-point boxes shall be closed with appropriate covers, plugs or plates.

Irreversible crimp compression connections are preferred for AC wiring. 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.

AC and/ or DC feed circuits should be labeled at the meet point and termination end with their source location.

AC or DC conductors that are not protected with thermoset cross-linked polyethylene (such as XHHW) or cotton braid (traditionally used on soft rubber RHW DC power wire) shall be protected at tie points and points of impingement with fiber sheeting.

When working near live polarities due to the need to keep service up, attempt to protect adjacent parts of differing voltage polarities with insulating materials.

In many cases, the Carrier Customer is responsible for the backup batteries at the site. However, as noted in Section 5.3, there are cases where Qwest owns battery backup at an outdoor Carrier location.

Qwest technicians working near batteries should discharge body static to a grounded surface before working on or near batteries, because even VRLA batteries emit small amounts of hydrogen gas (and non-hydrogen emitting batteries, such as Li-ion, have sensitive electronic components that can be damaged by electrostatic discharge [ESD]).

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.

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

Connections to battery posts/ lugs should 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 48 hours, and under close supervision during those 48 hours.

VRLA batteries in -48 VDC Plants generally float between -53.8 and -54.8 VDC (consult the battery manufacturer's literature for exact levels) at 77 °F Most power plants are equipped with temperature compensation. Temperature compensation lowers the float voltage as room and battery temperatures rise to prevent thermal runaway (and raises voltage in colder temperatures), and to lengthen battery life. Temperature compensation should be inspected/ adjusted at initial installation and at battery replacement to ensure that the slope of compensation falls within Qwest (see Tech Pub 77385, Chapter 13) and manufacturer guidelines.

VRLA Battery temperatures more than 10-15 °F above ambient cabinet temperature probably indicate thermal runaway (a potentially dangerous situation). In these cases, Qwest-owned batteries should be disconnected and replaced as soon as possible. If this is noticed on Carrier Customer-owned batteries, the Customer should be informed.

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6. Grounding Guidelines

This Section on Grounding addresses general and specific grounding principles for outdoor Carrier Cabinet locations.

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 Reliability (proper grounding helps ensure equipment circuit packs will not be damaged by the aforementioned transients, and gives a drain source for these transients through proper surge protection)
- 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, lightning 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, Outside Plant equipment cabinet 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 outside plant equipment cabinet and radio site grounding from Tech Pub 77355, the Qwest Grounding Standard.

The following sections may 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. However, it is also desirable to use wires in an outdoor and buried environment that will resist corrosion the longest.

Each ground wire should have its own termination point (lugs should not be stacked) to permit lifting of individual bonds for testing.

The minimum bending radius of a grounding conductor is 12 inches. Grounding conductors (other than ACEG) shall not be run in metallic conduit due to the "choke" effect this creates for lightning current. Where this is done, the grounding conductor shall be end-bonded.

Irreversible crimp compression connections (including 2-hole lugs where lugs are used) or exothermic welding are preferred for site and cabinet grounding. Two-hole irreversible crimp compression lug connections are preferred for grounding connections since they will create the longest-lasting solid bond. Typical hole size and spacing are ¼"-20 threads on $^{5}/_{8}$" centers, but $^{3}/_{8}$"-16 threads on 1" centers are also common. Single-hole connections (preferably irreversible crimp compression type) should use a star washer, lock washer, or "lock-bolt" to prevent loosening over time. Lock washers should not be placed between the connecting terminal and the contact surface.

Where pressure (mechanical) connections are used they must be tight.

A thin film of anti-oxidant should be applied to any grounding connection (other than exothermic welds) before it is tightened.

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.

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. Qwest Tech Pub 77355 prefers that it be lower than 5 Ω, although this is not always possible, depending on soil conditions, etc. For a Carrier Customer's outdoor cabinet, the earth grounding electrode system would be a buried system, consisting of any combination of the following: ground rod(s); buried bare ground wire (e.g., ground ring); ground well or chemical ground; and rebar in a concrete pad, foundation or footing (Ufer ground). If there is city water running to the site, metallic piping can be used as a supplemental electrode. The site ground electrode system must be tied to the electric utility's MGN (multi-grounded neutral), possibly through the ACEG (which by NEC Code must be bonded to the MGN at the site service entrance). This utility MGN serves as a grounding electrode as well. Per Code (NEC), all ground electrode fields at the site must be bonded together.

Metallic fencing within 6 feet of the equipment buildings/ cabinets should be bonded to the ground electrode system as well, and does serve as a grounding electrode of sorts at the posts.

Any ground wire extended to Qwest equipment (other than an ACEG) should not be enclosed in metallic conduit (if it is, it must be end-bonded at both ends of the conduit). For direct-burial or exposed outdoor grounding, solid copper wires (as opposed to stranded or braided) will last longer. Such wires used to create the ground electrode field and bond to it may be as small as #6 AWG, or preferably as large as #2 AWG (the largest commercially available solid copper wire). If the wire is tinned from the manufacturer, it will last even longer.

For buried connections, exothermic welds or irreversible crimp compression connections are preferred.

Cabinets on building rooftops deserve special consideration when there is an associated NFPA 780 lightning protection system for the rooftop. In these cases, the ground source will be the lightning protection system.

6.3 Cabinet Bonding

The Carrier Customer cabinet containing the Qwest equipment must be bonded to the site ground electrode field(s), and from an EMI perspective, the cabinet (except for cabinets or pedestals containing completely metallically sealed weatherproof Qwest equipment) must be made of metal that is bonded to this ground so that it can function as a Faraday cage. Hinged or removable doors that do not have a DC resistance of less than 100 milliOhms to the rest of the grounded cabinet should be positively bonded (typically using a braided strap or flexible wire) to the rest of the cabinet.

There should be continuity between the equipment mounting rails of the cabinet and the cabinet ground itself. If there is not, the Carrier Customer shall so specify, and allow Qwest to access a cabinet ground point (that is marked as such, or is clearly obvious due to the connection to it of bare copper wires or wires with green insulation) that has not already been lugged to (so that lug stacking can be avoided). If the equipment mounting rails are bonded, but they are painted, powder-coated, or otherwise insulated; this must also be specified so that Qwest knows that it must either scrape the coating or make a direct equipment shelf chassis-ground connection to a cabinet ground point.

All metallic cabinets at the site must be tied to each other or to the bonded ground electrode field(s).

Any direct-buried connections should be covered with a copper-impregnated anti-oxidant grease.

6.4 Equipment Grounding

Any DC power source serving Qwest equipment must be ground referenced (typically from the negative bus for nominal 24 V systems, or from the positive bus for nominal 48 V systems). If Qwest is placing its own rectifier, inverter, or UPS, it must have access to the cabinet ground point to reference the output of this separately-derived power source.

Chassis grounds for Qwest equipment frames are specified by the equipment manufacturer based on NEBS fault-current testing. Sometimes all that is required is screwing/ bolting the equipment shelf to grounded equipment mounting rails. However, when this is the case, self-threading screws and external tooth lock-washers shall be used. When the equipment shelf provides a separate chassis ground point, this should be used, and may be tied to the equipment mounting rails (if they are bonded to the cabinet ground), or directly to the cabinet ground bar/ point with a wire at least as large as that specified by the shelf manufacturer.

6.5 Grounding Metallic Entrances

Surge arrestors/ protectors must be used on all AC and DC power feeds to Qwest equipment and any copper signal drop (such as coax, Cat 5, etc.) from Qwest equipment that travels outdoors for more than 10 feet.

Wires used as ground drains for protectors for metallic facilities (e.g. TVSS, 5-pin protectors, coax surge arrestors, etc.) shall be sized at least as large as the minimum wire size specified by the surge arrestor manufacturer. Surge arrestors should be located as close as possible to cabinet/ building entry/ exit points with the "drain" wire being as short and direct as possible to an outside ground electrode field source.

Any Qwest copper cable shield entering or leaving the cabinet and traveling greater than 10 feet outdoors shall be bonded to the cabinet ground. For coax, or shielded Cat 5 or Cat 6, the grounding might be integral to the protector, or it might not. Check with the protector/ arrestor and mux/ router equipment manufacturers to determine if the shield must be ground-referenced separately. Also, for shielded Cat 5 or Cat 6 GigE cable, the grounding may be done through the equipment, and the protector may simply provide continuity in this case or provide gas tube or electronic device protection between the shield and ground. A shielded Cat 5 or Cat 6 cable should usually not be grounded at both ends, but this may be negotiated between Qwest and the Carrier Customer after consultation with the equipment manufacturers of both Qwest and the Customer. This single-end bonding is most easily accomplished for RJ-45/ 48 terminations by using a cable that has a metallic jack bonded to the shield at one end (which plugs into a bonded metallic jack receptacle), and a plastic jack at the other end.

If there are metallic strength members or metallic shields in any Qwest fiber cable entering or leaving the cabinet and traveling more than 10 feet outdoors, those must also be grounded to the cabinet ground as close as practical to their entry.

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7. Electromagnetic Compatibility (EMC) and Interference (EMI)

7.1 General Electromagnetic Compatibility Information

7.1.1 Overview of Electromagnetic Radiation, Radio Frequency Interference (RFI), and Compatibility

Electromagnetic radiation is all around us. It comes from space (emitted by stars and man-made satellites), lightning, radio and television transmission towers, cell towers and cell phones, electric transmission lines, and almost all electric and electronic equipment.

Electronic equipment is susceptible to excessive electromagnetic fields, and must be shielded from it (meaning that it can be damaged, cease to work, or work intermittently). In addition, the shielding employed by electronic equipment manufacturers serves to limit the amount of radiation given off by the equipment so that it does not adversely affect nearby equipment.

This shielding of equipment from harmful electromagnetic radiation and limiting the radiated energy from equipment is known generically as electromagnetic compatibility. Other somewhat interchangeable terms in common use in this field are electromagnetic frequencies (EMF), typically in reference to harmful levels of these; and electromagnetic or radio frequency interference (EMI or RFI, respectively).

In addition to shielding, EMI can enter through metallic wires (such as power cables or data transmission wires) that feed the equipment. Surge protection is usually necessary for these wires to prevent damage from "conducted" emissions that are induced on the wires when they are external to the shielded equipment or cabinet.

7.1.2 The Role of the Cabinet as a Faraday Cage

All electromagnetic interference consists of waves. These waves have frequency and wavelength. Grounded shielding with openings smaller than a given emitted wavelength will completely block the entrance or exit of that wavelength and all wavelengths longer than it (longer wavelengths correspond to lower frequencies). The higher the frequency of the radiation, the shorter the wavelength, and the smaller the openings are allowed to be in the shielding. A grounded metal box with no openings will block all frequencies. This is known as a Faraday cage (named after Michael Faraday, an early electric experimenter, who discovered this effect, along with many other important discoveries).

One of the reasons Qwest prefers a grounded metallic cabinet for the placement of its Carrier Customer-seriving equipment is because it functions as a Faraday cage to protect the Qwest equipment from externally-generated EMF. To this end, it is important that the cabinet grounding guidelines of Chapter 6 are followed. In addition, doors should generally remain closed and external openings should be covered with metal covers designed for the purpose where possible.

7.1.3 Grounding and Shielding of Metallic Cabling Interfaces

As noted previously, EMF can be induced on metallic cables entering and leaving a cabinet. These are known as conducted emissions, and generally need to be controlled through surge suppression, cable shielding, and proper bonding and grounding. Once again, the guidelines in Chapter 6 are of utmost importance.

Some metallic data cables are designed with shielding (which functions as a Faraday cage for the conductors inside the cable), while others are not. For those designed with shielding, sometimes the manufacturer desires bonding at both ends of the cable, and sometimes only at one end. The equipment manufacturer guidelines are important in deciding whether to ground one or both ends of a shielded cable and whether to use shielded cable at all (where there is a choice – in some cases, such as coax, the shield is an integral part of the cable). For data cables that do not have shielding (such as Cat 5 unshielded twisted pair [UTP] cable), surge protection of the wires is necessary.

AC and DC power cables are generally not shielded in and of themselves. Even when run in metallic conduit, the fact that the conduit is bonded at both ends means that EMF-induced currents (including those induced by lightning) will flow through the conduit and induce conducted emissions in the power wires inside the conduit. For this reason Chapter 5 generally requires that TVSS (aka SPD) be installed on power feeds that run outdoors for more than a few feet.

The surge protective device (SPD) must be grounded, and should "fire" to ground at relatively low voltage levels not too far above the normal voltage levels expected on the data and/ or power wires. If gas tube protection is not employed (i.e., MOVs and/ or SADs are the only components used), it is desirable that the protectors indicate when they have failed.

7.1.4 Electrostatic Discharge (ESD)

Electrostatic discharge (ESD) control goes along with proper grounding, surge protection, and shielding to minimize equipment damage. Qwest technicians shall wear a wrist strap connected to an appropriate ground terminal when removing, inserting, or handling circuit packs. They shall also keep circuit packs in static dissipative packaging until just prior to insertion, and as soon as possible after removal from the equipment card cage. Qwest techs shall handle circuit packs 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.

7.2 Electromagnetic Compatibility of Qwest Equipment

All Qwest electronic equipment is extremely electromagnetically compatible (friendly to all nearby equipment). The equipment deployed by Qwest will have passed 3rd-party (NRTL) NEBS certification to the stringent EMC requirements contained in GR-1089 (which not only meet, but exceed the most stringent FCC Part 68 and Part 15 criteria for radiated EMI, and for EMF susceptibility), and will also have been thoroughly tested in Qwest's own labs. The NEBS requirements Qwest-deployed equipment meets also contain stringent standards for conducted emissions.

7.3 Electromagnetic Compatibility Requirements for Carrier Equipment Located in the Same Cabinet with Qwest Equipment

Similar to the fact that Qwest does not require the Customer Carrier-owned cabinets to be tested to Telcordia GR-487, Qwest does not require that the Carrier Customer's equipment be NEBS-compliant. However, the Customer's equipment located in the same cabinet with Qwest equipment must meet the radiated emissions criteria of FCC Part 15 Appendix B in order to ensure proper operation of the Qwest equipment. These criteria ensure that for a given range of frequencies (the frequencies most likely to adversely affect other electronic equipment) that certain electric and magnetic field energy levels are not exceeded.

If the Carrier Customer equipment to be located in the same cabinet as the Qwest equipment only meets the less stringent FCC Part 15 Appendix A radiated emissions limits, they shall inform Qwest, and Qwest will work with the Carrier Customer and the Qwest equipment supplier for the project to determine if the particular radiated emissions given off by the Carrier Customer's equipment would be potentially service-affecting to the Qwest equipment. If they would not be service-affecting, Qwest will then be willing to co-locate their equipment in the Carrier Cabinet, with the caveat that the Qwest will not be liable for any EMC-related outages.

If the Carrier equipment cannot meet either of the FCC Part 15 radiated emission specs, it is best to place the Qwest equipment in a separate cabinet.

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8. Additional Cabinet Requirements

This section serves as a "catch-all" for Carrier Customer cabinet requirements not covered in other sections of this document.

8.1 Splice Chambers / Cable Interfaces

It is preferable that the cabinet have a separate splice chamber for cabling interfaces (including power), although this is a matter of negotiation between Qwest and the Carrier Customer. One advantage of such a chamber is that it provides a convenient place for a point of demarcation between Qwest wiring and Carrier wiring. A clear point of demarcation is typically required by regulatory rules and tariffs.

All metallic shields, strength members, surge arrestors (and other protectors) shall be grounded as soon as practical upon entrance to the cabinet, as described in Section 6.5.

The relevant interface requirements of the following Qwest Tech Pubs must also be followed in relation to the specific service being provided:

- Pub 77324 for DS-3
- Pub 77346 for DS-1, DS-3, SONET, and ethernet (both 10/ 100 Base-T and GigE)
- Pub 77375 for DS-1
- Pub 77411 for Ethernet (both 10/ 100 Base-T and GigE)

8.2 Flammability of Cabinet Materials

While flame-retardancy of the Carrier Customer Cabinet and its materials, and the ability of the cabinet itself to protect internal components from external fires (brush fires, for example) is not required, Qwest is absolved of legal, service, and monetary responsibilities for damages to its equipment from external fires. In addition, if a fire is caused by Carrier equipment in the cabinet, and it damages Qwest equipment, Qwest expects full monetary reimbursement for the damages.

If a Carrier wishes to ensure that their cabinet components are flame-retardant, typical materials tested are: plastic and polymer components to UL-94 (V-1 or better rating), foam gaskets to UL-94 (HF-1 or better rating), and wire insulation to UL-1581. For flame-retardancy of the cabinet itself, a brush-fire test should preclude ignition of internal components.

8.3 Corrosion Resistance

Often, cabinets are leveled (in order to facilitate easy opening and closure of doors) on a concrete or composite pad using metallic shims. These shims should be corrosion resistant (since they will contact the metallic cabinet, or the concrete pad, or both, electrolytic corrosion can be an issue).

8.4 Wind Resistance

While Qwest does not absolutely require that the Carrier Customer Cabinet have high wind resistance, Qwest is absolved of legal, service, and monetary responsibilities for damages to its equipment due to cabinet structural damage from wind forces.

If a Carrier wishes to test their cabinet for wind-resistance, the ability of the cabinet to resist the turning movement of a 150 mph gust should be sufficient.

8.5 Miscellaneous Hazards and Safety Items

The Carrier Cabinet containing the Qwest equipment should be free from sharp edges that pose a cut hazard to personnel.

For rare pole-mounted cabinets, where the bottom of the cabinet is more than 5 feet above ground level, the cabinet shall have a safety strap attachment point.

While Qwest does not require that the Carrier Customer Cabinet be mostly impervious to penetration from lower caliber bullets and pellets, this is desirable in rural areas, and in high-crime urban areas. Testing for this typically involves a 12-gauge shotgun for pellet resistance, and a .22 caliber long barrel rifle or 30-06 for bullet resistance.

Access to the cabinet in conformance with Codes is a must. Per the NEC, the cabinet must have at least 36 inches of clearance in front of doors and other openings meant for equipment or wiring access. The doors must open completely to at least 90 degrees. There also must be at least 30 inches of access width, and 78 inches of access height in front of these same aforementioned access openings and doors; both per the NEC.

8.6 Alarming

Qwest will carry alarms for its own equipment in-band, typically in the overhead bitstream of the backhaul circuit(s). In the rare cases where Qwest installs relatively unintelligent support equipment in the Customer Carrier Cabinet (such as fuse panels, DC-DC converter shelves, rectifier shelves, etc.), Qwest will run the binary alarms from this equipment into the housekeeping inputs of it's own intelligent equipment, program them, and test them to the Qwest alarm center.

While Qwest does not control nor require the Carrier Cabinet owner to alarm their own equipment and cabinet, they do have a couple of suggestions.

First, the Carrier should remotely alarm the commercial AC fail (and/ or battery-on-discharge) to a site so that they know whether they need to dispatch a portable genset during an extended AC outage (if there's a permanent on-site auto-start, auto-transfer engine-alternator, it should have the engine fail and engine run remotely alarmed, at a minimum).

Secondly, the cabinet should have an open door alarm (wired to all doors/ covers) so that a dispatch can be made to protect the equipment in case a door is accidentally left open after a tech leaves a site. If the Carrier requires that a Qwest tech call the Carrier's alarm center prior to entering the cabinet so that the alarm center knows why there is an open door alarm, they need to label (with a UV-resistant and weatherproof label) the outside of the cabinet with the number and instructions. If Qwest equipment is damaged because Carrier personnel leave a cabinet door or opening ajar, Qwest isnot legally or monetarily liable for damages, and expects reimbursement for the equipment costs.

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9. Customer Responsibilities and Agreement

Individual Agreements/ Contracts with Customers are negotiated by the appropriate Qwest Marketing Groups, possibly with the help of the Qwest Contracting Organization, and usually with Qwest Legal review and input. 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 (Qwest personnel can refer to these documents if further information is required).

- The Customer shall allow employees or agents of Qwest free access to the Premises and Cabinet where the digital equipment is located on a 7 x 24 x 365 basis. If premises and cabinet locks are used, the customer must use combination locks (with the combination provided to Qwest). This is necessary to ensure timely alarm response, reliable service, and to enable Qwest to meet the service guarantees of selected service offerings.
- The customer is required to provide an adequate cabinet environment for the equipment chosen for the service, as detailed in Chapter 4.
- When Qwest 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 AC and/ or DC power, wiring and the electrical junction box interfaces necessary for the proper operation of the Qwest equipment on their Premises. The customer shall also provide a suitable grounding point (referenced to the site grounding electrode system) in the cabinet.
- Qwest (and the NEC) requires 36" of acccess space in front of all cabinet doors and access panels. In addition 30" of width, and 78" of vertical clearancy from the ground/ pad is required.
- A point of demarcation shall be established (often in a cabinet splice chamber) for handoff of power and data circuits. Typically (unless otherwise negotatiated), the customer is responsible for running cabling and conduit as needed from this point.to their equipment.
- Any special structural work required for the facilities on the Customer's Premises shall be provided at the expense of the customer.
- Air-conditioned cabinets and air filters in general should mostly be avoided unless Qwest equipment specifically requires it; or the customer makes assurances (in writing) as to frequent preventative maintenance of the air-conditioning system, and frequent filter changeouts.

- Items to be negotiated may include: provisioning of and requirements around AC or DC power (see Chapters 3 and 5); equipment mounting details; rear access to equipment if needed; the type of cabinet (essentially the environmental protection level of the cabinet, as described in Chapters 2 through 4); the loacation of any meet points / points of demarcation for the handoff of electrical, metallic data, and fiber circuits; shielding of metallic cabling interfaces for GigE deployments, and how and where the shield should be grounded; and whether Qwest equipment can be placed if the Carrier's equipment collocated in the same cabinet does not meet FCC Part 15 SubPart B radiated emissions standards.
- Qwest is not liable for monetary or legal damages due to at least the following: outages caused by poor power quality provided by the customer (see Chapter 5 for further details); tripping of circuits when GFCIs are used to feed Qwest; delays in service restoral caused by inaccessibility to the premises and/ or cabinet; outages due to cabinet openings not being closed by Carrier personnel; outages due to radiated emissions from Carrier equipment in the same cabinet which exceed FCC Part 15 Subpart B levels; outages due to failure of an air-conditioning or other heat-exchange system; outages due to AC TVSS failure on the customers AC system; cabinet structural failure due to wind, or earthquake/ vibration; outages due to excessive water-intrusion for all non-sealed equipment (which is most Qwest equipment); Customer battery fires or explosions; outages due to fire (external to the cabinet or caused by Carrier equipment). In addition, Qwest expects reimbursement for at least the following causes of damage to Qwest equipment: fires caused by Carrier equipment; structural failure of a cabinet type not subjected to earthquake/ vibration testing, and failure of Qwest equipment due to a cabinet opening being left ajar by Carrier personnel.

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10. References

10.1 Acronyms and Definitions

A	Amp/ Ampere/ Amperes (a measure of electric current)
AC	Alternating Current (the type of electricity supplied by the power utility)
ACEG	AC Equipment Ground (aka the green or bare wire ground)
aka	also known as
AMC	Architectures, Models, and Configurations
ASTM	American Society for the Testing of Materials
ATIS	Alliance for Telecommunications Industry Solutions
Base-T	Baseline Twisted-pair (ethernet over twisted-pair copper)
BET	Building Entrance Terminal
C	Celsius or Centigrade (temperature)
Cat	Category (e.g., Cat 5 cable)
CFR	Code of Federal Regulations
coax	coaxial (cable)
dBrnC	decibels referenced to Noise Level C (an audible noise measurement of the AC ripple component of a DC voltage or current)
DC	Direct Current (electricity normally used by telecommunications equipment; rectified from AC, typically to -48 V)
DS-0	Digital Signal/ Service level 0 (a 56 kpbs digital channel, for carrying digital data or digitized analog voice)
DS-1	Digital Signal/ Service level 1 (a 1.544 Mbps digital channel, concatenated as one wide bandwidth, or split into 24 DS-0 channels plus some overhead; aka T-1 at times when carried on copper facilities)
DS-2	Digital Signal/ Service level 2 (a 6.3122 Mbps digital channel, typically containing 4 DS-1 channels plus some overhead)
DS-3	Digital Signal/ Service level 3 (a 44.372 Mbps digital channel, concatenated as one wide bandwidth, or split into 28 DS-0 channels plus some overhead; aka T-3 at times when carried on copper facilities)
DSL	Digital Subscriber Line service
E(E)C	European (Economic) Community/ Commission
EIA	Electronic Industries Alliance
EMC	Electro-Magnetic Compatibility

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 and EMC)
ESD	Electro-Static Discharge
ETSI	European Telecommunication Standards Institute
EU	European Union
F	Fahrenheit
FCC	Federal Communications Commission
FDH	Fiber Distribution Hub
ft	foot
genset	generator set (portable engine-alternator)
GFCI	Ground Fault Circuit Interruptor
GigE	Gigabit ethernet
I	symbol in electrical formulas for current (Amperes)
IBC	Internationl Building Code
ICBO	International Conference of Building Officials (supplanted by the ICC)
ICC	International Code Council
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
in	inches
IP	International/ Ingress Protection rating
kbps	kilobits per second
LATA	Local Access and Transport Area (a geographic area that separates local calling from long distance calling)
LSSGR	LATA Switching System Generic Requirements
LVD	Low Voltage Directive or Low Voltage Disconnect
Mbps (Mbit/ s)	Megabits per second
MGN	multi-grounded neutral
MIL	Military
mm	millimeter
MOE®	Metro Optical Ethernet
MOV	Metal-Oxide Varistor (a surge protective component that shorts to ground at higher voltages)

mph	miles per hour
MTBF	mean time between failure
mux	fiber multiplexer (combines several signals/ channels/ circuits into one larger bandwidth signal)
mV	milliVolts
NBS	National Burea of Standards (folded into NIST)
NEBS	Network Equipment — Building System (see the Telcordia references in Section 11.3 of this document)
NEC	National Electrical Code (NFPA Standards Document 70)
NEMA	National Electrical Manufacturers' Association
NFPA	National Fire Protection Association
NI(D)	Network Interface (Device) [the point of demarcation between Qwest equipment, and the copper or fiber plant owned by the customer]
NIST	National Institute of Standards and Technology
NOC	Network Operations Center
NRTL	Nationally Recognized Testing Laboratory
Ω	Ohms (measurement of electrical resistance/ impedance to current flow)
ONU	Optical Network Unit
OSP	OutSide Plant (all telecommunications locations outside the CO, including Customers Premises
P	Power (measured in Watts)
psi	pounds per square inch
Pub	abbreviation of Publication (as in Qwest Technical Publication)
RF(I)	Radio Frequency (Interference) — see EMF
RHW	Rubber High-temperature (75 °C) Water-resistant cable/ wire insulation
RJ	registered jack (e.g., RJ-45)
rms	root mean square (the average value of an AC voltage or current)
RT	Remote Terminal (remote end — closest to the customer — of a multiplexing system used to provide service to the customers)
SAD	Silicon Avalanche Diode (a fast-responding surge-protective device also known as a zener diode that breaks down above a certain voltage and shunts excess energy to ground)
SONET	Synchronous Optical Network
SPD	Surge Protection Device (see also TVSS)
Spec	Specification

SST	Synchronous Service Transport
STD	Standard
T-1	T-carrier level 1 (*see DS-1*)
T-3	T-carrier level 3 (*see DS-3*)
Tech	abbreviation of Technical (as in Qwest Technical Publication)
THD	Total Harmonic Distortion
TIA	Telecommunication Industry Association
TLPU	Telecommunications Line Protector Unit (aka 5-pin protector)
TVSS	Transient Voltage Surge Suppressor
UBC	Uniform Building Code
UL	Underwriters' Laboratories
UNE	Unbundled Network Element
UTP	Unshielded Twisted Pair
V	Volts
VRLA	Valve-Regulated Lead-Acid battery
W	Watts (a measure of "real" electrical power or heat used or produced)
XHHW	Cross-linked thermoset extra-High-temperature (90 °C) Water-resistant wire/ cable insulation

10.2 Qwest Technical Publications

Pub 77321	Special High Voltage Protection, Issue A, June 1988
Pub 77324	Qwest DS3 Service, Issue F, January 2005
Pub 77346	Synchronous Service Transport (SST), Issue S, April 2010
Pub 77350	Telecommunications Equipment Installation and Removal Guidelines, Issue N, December 2006
Pub 77351	Engineering Standards General Equipment Requirements, Issue G, March 2010
Pub 77355	Grounding - Central Office and Remote Equipment Environment, Issue G, June 2006
Pub 77368	Commercial Customer Premises and Carrier Hotels Electronic Equipment Environmental Specifications, Issue F, July 2009
Pub 77375	1.544 Mbit/ s Channel Interfaces, Issue G, June 2008
Pub 77385	Power Equipment and Engineering Standards, Issue J, May 2010

Pub 77386	Interconnection and Collocation for Transport and Switched UNEs and Switched UNEs and Finished Services, Issue M, October 2007
Pub 77411	Metro Optical Ethernet, MOE®, Issue L, December 2009

10.3 Telcordia Documents

BR-101-170-005	Quality and Reliability — Electrostatic Discharge, Issue 3, June 1996
GR-13	Pedestal Terminal Closures, Issue 4, January 2008
GR-63	Network Equipment — Building System (NEBS) Requirements: Physical Protection, Issue 3, December 2005
GR-409	Premises Fiber Optic Cable, Issue 1, May 1994
GR-487	Electronic Equipment Cabinets, Issue 3, April 2009
GR-513	LSSGR: Power, Section 13, Issue 2, January 2010
GR-937	Outdoor and Indoor Building Entrance Terminals (BETs), Issue 1, August 2005
GR-950	Optical Network Unit (ONU) Closures, Issue 2, December 1998
GR-974	Telecommunications Line Protector Units (TLPUs), Issue 3, June 2002
GR-1089	Electromagnetic Compatibility and Electrical Safety — Generic Criteria for Network Telecommunications Equipment, Issue 4, December 2005
GR-2834	Basic Electrical, Mechanical, and Environmental Criteria for Outside Plant Equipment, Issue 1, September 1995
GR-2836	Assuring Corrosion Resistance of Telecommunications Equipment in the Outside Plant, Issue 1, December 1994
GR-2898	Fiber Demarcation Boxes, Issue 2, December 1999
GR-3108	Network Equipment in the Outside Plant (OSP), Issue 2, December 2008
GR-3125	Outdoor Fiber Distribution Hubs (FDHs), Issue 1, March 2006
GR-3154	High-Density Feeder Distribution, Interconnection, and Surge Protection, Issue 1, January 2009
SR-3580	Network Equipment — Building System (NEBS): Criteria Levels, Issue 2, December 2005

10.4 Other Documents

ASTM B 117-A	Practice for Operating Salt Spray (Fog) Apparatus, 2005
ASTM D 56	Test Method for Flash Point by Tagged Closed Cup Tester, 2005
ASTM D 518	Test Method for Rubber Deterioration – Surface Cracking, 1999
ASTM D 610	Method for Evaluating Degree of Rusting on Painted Steel Surfaces, 2008
ASTM D 1654	Method for Evaluation of Painted or Coated Specimens Subject to Corrosive Environments, 2008
ASTM D 1693	Test Method for Environmental Stress-Cracking of Ethylene Plastics, 2008
ASTM G 21	Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi, 1996
ATIS 0600004	Equipment Surface Temperature, 2006
ATIS 0600010.01	Temperature, Humidity, and Altitude Requirements for Network Telecommunications Equipment Utilized in Outside Plant Environments, 2008
ATIS 0600307	Fire Resistance Criteria – Ignitability Requirements for Equipment Assemblies, Ancillary Non-Metallic Apparatus, and Fire Spread Requirements for Wire and Cable, 2007
ATIS 0600315	Voltage Levels for DC-Powered Equipment Used in the Telecommunications Environment, 2007
ATIS 0600329	Network Equipment – Earthquake Resistance, 2008
CFR47 1-15-B	Code of Federal Regulations, Title 47 (Telecommunications), Chapter 1 (FCC), Part 15 (Radio Frequency Devices), Subpart B (Unintential Radiators)
EC 95	The European Community (EU) Low Voltage Directive (LVD), 2006 (*replaced 73/23/EEC*)
EIA 310-D	Cabinets, Racks, Panels, and Associated Equipment, Revision E, 1996
ETSI 300 019	Classification of Environmental Conditions, V2.1.2, 2003
ETSI 300 019-2-2	Specification of Environmental Tests Transportation, V2.1.1, 1999
ETSI 300 119-2	Engineering Requirements for Racks and Cabinets, Edition 1, 1994
ETSI 300 119-3	Engineering Requirements for Miscellaneous Racks and Cabinets, Edition 1, 1994
ICBO UBC-1997	Uniform Building Code

ICC IBC-2009	International Building Code
IEC 60417	Graphical Symbols for Use on Equipment, October 2002
IEC 60529	Degrees of Protection Provided by Enclosures (IP Code), 2004 (*replaced IEC 529*)
IEC 60721-3-4	Classification of Groups of Environmental Severities and Their Parameters – Stationary Use at Non-Weatherprotected Locations, January 1995
IEC 61000-4-11	Electromagnetic Compatibility: Testing and Measurement Techniques – Voltage Dips, Short Interruptions, and Voltage Variations Immunity Tests, March 2004
IEEE C62.41	Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits, 2002
MIL-STD-781	Reliability Testing for Engineering Development, Qualification, and Production
MIL-STD-810F	U.S. Department of Defense Environmental Standards and Engineering Guidelines
NEMA 250-1997	Enclosures for Electrical Equipment (1000 Volts Maximum)
NIST NBS 2320	A Heat Transfer Analysis of Scald Injury, 1981
NFPA 70	National Electrical Code (NEC), 2011 Edition
NFPA 780	Standard for the Installation of Lightning Protection Systems, 2008 Edition
UL 50	Enclosures for Electrical Equipment, 12th Edition, 2007
UL 67	Panelboards, 12th Edition, 2009
UL 94	Test for Flammability of Plastic Materials for Parts in Devices and Appliances, 5th Edition, 1996
UL 746C	Polymeric Materials – Use in Electrical Equipment Evaluations, 6th Edition, 2004
UL 891	Switchboards, 11th Edition, 2005
UL 1449	Surge Protective Devices, 3rd Edition, 2009
UL 1581	Reference Standard for Electrical Wires, Cables, and Flexible Cords, 4th Edition, 2001
UL 60950	Information Technology Equipment, Including Electrical Business Equipment, 3rd Edition, 2000 (*replaced UL 1950*)

10.5 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.

ASTM Documents may be obtained from:

American Society for the Testing of Materials
100 Barr Harbor Dr.
West Conshohocken, PA 19428
Fax: (610) 832-9555
Phone: (610) 832-9500
Web: www.astm.org

ATIS Documents may be obtained from:

Alliance for Telecommunications Industry Solutions
1200 G St. NW, Ste. 500
Washington, DC 20005
Fax: (202) 393-5453
Phone: (202) 628-6380
Web: www.atis.org

EC Documents may be obtained from:

European Parliament Information Office
2, Queen Anne's Gate
London SW1H 9AA
UK
Fax: +44 / (0)20 7227 4301
Phone: +44 / (0)20 7227 4300
Web: www.ec.europa.eu

EIA Documents may be obtained from:

Electronic Industries Alliance
2500 Wilson Blvd.
Arlington, VA 22201
Web: www.eia.org

ETSI Documents may be obtained from:

European Telecommunications Standards Institute
650, route des Lucioles
06921 Sophia-Antipolis Cedex
France
Fax: +33 (0)4 93 65 47 16
Phone: +33 (0)4 92 94 42 00
Web: www.etsi.org

FCC Documents may be obtained from:

Federal Communications Commission
445 12th St. SW
Washington, DC 20554
Fax: (866) 418-0232
Phone: (888) 225-5322
Web: www.ecfr.gpoaccess.gov

ICC and ICBO Building Codes may be obtained from:

International Code Council
500 New Jersey Ave. NW, 6th floor
Washington, DC 20001
Fax: (202) 783-2348
Phone: (888) 422-7233
Web: www.iccsafe.org

IEC Documents may be obtained from:

International Electrotechnical Commission
3, rue de Varembé
P.O. Box 131
CH - 1211 GENEVA 20
Switzerland
Fax: +41 22 991 03 00
Phone: +41 22 919 02 11
Web: www.iec.ch

IEEE Documents may be obtained from:

Institute of Electrical and Electronics Engineers
445 Hoes Lane
Piscataway, NJ 08854
Fax: (732) 981-0060
Phone: (732) 562-6380
Web: www.ieee.org

MIL Specs may be obtained from:

Defense Standardization Program Office
8725 John J Kingman Rd., Stop 5100
Fort Belvoir, VA 22060
Fax: (703) 767-6876
Phone: (703) 767-6879
Web: www.dsp.dla.mil

NEMA Documents may be obtained from:

National Electrical Manufacturers Association
1300 N. 17th St., Ste. 1752
Rosslyn, VA 22209
Fax: (703) 841-5900
Phone: (703) 841-3200
Web: www.nema.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

NIST Documents may be obtained from:

National Institute of Standards and Technology
1 Batterymarch Park
Quincy, MA 02269-9101
Fax: (617) 770-0700
Phone: (617) 770-3000
Web: www.nist.gov

Qwest Technical Publications may be obtained from:

Web: www.qwest.com/ techpub

Telcordia documents may be obtained from:

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

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