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CHAPTER 1 GENERAL REQUIREMENTS

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1. General Requirements and Definitions

1.1 General

This section is intended to provide general requirements that apply to all of the units of the document which follow.

All power equipment shall be Manufactured, Engineered, and Installed in accordance with the following:

- Qwest Technical Publications
- Telcordia Requirements
- Federal Communications Commission (FCC)
- National Electrical Code NFPA 70
- Underwriters Laboratories Requirements
- Department of Labor - Occupational Safety and Health Standards (OSHA)
- Federal, State, and local requirements including, but not limited to, statutes, rules, regulations, and orders of ordinances imposed by law.
- Detail engineering for Qwest site shall meet all the above and Qwest Standard Configuration Documents.

All installed AC equipment will be provided with adequate working space as defined in the National Electrical Code NFPA 70 110.26. Minimum clear distance in front of electrical equipment is dependent of its nominal voltage to ground. For 0-150 volts, it is a minimum of 3 feet. For 151-600 volts, the minimum is 3 feet to an insulated surface, 3 ½ feet to a grounded surface, and 4 feet when there are exposed live parts on both sides of the work space. Minimum width is the width of the equipment or 30 inches, which ever is greater. Minimum headroom of the working space is the height of the equipment or 6 ½ feet, which ever is greater. For a full explanation of working space, see the National Electrical Code NFPA 70

All power equipment used shall have passed through the Qwest Product Selection procedure.

All requirements in this document are effective from the publication date of the document forward.

Qwest prefers that all end equipment be powered by nominal -48 V DC power (-42 to -59 V DC). Where -48 V and -24 V and 130 V DC-powered equipment exist in the same site, the primary power plant should be a -48 V DC power plant. The 24 V and 130 V equipment should be powered from converters (see Chapter 3 for exception).

Blowtorch, acetylene torch, including fiber fusion splicing or any open flames and/or sparks are not permitted in any Qwest battery room. Qwest Safety and Loss Prevention Program Handbook (issue 5-97 page C-39-2 paragraph 4) states that no open flames are allowed in the battery room Fire and Life Safety Manual and Uniform Fire Code and Qwest publication 77350.

1.2 Definitions

SHALL	When this designation is used in a requirement, it denotes a binding requirement due to fire, life, or safety reasons. These requirements are not optional.
MUST	When this designation is used in a requirement, it denotes a binding requirement, but does not involve fire, life, or safety.
WILL or SHOULD	When this designation is used in a requirement, it denotes a condition that is a Qwest preference.

1.3 AC Requirements

Three types of AC loads that may be required within a Qwest telecommunication site.

- Protected Loads — Those AC loads that shall have reserve power available within four microseconds or less. Protected loads will use either an inverter (Chapters 4) or UPS (Chapter 5).
- Essential Loads — Those telecommunications and building AC loads that must operate during prolonged loss of commercial AC power. These loads are normally run off a standby engine-alternator (Chapter 6)
- Nonessential Loads — Those that can experience long periods of commercial power interruption without needing some form of backup. Generally, these loads are not switchable to the standby source.

AC equipment shall be capable of operating without damage from any input source with the following characteristics:

The equipment shall be operational from either a single phase or a three phase AC service

The equipment shall be operational from a 60 Hertz (Hz) source ±10%.

- Voltage Limits — The limits shown below are consistent with range B utilization limits of American National Standard Institute (ANSI) Voltage Rating for Electrical Power Systems and Equipment, and apply to sustained voltage levels:

Nominal Phase	System Voltage	Voltage Limits	
		Minimum	Maximum
1	120	106	127
1	220/240	184	254
1/3	208/240	184	254
3	277/480	424	508

THHN, THW, or THWN type wire, color-coded in red, black, white, yellow, brown, orange and green are acceptable for use in AC circuits only. The use of colored tape on both ends of the wire is also acceptable for this application. The No. 6 AWG or smaller neutral conductors are exempt. These conductors require a continuous white or natural gray outer finish along their entire length. All AC wire for central office applications shall be run in conduit, raceway or metallic enclosure.

All AC neutrals shall be sized at the same size as the phase conductors, at a minimum. AC wires used in Outside Plant applications do not have to be run in raceway or conduit if they are cords terminated in a NEMA Twist-Lock plug. These wires must be fire retardant Hypalon coated or polyethylene (XLP-USE-2, or EPR-USE-2, or RHH/RHW-2). An AC neutral must be run with all branch circuits.

Color Code for AC 120/240 VAC single phase and 120/208 VAC 3 Phase (this requirement applies to installations from January 1996 forward).

Line	Color
1(A)	Black
2(B)	Red or Orange High Leg 240 V Delta
3(C)	Blue
Neutral	White
Grounding	Green

Color Code for AC 277/480, Three Phase (this requirement applies to installations from January 1996 forward).

Line	Color
1(A)	Brown
2(B)	Orange
3(C)	Yellow
Neutral	Grey
Grounding	Green

AC power wire shall be copper conductor only within the CO. Aluminum wire may be installed by the local utility from their equipment to the House Service Board Service entrance. The AC feeds from the house service board to the Power Distributing Service Cabinets (PDSCs) serving the chargers shall be dual feed. One dual feed PDSC or two separately feed PDSCs will meet this requirement. One feed shall be for the PDSC serving the odd number chargers. The other feed shall be for the PDSC serving the even number chargers. PDSCs' can be either stand-alone or wall mounted. The PDSC feeds from the house service board shall be sized to the capacity of that PDSC, (i.e., a 600 Ampere PDSC shall be sized and fed at 600 Amperes). A PDSC shall be dedicated to that charger line-up which it is serving. Circuit breakers for the chargers shall be sized to the manufacturers' recommendation for the chargers being served. PDSCs only need to be equipped with circuit breakers for existing chargers. Future circuit breakers should be added when chargers are added to the power plant. The cabinet and the circuit breakers will be rated for the available fault current (AIC). PDSC should be rated at 600 amperes, except in small remote sites where the PDSC can be rate at 200 Amperes. Sites that use a power pedestal for AC should be sized per Section 10.

All AC feeders in telecommunications equipment areas (including power rooms) will be enclosed in conduit or approved cable raceway. Insulation coated armored power cable (liquidtight) will only be used in special applications where conduit is not practical. Flexible metal conduit shall not be used ever in power rooms (NEC 350-5.3).

All rigid, Electrical Metallic Tubing (EMT) and metallic liquid tight flexible conduit runs shall be made with compression or threaded type fittings, couplings and junction boxes. Setscrew or stake type fittings and couplings shall not be used in Qwest locations. Exceptions are for screw type fittings and couplings that may be used on armored cable and flexible metallic conduit.

No PVC conduit or tubing of any kind may be used for AC service; there are NO exceptions to this rule.

AC feeds from the raceway or junction box to the charger must be run in either thinwall or liquid tight-conduit. Flexible conduit shall not be installed on cable racks.

1.4 Generic Technical Requirements

All power equipment must conform to American National Standards Institute (ANSI) requirements, and shall be UL (Underwriters Laboratory) Listed. Power components (chargers, controllers/monitors, inverters, UPS, converters, engine-alternators, transfer switches, generator set plugs, AC power cabinets, and power pedestals) shall meet the requirements of the National Electrical Code (NEC - NFPA 70), latest issue.

Powering equipment must pass and be listed to UL 1950 and UL 94-V0 and have a minimum LOI of 28%.

All CO grounding cable (that is not manufacturer internal shelf and intra-bay wiring) shall be green in color and be in accordance with Qwest Pub 77355, latest issue.

All active electronic devices shall be solid-state. Vacuum tubes shall not be used.

All relays will be solid-state or provided with dust covers.

Protection devices can be either Fuses (preferred for DC) or Circuit Breakers. All protection devices (fuses or circuit breakers) shall be sized at 125% of the load and rated for the available fault current (AIC) which meets or exceeds the maximum available fault current at that point in the system. All fuses or circuit breakers must be AC rated for AC circuits, and DC rated for DC circuits.

Fuses and circuit breakers shall be front accessible and labeled to indicate their Ampere rating and circuit assignment (frame/shelf), function. Circuit breaker size and trip setting will be visible without having to remove protective covers or if the breaker size and trip setting is not visible, it will be posted on the protective cover. Fuse size will be visible without having to open protective covers or removing power. If this is not possible, the size of the fuse installed shall be posted on the outside of the cover where it is visible. Circuit breakers shall be labeled according to the NEC. When circuit breakers are mounted horizontally the “UP” position shall be “ON”. All circuit breakers should be equipped with shields.

Fuses must be color coded to prevent mixing. Renewable link, and H type fuses are not acceptable for use. All internal circuits shall be protected with fuses mounted in a “dead front” fuse holder. Each fuse shall be provided with a blown fuse indicator connected to an alarm-indicating lamp on the control panel. All power semiconductor circuits shall be fused using KAA type fuses to prevent cascading or sequential semiconductor failures. All electrolytic capacitors shall be fused. A maximum of two capacitors shall be protected by one fuse.

Fuses or circuit breakers shall never be used in a parallel configuration (NEC 240-8).

If circuit breakers are used, they shall be of the thermal-magnetic (preferred) or magnetic type (only if approved by local code). They shall be of the trip free type. Contacts shall not be capable of being manually held closed during an overcurrent condition.

All DC runs in a raised floor environment (that is also used as an air plenum) must be in a plenum rated raceway, metal conduit, or metallic liquid tight flexible conduit; or must be plenum-rated cable MI type cable. If RHW type wire is used it must be ran in rigid metal or metallic liquid tight flexible conduit. Only two wires one feed set (battery and return) can be ran in one conduit, each load (A, B, etc.) must be ran in a separate conduit.

If forced air-cooling is used to keep components cool the blower motors shall be equipped with sealed ball bearings. Blowers shall be redundant. A failure of a blower unit shall generate an alarm. All air inlet and exhaust openings shall be protected with expanded metal guards.

The structural members of power equipment shall not carry or conduct load currents. Ferrous materials shall not be used for current carrying parts.

Metal parts, unless corrosion resistant, shall have a corrosion protection finish. Ferrous parts not required to meet an appearance criteria shall have zinc plate, cadmium plate, or an approved equivalent finish applied. The minimum thickness of the finish shall be 0.0002 inches plus a chromate treatment. When dissimilar metals are used in intimate contact with each other, protection against electrolysis and corrosion shall be provided. This protection may be metal plating or spraying, or use of a suitable insulating material.

Nut, bolts, and screws should be grade 5 or equivalent for connection and mounting requirements.

Insulating materials in arcing paths of contacts, fuses, etc. shall be of the non-tracking type. Insulating material shall not be used that will independently support combustion, or that will ignite from a spark, flame, or heating. The combustion products of insulating materials shall not combine with normal atmospheric air to form acid, toxic, or other deleterious products.

Wire used for carrying load current shall be copper conductor only. Wire subject to hinged action shall be of the stranded type.

Copper crimp-type connectors shall be used for all DC power wire connections. Anti-galvanic corrosion joint compound shall be applied to connections.

Bus bar shall be of 95% hard-drawn copper.

All individual components of power equipment should be assigned a functional designation. Each Test Point (TP) must be accessible and assigned a designation starting with TP1. These designations shall be shown on the schematic drawing, on or adjacent to the point being designated.

All power semiconductor circuits shall be fused to prevent cascading or semiconductor failures.

Internal fuses must be easily accessible.

1.5 NEBS Requirements

NEBS will not be waived.

Qwest cannot and does not certify testing facilities.

The supplier shall meet the requirements of Telcordia (Bellcore) GR-1089-CORE, and GR-63-CORE, as the GRs pertain to its equipment. The supplier must test to the GRs as required by Qwest, and Telcordia (Bellcore) SR-3580. Qwest requires that all NEBS test is performed at an independent third party test facility. These test facility must be accredited as part of a laboratory accreditation program sponsored by one of the following, American Association for Laboratory Accreditation (A2LA), National Voluntary Laboratory Accreditation Program (NVLAP), National Recognized Testing Laboratory (NRTL), and Underwriters Laboratory. Test facilities must be certified for those fields of accreditation that encompasses NEBS requirement.

Qwest will however accept test data from a supplier's testing facilities provided it is accredited to perform the test and observed by a member of another accredited laboratory as defined above. Qwest will not accept test reports written by the supplier or a supplier's interpretation of a test lab report. Qwest will only accept test reports written by the independent test lab performing the work or by the representative of the observing third party lab. All test reports must be written on the letter head of the test lab.

All components shall be tested as a system. However, if individual components or subsystems have been tested a letter from the testing lab stating that the assembly of the unit or subsystems into the system will not change the NEBS data will be acceptable.

Central Office
All of NEBS Level 3 and Others Criteria
EMI (Open Door) - NEBS Level 3
ESD (Open Door) - NEBS Level 3
EQ ZONE 4 - NEBS Level 3
Operational Thermal - NEBS Level 2

Remote Terminal (CEV, Hut)
All of NEBS Level 1
EMI (Open Door) - NEBS Level 3
ESD (Open Door) - NEBS Level 3
EQ ZONE 4 - NEBS Level 3
Operational Thermal - NEBS Level 2

Customer Premises

Power equipment must be UL Listed

Remote Terminal (Pole or Pad Mount, NID)
Listing Requirements - NEBS Level 1

1.6 Generic Alarming Requirements

All provided alarms will come equipped with a set of dry contacts so that the alarm can be remoted. The connecting point for these contacts will be easily accessible. All analog monitoring points (current shunts or volt meters) within the equipment will be equipped with terminal strip access for attaching remote monitoring devices. The connecting point for analog monitoring points will be located near the alarm connecting points and be easily accessible.

Circuit breakers shall generate an alarm signal when in the tripped state.

The status indicators and alarm outputs shall be in the form of visual indicators in the plant (preferably lighted and blinking), and electrical signals for alarm sending circuits, and for connection to the office alarm system. The visual alarm and status indication system shall have its own dedicated power supply circuit, operating from the plant voltage. This supply shall have an overcurrent protection device that will send a visual alarm when it has operated, or power has been removed from the "control and status" system.

Color-Codes for visual equipment indicators will be as follows:

Color	Description
Red	MAJOR/CRITICAL indicates a failure that currently affects power service to the load, or a failure which may mask an alarm associated with a service affecting problem
Amber, Orange, or Yellow	MINOR/PRELIMINARY — indicates an abnormal operating condition within the power system or equipment that requires attention, but power service to the load is not currently affected
Green	indicates proper operation of the system or equipment
White	signify conditions that have none of the above connotations of red, yellow, or green.

The alarm output for the office alarm system shall have two closures, one for the audible, and one for the visual alarm indications. The alarm sending circuit shall have one closure. The electronic or mechanical contacts for the closures shall be capable of supporting 60 VDC and 0.5 Amperes, and shall be electrically isolated from each other and the frame ground.

It is desirable that an Alarm Cut-Off key (ACO) be provided to inhibit the office audible alarm function, without interfering with the visual or remote alarm systems.

A method shall be available to actively test all status indicators to verify they are in working condition.

Distribution fuse fail alarms for BDFBs', and miscellaneous fuse panels in the IOF areas must be ran to the local mediation device (i.e., Dantel, E2A, etc.). These alarm leads must be ran in the switch board cable rack.

Power alarm and monitoring leads that are within the power area only may be ran the side of the cable rack 9-cord shall be used for securing these leads, clip or wire ties are not acceptable for use and cannot be used. Alarm leads other than power or power alarm leads outside of the power area must be ran on the switch board cable rack in accordance with PUB 77350. There will be no exception to this allowed.

CHAPTER 2 DC POWER PLANTS, BATTERIES AND CHARGERS

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2. DC Power Plants, Batteries, and Chargers

2.1 Overview

This unit covers requirements for DC power plants and their associated batteries and chargers used within telecommunications facilities.

2.2 General DC Power Plant Requirements

One powering scheme for a Central Office is shown in Figure 2-1. There are many other possible configurations. A characteristic powering scheme for an Outside Plant equipment enclosure (e.g., CEV, cabinet, Customer Premise site, etc.) is shown in Figure 2-2. Figure 2-3 shows a characteristic-powering scheme for a radio site.

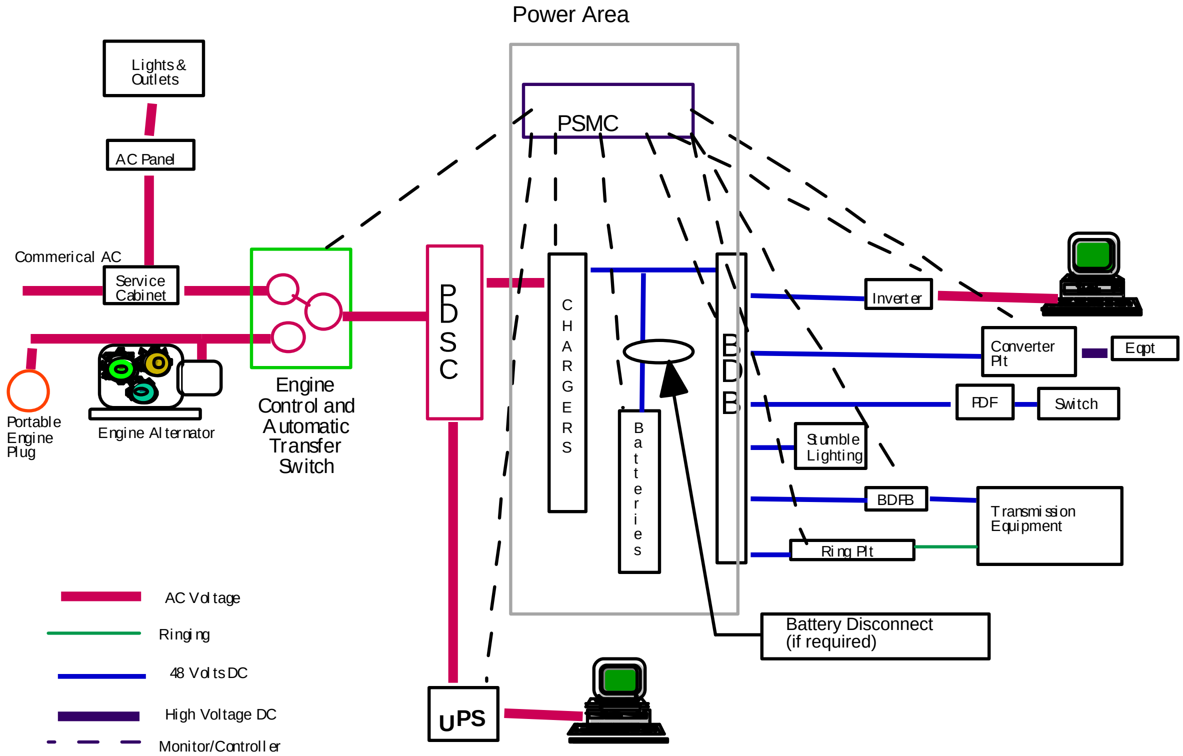

Figure 2-1 A Powering Scheme for a Central Office

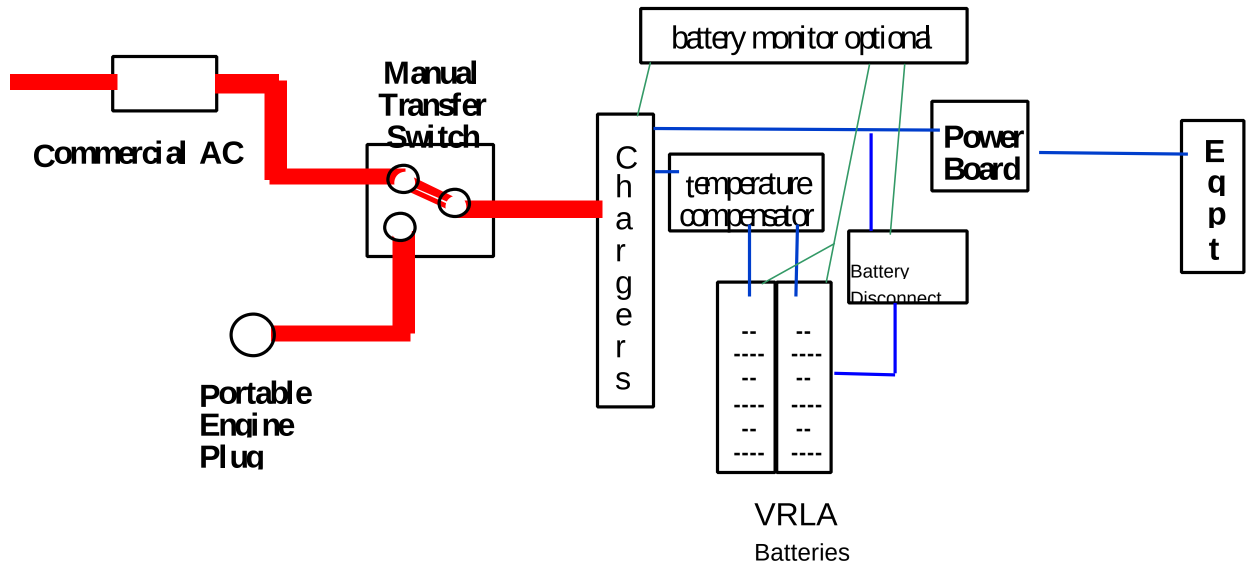

Figure 2-2 Typical Outside Plant Equipment Enclosure Power Scheme

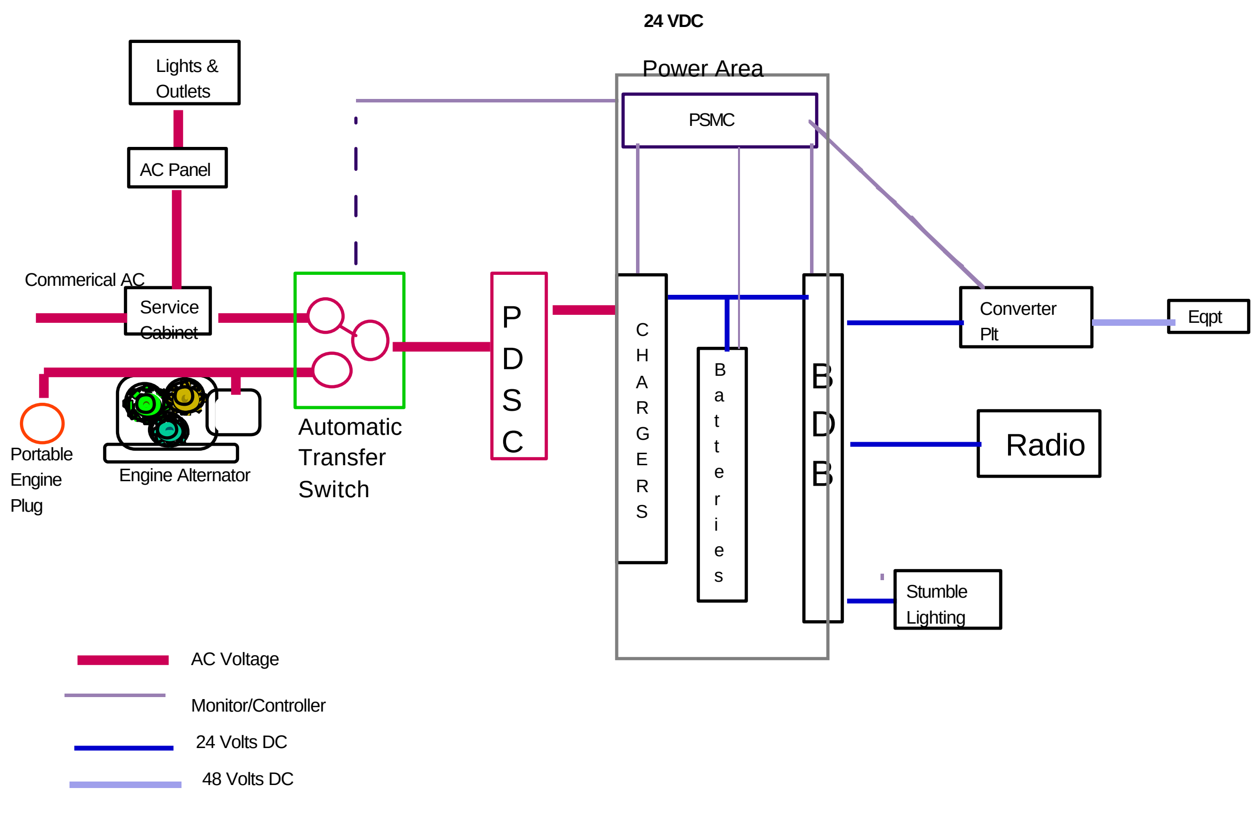

Figure 2-3 Typical Radio Site Power Scheme

The principle components of the power distribution plant are:

- LOCAL AC POWER DISTRIBUTION — which includes conduit, cabling, fasteners and protective equipment.
- CHARGING EQUIPMENT — consists of chargers and associated equipment to convert AC power to DC power at voltages suitable for Qwest applications.
- TEMPERATURE COMPENSATION — and/or current limiting may be separate or an integral part of the charging equipment for use with VRLA batteries. Temperature compensation measure's battery temperature(s), and adjusts the plant voltage accordingly to limit recharge current to the batteries thereby helping to reduce the risk of thermal runaway. Current Limiting simply limits the available charge current to the batteries.
- STORAGE BATTERIES — provide a source of DC power to the equipment when AC is not present, until the AC can be restored. They may also provide filtering of the charger output.
- DISCHARGE BAYS — contain the control and output circuits; including fuses and/or circuit breakers, shunts, meters, bus bar, alarm circuits and other equipment necessary for plant operation.
- BATTERY DISTRIBUTION BOARD (BDB), or POWER BOARDS — is the primary power distribution within the charger plant (the originating BDB includes the controller). It is powered directly from the batteries and chargers and contains the primary cable protection equipment and shunts. The BDB may also contain meters and alarms.
- DISTRIBUTION EQUIPMENT — is the primary protected power distribution to the equipment. Distribution equipment is powered from the BDB and includes Power Distribution Fuse Boards (PDFB), Battery Distribution Fuse Boards (BDFB), Area Bus Centers (ABC), and protective equipment. The BDB and distribution equipment may be combined in small power plants.
- CONTROL VOLTAGE — is the voltage used to operate alarm relays and control circuits in the power plant. The voltage of the primary plant (48 volts, if available) will be the control voltage.
- CONVENTIONAL CONTROL and/or POWER SYSTEM MONITOR CONTROLLER — There are two type of PSMC used in Qwest. Power System Monitor Controller - Central Office (PSMC-CO) and Power System Monitor Controller - Confined Locations (PSMC-CL). It is preferred that the PSMC and the conventional controller be integrated into the same unit. The Conventional Controller provides the interface between the chargers and the plant for "on and off" control under normal and adverse conditions. Both the Conventional Controller and the PSMC may provide for charger alarm and contain the visual readout devices for operation of the plant. They provide the means to assess the status of the elements of the power plant (with indications provided locally and remotely) that will permit determination of the impact of the alarm. Monitors (PSMC-CO) for use in central offices shall be capable of X.25/TL1 communication of plant alarms and any other alarms connected to them. PSMCs also measure analog values, such as voltages, currents, and temperatures. PSMCs for Confined Locations (PSMC-CL) are used with VRLA batteries, are a "scaled-down" version of a PSMC, and may or may not be capable of X.25/TL1 communication. A PSMC-CL is capable of some special features needed for VRLA batteries, such as the ability to detect and alarm thermal runaway.

All monitors are accessible by dial-up modem. All PSMC shall be capable of dial-up and be emulate a dumb terminal, i.e. VT100.

Grounding (and grounded) connections shall be of the two-hole crimp (preferred), exothermic weld, or amphanol type. Mechanical type or connectors that depend solely on solder are not acceptable.

Application	Preferred Method
Bus bar	two-hole crimp
Buried Termination	exothermic weld, (Note that exposed terminals need protection from elements)
Outside Connections	exothermic weld, or UL Listed crimps can also be used
Inside Connections	crimp

All DC power connections for both supply and return shall use crimp type copper connections and grade 5 stainless steel nuts and bolts. Connectors for direct battery connections are defined herein. Aluminum connectors shall not be used. Power connectors will be configured as follows:

- Within the supplier's equipment, power connections will be configured to meet the supplier's requirements.
- Between the supplier's equipment in the bay and the top of the bay, connections can be one hole or two-hole crimp, depending on equipment design.
- All connections to a battery return bus bar must be a two hole crimp only. Exceptions to the “two-hole” requirement are allowed for battery return bus bar rated at 50 Amperes or less.

Details for ground conductors can be found in Qwest Technical Publication 77355, "Grounding - Central Office and Remote Equipment Environment".

RHW-FLEX, Flex Cable, is the preferred power cable to be used in the Central Office power area.

All power equipment (including chargers, batteries, ring plants, fuse panels, etc.) to be used in Outside Plant equipment enclosures (e.g., CEVs, huts, Customer Premise sites, RT cabinets) shall be fully front accessible.

It is preferred that the shunt for power plants rated at 800 Amperes or larger be in the battery return (grounded) side of the charge/discharge bus bar. Exception is for bus bar type and distributed type power plants where the shunt can be in the battery bus bar located in the power board.

Low Voltage disconnect devices shall only be permitted in series with the battery strings, not in series with the load (see figures 2-1 and 2-2). The exception to this requirement is only when it is required by the using equipment manufacturer, in writing. It is preferred that LVD not be used.

2.3 Charging Equipment

When charging equipment is added to an existing power plant, the new equipment will follow the same design criteria as the existing plant. For proper plant operation, charging equipment shall have the following features or capabilities, whether they are required at the time of installation or not:

- HIGH VOLTAGE SHUTDOWN — will occur when high voltage on the DC output trips the high voltage alarm and causes charger shutdown. The high voltage shutdown setting shall be adjustable.
- REMOTE RESTART — allows a charger to be turned on from a remote location after high voltage shutdown.
- REMOTE STOP — permits charger shutdown. Remote stop may be used during transfer from commercial to standby AC power or vice-versa or for energy management.
- CURRENT LIMITING — protects the charging equipment when operating into an overload condition. The current limiting circuit is normally designed so maximum output current will not exceed 120 to 125 percent of rating. The current limiting shall be set between 105 and 110% (alarm threshold levels for charger overcurrent are provided in Chapter 12Chapter 12-5).
- CURRENT WALK IN — controls the charging current from a gradual increase to full output. This feature limits the surge of AC power required after AC power restoration and allows the control circuits to stabilize.
- LOCAL OR REMOTE SENSING — refers to the point where the output voltage is sensed for the feed back circuits. Local sensing causes the charger to regulate the voltage at its output terminals. Remote sensing carries the regulation point to the battery terminals or some other selected point. Remote sensing is the only type that is allowed in Central Office. Under no circumstances will local and remote sensing be mixed in the same power plant.
- AUTOTRANSFORMER — provides voltage matching of AC supply maintaining the nominal design voltage to the main transformers.
- SEQUENCE CONTROL — provides the ability to turn chargers on sequentially, so that when AC is restored the load imposed upon the AC plant by the chargers is sequential rather than block. Sequence control will be provided from the power plant controller. (See Chapter 7, Paragraph 7.5.)
- PARALLEL CONTROL — is when all chargers are connected to the output DC bus at all load levels. The capability of each charger to monitor battery voltage individually and supply current on demand is called parallel control of charging units.
- TEMPERATURE COMPENSATION — chargers to be used with Valve-Regulated Lead-Acid (VRLA) batteries shall have slope temperature compensation charging features utilizing temperature sensors located at the batteries. The compensation shall be capable of lowering the voltage of the chargers to within one volt or less of open-circuit voltage at 55 degrees C (131 degrees F).
- VOLTAGE ADJUSTMENT — Chargers to be used with VRLA batteries shall be voltage adjustable, both locally and remotely (e.g., sense leads).
- ALARMS and ALARM SETTINGS — shall be in accordance with Chapter 12 of this publication.

For proper plant operation, charging equipment may have the following additional features depending on the system size and equipment served:

- PROPORTIONAL LOAD SHARING — can be connected with other chargers and set to carry the load in proportion to the rating.
- PHASE SHIFTING — provides the ability for the AC input to be shifted to minimize the power factor in the AC input line.

For single-phase switchmode chargers, the AC current total harmonic distortion (THD) reflected back toward the source must be limited to 15 percent at full load. The third, fifth, and seventh harmonics must be 12 percent or less.

For three-phase switchmode chargers, the AC current total harmonic distortion (THD) reflected back toward the source must be limited to 35 percent at full load. The third, fifth, and seventh harmonics must be 20 percent or less.

On power plants that use the controller to set the float if the controller fails the chargers shall default to 2.17 to 2.20 volts per cell for floated batteries and 2.25 to 2.27 volts per cell for VRLA batteries.

At startup, the total peak inrush current must not exceed ten times the steady state current requirement.

The power factor must be no less than 0.8 (80%) lagging or leading at loads of 10% or greater.

The acoustic noise shall be a maximum of 65 decibels audible (65 dBa), measured from a distance of two feet in any direction.

The DC ripple noise at the batteries shall be less than 35 decibel reference noise C-Message (35 dBrnC).

Chargers for use in hardened equipment locations shall be capable of reliable operation at operating temperatures between -40 degrees and + 65 degrees C (149 degrees F).

Any new charger should be capable of providing 2.5 volts per cell.

Each charger must have its own dedicated AC connection. One AC circuit cannot be use to power a charger shelf. Exceptions are for customer premises and outdoor cabinet installations where the shelf could be configured for two feeds, one for the even numbered chargers and the other feed for odd numbered chargers.

AC connections must be run in conduit or raceway. Exceptions are for customer premises, where AC is provided by the customer. Hard wiring is preferred, but twist lock type plugs are an acceptable alternative. The worst case is a standard three-prong plug. In those cases, a plug with a ground screw (or something similar to prevent the plug from being pulled out), should be used whenever possible.

Green wire grounding (ACEG or “safety ground”) must be run with each AC charger feed, in accordance with the NEC.

Bus bar type power plants must use a remote ground window per 77355.

2.4 Batteries

Qwest uses several battery technologies in equipment locations. The characteristics and requirement of the battery types are not always interchangeable. The Qwest Engineers are responsible for the sizing of the battery reserve of a site. The battery technologies used in Qwest are:

- FLOODED LEAD ACID — flooded (or vented) lead-acid batteries are the "traditional" batteries used in telecommunications equipment locations. This group of batteries includes the pure lead and lead calcium batteries. Lead-antimony batteries are not to be used by Qwest. If it is possible to use flooded batteries, they shall be used.
- VALVE REGULATED — Valve-Regulated Lead-Acid (VRLA) batteries include both the starved electrolyte (Absorbed Glass Matte or AGM), and immobilized electrolyte (GEL) technologies. Starved electrolyte batteries are acceptable for use in power plants under 600 Amperes where space is not available for use of the flooded lead-acid or GEL batteries (only Gel batteries larger than 1500 Ampere-hours are allowed in COs). Starved electrolyte shall not be used in central offices. A "characteristic problem" of valve regulated batteries is the potential for thermal runaway. Suppliers of VRLA batteries will provide "safe operating environment" characteristics with VRLA batteries. VRLA batteries require a higher float voltage than flooded lead acid batteries. Charger plants supporting valve-regulated batteries should be able to sustain a float voltage of up to 2.45 volts per cell. VRLA's shall not be boost or equalizer charged unless they have not been charged for at least 6 months. In those cases' follow the suppliers' recommendations for charge times and charge voltages. For -48 volt plants twenty-four battery cells must be used for each string (two-string minimum). This also applies to $\pm$ 24 volt plants, where twelve battery cells must be used for each string (two string minimum). Dummy cells are not permitted for use within Qwest.
- NICKEL CADMIUM — Ni-Cad batteries are generally based on a valve-regulated technology. Because of their relatively small size, cell voltage difference and high cost, nickel cadmium battery use is generally limited to standby engine-alternator start and control batteries in higher temperature environments. Lead-acid cells are also used as start or control batteries for engine-alternators in Qwest Equipment.

Batteries shall be floated at the manufacturer recommended rate and per Chapter 12. Exceptions to this include flooded batteries that are installed in old WECO 100 and 300 type power plants; they should generally be floated at 2.17 volts per cell. See Chapter 12.5 for further information on float and alarm threshold settings for different battery types.

The first and last cells of a flooded battery string will not be in adjacent positions on the same shelf. The first and last cells of a battery string must be either on opposite ends of the same shelf or on separate shelves. Cell 1, the positive end of the string, shall be located on the lowertier (on two-tier stands where a string uses both tiers). Follow the manufacturers' recommendations for installation of all batteries. Each cell in the battery string shall be number; the numbers should be placed on the battery stand under the corresponding cell.

A minimum of 4 hours of battery reserve shall be engineered for sites with a permanent on-site engine-generator. Sites served by a portable generator shall have a minimum of 8 hours of battery reserve. The customer at Customer Premise sites has the option of no battery reserve. Radio sites that are inaccessible during certain times of the year should have more than 8 hours of battery reserve. The batteries shall use 1.86 end volts per cell.

Battery stands must be placed in accordance with Qwest Technical Publication 77351.

Single sided battery stands must not be placed closer than 6 inches to any wall, post, or pillar. All other battery stands shall follow aisle requirements stated in Qwest PUB 77351.

The battery side of a two tier two row battery stands must not be placed next to a wall, however the end can be place near the wall using the requirements in Pub 77351.

Two intercell connectors should be used in all applications where battery posts are designed to accept multiple intercell connectors. The thickness of the connectors should be designed so that the connector(s) will have sufficient strength and flexibility for earthquake zone 4.

All materials used in battery cases shall have minimum limited oxygen index (LOI) of 28% [per American Society of Testing Materials (ASTM) D2863] and meet the UL 94-V0-burn requirement. Battery cases shall have sufficient strength to withstand normal handling and internal pressure generated by positive plate growth and/or discharging and recharging.

All connections (nuts and bolts) made to battery posts, terminal plates, and inter cell connectors shall be made with stainless steel (preferred), lead, or lead coated copper.

Inter cell connectors, inter tier connectors, inter row connectors, terminal plates, and all connector lugs connected directly to the battery posts shall be lead or lead coated copper. There shall be NO exceptions to this. Tin-plated copper compression type lugs can be used when connecting to the terminal plates, however they cannot be used to connect directly to the battery posts. Lead plated compression type lugs are not required to have inspection holes. However all other tin plated compression type lugs are required to have inspection holes. There will be no connectors varnished, karo syruped or painted, during or after installation.

For battery connectors, heat shrink tubing will only be applied at the factory during initial manufacture. Heat shrink tubing that does not provide a hermetically sealed connection will not be allowed. If the correct lugs are unavailable, only clear heat shrink tubing may be used. Heat shrink is required on all battery connection cables.

During activities that could result in an acid spill, including the installation, removal, or rearrangement of batteries, sufficient acid neutralization material shall be on hand to neutralize and contain a minimum of eight gallons of acid.

All battery stands shall provide means for anchoring to the floor in order to meet Qwest earthquake Zone standards as required.

Battery strings should use alpha designations (A, B, C, etc.). The letters: ”O and I” should not be used.

Different string sizes and different battery manufacturers may be used in the same battery plant. However, this is discouraged for VRLA batteries. Cells of different sizes and/or different manufacturers shall not be used within the same battery string. If the battery is no longer manufactured, consult the manufacturer for suitable replacement alternatives.

Battery strings are to be connected in parallel, and individual batteries within a string are to be connected in series. Individual cells will not be connected in parallel, however multiple cell batteries can be connected in parallel within the battery case.

Reuse of storage type battery strings, using lead calcium, shall not be reuse in another site if the cells are older than 5 years from the manufacturing date on the battery. However, if the lead calcium batteries are less than 5 years old they may be reused in another site. Pure lead type batteries with a list number of L1S, L2S, L3S, or L4S may be reuse in another site if they are less than 15 years old. Any pure lead battery that has a list number ending with L1, L2, L3, or L4 shall not be reused for any reason; there are no exceptions to this rule.

New and significantly remodeled battery rooms must conform to the provisions of the Uniform Fire Code (1997 issue or later); be compartmentalized, and have acid spill containment as specified by the standard. Battery room containment is preferred within Qwest, however if this is not. practical, stand area containment is the next option; with individual stand containment as the least desirable option. Unless specifically ordered otherwise by the Fire Marshal, neutralization and/or absorptive pillows are not required under the battery stands (they are in the spill kits in the battery area for reactive response).

Figure 2-4: Typical Arrangement of Cables for A Battery Stand

The bus bar, auxiliary framing, or cable rack, shall be a minimum of six inches above the highest point of the battery. No framework, cable racking, bus bars or any other obstruction shall not interfere or impede with the maintenance of the batteries.

Battery bus bar over the wet storage battery stand (except the chandelier) may be stacked as long as the following requirements are met. The battery feed bus bar shall be located a minimum of one foot above the cable rack. The battery return bus must be located a minimum of six inches below the cable rack. Battery bus bar shall not be stacked on the same side of the cable rack; there are no exceptions to this. When the bus bar is not stacked the bus bar shall be a minimum of six inches below the cable rack. There must also be a separation of eighteen (18) inches minimum (center line to center line) between the battery and return buses; there is no exception to this rule.

Sizing of the cables from the bus bar above the battery stand to the main bus bar (chandelier) shall be in accordance with Chapter 8.

Battery suppliers shall provide a label or stamping on each battery containing the following information:

- Voltage
- Ampere-hour rating at the 8-hour rate to an end voltage of 1.75 Volts per cell (this requirement does not apply to batteries used in UPS applications).
- The minimum float voltage
- The operating temperature at which the battery lifetime is guaranteed (e.g., 25 degrees C or 77 degrees F)
- The date of manufacture (may be part of the serial number)

Pilot cells or the Temperature Reference cell should be in the top tier of the battery stand and have the lowest voltage read, after the initial charge of all the batteries on that tier for that string. Cells 1 and 24 cannot be used as the pilot cell.

For applications using VRLA batteries, there shall be a minimum of two strings. This requirement is waived for small remote terminals and customer premise locations serving 96 or fewer customers where space will not allow for the placement of two strings.

All VRLA batteries shall have a minimum of 1/2” spacing between batteries to allow for natural circulation of air, and adequate top clearance, preferably at least 4” to allow for maintenance. The requirement for top clearance may be reduced to 1/2” for batteries whose posts/terminals are front-accessible, or when the batteries are in a slide-out tray so that the tops are accessible.

2.5 Battery Disconnects

A disconnect breaker or other means to disconnect the battery string (i.e. plug) shall be connected in series with each string of VRLA batteries. There are no exceptions to this rule. Battery disconnect may also be required by the Fire Marshal for flooded batteries. The breaker or other disconnect shall be large enough to handle recharge capability. The battery disconnect breakers should be a sealed devices. When the Fire Marshall requires the installation of Battery Disconnects for each string of flooded batteries and/or an Emergency Power Off (EPO) switch, the EPO switch will disconnect the batteries, Engine, and AC Service. The Battery cabling must be sized on voltage drop (with a minimum of two cables) per Chapter 8. The disconnect (and cable ampacity) is sized at the 2 hour battery discharge rate (for an End Point Cell Voltage of 1.86) times

125%. The following table is an example of the typical battery sizes, their ampere hour rating, and the recommended disconnect size. This table represents the most common battery sizes used within Qwest.

How much current is safe current for the batteries? The chemical reaction in the battery proceeds at the same rate, but in reverse. This should not heat up the battery, leading to thermal runaway. Therefore a two-hour rate of charge current would be safe for the battery. To be on the safe side, size the breakers at 125% of the three-hour charging current, according to the size of the battery cell at 1.86 volts. This corresponds approximately to the two-hour discharge rate at 1.86 volts.

Table 2-1 Typical Battery Disconnect Sizes

AmpHr Rating @ 1.75V/C	AmpHr @ 2 hour rate at 1.86V/C	AmpHr @ 4 hour rate at 1.86V/C	AmpHr @ 8 hour rate at 1.86V/C	125 % of the 2 hour rate	Minimum Disconnect in Amperes
30	11.8	6.25	3.3	14.75	15
45	17.5	10	5	21.88	30
70	25.5	14	8	31.88	35
80	28.2	16	9	35.25	45
90	31.4	18	10	39.25	45
105	36.6	21	11.5	45.75	50
125	46.8	14	14	58.50	60
180	62.7	36	20	78.38	80
520	173	109	60.7	216.25	225
840	208	140	91	260.00	300
1680	415	280	181	518.75	600
4000	927	653	418	1158.75	1200

- Mini Tanks are rated at 927 AmpHr at the 2 hour rate, therefore 927A X 125% = 1158.75 Amperes which indicates the need for a 1200 Ampere battery disconnect. Three 750 kcmil cables are the minimum number of cables required. Voltage Drop calculations (per Chapter 8) may require more cables.
- 1680 AmpHr type batteries are rated at 415 Amperes at the 2 hour rate, therefore 415 X 125% = 519 Amperes which indicates the need for a 600 Amp battery disconnect. Two 350 kcmil cables are the minimum number of cables required. Voltage Drop calculations (per Chapter 8) may require more cables.

There are three possible scenarios, which differ from a standard design.

- Excess Chargers. This scenario has the possibility of providing more current to the batteries than even the two-hour charge rate. Obviously, this may operate our breakers, but excess chargers are the main cause of thermal runaway, and this is why we are placing the breakers in series with the batteries. The problem with this is that once the batteries are depleted they may never be recharged until the excess chargers are shut down.
- Excess Battery Capacity — Too Many Strings. This scenario may actually help prevent thermal runaway by reducing the current going to each string on charge, even when there are excess chargers.
- Excess Battery Capacity — Large Cells (Cells with large Amp-hour ratings require fewer strings). Excess chargers coupled with this scenario could be a problem, because the large cells mean that we need fewer strings. The worst case in this scenario is that the breaker sizing, based on the large Amp-hour rating of the cells, would exceed the total charging capacity of the plant. For example, a 540 Amp-hour VRLA cell used in a 100 Ampere plant with three 50 Ampere chargers would call for a breaker rated at 200 Ampere. However, the total charging capacity of the plant is only 150 Amp-hours. Although the disconnect device will never trip on charging, it can still be useful as a maintenance tool for manually disconnecting the string charging. In this case it may be necessary to lower the disconnect device rating (to 140 Ampere for example). If this is done, we must be careful to not go below the three-hour discharge rate of the batteries, because we do not want them to trip on discharge. It also might be wise in these cases to not install a disconnect device.

2.6 Engineering Guidelines

When sizing power plants, the following criteria shall be used:

- List 1 drain is used for sizing batteries and chargers; the average busy-hour current at normal operating voltage should be used. Telephony List 1 drains are measured at 9 ccs or at 18 ccs for the first 2 hours of a discharge and 6 ccs thereafter.
- List 2 drain is used for sizing feeder cables, circuit breakers, and fuses; the current that is required for projected peak under worst operating conditions should be used. Telephony List 2 drains are measured at 36 ccs at -42.75 V for a nominal -48 VDC plant.
- List 3 drain is used for sizing converter plants, the peak current that is required by equipment at a regulated operating voltage that should be used. For loads with no variability, the average busy-hour current at normal operating voltage should be used.

BATTERY PLANT SIZING — When a battery plant is initially installed, the meter and bus bar should be provided based on the projected power requirements for the life of the plant. Base chargers and batteries should be provided based on the projected end of engineering interval connected average busy-hour current drains (List 1).

WORKING SPARE — One more charger should be provided than the number required for the "average busy-season busy hour drain" needed at the end of the engineering interval for base charger requirements. The spare charger must be the largest charger in the plant.

RECHARGE — Size the charger plant such that it will carry the office busy-hour load with a minimum excess capacity of 20 percent to recharge the batteries (1.20 recharge factor). The capacity of the working spare charger is included as part of the recharge capacity. In addition, breakage of the charger sizing will usually provide a margin above the minimum 20 percent. The minimum recharge factor will charge batteries that have been subjected to a three-hour discharge to an end voltage of 1.75 to 1.90 volts per cell to 95 percent of full charge in less than 24 hours. For small power plants in remote terminal applications serving 96 or fewer customers, rectifier redundancy is not required.

Follow these general-engineering guidelines:

- Main conductors and feeders in the plant should usually be sized for the ultimate capacity of the plant. They should also be sized for a maximum temperature of 46 degrees C (115 degrees F). (See Chapter 8 for more information on distribution cable sizing.)
- Charger and battery capacity should be added as the load grows.
- Charge/discharge or supplementary bays should be added only as needed. The input cabling for these bays should be sized for the projected ultimate capacity.
- Distribution equipment (fuses, or breakers) should be added only as needed.
- Chargers not being used to meet the minimum requirements of the load plus the working spare and recharge capacity, shall be turned off but periodically rotated into service (unless doing so would cause capacitor dryout). (This can also be accomplished with Energy Management routines by the power plant controller).

The shunt size of the plant should be no more than twice the installed charger capacity to ensure accuracy of current readings. Each shunt installed should not exceed this requirement.

Power cable racking in the power room shall be located in accordance with Qwest Tech Pub 77351.

All charger and battery cables shall be considered as unprotected (unfused) leads. The charge leads shall be sized as follows for the chargers' sizes listed:

The voltage loop drop for the charge leads shall never exceed two volts.

CFR leads for 200-Ampere chargers shall be one 350 kcmil per battery and return.

CFR leads for 400-Ampere chargers shall be two 350 kcmil per battery and return.

For all other charger sizes, follow manufacturer recommendations.

Charger leads over 125 feet one shall be sized using the manufacturers' recommendations.

2.7 Conventional Controller

The traditional power plant controller shall be capable of basic alarm and control functions as described below. Normally, the alarms will be connected to an "intelligent" power monitor/controller (PSMC) as described in Chapter 7.

All provided alarms must be capable of being remoted. The connecting point for these contacts will be easily accessible. All analog monitoring points (current shunts or volt meters) within the equipment will be equipped with terminal strip access for attaching remote monitoring devices. The connecting point for analog monitoring points will be located near the alarm connecting points and be easily accessible. Binary alarm thresholds from analog points shall be settable. The following alarm indications shall be provided:

- Power Minor Alarms
  - Charger failure - single charger failure
- Power Major Alarms
  - Discharge fuse
  - High voltage
  - Low voltage (below battery open-circuit voltage)
  - Voltmeter and voltage regulator fuse
  - Charge fuse
  - Charger failure - multiple charger failure
- Power Critical Alarms
  - Very low voltage

Control functions of a traditional controller will be limited to high-voltage shutdown and restart capabilities, as defined herein and rectifier sequencing.

Plant controllers for 50 Ampere plants and larger must have digital voltage and current meters (this may be a combined meter). Power plants with a capacity of less the 50 Amperes are not required to have a meter, but shall have test jacks so that the plant voltage and current can be measured with a meter.

Rectifiers whose outputs are controlled by the power plant's controller must default to the rectifier's settings if the controller fails.

CHAPTER 3 CONVERTERS (DC/DC)

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3. Converters (DC/DC)

3.1 General

This unit covers DC/DC converters that transform the output of a charger/battery plant. The converter output voltage may be higher, lower, or at a different polarity than the input voltage. In some special cases, where ground or transient isolation is required, the output voltage and polarity may be the same as the input.

Converters can be applied in two ways: as bulk converter plants, or as embedded (dedicated) converters. Embedded plants are generally provided as a component of the served equipment. The requirements of this unit apply to bulk converter plants.

If the capacity of the converter plant is exceeded for any reason, the output voltage of the converters must be lowered rather than allowing the plant to fail.

PLANT SIZING — The converter plant size is based on the peak current loads of the connected equipment. A converter plant must not be designed to have short-term overload capability. In other words, sufficient converter capacity must be provided for possible short-term peaks.

WORKING SPARE — The number of converters in a plant should be at least one more than is required for the total anticipated current drains defined above, so that the failure of any one converter does not overload the remaining converters.

DISCHARGE FUSE CAPACITIES — Individual and total fusing capacity shall be limited so that the converter plant will be capable of blowing any discharge fuse when required. This requirement shall be met without the redundant or working spare converter in service.

3.2 Alarm Features

The following converter plant alarm indications are minimum alarming considerations. Alarms provided will include both audible and visual.

- MINOR — One converter failed: A converter failure (as opposed to being turned off) when two or more spare converters are in the plant will initiate a minor alarm.
- MAJOR — Converter major alarms include low bus voltage, two or more converters fail, or a control fuse operates.
- CRITICAL — DISTRIBUTION FUSE OR CIRCUIT BREAKER — plant distribution fuse, or breaker has operated and has disconnected power to a load.

3.3 Technical Requirements

Protection (fuses or circuit breakers) for feeds from a converter plant shall NOT exceed the capacity of the plant or total capacity of installed converters, whichever is less.

Individual Converters shall have individual power feeds, rather than a single power feed to the Converter Plant.

Converter output voltage static regulation shall be ±1% over a load range of 10% to full load.

Converter input voltage range is -42 to -59 VDC for nominal -48 volt input, and ±21 to ±29.5 VDC for nominal ±24 volt input.

The converter case shall contain an adjustable high voltage shutdown circuit that automatically shuts itself down when the output voltage exceeds a preset value, and gives a low voltage alarm indication.

The converter output current shall be limited to 110% of its rated capacity.

The converter output voltage shall be adjustable to ±10% of its normal output voltage.

The converters shall have meters displaying the output voltage and current. The current meter shall have a scale with a range of 150% of the rated capacity.

All components of the plant and converters shall be removable through front access.

The converter equipment shall be modular. During growth and additions, the delivery of power to the using systems shall be maintained.

All converter equipment shall have a nameplate with a minimum of the supplier's name, model and serial numbers, input and output voltages, and manufacturing date.

For loads with a different voltage and/or polarity than the primary battery plant, two choices exist to serve them:

- Converter plant, or
- Battery plant.

For loads less than 100 Amperes, typically a converter plant is the preferred option. For loads exceeding 100 Amperes, typically it is less costly over time to serve those loads with a new battery plant at their voltage and polarity. The engineer should evaluate the economics before making a decision.

Converters are considered separately derived DC power sources and shall be equipped with a grounding bus(s) that is referenced to the ground via the frame-grounding conductors. These buses should be grounded in accordance with Qwest Technical Publication 77355, Chapter 5.5 Frame Ground Reference Buses.

CHAPTER 4 INVERTERS (DC/AC)

Chapter and Section **Page**

4. Inverters (DC/AC)

4.1 General

Inverters change DC to AC at a voltage suited to the load, and are not considered an uninterruptible power source. Inverters may be of the solid state or rotary type.

Two basic configurations are provided.

- Standby — In the standby configuration, the AC input powers the load directly and the inverter is a source of back up power. This operating mode conserves the life of the inverter and conserves energy. However, the incoming power is untreated so the load must be able to tolerate any power line disturbances that may be present.
- ON LINE — In the on line configuration, the inverter operates continuously off the DC source to power the load, and the AC source, (if available) is the back up power. The online option is preferable.

Online is the preferred configuration. An automatic static transfer switch must be provided to switch to commercial AC in case of an inverter failure. A maintenance bypass switch must be provided. The maintenance bypass is not required when the inverter has redundant power modules that can carry 100% of the load (eliminating the need for maintenance bypass) during the service or replacement of a failed inverter module.

Components of the inverter shall be front-removable.

Inverters shall be modular to help design growths. Maintainability shall be stressed in the design. The design shall allow repair modular replacement.

Inverter nameplates shall contain the following information as a minimum: Supplier’s name, inverter model number, inverter serial number, and manufacturing date.

The following equipment should generally be connected to an inverter if it is found in a central office and uses AC power.

- Switches or other Network equipment that should have uninterrupted service and that require AC power
- Computers essential to switch operation. Typically, no more than 2 maintenance terminals need to be powered from inverter protected AC. No printers or personal computers are permitted on the inverters.
- 911 equipment that is not DC powered.
- Fire Alarm panels.
- Card Entry Systems.
- Emergency, task, or stumble lighting (this is an alternative to DC-powered lighting for these applications).
- Switchroom telephone systems (key systems, wireless systems, etc).
- Outlets serving modems essential to network elements.

- ➢ Outlets serving devices installed in frames that control or are essential to the operation of equipment serving over 1400 DSO's and/or any DS1's or DS3's (DISC's controllers, TLS controllers, etc).
- ➢ The circuit shall be identified that it is inverter powered by a permanent label at the point of termination. Outlets and covers shall be red in color.

Uninterruptible AC power provided by an inverter is very expensive (due to the high cost of the inverter itself and the battery backup). Non-critical and non-network loads should not generally be placed on the inverter. The Common Systems Power Engineer and the Power Maintenance Engineer shall be the final arbiters if there are any disagreement over whether to place certain types of equipment on the inverter.

4.2 Inverter Selection

Inverter plants must be selected to have proper characteristics and designed to be compatible with the equipment served.

For inverters operating in a Stored Program Control System (SPCS) environment, all loads must meet the grounding requirements described in the protective grounding section of Technical Publication 77355.

4.3 Load Classification

The mode in which inverter plants operate requires that they become part of the load for "other power plants" in the building. Inverter plants are always classified as an "essential load" for sizing the standby AC plant, when operated in the "on line mode. Inverters are also included as part of the "power failure load" for sizing the batteries of the charger-battery plant when the inverter is operated in the continuous "on line" mode. Inverters must be included as part of the "busy hour" load for sizing the charger/battery plant.

4.4 Alarm Features

The following alarm indications shall be provided for local and/or remote surveillance:

- ➢ Inverter "fail" — An inverter has failed.
- ➢ Inverter "supplying load" — A status indication used as an AC power failure indication.

Output circuit breakers shall be equipped with shunts so that they may be monitored by an alarm-monitoring device. All points, loads, and alarms shall be accessible for connection to a Power System Monitor Controller (PSMC).

Each fuse shall be provided with a blown fuse indicator connected to an alarm-indicating lamp on the control panel.

4.5 Technical Requirements

The inverter shall be capable of tolerating power factors as low as 0.8 (80%) leading or lagging without damage to the inverter.

Multi-phase inverters shall be able to operate with a line-to-line load imbalance of 20 percent or greater without damage to the inverter

All external metal parts shall be grounded and grounding requirements of Qwest Technical Publication 77355 shall be met.

The inverter shall have built-in protection against undervoltage, overcurrent, and overvoltage.

Inverters shall be capable of being mounted in 19" or 23" racks, or in a floor-mounted cabinet.

Redundant inverters should be considered for critical loads and in high profile offices. All fire systems and card readers, if AC operated, must be powered from an inverter plant (as opposed to commercial UPS) that is fed from the main DC power plant.

Copper wire in aluminum (or other non-ferrous) conduit must be used for the distribution system. Breaker cabinets for load distribution may be built of aluminum. If steel conduit is used, it may cause heating due to magnetic fields of high reluctance. In switching locations, conduit must not be run on cable racks. Input and output wiring must always be placed in separate conduits.

Inverters are considered separately derived DC power sources and shall be equipped with a grounding bus(s) that is referenced to the ground via the frame-grounding conductors. These buses should be grounded in accordance with Qwest Technical Publication 77355, Chapter 5.5 Frame Ground Reference Buses.

CHAPTER 5 UNINTERRUPTIBLE POWER SUPPLIES (UPS)

Chapter and Section **Page**

5. Uninterruptible Power Supplies (UPS)

5.1 General

This unit outlines general engineering considerations for Uninterruptible Power Supplies (UPS).

UPS require cooling of the ambient air to allow for full output and longevity of components. UPS equipment areas should be designed with the same environmental considerations as other equipment locations containing batteries.

The air in the room containing the UPS batteries must be exchanged a minimum of one complete change per hour to relieve the accumulation of battery fumes. If the batteries are located in an enclosed cabinet, that cabinet must be ventilated to the outside room at a minimum of one complete air change per hour. Local codes may require a higher rate of air exchange.

Larger UPS may induce extreme floor loading due to the combined weight of the system components. The loading factor may require the engineering of special floors. Some systems may require reinforced raised floors so that cool air can be introduced under the floor.

An UPS system must be engineered to be as reliable as the system it serves. As such, the manufacturers' recommendations for installation must be followed. This unit is an engineering guide for UPS systems that are not so defined by the manufacturer and provide minimum requirements for all UPS systems. Batteries for the UPS shall be flooded types where ever possible. Isolation transformers shall be used on all UPS systems above 10 kVA.

All components of the UPS shall be removable via front access.

UPS shall be modular to help design growths. Maintainability shall be stressed in the design. The design shall allow repair modular replacement. The design should be such that failure of any one module will not cause a complete UPS malfunction.

UPS nameplates shall contain the following information as a minimum: Supplier's name, UPS model number and serial number, kVA rating, nominal input and output voltages, and manufacturing date.

5.2 Definition of Terms

UPS Definitions:

AC LOAD PROTECTION — Devices to allow one of several loads to be isolated for fault clearance or maintenance.

BATTERY BANK — A group of cells used to provide the required reserve power to the inverters while there is no AC input to the chargers. The battery bank should be sized to provide the reserve for a minimum of 15 minutes.

BATTERY DISCONNECTS —A means to open leads between the UPS and the battery bank. This device should safely open both the + and - leads, as most systems are not grounded on either battery lead. The device must be rated for the voltage and amperage of the battery bank.

BYPASS — A source of AC power that will replace the inverter output.

HARD BYPASS — A source of AC that will allow shutdown of the UPS for maintenance and provide AC for distribution while the UPS components are not energized.

CHARGER — Charger(s) that changes AC to DC to power the inverters and float or charge the battery banks.

INVERTER — Unit that converts DC to the necessary AC voltage required by the distribution system, normally 120/240v single phase or 120/208v three phase.

TRANSFER SWITCH — A means of transferring the distribution system from the inverter's output to an alternate source, usually commercial power, or a source that can be transferred to a standby generator.

5.3 Technical Requirements

Outlets served from inverters shall be red and labeled as to source.

AC wiring must be sized to meet manufacturers' specifications. Rigid conduit must be used in areas where activity could jeopardize the integrity of the system.

Four hundred Hz systems may require the use of line regulators to provide a match of impedance between the load and the UPS.

Copper wire in aluminum (or other non-ferrous) conduit must be used for the distribution system. Breaker cabinets for load distribution may be built of aluminum. If steel conduit is used, it may cause heating due to magnetic fields of high reluctance. In switching locations, conduit must not be run on cable racks. Input and output wiring must always be placed in separate conduits.

Breakers must be sized and coordinated with system components to insure proper isolation of feeders due to faults or overloads. The input and output main circuit breakers shall be equipped with a factory-installed shunt.

DC wiring must be sized to meet manufacturers' specifications for loop loss between the battery and the charger or inverter. The voltage drop must meet National Electric Code (NEC) requirements within the temperature range of 5.3. These leads must be run on open cable racks or trays and should have RHW (preferred) or XHHW type insulation. Conduit may be used if both positive and negative leads are run in the same conduit. Conduit may be used only if other means are not available due to space requirements.

The operating temperature of all AC and DC wiring in UPS equipment will not exceed 20 degrees F higher than the ambient room temperature or 46 degrees C (115 degrees F) whichever is higher.

Electrically operated disconnect devices are required in some computer installations. They must be located in the computer room and not in the UPS area.

Grounding – The neutral lead of UPS systems must be grounded at one point only. A dedicated transformer and switchgear are normally used to provide bypass power. The neutral must be grounded at this transformer. The ground lead must not be switched. Grounding of computer areas served by UPS must be in accordance with the UPS manufacturers' specifications and the requirements defined in Technical Publication 77355. Ground bonds between the UPS plant and the metallic structures shall consist of electrical conductors specifically provided for grounding purposes. Incidental paths through framework, cable rack, building steel, etc., shall not be used for grounding purposes. Daisy chaining between frames is not permitted. The doors of the UPS enclosures shall be equipped with grounding strap connections for static electricity control.

The major components of the UPS shall be housed in freestanding, "dead front" vertical enclosures with a maximum height of 7 feet. The enclosures may be mounted on heavy-duty casters with leveling screw jacks. The enclosures shall be equipped with "piano-hinged" doors or equivalent. These doors shall be equipped with locking mechanisms to prevent the doors from opening. All sheet metal used in the enclosures shall be 16 gauge or better. All joints and seams shall be welded. Cable entry shall be through either the top or the bottom of the cabinet.

Forced air-cooling and or ventilation are normally required. Blower motors shall be equipped with sealed roller (ball) bearings. Each enclosure shall have a redundant blower. A failure of a blower unit shall generate an alarm. All air inlet and exhaust openings shall be protected with expanded metal guards.

UPS designed to serve non-linear loads shall have an output voltage THD of less than 5%. Output voltage single harmonic distortion of less than 3% under any or all of the following conditions: up to 100% non-linear load; up to 100% load current THD; and/or a load current crest factor up to 3.0.

The UPS shall have built-in protection against undervoltage, overcurrent, and overvoltage on both the input and output.

The UPS shall conform to NTA, Telcordia (Bellcore) TR-TSY-000757 ISSUE 1, *Generic Requirements for Uninterruptible Power Systems*. This document takes precedence over the TR.

Wherever possible and feasible, flooded batteries specifically designed for high discharge rate applications will be used with UPS, rather than VRLA batteries.

Note: Careful consideration of discharge rate capabilities must be considered when making the decision.

5.4 Alarming and Control

If the UPS utilize a microprocessor and software for control, detection of a UPS unit failure shall be built into the software, and shall send an alarm using X.25 and TL1, as described in Telcordia (Bellcore) TA-NWT-000370. If the UPS are not microprocessor controlled, dry contacts shall be provided for connection to an alarm system; these contacts will provide indication of UPS unit failure and operating status.

Internal alarms and monitoring devices shall be built into the UPS to identify failed modules.

Microprocessor driven UPS alarm/control will be either fully redundant, or capable of self-diagnostic and isolation in case of a microprocessor failure. This isolation will remove the microprocessor control from the system, provide a dry contact alarm, and revert to conventional operation.

Battery backup may be provided within the UPS to maintain power to the internal clock, in case of failure of the power source. If battery backup is provided, a low battery voltage alarm shall be provided allowing sufficient time to permit battery replacement on a non-emergency basis.

CHAPTER 6 STANDBY ENGINE ALTERNATORS

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6. Standby Engine/Alternators

6.1 General

This unit contains requirements for all standby AC systems and equipment including engine-alternators with automatic transfer equipment to be deployed in all Qwest Central Office facilities. This Qwest Engineering Document is the final authority for standby AC systems.

Terminology commonly used for AC power plants includes emergency, reserve, auxiliary, and standby. Standby (as opposed to "Emergency") is used in this document in conformance with the definitions of Article 701 "Legally Required Standby Systems" and Article 702 "Optional Standby Systems" of the National Electric Code (NEC); as well as the definitions given in NFPA 37 and NFPA 110.

The grounding system of a separately derived source (some engine-alternators) shall be according to Technical Publication 77355, and NEC 250-30 and NEC 250-20d, latest issues.

Operating documentation must be provided with each engine alternator and transfer switch. The documentation should include how to start or shut down the engine-alternator; how to back out of a transfer operation; and how to manually transfer the transfer switch. If this documentation can be shortened to a sheet or two for each operation, these sheets should be laminated and posted on the transfer and engine control cabinets.

6.2 Standby Engines

A typical AC power system for a Central Office (CO) equipped with a standby engine/alternator consists of the following:

- Commercial AC Service Entrance
- Standby AC System
  - Engine Alternator
  - Transfer Switch
- Building AC Distribution System

Commercial AC power is the normal energy source for COs. A prolonged commercial power failure requires backup in the form of standby AC power for both telecommunications services and essential building services. The standby AC system consists of one or more engine driven alternator(s), transfer system, electrical and mechanical controls, fuel storage and supply system, combustion air intake and exhaust system, engine starting system, and cooling systems appropriate to the type of equipment employed.

The size and type of standby AC system is determined by the combined building and equipment loads that require essential AC service. Telecommunications equipment may represent only a portion of the total load.

Standby AC power plants provide long term backup for essential AC loads, as defined in Chapter 1 of this publication.

6.3 Operation/Administration Requirements

Standby engine alternator power plants are power-limited sources that can be overloaded by simultaneous starting of connecting loads.

- Load Management — In order to avoid transient overloads or oversizing of the engine plant, the standby AC system for COs must provide the required controls for sequencing the start up of high inrush loads.
- Engine Fuels — Engines for standby engine-alternator plants shall be available in a version capable of meeting the equipment building environment requirements stated herein. Diesel engines or diesel-fired turbines (Gas turbines) shall be capable of meeting these requirements while operating with No. 2-D, 1, or winter blend fuel per American Society for Testing Materials (ASTM), Specification D-975.

  Note: In environmentally controlled applications (National Forest, wilderness, etc.) the fuel used will be based on regulatory requirements.

- Performance Ratings - Standby engine-alternators or turbines shall be designed and configured for reliable starting and continuous operation at full load within the range of operating conditions specified for COs. As an example, the maximum and minimum design values for ambient environmental and engine room temperatures and the CO's altitude above mean sea level. The system capacity specified shall be while operating under the following conditions:
  1. Alternator output at the kilowatt (kW) rating specified in the paragraph below (Kilowatt Rating).
  2. Operating at the site specified altitude
  3. Operating at the specified engine room ambient temperature
  4. Maximum back pressure from the exhaust piping system
  5. Maximum drop of radiator air handling system
  6. Maximum pressure of fuel supply system imposed on the engine fuel pump.
- Kilowatt (kW) Rating — The kW rating of all engines shall be based on the Continuous Duty (Prime) Rating at an 80% power factor. For small applications (under 30 kW where the power factor of the engine/alternator is 1.0), the engine/alternator must be capable of providing a peak load of 125% of the kW rating of the unit.
- AC Output — AC standby power systems shall provide outputs within Range A limits specified by American National Standards Institute (ANSI) Document ANSI C84.1-1982, "Voltage Ratings (60 Hz) for Electrical Power Systems and Equipment," and provide one of the preferred systems voltages per Table 1 of the above noted ANSI document.
- Fire Resistance of Materials — Materials and components employed in the standby AC system shall meet the requirements for fire resistance as stated in Telcordia (Bellcore) Technical Reference, GR-63-CORE "Network Equipment-Building System (NEBS) Generic Equipment Requirements (A Module of LSSGR, FR-64 and of TSGR, FR-440)".

The design engineering and installation of power systems for COs should conform to the requirements of Occupational Safety and Health Administration (OSHA) and all applicable local health and safety codes. All power systems and equipment shall be designed and constructed to comply with applicable requirements of the NEC and with applicable local electrical and building codes. When special requirements are necessary, they will be furnished by the Qwest Engineer. The standby AC plant, as installed, shall also conform to the requirements of National Fire Protection Association (NFPA) 37 "Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines" and NFPA 110, "Emergency and Standby Power Systems." Plus “Flammable and Combustible Liquids Code (NFPA 30).

All systems and equipment to be deployed in telecommunication sites shall satisfy the relevant space and environment requirements of Telcordia (Bellcore) Technical Reference GR-63-CORE. Major spatial (building space) requirements for standby AC plants are shown as follows:

- The clear ceiling height required for installation shall not exceed 12 feet 6 inches. This means the minimum height from the floor surface to the bottom of the lowest building structural member in the building must meet the NEBS requirements. Coordination may be necessary to assure that the standby AC plant installation will not interfere with cabling, air ducts or other building systems.
- The equipment weight, averaged over any 20 by 20 foot floor area, shall not exceed an absolute limit of 140 pounds per square foot (140 lb/ft^2) for equipment, supporting structures, cabling and lights. Special building structural considerations may exist due to the load concentration and dynamic loads associated with the engine alternators.
- All connections from the engine alternator (e.g. exhaust, fuel lines, coolant lines, electrical, etc.) shall be made with a flexible section for control of vibration.
- The environmental requirements in Telcordia (Bellcore) Technical Reference, GR-63-CORE, or GR-1089-CORE address temperature, humidity, heat dissipation, fire resistance, earthquake, office vibration, air borne contaminants, grounding, acoustical noise, illumination, electromagnetic compatibility, and electrostatic discharge. Environmental test methods are included in Telcordia (Bellcore) Technical Reference, GR-63-CORE and GR-1089-CORE, which may be used for evaluating equipment compliance with these requirements. If required by Qwest a factory representative will go to the job site for the initial start up.

The documentation for standby AC plants shall be provided in a clear, concise and organized manner per Qwest requirements. The information shall include all the equipment building environmental requirements.

6.4 Alternator Technical Requirements

The alternators’ design and performance shall comply with National Electrical Manufacturers Association (NEMA) MG 1, Part 22 (latest issue). The windings shall be "tropicalized" (i.e. designed to minimize effects of fungi and moisture). Alternators shall also meet the following requirements:

- Insulation Requirements — Insulation for the rotor and starter shall be Class H per NEMA MG 1, Section 1.65. Design full load temperature rise shall not exceed the continuous duty values in NEMA MG 1, Section 22.40.
- Altitude and Temperature Ratings — The engine/alternator shall be capable of continuously delivering the output (kW) specified by the Qwest Engineer for environmental ambient temperatures from –34 degrees C to 52 degrees C (-30 degrees F to +125 degrees F) and at altitudes from sea level to 12,500 feet above sea level. The manufacture shall supply derating

charts in one thousand (1000)-foot increments. This requirement shall be met at any power factor from 80% leading or lagging to unity, at any voltage within the limits of ±10% of rated voltage, and at a frequency of 60 Hz.

- Momentary Overload and Short Circuit Requirements — The alternator shall conform with the provisions of NEMA MG 1, Sections 22.41 and 22.45, "Maximum Momentary Overloads," and "Short Circuit Requirements", respectively. Ground fault protection is required for sets with output voltages greater than or equal to 480 VAC and/or output currents of 1000 Amperes or greater.
- Balance Requirement — The rotors (alternator and exciter) shall be in both mechanical and electrical balance at all speeds up to 125% of rated speed.
- Bearings — The alternator bearings shall be the antifriction type. The bearings, shaft, and housings shall be so designed as to prevent leaking out on the machine parts or windings. Each bearing shall be sealed for life.
- Deviation Factor — The deviation factor of the alternator open circuit terminal voltage shall not exceed 6%. The deviation factor is determined in accordance with Institute of Electrical and Electronic Engineer (IEEE) Standard 115-1983, "Test Procedures for Synchronous Machines".
- Telephone Influence Factor (TIF) — The balanced line-to-line open circuit voltage TIF shall not exceed 50. The line-to-line open circuit low frequency modulation is not to exceed 0.5 volts peak-to-peak, in the frequency range of 5 to 30 Hz. The total open circuit harmonic content of any line-to-line or line-to-neutral voltage shall not exceed 3% rms, with no single harmonic to exceed 1.5%.
- Lead Termination — The alternator leads shall terminate on the line side of the circuit breaker. Suitable crimp-type copper connectors shall be used to terminate the alternator's leads. A means will be provided to prevent connectors from turning when mounted on breaker studs.
- Vibration Isolation — Each engine alternator set will be mounted on vibration isolators, either internal or external to the sets' skid base, as determined by the Qwest Engineer.
- Current Boost — To improve motor starting capacity and to assist in the coordination of protective devices, a current boost circuitry should be provided. The alternator, voltage regulator and exciter assembly should be provided with current boost circuitry.
- Exciter Requirements — Each exciter shall be of the brushless type, using a rotating rectifier bridge circuit.
- Momentary Overloads — With the alternator stabilized at full load, the alternator shall be subjected to 150% of full load current for a minimum of five minutes. Winding temperature shall be monitored during the test and shall not exceed the short-term temperature rise for the insulation.
- Field Current Control — Exciter field current shall be automatically controlled by the voltage regulator. The voltage regulator shall provide under frequency protection.
- Circuit Breakers — The breaker shall be equipped with adjustable instantaneous trips, long time trip elements (thermal trips), and a shunt trip circuit.

- When an on-set breaker is required, the breaker assembly shall provide contact closure for OVERCURRENT audible, visual, and remote alarms. Lockout contacts should also be provided and interfaced with the engine control circuit to prevent starting of the engine alternator set before the breaker is reset.

➢ Trip Settings — The engine/alternator breaker trip settings shall provide protection for the alternator from damage due to AC system faults and to avoid nuisance tripping.

➢ Grounding — AC grounding will be in accordance with Qwest Technical Publications and the NEC. The only acceptable method of grounding the neutral of a set producing 480 VAC power or less is to connect it to the neutral of the commercial power at the house service entrance.

6.5 Control Cabinet and Transfer Switch Requirements

To minimize potential loose connections or trouble spots in the control circuitry, all interconnections of control circuitry wiring shall bestranded wire with crimp connectors and ring terminals securely fastened to terminating points with a machine screw. Only one termination shall be provided per screw. No plug in wiring harness connectors shall be used.

The only gauges that are to be physically located on a stationary engine are oil pressure, temperature, tachometer (if applicable), and fuel pressure non-electronic gauges. These gauges must be remotable to the control cabinet.

The manufacturer shall provide a lighted unit control module for a stationary engine/alternator. The control cabinet shall be a NEMA 1 enclosure with a hinged door. Contents of the controller shall be solid state. The solid state controller shall not be physically mounted on a stationary engine/alternator. The engine alternator set shall include the following:

➢ Gauges and Meters:

1. Oil Pressure
2. Coolant Temperature
3. Output Ammeter and Voltage Meter (equipped with a select switch for each phase)
4. Running Time Meter
5. Frequency Meter

➢ Manual Selector Switch with positions for:

1. RUN or MANUAL operation
2. STOP or OFF
3. REMOTE or AUTOMATIC operation

➢ Others:

1. Remote, 2-Wire control start-stop terminals
2. Manual reset Field Circuit Breaker
3. Indicator lamp(s) for the alarm conditions causing an automatic engine shut down.

4. An alarm-reset switch shall be provided to clear the indicator lamps and reset the system to allow restarting of the engine after an alarm shutdown. The control design shall be such that the alarm must be reset manually (either on the engine or from a remote location).
5. Manual reset Exciter Field Circuit Breaker.
6. Emergency STOP switch.
7. Dry alarm contacts for each failure condition.
8. Locking screwdriver type potentiometer shall be provided to adjust the following:
    - Voltage (5%)
    - Frequency (2%)

The remote control cabinet shall meet the requirements of this document. All connections between the remote control cabinet and the set cabinet will be run in conduit. These leads may be run along with the alarm leads.

The cabinet shall be front access via a hinged door that will latch. All switches, lamps, gauges and meters shall be mounted on the door. All electrical wiring shall be routed and secured to prevent connection deterioration due to movement and to allow access to the cabinet interior.

For floor mounted cabinets, leveling screws, wedges, or shims shall be part of the usable cabinet to level and plumb the cabinet and to compensate for variations in floor flatness. In addition, there shall be four holes provided in the corners at the bottom of the cabinet that will allow 5/8-inch anchor bolts to secure the cabinet to the floor. The cabinet shall have a kick plate extending a minimum of 4-1/2 inches from the floor.

All Automatic Transfer Systems shall be **LISTED** to Underwriters Laboratory (UL) 1008 or 1066 (restricted and certified are not acceptable), and meet the NEMA Standard defined in 2-447-01 and ANSI 37.16 as required. The transfer system should be sized to the main entrance facility when ever possible.

Each automatic transfer switch can be either an electrical or solenoid operated mechanism. The transfer system should be either circuit breakers or a switch. If breakers are used, these breakers may be used as the ground fault current protection device. Where permitted, the commercial breaker may also serve as the main service breaker. External shunt trips with engine start inhibit may be provided if required by local fire codes.

- Circuit breakers shall be of the thermal-magnetic (preferred) or magnetic type (only if approved by local code) rated for fault current and must be UL listed. Contacts shall not be able to be held closed during an overcurrent condition by holding the lever in the closed position. They shall be trip-free types. The AC circuit breakers shall be clearly marked as AC breakers (not DC). Circuit breakers shall generate an alarm signal when they either are in the tripped state or turned off.
- Switches shall meet all requirements of the applicable UL and ANSI standards and be rated for fault current. Ferrous materials shall not be used for current-carrying parts.

All transfer systems shall be equipped with plug-in or draw-out type elements to facilitate maintenance and replacement (such as the inspection and replacement of main arcing contacts) without creating an extensive power outage.

All auto transfer systems must be equipped with a load disconnect delay option. This option will ensure against rectifier or motor bucking and shutdown on an engine routine due to collapsing magnetic fields. This disconnect delay should be set for a 3-5 seconds delay.

The manufacturer shall supply interconnection information for connecting the engine alternator with an Automatic Transfer System.

There shall be a single standby engine alternator test switch mounted on the AC switch gear. This test switch will simulate a Commercial AC failure to the standby engine alternator and all transfer switches. Operating this Test switch will cause all the standby engines alternators to start and all transfer switches that operate when there is an actual AC failure, to transfer. Restoring this test switch will cause the standby engines and transfer switches to proceed with their normal timing to return to Commercial AC and engine shut down.

For automatic transfer, the system shall be capable of the following:

- Recognize the occurrence of a power failure.
- Open the commercial power source.
- Start the engine alternator set.
- Close the alternator circuit breaker.
- Automatically controls loading of the emergency bus.
- Recognize the return of commercial power.
- Transfer all loads from the standby power source to the commercial power source (only if the commercial AC load has been restored for 30 minutes).
- Shut down the engine alternator.
- There shall be a time delay for engine start, a time delay on retransfer to permit polyphase motor stop, a time delay on shutdown to permit engine cool down, and a time delay before transfer to engine to permit warm-up, polyphase motor stop or sequential loading. There shall be a minimum run time. All of the above times will be per engine manufacturer’s specification.

For automatic paralleling of multiple engines, the system shall be capable of performing the following operations:

- Recognize the occurrence of a power failure.
- Open the commercial power source.
- Initiate the Start signal to all engines simultaneously.
- The first engine to reach proper voltage and frequency closes its on-set breaker initiating closure of the engine transfer breaker powering the static loads;
- As additional engine alternators are paralleled to the essential bus, the Load Management Controller connects these loads on a priority basis.
- Recognize the return of commercial power.
- Transfer all loads from the standby power source to the commercial power source after the Holdover Timer has operated.

- Shut down the engine alternator.
- There shall be engine-starting contacts that will allow each unit to be started independently.

Load Management — The standby AC plant shall be equipped with load management features. Both manual and automatic control capabilities shall be provided for sequential operation of the served load. The system shall provide suitable time delays to prevent failure of the standby plant in response to transient conditions.

The system shall be equipped with a test switch to facilitate manual simulation of a power failure.

The system shall be equipped with a manually controlled retransfer override.

The system shall be equipped with indicating lights to indicate the source feeding the load.

Each automatic transfer switch shall include a control panel. The transfer switch must be in a secured area. For large or high voltage (greater than 400 VAC) systems, the switch may be outside the engine-alternator room, but must be readily accessible from the engine. A protective cover shall be provided. An isolation plug in the wiring harness shall be provided to disconnect all circuits between the control panel and the main transfer panel.

Full phase voltage sensing must be provided. Full phase protection shall also be provided. Three-phase relays may be field adjustable, close-differential type, with 92-95% pickup, and 82-85% dropout. Relays are to be connected across the commercial AC voltage input line side of the transfer system.

Independent voltage and frequency sensing of the commercial source must be factory preset to initiate transition to standby at 90% voltage and 58 Hz. Closed transition switches are not allowed.

Exercise timers must be provided. They must be adjustable for one week, two weeks, or monthly operation.

Synchronization must occur within 15 electrical degrees.

The transfer system shall be interlocking so that the commercial AC and standby source breakers cannot be closed at the same time. The transfer switch shall be "break before make".

The neutral shall not switch, and the neutral and ground shall not be bonded at the transfer switch.

Meters may be either analog or digital, and shall meet accuracy and range requirements of ANSI.

The overcurrent protection device can be either a fuse or a circuit breaker placed in the ungrounded supply lead. The protection device shall generate an alarm signal when it has operated or is in the "off" state.

All components must be marked on both the schematic drawings and in the cabinets themselves.

"Break-before-make and transfer/re-transfer delay requirements are waived for systems paralleling engines together and/or with the utility. These systems connect when in phase with the other source(s), and so cannot afford a transfer delay or they would be out of phase by the time the delay was completed. However, such systems need to have the capability to be manually operated with a transfer delay and break-before-make features, for emergency and maintenance purposes. The instructions for doing this must be posted on the transfer switch, engine control cabinet, and engine room/enclosure door."

6.6 Engine Requirements

Engines must be "In-Line" or "Vee" types, water cooled, and mounted on a common steel sub-base. The engine to be shipped with required accessories (except those items subject to damage in shipment). All parts in the engine shall be new. Engine should have replaceable cylinder liners.

All engine-moving parts must be maintainable. Any "lifetime" - permanently lubricated parts must be easily replaceable and 100% warranted for material and labor for a minimum of 7 years from date of installation.

6.7 Voltage and Frequency Regulation

Frequency and Phase Sensitivity - The voltage regulator shall be of the solid state design and shall not be frequency-sensitive between frequencies of 55 to 67 Hz. The regulator shall sense all phases of the alternator.

Voltage Droop and Cross Current Compensation — For engine alternator sets equipped for parallel operation, the regulator circuit shall have adjustable cross current compensation. The voltage droops due to the cross current compensation circuitry shall be adjustable from 0 to 5% of the set's rated voltage and shall be factory set at 3.5 to 4%.

Adjustment — The voltage regulator shall be furnished with an adjusting rheostat that should allow the alternator terminal voltage to be adjusted ±10% of its normal value. Means for voltage adjustment shall be furnished at the control cabinet.

Terminal Voltage Control — With the voltage regulator operating, the cross current compensation shorted out, and the thermal effect constant, the regulator shall control the terminal voltage at any load from no load to full load from 80% leading or lagging and unity. The above shall be within 2% when the no load speed is as much as 3 Hz above 60 Hz.

With the voltage regulator operating, the cross current compensation shorted out, the regulator shall hold the alternator output terminal voltage constant within 2% over an environmental ambient temperature range from -34 degrees C to 52 degrees C (-30 degrees F to 125 degrees F), with a speed change of ±5%. The above is based on the following conditions:

- The cross current compensation is shorted out.
- The load power factor is between 80% leading or lagging and unity.
- The engine has stabilized at its operating speed.
- The governor is adjusted for any droop between 0 and 5%.
- The ambient temperature remains within a 30-degree band after 5 minutes of operation.

Shutdown — Each alternator, exciter, and voltage regulator assembly should have under frequency and over voltage protection, including those conditions associated with shutdown and/or coast down.

Load Changes — When the load is increased or decreased in 25% of full-load steps from no load to full load to no load, the voltage shall recover to and remain within the 1/2% steady state voltage modulation band (dead band) in 1 second with the set cold or hot. The dead band for any uniform load shall not exceed 0.5% rms.

When the full-rated kVA load is rejected in one step, the transient surge voltage shall not exceed 20% of the rated voltage and shall recover to and remain within the 1% of the new steady-state voltage within two (2) seconds.

Governing System — Either a hydraulic or an electronic governor that meets the following requirements can be used. Isochronous type governors are preferred, manufacturer to specify type used.

- The governing system shall be capable of providing frequency vs. load regulation characteristics from isochronous to 5% droop.
- There shall be no sustained periodic variations in alternator output frequency under any conditions, including abrupt load changes.

Steady State Regulation — At any constant load from no load to full load, the maximum frequency ripple for the AC output shall be 0.15 Hz (1/4%) at any frequency between 57 and 63 Hz and at any load from no load to full load. This requirement is intended to apply at steady state conditions including stable temperature within the governing system. Frequency variations within the 0.15 Hz range shall be random (aperiodic).

Cold-to-hot Repeatability — Frequency drift due to changes in governing system temperature shall not exceed ±0.15 Hz for steady state operation at any load from no load to full load.

Note: "Steady State", for the purposes of this requirement is defined as operating at constant real (kW) load for a minimum of 5 minutes after full speed is attained at start up, or, for a minimum of 2 minutes after the disappearance of transients in output voltage and frequency due to a load change.

Hot Repeatability — After stabilizing at steady full load conditions, the engine alternator set shall return to the same output frequency ±0.15 Hz when load is repeatedly added or removed. This requirement shall be met for isochronous and droop operation, where applicable.

Governing System Adjustments — The output frequency shall be adjustable over the range of 57 to 63 Hz from the system control cabinet. External droop adjustment shall be provided at the governor or, where droop adjustment is via electrical means, by means of a potentiometer located within the engine control cabinets.

Frequency vs. Load Linearity — For both increasing and decreasing loads, the change of alternator output frequency with load shall be within 1/4% of true linear response with the governor set for any droop between 0 to 4%. The response of the engine alternator set to sudden changes in load shall meet the following criteria:

- For any sudden quarter-load change from no load to full load (increasing or decreasing the load) the frequency shall recover to and stay within the 0.15 Hz band within one second.
- For any sudden full load change (full load to no load), the frequency shall recover to and stay within 0.15 Hz band within 2.5 seconds.
- For any sudden quarter-load change from no load to full load (increasing or decreasing the load) the frequency shall depart from the steady state value by no more than 2% of the steady state value.
- For any sudden full load to no load change, the frequency shall depart from the steady state value by no more than 5% of the steady state value.

- For all of the above, the frequency shall stabilize at the steady state value after no more than one overshoot and no more than one undershoot.

Governor Oil — Hydraulic governor mechanisms, where used, shall be designed to employ the same oil used in the engine.

6.8 Paralleling Requirements

Paralleling — For engine alternator sets equipped for parallel operation, the voltage regulator and governor circuitry shall be designed to allow droop compensation type paralleling. Standby engine alternator sets equipped for automatic paralleling shall also be provided with means for manual synchronization (i.e., phase lamps). For paralleling applications, the engine/alternator breaker will be of the size and type to ensure protection of the engine/alternator in case of out-of-phase paralleling.

Parallel Operation — Each alternator set equipped for parallel operation shall have suitable characteristics to permit it to be paralleled with another unit or units specified by the Qwest Engineer. Each set shall be capable of operating in parallel with the set(s) so specified at any load from no load to full load, at any power factor from 1.0 to 0.8 lagging, while meeting the following requirements:

- Circulating current shall not exceed 10% of the combined full load current of all sets in parallel.
- The transfer of power between sets shall not exceed 2% of the rating of one set and such transfer shall not be cyclic.
- The division of real load between sets shall proportional to the set capacity.

For automatic paralleling, the system shall be capable of performing the following operations in addition to those listed herein:

- Parallel the alternators and send signals to automatically close successive load group circuit breakers as each associated alternator is brought on-line;
- Recognize the non-operation of any alternator(s) and open designated load circuit breakers to shed/disconnect those loads to maintain system operation.

6.9 Alarms and Shutdowns

Standby AC Plant Alarms and Shutdowns — Standby AC plants must be capable of extended operation without the intervention of an operator. Computer-based operating systems have been developed for remote surveillance of alarms. The standby AC plants covered by these requirements shall provide alarm interfaces with maintenance and operation systems in accordance with requirements in this publication.

An alarm termination strip shall be provided for all the engine alarms. The engine installer shall run the alarms from the engine to the terminal strip. The terminal strip shall be in an EAT (Engine Alarm Termination) box. The installer will be required to label the engine alarm on the terminal strip. Engine alarms are covered in chapter 6 and chapter 7. Qwest will be required to run the alarms from the EAT box to the PSMC.

Normal Shutdown — Normal shutdown of standby AC plants operating under manual control shall be accomplished by depressing a "STOP" or "OFF" switch located on the plant control panel. It shall be placed in a convenient location, readily accessible and clearly marked.

Emergency Shutdown — A momentary contact push button type switch designated "EMERGENCY STOP" shall be provided on each control panel or cabinet. When this switch is actuated, the set shall shut down and an alarm indication shall be given.

- The "EMERGENCY STOP" switch function shall also be capable of being duplicated by a switch located outside the engine room door, in a housing or otherwise protected, to prevent accidental operation.
- There must be a manually controlled shutdown device mounted on the engine. Operating this device shall:
  - Shutdown the engine
  - Activate alarm circuits; and
  - Disable the set's starting circuits

Status Monitoring and Alarms — Operating conditions to be monitored for standby AC plants include those listed below. Where an engine alternator set employs additional features or support systems essential to proper operation of the plant, additional monitoring and/or alarms may be required. Visual alarm and status indication shall be provided by colored lamps mounted directly on the local and, where present, remote control cabinet. Provisions shall also be made for transmitting alarm signals per the alarm requirements in this publication.

- The local control cabinet shall also be equipped with meters or gauges, with minimum accuracy as indicated below in parentheses, providing the following outputs:
  1. Alternator Output (alternator output meter shall be duplicated on the remote control cabinet, where equipped);
     - Amperes (3.0%)
     - Volts (3.0%) (Engine and Commercial)
     - Frequency (1.0%)
     - Kilowatts (2.0%)
     - Lubricating Oil Pressure (5%)
     - Fuel Pressure (5%)
     - Lubricating Oil Temperature (5%) (over 900 kW)
     - Engine Temperature (3%)
     - Hours of Operation (0.1 hour)
     - Tachometer
  2. Engine Start Battery Voltage (Operational at all times, not just during engine run)
  3. Engine Start Battery Amperage (Operational at all times, not just during engine run).

4 For monitoring voltage and amperage, it is acceptable to provide a phase selector switch rather than separate meters for multi-phase sets.

- The control cabinet shall be equipped with step-down current and voltage transformers to meet the monitoring needs of the Power System Monitor Controller at the site.

Condition's Resulting in Plant Shutdown — An alarm indication shall be given and the plant controls shall shut down affected standby engine alternator sets if one or more of the conditions listed below exist. For each of the conditions listed in this section, the engine alternator set shall shut down and require a manual reset after the problem has been cleared in order to restart the set.

- Low Engine Oil Pressure— Operates if the oil pressure falls below the safe value recommended by the manufacturer.
- Overcrank— Operates if the engine does not come up to a threshold speed within 10 seconds after three cranking attempts.
- Engine Over Speed: Operates when engine rpm exceeds 108% of normal operating speed.
- Over Voltage/Under Frequency — Operates if the alternator voltage exceeds the normal operating range by 15% to 18% and/or the frequency deviation is greater than 3 cycles for 5 cycles (the engine should shut down on an inverse time delay basis).
- Over Current — Operates if the alternator circuit breaker trips open.
- Reverse Power — Required only for engine alternator sets equipped for parallel operation, which may include paralleling with the commercial power. Operates if the engine alternator receives reverse power in excess of the threshold value specified by the manufacturer.
- Differential Fault — Required only for engine alternator sets rated 800 kW or larger. On sets so equipped, operates if the differential fault relays are energized due to differential fault current. (Required only when engine breaker is 1/2 of the transfer system.)
- Ground Fault — Required only for engine alternator sets with output voltages greater than or equal to 480 VAC and sets with rated output current of 1000 Amperes or greater. On sets so equipped, operates if the ground fault protection device is activated.
- Control Breaker or Fuse — Operates if a circuit breaker or fuse providing power to essential engine alternator set control functions operates.
- High Coolant Temperature — Operates if the temperature of the coolant, measured on the engine side of the set mounted thermostat exceeds recommended coolant temperature by 15%. Sensing arrangements shall be such that a shutdown signal will be issued if loss of coolant occurs.

Other Alarms — An alarm indication shall be given if one or of the following conditions exist. These conditions indicate impending problems, which may result in plant shutdown or other impairment if corrective action is not taken.

- Charger Failure — An Alarm shall be issued if the charger(s) floating the start/control batteries fail (high or low voltage).
- Fuel System Failure — For plants equipped with auxiliary fuel pumping systems and/or day tanks, an alarm shall be issued if the fuel level in the day tank is above or below the normal range.

- Preliminary High Coolant Temperature — An alarm shall be issued if coolant temperature in a liquid cooled diesel engine rises to within 10 degrees F of the "High Coolant Temperature" shutdown point.
- Low Coolant Temperature Immersion Heater Failure — An alarm shall be issued if the heating element fails or if coolant temperature drops to a level that may impair starting reliability.
- Visual Alarm Codes — Visual alarm and status indications are defined in Chapter 1 except as noted.

  Note: A red indicator on a circuit breaker indicates closed and is not an alarmed condition — per the NEC.

6.10 Fuel and Lubrication Systems

Fuel System/Fuel Scheduling — The rate of fuel supply to the engine's injection system shall be as required to prevent stalling, over speed, or over temperature under any steady state or transient loading conditions within the engine alternator set's rating, and when operating within the environmental limits (temperature, altitude, and humidity) as stated in Telcordia (Bellcore) Technical Reference, GR—63—CORE.

Manufacturers shall provide fuel consumption charts for their systems operating at full, 3/4, and 1/2loads.

Tanks — The fuel tank will be installed in a location as near as possible to the engine alternator in accordance with code restrictions. Because the fuel pump influences fuel tank location, the manufacturer shall provide fuel pump lift data.

Fuel tanks should be sized at a minimum of 36 hours of reserve based on full engine load, for metro areas and 60 hours for rural areas.

Note: A day tank is a fuel transfer tank used when the engine's fuel pump does not have the necessary lift to draw fuel from the supply tank or there is excessive back pressure on the return line due to the fuel tank being mounted above the engine. The day tank pump(s) shall be a DC driven motor for pumping from the storage tank. DAY TANKS SHALL BE AVOIDED WHENEVER POSSIBLE. If the use of a day tank is unavoidable, it shall incorporate both a containment device and a leak detection alarm. In addition, it should be equipped with a high fuel level and a low fuel level alarm. It should be equipped with a return line to the main fuel tank and a vent that is routed outside of the building. It should be sized to provide a minimum of 1 hour engine run at full load.

Fuel tanks shall be monitored in accordance with EPA, State, and Local requirements. Contact the local Qwest Environmental Consultant for the approved monitoring system.

Fuel Lines — Fuel delivery and return systems shall meet all national, state and local codes, and is UL listed. When rigid piping is used, it must be black iron, and flexible sections or aeroquip hose in containment shall be placed between the engine and the supply and return lines.

Grounding of above ground tanks shall conform to Qwest Publication 77355. . In addition, copper and galvanized piping shall not be used in fuel systems because of the impurities they may introduce into the fuel injectors.

Fuel Filters and Strainers — The primary and secondary fuel filters and strainers shall be of the replaceable element type and of sufficient capacity to permit a minimum of 200 hours of continuous operation without requiring service.

Note: This requirement will also be met when operating with fuels containing total organic and inorganic particulate matter (i.e., 1 micron or larger) or up to 5 milligrams per 100 cubic centimeters of fuel. For example, if the engine filtration system(s) removes 100% of the particles 1 micron or larger, the filter or combination of filters shall be sized to trap and hold approximately one pound of particulate matter for every 2000 gallons of fuel circulated through the filters.

Water Separators — Diesel fuel systems will be equipped with water separators.

Fuel Control System Maintenance — The fuel control system shall not require lubrication, adjustment, or other maintenance with more frequency than every 500 operating hours.

On Set Fuel System — A manually operated DC electrical or mechanical, permanently mounted priming pump shall be incorporated in the on set fuel system. The priming system shall be capable of priming the complete on set fuel system starting with drained fuel lines to the supply tank and drained on set fuel system in 1 minute or less.

High Lift Fuel Pump — The high lift fuel pump shall be capable of delivering at least 120% of the set's Fuel consumption rate when the set is operating at full-rated load and the suction lift (including flow losses in pipe and fittings) is 15 vertical feet of diesel fuel.

On Set Fuel System Configuration — The fuel system shall consist of two supply and return loops:

- Fuel from the fuel day tank or fuel supply tank flows through a fuel strainer, a high lift fuel pump, and into a fuel cup. A return line, with or without a pressure-regulating valve, provides a path for fuel not consumed by the engine to return to the day or fuel supply tank. . This return line shall be free from traps and/or valves.
- The second loop runs from the fuel cup to the engine's fuel metering/injection system (usually filtered and boosted by a high-pressure fuel transfer pump) with unburned fuel returning to the fuel cup

Engine Lubrication System — Filter elements shall be adequately sized to permit a minimum of 168 hours of continuous operation without replacement of the elements.

- Lubrication System Capacity — The lubricating oil capacity of the set shall be adequately sized to enable unattended operation for a minimum of 168 hours.
- Positive Lubrication — Positive lubrication shall be provided for all moving parts in the engine and accessory drive. The lubricating oil pump shall be gear-driven from the engine. Lubricating oil filtration shall be of the full-flow type. The lubricating oil filter shall have a built-in bypass arranged to permit oil to bypass the filter if the filter element becomes clogged.
- Lube Oil Filter — Lubricating oil filters shall be of the replaceable element type.
- Lube Oil System Priming — If the lubricating system is designed to require priming after, the system is drained for any reason, a manually operated pump shall be provided. This pump shall be permanently mounted on the engine alternator set.

- Lube Oil System Ventilation — Lubricating oil vapors shall not be vented within the CO building. All lubricating oil vapors from the engine shall be recycled or consumed within the engine.
- Low Lube Oil Pressure Shutdown — A lube oil pressure switch/gauge equipped with pressure sensors shall be provided to operate appropriate electrical contacts to shut down the engine if lubricating oil pressure falls below a safe level.

6.11 Exhaust System Requirements

Exhaust System/Manifold — The engine exhaust manifold provides the channeling for exhaust gases from each cylinder to an exhaust outlet. The manifold shall afford a minimum of backpressure and turbulence to the engine cylinders and valves. Two types of manifold are the dry air-cooled and the water jacket water-cooled; the air-cooled is preferred.

Exhaust Piping — Exhaust pipes must comply with applicable codes. The minimum requirements are as follows:

- Pipes shall be wrought iron or steel and strong enough to withstand the service.
- Pipes must not be supported by engine or silencer.
- Pipes must use vibration proof flexible connectors.
- Pipes must have a clearance of at least 9 inches from combustible materials and terminate outside the building.
- Pipes must be guarded and/or insulated to prevent burn injuries to personnel and excessive heat in the engine room. Insulating material shall the meet requirements stated herein.
- All connections shall be gasket bolted flange or welded. No automotive type exhaust pipe clamps are permitted.
- The outlet of the exhaust pipe shall be a 90 degree horizontal bend, designed for minimum back pressure, with the end of the pipe cut at a 45 degree angle, scarified, with expanded metal over the open end. Rain caps shall not be permitted.

Flexible Pipe Section — A piece of flexible, bellow type exhaust pipe must be used between the engine exhaust connection and the exhaust piping system.

Silencer — Exhaust silencer(s) shall be provided for each engine, of size(s) as recommended by the manufacturer and be engineered for a level of loudness specific for the area that the engine is sited. Silencer(s) shall comply with the requirements stated herein.

Exhaust must extend above the building when ever possible. Exhaust must meet local, state and federal laws and requirements.

6.12 Starting Systems

Electric Starting System — The battery shall be sized to permit a minimum of five (5) cranking attempts of 30 seconds' duration at the design low engine room temperature specified by Qwest (40 degrees F). After the third cranking attempt, no more attempts to start the engine should be made, and the control cabinet should issue an alarm shutdown due to an "Overcrank". The batteries should have the capacity to crank one more time after the Overcrank lockout. The start and control batteries shall be Ni-Cad or Lead Acid type. The batteries shall also be provided with a protective cover for protection while working on the alternator. Where applicable, the battery stand is to be a heavy earthquake zone installation. Engine driven alternators/generators shall not be used on a going forward basis for start and control battery charging.

Engines that are rated at 600 kW and larger must have redundant starter motors and batteries.

The starting battery shall be floated with a regulated charger. A start battery charger may be mounted either in the control cabinet or mounted on a wall near the start battery stand. The charger shall have the following:

- output capacity of 5 Amperes minimum,
- output voltage and Ampere meters,
- adjustable output voltage,
- internally protected output leads,
- high and low voltage alarms, and
- charger fail alarm.

6.13 Cold Starting Aids

All water cooled diesel engine alternator sets shall be provided with thermostatically-controlled heaters, designed to maintain jacket water temperatures not lower than 90 degrees F (per NFPA 110) and not higher than 120 degrees F.

Engine rooms (and their ventilation systems for use during engine run) should be designed for a maximum temperature (while the engine is running) approximately 15 degrees F above the ASHRAE maximum summer outside ambient temperature for that location.

For all engine alternator sets to be installed where outdoor ambient temperatures will fall below 40 degrees F, provisions shall be made to keep the indoor engine room temperature at a minimum of 40 degrees F. Even more desirable for the engine start and/or control batteries is an indoor temperature (when the engine is not running) between 50 degrees and 90 degrees F. (These temperature limits are dictated by NFPA 110.)

6.14 Acoustic Noise

Acoustic Noise Requirements — Sound levels within the building housing the standby plant and outdoor sound levels resulting from operation of this equipment shall meet the requirements specified by OSHA, Telcordia (Bellcore) Technical Reference GR-63-CORE, and local codes as specified.

Where the engine alternator set is equipped with a sound attenuating enclosure, the enclosure shall be designed to allow adequate cooling of the engine alternator set.

Sound-Attenuating enclosures, where employed, shall provide hinged doors or latched panels to allow access for normal maintenance and repair operations, including:

- Removal and replacement of fuel and lubricating filters;
- Replacement or cleaning of air filters; and
- Performance of all other normal maintenance operations specified by the manufacturer.

Enclosure Cooling — Where the engine alternator set is equipped with a sound- attenuating enclosure, it is desirable that the enclosure cooling requirements be met without booster fans or other accessory devices.

Note: The supplier must consider widely different climatic zones in Qwest when designing for this requirement. Some locations will require booster fans or other accessory devices.

Enclosure Acoustical Materials — Acoustical materials, such as acoustically absorbent liners, shall be non-capillary, non-hygroscope, free from perceptible odors, and must maintain their acoustic attenuating properties under the conditions of temperature, mechanical vibration, and exposure to petroleum products they may be subjected under normal operation. Elastomeric material used in sealing the acoustic enclosure must remain flexible and resist cracking in the environment they are exposed to in normal use.

6.15 Cooling System

Capacity — The cooling system furnished with the engine alternator set shall have sufficient cooling capacity to ensure continuous operation at full load at ambient temperatures up to 52 degrees C (125 degrees F) and at altitudes up to 12,500 feet above mean sea level.

Remote Cooling — Some installations require the radiator and fan mounted separately from the engine alternator.

- Pipe Sizing — When water flow is produced by the engine driven water pump, total piping pressure drop shall not exceed the engine manufacturer’s recommendation. If water flow is assisted by an auxiliary pump, piping pressure drop must be matched to pump capacity at desired water flow, as determined by the manufacturer.
- Remote Radiator Airflow — Remote radiators are designed for installations where no external airflow restrictions occur. If the remote radiator ventilates a room, has any ducting, or its airflow is opposed by prevailing winds, the cooling capacity is reduced.

¤ ¤ ¤ CAUTION ¤ ¤ ¤

Areas with below freezing temperatures’ will require consideration to protect against ice formation that can block air flow or damage fan blades.

- Remote Radiator Fan Motor — A remote radiator fan requires an electric motor compatible with the emergency power source. The voltage, frequency, and horsepower of the required motor must be specified. The fan can be direct or belt drive. If belts are used, multiple belts must be employed to ensure reliability. An indicator lamp must be on the Engine Control Panel, indicating proper operation of the fan. The fan motor shall be powered from engine alternator it serves.
- Heat Exchangers — Heat exchangers shall be utilized when the engine manufacturer’s specified maximum head pressure is exceeded. If a heat exchanger is required, an auxiliary pump shall be used in the system. The pump shall be powered from the engine alternator it serves.
- Radiator Fan — The fan shall be rated as "Quiet" with a maximum noise level of 81 dB (A) measured at twenty-five (25) feet.

- On Set Cooling System —Water cooled diesel engine plants, should have the water-to-air heat exchangers (radiators) mounted on the same sub-base as the engine alternator. For such systems, the cooling fan shall be mechanically driven from the engine. The fan shall be of the pusher type (that is, the cooling air shall be blown through the radiator). Where the fan is a belt-driven, redundant belt shall be provided, so that if one belt breaks, the remaining belt(s) shall be capable of driving the fan continuously.
- The set-mounted cooling systems as described above are capable of operating with total fan head equal to or greater than 0.5 inch of water.
- If air intake is provide with ductwork, a flexible radiator section, (rubber or flame retardant canvas type is preferred), shall be utilized to connect the radiator with the ductwork.
- Silicon type radiator hoses are required for use in all 3D-condo co-location buildings.

6.16 Safety

The engine alternator set shall be designed and constructed so those personnel hazards are minimized. Component parts shall be suitably arranged and/or guards shall be employed to minimize the possibility of accidental contact with hazardous voltages, rotating parts, or excessively sharp edges, and/or high temperature surfaces.

High Temperature Surfaces — Exposed equipment surfaces with temperatures greater than 46 degrees C (115 degrees F) shall be marked with warning labels. Surfaces with temperatures greater than 54 degrees C (130 degrees F) shall be guarded as well as marked with warning labels.

Insulation and/or ventilated guards shall be provided to protect he operator from coming in accidental contact with the high-temperature external surfaces of diesel engine exhaust system parts and piping, and any other components with surface temperatures higher than 54 degrees C (130 degrees F).

Rotating Parts — Suitable guards shall be provided for all fans, blowers, rotating parts of alternators, and any other rotating parts associated with the engine alternator plant to which the operator might otherwise be exposed.

- Guards shall be of substantial construction removable but securely fastened in place and of such design and arrangement that any part of the operators' body cannot project through, over, around or underneath the guard.
- All set screws, projecting bolts, keys, or keyways shall either be suitably guarded or of a safety type without hazardous projections or sharp edges.
- All in-running gears and sprockets otherwise exposed to personnel contact shall be completely enclosed or be provided with bandguards around the face of the gear or sprocket. Side flanges on the bandguard shall extend inward beyond the root of gear teeth. Air dryers/compressors shall not be installed in the engine rooms due to the static electricity and heat generated.

6.17 Hazardous Voltages

Voltages at or above 150 Volts DC or 50 Volts AC rms shall be enclosed or guarded to prevent accidental personnel contact. Warning labels shall also be provided and conspicuously displayed with guards in place or removed.

6.18 Portable Engines and Trailers

The portable engine-alternator shall meet all requirements of the previous sections of this Unit. (Exception: controls can be mounted on the portable engine alternator set.)

Although the ratio of generator sets to sites is a local decision, they must be equipped as described in this document. Examples of items to be considered when determining the ratio of generator sets to sites are:

- Area covered
- Number of high priority sites
- Typical weather conditions
- Power company restoration history
- Tolerable down time duration

For engines that are not air-cooled, an engine coolant heater shall be provided that can be plugged into a typical 120 VAC outlet. The start battery charger will also be connectable to a 120 VAC outlet.

Portables larger than 15 kW will be mounted on a multiple axle-type trailer that meet all Department of Transportation and local requirements.

- The trailer will have a locking tool box. Among the items in this toolbox, there will be four rubber wheel chalks.
- The trailer will be equipped with surge brakes, lights, wiring harness, and connector and an adjustable towing hitch.
- The trailer and portable will have a minimum 100 gallon fuel tank and gauge (or equivalent for LPG tanks).
- Permanently mounted generators or alternators must be grounded to the vehicle chassis they are mounted on. However, the neutral and ground should not be bonded together at the engine since that connection already exists at the AC meter, and we do not switch the neutral at the transfer switch.

All convenience outlets on the vehicle/trailers must be equipped with Ground Fault Interrupter (GFI) type protection and must be installed in accordance with current requirements for industrial and/or commercial mobile AC power. These outlets are intended to provide power for test equipment, power tools or other similar electrical devices, NOT POWERING the telecommunications equipment.

6.19 Portable Generator Set Connections

Standardization of portable generator set connection hardware is needed to meet the variety of power requirements and the need for a quick positive response during extended power failures. This section will present the standards for new equipment and enable the retrofitting of existing equipment to company standards.

Portable generator sets shall be grounded according to Qwest Publication 77355 and the NEC as required.

Sites equipped with a permanent stationary engine-alternator are generally not equipped with portable engine-alternator plugs. However, for large and important locations, it may be wise to invest in a tap box to allow faster connection of a large rented portable if a serious engine failure occurs.

There are many variations of portable engine alternators in use by Qwest. Only units capable of producing single-phase 120/240 volts AC, with a rated power output from 5 to 40 kilowatts (kW) will be addressed in this section. Although almost all Outside Plant powering is 120/240 volt single-phase, some of these sites may be served by engines capable of single or three-phase operation. These engines are sometimes used with three-phase COs (typically 120/208 volt three-phase). For conformity, the 100 and 200 Ampere cords and connectors have been designed to accommodate these types of engines. The 100 and 200 Ampere inlets have 4 pins, but only 3 of the pins are used on single-phase sites, as shown in the drawings. The "green-wire ground" is connected to the metallic case of the inlet.

The cable sets illustrated in Figures 6-1 through 6-10 have been standardized for use in Qwest. The local Power Maintenance Engineer or Inductive Coordination & Electrical Protection (ICEP) engineer should be consulted before length or gauge changes are made to the power cables specified in this document. Although emergency power cables may be fabricated locally by a licensed contractor, the desired procurement method is through the organizational supply network. Construction Engineering Memorandum (CEM) 8404 describes and defines the requirements for electrical protection of Outside Plant Electronic Equipment Enclosures.

The purchase of new 10-40 kW 120/240 volts single-phase engine alternators may be delayed in locations where existing portable engine-alternators are available. No Remote Terminals (RTs) have higher power requirements, (RT is a generic name for an Outside Plant electronics equipment enclosure, be it a CEV, CEC, hut, cabinet, etc.). This initial first cost delay could be cost effective. It is a local decision to delay the expenditure and should be based on the following:

- The number of Electronic Equipment Enclosure (EEE) huts or CEVs in use
- The number of custom buildings requiring one hundred Ampere emergency service
- The number of engine alternators and their output rating presently available
- Budget restraints
- Forecasted equipment for each location where a 10-40 kW engine alternator will ultimately be required

The Ampere rating of the plug chosen (see the Figures) will depend on the ultimate load expected at a given site (this load is to be computed by the design engineer who should then specify the Ampere rating of the AC service). When calculating the power requirements for RT locations the requirements of the convenience outlet must be included in the total power requirements (convenience outlets on the enclosure must be equipped with Ground Fault Interrupter [GFI] type protection). All hardware, including power panels, cabling, and devices shall be listed by a national testing laboratory. Installations shall conform to the NEC and local electrical codes. Under no circumstances shall the power installation be attempted by anyone other than a licensed contractor.

Van or truck mounted engine alternators presently in service capable of producing 30 Ampere, 120/240 volts single-phase AC 5-13 kW shall be equipped with a two pole 30-Ampere breaker.

(The 30-Ampere plug is only actually rated to carry 6.1 kW of 240 V power. The breaker will protect the cabling, engine, and plugs from having their ratings exceeded.) As an option, the 30 foot cable may either be permanently attached to the engine alternator terminal block as in Figure 6-1, or the alternator terminal block may be wired to a Hubbell # HBL-2710-SW twist-lock receptacle. In which case the alternator end of the cable shall be terminated with a Hubbell # HBL-2711 twist-lock plug, (see Figure 6-2). In both cases the load end of the cable shall be terminated with a 30 Ampere Hubbell # HBL-2713 twist-lock connector. The DLC housing, or power pedestal, shall be equipped with a Hubbell # HBL-2715-SW twist-lock inlet. The 30 foot, 30 Ampere cable in Figure 6-2 is made up of four # 8 AWG conductors in a Type W, UL sheath. (An exception to the use of Hubbell 30 Ampere plugs and receptacles are allowed for existing NEMA L14-30P/R equivalent plugs and receptacles.)

Van, truck, or trailer mounted engine alternators presently in service capable of producing 100 Ampere, 120/240 volts single-phase AC shall be equipped with a two pole 100 Ampere breaker for single-phase sets, or a three-phase 100 Ampere breaker for three-phase/single-phase sets. (The 100 Ampere plugs are actually rated to carry only 20.4 kW of 240 V power. The breaker will protect the cabling, engine, and plugs from having their ratings exceeded.) As an option the 30 foot cable may either be permanently attached to the engine alternator terminal block as in Figures 6-3 and 6-5, or the alternator terminal block may be wired to an Appleton # ADR1044CD receptacle. In which case the alternator end of the cable shall be terminated with an Appleton # ACP1044CD plug, (see Figures 6-4 and 6-6). In both cases the load end of the cable shall be terminated with a 100 Ampere Appleton # ACP1044CD-RS connector. The site housing, or power pedestal, shall be equipped with an Appleton # ADJA1044-200-RS inlet and back box, with pin 3 pulled, and the "green-wire ground" connected to the case. The 30-foot cable is made up of four (4), number 2 gauge conductors in a Type W, UL sheath. (Engines that are capable of either single-phase or three-phase operation will have five (5) conductor cable. An exception to the use of 100 and 200-Ampere Appleton plugs and receptacles is allowed where a NEMA equivalent Crouse-Hinds or Hubbell plug or receptacle has the exact same specs as the Appleton part numbers shown in the figures plugs or receptacle is already in place. All new 100 and 200 Ampere plugs and receptacles; however, shall be of the Appleton type.

The existing 50, and 60 Ampere (and other sizes besides 30, 100 and 200 amp) engine alternators, power cable sets and locations equipped with older connection devices should be retrofitted to conform to this document as money is available. The areas using these devices should migrate their equipment as required by attrition to conform to these specifications stated in this section. Until "migration" to the new standard is complete, it may be necessary to make adapter cords to match up old engines with new receptacles, and vice-versa.

In some cases, the power requirements of a site served by a portable generator set will exceed 100 Amperes. Van, truck, or trailer mounted engine alternators presently in service capable of producing 200 Ampere, 120/240 volts single-phase AC shall be equipped with a two pole 200 Ampere breaker for single-phase sets, or a three-phase 200 Ampere breaker for three-phase/single-phase sets. (The 200 Ampere plugs are actually rated to carry only 40.8 kW of 240 V power. The breaker will protect the cabling, engine, and plugs from having their ratings exceeded.) As an option the 30 foot cable may either be permanently attached to the engine alternator terminal block as in Figures 6-7 and 6-9, or the alternator terminal block may be wired to an Appleton # ADR20044 receptacle. In which case the alternator end of the cable shall be terminated with an Appleton # AP20044E plug, (see Figures 6-8 and 6-10). In both cases the load end of the cable shall be terminated with a 200 Ampere

Appleton # AP20044E-RS connector. The site housing, or power pedestal, shall be equipped with an Appleton # ADJA20044-250-RS inlet and back box, with pin 3 pulled, and the "green-wire ground" connected to the case. The 30-foot cable is made up of (four) 4, 3/0 conductors in a Type W, UL sheath. (Engines that are capable of either single-phase or three-phase operation will have 5-conductor cable.) (An exception to the use of 100 and 200-Ampere Appleton plugs and receptacles is allowed where an equivalent Crouse-Hinds plugs or receptacle is already in place. All new 100 and 200 Ampere plugs and receptacles; however, shall be of the Appleton type.)

Custom buildings should be provided with a commercial power cabinet or panel, a transfer switch, and a distribution panel that receives its power from the transfer switch. This arrangement allows nonessential loads to be eliminated from the emergency power load.

Variations of carrier installations require power load calculations based on each individual installation. Emergency power inlets at custom buildings should be sized for the ultimate power requirement of that installation. The -48 volt bulk power plants should be calculated based on all chargers being in operation at full rated output (a recharge condition). During a power failure, the engine alternator will have to provide power for the equipment and the recharging of the batteries.

In some cases, due to the local power companies, the AC service size they sell is much larger than what we need for the generator, plug, and cord size. For example, we may only need a 30 Ampere plugs on an 80 cabinet, but the Power Company gives us a 100 Ampere service. This is generally not a problem because the pedestal can be equipped with separate breakers for the incoming AC service and the generator plug. However, some local regulators insist that the emergency plug be the same size as the service. These cases should be handled on a one by one basis. Size the generator plugs, cords, and engines for a site. It will not necessarily be the same size as the incoming commercial AC service from the Power Company.

Sites equipped with plugs for portable generator connections shall be provided with a tag mounted next to the emergency power inlet (see Figure 6-11). A metal tag, similar to a cable tag should be used. It should be permanently attached and stamped to provide the following information:

- CLLI code of site
- Voltage and phase requirements

Engine alternator sets shall also be equipped with a tag mounted next to the receptacle stating the following:

- Output voltage and phase

It is the responsibility of the work group maintaining the field installation to ensure that all equipment and sites are properly tagged. The engineering manager is responsible for providing the emergency power load requirements to the field. This information should be provided in writing. Review of the emergency power load shall be undertaken prior to the installation of new equipment for a given site, and site tags must be up dated as power requirement change.

Sequenced instructions for implementing standby power operation should be duplicated and posted in all sites.

Most 3-phase sites will have forward phase-rotation (A-B-C rotation). However, there are some sites where the commercial feed and all motors in the building will be wired with reverse rotation (C-B-A). As a general standard, all three-phase alternators, cords, and plugs shall be wired for forward rotation. Sites with reverse rotation shall have the wiring between the generator set plug and the transfer switch configured so that the forward rotation from the generator becomes reverse rotation at the transfer switch.

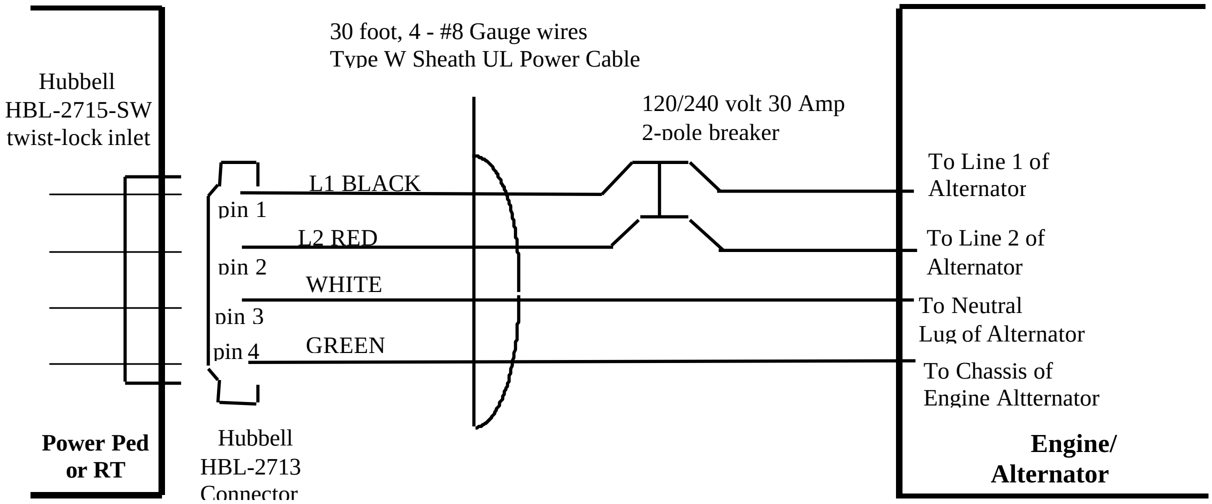


Figure 6-1 30-Ampere Cable Hardwired to Single-Phase Engine-Alternator

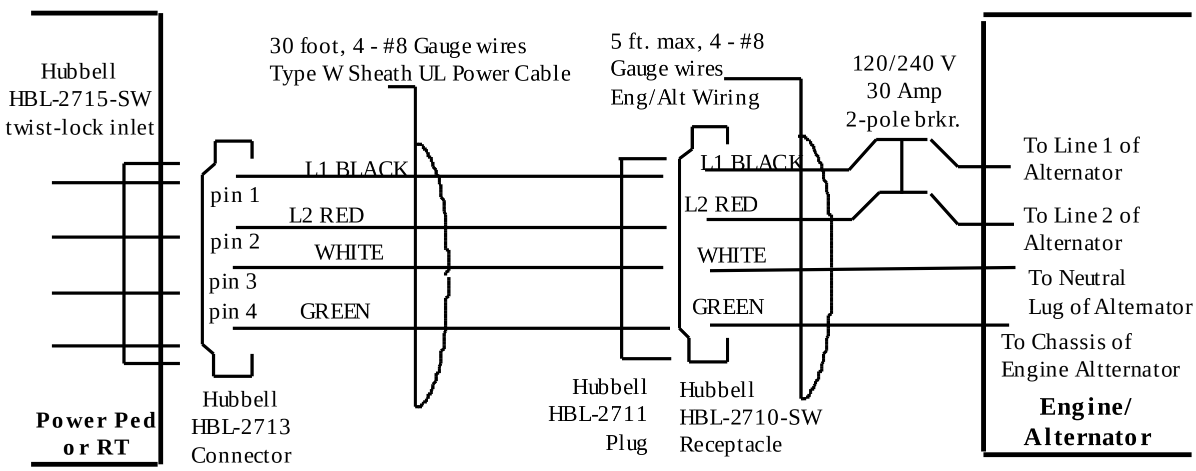


Figure 6-2 30-Ampere Cable to Single-Phase Engine-Alternator Receptacle

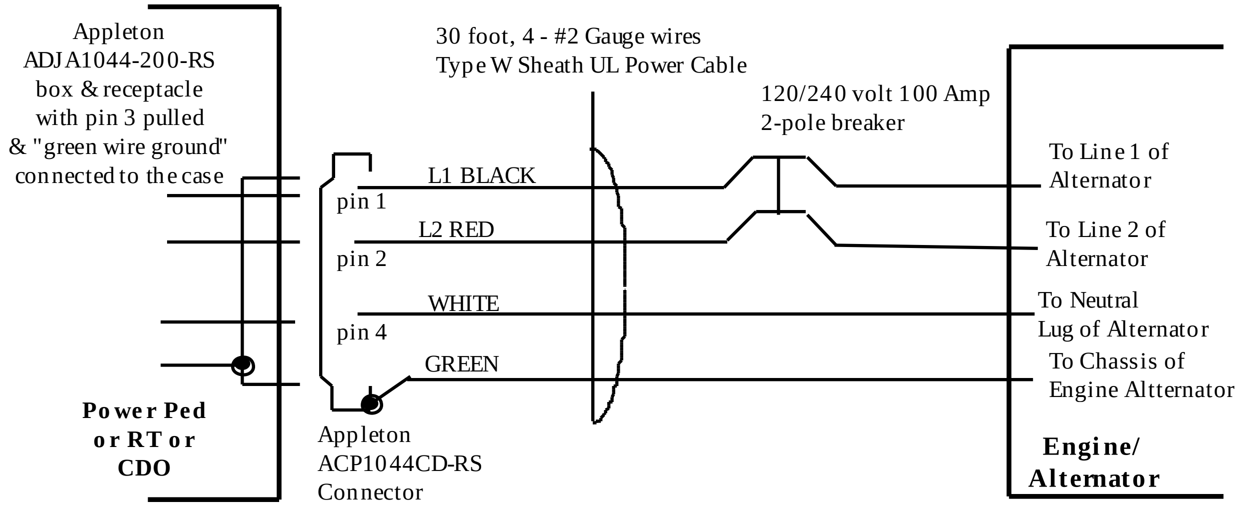


Figure 6-3 100-Ampere Cable Hardwired to Single-Phase Engine-Alternator

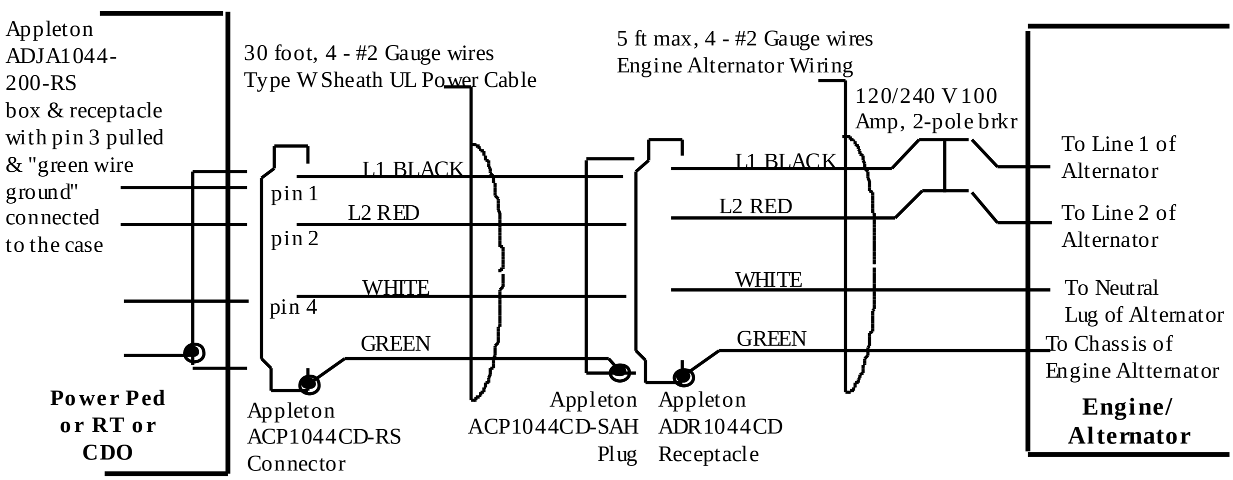


Figure 6-4 100-Ampere Cable to Single-Phase Engine-Alternator Receptacle

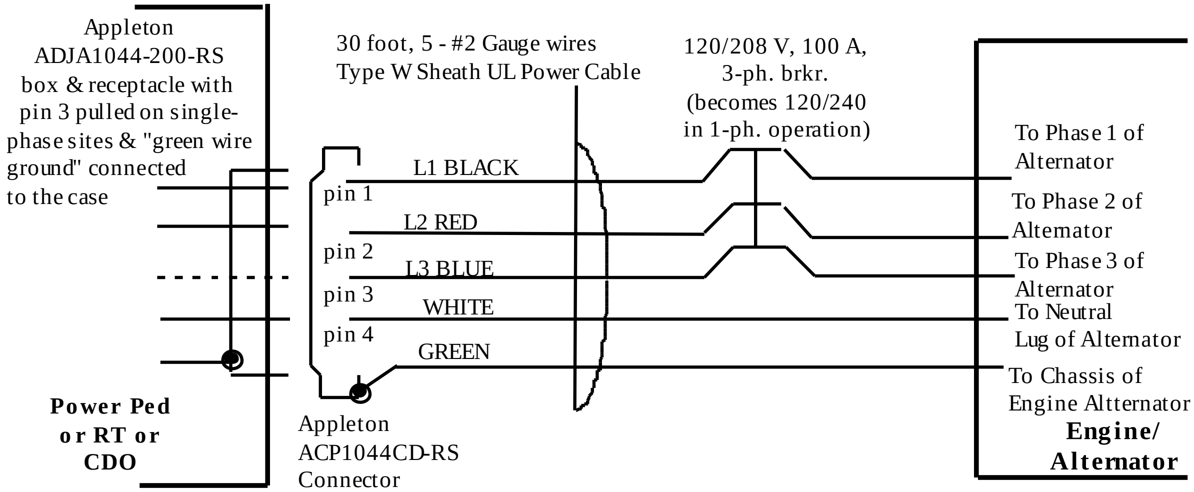


Figure 6-5 100-Ampere Cable Hardwired To Three-Phase or Single/Three-Phase Engine-Alternator

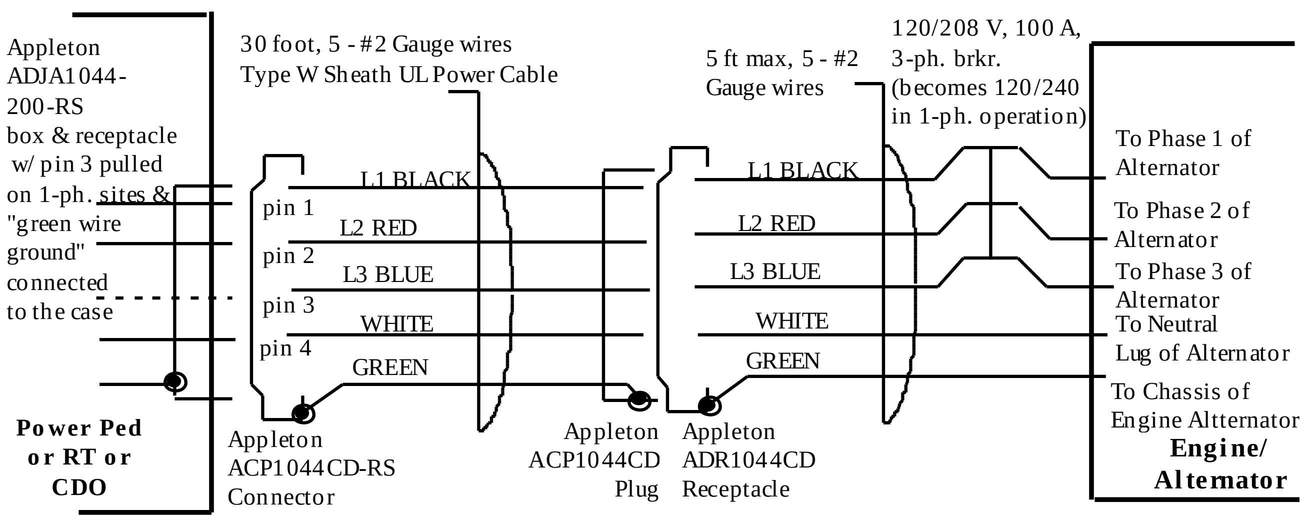


Figure 6-6 100-Ampere Cable To Three-Phase or Single/Three-Phase Engine-Alternator Receptacle

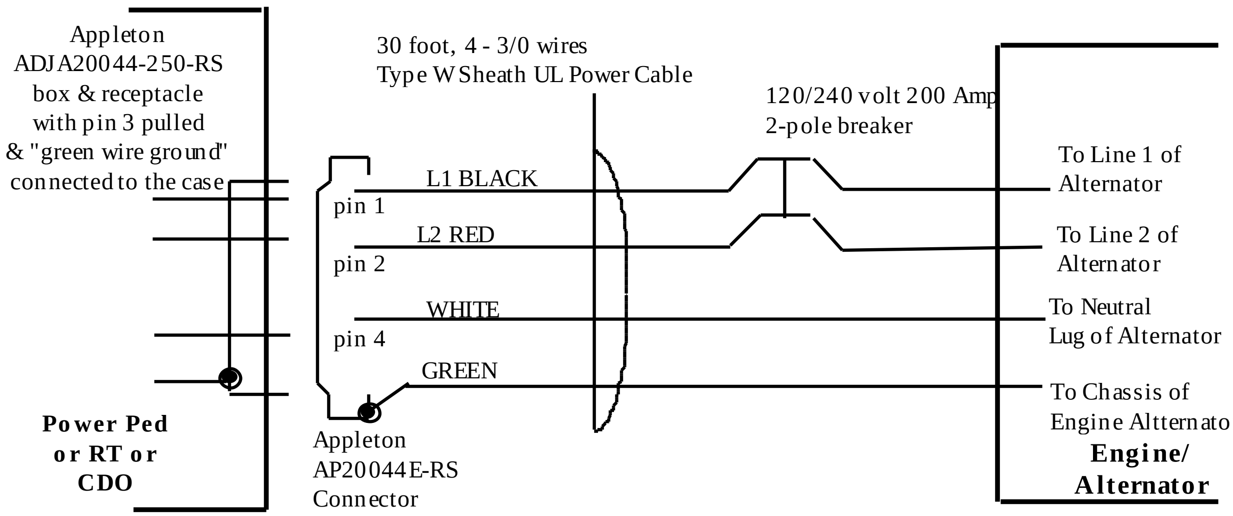


Figure 6-7 200-Ampere Cable Hardwired to Single-Phase Engine-Alternator

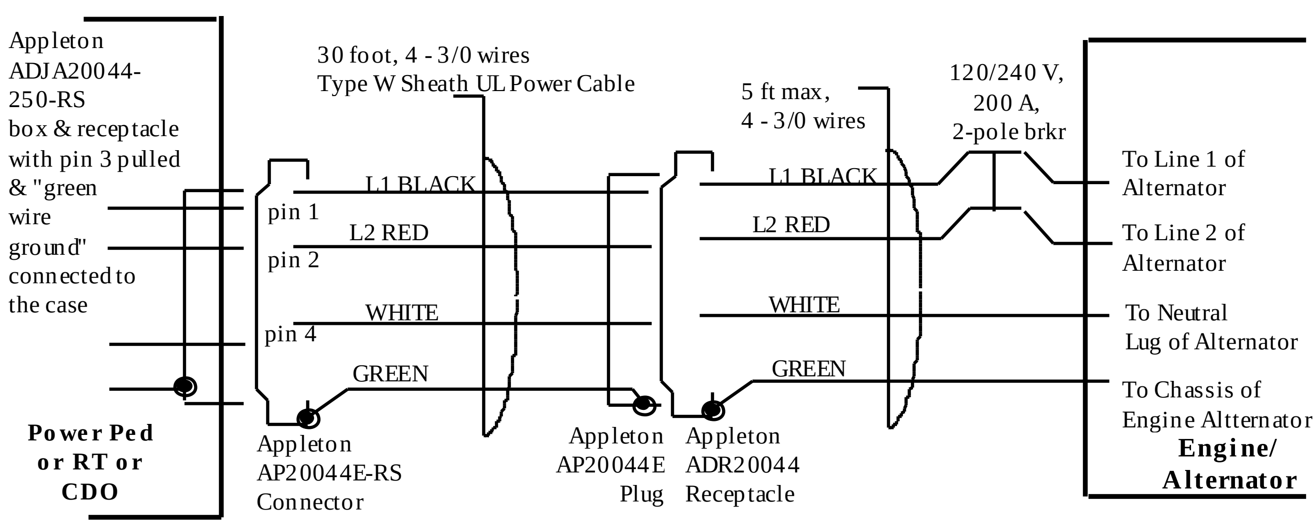


Figure 6-8 200-Ampere Cable to Single-Phase Engine-Alternator Receptacle

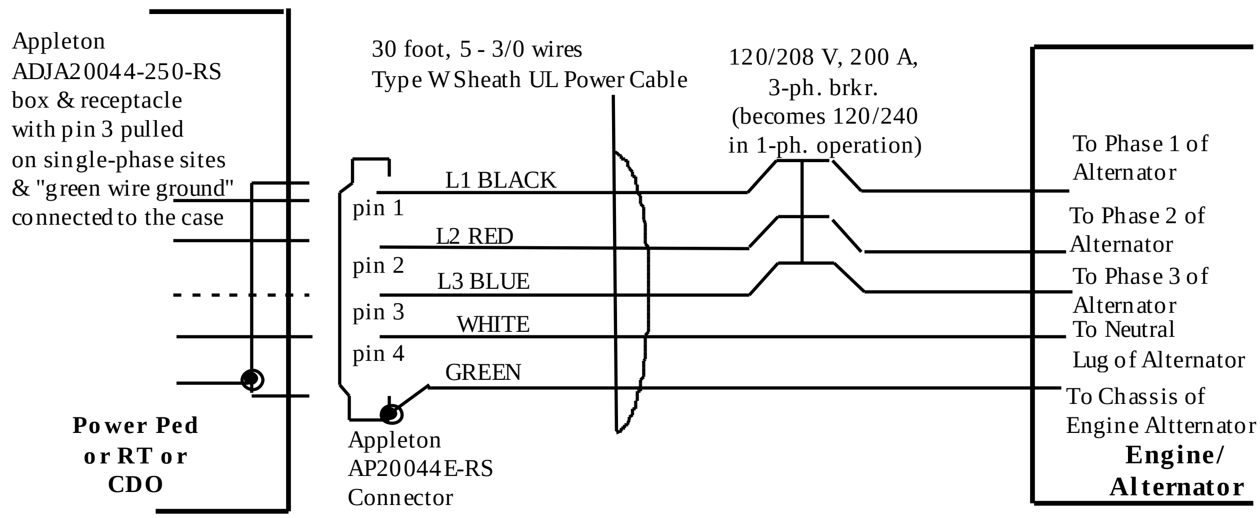


Figure 6-9 200-Ampere Cable Hardwired To Three-Phase or Single/Three-Phase Engine-Alternator

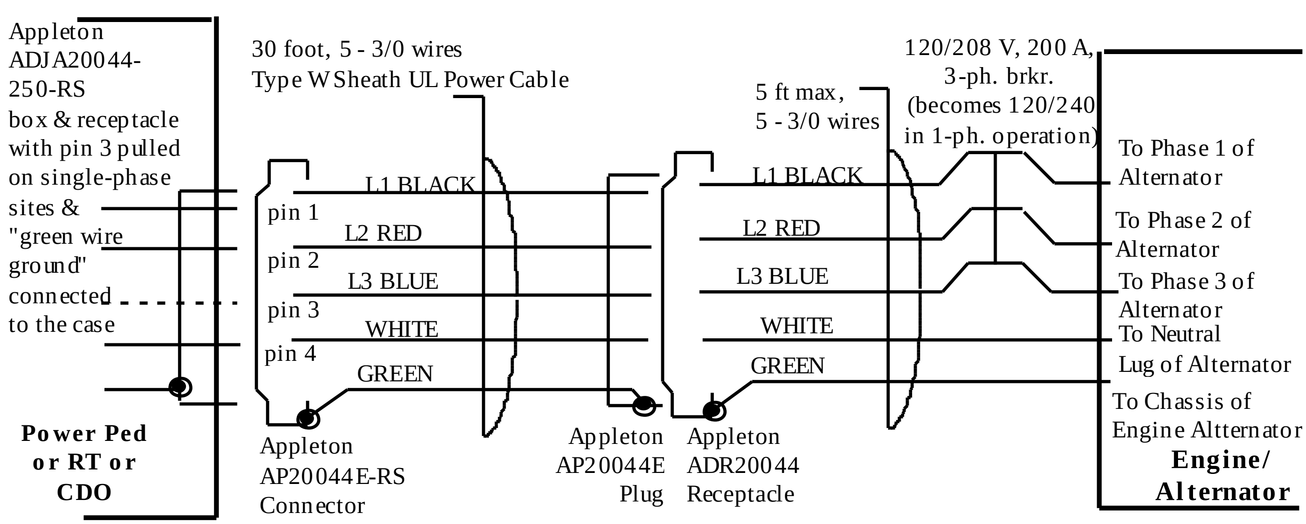
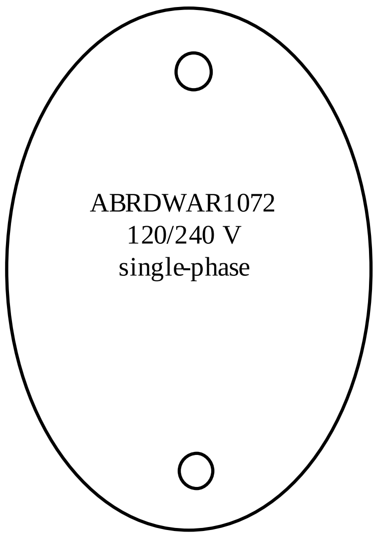
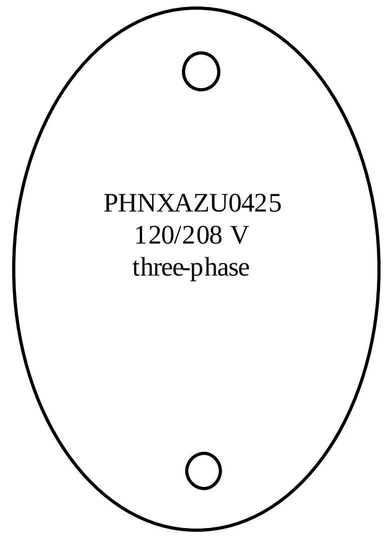


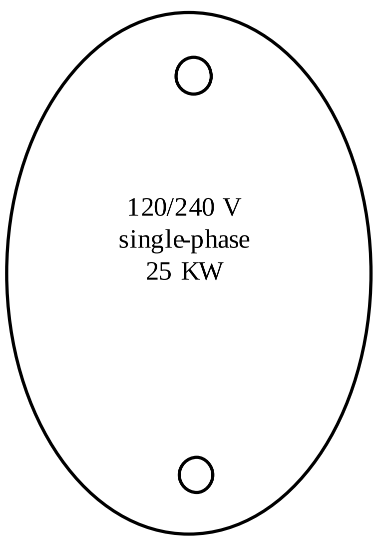
Figure 6-10 200-Ampere Cable To Three-Phase or Single/Three-Phase Engine-Alternator Receptacle



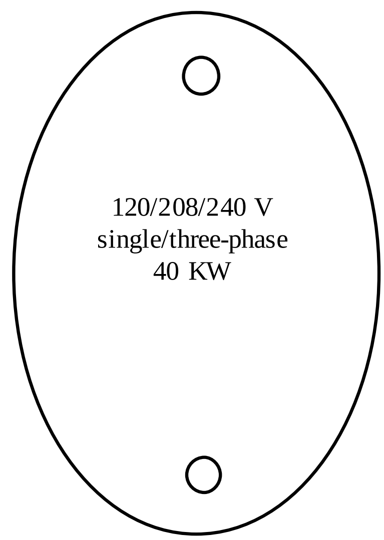
Example of Site Tag
for single-phase site



Example of Site Tag
for three-phase site



Example of Engine Tag
for single-phase engine



Example of Engine Tag
for three-phase site

Figure 6-11 Example Site and Engine-Alternator Tags

CHAPTER 7 POWER SYSTEMS MONITORS AND CONTROLLERS (PSMC)

Chapter and Section **Page**

7. Power Systems Monitors and Controllers

7.1 General

The Power Systems Monitor Controller (PSMC) will perform front-end control and status functions for DC power plants in Qwest. Control functions must be provided only when the power monitor is designed as an integral part of the power plant controller. It is recommended that each battery plant have its' own PSMC, however every office shall have at lease one PSMC for power alarming and monitoring.

The PSMC shall be equipped for remote access dial up capabilities, and must be MENU driven. Baud rate is to be determined by the originating modem. The PSMC's modem shall automatically adjust baud rate to match the baud rate of the originating modem.

The monitor should have in interface such that it can be accessed locally by connection of a cable to a laptop.

All modems and pads shall be DC only, AC modem and pads are not to order, installed or accepted for use within Qwest Communications, and there are no exceptions to this rule.

The PSMC shall be Network Monitoring and Analysis (NMA) compatible and support the Qwest TL1 recommended Power message set (see Chapter 12) via X.25 protocol standards. The PSMC must be able to simultaneously support dial up capability. Control functions must not be accessible via dial-up access.

Where plant low voltage disconnects exists, the PSMC shall be connected on the hot side of the low voltage disconnect circuit of the plant feeding power to the PSMC. If it can handle the low voltage levels, the NMA should also be connected on the hot side of the low voltage disconnect.

7.2 Standard Monitor and Control Points

The following sequence details the order of the power plants and equipment to be monitored by the PSMC:

- -48 volt battery plants
- +24 volt battery plants
- -24 volt battery plants
- +130 volt battery plants
- -130 volt battery plants
- +24 volt converter plants
- -24 volt converter plants
- +48 volt converter plants
- -48 volt converter plants
- +130 volt converter plants
- -130 volt converter plants
- Other miscellaneous converter equipment

- Ringing plants
- DC to AC inverter plants
- Uninterruptible Power Supply (UPS) systems
- Standby engines
- Commercial AC

The following points for monitor shall be wired to the PSMC. Monitor and control apparatus for standby engines shall be furnished as part of the transfer switch. The requisition should list the exact equipment to be monitored and what is to be monitored on each unit of equipment. Optional points should be monitored when the PSMC has the capacity or when directed by the Qwest Engineer.

7.2.1 Primary Power Plant

- Analog Points
  - Plant voltage
  - Plant current
  - Distribution current
  - Collocation circuits greater than (but not equal to) 60 Amperes, List 2 drain
  - BDFB feeders
  - PDF feeders greater than 100 Amperes, when spare points are available
- Binary Points
  - Discharge fuse alarm
  - Plant major alarm (this is generally only an output from the PSMC to an alternate alarm system, and not an input into the PSMC)
  - Plant minor alarm (this is generally only an output from the PSMC to an alternate alarm system, and not an input into the PSMC)

7.2.2 Chargers

- Analog Points
  - Charger current, when spare monitor points are available
- Binary Points
  - Charger fail (RFA) if controller or monitor have the ability to escalate from minor (single rectifier) to major (multiple rectifiers) that should be done.
  - Low Voltage Disconnect (LVD), if installed

7.2.3 Batteries

- Analog Points

- String current – A shunt will be placed in each battery string to monitor charge and discharge current (this may be pulled off the shunt on the battery disconnect breaker).
- Room temperature – One temperature sensor will be placed to monitor room temperature at five feet above the floor in the area of the batteries.
- Single cell voltage – The voltage of one cell will be monitored per plant.
- Cell temperature – Flooded batteries require one temperature sensor to be placed, to monitor the temperature of one cell per plant. VRLA batteries require one temperature sensor to be placed in each string, to monitor the temperature of one cell in each string.
- Mid-point voltage – (VRLA) Measure the voltage at the mid point of each battery string.

➢ Binary Points

- Battery String Disconnect – Required for all VRLA battery installations in controlled environments. Flooded batteries only if a battery disconnect is required by local Fire Marshall.

7.2.4 Converter Plants

➢ Analog Points

- Voltage
- Current (if shunts are already installed)

➢ Binary Points

- Distribution Fuse fails
- Converter Plant Major (if available)
- Converter Plant Minor (if available)

7.2.5 Converters

➢ Binary Points

- Converter Fail Alarm (CFA) — only if Plant Major/Minor are not available

7.2.6 Inverter

➢ Analog Points (Optional)

- AC voltage (per phase, line to neutral)
- Current (per phase)

➢ Binary Points

- Major alarm
- Minor alarm
- Mode indicator (indicates when inverter not functioning in normal mode)

7.2.7 Ringing Plants - Toll Ringing Plants for Non-Switched Circuits

- Binary Points
  - Minor
  - Major
  - Distribution Fuse Fail (if available)

7.2.8 Uninterruptible Power Supplies (UPS)

- Binary Points
  - Major alarm
  - Minor alarm
  - Mode indicator (indicates when UPS not functioning in normal mode or has failed)

7.2.9 Standby Engines/Transfer Switch Systems

(These points should be installed on a going forward basis. Older engines and control equipment may not be capable of all of these points.)

- Analog Points
  - Start battery voltage (Optional only if Start Battery Charger Fail installed)
  - Engine temperature (Optional) (if electrically available from the engine)
  - Engine oil pressure (Optional) (if electrically available from the engine)
  - Engine room temperature (Optional) (measured inside the room, not on the outside wall)
- Binary Points
  - Engine run – from run relay
  - Engine switch off normal – from contacts on control switch
  - Engine breaker open – from auxiliary contacts on breaker
  - Engine emergency stop – contacts on emergency stop push button
  - Fuel heater fail – from fuel heater control cabinet (when there is a fuel heater)
  - Engine low start battery – from battery charger
  - Tank rupture (not needed if fuel tank monitors generic alarm wired – see below)
  - ATS switch off normal – from contacts on ATS control switch
  - Engine Fail/Major (generic – use if there are not individual alarms as described **above and** below)
    1. Low oil pressure (Optional)
    2. Overcrank (Optional)

3. Overspeed (Optional)
4. High water temperature (Optional)

- **Engine** Minor (generic – use if there are not individual alarms as described above and below)
  1. Load transfers (Optional)
  2. Transfer Switch Off Normal (Optional)
  3. Start Battery Charger fail (Optional if Start Battery Voltage installed)
  4. Charger fails (Optional) (start batteries)
  5. Block heater alarm or low water temperature
- Tank Monitor
  1. Low fuel (this may be combined into the Fuel System Trouble)
  2. Tank rupture (this may be combined into the Fuel System Trouble)
  3. Fuel System Trouble

7.2.10 AC Power

➢ Analog Points

- AC voltage per phase – measured phase-neutral, and monitored on the load side of the transfer switch
- AC current per phase – monitored on load side of transfer switch

➢ Binary Points

- AC fail (although there should be one alarm, individual sensors per phase are desired, if possible). This should be monitored on the line side of the transfer switch (at the main disconnect if possible)
- Engine supplying load – from ATS contacts (optional)

For PSMCs that are an integral part of the power plant controller, the following control functions will be available:

- Chargers
  1. Re-start (RS)
  2. Shutdown (TR)
  3. Sequencing

7.3 Alarms

The PSMC will provide alarm surveillance and monitoring for specific power conditions.

If the PSMC fails, local visual and audible alarms will not be disabled when control is passed to the traditional power plant controller.

The PSMC will analyze incoming alarm information from the power plant components and provide settable downstream alarm levels as required (see Chapter 12).

The PSMC will report major, minor, and monitor fail (watchdog) alarms to another alarming system, as a backup to the X.25/TL1 communications

7.4 Statistical Channels

The PSMC will be capable of storing statistical data for engineering power plants. There will be a minimum of ten statistical channels supplied with the PSMC. Any analog channel can be assigned for statistical data. In assigning statistical channels, the user should realize that each statistical channel requires additional real time to process and transfer data.

Each statistical channel will be capable of storing peak high, hourly average high, daily low and hourly average low for each day while the channel is active. This data will be retained daily for a minimum of 30 days.

7.5 Energy Management/Sequencing

The PSMC will not be wired for power plant or engine control, unless the PSMC is an integral part of the power plant controller. This includes energy management and charger sequencing.

The power plant controller shall provide energy management as follows:

- The power plant controller will activate sufficient charger capacity per controlled plant to support the presented load.
- When energy management is active, the power plant controller will ensure that each charger or converter in each controlled plant is active for a minimum of 4 hours during each 30-day period.
- Sequencing priority will be individually selectable by charger.

The power plant controller will be capable of providing charger restart sequencing to every associated power plant upon restoral of AC power. The sequencing will be separately controllable for transitions to commercial AC versus the standby engine. If the transition scheme will not allow two configurations, then the transition scheme must be based on the capability of the standby engine.

7.6 PSMC for Confined Locations Requirements

A PSMC for Confined Locations (PSMC-CL) will perform monitoring for small locations in Qwest. A PSMC-CL shall be required in all sites using VRLA batteries.

The PSMC-CL shall be equipped for remote access dial up capabilities, and must be menu driven. Baud rate is to be determined by the originating modem. The PSMC-CL's modem shall automatically adjust baud rate to match the baud rate of the originating modem with no parity, 8 bits, and 1 stop bit (N81).

The PSMC-CL shall be password protected. Multiple access levels with “superuser” capabilities must be provided in order to make database changes.

The PSMC-CL must be able to monitor a maximum of 6 battery strings plus the required monitor points as specified below:

7.6.1 Primary Power Plant

- Analog Points
  - Plant voltage
  - Plant current
- Binary Points
  - Low voltage
  - High voltage
  - Power distribution fuse fail

7.6.2 Chargers

- Binary Points
  - Charger Fail

7.6.3 Batteries

- Analog Points
  - Voltage – every 12 volts on each battery string (minimum 2 points per string)
  - Cell temperature – One temperature sensor will be placed to monitor the temperature of a "reference" battery in each battery string.
  - Room temperature – Only one temperature sensor will be placed to monitor room (or cabinet) temperature. Sensor must not be mounted on an exterior wall, and should not be placed next to a heat or cooling source.
  - String current – A shunt will be placed in each battery string to monitor charge and discharge current (this may be pulled off the shunt on the battery disconnect breaker).
- Binary Points
  - Temperature differential/thermal runaway – the difference between ambient and cell temperature, set to alarm at a certain threshold (per Chapter 12).

The PSMC-CL shall report Power Major, Minor, and Critical alarms via form C contacts or solid state devices to the alarm telemetry of the site.

7.7 Alarms with NO PSMC

When there is no PSMC for the site the following binary alarms should be connect to the alarm device on site.

- Power alarms
- Major
  - Minor
  - Low Voltage

- AC system alarms
  - Commercial power fail – before ATS (at main disconnect if possible)
  - Engine supplying load – from ATS contacts
  - ATS switch off normal – from contacts on ATS control switch
- Engine alarms
  - Engine run – from run relay
  - Engine fail – from common engine alarm point
  - Engine emergency stop – contacts on emergency stop push button
  - Low fuel – from fuel monitor
  - Fuel leak / Fuel system trouble – from fuel monitor if available
  - Fuel heater fail – from fuel heater control cabinet (when there is a fuel heater)
  - Engine low start battery – from battery charger
  - Engine start battery charger fail- from battery charger

CHAPTER 8 DC POWER DISTRIBUTION

Chapter and Section **Page**

Figures **Page**

8. DC Power Distribution

8.1 General

This unit describes the engineering requirements for DC distribution. Qwest is responsible for the floor plan(s) layout of a site. Layouts of equipment shall be per Qwest Pub 77351, Qwest Standard Configuration Documents, GR-63-CORE, and GR-1089-CORE, as required.

8.2 Telecommunications Equipment Loads

The power load that the DC distribution system feeds is determined by the type, quantity, and mix of telecommunications equipment in an office. Once the load has been determined, it must be matched to a distribution system and to a power source with adequate capacity to power the loads after overcoming distribution losses. The power cable shall be sized according to the voltage drop guidelines of this section. Ampacity of the cable shall exceed the load and protector size. The protection devices (fuses or breakers) shall exceed the load, according to the NEC.

The nominal voltage levels for standard telecommunications equipment are 24 V, 48 V, and 130 V. Although nominal voltages are standardized, the limits permitted on individual equipment assemblies are more variable. Therefore, to define voltage requirements, determine the following values:

- HIGH VOLTAGE LIMITS — Above this supply voltage, equipment damage may occur.
- LOW VOLTAGE LIMITS — Below this supply voltage, equipment does not operate properly.

ELECTRONIC NOISE IMMUNITY — The supply power shall not exceed Central Office Equipment (COE) manufacturer's requirements, and in no case exceed 35-Decibel Reference Noise C-Message (dBrnC).

The formula for calculating copper feeders: $CM = \frac{K * Amperes * Feet}{VoltageDrop}$

- CM = Circular Mils
- Amperes = List 2 drain
- K= 11.1
- Feet = Loop distance from top to top, does not include drop into or out of equipment.
- Voltage drop = Distribution voltage drop per Figures 8-1, 8-2, 8-3, and 8-4.

The requirements for distribution voltage drop, and which drains to use for sizing are specified in the following paragraphs, and illustrated in Figures 8-1, 8-2, 8-3, and 8-4.

- The 0.10 one-way voltage drop (see requirements stated herein for guidelines on what cables constitute a "loop") from the "chandelier" negative bus to the primary power distribution board, shall be calculated to the bus bar ampacity of the distribution bay. The 0.10 one-way voltage drop from the chandelier positive bus to the plant return bar(s) is calculated at the Ampacity rating of the shunt. Add the shunt voltage drop to which ever side is equipped with the shunt. The maximum voltage drop of the shunt is typically 0.05 V (50 mV), leading to the 0.25 V shown in Figure 8-3 between BDB and the chandelier.

- All DC protected Power wire or Cable originating from a protection device (fuse or circuit breaker) on the Power Plant should be RHW (preferred) or XHHW type.
- Battery cable, from the overhead bus bar above the battery strings to the main bus bar chandelier shall be sized to either the 4 or the 8 hour discharge rate (see Chapter 2 for rules on whether the 4 or 8 hour rate is to be used). This is depending on the site's reserve time of the batteries at 1.86 volts per cell, using a 0.20 voltage loop drop. Where 2 strings on a stand (or the potential for two strings exists on a stand) exist that use common termination bars for both strings, the 4 or 8 hour rate of the batteries times 2 is used for the voltage drop sizing.
- For new bus bar plants that do not have a "chandelier" (all battery strings are cabled directly to the main busses above the BDBs), their cables are also sized at the 4 or 8 hour rates using a 0.20 V loop drop.
- The switch manufacturer's recommended total List 2 drain for the PDF, and the 1.0 V loop voltage drop shown in Figure 8-1 shall determine the cable size from the power board to the PDF. The manufacturers' recommended drain shall also determine the fuse or circuit breaker size for the power board. It is switch engineering/installation’s responsibility to run and size the battery fed and return cables from the main power board.
- The voltage drop, cable sizing, and drain from the switch secondary distribution (PDF) to the switch bay shall be determined by the switch manufacturer (see Figure 8-1).
- Any feeder from a power board to a BDFB should generally be protected based on a load of 225-400 Amperes for quadruple (4) loads, or 400-600 Amperes for dual (2) loads. Exceptions can be made based on the size of the panels and the loads at the BDFB. The cable sizing for this loop should be computed based on half the protector size used as the drain. However, cable ampacity shall always exceed the protector size. BDFB loads are limited to one half of the protector size on any one side of the feed (A or B, C or D, etc.) so that one side can carry the whole load if the other side fails and there is true redundancy in the equipment. For example, if we were feeding A and B panels on a BDFB with a protector size of 500 Amperes, the voltage drop calculation would be done at 250 Amperes (since any one side should normally not carry more than that). Cable ampacity would still need to exceed 500 Amperes.
- Each distribution fuse panel in a BDFB shall be individually fed at the maximum size permitted by the manufacturer. All feeds in a BDFB shall originate in the same power plant. The conductor(s) shall be, at a minimum, sized for the protection device and be increased in size as required to allow the total voltage drop to not exceed .5 volts one way, 1 volt loop. The return bar is a conductor and shall be sized by using the total of all the feed protection devices possible whether equipped or not.
- The maximum allowable loop voltage drop from the BDFB to any facilities (non-switch) equipment shall be a 0.25 volts, based on the List 2 drain. Any time a miscellaneous fuse panel is used to supply facilities’ equipment in a single framework; each redundant load will be fed with a minimum drain of 20 Amperes per load. The cable sizing from the secondary distribution (BDFB) to this fuse panel can be calculated with this 20 Ampere drain, and the 0.25 V loop drop shown in Figure 8-2.

♦ Note that many miscellaneous fuse panels are fed using drains much higher than 20 Amperes. Follow manufacturer's recommendations for protector sizing for the bay receiving the miscellaneous fuse panel, or lacking that information, add up the expected List 2 drains of the equipment expected to be fed from that panel. Calculate the voltage drop cable sizing for the miscellaneous fuse panel based on the given List 2 drain for the bay, or 80% (the inverse of the 125% protector sizing rule) of the fuse size.

- ♦ Note also that most loads fed from a miscellaneous fuse panels go to equipment that can switch from “A” to “B” supplies if one supply fails. This will double the load on the remaining fuse panel supply fuse. Therefore, the feeds to the panel must each be sized (ampacity) to handle both loads. The voltage drop calculation need only be sized for one load.
- ➢ Equipment fed directly from the power distribution board/bay (usually Outside Plant equipment) should have the cable sized based on the List 2 equipment drain provided by the manufacturer, and with a loop voltage drop of 1.0 V.

Every equipment bay and/or shelf which includes any DS1/T1 (or higher data rate) circuits must be fed independently from both the "A" and "B" power source (primary and/or secondary distribution). Equipment bays and/or shelves, which include only less than 1400 DS0 and/or POTS circuits are not required to have A and B feeds.

Mounting of more than one wire/cable, terminal end on a single lug (this practice is commonly referred to as “double-lugging”) is prohibited. A splice or tap should be used instead.

Input power connections to the using equipment should be of a crimped lug type. If plastic connectors are used they shall not protrude from the front or rear of the equipment where they may be inadvertently knocked off or loosen.

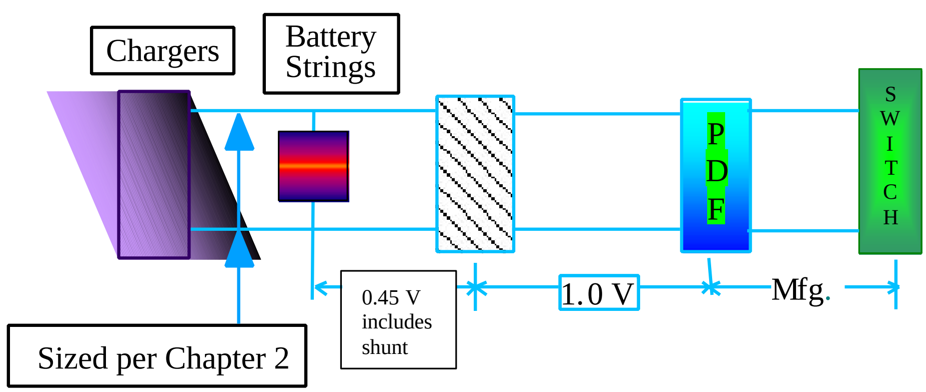


Figure 8-1 Switch Distribution Voltage Drops Loops

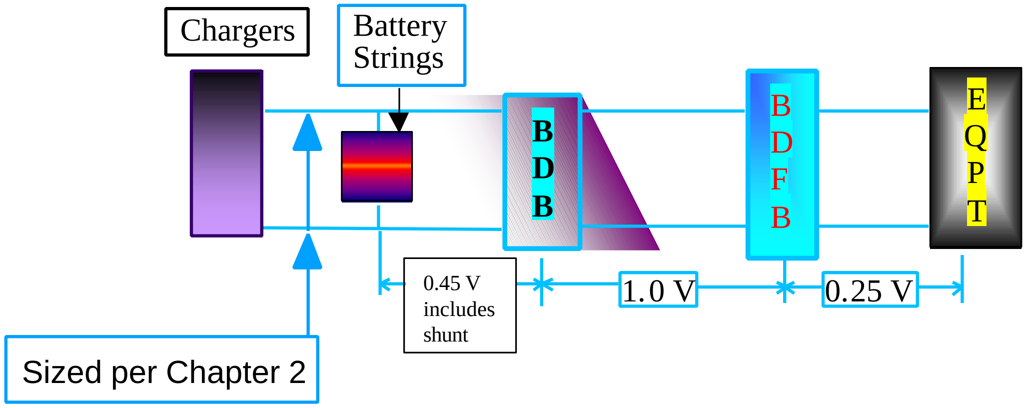


Figure 8-2 Equipment Distribution Voltage Drops Loop

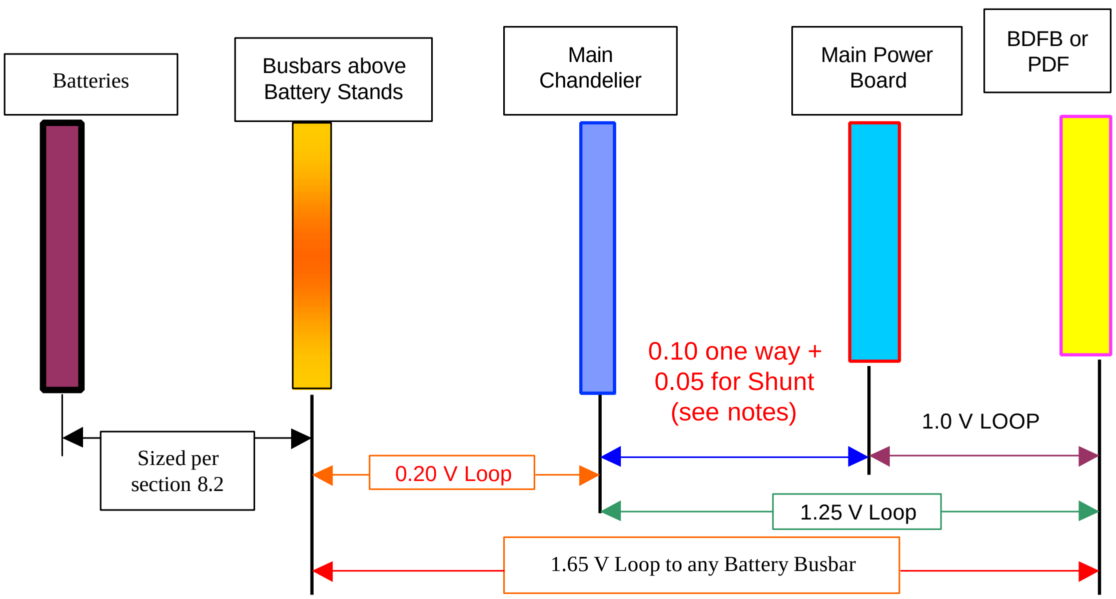


Figure 8-3 Voltage Drops from Battery Strings to BDBs

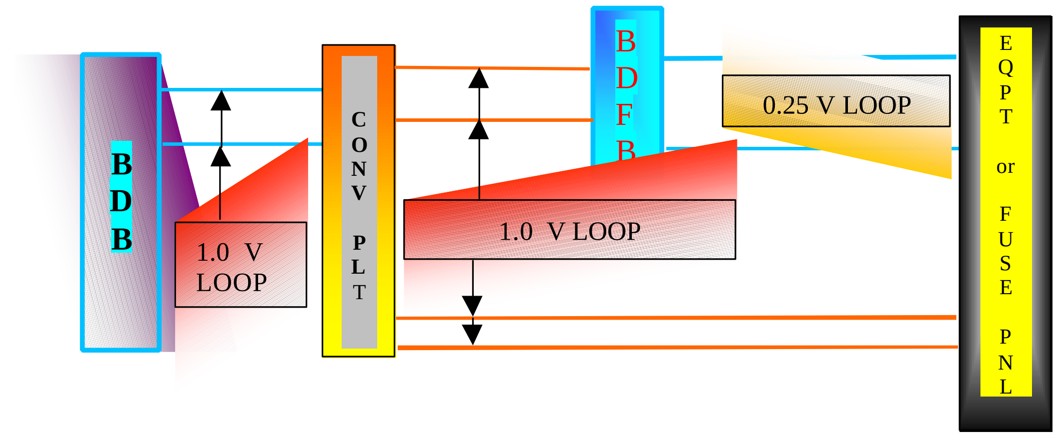


Figure 8-4 Equipment Distribution Voltage Drops for Converter Plants

All new battery cables (both feed and return) from the battery bus bar to the main battery bus bar chandelier will be sized per figure 8-3 and Chapter 2.5, use the potential disconnect as the ampere rating for the cable. Battery cables for the batteries sizes stated from the battery to the bus bar over the battery stands must be sized as follows:

- Batteries less than 840 Amphours: Ampacity to exceed disconnect device sizing (even if it does not have a disconnect) as stated in Section 2.5.
- Batteries 840 Amphours to 1700 Amphours four 4/0 AWG,
- Batteries over 1701 Amphours: four 350 kcmil.

8.3 Power Plant Distribution Characteristics

Protectors (fuses or circuit breakers) being fed from a converter plant or a ringing plant shall NOT exceed or equal the capacity of the plant. An example would be that a 2-Ampere ringing generator shall not have a fuse larger than 1.33 Amperes to the using equipment.

Distribution fuses and circuit breakers shall not be multipled (e.g., daisy-chained) between equipment bays. Exception is for ringing distributing as defined in Chapter 9.

DC circuit breakers in use shall be capable of being alarmed either in the tripped or off position. Installed DC circuit breakers, which are not being used, are not required to be alarmed. However, if they are alarmed, they shall be alarmed in the "on" position.

To design a distribution system, the following characteristics of a power plant must be determined:

- Plant voltage limits
- Protection requirements
- Capacity and size of charging equipment
- Ultimate current drain required of plant (using average busy hour current requirements)
- Physical relationship of the plant components based on floor space configuration
- Grounding requirements

DC/DC converters that are placed for equipment isolation should be physically located in close proximity to the served equipment.

8.4 Cabling and Bus bar

Cables or bus bar carry the current from the chargers to the batteries, from the batteries to the discharge panel, from the discharge panel to any converter plant or other distribution, and/or to the loads, and then back to the batteries and chargers in the grounded return lead(s). Bus bars are generally used within the larger battery plants, while cables supply the rest of the current path.

Whether cables or bus bars are used, each type of conductor must be capable of carrying current to or back from its loads without overheating or exceeding the voltage drop requirement.

Stranded copper wire shall be used in 600-volt AC-DC circuits that is insulated with any one of the following insulating compounds: flame-retardant synthetic or mixed rubber, e.g., styrene butadiene rubber (SBR), ethylene propylene rubber (EPR/EPDM); chlorosulfonated polyethylene (CP), thermoplastic elastomer (TPE), polyvinyl chloride (PVC), non-halogenated materials (e.g., poly [ethylene-co-vinyl acetate] thermosets), or EPDM-CP composite structures. The chief compositional distinctions between insulation materials that lead to functional consequences for power cable products are whether these insulations contain either lead or sulfur. Concerns about lead compounds arise from environmental regulations, pollution impacts, and high costs of landfill disposal. Elimination of lead coatings and lead-based stabilizers could result in copper corrosion, reduced electrical performance in humid and moist environments, and/or thermal degradation of insulation materials. Sulfur compounds are often used to promote or form crosslinks within rubber thermoset materials. These crosslinked materials are resistant to chemical and mechanical degradation as well as dimensional distortion at high temperatures. However, the sulfur can react with the copper and accelerate corrosion. Given these considerations, two distinctions are made between power cable products:

Sulfur-containing insulations and all other insulations

Cables with a braided covering and those without braids.

Power wire will be used to distribute DC and AC power from the AC service to AC and DC power plants to their load centers. The load centers supply telecommunications circuits. The maximum operating voltage will not exceed 600 volts rms. Depending on the specific application, one wire or several wires in parallel may be used and for DC application, they will be placed on cable rack. The wire types that are approved for use within Qwest are THWN, THW, or THHN for AC, XHHW, RHW-LS, and RHW-LS Flex for DC.

Single conductor, whether solid or stranded is called wire; cable is an assembly of two or more conductors in a common insulating sheath. The following are the gauges most commonly used within Qwest: 14 AWG, 12 AWG, 10 AWG, 8 AWG, 6 AWG, 4 AWG, 2 AWG, 0 AWG, 00 AWG, 0000 AWG, 350 kcmil, 500 kcmil, and 750 kcmil.

- Wire type – i.e., heat- and moisture-resistant flame-retardant (RHW), or heat-resistant flame-retardant (RHH)
- Insulation – i.e., SBR, EPR/EPDM, EPDM/CP, PVC, CP, TPE, or non-halogenated limited-smoke polyolefin
- Standard (Class B) or flexible wire (Class I)

- Conductor size.

For halogen type single cotton braid covered wire for all sizes of RHH or RHW type, the conductor must be copper and tinned.

Non halogenated thremo crosslinked wire (all XHHW and some types of RHW) does not require a cotton braid or to be fiber wrapped at lacing points. Nor does it require tinning outside the power room (there are no halogenic or sulfuric compounds to attack the copper). The exception is for class I type wire, which must be tinned.

To distinguish RHW that must have a cotton braid or fiber wrapping at impingement points from RHW that does not need it, the non-halogenated thremo crosslinked RHW shall be marked from the manufacturer. The gray wire with a blue tracer, the black wire shall be marked with a red tracer, and the green wire shall be marked with a yellow tracer.

Cables and bus bar must be copper. For flexible wire (class I) the conductors must be copper and tinned. Cables must meet the requirements of Telcordia GR-347-CORE, “Generic Requirements for Central Office Power Wire”. Ampacity for the wire shall be per Qwest Publication 77350 and NEC Table 310-16. Cable shall be rated at 75ºC for wire sizes of No. 1/0 AWG or larger, and at 60ºC for wire sizes No. 2 AWG and smaller.

The minimum distance between the bus bars and any other object shall be in accordance with Qwest Pub 77350. This includes negative, return, and grounding bus bars.

Cables from the chargers to the batteries, between battery stands, and from the batteries to the discharge panel will be on a separate cable rack from all other cables. These cables are generally referred to as non-fused cables. All DC cables from the battery stands, chargers and between the charge and discharge busses shall be considered as unfused and supported accordingly.

Cable rack "power cable brackets" mounted to the cable rack at eighteen inch intervals may be used for all fused power cables when small quantities of cables are required. Adhere to the stacking height limitations for brackets listed in Tech Pub 77350.

The use of segregated cable racks for power and switchboard cable is the first choice of installation in central offices. As an alternative, where segregation is not possible the following may apply with the approval of the Qwest Design Engineer. Cable with loads of 56 Amperes or less (70-Ampere protection device or less) can be run on the same cable rack as switchboard cables if they are sized at 4/0 AWG or smaller. All power cables larger than 4/0 regardless of protector size shall be run on dedicated fused power cable only cable racks (Reference 77350). The placement of any type of cable used for anything other than power on fused power cable only racks is strictly prohibited. The issuance of Letters of Deviation waving any of these requirements shall be considered invalid.

Dedicated fused power cable only cable racks shall not be equipped with screens, pans, or cable horns. T-intersections and/or 90 degree turns in the racks require corner brackets in order to maintain the minimum bending radius of larger size cables. All cabling on these racks shall be secured per 77350.

Power cables (Battery and Battery Return) on unsecured cable racks shall be closely coupled and paired securely together at 24 inch intervals.

Primary DC power distribution is defined as leads from the power plant to the BDFB (feeder conductors). Secondary DC power distribution is defined as power from the BDFB to the equipment (load conductors).

The cable between the Power Plant, Batteries, and Chargers shall be of the flexible RHW-FLEX type. Drops into equipment bays 4/0 or larger should be of the flexible RHW-FLEX type. For entry into equipment bays the cable should be 15 feet maximum whenever possible.

All wire shall be UL listed with copper conductors, an oxygen index (LOI) of 28% minimum, and a UL 94-V0 rating. (Wire used internal to the Power Plant, and the Power Plant manufacturers' recommendation for wires connected to the protection devices shall be excepted from the above rule.)

It is also a requirement in Qwest, that all cable rack located in the Power room or area be according to Qwest PUB 77351.

Armored power cable shall be no longer than three feet in length, except for vertical runs in manufacturer's equipment, and shall never be run on a cable rack with switchboard or other power cable. Insulation coated (liquid tight) armored power cable can be longer than three feet and shall be suspended beneath the power cable rack or run on a separate cable rack for power equipment applications only. When insulation coated armored power cable is suspended, it must be supported every two feet. Armored cable outside the power equipment application must be placed in accordance with Qwest Technical Publication 77351.

Cable temperature shall not exceed 115 degrees Fahrenheit (115 degrees F) in any horizontal cable rack. In addition, there shall be no instance where an equipment surface temperature exceeds 115 degrees F without a highly visible warning label. Cable temperature in the vertical riser within the bay to the overhead rack may exceed 115 degrees F. However, if the cable temperature in any vertical riser within a bay exceeds 125 degrees F, there will be a highly visible warning label.

If the battery return bus(s) is used as the ground window, the bar(s) and the interconnecting copper bus(s) must be sized to meet the ultimate ampacity of the Power Plant. See Qwest Technical Publication 77355 for separation and sequencing of connections.

The battery feed and returns bus bar above equipment racks (PDF) shall not be stacked. The bus bar shall be isolated on the cable rack and spaced a minimum of 1'6" from each other, per figure 8-5. Exceptions are allowed for the battery return bus bar for a BDFB, for the main charge/discharge bus, battery return bus bar, battery stands (see chapter 2), and the ground window.

Battery and battery return bus bar must be labeled as the power plant potential (-48V, +130V, -130V, +24V, -24V, etc.) and battery return. Labeling shall be per the requirements of Qwest Publication 77350. The battery return must not be labeled as a grounding bar, except when it is the MGB in the ground window (per Qwest Publication 77355).

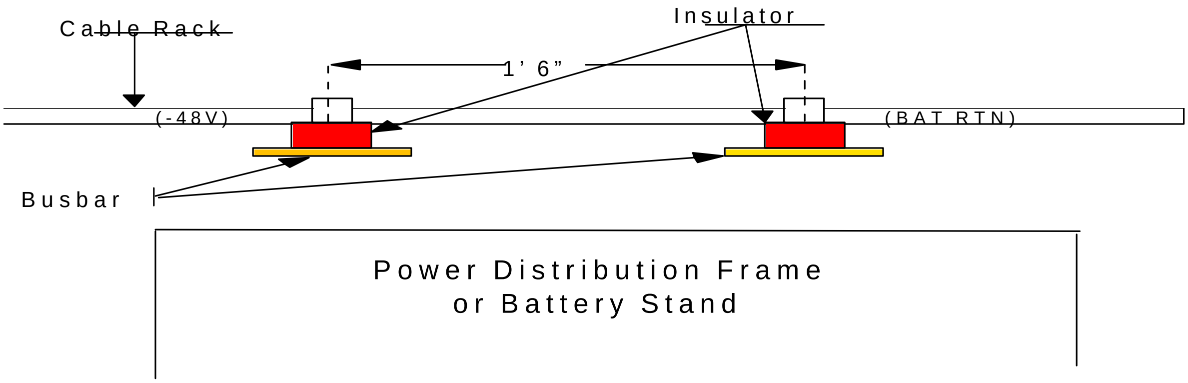


Figure 8-5 Typical Mounting of Bus Bar above PDFs and Battery Stands

8.5 Protectors and Cable Sizing

Since smaller capacity protectors will operate more quickly in the case of resistive faults, they should be sized as close to the peak currents as practicable. Protector selection also establishes the minimum allowable cable size. Cable sizes may be increased above the minimum to meet voltage drop requirements.

The discharge and distribution protectors must be engineered for each application and must have a current rating that will protect their cables. For example, a standard 0-gauge cable, which can carry 150 Amperes, should always be protected by a fuse or a circuit breaker no larger than 150 Amps.

The protector size should not be subsequently oversized if larger conductors are furnished to meet the voltage drop requirements. Protectors should not be so close in size that nuisance protector operation or over heating of the protector occurs.

Breakers and fuses shall be sized at 125% of the List 2 drain. These sizing rules apply unless the equipment manufacturer specifications are more stringent. These rules do not apply to fuses or breakers, which feed BDFBs from the primary BDB (main Power Board). For rules on sizing of fuses and breakers that feed BDFBs, see Section 8.2.

Cable sizing for the battery charge cables (from battery bus bars to main chandelier) should be the ampacity of the batteries at the four or eight hour rate at 1.86 volts per cell. If the battery stand is a two string stand using only one battery string, it is recommended that cabling be sized as if there are two strings on the battery stand.

It is also recommended that the BDB main feeder cable for the BDFB be sized to the full ampacity of the largest possible feeder fuse or breaker for that BDFB, (i.e. 600 Amperes).

Cables are sized in the following way. First, determine the appropriate cable path for power cables through the office following existing or new cable rack routes to determine the cable length. This length is determined by TOP TO TOP measurement. Top to Top is from the top of the power bay to the top of the use equipment bay. Then, cable sizes should be selected to meet the requirements discussed herein. To do this, size each cable for the ultimate simultaneous average busy season busy hour drains it will carry. If the drains are variable, a peaking factor of 1/3 must be added. Fuses should be selected for the application used not the maximum drains the cable can carry. Care should be taken with feeds and protection to devices that have A & B inputs and are switching capable, as in the case of certain fuse distribution panels (FDP's). In these cases, both A & B feeds need to be sized to handle both loads on either feed.

All class fuses and circuit breakers must be UL listed and rated for the available fault current.

All protection devices (fuses and circuit breakers) must be AC rated for AC circuits and DC rated for DC circuits. The fuses must be color coded to prevent mixing. AC rated fuses include but are not limited to FRN-R and NON types. DC rated fuses include but are not limited to TPA, TPN, TPL, TPJ, TPS, and 70 types. GMT Type fuses have a limited rating for both AC (300 volts) and DC (60 volts). TPN type fuses (or another DC-rated fuse that fits the fuse holder) must be used on a going forward basis (new fuses) in existing DC applications that used the FRN and NON (RK1 & RK5 rated) types.

Renewable link and H type fuses are not acceptable for use on a going forward basis. All DC circuits are required to have indicating or alarm type fuses (70, GMT, etc.).

Each fuse shall be provided with a blown fuse indicator connected to an alarm-indicating lamp.

Circuit breakers shall be of the thermal-magnetic or magnetic type and shall be UL listed. They shall be trip-free types. Contacts shall not be able to be held closed during an over current condition, by holding the lever in the closed position.

Circuit breaker must be DC rated for DC circuits and AC rated for AC circuits. They cannot be intermixed and must be clearly marked as either an AC or DC breaker.

Switches shall meet all the requirements of the applicable UL and ANSI Standards. Ferrous materials shall not be used for current carrying parts.

8.6 Fuse Sources

The following requirements will be used in engineering various fuse sources. Distribution from the primary fuse sources includes, but is not limited to the following:

- Located at the power plant:
  1. Battery Distribution Board (BDB)
  2. Power Distribution Fuse Boards (PDFB)
- Secondary Sources:
  1. Battery Distribution Circuit Breaker Boards (BDCBB)
  2. Battery Distribution Fuse Board (BDFB)
  3. Power Distribution Frames (PDF)
  4. Coded frame fuse panels associated with specific equipment where the feeder fuse is 100 Amperes or more
  5. Fuse Bay (FB)
  6. Coded frame fuse panels associated with specific equipment where the feeder fuse is less than 100 Amps

Distribution leads are always taken from the top of the bay. Incoming power leads enter from the top of the bay. The exceptions to this are when the secondary fuse source is mounted on a raised floor, or when Qwest Real Estate approves the drilling of the floor, in writing. Qwest Real Estate is solely responsible for coredrilling floors in a Central Office environment. No installation supplier or contractor (unless hired by Qwest Real Estate) is authorized to perform the core drilling function. Only on raised floors may distribution leads be taken from the bottom of the bay.

Tag both ends of every power, power return, and ground lead as instructed in Qwest Technical Publication 77350, "Central Office Telecommunications Equipment Installation and Removal Guidelines".

A separate battery return lead will be paired and sewn together or otherwise closely coupled with each distribution or source leads whenever possible.

- This "pairing" requirement does not apply to cabling between the power plant and batteries and/or primary distribution board, or the cable within a few feet of the return bus of a secondary distribution center — e.g. BDFB.
- It also is not required for Outside Plant applications — cabinets and Customer Premise — where the DC plant size does not exceed 100 Amperes.)
- In cases of a remote ground window where the served equipment is not on the same floor as the remote ground window the battery feed leads do not have to be paired with the battery return leads all the way to the ground window. For the portion of the run where the battery feed and the battery return leads are not paired, the battery return lead shall be paired back on itself, (this includes going though the same cable hole). The total impedance of the battery feed and the total impedance of the battery return must be equal (i.e., the voltage drop must be divided equally between the battery feed and the battery return — 0.5 V one-way drop for both the feed and return). Refer to Qwest Pub 77355 for ground window guidelines as required.
- Between the bays and/or battery stands, internal to the power plant, paired battery and return are preferred. However, unpaired leads are allowed internal to the power plant under the following conditions:
  - They are run as closely as possible,
  - No other cables are placed between them; and
  - No non-referenced (grounded) equipment is within ten (10) feet.

The battery return lead will be separate and isolated from the building ground. Specifically, frame ground return for equipment power will not be allowed. If a supplier chooses to combine the battery return with the building ground, the equipment must be:

- Electrically isolated from the floor and ceiling.
- A minimum of six feet from any other equipment.

Fuse panel vertical bus bar shall be used to interconnect the individual panels. All of the fuses connected to one supply lead must be in one group on each bay, but there may be several groups on one bay which are connected to different supply leads (A and/or B supply). Under no conditions will the "A and B" sources be tied together. Interbay bus bars are available if the fuses in one group require more than one bay.

Fuse reducers will not be used in "dead front" DC fuse panels or any AC panel. A "dead front" panel is defined as a fuse block with a cover on it. Fuse reducers shall only be used on "open face" fuse panels. "Open face" is defined as fuse panels in which the fuses are on the front and external to the panel face. Double fuse reducing (using more than one pair of reducers) is not permitted.

The largest fuse to be mounted on a BDFB shall be 100 Amperes. Some BDFBs do not allow fuses that large. Do not exceed the largest fuse size possible for that specific BDFB. Feeds to collocators may be exempt from this rule. In those cases, the largest fuse that can be used is per the BDFB manufacturer's requirements.

The largest cable size to be run within the BDFB shall be a No. 2 AWG (BDFB feeder wires are exempted). Feeds to collocators may be exempt from this rule, but must still follow the BDFB manufacturer's requirements with respect to wire size.

Blank panels on the BDFB shall be used in the following locations:

- Top panel
- Bottom panel
- Between panels, that provides a potential difference of more than 140 V
- Unequipped positions

Fuses shall be assigned starting on the bottom panel of each group and from left to right when facing the front of the assembly. Fuse panels should be equipped from the bottom up in top fed BDFBs.

A BDFB located on one floor shall not be used to supply equipment located on another floor. An exception may be made in those cases where requirements state that certain circuits must be supplied from the same BDFB and the circuits are located on different floors. Feeds from BDFBs to Collocators — Virtual or Physical CLECs — can also be exempt from this rule.

The BDFB has a maximum discharge capacity of 1200 Amperes divided equally between four input battery buses. The four buses are fused up to a maximum of 500 Amperes at the battery plant. A fuse panel shall not be subdivided to connect it to more than one bus section. The maximum size battery lead that can be connected to its associated bus bar is 500 kcmil.

For all new BDFB additions, a configuration of battery return bus bar are to be mounted in the immediate area above the BDFB framework. This bus bar will provide termination for calculated battery return feeders from the power plant. The battery return will be sized with up to 750 kcmil cable using the same engineering criteria as the power feeders for the BDFB. An equalize ground of 750 kcmil shall be run from this battery return bus to the CO Ground Bar, or the horizontal equalizer located on the same floor as the BDFB battery return bus, (per 77355).

The maximum continuous drain on each feeder to a BDFB shall not exceed one half of the protector (fuse or breaker) size for that BDFB. There are no exceptions to this rule. For example: for a BDFB protected at four hundred (400) Amperes (load A or B) the maximum continuous drain for each load (A or B) shall not exceed two hundred Amperes.

The BDFB each distribution fuse panel on the BDFB shall be labeled with the voltage, and polarity of that panel. Each fuse position 01 through XX on each of the panels shall be labeled both front and back to indicate its' location. Each fuse panel shall be labeled to indicate the panel's position within the BDFB, 1, 2, 3, or A, B, C, etc. Typical arrangements are shown in figures 8-6, 8-7, 8-8.8-7, 8-8, and 8-9.

All fuse positions must be installed and assigned from the bottom up to avoid cable congestion and for the safety of the installer adding future fuses.

Any additional fuse panels added to the BDFB after the initial order the panel position, voltage, and polarity shall be labeled by the installer.

The standard Qwest engineering will normally be requesting for the engineering, furnishing, and installation of 600A BDFBs. There will be some situations where a 600A BDFB will not be used, those will be the exceptions.

The installer shall stamp the load designations on the fuse labels and the meter load designation label. Reference loads with alphabetic characters (A, B, C, D, etc.). Panels linked together with a bus bar will have the have the same load designation.

The battery feed and battery return cables shall be labeled on both ends using a designation tag to indicate the other end of the cable, per Qwest publication 77350.

The following sign is to be placed on the BDFB. The sign should be visible and clear. Make sure the sign is laminated. A sign should be placed on the front of the BDFB. Two or more signs should be placed on each of the Plexiglas sections on the back of the BDFB. If you are powering from a BDFB that does not have the sign described above, make sure that the installer adds one. The size of the sign should be 3 inches by 4 inches.

All fuse positions must be installed from the bottom up to avoid cable congestion and for the safety of the installer adding future fuses.

Figure 8-6 BDFB Fuse Assignment Label

All BDFBs will be installed and labeled as the figures 8-7, 8-8 and 8-9 indicates.

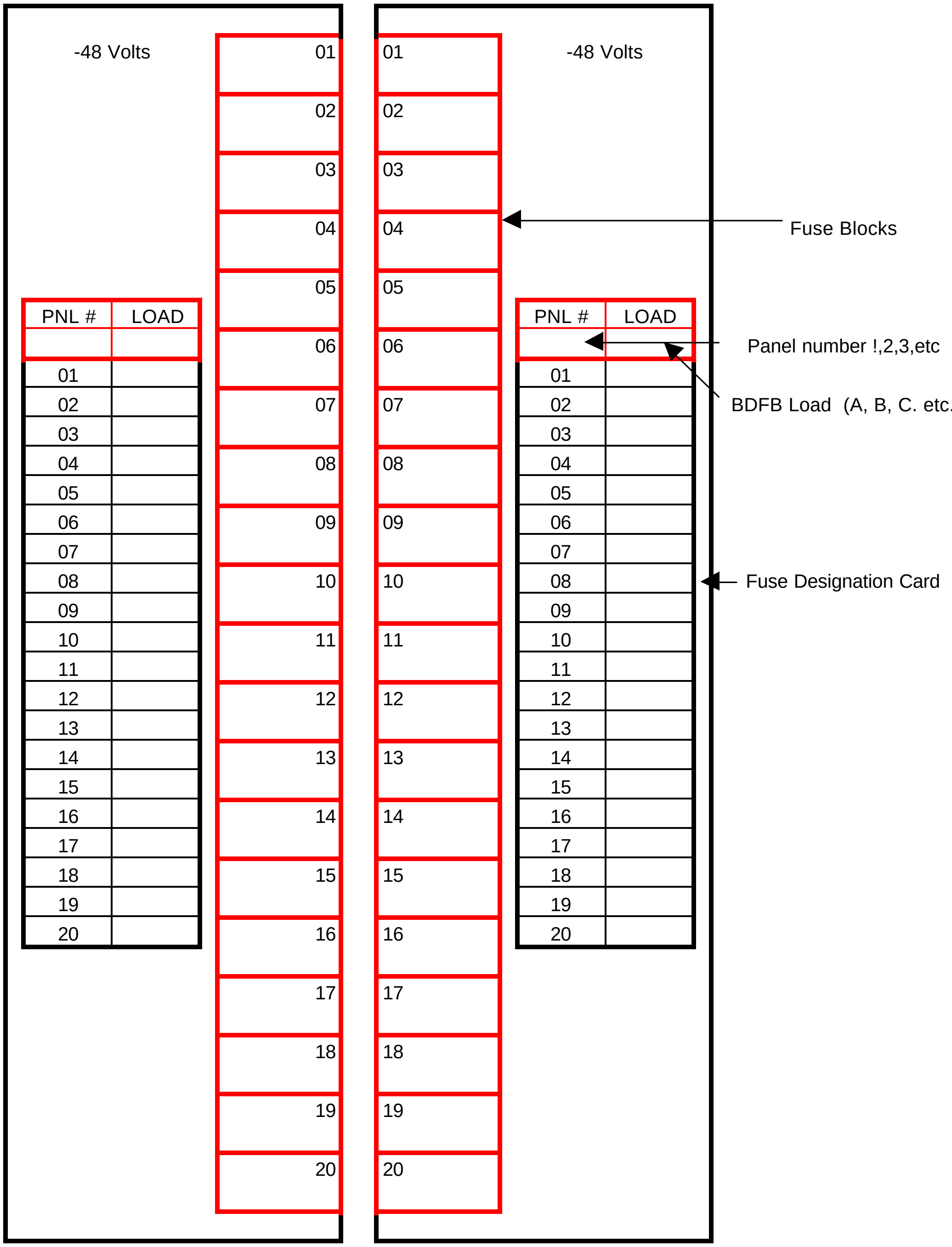


Figure 8-7 Typical Layout of BDFB Fuse Panels

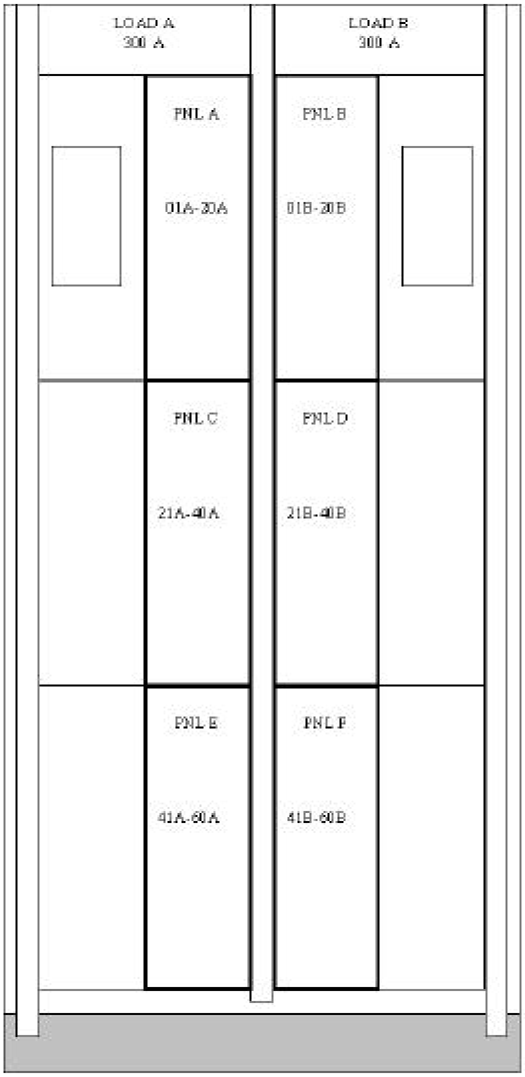


Figure 8-8 Typical Layout of 2 Load 600 Ampere BDFB

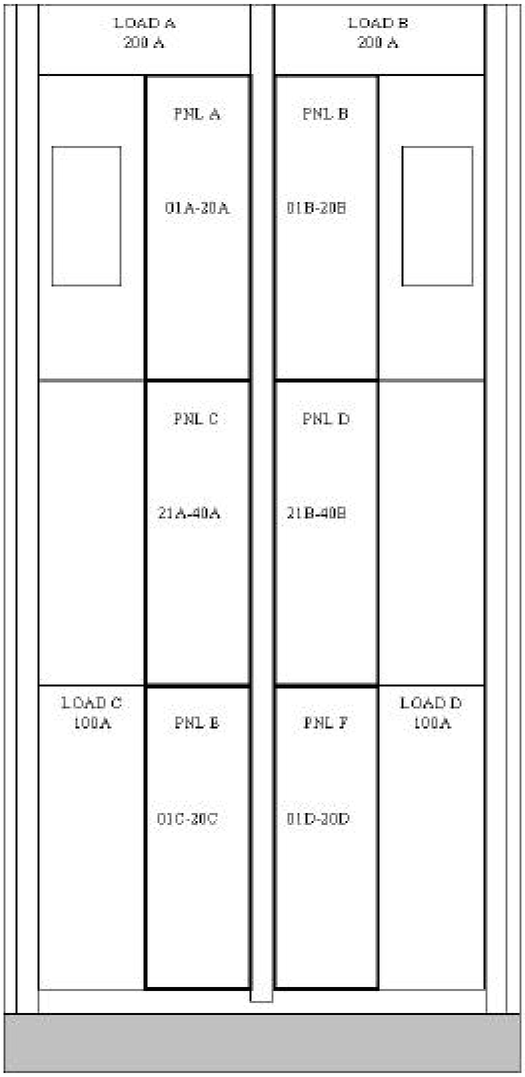
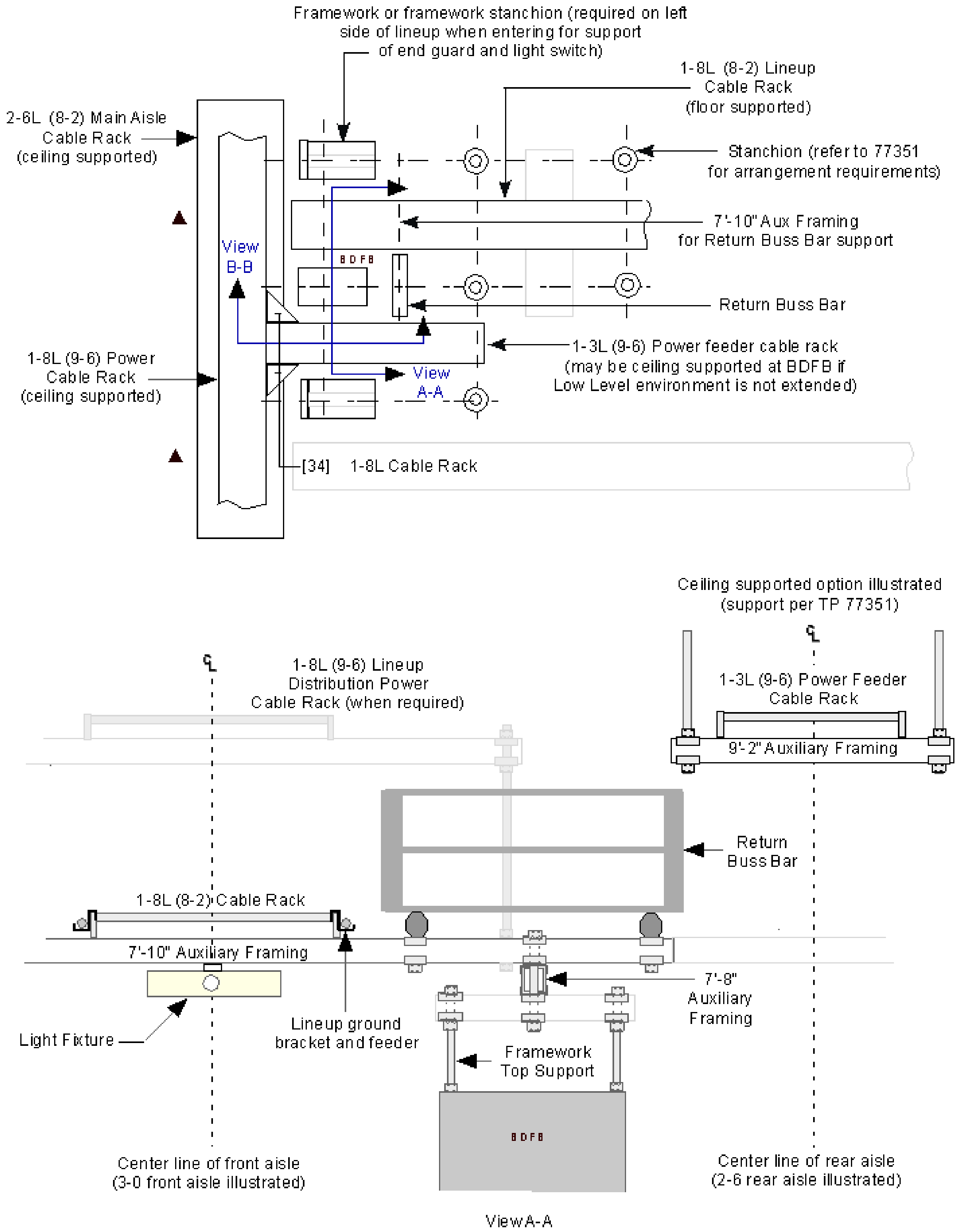


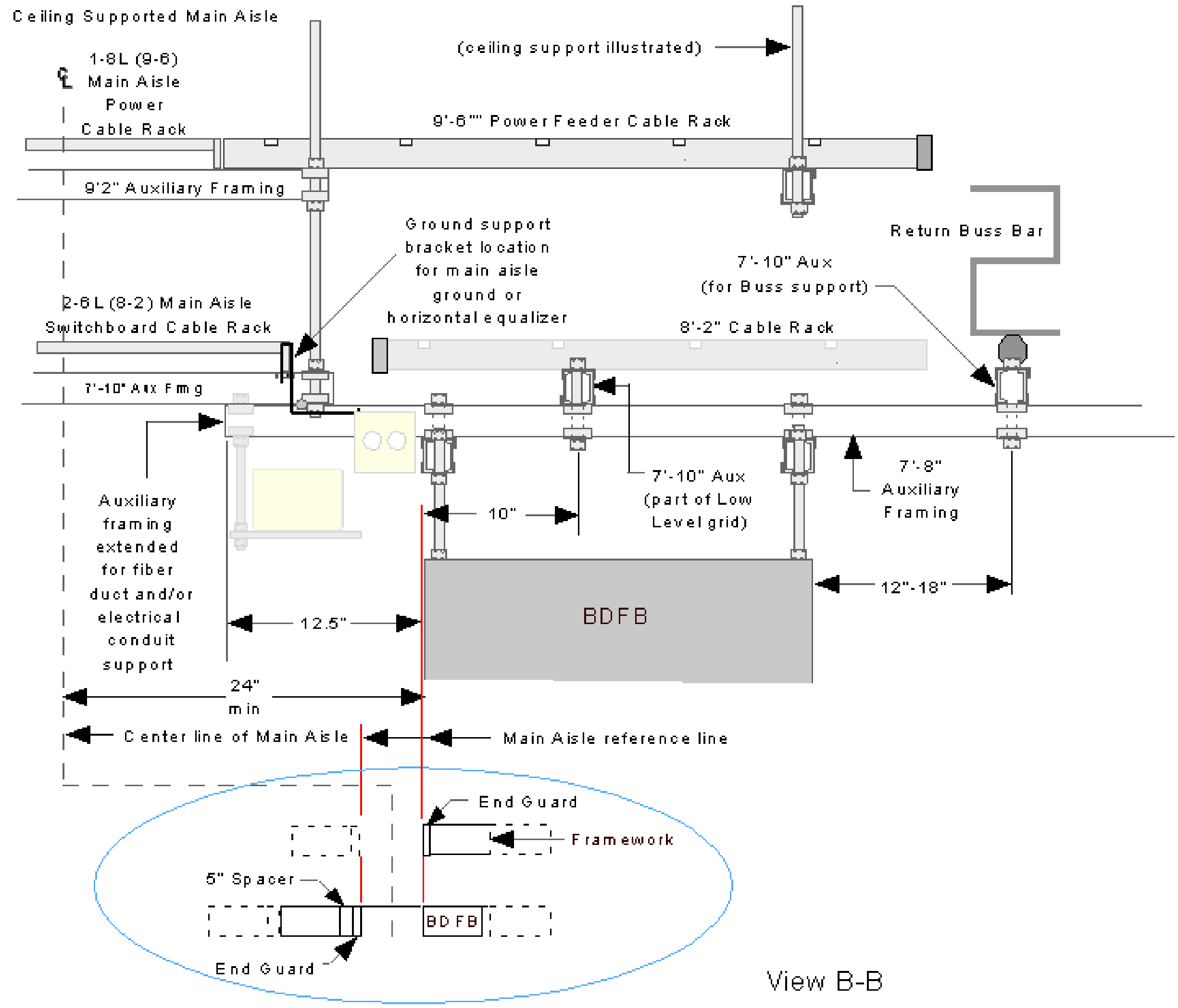
Figure 8-9 Typical Layout of 4 Load 400 Ampere BDFB

Battery return bus bars for the 7’-0” BDFB should be mounted using figures 8-10 and 8-11 as typical. Exception to these must be in writing from the Qwest Engineer. Nine foot or Eleven foot Six inch BDFB should be mounted per the Qwest Engineer’s instructions and Qwest standard configurations.



Note: Examples are for main aisle reference only and may not reflect all actual ironwork engineering requirements

Figure 8-10 Typical Return Bus Bar Mounting for a 7' BDFB (View A-A)



Main aisle cable racks are ceiling supported and centered in the main aisle.

The main aisle fiber duct and conduit arrangements are supported from the 7'-8" floor supported auxiliary framing extended 12.5" into the main aisle area. (measured from the main aisle reference line)

The conduit junction box should be aligned with the main aisle reference line.

The first lighting fixture in an equipment aisle should be located approximately 5" from the main aisle reference line.

Figure 8-11 Typical Return Bus Bar Mounting for a 7' BDFB (View B-B)

No loads may be added to any BDFB that has been EMBARGOED.

One or more of the following labels shall be on every BDFB:

The Maximum continuous drain on each feeder to this BDFB is ______ Amperes

The Maximum continuous drain on each feeder to this BDFB is 200 Amperes

The Maximum continuous drain on each feeder to this BDFB is 112 Amperes

As of __/__/__ this BDFB has been **EMBARGOED** for new growth due to load!

Figure 8-12 Load and Embargo Labels for BDFBs

Fuse Bays (FBs) or miscellaneous fuse panels are designed to provide a centralized location for switching or IOF equipment to obtain power of small Amperages. The FBs are provided with power from a BDFB, Power Board, ringing plant, etc.

The FBs are equipped from the bottom up with filtered supplies being located at the bottom and miscellaneous supplies directly above. Voltages increase toward the top of the bay. When equipping FBs, they should be arranged in a sequence that will group by voltages.

Loads shall not be parallel fused (the same exact load position fed from more than one fuse or breaker). Parallel fusing violates NEC Article 240-8.

A new BDFB should be added when one or the other of the following occurs (whichever occurs first):

- The existing BDFB has no remaining fuse positions
- The List 1 (average busy-hour, busy-season) drains of the served equipment exceed the capacity of the BDFB. The capacity is based on the rating of the upstream breaker or fuse. As an example, a BDFB panel fed by a 400 Ampere protection device has a nominal load limit of 200 Amperes on any one side (A or B) so that their total load does not exceed the 400 Amperes fuse capacity. Every effort should be made to obtain the List 1 drains from the equipment suppliers in order to determine whether another BDFB is needed. However, in cases where only the List 2 drain can be obtained, List 1 for toll/transport/IOF loads can be estimated as the List 2 drain divided by 2.5.

A single panel shall not be subdivided to connect it to more than one bus section. The exception to this rule will be in that small offices where split type arrangements are used to conserve relay rack space. These panels will be 5 Amperes or less.

Any given secondary or tertiary protection device shall be smaller than it is upstream primary or secondary protection device. The engineering supplier is responsible for proper sizing of protection devices and wiring them correctly (this is known as fuse coordination).

8.7 Bus Bar Labeling and Layouts

The following bus bars should be installed, labeled and laid out in accordance with requirements herein and Qwest publications 77350, 77351, 77355, and standard configurations

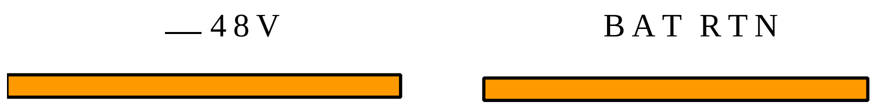


Figure 8-13 Bus Bar above Battery Stands

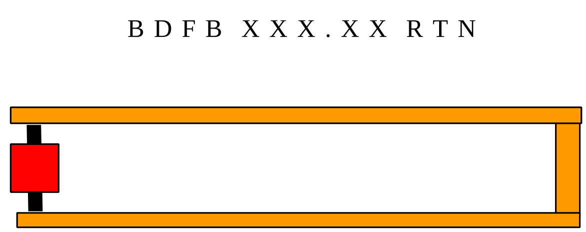


Figure 8-14 Battery Return Bus Bar above BDFB

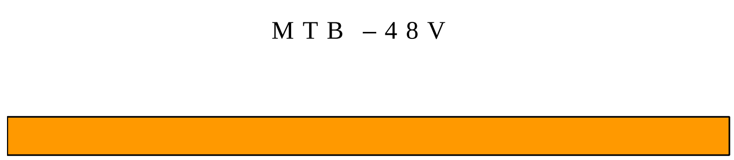


Figure 8-15 Main Terminal Bar in Power Room

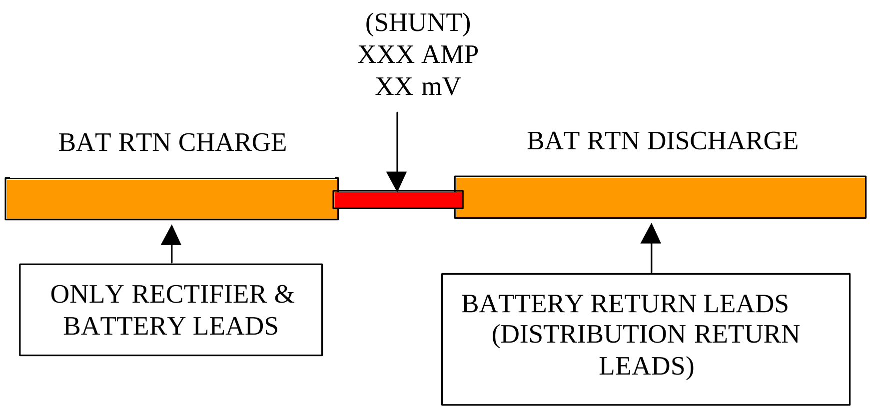


Figure 8-16 Main Return Bar in Power Room

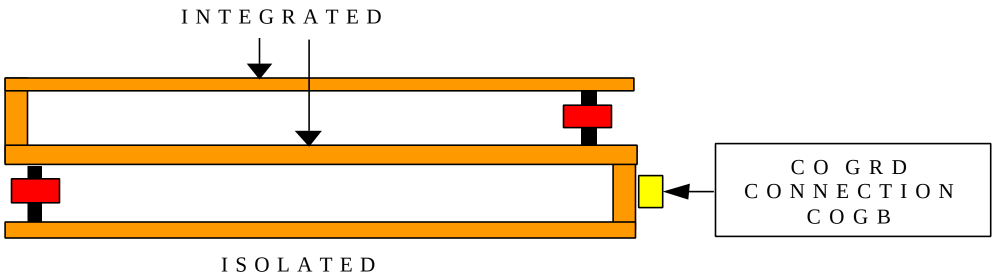


Figure 8-17 Remote Ground Window

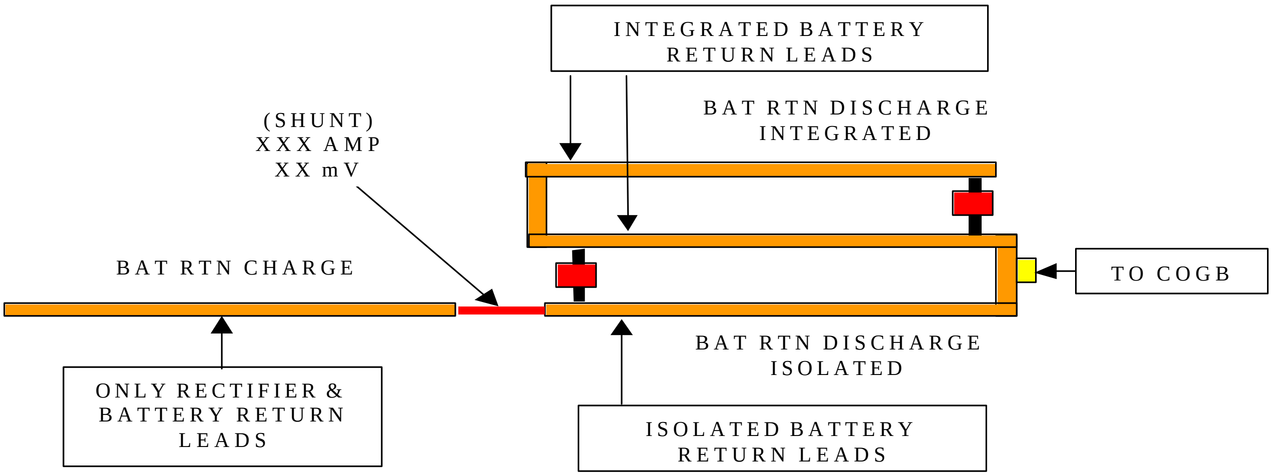
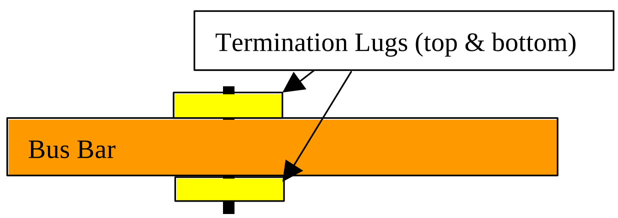


Figure 8-18 Main Return/Ground Window Bar in Power Room

Figure 8-19 Central Office Principle Ground Bus

Figure 8-20 Central Office Ground Bus



Note: Sandwiching of the battery loads and returns at the bus bars for the PBD, battery stands, ground window, and BDFBs is acceptable. Whenever possible the loads and returns should be from the same equipment location. However, the placing of two or more termination lugs under one bolt on the same size of the bus bar (also know as stacking) is prohibited without exception.

Figure 8-21 Example of Terminations for Bus Bar Loads and Return Leads (Sandwiching)

CHAPTER 9 RING, TONE AND CADENCE PLANTS

Chapter and Section **Page**

9. Ring, Tone and Cadence Plants

9.1 General

This unit is intended to provide general information regarding:

- Ringing systems currently in use in switching and transmission systems.
- The various call progress tones furnished by ringing plants.
- General information on ring plant sizing.

In Stored Program Control System (SPCS) offices, ringing, call procession tones, precision tones - Dual Tone Multi-Frequency (DTMF), dial tone, audible ringing tone, high tone and low tone) are provided by the switch. A separate ringing plant must be provide for all non-switched services such as Foreign Exchange (FX), ring down, Interexchange Carrier (IC) special ringing requirements, metallic facility, etc. This section describes the requirements for that separate ringing plant. (All power equipment must have completed the Qwest product selection procedure.)

9.2 Ringing and Tone Systems Technical Requirements

Ringing and tone plants are provided in SPCS offices to furnish 20 Hz ringing current. The plants must furnish call progress tones, such as dial and busy tones for the switched subscribers. The required capacity, types of ringing, and tones for the switched plants are provided from the SPCS supplier. Superimposed ringing supply must be furnished if the office requires four party full selective ringing. In some Central Office (CO), coded ringing is provided. With this arrangement, subscribers' ringers on party lines are assigned to various coded rings.

Some non-switched circuits will require a ringing supply. Generally, non-switched circuits only require 20 Hz, AC/DC Superimposed ringing. Ringing supplies for non-switched circuits will be separate from the ringing supply for the SPCS equipment. Where practical, the supply should be installed in close proximity to the non-switched circuits. If the ringing plant is not present, then the engineer should order a +48V ringing plant.

When ringing supplies are provided for non-switched circuits, they must be provided in a redundant configuration. Transfer to the reserve unit shall be accomplished by use of a manual transfer switch and automatically when the online supply fails.

The ringing equipment shall operate within an input voltage range of -44 to -59 VDC. The ungrounded supply lead(s) must be properly fused, and must have separate feeders for the regular and reserve units.

The input circuitry to any generator shall consist of an input fuse and an input filter that prevents noise from being fed back from the generators to the batteries.

The ringing equipment shall have built-in protection against under voltage, overcurrent, and over voltage on both the input and output.

The ringing generator output voltage level shall be regulated to a constant voltage level.

The wave shape of the ringing generator output must be low in harmonic content.

The efficiency of a ringing generator shall be high at light loads.

It is permissible to operate ringing generators in parallel, or in a primary-secondary configuration. Generator output power may also be increased by use of a power booster.

It is permissible to use the same ringing generator for both battery and ground-connected trip circuits, provide that an isolation transformer is used.

Precise tone generators must have a frequency stability of ±0.5%, THD of 1% or less, and output voltage regulation to ±1.0 dB

The Receiver Off Hook (ROH) generator shall be designed for fully automatic operation with permanent signal line systems. The 2600, 2450, and 2060 Hz frequencies of the ROH generator shall be stable within ±2% over the input voltage range, and output load range from no load to full load. The 1400 Hz frequency shall be stable within ±0.5% over the same input and output voltage range. Harmonics in the output frequencies of the ROH generator shall be limited to a level of 26 dB down from the level of the fundamental frequencies.

All components of the ringing equipment shall be removable through front access.

The ringing equipment shall be modular. During growth and additions, the delivery of power to the using systems shall be maintained.

All ringing equipment shall have a nameplate with a minimum of the supplier's name, model and serial numbers, and manufacturing date.

9.3 Distribution

A distribution fuse shall be provided. A split fuse panel may also be used. The engineering supplier is responsible for proper fusing and sizing of ringing supply leads.

Protection devices (fuses or circuit breakers) being fed from a ringing plant shall NOT exceed the capacity of the plant. An example would be a 2-Ampere ringing generator shall not have a fuse larger than 1.33 Amperes to protect the using equipment. Load fuses shall be smaller than the plant output fuse.

The engineering supplier is responsible for re-evaluating the fusing on each ringing supply path when adding new equipment to be fed by the ringing supply.

In SPCS offices, a separate ringing supply will be provided whenever more than 50 circuits or 4 carrier systems require ringing. A separate ringing supply is always required when ICs request high capacity service into a SPCS location.

All distribution from SPCS ringing and tone frames to non-SPCS equipment must be run within three feet of the ground window and the return lead bonded to the main ground bus. When a separate ringing supply is provided, all of these circuits must be moved to the separate supply, and the leads rerouted.

Ringing plant distribution fuses shall not be multiplied (e.g., daisy-chained) between equipment bays, although daisy chaining of ringing distribution within a bay is permissible.

9.4 Ringing Plant Alarms and Troubles

Alarms are required for all office ringing supplies. Typical alarms required are major, minor, ring machine transfer and interrupter transfer, (when interrupter is separate from ringing generator). Alarm indication, such as major, minor and transfer should be visual on the plant with provisions for remote alarming, office audible and aisle lamps as required. All alarm points shall be easily accessible for connection to a PSMC.

During normal operation, if a trouble condition should occur in the regular 20 Hz ringing generator, tone generator, or the interrupter, the load shall transfer to the reserve unit after a 2 second time delay. A trouble lamp(s) shall light to indicate trouble and an alarm signal(s) shall be activated. After the trouble has been cleared, that unit shall transfer back to normal operation by manual transfer only. In addition, all the associated alarm lamps shall be extinguished. If some element in the reserve side of the equipment fails without an earlier failure in the regular unit, a trouble lamp(s) shall light to indicate which output has failed, and an alarm(s) shall be activated.

CHAPTER 10 POWER PEDESTALS

Chapter and Section **Page**

10. Power Pedestals

10.1 General

This unit covers power pedestals for use in the Outside Plant environment. The power pedestal is the interface between commercial AC, standby AC connection, and the Outside Plant enclosure (e.g., CEV, RT, etc.).

The power pedestal shall be modular to help design, installation, maintenance, and growth. During growth and additions, the delivery of power to the using systems shall be maintained.

The power pedestal shall be designed to prevent personnel exposure to safety hazards, and pedestal damage shall not occur during normal installation, operation, and maintenance. The pedestal will be equipped with warning signs and guards, in agreement with UL requirements. The pedestal shall be UL listed and EUSERC approved.

Each pedestal and/or framework shall have a visible nameplate with the following information: suppliers name, serial number, model number, manufacturing date, nominal input voltage(s), number of AC phases, 60 Hz., the output voltage, the rated full load current, and the available interrupt current rating of the pedestal.

The interrupt current rating of the pedestal and its breakers must exceed the available fault current available from the serving utility company transformer.

The pedestal shall not have any openings sufficient to allow rodents, snakes, or other animals to enter and/or make their home inside the pedestal.

The pedestal shall meet the service requirements of any electric utility in Qwest territory.

Power pedestals are subject to electrical inspections, and must be approved by the serving electric utility company. Power pedestals used in Arizona must be pre-approved by Arizona Public Service (APS) and Salt River Project (SRP). These power pedestals must meet both UL and EUSERC requirements. Power pedestals in Utah must also meet EUSERC requirements, and be approved by Utah Power and Light (a subsidiary of Pacificorp). New Mexico also requires special pedestals that must be approved by PNM (Public Service of New Mexico). Power Pedestals in the rest of the former U S WEST territory don't have the specialized EUSERC requirements, and are common in all aspects except for meter socket types (check with the local electric utility for the approved type).

The Transient Voltage Surge Suppression (TVSS) can be MOV, SAD, or MOV/SAD hybrid. All TVSS units must be UL 1449 edition 2, LISTED.

10.2 Materials

Circuit breakers should have their interrupt current rating specified.

Input breakers for the commercial AC and standby engine alternator, emergency power, must be of the walking beam, and interlock type transfer switch.

The AC meter socket shall be rated at 200 Amperes and 250 volts. It shall be a five terminal socket contained in a separate housing. Both ring and ringless types are acceptable, and must be approved by the serving electric utility company.

10.3 Technical Requirements

The structural members of the power pedestal shall not carry or conduct load currents under normal operating circumstances.

All metal parts shall be grounded. Metal surfaces shall be bare metal at the points where they bolt together or connect to the grounding system.

The pedestal shall be capable of being mounted in one or more of the following configurations: on a concrete pad (self-supporting), on a pole, or in a NEMA 1A type cabinet.

Service entrance conductors shall be run only in conduit, and the pedestal shall be capable of overhead or underground entrance. If entrance is through the bottom of the enclosure, the supplier must provide a vented dead air space. No equipment shall be mounted in this area. The space must be a minimum of four and one half inches. The load conductors shall be run only underground, and in conduit.

The enclosure shall be lockable.

The enclosure shall be equipped with either a hinged door opening to a minimum of 160 degrees, or a removable front cover.

The commercial AC feed must not be accessible from the meter back towards the source.

The load center must be a minimum of twelve positions, equipped with one 15-Ampere breaker to be wired to a GFCI receptacle. The GFCI receptacle will be mounted in the enclosure.

Visual alarm and status indications shall be provided by colored, illuminated devices mounted directly on the power pedestal. The visual alarms in the subsystem that indicate that the power to the status indication and alarm overcurrent devices have operated, or that power has been removed from the status indication and alarm or control system shall be provided with a dedicated overcurrent device operating from the plant voltage. The device can be either a fuse or circuit breaker in the ungrounded supply lead.

CHAPTER 11 LIGHTING (EMERGENCY, TASK)

Chapter and Section **Page**

11. Lighting (Emergency, Task)

Emergency lighting is required by the NEC and Life Safety Codes (for 90 minutes) for egress from a building (stairwell lighting, exit signs, etc.). It should be run off a contactor, or left on all of the time. This egress lighting is best if -48 VDC powered, but the installation of this type of lighting is the ultimate responsibility of the Qwest Real Estate department.

Task lighting is not code required, but is required by Qwest for the following locations:

- Engine Room,
- Transfer Switch,
- Engine Control Panel
- AC Service Entrance
- Main DC Power Board

This lighting is best left on all of the time. Other options are running off a standard light switch, or run off a contactor.

The following methods can be used to provide this lighting

Incandescent bulbs shall be -48 VDC types. These older systems cannot be maintained they have both right and left-handed thread -48 VDC incandescent bulbs and fixtures, also used were ±130 VDC fixtures and bulbs. Left-handed thread -48 VDC bulbs are not available anymore from lighting supply and manufacturing companies. Right-handed thread bulbs are somewhat more common, but still a specialty item. In some cases left-handed thread systems can be replaced by right handed thread systems, however the fixture must be changed out too, not just the bulb. One problem with going to right-handed thread bulbs and fixtures is that it makes it easier to confuse regular AC bulbs with DC bulbs (fixture labeling is critical). These systems typically use a contactor that took an AC source to hold the contacts open, but allow DC to flow when the AC is off. These should be replaced with fluorescent fixtures at the next convenient opportunity.

Fluorescent ballasts for task lighting shall be -48 VDC types (as noted above, these same ballasts could also be used for emergency/egress lighting). There are several suppliers for this. These can be used in existing fixtures with existing bulbs, etc. There are -48VDC input fluorescent ballasts that can be used in an always on configuration, or in a switched circuit. Note however, that with these ballasts in a switched circuit, they will not automatically repower the lights in an AC Fail condition if the switch is turned off. Also there are -48VDC inverter “ballasts” that do not power the tubes directly, but are instead wired in parallel with AC input fluorescent ballast. If wired correctly, these can be used in a switched circuit that will automatically power/light the fixture in the event of an AC failure, regardless of whether the switch is off or on.

DC lighting can be fed from the nearest -48 VDC source (main Power Board, BDFB, or even miscellaneous fuse panels). If feeding from the main Power Board or BDFB, it is permissible to run several fixtures in parallel off a single circuit (similar to AC lighting), following the provisions of the NEC.

Because of the low power drain of DC lighting fixture ballasts and DC, bulbs pull between 1 and 2 Amperes of -48 VDC per fixture. Since we are using the nearest DC source, and the minimum voltage of the bulbs, or ballasts are approximately 30 VDC, voltage drop will not be an issue.

The following wire and fuse or circuit breaker sizing guidelines might generally apply for -48 VDC lighting circuits.

Number of Fixtures	Wire size (AWG)	Protection Device Size (Amperes)
1	14	5-15
2-3	14	10-15
4-5	14	15
6-7	12	20
8-10	10	30

Any circuit greater than three fixtures should be fed from a BDFB or main Power Board, not a miscellaneous fuse panel.

Although not required, these DC lighting circuits would generally be run in conduit. This conduit cannot contain any AC circuit wires. The DC wires cannot be the same color as required for AC wires (white, slate, gray, red, blue, black, brown, orange, or yellow). This will prevent accidental connection at junction boxes to the AC system. A green wire ground shall also be run, in accordance with the NEC, and tied down to the ballast and/or bonded to any metallic fixture case it feeds. Back at the fuse source, the green wire ground can then be tied to the frame. Any conduit must be metallically bonded back to ground too, either with a bond to the green wire at the fixture case, a junction box, etc.

Inverter fed lighting. If the site has a power inverter with spare capacity, regular AC lighting can be provided from it, remembering that the inverter is a separately derived source, and following the NEC. It can be switched or permanently on, or on a contactor, depending on whether it is emergency or task lighting. (Each fixture uses 75-100 W/VA of inverter load.) The fixture shall have a label visible from the floor identifying it as inverter fed.

If you have a site that has multiple engines in parallel, task lighting can be from the essential AC buss fed by these paralleled engines.

Battery pack lights. Although battery pack lights are permissible, they are not generally maintained. They should not be used going forward as the task/stumble lighting source. They are sometimes used for emergency egress lighting, but are not the best choice, especially when their batteries are not maintained. The best choice for emergency lighting (as already noted) is -48 VDC powered ballasts. A second choice could be "emergency/egress" ballasts with a built-in battery. At least there is assurance that the battery would be replaced when the ballast fails.

DC emergency and stumble light fixtures shall be labeled to preclude use of the wrong bulbs and/or ballasts.

Standard low-level equipment lighting arrangements shall be installed per Qwest Technical Publication 77351 and Qwest Standard Configuration documents.

CHAPTER 12 STANDARD TL 1 MESSAGES AND ALARM SETTINGS FOR POWER

Chapter and Section **Page**

Tables **Page**

12. Standard TL1 Messages and Alarm Settings for Power

12.1 General

The attached information is the standards for Qwest for Power messaging over PSMCs, using the X.25or IP packet protocol with TL1 command language. It is to be used for configuring, alarming, and interpreting messages interfaced to NMA.

There are several parts to this document. Sections 12-2 through 12-4 and Tables 12-1 through 12-4 explain the use of the AID and Condition Type fields. Section 12-4 and Table 12-4 define the TL1 queries that may be performed on X.25 and IP-compatible Power System Monitor Controllers (PSMCs) to extract useful information from them. Section 12-5 and Table 12-5 defines the threshold settings for binary alarms derived from analog readings. Section 12-6 and Table 12-6 provides a few examples of typical standard power messages.

Power and environmental alarms make their way to NMA over one of four different transmission media. These media are listed below in order of preference (for example, Qwest prefers e-telemetry transmission of power and environmental alarms over switch transmission). Alarms should not be sent through more than one of these mediums (except for backup generic majors and minors) due to the confusion multiple alarming causes for the surveillance technicians. Preference is based on the ease of NMA routing and/or analysis allowed by the particular media.

- TL1 on an X.25 or IP circuit from a Power Monitor (PSMC) with a backup major, minor and watch dog alarms through an e-telemetry or switch medium (environmental alarms in a CO should not generally use a PSMC, except for those specifically related to power, such as a battery room temperature)
- E-telemetry (e.g., Dantel, etc.)
- X.25 overhead bitstream from Remote Terminal (RT) locations
- Through the switch scan points

Binary alarms connected to any of the above devices may be connected as closed on alarm (NO), or open on alarm (NC). Either configuration is acceptable for power and environmental alarms. Most alarms are typically set up as closed on alarm (NO). However, critical alarms (such as the fire alarm or any other alarms considered very important) should probably be connected to open on alarm (NC). This setup (of alarming on an open condition) is also known as “guarded”. This refers to the fact that if the wiring is inadvertently cut or disconnected, or contacts get dirty, an alarm will be brought in. If alarms are connected in the “guarded” state, it is preferable that the reversal of the point be done on the alarm-monitoring device rather than in NMA. If the reversal is done in NMA, it can cause problems for both field and center technicians by causing red lights or bit sets (which normally mean alarmed conditions to these technicians) when there actually is no alarm.

12.2 AIDs and Condition Types for Power Alarms

The AID provides a "gross" definition of the equipment involved. An "n" associated with an AID indicates more than one entity of that type. The "n" will always be a number.

The second column in the AID table on the following pages provides a detailed identification of the hardware involved in the message. Every message will use the first column. However, the second column will not be used for every alarm condition. An "m" associated with the second column indicates more than one entity of that type. The second column may or may not have an associated "m". The "m" may be numeric, alpha, or alphanumeric. For those messages with the "m", it does not have to be there (this is especially true for generic plant alarms, such as a plant rectifier fail alarm).

As examples of messages, N48B1RECT4 refers to rectifier 4 in the negative 48-volt battery plant #1; and N48B1RECT would be the UNIT/SHELF for the generic plant rectifier alarm.

- CONDITION TYPE (CONDTYPE) uniquely defines the condition or trouble to be provided to NMA from the alarm reporting device. The CONDTYPE field is completely independent of the AID or UNIT/SHELF fields.

In order to obtain a full description of the problem associated with a particular NMA message, the AID or UNIT/SHELF and CONDTYPE must be provided. For example, a CONDTYPE of FAIL associated with an AID of N48B1RECT4 would indicate that rectifier 4 in the negative 48-volt battery plant #1 failed. The message would look as follows on the ticket.

N48B1RECT4 FAIL

For the generic plant rectifier fail alarm, the message would appear as follows (note that there is nothing in place of the "m").

N48B1RECT FAIL

Alarms are classified as minor (MN), major (MJ), and critical (CR) depending on the criticality of the alarm, and the time allowed before action must be taken.

For X.25 or IP capable power monitors, a genericTL1 template may be generated in NMA against the monitor at a site (the TID of the monitor). This template generates numerous NMA AID entities for that TID. If the AIDs programmed into the monitor match the AID entities of the template that is generated against, the TID (exclusively identifies the monitor — based on CLLI™ code standards), no more NMA programming needs to be done. However, each alarm must still be tested to ensure continuity, as it is impossible to make the template large enough to be all inclusive of every type of possible power alarm. So, if an alarm is tested after the template is generated, and a ticket is not created, a specific entity for that alarm must be created, or the AID in the monitor must be changed to match one of the template AIDs. Condition types are not generated in the NMA database. These TL1 condition types pass straight through from the monitor on the X.25or IP link as pure ASCII text.

Table 12-1 AID for Power Alarms
(Page 1 of 2)

UNIT/SHELF or AID + sub-AID		Description of UNIT/SHELF or AID
BATTERY PLANT		
P130Bn		positive 130 volt battery plant #n
N130Bn		negative 130 volt battery plant #n
N48Bn		negative 48 volt battery plant #n
N24N48 Bn		negative 24 and 48 volt battery plant
P24N48B n		positive 24 and negative 48 volt battery plant
P24Bn		positive 24 volt battery plant #n
N24Bn		negative 24 volt battery plant #n
PSMCn		power systems monitor/controller
COM		internal PSMC message
	CEMF	CEMF cell or CEMF battery string
	ECELL	end-cell or end-cell battery string
	EMGSW	emergency switch
	LVD	low voltage disconnect unit or contractor
	MPROC	micro processor
	PWRSUPPLY	internal power supply or feeding power supply
	ROOM	ambient power room temperature
	RPMm	Remote monitoring module for a PSMC
	SHUNTm	shunt or sub-shunt "m", or shunt-monitoring board
	TIMER	elapsed timer
	BATmLO	a cell in the lower tier of battery string "m"
	BATm	battery string "m"
	BATmHn	battery half string voltage in string "m", "n"th half of string
	BATmM	battery midpoint voltage for string "m"
	BATmPC	pilot cell in string "m"
	BATmQn	quarter string voltage in string "m", "n"th quarter of string
	BATmUP	a cell in the upper tier of battery string "m"
	BMS	battery temperature compensation device
	ABS	fuse feeding alarm relays
	CHARGE	charge fuse (input fuse)
	CNTRLm	control fuse, breaker or relay "m"
	DISTm	distribution (discharge) fuse/breaker "m"
	REG	voltage regulator power supply or regulator fuse
	RECTm	rectifier "m"
CONVERTER PLANT		
P130Cn		positive 130 volt converter plant #n
N130Cn		negative 130 volt converter plant #n
PN130Cn		positive & negative 130 volt converter plant #n
P120Cn		positive 120 volt converter plant #n
N120Cn		negative 120 volt converter plant #n
PN120Cn		positive and negative 120 volt converter plant #n
P48Cn		positive 48 volt converter plant #n
N48Cn		negative 48 volt converter plant #n
P24Cn		positive 24 volt converter plant #n
N24Cn		negative 24 volt converter plant #n
	ABS	fuse feeding alarm relays
	CONVm	converter "m" in plant #n
	DIST	distribution fuse/breaker for plant #n

Table 12-1 AID for Power Alarms
(Page 2 of 2)

UNIT/SHELF or AID + sub-AID		Description of UNIT/SHELF or AID
INVERTER PLANT		
1PHINVn		single-phase inverter plant #n
3PHINVn		3-phase inverter plant #n
	TRNSW	transfer switch in _-phase inverter #n
	DIST	distribution fuse/breaker for _-phase inverter #n
UPS		
1PHUPSn		single-phase UPS plant #n
3PHUPSn		3-phase UPS plant #n
	BATCHGm	battery charger "m" in _-phase UPS #n
	BATm	battery string "m" in _-phase UPS #n
	INVm	inverter "m" in _-phase UPS #n
	TRNSWm	transfer switch "m" in _-phase UPS #n
RING PLANTS		
RNGn		ringing generator (plant) #n
	FUSEm	ringing generator fuse "m"
	RGENm	ringing generator "m" in ring plant #n
	INTERm	ringing interrupter "m" in ring plant #n
STANDBY ENGINE-ALTERNATORS		
ENGALTn		stand-by engine/alternator #n
	FUELPRES	fuel pressure
	BATCHG	start battery charger for standby engine #n
	BATENGm	start battery string "m" for standby engine #n
	COOLANT	standby engine coolant
	CURNTm	input AC phase "m" current
	DAYFUEL	day tank of standby engine #n
	FAIL	optionally used for engine failure
	FAN	fan for standby engine #n
	MAINFUEL	main fuel tank of standby engine #n
	OIL	oil level
	OILPRESS	oil pressure for standby engine #n
	PHASEm	AC phase from engine/alternator
	ROOM	ambient engine room temperature
	TRNSWm	transfer switch "m" operated
	VOLTm	engine output AC phase "m" voltage
COMMERCIAL OR STANDBY AC		
COMACn		commercial AC service entrance #n
ACINn		AC measured on load side of transfer sw. #n (this is the essential AC)
	CURNTm	input or output AC phase "m" current
	PHASEm	AC phase
	TRNSWm	input AC transfer switch "m"
	VOLTm	input AC phase "m" voltage

Table 12-2 Power Alarm Condition Types
(Page 1 of 2)

CONDTYPE	CR, MJ, or MN	Description of Condition Type
ALARM_CUTOFF	MN	alarm cutoff — can also be indicated by adding " _ACO" to the end of any other condition type
BYPASS	MN	inverter, or UPS bypass mode
CAPACITY_EXCEEDED	MN	near or exceeding capacity of plant, rectifier, etc.
COML_AC_FAIL	MJ	commercial AC failure
CRANK_FAIL	MJ	engine has cranked too much and cannot start
CRITICAL	CR	a critical power alm. (e.g., very low voltage, temperature differential)
CTLLR_OK	—	internal message (used with a watchdog)
DIFFERENTIAL_TEMP	MJ/CR	high or low differential temperature between batteries and ambient — criticality depends on threshold (see section of this document dealing with that issue)
DISCONNECT	MJ/MN	any disconnect operated (minor if there is redundancy)
ELAPSED	MN	an alarm has timed out (elapsed)
EMERGENCY_STOP	MJ	standby engine emergency stop, or any other emergency stop
EMG_STOP_BUTTON	MJ	emergency stop button has been operated
FAIL	MN/MJ	any equipment or plant failure — minor for individual rectifiers, ringers, or converters, major for multiples of these, critical when all batteries in plant have died and there is no AC power, major for everything else
FAIL_PARALLEL	MJ	engine-alternators failed to parallel
FAN	MJ	rectifier, engine, or UPS fan fail alarm
FUEL_LEAK	MJ	any fuel tank leak
FUEL_SYS_TRBL	MJ	alarm from fuel system monitor.
FUSE/BRKR_OPERATE	MJ/MN	any fuse or breaker operation — generally major for main power board distribution fuses unless otherwise specified
HIGH	MN/MJ	any high fluid level or pressure
HIGH_FREQUENCY	MJ	UPS or standby engine high frequency
HIGH_TEMPERATURE	MJ	any high temperature (environment or equipment) — critical for some battery temperatures (see threshold section of this document), and major for everything else
HIGH_VOLTAGE	MJ	any high voltage, AC or DC — criticality depends on threshold (see section 9 of this document) — assume major
HIGH_VOLTAGE_HVSD	MJ	the rectifier(s) have shut down on high voltage
IMBALANCE	MN	Current is imbalanced between phases, battery strings, or rectifiers
INPUT_FAIL	MJ	any AC or DC input fail
LOW	MJ	any low fluid level or pressure
LOW_TEMPERATURE	MJ	any low temperature, including engine block heater fail
LOW_VOLTAGE	MJ	any low voltage (e.g., low float, or battery on discharge)
LO_VOLT_DISCONNECT	CR	plant, battery, or load disconnect on low voltage
MAJOR	MJ	any generic major alarm from the power plant
MAJOR_CRITICAL	MJ	any power major or critical — used when not enough points

Table 12-2 Power Alarm Condition Types
(Page 2 of 2)

CONDTYPE	CR, MJ, or MN	Description of Condition Type
MICROPROC_FAIL	MN	the microprocessor in the PSMC or power plant has failed
MINOR	MN	any generic minor alarm from the power plant
MULTIPLE_ALARMS	MJ	used when PSMC has to upgrade an alarm from minor to major
NORMAL	MN	any normal position (e.g., transfer switch)
OFF_(NORMAL)	MN	equipment normally off
OFF_NORMAL	MJ/MN	equipment not in a "normal" functioning condition
OPERATE	MN/MJ	a switch or other device has operated — criticality will depend on the alarm. If this is simply a status alarm, it is a minor. It is a major for all other cases
OVERCURRENT	MJ	excessive current on distribution, rectifiers, etc.
OVERRIDE	MN	the override of any function
OVERSPEED	MJ	engine overspeed
PROPER_OPERATION	MN	proper operation for any equipment
RECHARGE	MN	indicates batteries are recharging
RELAY_OPERATE	MN	any relay has operated
RESTART	MN	equipment has restarted
RESET	MN	any reset condition
RESTORE	MN	any restored condition
REVERSE_POWER	MJ	alternator output power is reversed
SEQUENCE	MN	rectifiers are sequencing back on line to avoid engine overload
SHUNT_FAIL	MN	shunt board/communications failure
STBY_ENG_FAIL	MJ	standby engine/alternator has failed
STBY_ENG_RUN	MN	standby engine/alternator running
SURGE_ARRESTOR	MJ	commercial AC high voltage or spike protector problem
TIMER	MN	sequence, engine, etc., timer or other type of timer problem or timeout
TRANSFER	MN	any transfer (ring, inverter, etc.)
UNABLE_EQUALIZE	MN	plant voltage controller unable to switch to equalize voltage
UNABLE_FLOAT	MJ	plant voltage controller unable to switch to float voltage
VERY_LOW_VOLTAGE	CR	very low voltage — AC or DC
VOLTAGE_OUT_OF_LIMIT	MJ	use when alarming device can't distinguish high and low
WATCHDOG	CR	the PSMC is not working

12.3 "Reduced-Character" and Overhead Bitstream TL1 Condition Types

Some smaller battery monitors are not capable of holding all of the characters described in Table 2 above. Some fiber multiplexers, which carry power and environmental alarm messages on their X.25 overhead bitstream are sometimes limited to 10 characters for the TL1 condition type (often referred to in manufacturer or Telcordia (Bellcore) documentation as the ALMTYPE). This TL1 condition type for these messages must totally describe the event within the 10-character limit. Most muxes also have a miscellaneous minimum 40-character text field that can be seen by browsing the mux or sending an RTRV-ATTR-ENV or RTRV-ALM-ENV TL1 command. The following shortened messages may be used in place of the messages of Table 12-2. If a message is not found here, that means the message of Table 12-2 is short enough. . In some muxes, the ALMTYPE 10-character message is limited to the standard Telcordia (Bellcore) set, but the applicable power messages from the standard Telcordia (Bellcore) set are among the messages in the table below:

Table 12-3 "Reduced-Character" and Overhead Bitstream TL1 Alarm Condition Types (Page 1 of 2)

CONDTYPE (ALMTYPE)	**CR, MJ, or MN NTFCNCODE**	**Description of Condition Type (some of this may be used in the 40-character ALMMSG field)**
AIRCOND	MJ	air-conditioning system failure
BATMIDVOLT	MN/MJ	battery string midpoint voltage imbalance (see Table 12-5)
BATT-DISC	MJ	battery disconnect brkr manually or automatically operated
BATTTEMP	MJ	high battery temperature
COMLACFAIL	MJ	commercial AC power failure
POWER		
DIFFTEMP	CR	high differential temperature between batteries and ambient
DIST-FUSE	MJ	power distribution fuse or breaker fail or operation
FUSE		any fuse operation — distribution, rectifier, miscellaneous, etc.
CKT-BRKR	MJ	any breaker operated
HI-LOVOLT	MJ	high or low DC plant voltage
HIVOLTAGE	MJ	high DC plant voltage
RECTHI		
BATDSCHRG	MJ	low battery voltage – battery on discharge
LOVOLTAGE		
LWBATVG		
LVD-DISC	CR	low voltage disconnect switch operated
LVD-FAIL	CR	low voltage disconnect device has failed
PWR-48	MN/MJ/CR	any power alarm or combination (may append criticality)
N48B1MJ	MJ	any power major alarm combined on this point
N48B1MJCR	MJ	power major or critical – used when not enough points
N48B1MN	MN	any power minor alarm combined on this point
N48B1CR	CR	any power critical alarm combined on this point

Table 12-3 "Reduced-Character" and Overhead Bitstream TL1
Alarm Condition Types (Page 2 of 2)

CONDTYPE (ALMTYPE)	CR, MJ, or MN NTFCNCODE	Description of Condition Type (some of this may be used in the 40-character ALMMSG field)
OVERCURNT	MN	plant load exceeds 80-100% of n-1 rectifier capacity
RECTCAP		
RECT	MN/MJ	DC plant rectifier failure
RECTFAIL		
RECTLO		
RINGFUSE	MJ	ringing distribution fuse operated
RINGMN	MN	ringing plant generic minor (e.g., one ring generator failed, etc.)
RINGMJ	MJ	ringing plant generic major (e.g., both ringers failed, etc.)
WATCHDOG	MJ	battery monitor or power monitor failure
VHILOVOLT	CR	very high or very low voltage

12.4 TL1 Query Messages for Power

A power monitor or a mux equipped for X.25or IP communication may receive messages, as well as send the SIDs, AIDs, and condition types defined earlier. The messages that these machines may receive (along with a couple of “report out” messages) are defined below. Each machine, depending on the manufacturer, will not accept all of the messages listed below, only the ones that have been programmed into that machine's hardware and software (the minimum required power monitor messages have been marked with an asterisk). The message shown below is not the complete message; most messages include the AID and other commands defining what the user is looking for. See the Telcordia (Bellcore) GRs-811, 833, and associated documents (or the manuals for the monitor) for the correct and complete formats.

Table 12-4 TL1 Query Messages for Power
(Page 1 of 2)

MESSAGE	EXPLANATION
ACT-USER *	a logon (not required if software configured correctly)
ALW-MSG-ALL	not necessary if the software doesn't restrict messages
ALW-MSG-EQPT	allow an individual alarm message to be sent
CANC-USER *	a logoff if ACT-USER was used
DLT-SECU-USER	remove a TL1 user
ED-DAT	edit date and/or time
ED-SECU-USER	modify a TL1 user's privileges, passwords, etc.
ENTER-SECU-USER	add a TL1 user
INH-MSG-EQPT	prevent an alarm message from being sent
INIT-REG-EQPT	initialize register: turn statistics on/off, erase highs and lows
INIT-SYS	reboots the system
MEAS-CUR	measure current

Table 12-4 TL1 Query Messages for Power
(Page 2 of 2)

MESSAGE	EXPLANATION
MEAS-VG	measure voltage
OPR-ACO-ALL	masks or removes all alarms
OPR-ACO-EQPT	operate alarm cutoff for individual alarm
OPR-EXT-CONT	operates a control relay (e.g., shutdown rectifier)
RLS-EXT-CONT	releases the operated control relay (e.g., turn rectifier back on)
RTRV-ALM-ALL *	retrieves all alarms
RTRV-ALM-ENV	retrieve alarm information from "environmental" alarms info for a specific overhead bitstream housekeeping alarm
RTRV-ALM-EQPT *	retrieve a specific alarm or all active alarms, depending on the PSMC
RTRV-ATTR	retrieve alarm security (major, minor, etc.)
RTRV-ATTR-ENV	Retrieve information for overhead bitstream alarm points
RTRV-ATTR-EQPT	retrieve alarm security (major, minor, etc.) for a specific alarm
RTRV-EQPT *	retrieves the settings for a specific AID (channel)
RTRV-EXT-CONT	retrieve the state of an external control relay or contact
RTRV-HDR *	retrieves header info on site and monitor
RTRV-MMREPT	reports analog readings for a particular AID
RTRV-PM-ALL	retrieves readings, histories, and statistics for all channels
RTRV-PM-EQPT	retrieve current readings, statistics, or highs and lows
RTRV-SECU-USER	retrieve a list of authorized TL1 users
RTRV-TH-EQPT	retrieve alarm thresholds for a specific alarm
SET-ACO-EQPT	set up the alarm cutoff mode
SET-ATTR-ENV	Change the classification and messages of an overhead alarm
SET-ATTR-EQPT	change the classification (major, minor, etc.) of an alarm
SET-SID	set the office name or name of the alarm device
SET-TH-EQPT	set the thresholds for a specific alarm
REPORT MESSAGES (these precede the actual alarm message to NMA)	
REPT^ALM^ENV	cause an environmental alarm and verify output
REPT^ALM^EQPT *	cause a power alarm and verify output

12.5 Analog Power Alarm Set Points (Thresholds)

Analog points are derived from reading actual voltage or current levels within the system and delivering alarms based on the analog levels or combinations of various analog levels and binary switch positions.

Analog points are based on temperature, voltage, current, or a combination of analog and binary information. The following tables describe the values that should be associated with the various analog levels.

In many cases, both minor and major alarm thresholds are listed for each type of alarm. In these cases, typically only the major alarm is required, and the minor alarm is optional if the monitor type allows it, and/or there are enough spare points.

The values in Parts 1A through 1C of Table 12-5 are based on single cell voltages and 24 cell (-48 V) battery strings unless otherwise specified. For other strings (e.g., ±130 V, or ±24 V), simply multiply the single cell numbers by the number of cells to obtain the correct string thresholds.

This document (and others) reflects a transition from a traditional float voltage of -2.17 to -2.20 volts per flooded cell (as recommended by flooded battery manufacturers) in order to provide more reliable batteries. The further stipulation is that all new -48 V battery plants have 24 batteries per string, providing a float voltage of -52.8 V for flooded strings. Sites that won't function with a float voltage of -2.20 V/cell (some older plants cannot easily have the float voltage raised to -52.8 V due to HVSD settings, etc.); or that have lead antimony batteries; must be configured at the traditional -2.17 V/cell. For lead-calcium batteries that cannot be raised due to alarm or HVSD settings, perhaps the float can be raised part of the way (for example, -52.5). This is better for these batteries than the traditional -52.08.

Boost or equalize voltage (when used in rare cases to quickly recover battery capacity, it should be closely monitored to ensure we don't stay in boost mode too long). Voltages should generally be set at about -54 V for a -48 V flooded cell plant (don't boost or equalize VRLA cells as a general rule), and if there are associated high voltage alarms for the boost mode, set them 1 V higher (-55 V).

Table 12-5 Alarm Thresholds on Analog Points
Part 1A: DC Voltage for Flooded (Vented) Batteries

AID or SUB-AID	**CONDTYPE**	**MJ, MN or CR**	**NOTES**	**THRESHOLDS**	
				LOWER	**UPPER**
BATmPC	LOW_VOLTAGE or HIGH_ VOLTAGE or VOLTAGE_OUT_ OF_LIMIT	MINOR	CELL float VOLTAGE normally -2.20 V/cell (*-2.17 V/cell under certain conditions)*	±0.05 V/cell *(±0.03)* from the nominal float of the pilot cell	
		MAJOR	(if only one alarm possible, Major is preferred to Minor)	±0.07 V/cell *(±0.04)* from the nominal float of the pilot cell	
N48B1	LOW_VOLTAGE or HIGH_ VOLTAGE or VOLTAGE_OUT _OF_LIMIT or VERY_LOW_ VOLTAGE	MAJOR	plant float VOLTAGE -52.80 V *plant floatVOLTAGE -52.08 V*	-50.1 -50.1	-53.8 -53.1
		CRIT.		-46.5	-54.5
	HIGH_VOLTAGE_ HVSD	CRIT.		-54.0 (restart)	-56.0
LVD	DISCONNECT	CRIT.	at the plant *at the equipment (per mfg; or)*	-43.25 -42.0	-44.0 (reconnect)
BATmM	LOW_VOLTAGE or HIGH_ VOLTAGE or VOLTAGE_OUT_ OF_LIMIT	MINOR	(midpoint voltage should be near -26.4 or *-26.04* V)	-25.6 -25.3	-27.2 -26.8
		MAJOR		-24.8 -24.5	-28 -27.7
BATmH	VOLTAGE_OUT_ OF_LIMIT	MINOR	differential voltage when comparing the two halves of a battery string		0.8
		MAJOR			1.6

These points can be set at the PSMC, the conventional DC Plant Controller, and/or the Rectifiers, depending on the manufacturer and model. When the set points can be set in multiple places, the PSMC takes first priority (uses the levels given above), the Plant Controller second priority, and the Rectifiers final priority. In these cases, each successive priority level should be set approximately 0.5 V above or below (depending on whether it is a high or low voltage threshold, respectively) the previous value. For example, if I set the PSMC Low Voltage at –50.1 V, I can set the DC Plant Controller Low Voltage at –49.6 V, and the Rectifier Low Voltage at –49.1 V. The exception to this rule is for HVSD. In the case of HVSD, the controller should have the lowest voltage setting (-56 V, as shown above), and the rectifiers should be set at –56.5 V. To help ensure that only offending rectifiers stay off, you may need to turn off load sharing in switch mode plants, and ensure that the plant rectifier restart circuit works. If the switch mode rectifier plant is not capable of working without load sharing on, then it is best to set the rectifiers to the lower HVSD setting (if there are settings for both the rectifiers and controller). Generally, PSMCs (unless an integral part of the Plant Controller) are not wired for control features (per Technical Publication 77385, Section 7), so HVSD would not be set on them (or if it is set, it would be the last level of defense — e.g., at –57 V).

It is generally not necessary to dual wire the same alarms (although backup major and minor alarms through a separate reporting device are encouraged). For example, if each rectifier fail is directly wired to the PSMC, the rectifier minor from the plant controller is probably not necessary.

Very Low Voltage alarms (the “critical” low voltage described above) are discouraged due to the confusion they introduce to those who monitor alarms when they are incorrectly set (those who monitor alarms at Qwest have the importance of the regular low voltage alarm impressed upon them). However, if a very low voltage alarm is wired out or set to report an alarm, its threshold should be set at the –46.5 V level shown above.

Table 12-5 **Alarm Thresholds on Analog Points**
Part 1B: **DC Voltage for VRLA Batteries**

AID or SUB-AID	CONDTYPE	MJ, MN or CR	NOTES	THRESHOLDS LOWER	THRESHOLDS UPPER
BATmPC or BATmQn (quarter voltages for 12 V batteries only)	LOW_VOLTAGE or HIGH_VOLTAGE or VOLTAGE_OUT_OF_LIMIT	MINOR	normal CELL float VOLTAGE -2.25 to -2.27 V/cell at 77 degrees F	±0.04 V/2 V cell (±0.06 V/4 V batt, ±0.08 V/6 V batt or ±0.15 V/12 V battery) from the nominal float of the pilot	
		MAJOR	(if only one alarm possible, Major is preferred to Minor)	±0.07 V/2 V cell (±0.10 V/4 V batt, ±0.15 V/6 V batt or ±0.25 V/12 V battery) from the nominal float of the pilot	
N48B1	LOW_VOLTAGE or HIGH_VOLTAGE or VOLTAGE_OUT_OF_LIMIT	MAJOR	plant float VOLTAGE -54.4 V *plant float -52.2 V (23 cell string)*	-51.5 -49.4	-56.5 -54.5
		CRIT.		-46.5 -46.5	-57.0 -55.0
	HIGH_VOLTAGE_HVSD	CRIT.		-56.1 (restart)	-57.5 -56.0
LVD	DISCONNECT	CRIT.	at the plant *at the equipment (per mfg; or)*	-43.25 -42.0	-44.0 (reconnect)
BATmM	LOW_VOLTAGE or HIGH_VOLTAGE or VOLTAGE_OUT_OF_LIMIT	MINOR	*midpoint measured between cells 12 & 13 on a 23 cell string*	-26.2	-28.2
		MAJOR		-25.6	-28.8
BATmH	VOLTAGE_OUT_OF_LIMIT	MINOR	differential voltage when comparing the two halves of a battery string		1.0
		MAJOR			1.6

VRLA Batteries less than a year old are still forming and equalizing in voltage, so in that timeframe, they may be out of the pilot cell limits listed above (may need to set them wider initially).

Most of these voltages are based on a premise of a float voltage of -2.27 volts per cell for the VRLA batteries, and that a 48 volt battery string is equipped with 24 batteries (a float voltage of -54.4 volts). *Some VRLA strings are equipped with 23 cells because of a misassumption that some older equipment could not handle the -54.4 float voltage (this fact is reflected above).*

When Temperature Compensation is used, the pilot cell low voltage alarm should be set at -2.15 volts per cell for typical VRLA batteries (multiply this value by the number of cells to get the proper value for 4, 6, and 12 volt batteries). Similar settings may be needed for pilot cell high voltage alarms when temperature compensation at low temperatures raises the voltage.

Low voltage disconnects are generally discouraged (because they are usually designed to protect the batteries, but fail when they're not supposed to, jeopardizing the critical loads); unless required by the manufacturer of the served equipment. If used, they should generally be in series with only the batteries; and not directly in series with the load (unless required by an equipment manufacturer).

Table 12-5 **Alarm Thresholds on Analog Points**
Part 1C: **DC VOLTAGE for "Constant Current" Applications of VRLA BATTERIES**

AID or SUB-AID	**CONDTYPE**	**ALARM**	**NOTES**	**THRESHOLDS**	
				LOWER	**UPPER**
BATmQn	LOW_VOLTAGE or HIGH_VOLTAGE	MAJOR	CELL float VOLTAGE normally near -2.33 V/cell (-14.0 V/12 V battery)	-13.0	-15.2
N48B1	LOW_VOLTAGE or HIGH_VOLTAGE or VOLTAGE_OUT_OF _LIMIT	MAJOR	plant "float" VOLTAGE varies around -56.0 V	-52.5	-59.5
		CRIT.		-46.5	-60.5
BATmM or BATmH	LOW_VOLTAGE or HIGH_VOLTAGE or VOLTAGE_OUT_OF _LIMIT	MINOR		±0.8 V from $^1/_2$ of the string voltage	
		MAJOR		±1.6 V from $^1/_2$ of the string voltage	

Gates/Hawker 6-packs have a higher specific gravity, and therefore, a higher float voltage than the levels reflected below. Some plants designed for use with these batteries are not capable of being voltage adjusted manually (e.g. AT&T/Lucent 3A, 3B, 3C), but the chargers will fluctuate the voltage greatly. "Float" voltages as low as -52.5, and as high as -59.5 are not abnormal, depending on the state of charge of the battery, in order to maintain a constant current to the battery. In these cases, thresholds should be set at the levels above. Because of the variation in battery float voltage, it may be wiser to alarm rectifier (as opposed to battery charger) voltages in these plants (either at the levels of Parts 1A or 1B, or at those recommended by the manufacturer — since the rectifiers don't float the batteries, float voltage is not as critical), and alarm the battery charger currents per Part 4 of this table or the manufacturer's recommendations.

Table 12-5 Alarm Thresholds on Analog Points
Part 1D: DC Voltage Set Points for Converter Plants and Engine Start Batteries

AID: P130Cn, N130Cn, N48Cn, P48Cn, N24Cn, P24Cn, ENGALTn, etc.

AID or SUB-AID	**CONDTYPE**	**ALARM**	**NOTES**	**THRESHOLDS**	
				LOWER	**UPPER**
(none) or BATENGm or BATCHG	LOW_VOLTAGE or HIGH_VOLTAGE or VOLTAGE_OUT_OF _LIMIT	MAJOR	Plant output of a converter plant should be set as near as possible to the nominal plant voltage (e.g., 130 V) Float of engine start batteries should be per manufacturer recommendation	±2 V from the nominal plant voltage	

Table 12-5 Alarm Thresholds on Analog Points
Part 2: Temperature Compensation and Current Limiting

To prevent thermal runaway in VRLA batteries, the charge current flowing to the batteries can be limited by automatically lowering the float voltage as the battery temperature rises (this is temperature compensation). The recommended settings for temperature compensation devices are shown below (not all devices have each of these settings, so try to match those that apply to the particular device). An attempt should be made to get as close as possible to these settings, but not all devices will be able to match these settings. Voltage should not be lowered below open circuit to avoid severe loss of battery life.

Optimum float voltage at 77° F	-54.4 V *(-52.2 for 23-cell string)*
Lowest voltage where compensation should stop	-52.0 V *(-49.9 for 23-cell string)*
Highest voltage where compensation should stop	-56.0 V
Temperature at which compensation to lower the float should start	77° - 86° F (25° - 30°C) *allowable to automatically raise float from 77° - 40° F (25° - 5°C)*
Maximum temperature at which compensation should end (to avoid taking the batteries below open-circuit voltage — also reference the end voltage above), or maximum Step Compensation Temperature	135°F (57°C)
Final Step Temperature (temperature at which voltage should be stepped 1-2 V below open circuit [-50 V])	160°F (71°C)
Maximum Battery Disconnect Temperature	175°F (80°C)
slope of compensation	-4.0 mV/cell/°C rise

Not all compensation is slope compensation. An attempt should still be made to match the parameters shown above (except for the slope parameter) when step compensation is used.

Many existing rectifiers used with VRLA batteries in OSP locations have voltage sensing circuits inaccessible by temperature compensation devices. For these, to limit battery charge current, a **Current Limiting** device placed in series with each battery string may be used. In addition, some devices perform both compensation and current limiting functions, offering even greater protection from thermal runaway. The acceptable limits for current limiting devices are shown below:

Acceptable Limits: Between C/8 and C/30

Where C is the Amp-hour rating (at the 8-hour rate to 1.75 V/cell) of the string. For example, the current limit of a 100 A-hr battery string limited to C/20 would be 5 Amps.

Care must be taken to ensure that current limiting does not cause the plant to perform a High Voltage Shut Down while attempting to recharge the batteries. This can happen on certain chargers if the current limiting is set too tightly. For example, one type of rectifier may perform an HVSD while attempting to recharge if the current limiting is set for C/20. In this case, the limits should be set for C/10. Check the documentation of the suppliers of the current limiting device and power plant to see if this may be a problem. Also, because discharge current as well as recharge current must pass through the current limiting device, ensure that the discharge current capacity of the device and its associated cabling is sufficient to meet the portion of the projected site load that will be placed on the individual string or group of strings served by the current limiting device.

There is no need to remotely report an alarm when temperature compensation or current limiting is active. However, battery temperature alarms or battery current alarms may be set in accordance with the guidelines given in the other Parts of this Table 12-5.

Table 12-5 Alarm Thresholds on Analog Points
Part 3: Temperatures

AID: P130Bn, N130Bn, N48Bn, P48Bn, N24Bn, P24Bn, ENGALTn

SUB-AID	CONDTYPE	MJ, MN or CR	DESCRIPTION	THRESHOLDS LOWER	THRESHOLDS UPPER
ROOM	LOW_TEMPERATURE or HIGH_TEMPERATURE or TEMPERATURE	MINOR	Room temperature is outside of "normal" operating temperature for the eqpt. *CEV, hut, or other OSP controlled enviro.*	65° F 52° F	81° F 95° F
		MAJOR	When the room temperature reaches this range, there can be an immediate degradation of battery reserve (low side) or equipment damage (high side) *CEV, hut, or other OSP controlled enviro.*	60° F 50° F	85° F 100° F

AID: P130Bn, N130Bn, P48Bn, N48Bn, P24Bn, and N24Bn

SUB-AID	CONDTYPE	MJ, MN or CR	DESCRIPTION	THRESHOLDS LOWER	THRESHOLDS UPPER
BATm or BATmUP or BATmLO or BATmPC	HIGH_TEMPERATURE or LOW_TEMPERATURE	MINOR	Flooded batt. temps. (especially on an upper tier) on charging can be several degrees higher than room temperature *For VRLA batts. in a controlled enviro.* *For VRLA bats. In uncontrolled enviro.*	64° F 52° F 57° F	86° F 98° F N/A
		MAJOR	For Flooded batteries *For VRLA batteries in a controlled enviro.*	59° F 50° F	90° F 105° F

AID: P130Bn, N130Bn, P48Bn, N48Bn, P24Bn, and N24Bn

SUB-AID	CONDTYPE	MJ, MN or CR	DESCRIPTION	THRESHOLDS LOWER	THRESHOLDS UPPER
BATm	DIFFERENTIAL_TEMP	MINOR	Flooded batt. temp. is 8° F above high ambient thermostat setting *VRLA batt. temp. is 13° F above high ambient thermostat setting*		8° F 13° F
		MAJOR	Flooded batt. temp. is 12° F above high ambient thermostat setting *VRLA batt. temp. is 20° F above high ambient thermostat setting*		12° F 20° F

When room temperatures are alarmed, temperature measurements of flooded batteries are often unnecessary because their thermal mass keeps them relatively free of thermal runaway and in-line with room temperatures that are not widely varying. The exception to this rule may be lead-antimony batteries. When lead-antinomies begin to approach end-of-life, they are susceptible to thermal runaway, and monitoring of battery temperatures to detect this condition is desirable.

Because of the high susceptibility to thermal runaway of VRLA batteries, whenever a monitor is available at the site capable of monitoring battery and/or differential temperatures, this should be done; and is much more useful than room temperature, especially in uncontrolled environments.

Table 12-5 Alarm Thresholds on Analog Points
Part 4: DC Current

Alarm points and levels will be monitored to the extent provided: All possible current monitoring points may or may not be monitored depending on the situation. This Tech Pub states that "major" power sources and Primary distribution source ends will be monitored. The following table should be used to provide alarms as required.

AID: N130Bn, N48Bn, P24Bn, N24Bn, P130Cn, N130Cn, P48Cn, N48Cn, P24Cn, and N24Cn

SUB-AID	**CONDTYPE**	**MJ, MN or CR**	**DESCRIPTION**	**THRESHOLDS LOWER**	**THRESHOLDS UPPER**
BATm	CAPACITY_EXCEEDED	MINOR (80%) MAJOR (100%)	Batteries should be engineered for a minimum of 4 or 8 hrs. reserve depending on whether there is an on-site engine. By alarming when batt. discharge reaches this minimum; we're alerted to add more strings due to growth. For example, a site with an engine, using 1680 A-hr. batts., is originally engineered for 6 hrs. to allow for growth — this is a discharge current in each string of approximately -240 A. As the load grows, the 4-hr. min. reserve is reached when each 1680 A-hr. string discharges approx. -295 A (the 4-hr. min. level for 4000 A-hr. cells is approx. -650 A; and the 8-hr. min. rate for 1680 A-hr. cells is approx. -190 A). By alarming at this level (or lower), there is warning to provide more batteries. (For the Lucent Galaxy, charge current is negative, and discharge is positive.)	80 to 100% of 4 or 8 hour disch. rating of battery	
	RECHARGE	MINOR or "Record Only"	This threshold is simply a status alarm to let the monitoring tech(s) know when the battery is recharging. Recharge will slow, the recharge current should drop below this threshold, and the alarm will go away. Set this at 3-5% of the 4-hr. discharge rate of the string. For example, the 4-hr. discharge rating of a 1680 A-hr. string is approx. 295 A. The alarm threshold could be set at 10 A.		≈C/150 (wet cells) ≈C/50 (VRLAs)
Battery or Converter “plant"	CAPACITY_EXCEEDED	MINOR	The **Plant** or **Converter** being monitored is at 80-90% of its rated capacity. (Capacity equals busbar or shunt capacity; or total rectifier/converter capacity minus one — n-1; or 80% of total rectifier capacity — extra 20% allows for recharge.)		80-90% of capacity
		MAJOR	The **Plant** or **Converter** being monitored is at 100% of its rated capacity. (Capacity equals busbar or shunt capacity; or total rectifier/converter capacity minus one — n-1.)		100% or n-1
CNTRL or DISTm	CAPACITY_EXCEEDED or OVER CURRENT	MINOR	The **Breaker** or **Fuse** is nearing its engineered capacity		80%
		MINOR	The Fuse or Breaker is near the engineered feeder capacity of the BDFB		40-50%
RECTm		MINOR	The **Rectifier** exceeds its rated capacity		110%
		MAJOR			115%
BATm	IMBALANCE	MINOR	This applies during both discharge and recharge if the current from this string exceeds the average current per string by this percentage. The average current per string	10% (wet) 30% (VRLA)	10% (wet) 30% (VRLA)
		MAJOR	is the total current flowing into or out of all strings divided by the number of strings.	25% (wet) 50% (VRLA)	25% (wet) 50% (VRLA)

Table 12-5 Alarm Thresholds on Analog Points
Part 5: AC Voltage

AC voltage measurements are defined as the rms (effective)voltage difference between any two conductors of the circuit. The actual level of the voltage is determined by the phase of the circuit (single or 3 phase), configuration, and the base voltage.

From section 220-2 of the National Electric Code (NEC, the following voltage levels should be used in AC computations:

- 120 V, 1-Ø
- 120/240 V, 1-Ø
- 208/120 V, 3-Ø, Y, where 208 can be used as a 1-Ø or 3-Ø voltage, and 120 is 1-Ø
- 240 V, 3-Ø, Δ, for 1-Ø or 3-Ø loads (a leg can also be center-tapped for 120 V, 1-Ø)
- 480/277 V, 3-Ø, Y, where 480 is three-phase, and 277 is a single-phase voltage

Because of this wide variation in voltages, it is essential to ensure that the served equipment is properly configured for the provided voltage, and the PSMC is configured to reflect the actual voltage at a site.

AID: ENGALTn, COMACn, ACINn

SUB-AID	CONDTYPE	ALARM	DESCRIPTION	THRESHOLDS	
				LOWER	**UPPER**
VOLTm Or PHASEm	LOW_VOLTAGE or HIGH_VOLTAGE Or VOLTAGE_OUT_OF_LIMIT	MINOR	The AC voltage being provided to the system is outside of acceptable levels. If the voltage doesn't return to normal, a tech must investigate	95%	105%
		MAJOR	The AC voltage being provided to the system is dangerously outside of acceptable levels. Immediate action must be taken by a qualified power technician	90%	110%

Table 12-5 Alarm Thresholds on Analog Points
Part 6: AC Current

AID: ENGALTn, COMACn, ACINn

SUB-AID	CONDTYPE	ALARM	DESCRIPTION	THRESHOLDS	
				LOWER	**UPPER**
CURNTm or PHASEm	CAPACITY_EXCEEDED	MINOR	The AC current exceeds engineered capacity of the protector. Set at 80% of capacity and/or ampacity of feeder(s) or breaker/fuse		80%
	IMBALANCE	MINOR	One leg of the AC current to the system is out of balance with the other legs (based on the normal load current — which may have to be adjusted as the load grows). The situation should be investigated for possible engineering or installation errors, or phase failures	85%	115%

Table 10 Alarm Thresholds on Analog Points
Part 7: Fuel Alarm Thresholds

Fuel Tanks come in all different sizes. To have a common measuring point for sizing fuel tanks, they are sized based on engine run hours at full rated load. The engine manufacturers will gave gallons/hour consumption at this load, from which the tank size is computed; or similarly, the hours reserve remaining in the tank can be computed by dividing the consumption rate into the gallons.

AID: ENGALTn

SUB-AID	CONDTYPE	MJ, MN or CR	DESCRIPTION	THRESHOLDS	
				LOWER	UPPER
MAINFUEL or DAYFUEL	LOW	MAJOR	The level in the fuel tank is at such a level that if a fuel order is not placed within the hour, and the engine is running, we may not get fuel to the site for a prolonged run. The minimum and the fuel tank size may be extended for very remote locations.	25-33% (min. 12 hrs. @ full load)	

12.6 Typical Power Alarm and Monitor Points

Because of limited numbers of points on PSMCs, it is not feasible to alarm everything in a site. This section serves as a guide to which alarm, monitor, and control points to connect for different types of sites.

12.6.1 Typical PSMC-CL Points in Smaller Sites

The more information that can be communicated from a site with its “alarming” system, the better the analysis and dispatch will be. A PSMC for Confined Locations (PSMC-CL) can convey the most information about a small site. Sample PSMC-CL points are listed below in Parts 1A and 1B of Table 12-6. Each of the analog points listed (e.g., plant voltage, string current, etc. will also have binary thresholds (listed in Table 12-5).

Table 12-6 Typical Power Alarm and Monitor Points
Part 1A: Typical Power Points for OSP Cabinets and Customer Premise (PSMC-CL)

AID and sub-AID	CONDTYPE or ACTION	CR, MJ, or MN	TYPE	NOTES
COMAC1	COML_AC_FAIL	MJ	binary	
N48B1	MAJOR	MJ	binary	power plant major
N48B1	MINOR	MN	binary	power plant minor
N48B1	CRITICAL	CR	binary	power plant critical alarm
N48B1RECTm	FAIL	MN	binary	generic plant rect. fail (individuals if possible)
N48B1BATm	DIFFERENTIAL_TEMP	CR	binary	one per string **if possible** (battery - ambient)
N48B1DIST	FUSE/BRKR_OPERATE	MJ	binary	generic distribution fuse or breaker alarm
N48B1	LOW_VOLTAGE	MJ	binary	plant low voltage or battery on discharge
N48B1	VERY_LOW_VOLTAGE	CR	binary	
N48B1	HIGH_VOLTAGE	MJ	binary	
N48B1BATm	DISCONNECT	MJ	binary	individual strings or all batteries disconnected
RNG1	MAJOR	MJ	binary	ring plant major (if there is a ring plant)
RNG1	MINOR	MN	binary	ring plant minor
N48B1	VOLTAGE		analog	plant voltage
N48B1	CURRENT		analog	plant current
ROOM	TEMPERATURE		analog	cabinet or room ambient temperature
N48B1BATmPC	TEMPERATURE		analog	one battery temperature per string (2 if possible)
N48B1BATmH1	VOLTAGE		analog	first half voltage per string
N48B1BATmH2	VOLTAGE		analog	second half voltage per string
N48B1BATm	CURRENT		analog	string current per string

If there is a PSMC-CL that is not reporting via X.25/TL1, choose the most important points at the top of this list, and have them connected to the output contacts of the monitor. Then connect these output contacts to the alarm device of the site.

Table 12-6 Typical Power Alarm and Monitor Points
Part 1B: Typical Power Points for CEVs, HUTs, CDOs (small COs without an engine), and Radio Sites (PSMC-CL or PSMC)

AID and sub-AID	CONDTYPE or ACTION	CR, MJ, or MN	TYPE	NOTES
COMAC1	COML_AC_FAIL	MJ	binary	
N48B1	MAJOR	MJ	binary	power plant major
N48B1	MINOR	MN	binary	power plant minor
N48B1	CRITICAL	CR	binary	power plant critical alarm
N48B1RECTm	FAIL	MN	binary	generic plant rect. fail (individuals if possible)
N48B1BATm	DIFFERENTIAL_TEMP	CR	binary	one per string **if possible** (battery - ambient)
N48B1DIST	FUSE/BRKR_OPERATE	MJ	binary	generic distribution fuse or breaker alarm
N48B1	LOW_VOLTAGE	MJ	binary	plant low voltage or battery on discharge
N48B1	VERY_LOW_VOLTAGE	CR	binary	for ECS plants, these alarms are not distinct, &
N48B1	HIGH_VOLTAGE	MJ	binary	the condition is "VOLTAGE_OUT_OF_LIMIT"
N48B1BATm	DISCONNECT	MJ	binary	individual strings or all batteries disconnected
RNG1	MAJOR	MJ	binary	ring plant major (if there is a ring plant)
RNG1	MINOR	MN	binary	ring plant minor
xC1	MINOR	MN	binary	converter plant minor (converter fail)
xC1	MAJOR	MJ	binary	converter plant major (other converter alm)
1PHINV1	FAIL	MJ	binary	inverter plant fail (if there is an inverter
N48B1	VOLTAGE		analog	plant voltage
N48B1	CURRENT		analog	plant current
ROOM	TEMPERATURE		analog	cabinet or room ambient temperature
N48B1BATmPC	TEMPERATURE		analog	one batt. temperature per string (2 if possible)
N48B1BATmM	VOLTAGE		analog	midpoint voltage per string
N48B1BATmPC	VOLTAGE		analog	pilot cell voltage; one per string
N48B1BATm	CURRENT		analog	string current per string
COMAC1VOLTm	VOLTAGE		analog	AC voltage per phase
COMAC1CURNTm	CURRENT		analog	AC current per phase

A CEV, Hut, Radio site, or small CO (CDO) will usually only have one small battery plant, no engine, a ring plant, and may or may not have converters/inverters. Therefore, there will not be many alarms. Many of these sites (particularly the newer ones) will have a power plant controller that can be easily converted into a small PSMC (capable of analog and control features) with the simple addition of a circuit pack. Again, this list is prioritized, so that those sites without a monitor may use the alarms at the top of the list first.

Radio sites generally have Negative 24 volt plants instead of Negative 48 volt plants. Therefore, replace all N48 in the table above with N24. The "x" above in the AID for converter plants means to replace it with the polarity and voltage of the converter plant (e.g., N130).

12.6.2 Typical Central Office Power Alarm Points

The following Table lists “typical” central office power alarm points. Central Office configurations and alarming vary so greatly, that it would be impractical to try to list every possible alarm found in these locations. Therefore, this Table serves as only a guide to the most common points. The table assumes the use of a PSMC in the site.

The numbers of points that can be monitored in mid-sized and larger COs are limited only to the number of points available on the PSMC. The following table is a list of possible points that (it is not all-inclusive, but only suggestive of possible points) organized by priority under each heading. The criticality (critical, major, or minor) of the alarm has not been included here. It can be found in Table 12-2. Each of the analog points (e.g., plant voltage, etc.) will also have binary alarm set points (listed in Table 12-5).

Per Chapter 7 of this Tech Pub, several alarm points listed below are optional, dependent on whether there are enough available alarm points on the PSMC. Use the information in Chapter 7 in conjunction with the available points on the site’s PSMC to determine which alarm points are to be used.

This site assumes one -48 V battery plant, one -130 V converter plant, and a single-phase 120 V inverter and UPS. Sites with plants having other polarities and voltages should substitute the appropriate AID, as per Table 12-1. There may be more than one plant of a particular type. Each plant will have its own points.

Table 12-6 Typical Power Alarm and Monitor Points
Part 2: Power Points for Central Offices with Engines

AID and sub-AID	CONDITION TYPE	TYPE	NOTES
BATTERY/RECTIFIER PLANT			
N48B1RECTm	FAIL	binary	generic plant rectifier fail (individuals if possible)
PSMCn or N48B1	MAJOR	binary	backup generic major and minor from PSMC or plant, connected to Dantel or other alarm device
PSMCn or N48B1	MINOR	binary	
N48B1DIST	FUSE/BRKR_OPERATE	binary	generic distribution fuse or breaker alarm(s)
N48B1	LOW_VOLTAGE	binary	or taken as threshold off analog plant voltage
N48B1	VERY_LOW_VOLTAGE	binary	(optional)
N48B1	HIGH_VOLTAGE	binary	or taken as threshold off analog plant voltage
N48B1	VOLTAGE	analog	plant voltage
N48B1	CURRENT	analog	plant current
N48B1ROOM	TEMPERATURE	analog	battery plant room ambient temperature
N48B1BATmPC	TEMPERATURE	analog	one battery temperature per plant
N48B1BATmM	VOLTAGE	analog	midpoint voltage per string (optional)
N48B1BATmPC	VOLTAGE	analog	pilot cell voltage; one per plant
N48B1BATm	CURRENT	analog	string current per string
N48B1RECTm	CURRENT	analog	individual rectifier currents (optional)
N48B1DISTm	CURRENT	analog	currents to larger individual loads (optional)
PSMCn	WATCHDOG	binary	PSMC failure run to Dantel or other alarm device
RING PLANT			
RNG1	MAJOR	binary	use only if other alarms that make up this major and minor are not remoted to NMA
RNG1	MINOR	binary	
RNG1RGENm	FAIL	binary	generic or individual generator fail
RNG1INTERm	FAIL	binary	generic or individual interrupter fail
RNG1FUSE	FUSE/BRKR_OPERATE	binary	ring plant distribution fuse alarm
RNG1	TRANSFER	binary	generator or interrupter transferred to backup
UPS			
1PHUPS1	FAIL (or MAJOR)	binary	UPS fail or other major UPS alarm
1PHUPS1	MINOR	binary	any minor UPS alarm (non-service-affecting)
1PHUPS1	OFF_NORMAL	binary	UPS in an abnormal state (e.g., on bypass, etc.)
1PHUPS1	VOLTAGE	analog	UPS AC output voltage (optional)

Table 12-6 Typical Power Alarm and Monitor Points
Part 2: Power Points for CENTRAL OFFICES with ENGINES
(Page 2 of 2)

AID and sub-AID	CONDITION TYPE	TYPE	NOTES
INVERTER PLANT			
1PHINV1	FAIL (or MAJOR)	binary	inverter plant fail or other inverter major alarm
1PHINV1	MINOR	binary	inverter minor alarm (e.g., transferred, etc.)
1PHINV1	OFF_NORMAL	binary	inverter in manual bypass or other abnormal state
1PHINV1	VOLTAGE	analog	inverter output voltage (optional)
1PHINV1	CURRENT	analog	inverter output current (optional)
COMMERCIAL AC			
COMAC1	COML_AC_FAIL	binary	to be monitored per phase, if possible
COMAC1TRNSW	RESTORE	binary	commercial AC restored (optional)
ACIN1PHASE	IMBALANCE	binary	(optional)
ACIN1VOLTm	VOLTAGE	analog	voltage and current, measured on the load side of the transfer switch (per phase in most cases)
ACIN1CURNTm	CURRENT	analog	
STANDBY ENGINE			
ENGALT1	MAJOR	binary	use only if other alarms that make up this major and minor are not remote to NMA
ENGALT1	MINOR	binary	
ENGALT1	STBY_ENG_FAIL	binary	
ENGALT1TRNSWm	PROPER_OPERATION	binary	transfer switch operated (optional)
ENGALT1	STBY_ENG_RUN	binary	
ENGALT1BATCHG	FAIL	binary	engine start battery charger fail
ENGALT1	CRANK_FAIL	binary	(optional) if these alarms are combined into generic engine major and minor or engine fail
ENGALT1COOLANT	LOW_TEMPERATURE	binary	
ENGALT1COOLANT	HIGH_TEMPERATURE	binary	
ENGALT1	OVERSPEED	binary	
ENGALT1FAN	FAN	binary	
ENGALT1OILPRESS	LOW	binary	
ENGALT1MAINFUEL	FUEL_SYS_TRBL	binary	generic fuel system problem (e.g., leak, low fuel)
ENGALT1MAINFUEL	FUEL_LEAK	binary	(optional) if combined into generic fuel system trouble
ENGALT1MAINFUEL	LOW	binary	
ENGALT1BATCHG	VOLTAGE	analog	start battery voltage
CONVERTER PLANT			
N130C1	MINOR	binary	use only if other alarms that make up this major and minor are not remote to NMA
N130C1	MAJOR	binary	
N130C1CONVm	FAIL	binary	generic or individual converter fail(s)
N130C1DIST	FUSE/BRKR_OPERATE	binary	generic converter distribution fuse alarm(s)
N130C1	VOLTAGE	analog	plant voltage
N130C1	CURRENT	analog	plant current — if shunt available and accessible

CHAPTER 13 TURN UP, TEST AND ACCEPTANCE PROCEDURERS

Chapter and Section **Page**

Forms **Page**

13.1 General

The attached forms are for use in all types of sites for performance of power turn up, test and acceptance. The forms are self-explanatory, with listings for notes, functions, and supporting documentation. Supporting documentation for the functions will vary by site because there are many different manufacturers for each type of equipment.

13.2 Maintenance Window Guidelines for Power

A Maintenance (Installation) Window is a predetermined period during each day when specific planned maintenance and infrastructure provisioning work activities should be performed. The purpose of scheduling work during specific times is to ensure a minimal amount of disruption to Qwest customers. Although load and service conditions vary by site, nighttime is generally the time of least traffic in most Qwest sites. Therefore the official Maintenance Window is:

- Monday through Friday 10:00 p.m. to 6 a.m.
- Saturday 10 p.m. to Monday 6 a.m.

If in doubt, almost all Power work that involves working on live equipment should be done in the Maintenance Window to be safe, because nothing works without Power. However, because local conditions for each site are more likely to be known locally, the final decision is left up to the local managers.

- Functional testing of rectifier, converter, inverter, and ring plant power cycling and transferring
- Any maintenance that involves physically touching live equipment with metallic wrenches/tools, etc.
- Generally, anything that involves changing voltage or current levels of equipment manually (including to test alarms)

The following Power and Grounding Installation/Removal activities must be performed in the Maintenance Window. These generally only apply to in-service or "hot" equipment, or the specific times when "dead" equipment is being connected to "live" equipment. Power and Grounding Installation Guidelines are contained in Chapters 8, 9, and 10 of Qwest Technical Publication 77350.

- Any work on (connections to) the Ground Window MGB, CO Ground Bars, or main Horizontal or Vertical Equalizers while they are "in-service"
- Any work on or connections to the main power board or BDFB busses (including the "return" busses) while they are "hot" (running) — Turning on the breaker or installing the fuse is not considered a connection to the buss, and therefore, may be done outside of the Maintenance Window; however, although connection of cables to "dead" fuse or breaker positions on the rear is not technically "hot", there are nearby hot busses, which may merit consideration for moving that work to the Maintenance Window
- Any addition or removal of batteries from "live" strings (although it's desirable to do all this work in the Maintenance Window, it's only absolutely required for single string plants)

- Any connection or disconnection on the main AC power Board (feeder side) or any work on the AC transfer switch

Outside Plant locations (e.g., RT Cabinets, CEVs, huts, Customer Prem, etc.) deserve special Maintenance Window consideration due to access, lighting, and affected customers. Note that, in all cases, the final decision is up to the local manager. These managers also sign installation MOPs (even though Pub 77350 is geared towards CO work, the MOP process is recommended for OSP sites as well; especially Customer Prem sites, as per Pub 77368). Some guidelines for OSP Power work, from NROC Power Tech Support, follow. They apply to installation and maintenance activities described above, but modified by the following paragraphs.

- OSP sites/equipment with less than 96 DS0 (POTS) customers (equivalent to 4 or less T1s), might usually be exempted from the power maintenance window. SHRPS/SHNS and other guaranteed services should usually follow the Maintenance Window, due to significant customer refunds for outages.

- For RT cabinets, night work may not be feasible in all cases (although small jobs may be done by flashlight); due to the disruption that lighting, running trucks, generators, etc. can cause in neighborhoods. In some neighborhoods, for some "planned" activities (especially routine maintenance), night work may cause more customer ill will than it prevents'

- Customer Prem installations are supposed to allow us 7 x 24 access, but this doesn't always happen. For Customer Premises that allow 7 x 24 access, Maintenance Window guidelines should generally be followed due to the HiCap circuits/services usually located there. Any Customer Maintenance Window should supersede our own (coordinate with them).

- Controlled environment electronic equipment enclosures (EEEs) include CEVs, CECs, huts, UEs, etc. These sites generally have fiber, and/or enough POTS customers to warrant Maintenance Window guidelines being followed.

FORM 820

Qwest
GENERIC TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
Equipment Verification		
Frames located per floor plan		
Installed per drawings		
Equipment is what was ordered		
Equipment options are correct		
Spare equipment provided per ordering spec (if applicable)		
Power feed to equipment checked		
Workmanship		
Frame alignment and equipment mounting		
Relay rack numbering		
Wiring and cabling		
Equipment numbering and lettering		
Cable openings sealed		
Cable racks and other ironwork		
Power and fusing (spare fuses available also)		
Performance Tests		
Tests per recommended equipment manual		
Tests per Test & Acceptance package sent out with job (contact the Engineer if no such package sent)		
Documentation		
"As-built" drawings sent back to engineering		
Replacement drawings		
Initial battery charge reports (if applicable)		
Equipment manuals received		
Original test results retained		
Alarms		
Affected alarms tested prior to work start		
Local and audible alarms (as applicable) tested prior to work start		
Remote alarms installed and tested with NROC Alarm Center (800-713-3666)		
Name of NROC Center Contact with whom alarms were tested:		
Other		

Comments (all No answers must be commented on)

Form 820 Generic Test and Acceptance Checklist

FORM 821A

Qwest
POWER ROOM LIGHTING TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. Lighting provided in the power areas is adequate, and located in accordance with the SITE: record lighting plan drawing		
2. As a minimum, emergency and task/stumble lighting is available in stairwells, over the "power board", over the engine control panel and AC transfer switch, over the AC switchgear, and in the engine room		
3. Emergency and task/stumble lighting works		
4. Feeding fuse/breaker positions and emergency and task/stumble lighting fixtures are properly stenciled as to the equipment they feed or where they are fed from		

Test & Acceptance should be performed with the installer on site. Note below all problems they fix
Comments (all No answers must be commented on)

Form 821A Power Room Lighting Test and Acceptance Checklist

FORM 821B

Qwest
ALARM AND/OR POWER MONITOR/CONTROLLER (PSMC)
TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. Complete copy of suppliers' manuals and drawings available on site		
2. Verify accuracy of the database, and ensure an electronic backup is made where applicable		
3. Verify that analog channel readings are within 1% of the values measured by plant meters or by technician's hand-held meter		
4. Bring in **each** binary alarm associated with this monitor (or other alarming device) and verify that technicians in Power NROC (800-713-3666) receive the alarm over NMA		
A. There is local indication of the alarm on the monitor, if monitor is capable of this function		
B. If monitor is capable and equipped, verify the difference between Minor Rectifier Fail (1 rectifier), and Major Rectifier Fail (2 or more rectifiers failed)		
5. Bring in binary alarms associated with the threshold settings of analog points (e.g., low voltage, etc.), and ensure that these alarms report locally on monitor and over NMA		
A. Analog points' binary thresholds are set properly (according to REGN 154-103-001)		
6. If monitor is controlling High Voltage Shutdown (HVSD) verify proper operation		
7. Ensure that all binary, analog, & control points requested on engineering job were provided, & ensure that there is a record left in office on paper and/or on disk of the assignments		
8. If monitor is capable and equipped, verify the difference between Minor Converter Fail (1 converter), and Major Converter Fail (2 or more converters failed)		
9. Verify security levels (e.g., different passwords), and dial-back numbers (if applicable)		
10. System reboots properly after being turned off/on		
11. Verify through NROC Center or NMA database group continuity of X.25 link where applicable		
12. When monitor is equipped with control functions, verify proper operation of these functions (e.g., rectifier shutdown/restart, engine start/stop, etc.)		
13. Verify that laptop can communicate with monitor over RS-232 port		
14. Verify communication with unit over a dial-up		

Test & Acceptance should be performed with the installer on site. Note below all problems they fix
NOTE: Use supplier, Bellcore, and Qwest documentation as a guide to performing the tasks above. NOTE: When testing alarms and functions, be sure not to interrupt service unless done during the Maintenance Window and with notification to appropriate personnel
Comments (all No answers must be commented on)

Form 821B Alarm and/or Power Monitor/Controller (PSMC) Test and Acceptance Checklist

FORM 821C

Qwest
BDFB, POWER BOARD, OR FUSE PANEL
TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. Proper equipment was ordered and is sized appropriately for the application		
2. Verify proper load bus arrangements		
3. Verify proper return bus options		
4. Verify accuracy & proper operation of the digital or analog meters & current shunts		
5. Test fuse alarms for proper operation and continuity to NROC (Note: BDFBs and other secondary fuse panels are not monitored by the Power NROC group, but by the groups who monitor the equipment served by these secondary protection devices)		
6. Verify proper placement, anchoring, and stenciling of the bay(s) and/or shelves		
7. Ensure that all fuse/breaker assignments are properly marked/stenciled for the loads they feed, and that all incoming and outgoing cables are properly tagged		
8. Verify proper connections of wires/cables to the fuse distribution, ground, and battery return busses/connections		
9. Verify proper cable routing		
10. Verify proper frame and central office grounding		
11. Ensure that BDFBs are equipped with a sticker(s) specifying the maximum feeder load (50% of the protector size) for each feeder		

Test & Acceptance should be performed with the installer on site. Note below all problems they fix

NOTE: Use supplier documentation as a guide to performing the tasks above.
NOTE: Work on a Power Board or BDBF has the potential to interrupt service. Service shall not be interrupted when installing primary or secondary distribution panels. Cutover of a BDFB or Power Board should probably occur during the Maintenance Window if the power plant is already up and supporting loads.

Comments (all No answers must be commented on — use the back of this form if necessary)

Form 821C BDFB, Power Board, or Fuse Panel Test and Acceptance Checklist

FORM 822

Qwest

BATTERIES & BATTERY STANDS TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. Battery stands and batteries are stenciled or identified with a minimum of installation and/or manufacturing date (on batteries), string numbers/letters, and cell numbers.		
2. Batteries and connectors are free of the following defects.		
A. Cases crazed, cracked, bulged, corroded, or leaking		
B. Level indicators stuck or missing		
C. Cover or post rise, and/or post corrosion		
D. Excessive positive plate growth or strap growth		
E. Excessive plate bowing or cracking		
F. Excessive needle growth		
G. Lead-sulfate crystals (this should be checked after batteries have received their full initial charge)		
3. Electrolyte level is proper, and limits for electrolyte level are marked on the batteries.		
4. Proper vent and filler caps or funnels are installed, and flame arrestors are equipped with dust covers.		
5. Battery records/logs and any manufacturer documentation are on-site and easily accessible. The Storage Battery report (RG47-0001) should have been filled out by the installation vendor.		
6. Neutralizing agents and protective equipment are available nearby for use as required in the battery area (eyewash, baking soda or equivalent, rubber gloves, goggles, rubber apron).		
7. Thermometers, hydrometers, and holders are furnished and mounted as required.		
8. Check batteries and intercell connections integrity by placing string on a short 5 minute discharge test into a real load or load box load. (This requirement is optional due to the fact that some battery strings are installed long before they are connected to the real load.) As a minimum attempt to determine if connections were properly tightened with a torque wrench.		
9. All voltage readings are within ±0.05 of the float average (e.g., 2.20 V/cell)		
10. Spill and disposal procedures are posted near the batteries.		
11. Battery stand is braced appropriately for earthquake zone in which site is located.		

Test & Acceptance should be performed with the installer on site. Note below all problems they fix.
Comments (all No answers must be commented on)

Form 822 Batteries and Stands Test and Acceptance Checklist

FORM 823A

Qwest
RECTIFIER TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. Rectifiers are properly assembled, installed, and stenciled or identified		
2. Correct type & capacity fuses are provided, & all fuses are clean & properly installed		
3. AC power connections are properly made. Ensure proper transformer taps and phase rotation where applicable		
4. Ensure that correct rectifier (size, type, AC input, etc.) was ordered, including correct wiring or apparatus options		
5. Rectifiers operate per individual operation tests, and basic operational features work		
6. Plant meters are accurate and properly adjusted		
7. Alarm settings are adjusted to requirements, and proper alarm signals are transmitted (ensure alarms reach the NROC Center)		
8. Current limiting and partial load features of units are set and adjusted properly		
9. High voltage shutdown (HVSD) feature operates properly, and all other DIP switches, potentiometers, and other options are properly set, including alarm thresholds		
10. Outputs of all units are stable (non-hunting, except for load sharing variations), & rectifier float voltages are properly set for battery type (see REGN 154-103-001) & load sharing		
11. Test rectifier fail alarms for continuity to the NROC Center		
12. Simulate an AC power failure to verify that the units' auto-restart capability and current walk-in feature operate properly when AC power is restored. Ensure also that alarms clear and that the units return to float voltage		
13. All rectifiers are capable of operating, regulating, and current limiting at full load		
14. Ensure AC fuse panel(s) feeding rectifiers have adequate spare capacity. If not, notify Real Estate		
15. For multi-phase fed rectifiers, verify appropriate operation or shutdown during phase failure		
16. Ensure proper selection and routing of rectifier control cables to plant controller		
17. Ensure rectifier frames are properly grounded & that battery return cables are properly grounded & sized, dependent on whether plant is integrated, isolated, or combined		
18. Ensure rectifier DC output cables are properly installed, & sized according to Tech Pub 77385 (for 200 and 400 Amp rectifiers), or manufacturers' recommendations (all other sizes)		
19. Ensure that there is adequate ventilation & heat dissipation so rectifier will not overheat		
Test & Acceptance should be performed with the installer on site. Note below all problems they fix		
NOTE: When testing alarms and functions, be sure not to interrupt service unless done during off hours and with notification to appropriate personnel		
Comments (all No answers must be commented on)		

Form 823A Rectifier Test and Acceptance Checklist

FORM 823B

Qwest

POWER/BATTERY PLANT TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. All battery distribution cables are of correct size and type, and properly terminated		
2. All equipment of control and distribution bays are correctly stenciled or identified		
3. All control circuit, charge, and discharge fuses and/or circuit breakers are of the correct type and capacity, and located as shown on the drawings		
4. Alarm fuse positions are equipped with correct fuses, and fuse and circuit breakers are properly designated as to the equipment they serve		
5. Verify alarm operation, both locally, and to the NROC Center		
6. All DC meters are calibrated and properly adjusted		
7. All fuses are tight in their respective fuse holders, and fuses and circuit breakers are free of excessive heat		
8. The battery float voltage is correct (check after meter calibration, and initial charging of the batteries)		
9. The voltage alarm settings are correct per REGN 154-103-001		
10. Spare fuses are provided, and properly located and designated, on or near the battery plant		
11. If LVD is used (use only where required, such as with a DMS®10 switch), ensure setting is -43.25 V or less.		

Test & Acceptance should be performed with the installer on site. Note below all problems they fix
Comments (all No answers must be commented on)

Form 823B Power/Battery Plant Test and Acceptance Checklist

FORM 824A

Qwest
CONVERTER PLANT TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. The converter plant is properly assembled and installed (including properly made electrical connections, and stenciled or identified		
2. The input and output fuses are the correct type and capacity		
3. The discharge fuse alarms are operative, and connected properly, and spare fuses are available		
4. The voltage alarm levels are properly adjusted to specified limits		
5. All alarms function properly, and are received by the NROC Center		
6. High voltage shutdown (HVSD) feature operates properly		
7. The converter plant meters are accurate, and properly adjusted, and all other LEDs or other indicators work properly		
8. The output voltage is adjusted within the specified limits, and can be accurately read from the test jacks		
9. The output current limit is properly set, as well as any other options set through DIP switches or potentiometers		
10. Verify that the converter plant functions properly under load for at least 30 minutes, and that there are no problems if the converters are switched on and off.		

Test & Acceptance should be performed with the installer on site. Note below all problems they fix
NOTE: When testing alarms and functions, be sure not to interrupt service unless done during off hours and with notification to appropriate personnel
Comments (all No answers must be commented on)

Form 824A Converter Plant Test and Acceptance Checklist

FORM 824B

Qwest
RESIDUAL RING PLANT TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. The ringing plant is properly assembled, installed, and stenciled or identified		
2. Ringing plant fusing is in agreement with site drawings		
3. All alarms operate properly, including transfer alarms (ensure alarms reach NROC center)		
4. The transfer feature operates automatically when a power failure occurs (for units when Ring Generator 1 is AC powered), or if Ring Generator 1 fails. (This transfer also applies to those sites equipped with interruptors besides the ring generators)		
5. If equipped, the transfer feature operates properly by manual or test transfer methods		
6. All voltages, tone levels, and frequencies are within specified limits		
7. If meters are provided, they are accurate, and within adjustments		

Test & Acceptance should be performed with the installer on site. Note below all problems they fix
Comments (all No answers must be commented on)

Form 824B Residual Ring Plant Test and Acceptance Checklist

FORM 825A

Qwest
INVERTER TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. The inverter plant is properly assembled and installed (including proper electrical connections), and stenciled or identified		
2. Input, output, and alarm fuses are the correct type and capacity, and output distribution is properly sized and connected		
3. Simulate an AC power failure. Ensure proper operation and transfer. During outage check output voltage and frequency		
4. Verify that plant is capable of operation at full load, in both AC input or DC input modes. (Use a dummy load — e.g., load box — if necessary to fully load the plant)		
5. Verify proper operation of maintenance bypass, if equipped		
6. Verify proper operation of transfer switch		
7. Alarms operate and clear properly (ensure alarms remote to the NROC Center)		
8. Verify proper operation of any automatic shutdowns (e.g., low voltage, emerg. stop, etc.)		
9. Verify proper operation of all controls and indicators (meters, LEDs, etc.)		
10. Ensure that the green wire ground is properly connected		
11. Ensure there is adequate room and ventilation around the inverter		

Test & Acceptance should be performed with the installer on site. Note below all problems they fix
NOTE: When testing alarms and functions, be sure not to interrupt service unless done during off hours and with notification to appropriate personnel
Comments (all No answers must be commented on)

Form 825A Inverter Test and Acceptance Checklist

FORM 825B

Qwest
UPS TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. The UPS is properly assembled, installed, and stenciled or identified in accordance with Engineering instructions		
2. The correct type and capacity fuses are provided, and all fuses are clean and properly installed		
3. AC/DC power connections are made in accordance with Engineering instructions, and in compliance with Qwest Technical Publication 77355		
4. Transformer taps are set properly		
5. Ensure proper AC phase rotation on the output		
6. Plant meters are accurate and properly adjusted		
7. Alarm settings are adjusted to requirements, and proper alarm signals are transmitted. Ensure that alarms reach NROC Center		
8. Correct wiring or apparatus options provided		
9. Current limiting and partial load features of units are set and adjusted per Engineering requirements		
10. High voltage shutdown feature operates properly		
11. Outputs are stable (non-hunting, except for load sharing variations)		
12. Simulate AC power failure to verify unit's auto-switch capability, and that it operates properly when AC power is restored (ensure that alarms clear when AC is restored). Check for proper return to battery float voltage		
13. UPS capable of operating at full load		
14. Battery chargers are operating at the required output voltage		

Test & Acceptance should be performed with the installer on site. Note below all problems they fix

NOTE: Use supplier documentation as a guide to performing the tasks above.
NOTE: When testing alarms and functions, be sure not to interrupt service unless done during off hours and with notification to appropriate personnel

Comments (all No answers must be commented on)
reference Routines EE550 and EE551

Form 825B UPS Test and Acceptance Checklist

FORM 826A

Qwest

STANDBY ENGINE TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. Engine-alternators & associated equipment are located according to the floor plan drawings, & are installed according to Engineering request, & are properly sized (e.g., fuel and exhaust system piping & tubing)		
2. Engine start batteries and chargers are in good condition, and installed and operating properly		
3. Verify start batteries and charger per Forms 822, 823A, manufacturers' documentation, and TPP below		
4. A remote emergency stop switch/button is located outside but near the engine room, & is properly identified		
5. Test records, logs, and manufacturer documentation is on site and accessible		
6. Before operation, inspect for the obvious, like assembly; fuel or oil leaks; or loose, missing or damaged parts		
7. Fuel in main and day tanks is sufficient and free of excess water and other contaminants		
8. Oil and coolant levels are sufficient, fluids are contaminant-free, and jacket water heater is operational		
9. Engine-alternator operating instructions are posted near the engine, and are clear and easy to use		
10. Adequate ear and eye protection is available in the engine room, and adequate warning labels are posted		
11. Ensure that engine, engine room metallic parts & lines, and alternator neutral are all grounded per Pub 77355		
12. Engine crankcase breather is vented to atmosphere or discharge damper		
13. With the engine mfg & the installer present perform a first test of the genset with the engine on a full load bank for 2-4 hrs (preferably run this test on site; however, the test may be done at the mfg's location with Qwest present to observe). Observe all functions, readings, alarms, etc., & note abnormalities, paying special attention to the following:		
A. Water, fuel, and oil temperatures and pressures are within limits		
B. Ensure proper operation of the transfer switch		
C. Frequency, current, kW, and voltage readings are correct, and within limits		
D. Test all alarms during run, both locally and remotely (to Power NROC) for proper operation		
E. If provided, rectifier sequencing functions properly		
F. Exhaust press. < limits; no exhaust leaks; internal exhaust pipes insulated; 9" min. exhaust clear from combustibles; hot "reachable" parts guarded and/or labeled; exhaust couplings use bolted flanges with gaskets or threaded pipe; has a flex connection to engine & flex supports to allow for expansion/contraction; & end of exhaust stack protected		
G. Ensure proper operation of all fuel pumps, and the day tank (where applicable)		
H. Intake/exhaust fans/louvers operate (& held open by spring on AC loss), & properly sized per dwgs. (Check proper intake size by seeing if engine room door opens easily). Air intake filters properly installed? (Exhaust fans to be controlled by room thermostat, if separate.) Exhaust positioned so its gasses & heat are not part of intake air.		
I. If provided, paralleling functions properly		
J. Current load is reasonably balanced between phases		
K. All required gauges, meters, and local and remote alarms are present as per Pub 77385		
L. Test emergency shutdown		
14. Check fluids and fuels after run, and visually inspect for leaks, loose parts, etc.		

NOTE: Use supplier documentation, as well as **TPP T.AMC.POWR.96.0008** for more complete engine Test and Acceptance
NOTE: When testing alarms and functions, be sure not to interrupt service

Comments (all No answers must be commented on — **Please use the back of this form for comments**)

Form 826A Standby Engine Test and Acceptance Checklist

FORM 826B

Qwest
TRANSFER SWITCH AND AC SERVICE ENTRANCE
TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. Ensure proper operation of the transfer switch. Simulate an AC failure and return of Commercial AC. Ensure that all timers function properly.		
2. If provided, paralleling functions properly and that there are sequencer lights or meters which properly operate if paralleling is to be done manually.		
3. Ensure that drawings for the transfer switch are on site.		
4. Ensure that a single line-drawing is on site (it may be physically etched or drawn on the AC switchgear)		
5. Visually inspect (or thermally with a thermal gun or camera) all connections in the transfer switch and AC service entrance cabinets for tightness.		
6. Ensure that the AC loads of the site do not exceed buss bar and breaker capacities in the AC switchgear.		
7. Ensure that electrical safety equipment is available for the site: electrical gloves, goggles, and tags/locks for use in lockout/tagout procedures when AC work is being done and possibly fire-retardant Nomex gear.		
8. Ensure that AC service entrance has a lightning arrestor and/or surge suppressor properly installed.		
9. Ensure that the AC fail is monitored per phase, and that an AC fail alarm properly reports through the alarm systems to the NROC Center.		
10. If the site is equipped with a power monitor (PSMC), verify that AC voltage (per phase, line-neutral) and currents (per phase) are monitored and reading properly.		
11. Ensure that the power company transformer is adequately sized to handle the site load.		
12. Ensure that the AC Service Entrance and Transfer Switch have proper grounding connections per Pub 77355		
13. Ensure that there is proper interrupt current rating coordination from the power company transformer down to the PDSCs (e.g., ensure that the K.A.I.C of the service entrance equals or exceeds that of the power company transformer, etc.)		

NOTE: Use supplier documentation, as well as **TPP T.AMC.POWR.96.0008** for a more complete Test and Acceptance
NOTE: When testing alarms and functions, be sure not to interrupt service

Comments (all No answers must be commented on — Please use the back of this form for additional comments)

Form 826B Transfer Switch and AC Service Entrance Test and Acceptance Checklist

FORM 826C

Qwest
FUEL TANK, FUEL SYSTEM, AND FUEL MONITOR
TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. Fuel in main and day tanks is sufficient and free of excess water and other contaminants		
2. Ensure that outdoor tanks are placed in such a position that water will not flow into or pool on top of them.		
3. If the outdoor Diesel fuel tank is aboveground in a climate where temperatures may get below 32° F, ensure that the tank is either using #1 Diesel fuel, or is equipped with a tank heater.		
4. Visually ensure that all fuel tanks (both main and day) have containment that will contain all of the fuel in the tank in case of a leak.		
5. Inspect tank(s) and all fuel piping and pumps for any leaks		
6. Ensure fuel lines are connected to engine through a flexible section		
7. Fuel Lines are installed and routed in accordance with the vendor-supplied Engineering specs and drawings.		
8. Verify that an anti-siphon valve is installed on the fuel suction line at the first entrance point to the generator room. The melt link should be 195 degrees.		
9. Verify that an electric fuel solenoid (operating from the engine start and/or control batteries at 12 V or 24 VDC) is installed on the supply line at each generator's fuel pump's flex hoses. The solenoid must be connected to the generator run circuit in the control panel.		
10. Verify that fuel lines running on the floor are routed so as not to create a safety hazard. (Fuel lines lying on the floor should be covered with a metal shroud, and the shroud should be painted yellow or yellow with black diagonal stripes.)		
11. Verify that the fuel lines are Aero-quip or Strotoflex hose or black iron. (Aero-quip and Stratoflex lines are permitted, but must be run inside a containment conduit. Galvanized pipes and fittings are not permitted.)		
12. Verify that the fuel return line is free from all obstructions. (No gates, valves, or traps are permitted.)		
13. Ensure proper operation of all fuel pumps, plus any day tank valves		
14. Ensure that a low fuel alarm is reported as a minimum (may be reported as a generic fuel system trouble) all the way to the NROC Center. The low fuel alarm should report when there is 8 hours or more of fuel left.		
15. If site is equipped with a fuel tank monitor, ensure that it has at least a generic fuel system trouble alarm wired and reporting all the way to the NROC Center		
16. Ensure fuel tank monitor is equipped with a dialup modem and a working phone line (some radio sites and other sites where phone service is inaccessible may be exempt from this requirement), and that Power NROC and the local Power Crew have that number.		
17. Ensure that the fuel tank monitor is equipped with paper tape and ink, and a method of storing the paper tape.		
18. Ensure that all fuel lines and tanks are properly grounded in accordance with Qwest Tech Pub 77355.		
NOTE: Use supplier documentation, as well as **TPP T.AMC.POWR.96.0008** for a more complete Test and Acceptance NOTE: When testing alarms and functions, be sure not to interrupt service		
Comments (all No answers must be commented on — **Please use the back of this form for comments**)		

Form 826C Fuel Tank, Fuel System, and Fuel Monitor Test and Acceptance Checklist

FORM 827

Qwest
OUTSIDE PLANT SITE TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. Ensure that internal and external grounding is per Qwest Technical Publication 77355. Ensure proper grounding of the site using a megger.		
2. Do ventilation and exhaust openings have free access		
3. Ensure that the site and all of the bays and wiring in the RT are properly tagged/stenciled		
4. Ensure proper operation of A/C, sump pump, gas monitor and other environmental systems with the vendor present for CEVs, CECs, and huts, as applicable		
5. Ensure safety equipment (e.g., fire extinguisher, first aid kit, gloves, eyewash fluid, etc.) is present, as applicable		
6. Ensure that all holes in a CEV are properly sealed		
7. Emergency lighting, gas monitors, environmental controllers, or any other device that should be powered by -48 VDC is connected to the DC Plant.		
8. Site properly constructed, landscaped, and backfilled; and weeds are abated		
9. Emergency engine connection available and sized properly. Verify that a generator can be parked within 10 ft of the transfer switch, and that the soil is such that there is access under adverse weather conditions. After turn-up, transfer the site to generator to confirm backup.		
10. Site has records/forms for proactive maintenance of the power plant. Ensure that the power plant was turned up correctly per Forms 823A and B. Load tests the plant and batteries.		
11. Ensure continuity of power and environmental alarms, and any other alarms to the NROC Center (Power Major, Power Minor, Intrusion, High Temperature, and Explosive Gas Alarm for CEV/Cs are a minimum). If a mux is used, verify that it is configured for phase 2 and provisioned for X.25/TL1. (See Standard Configuration and REGN 154-103-001 for power and environmental alarm standards.)		
12. Lightning/surge arrestor installed in power pedestal, and power pedestal wired per the NEC		
13. Confirm that controlled environment sites are set to operate within 55-85° F.		

This Test & Acceptance checklist should be performed with the installer(s)/contractor(s) on site. Note on attachment all problems they fix
Comment below or attach comments (all No answers must be commented on)

Form 827 Outside Plant Site Test and Acceptance Checklist

FORM 828A

Qwest
CO GROUNDING TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:		
Engineer:	Job Vendor:		
Date of Installation completion:	Date of Vendor Departure:		
Tested by:	Date:		
ITEM		**YES**	**NO**
1. The site ground is the proper size, and installed in accordance with the site record drawings, Engineering instructions, and Qwest Technical Publication 77355			
2. Both ends of all site ground cables are tagged, and designated to show opposite end terminating location			
3. All site ground cables between floors and through wall are run through nonmetallic sleeves or conduit. If site ground leads are run through metallic conduit or sleeves, both ends of the conduit or sleeve are bonded to the site ground lead.			
4. Isolated frames, cabinets, rectifiers, etc. containing AC service are properly grounded (usually identified with green-wire ground)			
5. If associated switching system uses isolated grounding, integrity must meet the system requirements spelled out in Qwest Technical Publication 77355			
Test & Acceptance should be performed with the installer on site. Note below all problems they fix			
For a complete grounding review, contact the NROC Center			
Comments (all No answers must be commented on)			

Form 828A CO Grounding Test and Acceptance Checklist

FORM 828B

Qwest
POWER DISTRIBUTION BUS BAR & CABLING
TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. AC bus duct and conduit is installed in accordance with site record drawing layout, and the manufacturers' specifications		
2. The proper type and size fuses and/or circuit breakers are installed in AC bus duct plug-in units		
3. Warning labels are placed at all access openings and end sections of AC bus duct, as required		
4. Bus bar is installed in accordance with site record drawing layout		
5. Bus bars and risers are stenciled to properly identify CHARGE, DISCHARGE, BAT, GRD, voltage, etc.		
6. The ammeter shunt is properly mounted and stamped to indicate voltage and ampere rating		
7. Installation meets Qwest workmanship standards, and is in accordance with Engineering standards and drawings, as spelled out in Qwest Technical Publications 77350, 77351, 77352, 77355 and 77385		
8. Bus bars, joints, and terminating connections to bus bars are free of excessive heat. (Technicians may use heat strips, or heat guns to determine heating. If major problems are suspected, a Power NROC Tech Support person may be called in to do a scan with a thermal camera)		
9. Power cable is routed in accordance with site record drawings		
10. Power cable is run and secured on cable racks		
11. Adequate insulating protection is provided on cable rack straps, stringers, thread rods, auxiliary frame bars, and other metallic objects where power cable makes contact with sharp surfaces		
12. Power cable insulation is free of damage		
13. Terminating wires and cables are properly tagged and designated at both ends of conductors when required		
14. All cables listed on power cable running list are installed with correct type and size of cable as specified, or otherwise calculated		

Test & Acceptance should be performed with the installer on site. Note below all problems they fix
Comments (all No answers must be commented on)

Form 828B Power Distribution Bus Bar and Cabling Test and Acceptance Checklist

FORM 829A

Qwest
POWER AREA FLOOR PLAN TEST & ACCEPTANCE CHECKLIST

Site:	Job Number:
Engineer:	Job Vendor:
Date of Installation completion:	Date of Vendor Departure:
Tested by:	Date:

ITEM	YES	NO
1. Power equipment is located and designated as shown on floor plan drawing		
2. All cable holes appear to be closed properly (wall, ceiling, and floor type, as applicable)		
3. Wall and column mounted equipment are properly located and shown on floor plan, cable rack plan, or other associated site record drawings		
Test & Acceptance should be performed with the installer on site. Note below all problems they fix		

Comments (all No answers must be commented on)

Form 829A Power Area Floor Plan Test and Acceptance Checklist

FORM 829B

Qwest
POWER DOCUMENTATION TEST & ACCEPTANCE CHECKLIST

Site:		Job Number:	
Engineer:		Job Vendor:	
Date of Installation completion:		Date of Vendor Departure:	
Tested by:		Date:	

ITEM	YES	NO
1. All new power equipment drawings furnished on this project are in acceptable condition		
2. All power drawings that were supposed to be provided with this job were provided		
3. All operating and maintenance instructions for new or added power equipment are available and accessible at the site		
4. All installer job completion reports are available		
5. Installer(s) followed written MOPs		
Test & Acceptance should be performed with the installer on site. Note below all problems they fix		
Comments (all No answers must be commented on)		

Form 829B Power Documentation Test and Acceptance Checklist

FORM 840

Qwest
CENTRAL OFFICE POWER EQUIPMENT INVENTORY

OFFICE:	CLLI:	Date:
ADDRESS:	TECH:	PHONE:

BATTERY PLANTS		
Voltage & Polarity: Plant #1	Plant #2	Plant #3
Plant/Controller Mfr. & Model:		
Plant Size (shunt & bus bar ampacities):		
Rectifier Fr & Model:		
Battery Strings & A-hr Size:		
Battery Fr & Model:		
Battery Installation Date:		
Plant Load in Amps:		
PDSC Bus Ampacity & Fdr Fuse/Brkr Size:		
add Rect. max loads for total max on PDSC:		

CONVERTER PLANTS		
Voltage & Polarity: Plant #1	Plant #2	Plant #3
Fr & Model:		
Associated Battery Plant:		
Qty & Sizes of Converters:		
Plant Load in Amps:		

RING PLANT(S)		**PSMC MONITOR and OTHER ALARM DEVICES**
Fr:	Model:	PSMC Fr & Model:
Ringers:	Interrupters:	Software Version:
Tone Generators:	Installation Date:	Dial-Up #:
INVERTER(S)/UPS		X.25 Ckt #:
Fr & Model:		Other Alarm Devices (e.g., Dantel, etc.):
Size, AC Voltage/Phase:		**ENGINE & TANK DATA**
Load (AC Amp/kVA):		Fr & Model:
Associated Battery Plant:		Voltage & kW:
Installation Date:		Install Date (note if not Autostart):
COMMERCIAL AC		Fuel Type & Consumption (gal/hr):
Voltage & Phase:		Actual Engine Load (in kW):
Size (Amps):		Start Batt Fr & Model:
Lightning Arrest Fr & Model:		Start Batt Install Date:
PORTABLE GENSET INFORMATION		Xfr Switch Type/Size:
Plug Fr, Mod, & Size (Amps):		Day Tank Capacity (gal):
Portable Fr, Size, Fuel:		Main Tank Type & Capacity (gal):
Storage Location:		Tank Monitor Fr & Model:
NOTES & COMMENTS (use back of sheet as needed)		Tank Monitor Dialup:

Retain a copy of this form and send a copy to the Power Engineers (http://saw3/NROC/Power/power-mop/Directory.html)

Form 840 Central Office Power Equipment Inventory

FORM 841

Qwest

BDFB OR POWER BOARD PANEL FUSE/BREAKER ASSIGNMENT RECORD

Site:	**CLLI:**	**Date:**
Address:		
Tech:	**Phone/Pager:**	
PBD/RR of this BDFB/PBD:	**PANEL(s):**	
Fdr Fuse/Brkr PBD & Position:	**Fdr Fuse/Brkr Size:**	**Panel Load:**

Position #	Equipment & Relay Rack Fed	Fuse or Brkr Size	Mfg L-2 Drain	Mfg L-1 Drain	Actual Load
			Totals		

additional panels may be placed on additional sheets

List 2 drains are peak drains (fuses sized at 125% minimum of this; and cable sized from them too), and List 1 drains are average drains

assigning fuses from the bottom to the top of a bay or panel (or inside to outside for horizontal panels) eases future installation and reduces cable congestion

as needed, contact your Design Engineer for a fuse assignment (if those are tracked in your area)

Please note if this Panel is "bussed" or "cabled" in the rear to adjacent panels (e.g., C, A2, etc.)

information for all columns may not be available to you — some columns are for Engineering use, and some for the "field"

Notes:

Form 841 BDFB/PBD Panel Fuse/Breaker Assignment Record

Form 844

Qwest

CRITICAL CO POWER AND ENVIRONMENTAL ALARM VERIFICATION

Alarm	NMA tkt #	Notes
Critical Power Alarms		
Commercial AC Fail		
Power Major		
Power Distribution Fuse/Breaker Major		
Low Voltage and/or Battery on Discharge		
Very Low Voltage (if applicable)		
High Voltage		
Rectifier Fail Major		
Ring Plant Major		
Low Voltage Disconnect (where applicable)		
Engine Run		
Engine Fail/Major		
Critical Environmental Alarms		
High Temperature (of the site or any room therein)		
Fire Alarm		
Fire System Trouble		
High Water/Sump (in cable vault, if applicable)		
Open Door/Intrusion		
Alarm Center Contact Person:		**Alarm Center Phone:**
Site CLLI:	**Site Address:**	
Alarm Telemetry System Type:		
X.25 (PSMC)	**e-tel** (Dantel, E2A, Westronics)	**Switch or other**
NROC Tech with whom Test performed:		**Phone:**
It may not be wise to test some alarms except in the Maintenance Window due to the possibility to cause an outage if they are truly tested; and/or in some cases, it may be best to simply verify alarm continuity by shorting the alarm pins instead of actually bringing in the alarm, for the same reasons		
Environmental Alarms may be tested by Real Estate		
Additional Notes:		

Form 844 Critical CO Power and Environmental Alarm Verification

FORM 845

Qwest

OUTSIDE PLANT POWER EQUIPMENT INVENTORY

Common Name of Location	
State	
CLLI	
Address	
Upstream Office (serving Wire Center)	
Access & Directions	
Map coordinates (if applicable)	
Customer (primarily for Customer Prem sites)	
Site Type (RT, CEV, UE, CEC, hut, rptr, CPE) (list RTs by type: e.g., 80 cabinet, etc.)	
Date of this review	
Reviewer name & contact #	
Air-conditioning type & maintenance contact	
Power plant type (also list J-spec, KS-, or model #)	
Load (in Amps)	
# Rectifiers	
Rectifier type [also list the model number(s)]	
Rectifier size(s)	
Float Voltage	
# Battery strings	
Battery type (model #, KS-spec, etc.)	
Battery size (A-hrs)	
# cells per string	
Battery installation date(s)	
Residual Ring plant type (model number, etc.)	
Comm. AC voltage, phase, and Amp rating	
Generator Plug Mfg., type, and size	
Alarm system (E-tel, X.25, overhead, etc.)	
Alarm Center & Center phone #	
CIRCLE ALARMS THAT ARE PRESENT (Add any others not listed here) POWER MJ POWER MN RECT. FAIL OPEN DOOR LOW TEMP HIGH TEMP AC PWR FAIL SMOKE/FIRE HUMIDITY SUMP PUMP COMBUSTIBLE GAS TOXIC GAS	
Notes:	

Form 845 Outside Plant Power Equipment Inventory

FORM 846

Qwest

OSP EQUIPMENT ENCLOSURE HOUSEKEEPING ALARM VERIFICATION

Alarm	Works?	Doesn't Work?	N/A
Commercial AC Fail			
Power Major			
Power Minor			
High Battery Temperature			
Power Distribution Fuse/Breaker			
Low Voltage and/or Battery on Discharge			
Very Low Voltage			
High Voltage			
Rectifier Fail (list the number of these alarms if more than 1)			
Ring Plant Major			
Ring Plant Minor			
High Temperature (of the enclosure)			
Explosive Gas Alarm			
Toxic Gas Alarm			
Toxic/Explosive Gas Alarm (combined)			
Fire Alarm			
Fire System Trouble			
High Water			
Sump Pump Failure			
Open Door/Intrusion			
Ventilation/Fan Fail			
Air-Conditioner Failure			
High Humidity			

Tech Performing Test:		**Phone/Pager:**
Site CLLI:	**Site Address:**	
Alarm Telemetry System Type:		
X.25 overhead (fiber mux)	**e-tel** (Dantel, E2A, Westronics)	**other** (list)
NROC Tech with whom Test performed:		**Phone:**
Additional Notes:		

Form 846 Outside Plant Equipment Enclosure Housekeeping Alarm Verification

CHAPTER 14 DEFINITIONS

Chapter and Section **Page**

14. Definitions

ABC	Area Bus Centers
AC	Alternating Current
ACO	Alarm Cut-Off
AID	Alarm Indicating Definition
ANSI	American National Standards Institute
APS	Arizona Public Service
ASHRAE	American Society of Heating, Refrigerating, and Air-conditioning Engineers
ASTM	American Society of Testing Materials
AWG	American Wire Gauge
BDB	Battery Distribution Board (Main Distribution or Power Board)
BDCBB	Battery Distribution Circuit Breaker Board
BDFB	Battery Distribution Fuse Board
ccs	centi-call seconds (or hundreds of call seconds — full usage is 36 ccs/hr)
CDO	A small Central Office (Community Dial Office)
CEM	Construction Engineering Memorandum
CEV	Controlled Environmental Vault
CFR	Controlled Ferro Resonance
Charger	Or Rectifier
CO	Central Office
COE	Central Office Equipment
Daisy Chain	Linking components or frames together to provide an electrical path.
DC	Direct Current
DTMF	Dual Tone Multi-Frequency
DS-0	Digital Signal (level) 0, a digital data rate/channel of 64 Kbit/s
DS-1	Digital Signal (level) 1, a digital data rate/channel of 1.544 Mbit/s
Equipment Bays	Are any equipment that is not the primary power source.
FB	Fuse Bay
EEE	Electronic Equipment Enclosure
EMT	Electrical Metallic Tubing
EPA	Environmental Protection Administration

EUSERC	Electric Utility Service Equipment Requirements Committee
FX	Foreign Exchange
GFCI	Ground Fault Circuit Interrupter
GFI	Ground Fault Interrupter
GR	Ground
Hardened Equipment	Equipment that must operate at the temperature extremes of -40° and +65° C.
HVSD	High Voltage Shut Down
Hz	Hertz
IC	Interexchange Carrier
ICEP	Inductive Coordination and Electrical Protection
IEEE	Institute of Electrical and Electronic Engineers
IOF	Inter Office Faculties
kcmil	Kilo Circular Millimeter
kVA	Kilo Volt Amp
kW	Kilowatt
LOI	Limiting Oxygen Index
LPG	Liquid Propane Gas
MOV	Metal-Oxide Varistor
NEBS	Network Equipment-Building System
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
Ni-Cad	Nickel Cadmium
NMA	Network Monitoring and Analysis
NTA	National Telecommunication Association
OSHA	Occupational Safety and Health Administration
PDF	Power Distribution Frame
PDFB	Power Distribution Fuse Boards
Power Room/Area	Is the area containing the Rectifiers, Batteries, Battery Stands, Bus bar above battery stands, Control Board, and the Battery Distribution Board (BDB).
POTS	Plain Old Telephone Service
PSMC	Power System Monitor Controller

PSMC-CL	Power System Monitor Controller-Confined Locations
rms	Root Mean Square ("effective", "average" AC voltage)
ROH	Receiver Off Hook
RT	Remote Terminal
SAD	Silicon Avalanche Diode
SPCS	Stored Program Control System
SRP	Salt River Project
T1 (or T-1)	T-carrier rate 1 — data line signaling rate of 1.544 Mbit/s, the physical standard defining equipment and distances for carrying a DS-1 signal
TIF	Telephone Influence Factor
Top To Top	From the Top of one equipment bay to another this does not include the drops into any equipment bay or out of the distribution bay.
TP	Test Point
TVSS	Transit Voltage Surge Suppression
UBC	Uniform Building Code
UFC	Uniform Fire Code
UL	Underwriter's Laboratory
UPS	Uninterruptible Power Supply
V	Volts
VRLA	Valve Regulated Lead Acid
3D Condo	A co-location building that is jointly owned.

CHAPTER 15 REFERENCES

Chapter and Section **Page**

15 References

All reference documents are latest available issues.

15.1 Telcordia Publications

GR-63-CORE	Network Equipment-Building System (NEBS) Generic Equipment Requirements
GR-78-CORE	General Physical Design Requirements for Communications Products and Equipment
GR-230-CORE	Generic Requirements for Engineering Complaints
GR-347-CORE	Generic Requirements for Central Office Power Wire
GR-833-CORE	Set: Network Maintenance: Network Element and Transport Surveillance Messages
GR-1089-CORE	Generic Requirements for Network Telecommunication Equipment.
TA-NWT-000370	*Generic Requirements for Mechanized Power Room Operations Monitor (MPROM)*
TR-TSY-000757	*Generic Requirements for Uninterruptible Power Systems (UPS)*
TR-NWT-000811	OTGR: Operations Application Messages - TL1 Message Index
TA-NWT-001360	Generic Requirements for Power Systems Messages at the OS/NE Interface
SR-3580	Network Equipment-Building System (NEBS) Criteria Levels
SR-4228	VRLA Battery String Certification Levels Based on Requirements for Safety and Performance

15.2 Qwest Technical Publications

PUB 77350	*Central Office Telecommunications Equipment Engineering Installation and Removal Guidelines*
PUB 77351	*Qwest Communications, Inc. Engineering Standards*
PUB 77354	*Guidelines for Product Change Notices*
PUB 77355	*Grounding - Central Office and Remote Equipment Environment*
PUB 77368	*Commercial Customer Premises Electronic Equipment Environmental Specifications and Installation Guide*

15.3 Miscellaneous Publications

ANSI T1.311	DC Power Systems — Telecommunications Environment Protection
ANSI T1.315	Voltage Levels for DC Powered Equipment Used in the Telecommunications Environment
IEEE 115	Test Procedures for Synchronous Machines
IEEE 484	Recommended Practice for the Design and Installation of Vented Lead-Acid Batteries for Stationary Applications
IEEE 485	Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications
IEEE 1187	Recommended Practice for the Design and Installation of Valve-Regulated Lead-Acid Storage Batteries for Stationary Applications
IEEE 1189	Guide for the Selection of Valve-Regulated Lead-Acid Batteries for Stationary Applications
IEEE 1375	Guide for the Protection of Large Stationary Battery Systems
IFC	International Fire Code, published by the International Code Council
NEMA MG1	National Electrical Manufacturer's Association Publication
NFPA 70	National Electrical Code
NFPA 37	Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 101	Life Safety Code
NFPA 110	Standard for Emergency and Standby Power Systems
UBC	the Uniform Building Code, published by the International Conference of Building Officials (ICBO)
UFC	Uniform Fire Code, published by the Western Fire Chiefs Association (WFCA)
UL 1449	Transient Voltage Surge Suppressors
UL 1950	Safety of Information Technology Equipment, Including Electrical Business Equipment

15.4 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.

Ordering Information for Employees of Qwest Communications, Inc.

Information Resource Management (IRM)
1801 California St., Rm. 1340
Denver, CO 80202
(303) 965-0808

Those who are not Qwest employees may order:

- Telcordia documents from:

  Telcordia Technologies
  45 Knightsbridge Road
  Piscataway, NJ 08854
  Telex: (201) 275-2090
  Fax: (908) 336-2559
  Phone: (800) 521-CORE (US calls only)

  http://www.telcordia.com

- Qwest Technical Publications are downloadable from:

  http://www.qwest.com/techpub

- IEEE documents:

  The Institute of Electrical and Electronic Engineers (IEEE)
  445 Hoes Lane
  PO Box 1331
  Piscataway, NJ 08855

  (723) 981-0060

  http://www.ieee.org

- UL documents:

  Underwriters Laboratories

  (888) 853-3503

  http://www.ul.com

- ANSI documents:

  American National Standards Institute
  1819 L St. NW, 6th Floor
  Washington, DC 20036
  (212) 642-4900
  http://www.ansi.org

- NFPA documents:

  National Fire Protection Association
  1 Batterymarch Park
  P.O. Box 9101
  Quincy, MA 02269
  (800) 344-3555
  http://www.nfpa.org

- NEMA documents:

  National Electrical Manufacturers Association
  http://www.nema.org

- Building & Fire Codes:

  International Code Council
  5203 Leesburg Pike, Ste. 600
  Falls Church, VA 22041
  (703) 931-4533
  http://intlcode.org