DC Distribution

1. General

1.1 This addendum is issued to change and/or supplement the information contained in Bellcore Practice BR 790-100-656, DC Distribution. Issue B changes guidelines for sizing fuses, adds engineering considerations and standards for Battery Distribution Fuse Boards (BDFB), and provides information on DC distribution to collocation areas.

2. Cable and Bus Bars

2.1 Only approved cable is to be used in a DC distribution system. See the current list of approved products for approved cables.

2.2 All new cable and all new bus bars shall be copper.

3.0 Battery Capacity Versus Cable Size

3.1 Minimum volts per cell (MVPC) used in calculating battery requirements for all central office applications is 1.86. MVPC for RT applications is 1.75.

3.2 Cable sizing shall be consistent with the MVPC criteria above. Previous use of a higher MVPC at a site, such as 1.88 or 1.90, may have resulted in use of smaller cabling, that will not be adequate at 1.86 MVPC. If it is determined that the 1.86 MVPC cannot be sustained, the requirement of 3.1 (above) is waived.

4. Protection Apparatus

4.1 For new primary distribution equipment used in central office power, fuses are recommended for all circuits of 226 amps and above. Cartridge type fuses shall have an interrupting rating of 100,000 amps. See Detail Engineering Requirements TP76400MP, Section 12 for further guidelines on fuse selection. Existing primary distribution equipment may have either a fuse or circuit breaker for circuits with loads of 225 amps or less. Fuses are recommended for circuits with loads of 226 amps or larger.

4.2 New switch and fuse units are not recommended because of their cost and size.

4.3 Fuses or circuit breakers may be used in RT power applications and power plants sized at 600 amps and below.

4.4 Fuses shall be equipped with an alarm feature that indicates an operated fuse. The alarm fuses shall all be equipped with .18 fuses.

4.5 Circuit breakers shall be equipped with an alarm feature that indicates when the breaker is operated in “TRIPPED” positions.

5. Protector Sizing

5.1 The DC distribution protector size is engineered based on each circuit’s peak current drain and must be sized to protect the distribution cables. The actual size of the cables provided must have an ampacity equal to or greater than the protector selected. See Detail Engineering Requirements TP76400MP, Section 12 for cable ampacities.

5.2 The distribution system shall be designed to ensure that the protector nearest a fault operates before any upstream protector operates.

5.3 The minimum fuse size is 125 per cent of the peak load being protected. Since most DC distribution circuit breakers are full load rated, if used, a circuit breaker may be of the same capacity as the List 2 drain.

6. Power Cable Sizing

6.1 The size of a power lead depends upon the amount of current it must ultimately carry. The proper cable size is selected by the following formula:

$$CM = \frac{11.1 \times I \times Ft.}{V}$$

Where:

CM = Circular Mil area of the cable
11.1 = Conductivity factor for copper cable
I = Peak List 2 Drain
Ft. = One-way length of cable in feet
V = Allowable voltage drop one-way

6.2 Cables can be selected through the use of a circular slide rule, the Power Lead Calculator. The directions for use are shown on the calculator. The calculator may not have a correct ampacity value for currently approved power cable. The following chart represents the correct amperage to cable limits for Telco applications. If the circular mils calculated from the slide rule do not match the industry standard cable sizes, the Power Engineer shall round up to the next size cable.

Wire Size AWG or KCMIL	Current Capacity (Ampacity)
8	55
6	75
4	95
2	130
1/0	170
2/0	195
4/0	260
350	350
500	430
750	535

Table 1: Ampacity - RHH Wire at 90°C

6.3 If multiple conductors are required for voltage drop reasons they shall be electrically joined at both ends to form a single conductor and meet the following conditions:

A. Be the same length.
B. Have the same conductor material
C. Be the same size in CM area.
D. Have the same insulation.

7. BDFB Engineering

7.1 A Battery Distribution Fuse Board (BDFB) serves as a secondary distribution center for large central office power schemes. Use of BDFB's is usually limited to feeding transport systems. Large central office switching systems have secondary power distribution systems integral to the switch.

7.2 A BDFB is placed to accomplish overall cost savings compared to running all power distribution from the main battery control board. It reduces the number of fuse positions required at the power plant, reduces cable congestion in cable racks, and optimizes the investment in power cable by distributing a few large loads over a longer distance and many smaller loads over a shorter distance.

7.3 The engineer must carefully consider the placement location of the BDFB, the size of the loads, and the number of secondary fuses per primary load in order to obtain the most efficient use of the system and the lowest cost.

7.4 With the MVPC of 1.86, the engineer has a voltage drop budget of 2 volts from batteries to equipment and return, or a maximum allowable one way voltage drop of 1 volt from batteries to served equipment via the BDFB. After determining voltage drop from batteries to main battery control board, the remaining budget is allocated to serve from the primary distribution to the served equipment to minimize the cost of cable and placement.

7.5 Each BDFB shall have a minimum of two load buses, designated A and B. The loads may be up to 480 amps each, limited by the maximum size DC fuse of 600 amps. Check the manufacturers rating of the BDFB's internal bus to assure it equals or exceeds the rating of the primary fuse feeding the load.

7.6 Previous standards have allowed the use of independent single load BDFB's. These BDFB's should be used until exhausted. The placement of all new BDFB's should follow the guidelines as stated in paragraph 7.5. The future use of single feed BDFB's should be discontinued.

7.7 Secondary distribution (cable and protection) from the BDFB is engineered based on the List 2 drain of the equipment being served. Typical distribution is redundant, with a feed from load A and another feed from load B each capable of carrying the full List 2 drain. However, there are applications for a single feed, and other distribution arrangements dictated by the transmission system being deployed. In these cases individual loads shall be equally distributed across the A/B buss to avoid exhausting one side of the BDFB prematurely.

7.8 Within the process of adding load to an existing BDFB (i.e. additional load created by transport growth) the use of List 1 drain figure is considered acceptable for use in planning additional power plant requirements. Triggering power plant additions using List 1 numbers will allow the power engineer to grow the power plant in a more conservative, economical manner.

7.9 Previous standards have called for the primary distribution fuse to be the larger of 400 per cent of the largest secondary protector, or 150 per cent of the sum of all List 2 drains. Because of splitting the loads across redundant feeds, the unusual circumstances that must prevail to realize the List 2 drains, and the low probability of realizing all List 2 drains simultaneously, we now recognize this standard is not warranted, and results in gross under utilization of the power distribution system.

7.10 The actual measured ampere load on any BDFB load during normal operation conditions (float Voltage), shall not be allowed to exceed two-thirds of the engineered, calculated ampacity of that load. Once this load is reached, the BDFB is capped, and no additional fuses are assigned until there is a measurable decrease in the load. Thus our typical BDFB placed prior to 1999 with two 400-amp loads protected with a primary fuse of 600 amps can be loaded to 267 amps per load. A new BDFB with two 480-amp loads protected by 600 amp fuses can carry 320 amps per load. (It is expected that each load in a two load BDFB will approximate the other. Wide variations should be investigated.)

7.11 A BDFB is exhausted when there are no more assignable fuse positions, or when the actual load meets the 2/3 of actual criteria in 7.10 above. Since the relief job needs to be placed prior to exhaust, the power equipment engineer must monitor BDFB loads and assignment levels just as if it was a small power plant. The Detail Engineering Center (DEC) shall help in this surveillance effort by reporting periodically the loads assigned (List 2 drain) beginning at 150 per cent of the engineered capacity of the primary loads, and shall also notify when limited fuses remain for assignment.

7.12 In most instances, a BDFB will exhaust based on fuse positions rather than load. If substantial growth capacity remains on the primary loads, the power equipment engineer shall first consider adding additional fuses to the loads. With large loads (300 amps and above), substantial growth capacity remains if actual load is less than 40 per cent of engineered capacity (i.e. a 400 amp capacity load is carrying less than 160 amps).If the BDFB is fully equipped with distribution fuses, then a second BDFB shall be placed in close proximity (less than 20 feet) to the first, and the loads shall be tapped and extended to the new BDFB. Voltage drops and ampacities for both BDFB must be recalculated from the two furthest points, the resulting system is then administered as if it were a single BDFB.

7.13 New BDFB’s (see exceptions for collocation BDFB’s in 9 following) that are not paired as in 7.9 shall be fully equipped with high density TPS-type fuse panels and an external ground bar. This allows secondary fusing of up to 70 amps (sufficient to protect a 56 amp load). Other fuse sizes and types shall be fully cost justified with an economic study.

7.14 In larger central office installation, alternative solutions to power distribution in lieu of BDFB’s may be considered. Multiple floors can segregate power plants from transport loads to the extent that costs related to the placement of a new power plant to serve current and future circuit needs may be a more economical choice. This flexibility can also add to the network reliability by reducing the services subject to failure by the loss of a single power plant.

7.15 The proper identification used to number the BDFB shall be the responsibility of the Power Equipment Engineer. Even though this task can be assigned to the DESP for numbering, the Power Engineer has the final approval of the designation.

8 Secondary Distribution

8.1 Secondary distribution is defined as fuse requirements beyond the BDFB. Generally, fuse requirements of a smaller caliber (less than 15 amperes) should be contained in this secondary distribution. Because of the tremendous expenses associated with the placement of BDFB’s, properly using these secondary fuse panels will further manage the utilization of the BDFB.

8.2 Previously, secondary distribution had been provided through the use of fuse bays. This older style fusing, usually containing 35 type fuses has been used for many years. With the advent of the distribution fuse panel, the use of this style of fusing has discontinued and should be eliminated through attrition.

8.3 This distribution fuse panel can be described as, but not limited to, dual A/B loads with a minimum of 10 GMT or 70 type fuse positions. Many GMT type fuse panels can be equipped with up to 15 amp fuses. Listings of fuse panels approved for use in the SBC LEC can be found on the Common System web page http://home.sbc.com/commonsystems/.

8.4 The use of the secondary fuse panels can be found in miscellaneous equipment bays and transport equipment needing numerous small input fuses. Serving equipment outside of the bay where the fuse panel resides is acceptable as long as it is within a close proximity of the fuse panel (less than 9 cable feet).

8.5 To properly engineer the secondary distribution fuse panel understanding BDFB engineering in Section 7 is critical. Voltage drop requirements are the same as described in 7.4.

8.6 While engineering the secondary distribution fuse panel, under no circumstances should the BDFB fuse serving the fuse panel be sized larger than the manufactures rating. For example: a fuse panel equipped with A/B loads has a manufacturers rating of 60 amps per load. The BDFB fuses shall not be larger than 60 amps.

8.7 Sizing of the circuit fuses at the fuse panel should follow the same guidelines as described in Section 5 Protector Sizing of this document.

9. Collocation

9.1Under various Federal Communication Commission (FCC) and Public Utility Commission orders, Competitive Local Exchange Carriers (CLEC) are allowed to place telecommunications equipment in central offices and remote terminals. The arrangements are provided either as Physical Collocation, where space is leased for placing equipment and self-maintenance by the CLEC, or as Virtual Collocation, where the equipment is placed directly in to existing equipment line ups and is maintained by the SBC LEC.

9.2 With either physical or virtual collocation in SBC LEC facilities, power is provided by the SBC LEC as a matter of company policy. This is primarily a fire and personnel safety issue.

9.3 With virtual collocation, power distribution is provided just as if the equipment were our own.

9.4 With physical collocation, -48 volt DC power is normally provided in increments defined per state tariffs where they exist, or in increments described as “standard power arrangements” in the Technical Publication for Physical Collocation. While the increments may vary from state to state, all are characterized as redundant (load A and load B) arrangements of specific amperage.

9.5 The power increments described in 9.4 above may be provided from a BDFB or directly from the main Battery Control Board, whichever is more cost effective.

9.6 The full load capacity of a collocation BDFB may be assigned, and is not to be exceeded. Thus, in California where 40 amp circuits are tariffed, a maximum of 10 such circuits may be assigned to a 400 amp load. The principle holds in other states as well.

9.7 A collocation BDFB will likely exhaust its load capacity before its fuse assignment capacity. It is cost effective to plan for multiple loads, such as a four load or six load BDFB as a cost conservation measure. A BDFB dedicated to collocation may be equipped with as few as one fuse panel per load.

9.8 If a BDFB is serving Telco and Collocator loads, care must be taken to reserve the full-subscribed capacity of the Collocator, whether or not the load has been actualized. Thus the 2/3 rule of 7.10 above must be tempered by factoring in the potential collocation loads.

9.9 If a Collocator requires a “non-standard” power arrangement, such as a large power feed or isolated ground, the request shall be considered on an “Individual Case Basis”. Technical staff shall be consulted as special engineering or cost considerations may apply.