Fermilab
FESHCom
Electrical Safety Subcommittee

STANDARD CONVENTIONS
for the
Fermilab Electrical AC Power Distribution System

Reviewed and Approved by the ESS
September 10, 2012

The following represents agreed upon standard conventions for the Electrical AC Power Distribution System at Fermilab. The conventions were first developed by knowledgeable representatives from FESS Engineering and Operations and the Accelerator Division. The conventions were subsequently reviewed and sanctioned by the Electrical Safety Subcommittee. It is acknowledged that these conventions are not totally inclusive of all possible aspects, equipment types, or configurations of the existing electrical distribution system. The stated standard conventions should be applied to new construction and to systems undergoing significant modification. It is not intended that older systems be modified, although partial conformance may be reasonably accommodated.

Panelboard Naming Conventions

Panelboards shall be classified solely as per operating voltage and ampacity, regardless of their position in the electrical distribution system. The acronyms for panelboards are as follows:

SWBD	Switchboard, 2000 A and Above, 480Y/277 VAC
DHP	Distribution, High Power Panelboard, 600 A to 1600 A, 480Y/277 VAC
PHP	High Power Panelboard, 100 A to 400 A, 480Y/277 VAC
LP	Lighting Panelboard, 100 A to 225 A, 480Y/277 VAC (Typically Outfitted with Single Pole Circuit Breakers)
PP	Power Panelboard, 100 A to 225 A, 208Y/120 VAC or 240/120 VAC
Exxx	Emergency, Prefix for Panelboard Capable of Being Powered by a Dedicated Emergency Power Source
Sxxx	Standby, Prefix for Panelboard Capable of Being Powered by a Dedicated Standby Power Source

Other Equipment Naming Conventions

Acronyms for other certain components of the electrical distribution system shall be as follows. Some explanations of particular categories are appended.

DSTR	Distribution Switch (Generally 13.8 kVAC)
USS	Unit Substation (Generally 13.8 kVAC to 480Y/277 VAC)
TR	Transformer, Various Ampacities and Voltages, Compads Included

ETR	Transformer, Capable of Being Powered by a Dedicated Emergency Power Source
STR	Transformer, Capable of Being Powered by a Dedicated Standby Power Source
MCC	Motor Control Center (Generally 480 VAC without Neutral)
DS	Disconnect Switch, Not Fused, Various Ampacities and Voltages
FDS	Fused Disconnect Switch, Fused, Various Ampacities and Voltages
CB	Circuit Breaker, Stand Alone, Typically External to a Panelboard in Lieu of a Panelboard Main Breaker and Also Serving as a Service Disconnect
MTS	Manual Transfer Switch, Various Ampacities and Voltages
ATS	Automatic Transfer Switch, Various Ampacities and Voltages

DSTR is an established convention for 13.8 kVAC distribution switchgear. These switches may be of the oil type, but are more often air switches such as the compartmentalized switches manufactured by S&C. They are used frequently in the 13.8 kVAC feeder distribution system of the Laboratory for purposes of equipment isolation and feeder isolation or reconfiguration.

The Unit Substation designation, **USS**, refers to compartmentalized distribution equipment that includes a 13.8 kVAC air switch, the transformer, and multiple rack-in load breakers on the secondary side. While there are numerous USSs at the Laboratory, they are not preferred for new installations.

The transformer category, **TR**, covers a wide range of equipment. A typical yard transformer would be of the "**Compad**" type now generally favored. Such a transformer would generally include an incoming line switch (for isolation only) and fuses at 13.8 kVAC and usually a single load circuit breaker. Compads are generally sized at 500, 750, or 1500 KVA. Another very common example is the 480 to 208Y/120 VAC three phase transformers typically found inside technical buildings. Transformers with other primary and secondary voltages are also covered by the "TR" identifier.

AC Voltages

Some consistency is desired in the identification of voltages present in the AC power distribution system. The following delineates acceptable or preferred practices. The specific characterization of voltage sources as wye or delta connected may be omitted if commonly understood or of minimal interest to user applications.

Acceptable:	V, VAC, Volts, Volts AC, kV, kVAC, kVolts, kVolts AC	
	208Y/120 VAC	(Three Phase)
	240/120 VAC	(Single Phase)
	480Y/277 VAC	(Three Phase)
	480 – 208Y/120 VAC	(Three Phase Transformer)
	480 – 240/120 VAC	(Single Phase Transformer)
	13.8 kVAC – 480Y/277 VAC	(Three Phase Transformer)
	13.8 kV – 480 V	(Three Phase Transformer)

Panelboard and Transformer Labeling

Panelboards and transformers of the distribution system shall be uniquely identified with labels be made from engraved plastic lamocoid material and generally 1/16 inch thick, 2.5 inches high, and a minimum 9 inches wide. The overall dimensions may be reduced for cases where the equipment cannot accommodate the standard size.

These labels generally have two lines of text. The first line would be the panelboard or transformer name (e.g. PHP-MI60A-3, TR-MI60A-3-A). The second line would describe the operating voltages or voltages present (e.g. 480Y/277 VAC, 480-208Y/120 VAC).

First line characters are to be 0.85 to 1.0 inch high with a 1/8 inch line width. Second line characters are 0.5 inches high with a 1/16 inch line width. The edges of the label are to be beveled.

RED labels with **WHITE** characters shall be used for equipment operating at 480Y/277 or 480 VAC or higher. A 480 to 208Y/120 VAC transformer would be outfitted with a label having these colors. When such equipment is capable of being powered by a dedicated Emergency or Standby power source, the equipment label shall be **ORANGE** in color with **BLACK** characters.

BLACK labels with **WHITE** characters shall be used for equipment operating at 120, 208Y/120, or 240/120 VAC. When such equipment is capable of being powered by a dedicated Emergency or Standby power source, the equipment label shall be **YELLOW** in color with **BLACK** characters.

Equipment labels are preferably attached with a high quality, double-sided adhesive tape rather than screws. For indoor applications to smooth surfaces, 3M tape 9500PC is a preferred choice. For outdoor or rougher surface applications, Normount tape V2830 is a preferred choice although the 9500PC tape is often acceptable.

Naming Conventions for "Yard" Transformers

Discussion of "yard" transformers necessarily includes Unit Substations and Compads. The names of these 13.8 kVAC primary transformers shall generally be referred to as "LOC#". LOC# is an alpha-numeric acronym that will uniquely describe the transformer location and distinguish more than one transformer at that location.

While LOC is a unique alpha-numeric acronym for the USS or Compad location, the # aspect of the LOC# identifier consists of an alpha character (A, B, C, D, E, etc.). For example: one Compad at F1 would have a LOC# identifier of F1A; one USS at the Booster East Gallery would be BEGA; and three Compads and two USSs at MI-60 would be MI60A, MI60B, MI60C, MI60D, and MI60E. Notice that there is always an appended alpha character – even if there is only one transformer or USS at the location.

The generalized labeling of yard transformers would be USS-LOC# or TR-LOC# for Unit Substations and Compads respectively. The above transformers would be marked as TR-F1A, USS-BEGA, TR-MI60A, TR-MI60B, TR-MI60C, USS-MI60D, and USS-MI60E.

Naming Conventions for Primary Panelboards

Primary panelboards are those considered to be the first panelboard to receive power from a yard transformer circuit. These panelboards shall include the transformer LOC# in their name. For the example of a Compad at F1 with a single internal load breaker power powering a DHP panelboard, the panelboard would be named DHP-F1A.

A USS typically supplies power to multiple primary panelboards in accord with the number of rack-in load breakers. Additionally, a Compad may be outfitted with or have the provision for more than one load breaker. In order to distinguish these multiple feeds as distinct sources of power, the LOC# for the primary panelboards shall have an appended number "n" (1, 2, 3, 4, etc.) relating to the specific yard load breaker. "LOC#n" now uniquely describes the source of power.

For the example of a USS at Booster East Gallery having three load breakers separately powering a SWBD, DHP, and MCC; these primary panelboards would be named SWBD-BEGA1, DHP-BEGA2, and MCC-BEGA3. For the example of a Compad at F2 with a single internal load breaker power powering a DHP panelboard and provision for a second load breaker, the primary panelboard would be named DHP-F2A1.

Naming Conventions for Sub-Primary Panelboards and Transformers

Primary panelboards feed "sub-primary" panelboards, transformers, or utilization equipment. Labeling of utilization equipment is not of concern since the connection of such equipment is documented in the panelboard schedule. The developed naming convention does not involve the physical location or pole position of the sourcing circuit breaker as has been past practice. The potential for confusion is reduced in that such locations or positions are subject to change as the distribution system is modified.

Sub-primary panelboards names are developed with a portion of the name of the upstream panelboard with an appended "-n" where n equals 1, 2, 3, 4, etc. As an example, say primary panelboard SWBD-BEGA1 feeds a DHP panelboard, and two PHP panelboards. These panelboards would be labeled as DHP-BEGA1-1, PHP-BEGA1-2, and PHP-BEGA1-3. To continue this convention for additional downstream panelboards, take as example that PHP-BEGA1-2 feeds a PHP and a LP panelboard. These panelboards would be labeled as PHP-BEGA1-2-1 and LP-BEGA1-2-2. As is the case for primary panelboards, the LOC# or LOC#n identifier is retained and continues to indicate BEGA1 as the single primary source of power.

While sub-primary panelboards are identified with an appended numeric character, transformers shall be identified with an alpha character. Consider primary panelboard DHP-BEGA1-1 feeding three 480 - 208Y/120 VAC transformers. Here the transformers would be named as TR-DHP-BEGA1-1-A, TR-DHP-BEGA1-1-B, and TR-DHP-BEGA1-1-C. A benefit of this convention is that the "DHP-BEGA1-1" part of the transformer's name is a direct indicator of the transformer's fed-from source.

Continuing the above example, assume the first two transformers each feed a single PP panelboard, and the third feeds two PP panelboards. These 208Y/120 VAC panelboards would be named PP-BEGA1-1-A1, PP-BEGA1-1-B1, PP-BEGA1-1-C1, and PP-BEGA1-1-C2. Additional panelboards are readily accommodated without modification of the names of existing equipment.

Naming Conventions for Disconnect and Transfer Switches

Disconnect and Transfer Switches, including **DS**, **FDS**, **MTS** and **ATS** types, are sometimes named. Such switches that provide isolation between elements of the AC Power Distribution System must be named. If named, the switch shall be appended with the name of the downstream piece of equipment that it serves to isolate. **DS-PP-MI65A-A1** is an example of a disconnect switch that isolates all three ungrounded phases powering panelboard PP-MI65A-A1. Where the switch position is remote from connected and downstream equipment, it should be named. If the downstream connection for a switch is not apparent or if there is more than one switch at a particular physical location, all such switches must be named.

All such switches shall be identified as to the nominal operating voltage of interior circuits.

Naming Conventions for Wall Receptacles

Receptacles are typically labeled with the name of the breaker panel immediately upstream followed by the circuit number. PP-CL-14E-2 CKT 15 is an example of a receptacle fed from panel PP-CL-14E-2 and coming off of the circuit breaker labeled 15.

Panelboard Schedules

At a minimum, panelboard schedules shall list and be in accord with the following:

- Panelboard name. (e.g. PP-BEGA1-1-B1)
- Normal operating current (e.g. Trip Current of Upstream Overcurrent Protection Device as opposed to the ampacity rating of the panelboard)
- Operating voltages and number of phases. (e.g. 208Y/120 VAC, 3 Phase)
- Fed-From source of power. (e.g. TR-DHP-BEGA1-1-B and DHP-BEGA1-1 CB#27)
- Load descriptions and corresponding circuit breaker positions
- Load descriptions shall be specific rather than general if at all possible (e.g. Lighting – Room 101 vs. Lighting)
- Legible
- Current

It is strongly suggested that panelboard schedules be generated in a computer word processor or spreadsheet format to facilitate ease of modification and lockout/tagout performance. It is advised to provide a second copy of the schedule at the panelboard. In addition to the above, the following information might be included in the electronic file. Some of the below may be added to the displayed panel schedule as appropriate.

- Panelboard Rated Ampacity
- A listing of all available circuit breaker positions. Non-occupied positions shall be designated as “Blank” or “Space”. Unused breakers shall be designated as “Spare”.
- The overcurrent rating of the circuit breaker
- The phase of power for the particular circuit breaker position
- The physical location of the panelboard
- The type of panelboard (e.g. Square D I-Line, Square D NQOD)

- Whether or not there is a Panel Main Breaker. If present, show the ampacity of the Panel Main breaker.
- The kVA rating of the upstream powering transformer, if the panelboard is directly fed by the transformer
- The FESS bar code inventory number
- The wire size of the feed conductors for the ungrounded, grounded, and grounding conductors
- The size, type and quantity of the conduits containing the feed conductors
- Type of Circuit Breaker
- Instantaneous Current Trip Setting (In Amps or Set Point Position)
- Minimum recommended Circuit Breaker AIC
- Date of Issue
- Who to notify if the schedule needs updating. Generally this is the Division/Section Electrical Coordinator.
- Special notes pertinent to the panelboard. One should include here the specific location of the fed-from source if not obvious.

Circuit Breaker Position Labeling

Panelboard circuit breaker positions shall be numbered in accord with provided electrical drawings. Generally, left side breakers are labeled with odd numbers 1 – 3 – 5 - …etc. top to bottom while the right side breakers are generally labeled with even numbers 2 – 4 – 6 - …etc. top to bottom. Positions are typically marked with self-adhesive numbers provided by panelboard manufacturers.

Numbers shall be neatly applied to the panelboard front mat adjacent to each breaker pole position. Three pole breakers need only be labeled at the center pole position. Circuit breaker position numbers shall <u>not</u> be applied to the physical circuit breaker.

A second set of numbers may be installed interior to the panelboard in direct correspondence to the mat numbers to facilitate branch circuit identification during panelboard access.

Color Coding of Conductors

Color Coding shall be utilized to distinguish the conductors of the power distribution system. The requirements are fully explained in the Technical Appendix of FESHM Chapter 5042. Briefly stated, the requirements for the prevalent three phase distribution systems are as follows:

For conductors in <u>all</u> systems, <u>except</u> those in a 480Y/277 VAC system, the color code for ungrounded conductors corresponding to Phase A-B-C shall be **Black-Red-Blu**e (BRB). The grounded or neutral conductor shall be coded **White**.

For conductors in a 480Y/277 VAC system, the color code for ungrounded conductors corresponding to Phase A-B-C shall be **Brown-Orange-Yellow** (BOY). The grounded or neutral conductor shall be coded **Gray**.

Grounding conductors shall be color coded with **Green**, with or without Yellow stripe, or bare.

Miscellaneous

Fed-From Labeling, though included in the panelboard schedule or the transformer name, may be additionally displayed on the front face of the equipment. In that this information is subject to change as the AC Power Distribution System is modified, this labeling should be semi-permanent in nature.

Equipment having **Multiple Energy Sources** must be clearly identified as such. Panelboards or transformers that are capable of being powered by dedicated Emergency or Standby power source need <u>not</u> be so identified when properly labeled with the E or S prefix and an orange or yellow lamocoid with black lettering.