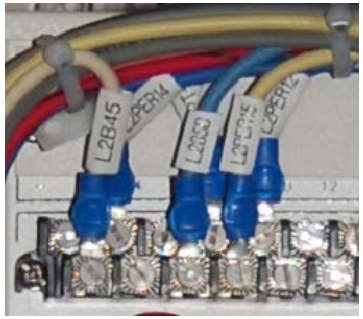
Breaking Paradigms in Control Building Design

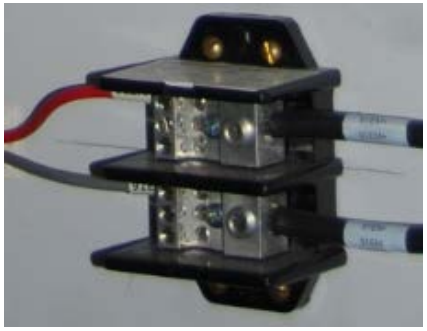
By
Robert Frye
Tennessee Valley Authority
April 6, 2017

Paradigms

1) We accept live terminals in close proximity with our electricians and operators.
2) Relays and other equipment must be mounted in a cabinet or other U-shaped structure.
3) Terminal blocks must be mounted in the cabinet with their corresponding relays.
4) A standard control building suiting the needs of every site is not possible.



Live Terminals



- Live terminals are found in every substation at every utility.
- 1,000s to 10,000s in a substation
- When in small spaces with other live terminals or grounded surfaces, live terminals are an electrocution risk.
- As an industry, we are too comfortable with live terminals.

The Situation

- Lots of live terminals and grounded surfaces in panels and cabinets
- NESC requires 3’ minimum working clearance “about” electrical equipment.
- It’s difficult or impossible to deenergize all circuits in a work area.
- Utility employees routinely go within energized panels and cabinets to perform work.

Cabinets and Panels and Live Terminals

Relay cabinets are booth shaped enclosures with equipment and live terminals typically on three sides. All cabinets have doors and many have swinging equipment panels and thresholds.

Relay panels are similar to cabinets, but they don't have doors.

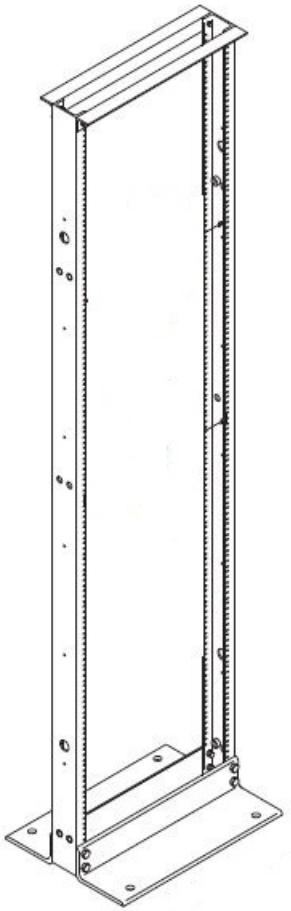
Acrastyle Limited

Side Panels are the Problem

- Side panels create the U-shape to form the enclosure concentrating the electrocution hazard.
- But, side panels provide space for terminal blocks and other miscellaneous components.
- Modern relays have negated the need for most side panel components, but a few components still remain.
- We need only to retire or relocate these few items to do away with side panels entirely.
- For the safety of our coworkers, we must retire side panels.

Racks

- TVA selected the 19” Universal Rack for mounting protection & control equipment
- Benefits
  - No side panels to enclose workers
  - Racks are commercially available from many vendors.
  - Readily accepts protective relays and other control components
  - Future-proof mounting system



Chatsworth Products Inc.

Control Circuit Fuses

- To minimize exposure to live terminals, TVA abandoned new installations of live-front fuses.
- TVA selected a commonly available, dead-front fuse and holder.
- We created a rack mounted bracket for 15 fuses.
- We moved the fuses from the side panels to the front of the rack.

Test Switches

- To further minimize shock hazards, TVA evaluated the test switches.
- Most test switches provide 30 test points in a 3RU space.
- In the past, TVA installed one row of test switches per relay – 30 test points – this wasn't enough to isolate most relays.
- Without enough test switches, human performance events occurred when personnel lifted and improperly re-landed wires after testing. This created even more exposure to live terminals.
- TVA added more rows of test switches. Then, we were dedicating more space for test switches than for relays!

Test Switches

- TVA now requires test switches in all circuits connected to digital relays.
- Test switches should be dead front.
- TVA found a small, modular test switch delivering eight test points in a 1-1/2” x 2RU space.
- With 10 modules placed in a frame, this gave TVA 80 test points in 2RU.

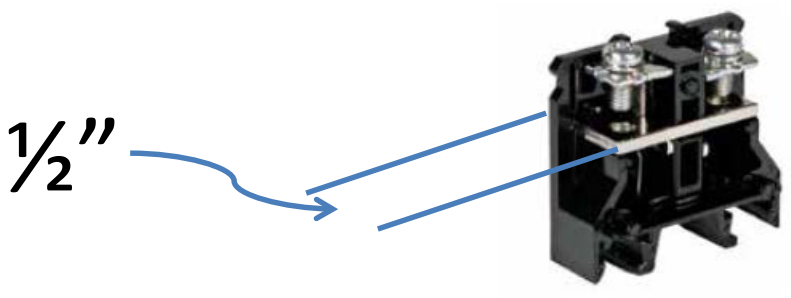
- With enough test switches and the fuses on the front of the racks, employees have no need to go behind the racks except during construction or difficult troubleshooting activities.

Terminal Blocks

- So simple, but they are not!
- A place to land local & field conductors
- Accommodation of multiple conductor sizes?
- No lugs or lugs?
- What kind of lugs: ringed, forked, or ferrules?
- How many conductors will the terminal block accept?
- Lots of voltage & current ratings available
- Many screw sizes available, and are they captive?
- Many different compression technologies available
- Cost $ to $$$$$
- Represent a labor rate to mount and wire
- Require space, but we can’t allow too much space

Terminal Blocks

- Ultra-high density terminal blocks are a great idea, but the area around them can become congested and inaccessible.
- We found terminal blocks ½” wide offer the best density without sacrificing access and wire training area.



- TVA selected a 30 amp, rail mounted, sectional terminal block with captive screws and capable of accepting ring lugs and multiple wire sizes.

Terminal Blocks

- TVA moved to a rack type design where no room was available for terminal blocks.
- So, where did we place the terminal blocks?