

Human Performance Tools

EAP Electrical Equipment and Protection
Committee – Spring 2024 Conference

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Relay Test, PPL Electric Utilities

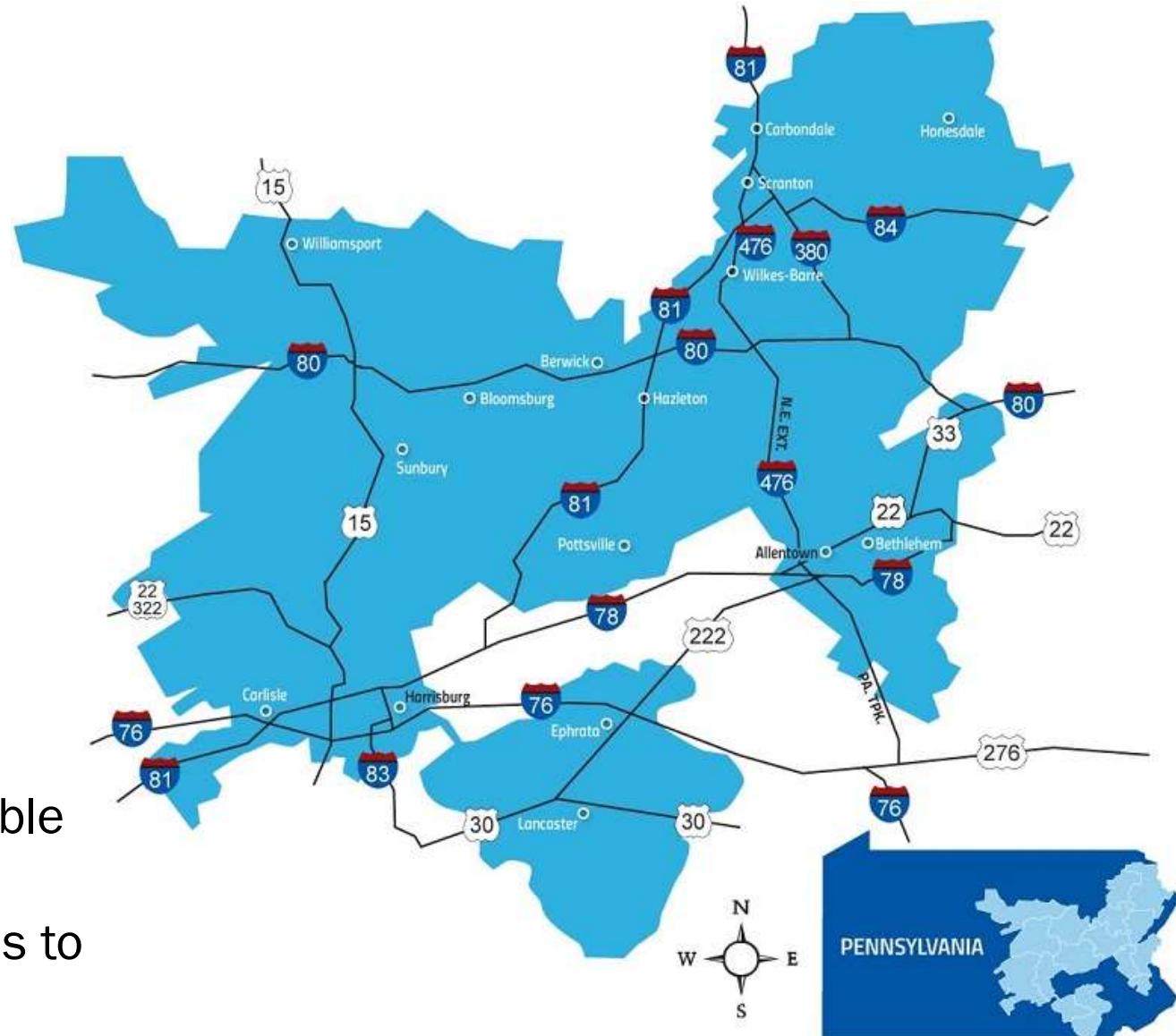


About PPL Electric Utilities



- ❑ Located in Eastern Pennsylvania
- ❑ 1.5M Customers
- ❑ 29 Counties
- ❑ 1.7k Employees
- ❑ 50.6k miles of power lines

Our Vision is to provide safe, affordable, reliable, sustainable energy to our customers and competitive, long-term returns to shareowners.



“To err is human..” – Alexander Pope

“People, even the very best people, will make mistakes.” – <https://www.nerc.com/>

Human Performance – A series of behaviors executed to accomplish specific task objectives or results.

In my words...

“Any work where a human being is involved in carrying out specific tasks to achieve an intended result.”

Applying HuP Tools – broad view



- Mindset Shift
- Culture Change
- Implementation of small habits
- Tools and Procedures need to be low effort to be accepted

HuP at PPL



HuP Practices

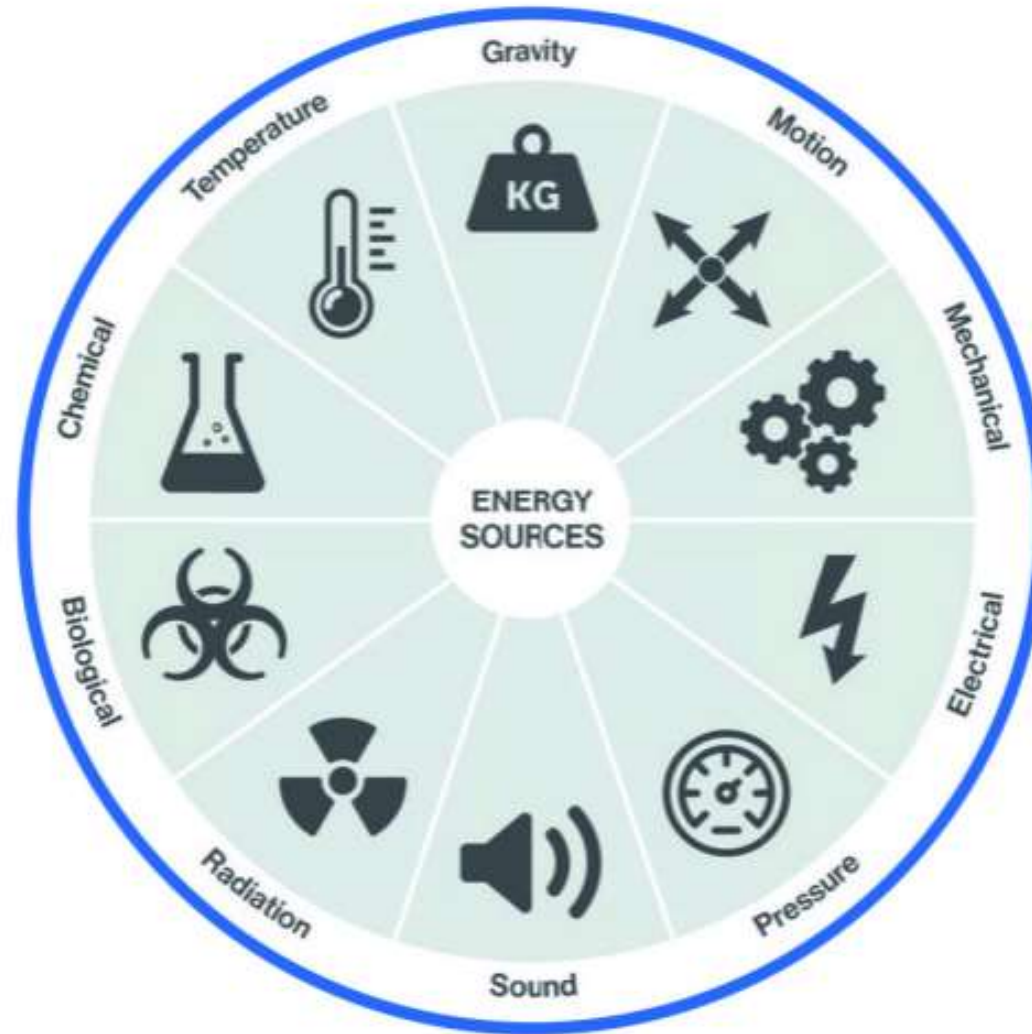
- Flagging
- Energy Wheel
- Hierarchy of Controls
- Situational Awareness
- Questioning Attitude

Human Performance Tools

- Self-Check
- Peer-Check
- 3-Part Communication
- Tailboard
- STOP/Timeout
- Procedure Use
- Six Steps of Switching



Energy Wheel



- ❑ Raises sense of awareness regarding certain hazards
- ❑ Learn from other mistakes, or almost mistakes (good catches/near misses)
- ❑ First Report of Incidents
 - ❑ Shared with front-line supervisors and managers bi-weekly
- ❑ Event Analysis Procedure
 - ❑ Eliminate similar errors in the future, find gaps in the system rather than fault in a person



HuP Tools within PPL EU Relay Test



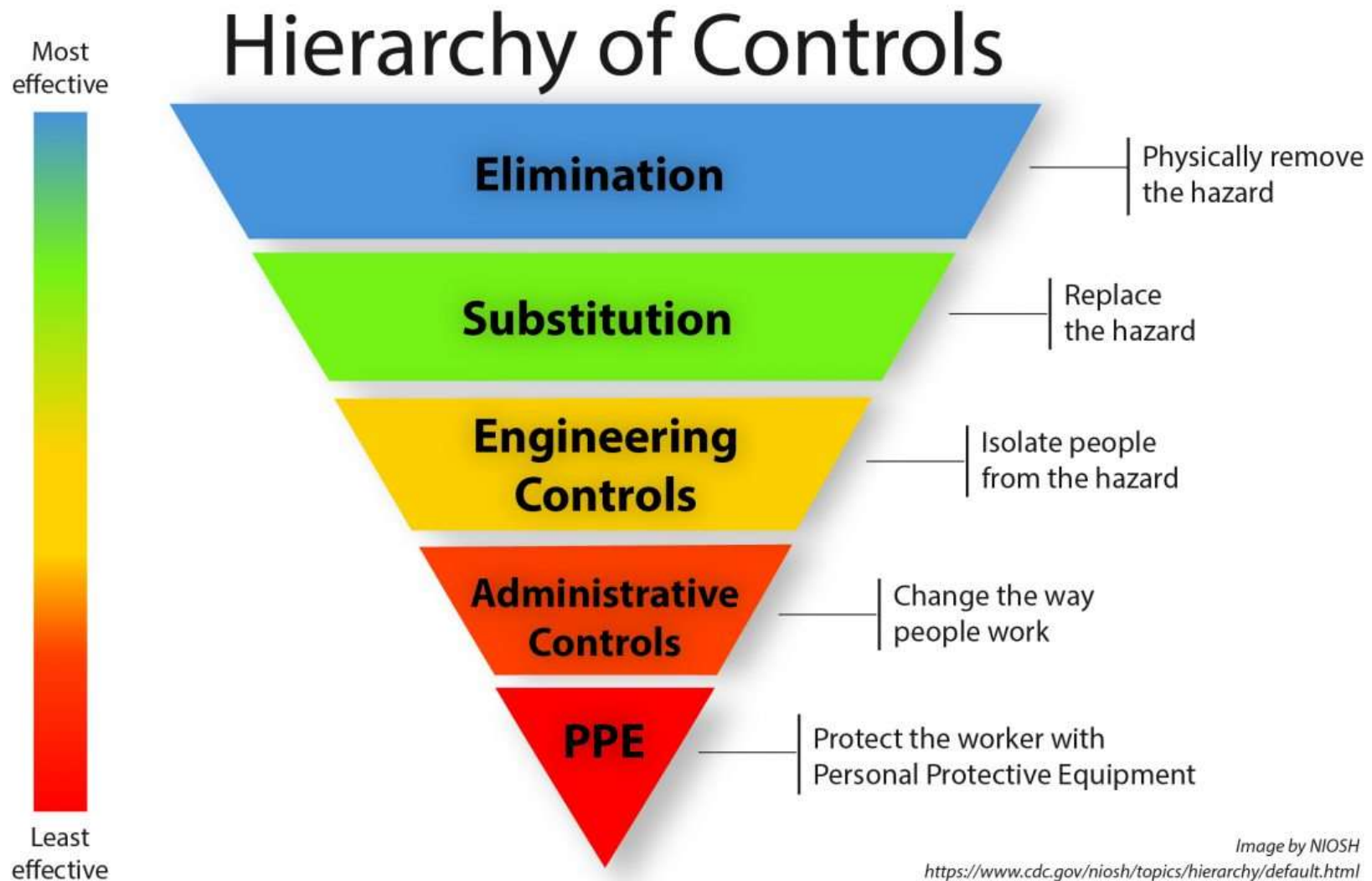
Active Errors

- Personal injury
- Operating equipment unintentionally
 - Tripping a closed device (CB, Switch, etc.)
 - Closing an open device (CB, Switch, etc.)
- Damaging equipment

Latent Errors

- Inadequate protection
- Unreliable system
 - Failure to reclose
 - False SCADA data (causes improper decisions to be made)

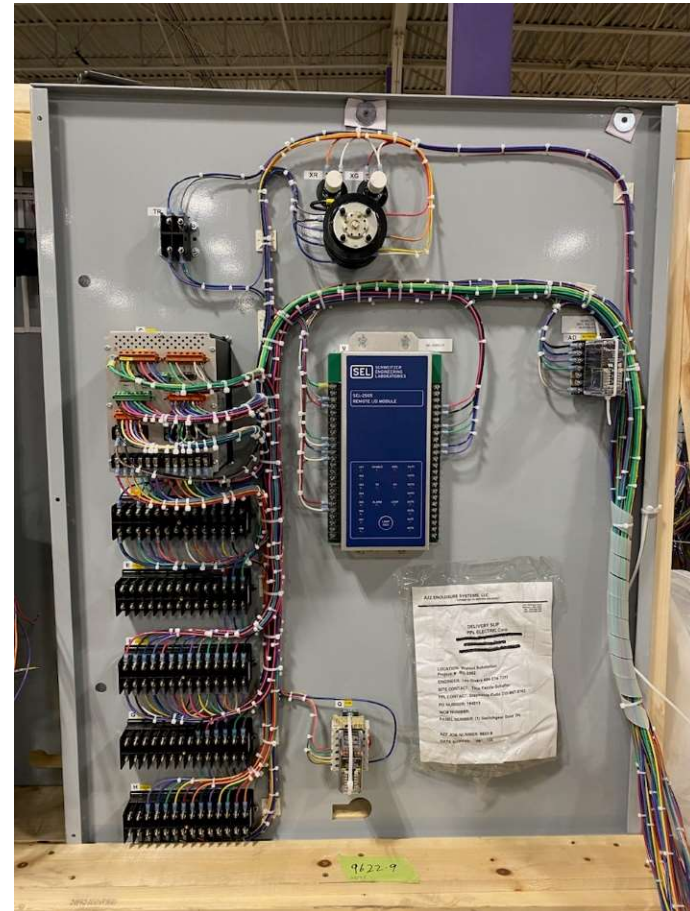
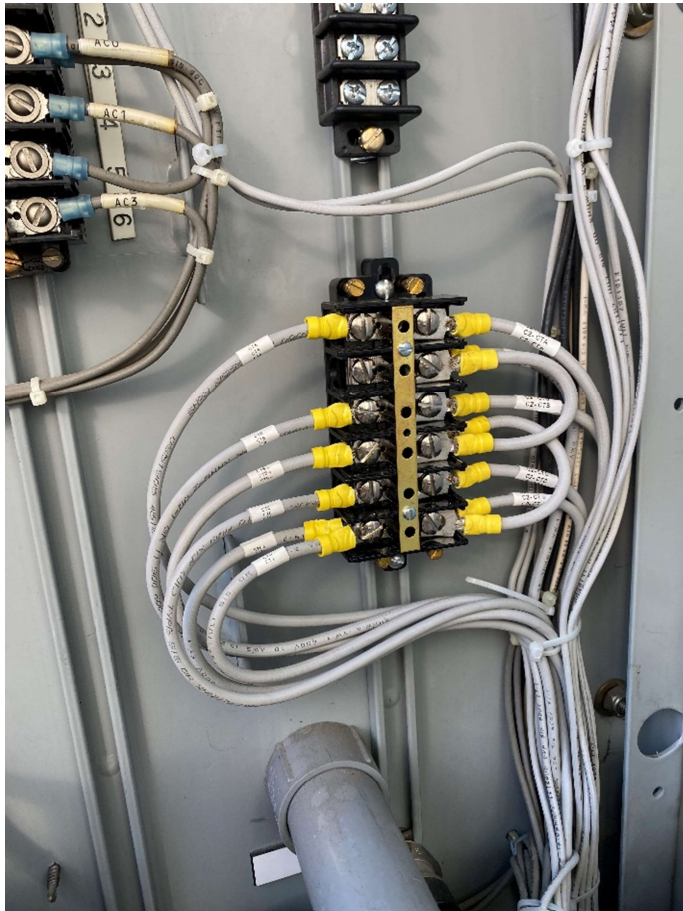
- ❑ Operating relay schemes to prove functionality
 - ❑ Pulsing relay outputs, injecting current/potential
- ❑ Changing the way devices operate
 - ❑ Control circuitry changes
 - ❑ Set-point changes (i.e., settings file upload)
- ❑ Commissioning/Decommissioning
 - ❑ Isolating equipment for removal or energizing equipment for installation
 - ❑ Opening/closing links, removing/inserting fuses, installing jumpers etc.



Work Scheduling, how can it be done differently?

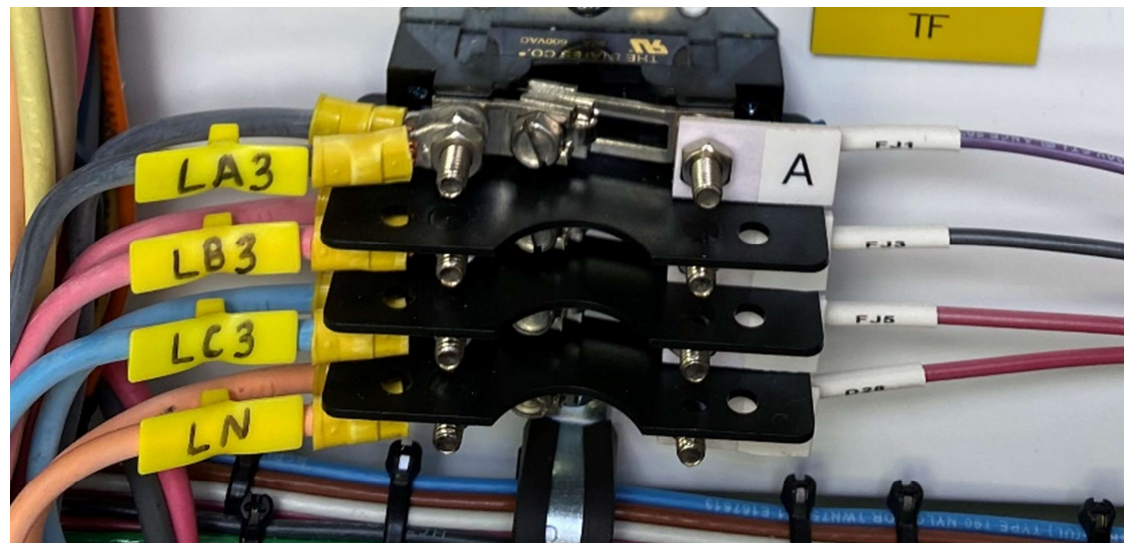
- Can the work be done with equipment deenergized?
 - Device settings changes
 - Certain repair work
 - All Relay Calibration and testing
- Can the work be done remotely?
 - Event record retrieval
 - SCADA configuration changes

Control Wiring - Colors



NEC Color Codes

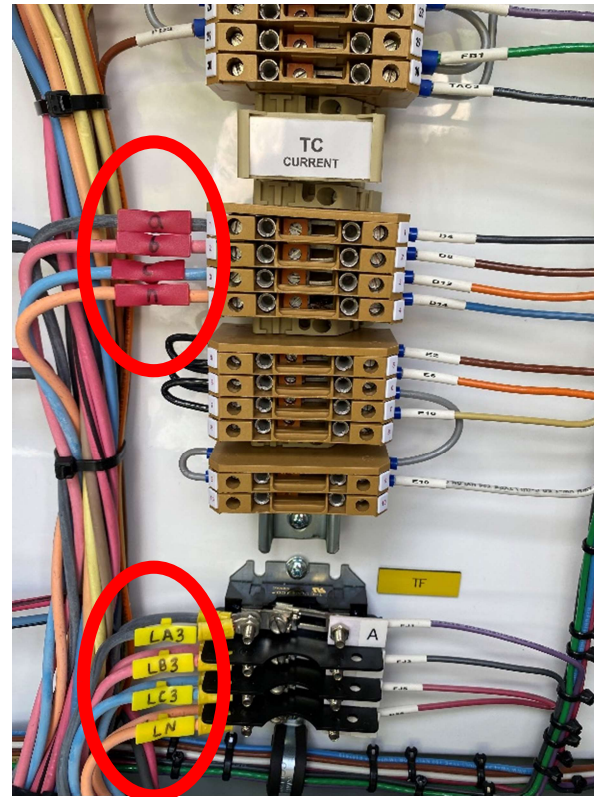
- ❑ 120-240 AC - Black (L1), Red (L2), Blue (L3)
- ❑ 277-480 AC - Brown (L1), Orange (L2), Yellow (L3)
- ❑ DC - Red (+), Black (-)



Potential Circuit

Wire labels

- ❑ Make it make sense (BFT-2R = Breaker Failure Trip for the 2R CB)
- ❑ Can also be color coded (red – current; yellow – potential)



Engineer equipment that is easy to test

- ❑ Flexi-Test Switches
- ❑ Diodes in an Alarm Circuit



Note the color code (red – current; black – potential; orange – controls)

Less Intrusive Testing

- Example: Tripping a CB (testing trip circuit)
 - Trip with every function
- OR
- Trip once and verify voltage afterwards (less intrusive)
- Depends on what needs to be accomplished, commissioning vs. periodic testing

Scenario: Blocking an SEL-487E Transformer Differential Relay

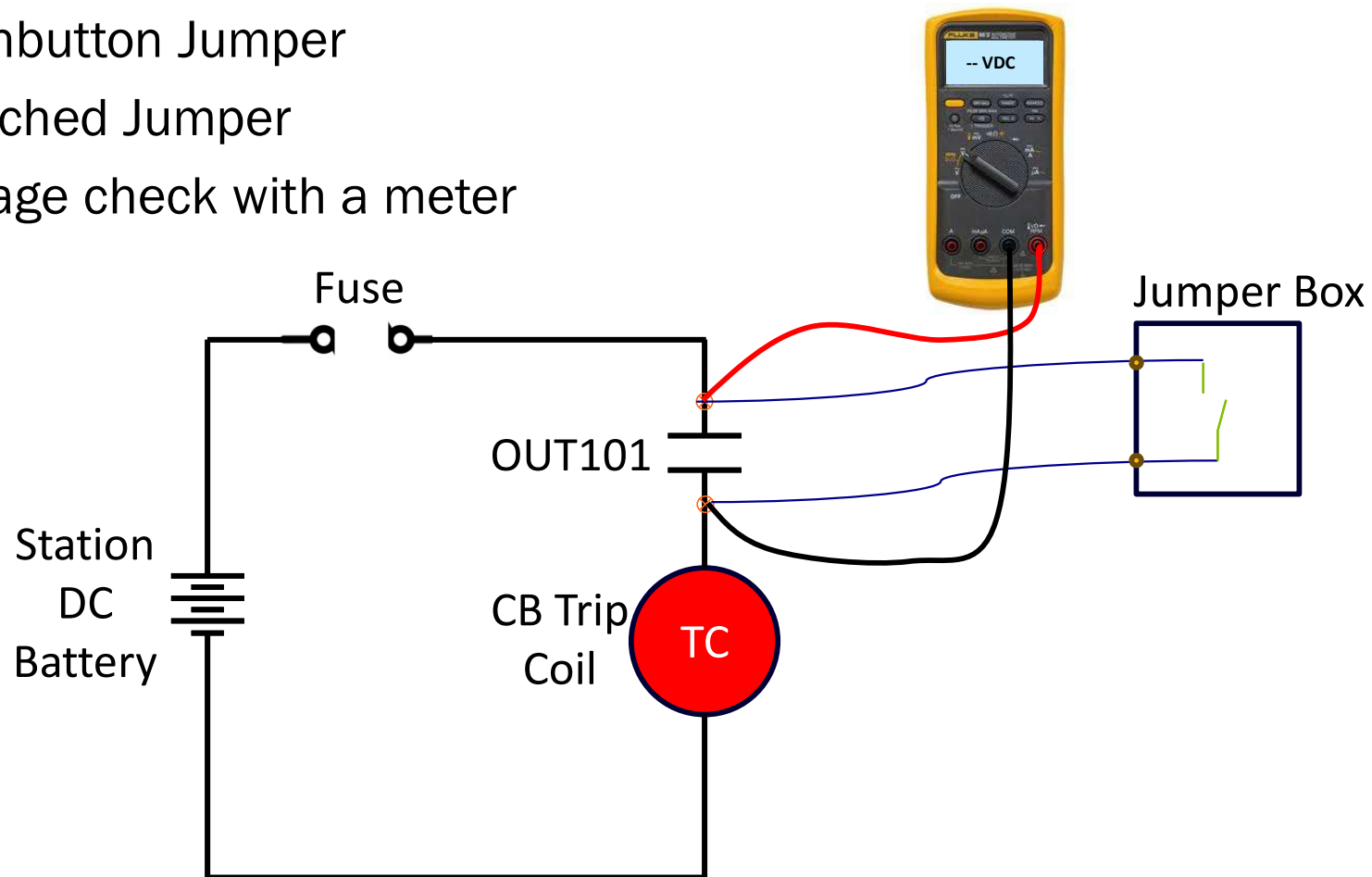
1. Prior to work, elementary and wiring diagrams are reviewed to determine blocking/isolation points.
2. Blocking sheet is peer-checked
3. Blocking sheet includes panel, test switch block, and switch number, as well as functional description (i.e., Panel 10R1, Block FTBDC2, Switches E & F, CB 2L Trip)
4. Blocking is applied by two technicians
 1. 3-Part Communication
 2. Phonetic Alphabet
5. Switches are recorded when they are opened.
6. Prior to unblocking, points are checked to ensure contacts are in the original state.
7. Unblocking follows the same process, after all blocking is removed the sheet can be reviewed for any remaining points.

Procedure Use

- Work Methods
 - Detailed, several pages in length
- One Point Lessons (OPLs)
 - One-page, small tasks/procedures

Jumper Boxes and Meters

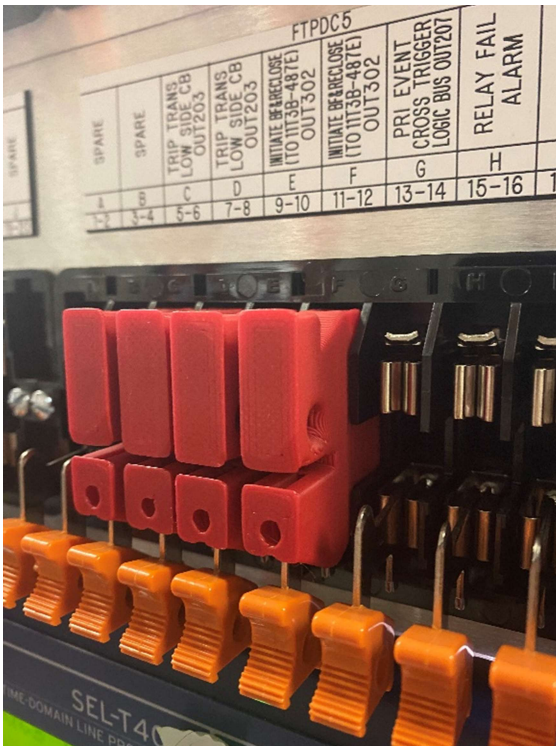
- Pushbutton Jumper
- Switched Jumper
- Voltage check with a meter



- Current check with a meter (i.e., blocking current circuits)

Connecting Leads to live circuits

- ❑ Retracting meter leads
- ❑ Banana jumpers
- ❑ Banana screw on adapter
- ❑ FT switch covers



Operating Switches/Control Handles

- Control switch hangers
- Control handle covers
- Tape



- Safety is everyone's responsibility!
- We have many HuP Tools available to work safely and reliably.
- Don't be afraid to speak up.
- Go home the same way you come in.