T&DWorld™

OPERATING ON THE POWER GRID

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Introduction

Many utilities are upgrading electrical equipment and protective relaying in transmission and distribution substations. Unfortunately, only small portions of the power in the substation can be turned off at any one time. Therefore, upgrades must take place adjacent to other energized control circuits, and equipment. Often the protective relay control circuits of the equipment being replace are intermingled with circuits that need to stay online. Even small mistakes or lapses in judgement can cause unwanted equipment outages and the magnitude if these outages can be very significant. Protection and Control (P&C) techs are often required to work in substations where one mistake can cause a critical power outage. This type of work in a substation can be compared to the critical nature of a surgeon operating on a patient. We are basically operating on the power grid when performing this work. With one mistake, you can lose the power to a city or large geographical area. Therefore, this type of work requires highly skilled technicians and engineers, plus the highest level of attention to details and techniques to reduce the possibility of human performance error.

Even the best, most seasoned P&C tech can make a mistake, without using extreme caution and the proper use of human error elimination tools. Many of the terminals, lockouts, relays, control handles, etc. look very similar and are marked or numbered in the same manner. It is very easy to make a mistake. We are all human, and humans will make mistakes. To reduce errors and lower the risk of mistakes, we must first acknowledge that mistakes will happen if we do not use proper human error elimination tools. Every human is prone to error and no matter how much experience or how smart they are, errors will occur, if proper controls are not taken. Here are some tools that should be used when working in this environment.

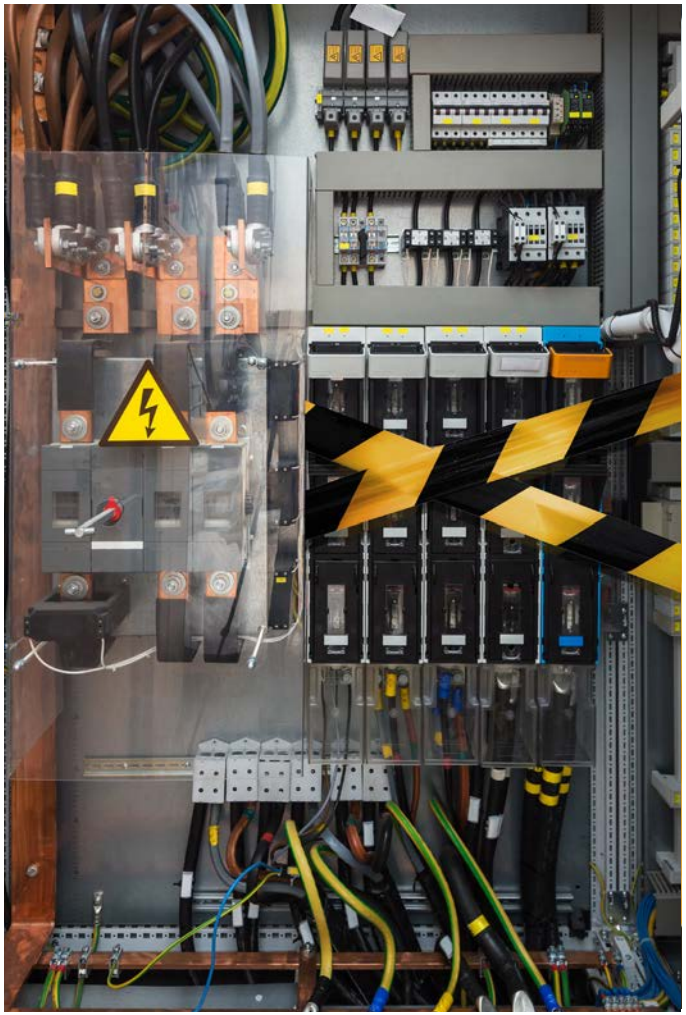

Figure 1

Create a Step-by-Step Procedure

When modifying wiring or commissioning a protective relay circuit, a step-by-step procedure should be used. This procedure should have as many identification points as possible outlined within and should not be generic statements. The procedure should be created based on the protective relaying control prints by a senior relay tech or engineer. It should be reviewed by a second set of eyes for an independent peer check. Independent means that this is not two people creating the procedure together, but one creating and the second one reviewing. A person can be swayed to think the same way as the other with comments if it is created together. Being independent allows for a more unbiased view when reviewing.

1. Barricade Look-a-Like Equipment

There are many ways to barricade equipment. This can be as simple as affixing barricade tape on adjacent panels, so the worker does not accidently enter the wrong relay panel. An example of this is shown in **Figure 1.**

Figure 2

Figure 3

Or using different colors of electrical tap to identify which points can and cannot be worked on. They also make different types of terminal block barriers as shown in **Figure-2**. The protective relay techs at this site are required to use the red barrier to identify circuits that P&C tech knows can cause a false trip, and the yellow barrier to identifies the test points that the crew plans to work on.

Barricading look-a-like circuits should always be the first step before beginning to modify any protective relaying circuit.

Barricading should also include barricading control switches, test switches, or lockouts that you do not want to accidently operate. **Figure-3** shows test switch isolation covers in use. Here the red covers are put on test switches that could cause a false trip if accidently operated during the commissioning process. The Blue and Black covers are used to mark different steps in the Identify wires that should be removed or not removed, or demolished, when replacing a relay.

Figure 4

Figure 5

2. Identify Wires

Identify wires that should be removed or not removed, or demolished, when replacing a relay. Often the P&C tech will identify wires to be demolished and then the electrician will do the physical task of demolishing. Highly visible wire markers can be used to identify critical wires. See **Figure-4.**

3. Clearly Marking Lifted Wires

If wires are to be lifted during commissioning or testing, it is important to cover them, in case they become energized, and to ensure they do not create shorts or a shock hazard if inadvertently energized. See **Figure 5**. Any time a wire is lifted the other end should be known. Wires that are un-known must be traced out; assumptions on wires should not be made. It is often found that there are more wires on a terminal block than the print indicates. This is because modifications have been made and the prints were never updated. Unfortunately prints have errors, and when additional wires or missing wires on terminals are found we must understand the differences to the print before proceeding. This may create a need for the step-by-step procedure to be changed.

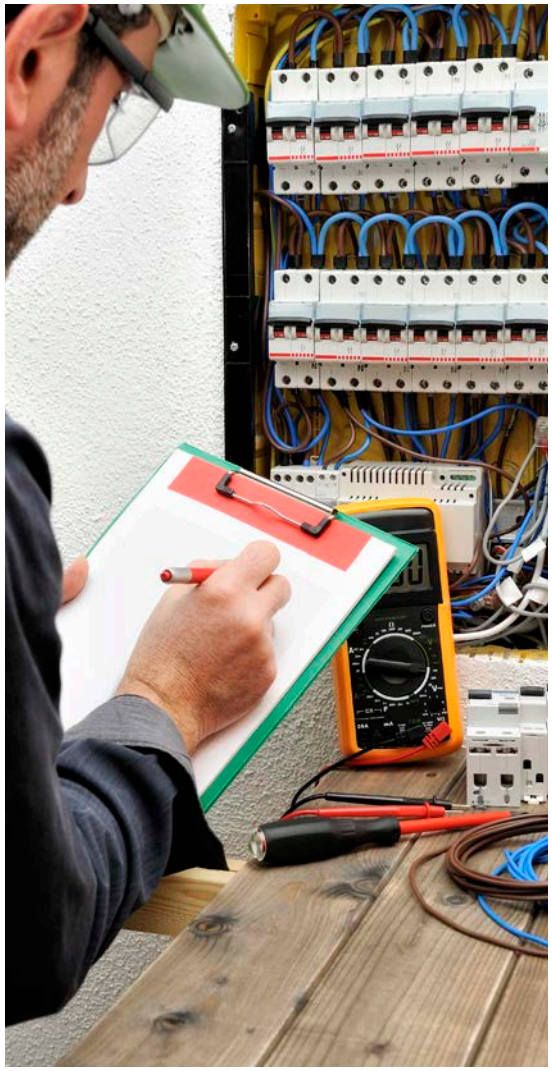

Figure 6

4. Clearly Mark Equipment that is Placed Out of Normal Position

Often during commissioning, it is required to change the position of a control switch to disable protection during testing. It is very important to clearly mark any switches that are modified to ensure they are correctly switched back to the proper position after commissioning. The modification of these switches should also be clearly outline in the step by step procedure as when to operate them. Also when defeating any, in service protection, this must be cleared with operations, per the utilities companies procedures.

5. Peer Checking and 3 Way Communication

When following the step-by-step procedure, each item should be verified by two techs. One tech should call out what is to be done and a second tech should restate the step to be done and get confirmation prior to performing the task. For example, if you are installing a jumper between two terminals the first tech should call out the cell information, terminal block, and terminal numbers where to install the jumper. The second tech should locate the terminals, repeat where they understand to install and wait for conformation before performing the task.

Conclusion

When commissioning protective relay panels during transmission or distribution upgrades, human performance error elimination tools and techniques are key to keep the power on. This article outlines a few key tools and techniques that should be used anytime this work is being performed. I have heard many senior protective engineers say, that if you have not tripped a sub off-line, then you have not worked in a sub. This is an old way of thinking. Today we understand how important human performance tools are and that the proper use of them. This will keep us from making critical errors. Performing protective relay commission deserves the same detail to error elimination as a surgeon would use when operating.