APPLICATION NOTE

Electrical testing safety

Part 2: Is it a backfed or induced voltage?

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You're about to test for the absence of voltage and have gone through the Lockout/Tagout process. You're wearing the proper personal protective equipment (PPE) and equipment, you have the right voltage test instrument and you know how to use it. As you touch the test probes onto the circuit you get a voltage where there should be none! What's going on?

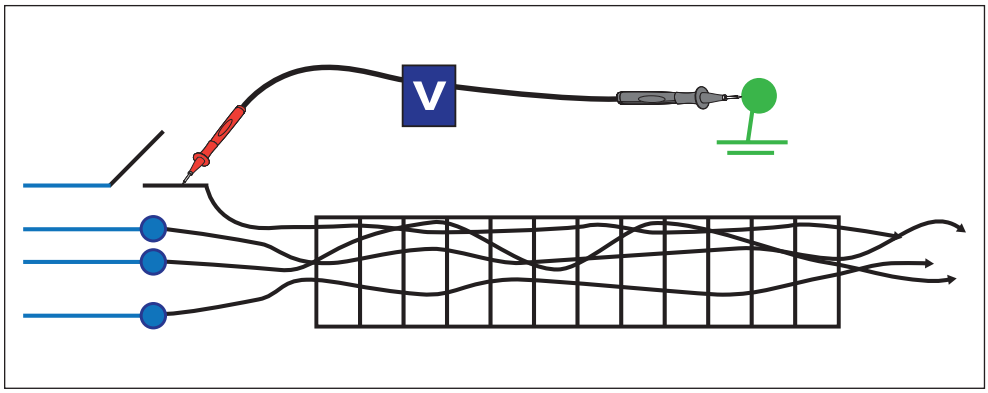

Figure 1. Low-voltage induced voltage scenario.

1 **You might be on the wrong piece of equipment.** Certainly not you! This is a big enough problem that the NFPA 70E included a new article about it in the 2015 edition in Article 130.7(E), Alerting Techniques, **"(4) Look-Alike Equipment. Where work performed on equipment that is deenergized and placed in an electrically safe condition exists in a work area with other energized equipment that is similar in size, shape, and construction one of the altering methods in 130.7(E)(1), (2) or (3) shall be employed to prevent the employee from entering look-alike equipment."**

2 **Is it really off?** If the circuit breaker or fuse feeding the circuit being tested is not clearly marked, or if a molded-case circuit breaker has tripped, shocking things can happen! I have been bit more than once from a "tripped" molded-case circuit breaker only to find out the contacts did not completely open. They wouldn't carry current, but they sure carried voltage! Always set a tripped breaker to the full OFF position before working on it.

3 **Are the test leads serviceable?** Recently an accident occurred during absence of voltage testing. The worker tested his meter and it seemed to work. He tested the circuit for the absence of voltage and got no indication. He then assumed the circuit was deenergized. As he made contact with the 480 V bus with his tool and arc flash occurred. Not wearing any arc-rated clothing or PPE, he was severely injured. No, he did not complete the verification of his test instrument, but the question became why did his meter show no voltage present? Turned out the test leads were broken at the 90° elbow where they are inserted into the test instrument. After wrapping the leads around the body of the meter repeatedly, over time the stress damaged the leads. See Part 1 on how to inspect your test instrument and leads prior to use.

4 **Induced or "ghost" voltages could be present.** Many people think induced voltages only happen in outdoor, high-voltage substations. While that's the biggest danger from induced voltages, low-voltage circuits run in cable trays can also induce a voltage into deenergized cables that are in the same cable tray (see Figure 1). Applying a static ground to this circuit would dissipate the voltage without problem, since an induced voltage does not have any short circuit current capability.

5 **It could be backfed.** Control power transformers (CPTs), indicating lights and "foreign" circuits (those coming from another panel or area) can be the culprit. Assuming the voltage measured is an induced voltage and applying a static ground to a backfed circuit could cause arcing, which is unsafe.

Backfed voltages

Often, backfed voltages and induced voltages can be very similar in magnitude. Although induced voltages are typically much lower than the circuit's nominal voltage, backfeeds can be in the same voltage range as induced voltages due to the impedances that may be in the circuit. Since it is not safe to ground a backfeed, what can be done?

Backfed voltages are voltages that often originate from another circuit or part of the equipment, but "backfeed" through indicating lights, CPTs or even resistors in equipment. These voltages are usually less than the nominal voltage of the circuit and can be approximately the same value as induced voltages. It can be difficult to tell the difference between a backfed or induced voltage. If an induced voltage is connected to ground, there is no generation (current) source and the voltage will dissipate. A backfed voltage, even though it is lower than nominal, does have a generation source feeding it and will arc if it is connected to ground.

Low vs. high-input impedance test instruments

The solution is to use a combination of test instruments in order to determine whether the voltage is backfed or induced, and then verify the initial results.

Good quality voltage test instruments typically have a high-input impedance. I found out the value of this when I was testing a 9,000 ton chiller that had an intermittent problem. I connected the test probe to one side of the coil and when I touched the other probe to ground, the coil closed, tripping the chiller off-line. This was not a career-enhancing moment. The meter I was using had an input impedance of only a few thousand ohms, what I like to call a Radio Shack® meter. When I made the connection between the energized coil and ground, enough current flowed through the meter to operate the coil. A meter with a high-input impedance would not allow enough current through the meter to cause the coil to operate. I took my inexpensive, low-input impedance multi-meter home and bought a good quality unit, one that had a high-input impedance.

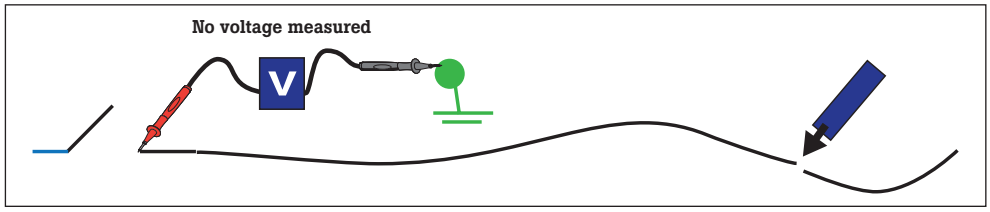

Figure 2. Induced voltage indication.

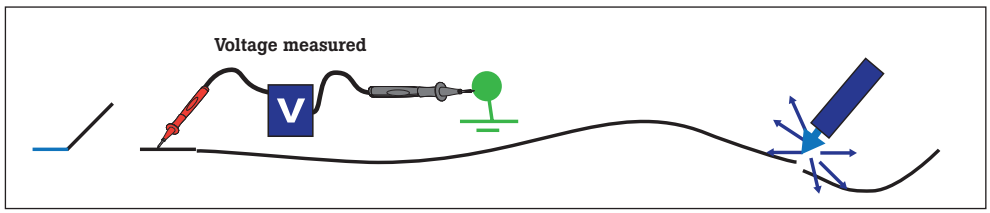

Figure 3. Backfed voltage indication.

The problem is carrying two test instruments for the same task. It's not practical. The solution is to use a single meter that has a high-input impedance, and a low-input impedance, such as the Fluke 117 or 289. If the voltage is induced, the low-impedance input should dissipate the voltage once it is connected to ground. Using a low-voltage proximity tester, measure along the circuit being tested while the low-impedance voltage tester is still connected. Figure 2 illustrates the end readings; no voltage indicated by the proximity tester and no voltage displayed on the low-input impedance tester. If the low-input impedance voltage tester does measure a voltage, as in Figure 3, even though it may only be several volts and the proximity tester indicates the presence of voltage, the voltage on the circuit is probably a backfeed and needs to be found before proceeding.

Applying a ground on a backfed circuit would result in arc welding! A dual-impedance meter is perfect for this test—better than carrying two separate meters or making an unsafe measurement.

Summary

If you find a circuit that shows voltage when there should be none, be careful what you do next. Creating an arc is an unsafe act and could get you fired or much worse. Be safe. Determine whether the voltage is induced by nearby, energized cables or if it is being backfed from an unknown source.

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