

Hot Stuff!

Power Monitoring on Live Circuits Can Be Done Safely

By Michael Daish, Summit Technology, Inc, Walnut Creek, CA

Introduction

Our modern technological world depends on systems and processes that require 24 x 7 x 365 operation. When their electrical infrastructures need maintenance it must inevitably be performed on live circuits. This article discusses a procedure to keep workers safe when performing “hot work”. NFPA 70E Article 130 FPN.2 discusses the justification for live work on “continuous processes” for “performing diagnostics”. Examples include start-up tests and trouble-shooting, verifying voltage quality, measuring circuit current loading capacity, and energy consumption studies. Here’s how to best to deal with the practical implications of complying with CSA and NFPA safety regulations to ensure success:

Document the Testing

An Electrical Hot Work Approval Form (EHWAF) must be completed first. It is a work plan with a step by step job description for installing and removing

test equipment. The EHWAF must declare safety boundaries; the Restricted Approach Boundary, and the Prohibited Approach Boundary. No worker shall cross the Prohibited Approach Boundary – meaning no live work can be done beyond this boundary. The region between the Restricted Approach Boundary and the Prohibited Approach Boundary is where PPE (Personal Protective Equipment) is mandatory. The form requires approval, usually by the facility owner (or manager) who approves and grants permission to perform live work, and authorizes designated workers. The form keeps safety awareness uppermost in workers minds, and warns others of the proposed work.

Equip For Safety

CSA Z462 and NFPA 70E requirements are in force for the protection of electrical workers. Arc flash hazard labels



indicating arc flash hazard severity and the required protective equipment should be present at the testing location. If no label exists a qualified engineer must assess what workers need to wear until a complete Arc Flash study is arranged. The following table is a guide:

Incident Energy From (cal/cm2)	Incident Energy To (cal/cm2)	Hazard Risk Category (HRC)	Clothing Description	Clothing Layers [1]	Required Minimum Arc Rating of PPE (cal/cm2)
0.0	1.2	0	Untreated Cotton [2]	1	N/A
1.2	4.0	1	FR Shirt & Pants [2]	1	4
4.0	8.0	2	Cotton Underwear + FR Shirts & Pant [2] [3]	1 or 2	8
8.0	25.0	3	Cotton Underwear + FR Shirts & Pant + FR Coverall [2] [3] [4]	2 or 3	25
25.0	40.0	4	Cotton Underwear + FR Shirts & Pant + Multi Layer Flash Suit [2] [3] [4] [5]	3 or more	40

[1] Layering generally gives more protection than the sum total of the ATPV values of the individual garments being layered. However, this needs tested for each specific garment being layered and thus is never explicitly included in layered calculations, Nomex fabric and layering FR clothing grants you some extra protection.

[2] Hard hat w/arc rated face shield + hearing protection + safety glasses (UV rated) + insulating gloves w/leather protectors + leather shoes.

[3] Sock Balaclava

[4] Arc rated (25 cal) arc flash hood and 25 cal flash suit.

[5] Arc rated (40 cal) arc flash hood and 40 cal flash suit.

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Best practices endorse the “buddy system” i.e. having another worker to assist, confirm the steps being taken, and be close by in case of a mishap. In addition to the PPE above hard hats are required with amber-tinted face shields that will protect against blasts and radiation that can damage corneas. Hearing protection should not be overlooked either as blasts generate high pressures that can rupture eardrums. Safety boots need to be chosen carefully for electrical insulation, and using rubber floor mats is a prudent precaution. PPE also applies to the selection of tools so the meter or test instrument must be chosen with the appropriate CAT safety rating.

Hot Testing

The following procedure from the EHWF describes the steps to be followed when installing and removing a power monitor.

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DETAILED JOB DESCRIPTION PROCEDURE TO BE USED FOR INSTALLATION OF POWER MONITORING EQUIPMENT:	
1.1	Complete Electrical Hot Work Approval Form (attached).
1.2	Inspect electrical equipment room to ensure it is free of potential fire hazards and flammable substances.
1.3	Stage safety equipment and have non qualified personnel leave the immediate work area.
1.4	Stage monitoring equipment.
1.5	PPE suit-up.
1.6	Remove electrical panel covers. Inspect for debris and obstacles to conductors. Determine whether clamp-on probes are suitable or if flexible probes are need for tight and confined conductor access.
1.7	Perform IR scan to verify integrity of electrical connections.
1.8	Install test meter or monitor in the panel or enclosure where it can be safely left and remain undisturbed during testing and monitoring. Connect to voltage conductors using fused voltage probes, and place current probes around phase conductors. Insure that wires will not be trapped or disturbed when panel covers are replaced.
1.9	Connect monitor to a notebook PC or Netbook. (Preferably with a wireless-capable instrument.) Verify correct monitoring configuration and voltage/current readings. Perform appropriate set up and programming. Initiate monitoring. Verify recording has begun before disconnecting PC.
1.10	Replace electrical panel covers. (Note: If the monitoring equipment can not be placed entirely inside the electrical enclosure then the leads to the monitoring equipment will be brought out in a safe and protected manner and monitor should be secured.)
1.11	Install appropriate hazard/warning tape and signs indicating monitoring activity being performed and emergency contact information.

DETAILED JOB DESCRIPTION PROCEDURE TO BE USED FOR REMOVAL OF POWER MONITORING EQUIPMENT:

- 2.1 Inspect electrical equipment room/work area to ensure it is free of potential fire hazards and flammable substances.
- 2.2 Stage safety equipment and have non-qualified personnel leave the immediate work area.
- 2.3 Station Safety Attendant and install Barrier Tape as required.
- 2.4 If using a wireless capable monitor connect monitor to laptop computer. Download and transfer monitoring data.
- OR if transfer of data is via a cable or memory card steps 2.5 to 2.7 must be done before 2.4 and before handling the testing monitor, connecting communications cable, or removing memory card.
- 2.5 PPE suit-up.
- 2.6 Remove electrical panel covers.
- 2.7 Perform IR scan to verify integrity of electrical connections.
- 2.8 Remove voltage probes, current clamps and power monitor as needed.
- 2.9 Replace electrical panel covers.
- 2.10 Remove hazard warning signs and barrier tape.
- 2.11 Repack monitoring equipment in carrying cases.

Before connecting the test meter, an initial inspection should note the condition of the panel, conductors, debris, and obstacles that would interfere with

safety. A thermographic scan with an IR camera will indicate hot spots due to loose or deteriorated connections that may cause flash-overs if disturbed. The



Safely perform testing via wireless from a laptop or an inexpensive Netbook PC.

presence of ozone odor may warrant an ultrasound test to locate corona discharges. Before any testing an assessment needs to be made

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to rectify potentially unsafe conditions.

Distance is Safety

Fact: Workers dislike wearing claustrophobic PPE. Vision is restricted by face shields, while thick gloves limit tactile feel and manipulation of tools. Plus,

it gets hot inside those suits - workers want relief! Thankfully, wireless technology has come to their aid. A new generation of monitoring instruments now incorporate wireless technology (Wi-Fi or Bluetooth) to allow testing remotely, up to 25 feet, from a notebook

PC, Netbook, PDA etc. Hoods, visors, and gloves can be removed allowing measurements and testing to be performed from a safe distance.

Verify the Data

Verify the data integrity before leaving the site and make sure useful data has been captured by the monitor. If it hasn't, it may be due to incorrect set-up, incorrect connections, or the monitor got disturbed and lost its connections during the test. To avoid wasted studies double-check the connections before monitoring by viewing a phasor diagram; errors become apparent immediately. The more intelligent meters automatically check connection errors and inform the user of missing signals or incorrect phase rotation errors.

To verify the data it may not be necessary to always remove the panel covers. Sometimes enough RF leakage occurs at gaps in panels, so data transfer is possible with panel covers closed. If the panel is tightly sealed no wireless signal escapes, covers must be removed requiring PPE.

Before leaving the site view the data on the notebook PC to make sure the downloaded data is good. A report can be generated on the PC to display log graphs and events. If the data looks good then the de-installation of the meter can proceed and the tech can rest assured sufficient useful data has been captured for subsequent analysis.

Conclusion: A Safer, Better, User-Experience

Electrical testing on live circuits must comply with CSA and NFPA safety requirements. By establishing a process, via a set of properly planned procedures as suggested above, testing can be performed on live circuits in complete safety.

Working on live circuits in PPE is daunting and uncomfortable. Using test instruments with wireless communications for remote control provides workers with welcome relief from wearing safety gear for long periods. With wireless-enabled test tools, workers are safer, more comfortable, and thus more productive.

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