

# Caution Bulletin

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**Title:** Assumptions Contribute to Arc Flash Incident at 331 Building

**Date:** August 24, 2006

**Identifier:** 2006-RL-HNF-0036

**Lessons Learned Summary:** Past experience can refine a person's judgment or cloud it. If assumptions made are correct, valuable time can be gained and effort saved. But if the assumptions are wrong, they can lead to undesirable outcomes. At 331, a previously unknown deficiency was eclipsed by a mindset grounded in past experience.

Making assumptions can lead to ascribing symptoms of a problem to the wrong cause. This can be a barrier to identifying the correct cause. And this can be dangerous. On Friday, April 21, 2006, a PNNL electrician was performing repair of an electrical system for the 331 Building chilled water pump when an electrical arc flash occurred inside a 480V combination motor starter. Incorrect breaker labeling and the ineffective Safe-Condition and Safe-to-work checks resulted in the undetected presence of electrical energy during the performance of the work scope - which led to the arc flash.

**Discussion of Activities:** To troubleshoot and repair a malfunctioning chilled water pump at the 331 Building, work planning actions were taken, including isolation of the electrical source and use of lockout/tagout (LOTO) for hazardous energy control. Personnel involved in the repair activity were aware of the electrical hazards associated with this type of work, and took precautions, as identified in existing procedures, to create a safe work environment. The LOTO activities included Safe-Condition and Safe-to-Work checks of the de-energized condition of the combination motor starter.

Following apparent verification that the combination motor starter was de-energized, staff removed their PPE. An arc flash occurred during performance of the work, and the electrician was taken to the on-site medical provider for evaluation. He wasn't shocked, but did receive a minor, superficial first degree burn on his left wrist. He was released for return to work without restriction.

All work was stopped and access to the area was restricted. Other potential energy sources in the area were isolated as a precaution. Additionally, a timely order was issued to control other F&O related electrical work until results of the investigation were in.

**Analysis: Leading up to the event -** The two breakers involved had been mislabeled. Reverse identification. But this was not immediately known. During diagnostics of the system, the operator noted that chilled water pump #1 shut down when the breaker labeled as the



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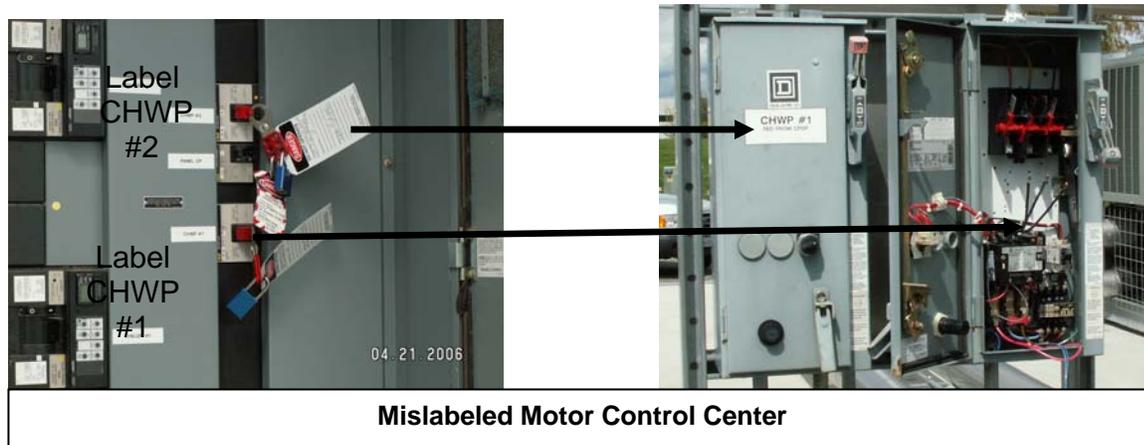


Work location



Close-up of contact point

supply for chilled water pump #2 was manually opened (de-energized). This operational anomaly was noted and logged in the operator's log on Thursday April 20, 2006.



The possibility of reversed breaker labeling, however, was never identified as a possible explanation of the conditions noted by the operator.

Note: This labeling error dated from the time of system construction in the summer of 2000, and contributed to incorrect system configuration and placement of LOTO on the wrong breaker. Note also that there was no requirement to verify correct labeling when new equipment was received or existing equipment modified.

**The Assumption** - The decision to troubleshoot and repair relied heavily on the premise that the issue was likely a problem with the automated facility control system (METASYS). Operations and maintenance staff often considered METASYS to be responsible for operational issues that were not readily apparent. During the performance of work prior to the arc flash, this belief was further supported when a failed control transformer was identified as the cause of the failure of chilled water pump #2 to operate.

*Based on past experience, and their current mindset, staff attributed the shutdown of chilled water pump #1 when Breaker #2 was opened to software control interlocks with the automated control system. On the basis of this assumption, they proceeded to apply lock-out/tag-out to Breaker #2.*

As work progressed, the possibility of a breaker labeling error and resulting isolation of the wrong breaker were masked by another error--the results of the Safe-Condition and Safe-to-Work Checks.

Staff performed a series of voltage measurements on the combination motor starter that they thought was supplied from Breaker #2, both energized and de-energized, before they installed lockout/tagout. The Fluke model T-2 test meter indicated a de-energized state during both the Safe-Condition and Safe-to-Work check determinations. This turned out to be false, but in the mean time the combination motor starter providing power to chilled water pump #2 remained energized during performance of the troubleshooting and repair work.

**But was it the test meter?** The design of the Fluke model T-2 meter incorporates a probe holder in the meter housing which was used during this work to position one of the test probes for the Safe-Condition and Safe-to-Work checks.

A factory-provided arc suppressor, designed to prevent phase-to-phase arcing within the combination motor starter, was in place during the Safe-Condition and Safe-to-Work checks. The design of the arc suppressor, however, limited access and visibility of the phase lugs (the intended point of contact).

Use of the probe holder on the Fluke model T-2 meter to position the test probe could have resulted in failure of the probe to contact the phase lug. The two most likely scenarios were:

- If the probe was not positioned in the meter probe holder correctly, or if the probe shifted position (slid back) in the holder as a result of contact with other conductors during previous checks, the probe may not have reached far enough through the arc suppressor to make contact with the phase lug.
- Staff performing the checks could have mistaken contact with the arc suppressor as contact with the phase lug without any distinct indication from the Fluke model T-2 meter.

The investigation team was not able to determine conclusively which of these scenarios was responsible for the ineffective Safe-Condition and Safe-to-Work check associated with this work. They were, however, in agreement that lack of contact caused the false indication of a de-energized state of the combination motor starter supplying power to chilled water pump #2.

**The Verdict** - Incorrect breaker labeling and the ineffective Safe-Condition and Safe-to-work checks resulted in the undetected presence of electrical energy during the performance of the work scope—which led to the arc flash.

#### **Recommendations:**

Verifying breaker labels should be included as part of acceptance testing for all new or modified electrical systems or components.

Engineering procedures for new or modified electrical systems should include verification of correct component labeling, and confirmation that the labeled isolation point correctly isolates the identified component.

Electrical Safety and LOTO procedures and training should require workers to verify the electrically de-energized condition (Safe-Condition and Safe-to-Work Check) by observing the test meter probe contact with the component to be tested. Procedures should also incorporate the option, where appropriate, to allow for verification of the test meter probe contact by watching presence of electrical energy and the test meter indications falling when de-energized.

As a result of the manufacturer's voluntary recall, immediately stop using all Fluke model T2 electrical test meters and remove them from the field.

**Cost Savings/Avoidance:** NA

**Work Function:** Maintenance - Electrical

**Hazards:** Electrical/NEC

**Keywords:** Arc Flash, electrical, lockout/tagout,

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**References:** None

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