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Subject: Yellow Alert: Near Miss Electrical Arc

TITLE: **Near Miss Electrical Arc**

IDENTIFIER: BN-LL98-046
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LESSONS LEARNED STATEMENT: A wireman was tightening an electric wire splice when an arc went from the jaws of his pliers to the edge of the junction box. This event demonstrates the problems associated with aging DOE facilities and equipment, the need to check for zero voltage upstream from the work point as well as at the work point, and the need for periodic preventive maintenance on circuit breakers and panels. Although not a contributing factor to the event, proper lockout/tagout procedures need to be followed.

DISCUSSION: On January 12, 1998, as a wireman was tightening an electric wire splice, an arc went from the jaws of his pliers to the edge of the junction box. He was not injured, and no electricity entered his body. There was no apparent property damage. The following are the findings of the investigation as of January 14th.

Electricians began troubleshooting a faulty air conditioner unit on the roof of Building 23-650, which is the Medical Clinic at NTS. Initially, the foreman sent two electricians to investigate the problem. They *isolated* electric power from the unit to be serviced by throwing the 480 volt/150 amp circuit breaker lever to the off position. The breaker which controlled the unit was in the breaker box in the building*s downstairs equipment room. They were having trouble identifying the problem, and were assigned to do another job. They placed a craft lock on the circuit breaker to keep the lever off and attached the tag and permit which was issued for this lockout.

The wireman, who knew more about this particular problem, was then assigned to do this job. The copy of this Work order does not have foreman's initials to show that he gave Wireman the required hazard control briefing before starting to work. However, they both state that hazards of 480 volts and of working on the roof of 650 were identified and controls were discussed.

The wireman arrived at Building 23-650and went to the equipment room to confirm that the correct circuit breaker was locked and tagged out. He did not place his own personal red lock on it, but instead chose to work with the craft lock applied. This action violates of the BN Lockout/Tagout (LOTO) Procedure. He then went up on the roof and tested the contacts on the source side of the air conditioner control box and found zero voltage on all three phases which he took to confirm that the power to the circuit was indeed off. In fact, the three phase 480 volt circuit was still powered because the A and C phase switches had failed to open even though the lever was locked in the off position because the switch had molded inside the circuit breaker. This power was not detected when the Wireman tested the circuit because of a loose wire splice that was upstream from where the contacts were tested for zero voltage.

When the wireman started tightening the Kearney fitting on the loose wire splice, the circuit was completed and electricity flowed from the splice fitting through the jaws of the pliers and to ground through the case of the junction box. This caused an electric arc until the pliers were withdrawn from contacting the fitting. The wireman was not burned and no electricity entered his body. He was not wearing gloves because he thought the power was locked off, but was wearing safety glasses and hard-toe shoes.

He then contacted his foreman to report the incident who came to the scene. They initially thought that the air conditioner circuit may have been fed from a secondary power source or that the wrong circuit breaker had been locked out. They went to the equipment room and removed the face from the locked out circuit breaker. They tested for voltage on the load side of it and discovered that the A and C phases were still powered due to a malfunction in the circuit breaker. They then disconnected the power leads on the source side of this faulty circuit breaker and discontinued work until a replacement breaker can be ordered and installed.

ANALYSIS: This splice was made about five years ago when a subcontractor made modifications. The only other work that the subcontractor was known to do at NTS was on the air conditioner on Building 23 -726. That wiring job had been checked and upgraded to make it safe after subcontractor was finished.

As can be seen from the above, there were the conditions of the faulty circuit breaker and the loose splice which combined to lead to this incident. If either the circuit breaker had opened its switches as designed when the lever was turned off, or if the splice had not been loose so that voltage would have been detected when tested downstream, this incident would not have happened.

The root cause is that the circuit breaker failed to operate correctly when turned off. A contributing cause is that the wireman failed to detect that power was on because he tested for voltage downstream from a loose splice. Because it is not possible to determine where splices may be loose in the circuit, the only sure way to test that power had been locked off was to test all three phases on the load side at the circuit breaker that was locked off. This would be more time consuming because the front of the panel must be taken off and it also would expose the worker to other circuit breaker's contacts which were not locked out and would be live.

A preventive measure which would directly address the root cause would be to perform adequate preventive maintenance on circuit breakers. The preventive maintenance on this one was less than adequate. Preventative maintenance has not been performed on any circuit breakers at NTS for the past two years, and for this particular one probably none has been performed for at least 26 years.

Additionally, the main 480 volt/ 400 amp circuit breaker controlling this incident's whole panel did not trip when the arc occurred. From the melted metal mark on the pliers, it is thought that more than 400 amps passed through the pliers, so there was probably another circuit breaker involved in this incident which did not operate properly.

RESOLUTION/RECOMMENDED ACTIONS: Because of the aging facilities, an incident similar to this could happen again. When working with electrical circuits, management should reemphasize to craftsmen who perform LOTO involving electrical circuits to always test for zero voltage on phase to phase and on phase to ground when verifying a lockout. Additionally, craftsmen should be reminded to test for zero voltage on the immediate upstream line side from the area they plan to work, and to do another zero voltage test again if them move their work area up line nearer the power source. Other control measures. such as testing for zero voltage on the load side of the LOTO point and the wearing of insulated gloves, should be considered.

Management should consider conducting periodic preventive maintenance on circuit breakers and panels in aging facilities under their control.

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FOLLOW-UP ACTION: Information in this report is accurate to the best of our knowledge. As means of measuring the effectiveness of this report please notify Dennis W. Murphy by e-mail at murphydw@nv.doe.gov (or phone 702-295-0734) of any action taken as a result of this report or of any technical inaccuracies you find. Your feedback is important and appreciated.