



## RECORD OF EVALUATION

SUBJECT: 10CFR 21 Report of Product Defect - Stationary Secondary Disconnect Conductor Strips for ITE 5HK Circuit Breaker Control at San Onofre Nuclear Generating Station - Southern California Edison.

1.) Description of Deficiency:

A conductor strip making an electrical connection to a removable circuit breaker element, broke and opened an indicating light circuit during insertion (racking in) of the circuit breaker. The failure was detected by a dark "breaker open" indicating light. Investigation of the cause identified one conductor strip on the secondary disconnect device which was broken at a 90 degree bend. Two other strips on the secondary disconnect exhibited cracks at 90 degree bends. A test of the disconnect showed that one additional contact strip, with cracking at the bend, failed after the equivalent of 32 racking cycles; but other testing of disconnects with cracks in the conductor strips found no failures or crack growth after the equivalent of 500 racking cycles. The strips are components of a 12 conductor disconnect which automatically makes and breaks contact between control components on the removable circuit breaker and the stationary equipment. Conductor strip material is cold-formed brass #2 (Half Hard) with silver plated surface.

2.) Location and Date:

The failure was discovered by operating personnel at the San Onofre Nuclear Generating Station - Southern California Edison in June 1995. The HK Switchgear was shipped in 1976.

3.) Analysis of Safety Implication:

San Onofre personnel conducted further onsite investigation and prepared a comprehensive "Safety Engineering Root Cause Report" which explores function of the disconnect, mitigation of risks and corrective action planned for San Onofre - Attachment #1.

The broken conductor deficiency, in another location on the disconnect, could have prevented trip or close of the circuit breaker by electrical control. This would disrupt normal operations and require manual trip or close at the circuit breaker location.

San Onofre personnel checked records for similar problems in the past on their system and at nine other nuclear stations which use 5HK switchgear. One prior instance of disconnect conductor breakage at San Onofre in 1990 and one possible instance at another plant were found.

ABB has had no indication that this is a significant maintenance problem. The HK switchgear design has been in production since the early 60's, there are hundreds of thousands of these conductor strips in commercial and nuclear service and only three known failures have occurred. The material specification for these conductor strips was originally C.F.Brass #2; the specification was changed in 1982 to add "Alloy C230". No cracking of conductor material during forming has been noted with the C230 alloy material.

Functional testing to verify circuit breaker ability to close, trip, recharge stored energy springs and provide accurate indication verifies that nothing has disrupted the electrical connections to the breaker during racking. This is a prudent measure to take after racking HK breakers into "connected" position; assuring the operator that the breaker will function electrically as long as it stays in that position.



4.) **Conclusions:**

The flexure of the conductor strip during racking operations is the cause of failure. The San Onofre Report asserts that seismic forces will have no effect on the conductor strips of a fully engaged breaker, ABB concurs.

There is evidence that pre-'82 disconnect conductor strips may be C.F. Brass Alloy C260 and may exhibit cracks at the bends. There is no method of judging the vulnerability of strips with visible surface cracks, surface hardness is not a reliable indicator. It is advisable, therefore, that a careful visual inspection of 5HK, 7.5HK and 15HK secondary contacts on critical circuit breaker positions be planned at a maintenance availability during which the switchgear can be completely deenergized. Replacement of disconnects which exhibit cracks in conductors is suggested. Attachment 3 lists HK nuclear switchgear orders which are likely to have disconnects with conductor strips subject to cracks.

Conductor strips which have surface cracks at bends will probably never break but breakage during racking cannot be ruled out, based on present data. If the strips have no obvious cracks at bends, no action should be taken; there is no evidence that cracks develop in service.

5.) **Corrective Action:**

The 1982 specification change, calling for Alloy C230, appears to have eliminated the possibility that cracks occur during fabrication of the conductor strips. Inspection of parts in stock provides further assurance, see attachment 2 for test data.

6.) **Reference Documents:**

Attachment #1 - Root Cause Evaluation of 4KV Breaker Secondary Contact Block Failure, RCE 95-010, Southern California Edison. (Full Report-less attachments)

Attachment #2 - ABB Material Analysis of currently stocked secondary conductor strip samples.

Attachment #3 - HK switchgear which may incorporate Alloy 260 conductor strips, with possible forming cracks, into secondary disconnect assembly.

7.) **Action to Prevent Recurrence:**

Material change, see #5; ongoing parts inspection.

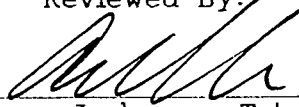
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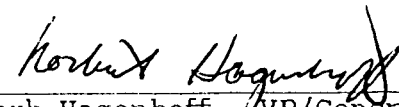
  
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