UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

December 16, 1987

NRC INFORMATION NOTICE NO. 87-35, SUPPLEMENT 1: REACTOR TRIP BREAKER, WESTINGHOUSE MODEL DS-416, FAILED TO OPEN ON MANUAL INITIATION FROM THE CONTROL ROOM

Addressees:

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose:

This information notice is being provided to alert addressees to the determination of the cause of the mechanical binding that resulted in the failed reactor trip breaker (RTB) described in Information Notice No. 87-35. The NRC is considering the need to request action by licensees using Westinghouse DS series breakers in Class 1E applications. This supplemental notice also discusses other concerns that arose during investigations of the RTB failure but that did not contribute to the binding of the RTB. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Background:

Information Notice 87-35, dated July 30, 1987, discussed the July 2, 1987, event at McGuire 2 in which an RTB would not open upon receipt of an electrical command signal. The RTB had bound mechanically. The shunt trip coil burned and shorted during the attempt to open the breaker. Operators in the control room stated that they observed open indications for both redundant RTBs, but the event recorder showed that only one had opened. The licensee's investigation, observed by an NRC Augmented Inspection Team, revealed abnormal wear of the pole shaft assembly and a broken weld joining the center pole lever and the pole shaft, but did not identify the specific cause of binding. Because the licensee's facilities for further investigation were limited, further investigation was to be conducted in a Westinghouse laboratory.

Failure Mode:

The McGuire 2 RTB failed to open because the main roller was wedged between the raised edge of the close cam and the right-hand side frame plate (viewing the RTB from the rear). A labeled view of the RTB mechanism is shown in Figure 1. When the RTB is closed, the position of the mechanism is as shown in Figure 2. A conceptual sketch showing the main roller wedged between the right side frame plate and the left cam segment, as viewed from the rear of the RTB, is shown in Figure 3. Similar wedging could occur between the left side frame plate and the right cam segment.

In the Westinghouse DS series breakers, the close cam (item 2 in Figure 1) is composed of four steel segments that are sandwiched together and held by three rivets. The two outer segments are heat-treated steel; the two inner segments are non-hardened steel. The surface of the segments is supposed to be of uniform shape. However, on the McGuire RTB, the two outer segments are slightly larger than the inner segments, providing the edge to catch the main roller (item 15). Only a slightly raised cam edge is necessary to allow binding. In addition, the distance between the inner surface of the close cam edge and the side frame plate (item 19) must be close to the width of the main roller.

The main roller can become wedged during the closing action of the breaker. As the close cam rotates, the edge of the main roller is caught, as shown in Figure 4. Continued rotation of the close cam causes the main roller axis to straighten. This action causes the edges of the main roller to attempt to separate the close cam and the side frame plate. However, the close cam and side frame plate are not free to move and, therefore, they wedge the main roller in place. When an attempt is made to trip the breaker, the wedging of the main roller prevents the main roller from rolling down the close cam face to allow the circuit breaker to open. The wedging of the main roller also prevents full discharge of the closing springs (not shown in Figure 1), leaving the close cam 18 degrees from a fully rotated position.

Both lateral displacement of the main roller end of the main drive link (item 14) and a small rotation (3 to 5 degrees) of the main roller axis are necessary to allow wedging. If the weld joining the center pole lever (item 9) to the pole shaft (item 8) is sound, the main roller end of the main drive link could still move laterally and even allow the main roller to strike the side plate. However, a sound weld would not allow sufficient rotation of the axis for wedging to occur. A large number of cycles of operation (3000 or more), however, could cause wear that would allow the necessary rotation of the axis.

Additional details on the failure mode and the Westinghouse tests are contained in References 1, 2, and 3.

Other Concerns:

Stop Roller Binding. The inspection of the McGuire 2 RTB components at Westinghouse revealed that the close cam surface had been peened. The peening

flattened and laterally expanded the surface of the outer cam segments, creating a mushroom shape. Of key concern was mushrooming in the area of the stop roller (item 1), which holds the mechanism in readiness for release of the spring release latch (item 16). The extreme mushrooming impeded rotation of the stop roller. It is possible that sufficient mushrooming could totally prevent operation of the stop roller, which could prevent closure of the circuit breaker upon demand. While not of safety concern for an RTB, this failure to close condition would be of concern for a breaker in a Class 1E application requiring energization of the connected loads.

RTB Position Indicating Light. At McGuire, red and green lights placed below each of the two RTB spring-loaded manual control switches in the control room serve to indicate whether the associated RTB is closed or open, respectively. Operators are trained to operate both control switches simultaneously, one with each hand, and to interpret each set of lights as representing the actual status of each breaker. However, the red lights serve the additional purpose of indicating continuity of the shunt trip circuit for each breaker.

The design circuitry is such that the absence of the red light can mean either that the breaker has opened as intended or that the associated shunt trip circuit has been interrupted. Determining which is the case cannot be done from the red light behavior alone; rather, the red light behavior must be interpreted in combination with the green light behavior and other control room indications, such as rod position displays. Operators need to understand that a "malfunction" of the red light may in reality be a valid indication that the associated shunt trip circuit is inoperable. Additionally, it is important that operators understand that the combined absence of the red and green lights after release of the spring-loaded manual control switch may mean that the associated breaker has failed to open in response to the electrical demand and that immediate local verification or trip action is needed. At McGuire, pressing the manual trip plate at the RTB did not open the breaker, but manipulating the manual spring-charging handle did open it.

Since the McGuire event, the licensee has modified the requalification training program for operators to ensure that they understand the potential meaning of the various combinations of RTB indications and that they follow appropriate verification procedures for suspected "malfunctions" of these indications.

Trip Latch Pivot Pin. During an NRC inspection at Braidwood 2 in late September 1987, the licensee reported that a Westinghouse DS-416 RTB at Braidwood 1 failed to close because improper brazing of the pivot pin (item 4 in Figure 1) to the trip latch (item 5) resulted in disengagement of the two. While not of safety concern for an RTB, this failure to close condition would be of concern for a breaker in a Class 1E application requiring energization of the connected loads.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact the technical contact listed below or the Regional Administrator of the appropriate regional office.

Charles E. Rossi, Director
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Office of Nuclear Reactor Regulation

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(301) 492-8196

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(301) 492-8961

K. R. Naidu, NRR
(301) 492-9659

References:

1. "Interim Report on McGuire 2B Reactor Trip Breaker Failure Evaluation and Recommended Corrective Actions from Westinghouse," Franklin Research Center, September 30, 1987, enclosure to letter from D. S. Hood, NRC, to H. B. Tucker, Duke Power Company, October 16, 1987, NRC Docket No. 50-370
2. NRC Inspection Report Nos. 50-369/87-22 and 50-370/87-22, August 31, 1987
3. "Reactor Trip Breaker Failure Due to Mechanical Failure," Licensee Event Report 50-370/87-009, Duke Power Co., August 3, 1987

Attachments:

1. Figure 1. Linkages of DS-416 Breaker Mechanism
2. Figure 2. Position of Mechanism with RTB Closed
3. Figure 3. Roller Wedged Between Left Cam Segment and Right Side Frame Plate
4. Figure 4. Binding of Roller
5. List of Recently Issued NRC Information Notices

1. Stop Roller
2. Close Cam
3. Roller Constraining Link
4. Pivot Pin
5. Trip Latch
6. Trip Shaft Latching Surface
7. Trip Shaft
8. Pole Shaft
9. Center Pole Lever
10. Pole Lever Pin
11. Moving Contact Arm
12. Stationary Arcing Contact
13. Moving Contact Pivot Pin
14. Main Drive Link
15. Main Roller
16. Spring Release Latch
17. Insulating Link Adjusting Stud and Locknut
18. Insulating Link
19. Mechanism Side Frame

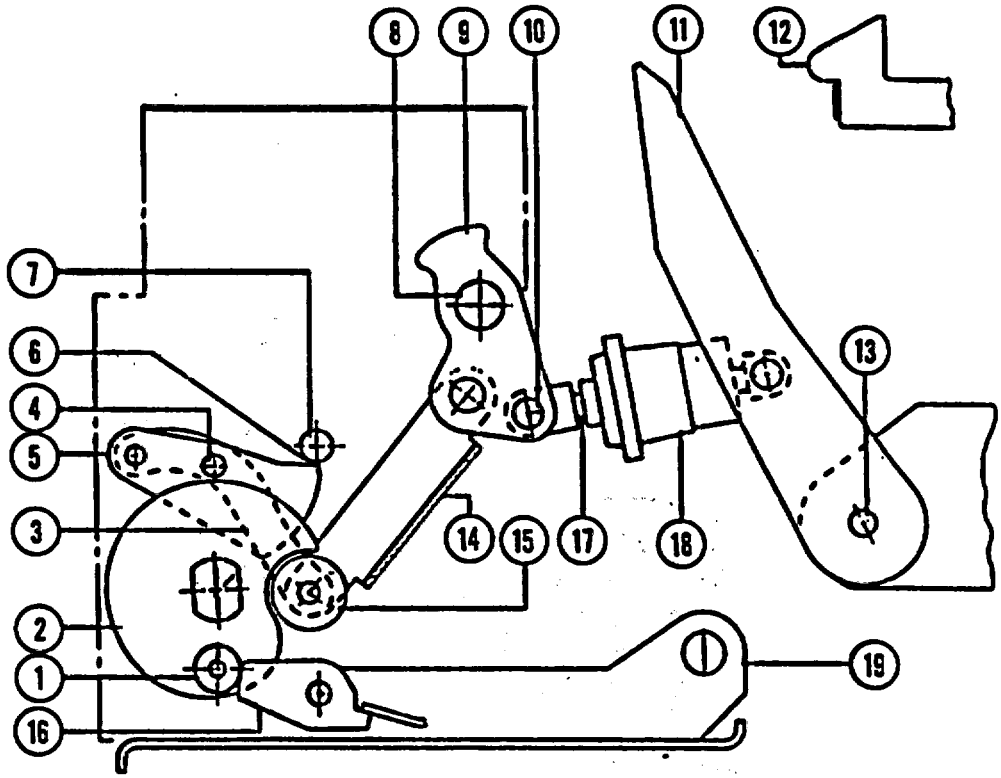


Figure 1. Linkages of DS-416 Breaker Mechanism Shown with CB Open and Springs Charged (Source: Instructions for Low-Voltage Power Circuit Breakers Types DS and DSL, Westinghouse Electric Corp., Instruction Bulletin 33-790-IE)

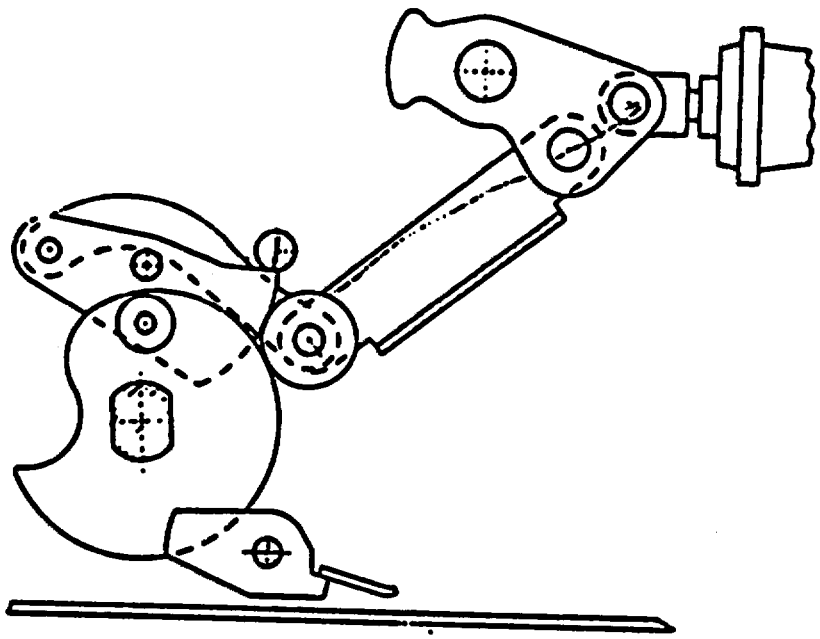


Figure 2. Position of Mechanism with RTB Closed (Source: Instructions for Low-Voltage Power Circuit Breakers, Types DS and DSL, Westinghouse Electric Corp., Instruction Bulletin 33-790-IE)

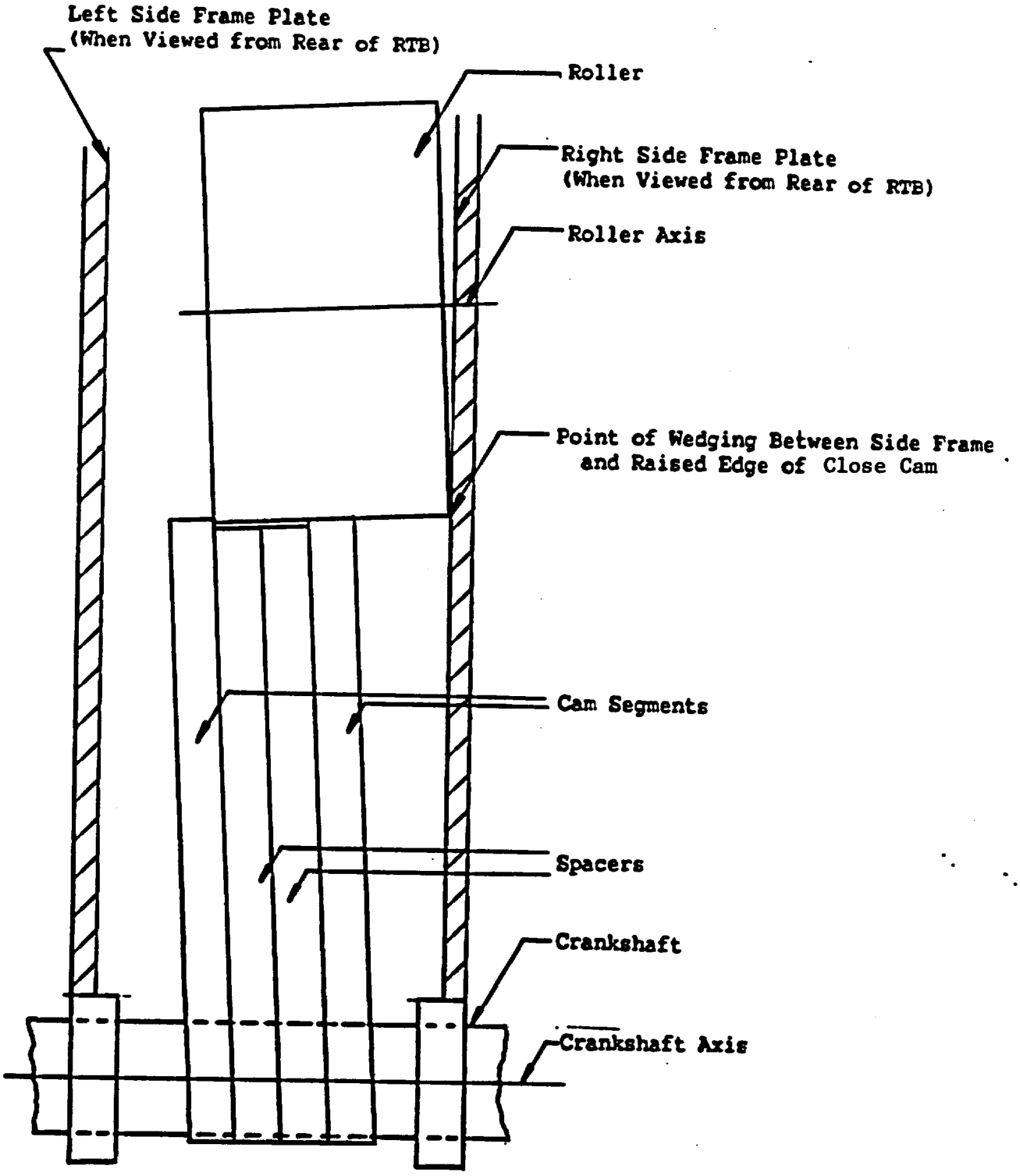
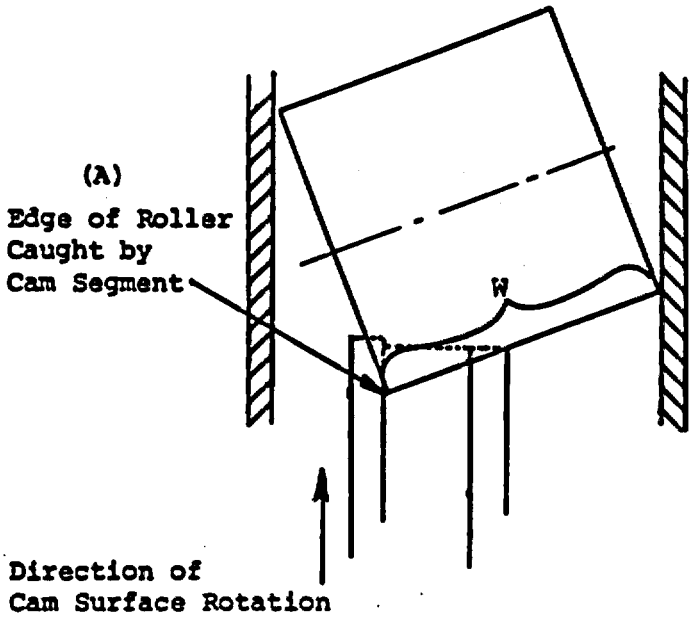


Figure 3. Roller Wedged Between Left Cam Segment and Right Side Frame Plate (Conceptual Drawing, Not Fully to Scale; Source: Franklin Research Center, Interim Report, September 30, 1987)



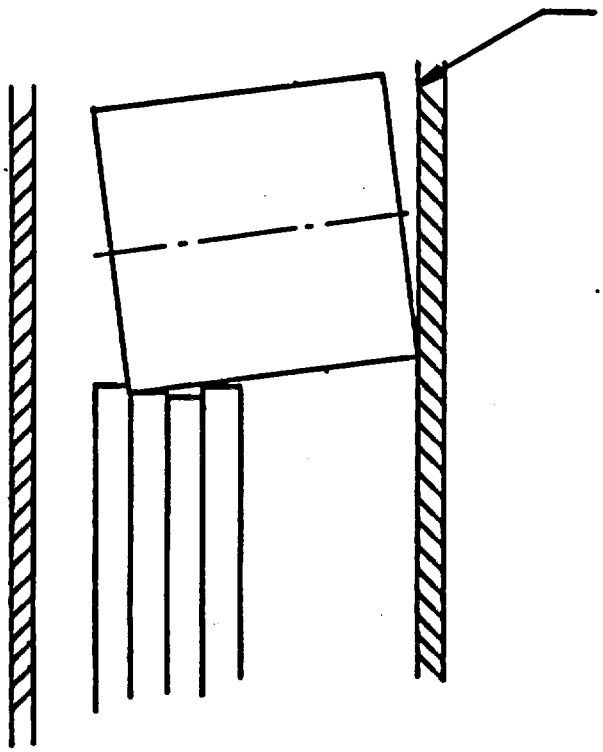


Figure 4. Binding of Roller
(Source: Franklin Research Center, Interim Report, September 30, 1987)

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES 1987

Information Notice No.	Subject	Date of Issuance	Issued to
87-63	Inadequate Net Positive Suction Head in Low Pressure Safety Systems	12/9/87	All holders of OLs or CPs for nuclear power reactors.
87-62	Mechanical Failure of Indicating-Type Fuses	12/8/87	All holders of OLs or CPs for nuclear power reactors.
87-61	Failure of Westinghouse W-2-Type Circuit Breaker Cell Switches.	12/7/87	All holders of OLs or CPs for nuclear power reactors.
87-60	Depressurization of Reactor Coolant Systems in Pressurized-Water Reactors	12/4/87	All holders of OLs or CPs for PWRs.
86-108, Supp. 2	Degradation of Reactor Coolant System Pressure Boundary Resulting from Boric Acid Corrosion	11/19/87	All holders of OLs or CPs for nuclear power reactors.
87-59	Potential PHR Pump Loss	11/17/87	All holders of OLs or CPs for nuclear power reactors.
87-58	Continuous Communications Following Emergency Notifications	11/16/87	All nuclear power reactor facilities holding an OL and the following fuel facilities that have Emergency Notification Systems: Nuclear Fuel Services, Erwin, TN; General Atomics, San Diego, CA; UNC, Montville, CT; and B & W LRC and B & W Navy, Lynchburg, VA.

OL = Operating License
CP = Construction Permit

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*SEE PREVIOUS CONCURRENCES

			D/DOEA:NRR	*C/OGCB:DOEA:NRR
			CERossi	CHBerlinger
			12/11/87	12/08/87
*OGCB:DOEA:NRR	*PD23:DRP:NRR	*ADR2/DRP:NRR	*EAD/DEST:NRR	*PPMB:ARM
CVHodge	DHood	GLainas	JRichardson	TechEd
12/03/87	12/03/87	12/07/87	12/07/87	12/04/87

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1. "Interim Report on McGuire 2B Reactor Trip Breaker Failure Evaluation and Recommended Corrective Actions from Westinghouse," G. J. Tolman, Franklin Research Center, NRC Docket No. 50-370, NRC Contract NRC-05-86-168, Task EL-305, September 30, 1987
2. NRC Inspection Report Nos. 50-369/87-22 and 50-370/87-22, August 31, 1987
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			CERossi	CHBerlinger
			12/ /87	12/8/87
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2. NRC Inspection Report Nos. 50-369/87-22 and 50-370/87-22, 31 August 1987
3. "Reactor Trip Breaker Failure Due to Mechanical Failure," Licensee Event Report 50-370/87-009, Duke Power Co., 3 August 1987

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12/03/87	12/ /87	12/ /87	12/ /87	12/ /87

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CVHodge	DHood	TechEd	CHBerlinger	CERossi
12/03/87	12/3/87	12/ /87	12/ /87	12/ /87