James S. Baumstark
Vice President
Nuclear Engineering

Consolidated Edison Company of New York, Inc.
Indian Point 2 Station
Broadway & Bleakley Avenue
Buchanan, New York 10511

Internet: baumstarkj@coned.com
Telephone: (914) 734-5354
Cellular: (914) 391-9005
Pager: (917) 457-9698
Fax: (914) 734-5718

October 9, 1998

Re: Indian Point Unit No. 2
Docket No. 50-247
LER 97-024-01

Document Control Desk
US Nuclear Regulatory Commission
Mail Station PI-137
Washington, DC 20555

The attached Licensee Event Report 97-024-01 is hereby submitted in accordance with the requirements of 10 CFR 50.73.

Very truly yours,

Attachment

cc: Mr. Hubert J. Miller
Regional Administrator - Region I
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Mr. Jefferey Harold, Project Manager
Project Directorate I-1
Division of Reactor Projects I/II
US Nuclear Regulatory Commission
Mail Stop 14B-2
Washington, DC 20555

Senior Resident Inspector
US Nuclear Regulatory Commission
PO Box 38
Buchanan, NY 10511

Je22

NRC FORM 366 (6-1998)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Indian Point No. 2	05000-247	1 OF 8

TITLE (4)

Westinghouse Model DB-50 Breaker Investigation

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER 05000
10	31	1997	1997	-- 024 --	01	10	09	1998	FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9): N

POWER LEVEL (10): 000

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.2201(b)		20.2203(a)(2)(v)		50.73(a)(2)(i)		50.73(a)(2)(viii)
	20.2203(a)(1)		20.2203(a)(3)(i)		50.73(a)(2)(ii)		50.73(a)(2)(x)
	20.2203(a)(2)(i)		20.2203(a)(3)(ii)		50.73(a)(2)(iii)		73.71
	20.2203(a)(2)(ii)		20.2203(a)(4)		50.73(a)(2)(iv)	X	OTHER
	20.2203(a)(2)(iii)		50.36(c)(1)		50.73(a)(2)(v)		Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iv)		50.36(c)(2)		50.73(a)(2)(vii)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
James J. Maylath, Senior Engineer	(914) 734-5356

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
X	ED	BKR	W120	Y					

SUPPLEMENTAL REPORT EXPECTED (14)				EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
	YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On October 31, 1997, with the unit at cold shutdown while performing a comprehensive investigation of the Westinghouse Model DB-50 breakers, preliminary results of testing and inspection revealed two items affecting breaker performance that were voluntarily reported. These items included low trip bar forces and winding of the trip pan spring. The diagnostic testing that revealed these two items showed the critical nature of closing coil de-energization timing to breaker latching, the importance of trip bar forces, the possibilities of physical impairments of certain components, and the correlation of closing forces to certain gap adjustments. Other items affecting breaker performance were found from this testing. Also, a modification of the breaker closing coil auxiliary relays was made based on documentation on similar auxiliary relays in other Westinghouse breakers. A plan to test the DB-50 breakers using settings, adjustments, and modifications based on optimizing the items found during diagnostic testing was developed and implemented. Following satisfactory testing, DB-50 breakers were returned to service.

PLANT AND SYSTEM IDENTIFICATION:

Westinghouse 4-Loop Pressurized Water Reactor

IDENTIFICATION OF OCCURRENCE:

Westinghouse Model DB-50 Breaker Investigation

EVENT DATE:

October 31, 1997

REPORT DUE DATE: REVISION DATE:

December 1, 1997 October 9, 1998

REFERENCES:

Condition Identification and Tracking System (CITRS) No. 97-E03826

PAST SIMILAR OCCURRENCE:

LER 83-009

DESCRIPTION OF OCCURRENCE:

On October 31, 1997 at 1809 hours, with the unit at cold shutdown while conducting a comprehensive investigation of performance of the Westinghouse Model DB-50 breakers, two potential contributing factors for breaker misoperation were identified. A voluntary report of these items was made to the Nuclear Regulatory Commission (NRC) Operations Center. The breaker investigation included high speed videotaping to observe and evaluate key relationships of breaker moving parts. Comparisons were made between breakers that had experienced misoperations and breakers that had no operating abnormalities. This effort revealed the critical nature of closing coil de-energization timing to breaker latching, the importance of trip bar forces, the possibility of physical impairments of certain components, and the correlation of closing forces to certain gap adjustments.

Station management had made a discretionary decision to bring the plant to hot shutdown and complete a comprehensive investigation of the DB-50 breakers, following the failure of Safety Injection Pump (SIP) 21 to start on 10/14/97 due to misoperation of its DB-50 supply breaker. Although a spare DB-50 breaker that tested satisfactorily had been installed for SIP 21, station management commenced the plant shutdown because the cause of SIP 21 DB-50 breaker failure, as well as previous DB-50 breaker anomalies, was unknown and confidence that other safety related DB-50 breakers would operate properly could not be assured. The reactor was safely brought to hot shutdown conditions on October 14, 1997 and cold shutdown on October 25, 1997. The investigation of the DB-50 breakers was commenced, and an investigative team was formed to review the breaker problems and conduct a detailed analysis of the functions and interactions of DB-50 circuit breaker components.

ANALYSIS OF OCCURRENCE:

This report is voluntarily being made because of the safety significance of DB-50 breaker misoperations and the potential generic implications for licensees with similar breakers. This report follows the voluntary verbal report made on October 31, 1997.

No major circuit breaker hardware or program deficiencies were noted during the breaker investigation. However, there were recommendations to enhance the breaker preventive maintenance (PM) program and to initiate a DB-50 breaker overhaul program. In late July 1997, three DB-50 breakers had been sent to National Switchgear Systems, Inc. (NSSI) for overhaul under the supervision of Nuclear Logistics, Inc. (NLI). When these breakers were returned following overhaul in late September 1997, several anomalies were found during the performance of the station PM. These anomalies were still being reviewed with NSSI and NLI when the safety injection pump breaker also malfunctioned. At that time, an accumulation of dust and lubricant was observed in the overhauled breakers, but this accumulation did not appear sufficient to cause binding in the breaker.

The diagnostic testing performed with the investigation of the DB-50 breakers, following the SIP 21 breaker failure, revealed the critical nature of closing coil de-energization timing to breaker latching, the importance of trip bar forces, possibilities of physical impairments of certain components, and the correlation of closing forces to certain gap adjustments. Any one or combination of more than one of these items can be a potential contributing factor to breaker misoperation. Previous station PMs had not addressed all the items found during the present investigation and did not fully optimize breaker characteristics that were considered.

The extensive data gathering effort conducted during the investigation developed the full understanding of the original design basis intended by the original equipment manufacturer (OEM) of these breakers. A comprehensive component design basis evaluation program was developed. This effort used fine-time incremented diagnostics, which included high speed videos and linear variable differential transducers (LVDTs). A thorough comparison of inspection and test results of the breakers was made. The evaluation of the findings of this effort included:

a. Participation of OEM
b. Participation of two separate independent consultants
c. Discussions with other major nuclear plants using DB-50 breakers, vendors and third-party dedicators
d. Use of high-speed videos to test and confirm individual findings as different mechanisms and design basis items were identified
e. Acquisition of new information and insights into the interactions of mechanisms in fine-time increments

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Indian Point No. 2	05000	1997	-- 024 --	01	4 OF 8

TEXT *(If more space is required, use additional copies of NRC Form 366A)* (17)

CAUSE OF OCCURRENCE:

This investigation of the Westinghouse Model DB-50 breakers was initiated following the failure of Safety Injection Pump (SIP) 21 to start on 10/14/97, while performing a scheduled quarterly test, due to misoperation of the associated Westinghouse Model DB-50 breaker. This failure followed similar breaker problems identified during the 1997 Refueling Outage. An investigation at that time included a review of past breaker problems at Indian Point 2, a review of the plant maintenance procedures, a survey of the industry for operational problems and best practices, and the utilization of circuit breaker consultants to help identify root causes. This investigation had determined that, based upon industry experience, the root cause of the breaker misoperations was the binding of the operating mechanism, due to accumulated dust and lubricant after 25 years of service. However, previous investigations and PMs had not addressed all the items found during the investigation that followed the SIP 21 breaker failure. These items are described in the paragraphs below. Any one or combination of these items could potentially cause breaker misoperation. Accumulated dust and lubricant can make the effects of some of these items more pronounced.

The breaker investigation determined that low breaker trip bar forces and over winding of the breaker trip rolling arm spring to be potential contributing factors for breaker misoperation. If the breaker trip bar force is too low, the vibrations resulting from closing the breaker may cause the trip bar to raise sufficiently to trip the breaker. Conversely, if the trip bar force is too high, the force required to trip the breaker could be excessive and impact the breaker trip capability. Low trip forces were found on some breakers without molded trip pads (weights). These trip pads had been removed when the breakers were modified in accordance with Westinghouse instructions to replace the electro-mechanical trip units with amptectors. During testing, breakers without trip pads were found to sometimes trip free.

On some breakers, the trip rolling arm spring was found to be over wound. This spring, which is part of the operating mechanism, when over wound can provide an additional unwanted force on the trip roller arm linkage, as well as the trip bar. Excessive force on the trip roller arm will preclude the breaker arcing and main contacts from properly closing. Physical indication of this abnormality was noted when the breaker closing mechanism could be moved during manual closure even with the trip bar raised. As stated above, if the trip bar force is too high, the breaker trip capability will be affected. Therefore, the investigation determined that excessive spring force could result in breaker misoperation.

The DB-50 breaker investigation revealed other factors that may be present which contribute to breaker performance. These included:

a. Breaker force requirements
b. 'G' gaps
c. Operating mechanism stalling
d. Control (X) relay release arm flutter

e. Control relay residual magnetism problem (identified in Westinghouse Letter NSAL-93-020, and NRC Information Notice 93-85, 93-85 Rev. 1)
f. Other breaker anomalies

The DB-50 breaker operates as a 'force balance' device. This determines the breaker force requirements. The driving force of the breaker is the solenoid coil acting through the breaker mechanism. This is balanced by contact forces on the breaker, supplied by springs. This critical adjustment that affects the force balance of the breaker is the 'G' gap, which is measured between two parts of the moving contact assembly. This is an indirect measurement of contact force. A "high" 'G' gap equates to more contact force, as well as more force required by the breaker operating mechanism. Reducing the forces that are required to close the breaker by narrowing the acceptable 'G' gap range can enhance the breaker closing operation without impacting the breaker tripping operation.

Breaker operating mechanism hesitation was detected during high speed video inspections of the SIP 21 breaker, when the closing solenoid coil and breaker operating rod hesitated during the closing operation. This hesitation occurs when high contact forces are present, and can affect the timing of closing solenoid coil de-energization. This can cause the breaker to fail to latch closed resulting in the breaker tripping free. This hesitation can be minimized by setting the breaker contacts with similar clearances and by optimizing the 'G' gap settings as described above.

The high speed video investigation also showed examples of flutter of the X-relay release arm. This is the effect of pre-loading the relay release arm when the breaker is open and the closing solenoid coil is at its low point. In this position the relay release arm, which is attached to the bottom of the closing solenoid coil, is touching the lower edge of the relay lever window. This investigation found that, when the pre-loading force is excessive, the relay release arm bends upward. When the breaker is called upon to close, the closing solenoid coil rises up to the operating mechanism, and the relay release arm rises from the lower edge of the relay lever window to the upper edge. As the relay release arm reaches the upper edge of the relay lever window, it may flutter against this upper window edge and cause premature snapping of the relay lever to open the X-relay contacts. Thus the closing solenoid coil may be de-energized prematurely before the dynamic carry through momentum can enable the breaker to latch. This phenomenon is intensified if the hesitation described above occurs.

Westinghouse Letter NSAL-93-020, and NRC Information Notice (IN) 93-85, 93-85 Rev. 1 identified a potential problem in which the control or X-relay could hang-up. These letters were issued following control relay failures in Westinghouse Type DB-25 and DHP-250 breakers. Since the Westinghouse Type DB-50 and DB-75 breakers have similar control relays, vulnerability of DB-50 and DB-75 breakers at Indian Point 2 to this phenomenon was considered. Westinghouse determined that the most likely reason for this problem is residual magnetism from prolonged energization of the relay or mechanical adherence causing the control relay plunger to not drop out immediately. If this relay is hung up, its contacts in the breaker closing coil circuit will not be reset to the closed to permit breaker closing on a subsequent close signal (whether manual or automatic). The circuit where the malfunction was first observed and reported by Westinghouse maintained the control relay energized, as opposed

TEXT *(If more space is required, use additional copies of NRC Form 366A)* (17)

to a momentary energization of the control relay. Westinghouse had indicated that while some control relays have exhibited a tendency to hang-up, this had not been a widespread problem in the industry. This was because they assumed that vibration caused by the breaker operation would drop out the control relay plunger. Also, many applications were in momentarily energized circuits where the effect of this residual magnetism or mechanical adherence was correspondingly small. As a result Westinghouse, in NSAL-93-020, determined that this issue was not reportable to the NRC under 10 CFR 21.

Five other types of breaker anomalies were identified during the DB-50 breaker investigation. These included:

a. Control relay flair found upside down on internal brass tube for three breakers - found on November 4, 11, and 24, 1997 (this can be considered a potential manufacturer's defect)
b. Breaker platform dimension discrepancy - found on November 4, 1997
c. Control relay spring found upside down - found on November 19, 1997
d. Position switch screw composed of material different than other screws with the same application - found on November 21, 1997
e. Inertial latch binding - found on various breakers following the December 1, 1997 submittal of this Licensee Event Report

The internal brass tube flair in the X-relay of some breakers was found upside down. Each of these deficiencies was discovered when the X-relay was being disassembled to implement a modification recommended by Westinghouse for the residual magnetism issue. Although no X-relay with this deficiency had failed, this condition could cause a failure of the relay and result in misoperation of the breaker. Upon finding the first relay deficiency, the relay was administratively failed, and the scope of the breaker inspection was expanded to include the X-relays for DB-75 breakers, as well as the DB-50 breakers. During the implementation of the above modification, one other control relay was found to have a discrepancy inside the control relay. An internal spring was found upside down. This relay had not failed while in service with the upside down spring.

For one DB-50 breaker, the 'G' gaps and arc gaps could not be properly aligned. This was because of a discrepancy in the breaker platform dimensions. This discrepancy resulted in the breaker operating mechanism to be skewed by ⅛″ to the back of the breaker. Damage on the A phase insulating link reflective of such a skewing of the operating mechanism had been found. This inconsistency of the breaker platform dimensions was not identified by the criteria used for receipt inspection of the breaker.

While performing the PM and modifications of the breakers based on optimizing the items found during diagnostic testing, a screw for the breaker lower auxiliary position switch was found cadmium plated rather than the required silicon bronze. This anomaly had not affected that breaker's performance.

On December 10, 1997, during cycling of the DB-50 breaker for the turbine auxiliary oil pump, the breaker failed to close on the 19th of a planned 25 cycle test. Inspection of this breaker found the crossbar abnormally close to the inertia bar causing the inertia bar to intermittently jam under the crossbar. Following the December 10, 1997 occurrence, all the DB-50 breakers were inspected for clearance (acceptance criteria were established) between the top of the inertial latch when pulled up to the bottom of the crossbar for visual observation of the pin and hole assembly on the closing clevis which is captured by the inertial latch.

The inertial latches for approximately 40 of the DB-50 breakers were replaced with new inertial latches. On August 11, 1998, during functional testing of Auxiliary Feedwater Pump 21, its DB-50 breaker failed to close. This failure was found to caused by inertial latch binding on a new inertial latch (new inertial latches are those procured following the December 1, 1997 submittal of this Licensee Event Report). The failure of the Auxiliary Feedwater Pump 21 DB-50 breaker to close was due to spalling or breaking away of the surface coating on the shaft pin and possibly on the female surface of the bushing of the latch causing the latch to bind. This is detailed in LER 50-247/1998-012 which was submitted on September 11, 1998.

CORRECTIVE ACTION:

Following the failure of the SIP 21 DB-50 breaker on October 14, 1997, the plant was brought to hot shutdown and a comprehensive investigation of the DB-50 breakers was undertaken. This investigation included diagnostic testing which revealed the critical nature of closing coil de-energization timing to breaker latching, the importance of trip bar forces, possibilities of physical impairments of certain components, and the correlation of closing forces to certain gap adjustments. Based on the data acquired, a plan was developed and implemented to optimize breaker performance by adjusting the settings on the breakers and making modifications as described below. This optimization process included an initial extensive data collection effort gathering information, which was not initially available, tests and evaluations of the breakers using sophisticated testing equipment to evaluate key relationships, determination of optimum breaker settings based on this analysis, and performance of final verification tests.

Key elements of the revised breaker settings, adjustments, tests, and modifications to optimize breaker performance included:

a. Performance of initial as-found testing at reduced voltage (90V test)
b. Measurement of breaker closing coil energization time
c. Measurement of alignment of arcing contacts
d. Measurement of closing solenoid positions and key operational point setting
e. Measurement of the force that causes breaker to latch
f. Inspection of the control relay release lever for bending
g. Determination of the pre-load force on the control relay release arm
h. Measurement of the forces to raise or lower the control relay lever
i. Machining, where necessary, the closing coil stop to allow the solenoid to travel sufficiently to assure adequate margin for breaker latching
j. Modifying, where necessary, the control relay actuating arm window and actuating lever to delay the de-energization of the control relay until after the breaker has latched

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Indian Point No. 2	05000	1997	-- 024 --	01	8 OF 8

TEXT (*If more space is required, use additional copies of NRC Form 366A*) (17)

l. Measurement and setting of the trip bar force where no lower limit previously existed, with the addition or removal of trip bar weights as necessary and/or replacement of the operating mechanism if the force exceeds 1.9 pounds
m. Measurement of the trip roller arm spring force and replacement of the operating mechanism if the force exceeds 1.1 pounds
n. Addition of a brass spacer to the control relay to preclude any residual magnetism as described in Westinghouse NSAL-93-020 and IN 93-85, Rev. 1
o. Replacement of the breaker platform that had inconsistent dimensions
p. Replacement of the X-relays of the breakers where the internal brass tube flair was found upside down
q. Correction of the internal spring in the X-relay where the spring was found upside down
r. Replacement of the cadmium plated screw with a silicon bronze screw
s. Collection of trendable data for the optimized breakers
t. Performance of a complete revised PM on the DB-50 breakers that incorporates the measurements and adjustments described above
u. Replacement of inertial latches as described above
v. Grinding of the inertial latch to obtain adequate clearance with the crossbar where necessary
w. Filing of the pin and hole assembly on the closing clevis at raised areas or burs where necessary

Following completion of the revised breaker settings, adjustments, tests, modifications, and PM, the breaker optimization effort was verified by:

a. Conservative envelope testing at 90V, 125V, 140V DC
b. Validation of results by high speed videos
c. In-situ testing - current traces with breakers in the "test position" and "racked-in" the cubicle compared with traces obtained in the maintenance shop area (breakers were physically removed from their cubicles for the optimization effort)

Upon completion of this verification with satisfactory test results, DB-50 breakers were returned to service. The modification providing for the addition of a brass spacer to the X-relay to preclude residual magnetism as described in Westinghouse NSAL-93-020 and IN 93-85, Rev. 1, was also implemented on the DB-75 breakers. A test program, similar to the DB-50 breaker test program, was also implemented on the DB-75 breakers.

Following the August 11, 1998 failure of the Auxiliary Feedwater Pump 21 inertial latch, the latch was sent to Altran Corporation for detailed analysis and was replaced with a new inertial latch. This replacement inertial latch and all other DB-50 breaker inertial latches in service and in spare breakers with the new mechanism were inspected to determine if a similar condition existed. These inertial latches were cleaned, adjusted, and tested as necessary to assure proper breaker operation. During future continuing maintenance of the DB-50 breakers, newly procured inertial latches will be inspected to determine if a surface coating similar to that discovered on the Auxiliary Feedwater Pump 21 breaker inertial latch exists. These inertial latches will be cleaned, adjusted, and tested as necessary to assure proper breaker operation prior to installation.