U.S. NUCLEAR REGULATORY COMMISSION

REGION I

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Licensee:	Niagara Mohawk Power Corporation
Facility:	Nine Mile Point Unit 2
Location:	Scriba, New York
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Executive Summary

Nine Mile Point Unit 2 Nuclear Station
NRC Inspection Report 50-410/98-18

An inspection was conducted on September 21 - 25, 1998, using the guidance of Temporary Instruction (TI) 2515/137, Inspection of Medium-Voltage and Low-Voltage Power Circuit Breakers, dated March 9, 1998. The inspection team was comprised of Region I and Headquarters personnel.

Maintenance

- The physical condition of safety and nonsafety-related breakers was good. The switchgear was located in clean, well maintained and adequately lighted areas. The technicians performing breaker testing were knowledgeable and familiar with breaker test requirements. The safety-related breakers at NMP2 had performed acceptably during the past five years. (M2.1, M2.2)

- Satisfactory progress had been made in refurbishing safety-related 4.16 kV Magne-Blast breakers. Although the licensee's planned actions to refurbish safety-related ABB Type HK breakers and safety-related ABB K-Line breakers on an accelerated basis were acceptable, the licensee's previous poor review of Information Notice 95-22 reflected a missed opportunity to establish a more timely refurbishment program. As a result, many ABB K-Line breakers exceeded the 10-year recommended interval for refurbishment and showed indication of lubrication degradation. (M2.3)

- The licensee's PM programs for medium-voltage and low-voltage breakers were generally good and had incorporated most vendor-recommended preventive maintenance actions, and recommendations identified in NRC Information Notices (IN). The Magne-Blast breaker procedures had been recently improved to include reduced-control-voltage testing. Examples in which procedures deviated from accepted industry practices were identified. During the inspection, the licensee initiated actions to include further improvements to the procedures. (M3.1, M3.2)

- The work requests and Deviation/Event Reports (DER) were well documented. Corrective actions were appropriate and timely. The root cause evaluation and apparent cause evaluations were well documented, thorough, and contained appropriate recommended corrective actions. (M4.1)

- The licensee's operating experience review (OER) program to review industry events and problems was weak. In many cases, the reviews were narrowly focused, without considering generic applicability. Some reviews were performed by personnel not familiar with plant equipment, resulting in inappropriate conclusions. Although some of the weak reviews were identified by the licensee in their self-

assessment audits, the team identified additional examples. The past incomplete reviews missed the opportunities to prevent two breaker failures. The OER program procedure did not provide guidance for detail reviews to determine generic applicability of NRC INs. (M6.1)

- The licensee's vendor interface program for medium-voltage and low-voltage breakers was weak. The vendor manual binders were poorly organized, incomplete and contained irrelevant materials. The licensee's "periodic re-contact" of breaker vendors was ineffective. There were cases where incorrect vendor department or inappropriate vendor personnel were contacted. Although many of the examples were identified by the licensee in their self-assessment audits, others were identified by the NRC team. (M6.2)

- The licensee's treatment of power circuit breakers under the Maintenance Rule (MR) was consistent with MR requirements and industry practices. The licensee's close review of breaker performance by class associated with standard-MR-performance-monitoring had helped to identify and to provide prompt corrections of common breaker problems caused by inadequate preventive maintenance in the past. (M6.3)

- The licensee's self-assessment audits for the medium-voltage and low-voltage breakers program were good, resulting in many significant findings in the operating experience review and breaker vendor interface areas. The audit reports were of good quality. However, at the time of the inspection, the resolutions for most of the audit findings were not yet complete. Also, the team identified additional examples of problem in areas identified by the licensee as being weak. (M7.1)

Engineering

- The licensee's control-circuit-voltage-drop calculations were weak. The calculations required several corrections during the team's reviews. The basis for assuring safety-related breakers had sufficient control-voltage for proper breaker operations was initially not well developed, and required the development of an operability determination and additional, revised testing of the breakers. (E8.1)

Report Details

Summary of Plant Status

Nine Mile Point Unit 2 (NMP2) operated at 100% power during the inspection period.

Introduction

This inspection was to determine the adequacy of licensee programs, procedures, equipment and supporting documentation for the maintenance of medium-voltage and low-voltage power circuit breakers. The overall scope of the inspection was defined in Temporary Instruction (TI) 2515/137, "Inspection of Medium-Voltage and Low-Voltage Power Circuit Breakers," dated March 9, 1998. The 13.8 kV safety-related circuit breakers at NMP2 are type HK manufactured by Area Brown Bavaria (ABB); the 4160 V circuit breakers are type AM-4.16-250-9H (Magne-Blast) manufactured by General Electric Company (GE); and the 600 V/125 V circuit breakers are K-Line type circuit breakers manufactured by ABB.

The licensee performed several self-assessment audits of their breaker maintenance program. The assessment of these audits is discussed in Section M7.1.

II. Maintenance

M2 Maintenance and Material Condition of Facilities and Equipment

M2.1 Walkdown of Switchgear Areas and Witness of Breaker Testing

a. Inspection Scope (TI 2515/137)

The team performed a walkdown of several switchgear areas containing safety and nonsafety-related breakers to observe and assess the physical condition of switchgear located in those areas. In addition, the team interviewed the technicians to assess their knowledge of breaker testing being conducted.

b. Observations and Findings

The safety-related switchgear rooms contained switchgear for 125 Vdc, 600 Vac, 4.16 kV and 13.8 kV systems. The team found that all rooms were clean, well maintained and adequately lighted, with no broken or missing parts on switchgear components. The team noted no breaker deficiency tags in the switchgear rooms toured. The licensee opened a spare cubicle (2ENS*SWG103-6) and the service water pump F cubicle (2ENS*SWG103-7) for the team to inspect. The team found both cubicles to be clean and well maintained. The 4160 Vac spare circuit breaker (serial number 295A5517-012) was placed in the appropriate position for seismic considerations while the 4160 Vac service water pump F circuit breaker (serial number 269A4395-010) was fully racked into position and ready to operate if

needed. The team also examined a spare 4160 Vac circuit breaker (nonsafety-related, serial number 303A8179-001 that had recently been refurbished by General Electric) stored in the normal switchgear room. The circuit breaker was secured in a breaker FME (foreign material exclusion) cover to keep it in a clean condition.

The team also witnessed the testing of several K-Line circuit breakers during the walkdown. The circuit breakers were being tested per work order (WO) number 98-10679-00, "Test Various Unit Sub Spare Breakers for Pick Up Voltages to Close and Trip." The team observed that the technicians followed the instructions in the WO and used the appropriate test equipment to determine the minimum voltage for closing and tripping the circuit breakers. The technicians appropriately answered the team's questions regarding circuit breaker testing. The team found the technicians knowledgeable of breaker testing and familiar with the WO test requirements.

c. Conclusions

The physical condition of safety and nonsafety-related breakers was good. The switchgear was located in clean, well maintained and adequately lighted areas. The technicians performing breaker testing were knowledgeable and familiar with breaker test requirements.

M2.2 Material Condition of Circuit Breakers

a. Inspection Scope (TI 2515/137)

The team reviewed circuit breaker failure records to assess the material condition of the circuit breakers and to determine if any trends or generic performance problems existed at NMP2.

b. Observations and Findings

The team reviewed the licensee's records for circuit breaker failures over the past five years and found no indication of any particular trend or generic performance problems. The records showed that there were six breaker failures of safety related breakers including one in-service failure during that time period. The in-service failure occurred during a quarterly surveillance of the LPCS/LPCI pumps. The licensee discovered that the Division 1 normal power automatic start LOCA signal to the low pressure core spray pump number 1 time delay relays was not received. The licensee determined that the cause of this failure was open contacts in the switchgear and circuit breaker ENS*SWG101-13 due to a plunger (which operates the contacts) being out of adjustment. The team found that the licensee had entered this breaker failure into their corrective action program and made the proper adjustments to the plunger to restore the breaker to the normal operating condition. The team also found that NMP2 had an acceptable breaker performance record with one in-service breaker failure (confirmed by NRC review as discussed in Section 4.1) over the last five years.

c. Conclusions

The safety-related breakers at NMP2 had performed acceptably during the past five years. The failures of the safety-related breakers at NMP2 did not indicate a trend or generic performance problem.

M2.3 Breaker Overhaul/Refurbishment

a. Inspection Scope (TI 2515/137)

The team reviewed the licensee's refurbishment program for medium-voltage and low-voltage breakers to assess the adequacy of the program. The review included current breaker status, vendor information, industry experiences, and breaker test results.

b. Observations and Findings

Refurbishment of GE Magne-Blast Breakers

The licensee began refurbishment of their Magne-Blast breakers in 1994. During refueling outage 6 (RFO6) in 1998, the licensee had 16 safety-related (out of a total of 28 plus five spares) and 10 nonsafety-related (out of a total of 36 plus five spares) Magne-Blast breakers refurbished. The remainder of the active GE breaker were scheduled to be refurbished by RFO7 scheduled for March 2000.

Also, during RFO6, 28 safety-related Magne-Blast breakers passed timing tests and minimum control voltage (pickup type) tests, some of which were performed on breakers undergoing scheduled refurbishment. In addition, 23 nonsafety-related Magne-Blast breakers passed minimum control voltage tests, but one of these failed its as-left timing test and was refurbished as well.

The team determined that the overhaul program for NMP2's Magne-Blast breakers, which have been in service since 1986, was progressing satisfactorily. The team also determined that there had been adequate interim performance testing to provide reasonable assurance of continued operability until all the breakers have been refurbished in year 2000.

Refurbishment of ABB K-Line Breakers

The licensee had not refurbished any of their 600 Vac ABB K-Line breakers (27 safety-related plus three spares and 182 nonsafety-related plus 40 spares), since they entered service in early 1986. Although the licensee reported no maintenance-preventable functional failures (MPFF) among K-Line breakers, industry experience has shown that age-related failures, principally due to degraded lubrication, began to occur after about 12 years of service, even in the relatively benign nuclear plant environment.

NRC Information Notice (IN) 95-22 addressed this issue and even cited failures and sluggish operation of ABB Type HK and K-Line breakers as examples. However, the licensee had incorrectly classified (identified by the licensee during their self-assessment audits) IN 95-22 as not applicable for NMP2 breakers, and the issue identified by the IN was not acted upon (detail of this issue is discussed in Sections 6.1 and 7.1 of this report). In addition, ABB Maintenance and Service Manual MS 3.1.1.9-2D for K-Line switchgear, issued in April 1991, specified that breakers should be refurbished at a maximum interval of 10 years (more detail is discussed in Section 7.1 of this report). The licensee obtained a letter from the vendor, ABB Service Company, Henrietta, New York, in June 1998, which stated that the K-Line breaker did not need to be immediately refurbished. Based on this letter, the licensee decided not to refurbish their K-Line breakers at the 10-year interval.

During this inspection, the licensee was testing several K-Line breakers. The test method was to gradually increase the voltage (beginning at zero) applied to the closing and tripping coils to determine the lowest voltage at which the breakers' closing (spring release) solenoids and tripping solenoids would first close or trip the breakers. The actual closing and tripping voltages were recorded by a chart recorder. The licensee stated that they had completed testing two safety-related breakers and that both breakers closed at closing coil voltages between 50 and 60 volts, which were within the benchmark voltage specified by the vendor. The team later witnessed the testing of several breakers and reviewed the test records of several breakers, and found that the results varied widely among breakers ranging from 45 to 84 Vdc. These results suggested the beginning of lubrication degradation in some of the K-Line breakers. Based on the new test results, the licensee determined to refurbish their safety-related K-Line breakers on an accelerated schedule and establish a ten-year refurbishment schedule thereafter. During the inspection, the licensee indicated that they plan (documented in the amended disposition to DER 2-98-2523) to complete the following actions:

- Complete additional low control voltage testing on safety-related breakers to identify any with marginal performance.
- Refurbishment to begin promptly with spares.
- The four breakers requiring remote operations would be refurbished or replaced during the next opportunity (including forced outage)
- Half of safety-related breakers to be refurbished by RFO7 (year 2000).
- Those breakers not initially scheduled for refurbishment during RFO7 would be low-voltage tested, and replaced if they do not meet low-voltage acceptance criteria to be developed by the vendor and the licensee.
- Remaining safety-related K-Line breakers to be refurbished by the end of RFO8, scheduled for 2002.

The team determined these actions acceptable.

Refurbishment of ABB 15HK Breakers

NMP2 had four ABB Type 15HK1000, 13.8 kV reactor-recirculation-pump-motor circuit breakers. Because of their important-to-safety anticipated-transient-without-SCRAM (ATWS) trip function, the licensee classified them as safety-related. There were also two nonsafety-related and one spare 15HK1000 breakers. NMP2's 15HK1000 breakers had been reliable, with no reported failures in their history. The licensee had not refurbished any of these ABB medium-voltage breakers since they entered service in early 1986. Up to the time of this inspection, the licensee had not established any refurbishment schedule for these breakers.
However, as discussed in NRC IN 95-22, these breakers had reached the age at which industry experience has shown that the breakers are likely to begin to experience age-related failures, particularly involving degradation of lubrication. During this inspection, the licensee planned to refurbish all safety-related ABB Type 15HK1000, 13.8 kV breakers by the end of RFO7, as documented in the amendment to the disposition of DER 2-98-2522, dated September 23, 1998, and established a 10-year refurbishment frequency thereafter for these breakers.

The team determined the licensee's actions acceptable.

c. Conclusions

Satisfactory progress had been made in refurbishing safety-related 4.16 kV Magne-Blast breakers. Although the licensee's planned actions to refurbish safety-related ABB Type HK breakers and safety-related ABB K-Line breakers on an accelerated basis were acceptable, the licensee's previous poor review of Information Notice 95-22 reflected a missed opportunity to establish a more timely refurbishment program. As a result, many ABB K-Line breakers exceeded the 10-year recommended interval for refurbishment and showed indication of lubrication degradation.

M3 Maintenance Procedures and Documentation

M3.1 Maintenance Procedures for Medium-Voltage Circuit Breakers

M3.1. Medium-Voltage Breaker Maintenance Procedures

a. Inspection Scope

The team reviewed various maintenance procedures for medium-voltage breakers to determine their adequacy. The procedures reviewed included: Procedure N2-EPM-GEN-2Y852, "GE 4.16/13.8kV Magne-Blast Breaker Timing PM," Revision 00, dated September 10, 1998; Procedure N2-EPM-GEN-4Y550, "GE 4.16kV Magne-Blast Breakers and Associated Motors," Revision 00, dated September 10, 1998; and Procedure N2-ESP-EPS-5Y565, "60 Month 13.8kV Breaker Inspection and Preventive Maintenance," Revision 04, dated September 6, 1996. The 13.8 kV breakers were ABB Type HK breakers used for the reactor recirculation pump switchgear equipment. The team also reviewed preventive maintenance (PM) records and interviewed cognizant licensee staff.

b. Observations and Findings

GE Magne-Blast Breakers Procedures

Procedure N2-EPM-GEN-2Y852 prescribed inspection and preventive maintenance activities of GE Magne-Blast breakers to be performed every two years, while Procedure N2-EPM-GEN-4Y550 was used for more extensive maintenance to be performed at four-year cycle. The licensee had been maintaining the breakers at five-year intervals, using Procedure N2-EPM-GEN-5Y550 (superseded, last revision was 05), until summer this year. In addition, the licensee was implementing a comprehensive breaker performance trending program for the Magne-Blast breakers. The team found the 2-year and 4-year preventive maintenance schedule acceptable.

The team found that maintenance activities prescribed in N2-EPM-GEN-4Y550, such as tests and adjustments, inspection and lubrication, were generally consistent with the applicable vendor technical manuals which were referenced in the procedure. The licensee had adequate justification in most cases for deviations from vendor recommendations. In addition, the team found that with a few exceptions, most of the information contained in relevant operating experience documents and vendor technical bulletins had been appropriately addressed and referenced in the current revisions of the procedures. The team noted that these procedures prescribed good lubrication instructions.

Review of the work orders and maintenance records of Magne-Blast major PMs performed mostly in 1997 and 1998 using the former 5-year schedule of the Magne-Blast PM procedures (N2-EPM-GEN-5Y550, Revision 05) indicated that both the component ID and breaker serial numbers were recorded in the maintenance records.

With the latest revisions to Procedures N2-EPM-GEN-2Y852 and N2-EPM-GEN-4Y550, the licensee had initiated reduced-control-voltage functional trip and close testing at the minimum trip and close voltages (70 Vdc for tripping and 90 Vdc for closing) given in the vendor manual. However, the procedures did not require these tests until after the breaker has been cleaned, lubricated, exercised and adjusted; thus losing information on the as-found ability of the breaker to trip or close at the calculated minimum control voltages. The licensee intends to revise the procedures to perform this testing before cleaning, adjusting or lubricating the breakers so as to obtain the best trendable as-found performance data. Because the calculated control-voltages for most safety-related 4.16 kV breakers were below 90 V (discussed in Section E8.1 of this report), the licensee also decided to revise the procedure and to use 70 Vdc as the voltage acceptance criterion for both closing and tripping.

The team also found the following examples in which procedures deviated from accepted industry practices. These findings did not constitute inadequate procedures, and are provided for your consideration.

- Measurement of the insulation resistance for line-side to load-side (with breaker open, recommended by EPRI/NMAC NP-7410) for each phase was not specified;
- The as-found (before cleaning and inspection) insulation resistance measurement (for potential insulation degradation between PMs) was not specified;
- Acceptance criteria for main-pole insulation resistance were 5.2 megohms instead of the industry-achievable value of 100 megohms;
- Breaker timing for as-found condition (for trending) was not specified;

The licensee indicated their plan to incorporate the above enhancement into their Magne-Blast breaker maintenance procedures for enhancement and track them under DER 2-98-2525.

ABB Type HK Breaker Procedure

Procedure N2-ESP-EPS-5Y565 prescribed the PM activities for ABB 15HK1000 breakers at five-year cycle. Although the important-to-safety ATWS tripping function of these breakers was tested according to the Technical Specifications, these breakers' closing function was not safety-related. The team's review of this procedure also identified the following examples in which the procedure deviated from accepted industry practices. These findings did not constitute an inadequate procedure, and are provided for your consideration.

- The procedure did not prescribe reduced-control-voltage tests (to determine tripping voltages);
- Measurement of the insulation resistance for line-side to load-side (with breaker open, recommended by EPRI/NMAC NP-7410) for each phase was not specified;
- The as-found (before cleaning and inspection) insulation resistance measurement (for potential insulation degradation between PMs) during PM was not specified;
- Acceptance criteria for main pole insulation resistance were 15 megohms instead of the industry-achievable value of 100 megohms;
- Breaker timing test for as-found condition (for trending) was not specified, and as-left timing test was specified as "if required" without explaining the condition.
- the procedure did not specify steps to measure and record the as-found main and arcing contact resistance (recommended by vendor manual).

The licensee indicated their plan to incorporate the above enhancement into their Type HK breaker maintenance procedure for enhancement and track them under DER 2-98-2522. The licensee also stated that the procedure would be revised to include 70-Vdc tripping and 90-Vdc closing test voltages for the HK breakers.

Review of Operations Procedure

The team discussed the following breaker operations issues with the licensee:

Several NRC generic communications, including Information Notices (INs) 83-50 and 84-46, as well as several nuclear-industry notifications had alerted licensees to the problems of secondary electrical connections and interlocks and breaker/cubicle mechanical interfaces and interlocks not being fully or properly restored (and verified to be restored) after racking breakers into the connected position. In some cases, breakers had remained in an undetected inoperable state for months, their condition not being discovered until they failed to operate (typically to close electrically and remain closed) upon demand (either by automatic signal or control room operator action).

The team noted that the stationary auxiliary switch-to-breaker plunger gap (as discussed in NRC Information Notice 93-91 and SAL 350.1), was not required to be rechecked after elevating the breaker up into the connected position for the full load test. Checking that the closing spring had been recharged properly after closing the breaker was not prescribed. And finally, even though tripping problems are less common after initial restoration, there was no requirements to trip the breaker to confirm proper tripping and indications as was required for closing.

The team reviewed Operations Lineup Procedure N2-ELU-01, "Walkdown Order, Electric Lineup and Breaker Operations," Revision 00, dated January 3, 1997, which contained procedure for returning breakers to service. The team found that this procedure did not provide for verifying the proper remote closing and opening functions of the breaker and associated interlocks by actually closing the breaker, and (running its load equipment if applicable) after the breaker was racked in (or up) to the connected position on every occasion, regardless of the reason for which the breaker had been racked out. In addition, there was no provision for checking the gap (with the breaker open) between the breaker stationary-auxiliary-switch (52STA) plunger and the 52STA operating rod after racking it back into the connect position. As stated above, maintenance procedures, such as those covering post maintenance testing, required running a breaker's load equipment (e.g., a pump) as an operational test if either the breaker or its load had been worked on. However, no procedure specifically required the full-load test if the breaker had been racked out for a reason that did not involve any work on the load equipment or the breaker itself.

The licensee breaker maintenance staff stated that they would evaluate the above issues with Operations, and would consider how best to incorporate procedures for routine full load testing. They also considered to use a go-no-go gage to set and check the plunger gap on each full elevation of breakers into the connected position. The team considered this approach acceptable.

c. Conclusions

The licensee's PM program for medium-voltage breakers was adequate. The Magne-Blast breaker procedures had been recently improved to include reduced-control-voltage testing. However, examples in which procedures deviated from accepted industry practices were identified. These findings did not constitute inadequate procedures, and are provided for your consideration. During the inspection, the licensee initiated actions to include further improvements to the procedures.

M3.2 Low-voltage Breaker Maintenance Procedures

a. Inspection Scope (TI 2515/137)

The team reviewed the preventive maintenance procedures for the low-voltage power circuit breakers. The procedures were compared to the maintenance section of the manufacturer's instruction manuals. The procedures were reviewed in light of good industry practice for breaker maintenance, as well as specific guidance in NRC Temporary Instruction (TI) 2515/137.

b. Observations and Findings

The team found that, in general, low-voltage circuit breakers' preventive maintenance procedure N2-EPM-GEN-V551, "600VAC/125VDC ITE Breaker/Motor and Breaker Load Test," Revision 1, incorporated vendor-recommended preventive maintenance actions. Additionally, the procedure was modified to incorporate the recommendation identified in NRC issued Information Notices (INs) and 10 CFR Part 21 issued by the breaker manufacturer (ABB). Although the low-voltage breaker maintenance procedure was adequate, the team identified some examples in which this procedure deviated from accepted industry practices. These findings did not constitute an inadequate procedure, and are provided for your consideration.

- Not all pertinent vendor manuals were referenced (example; MS 3.1.1.9 -2E - Maintenance and Surveillance Low-Voltage Switchgear Equipment and IB 6.1.2.7 - 2E - Installation/ Maintenance Instructions K-3000, K-4000, . . . , 3000 and 4000 Amps, were not referenced);
- Breaker test voltage-acceptance criteria (reduced control voltage testing) were not consistent with the minimum expected control voltage at the closing and trip coils;
- Breaker serial numbers (for breaker tracking purpose) were not included in the breaker test reports;
- As found contact resistances (for detecting potential degradation and trending) were not measured;
- Breaker closing coils (52X and 52Y) and tripping coil resistances were not measured for trending;
- Verification of anti-pump and trip free operations (recommended by vendor manual) of breakers were not included in the procedure;

- The insulation-resistance acceptance criterion for 600V breakers was $\geq$1.6 Meg ohms instead of the industry-achievable value of 100 Meg ohms;
- Current transformers (CT) polarity check and the wiring from CT terminal blocks to solid state trip device terminal blocks needed to be verified per IN 98-03;
- K-Line breakers were not cycled every two years as recommended by the vendor manual;
- Torque requirements for bolts per vendor manuals were not included in the procedures;
- An acceptance criterion of contact resistance for 125 volt dc breakers did not include an upper limit;
- The maintenance frequency shall be based on the number of operations as specified in the vendor's manual or five years which ever occurs first.

The team also reviewed a sample of test records for K-line breaker testing using this procedure and found the tests appropriate except the contact resistances of 125 Vdc Breaker 2BY*SWG002A in cubicle 2D were high (335 and 320 micro ohm).

The team reviewed Procedure N2-EPM-GEN-20Y711, "600V Load Center Bus Work," Revision 0, dated October 22, 1997, and found it adequately addressed the inspection and maintenance of buses, insulators, connections, and cubicles. However, the team noted that the insulation resistance acceptance criterion was too low. Also, the procedure did not provide guidance to verify that all accessible bolted connections were tight.

The licensee agreed to incorporate the above findings to their low-voltage maintenance procedure for enhancement and track them under DER 2-98-2523.

c. Conclusions

The preventive maintenance for low-voltage breakers was adequate, and had incorporated most vendor-recommended preventive maintenance actions, and recommendations identified in NRC INs. Examples in which the low-voltage breaker preventive maintenance procedure deviated from accepted industry practices were identified. These findings did not constitute an inadequate procedure, and are provided for your consideration.

M4 Maintenance Staff Knowledge and Performance

M4.1 Corrective Actions for Circuit Breaker Deficiencies and Root Cause Evaluations

a. Inspection Scope (TI 2515/137)

The team reviewed the licensee's corrective maintenance records for circuit breaker deficiencies to determine whether the corrective actions were appropriate and timely. The team also reviewed root cause evaluations to determine the adequacy of the evaluations.

b. Observations and Findings

The team reviewed the list of Circuit Breaker Corrective Maintenance History at NMP2 for the past five years and selected the corrective maintenance associated with the following six work orders (WO):

- W.O. #11-07875-00- 2BYS*SWG002-2C Breaker failed initial load test.
- W.O. #95-09728-00- Diesel output breaker would not close when demanded, the springs were found discharged. (DER 2-95-2567)
- W.O. #95-05136-00- Diesel generator output breaker will not close when required.
- W.O. #93-02403-00- Breaker failed load/current trip test during PM.
- W.O. #95-03010-00- RHS-P1A will not run when demanded, pump breaker failed to close. (DER 2-95-0740)
- W.O. #95-07058-00- Auxiliary contacts for breakers not making up. (DER 2-95-2098) (In-service failure)

The team found that the cause determinations, immediate corrective actions, and long term corrective actions for all six cases were appropriate and that all corrective actions were accomplished in a timely manner. The team found that appropriate post-maintenance testing was performed to ensure breaker operability when work had been completed.

The licensee stated that there had been one in-service failure for medium-voltage and no in-service failures for low-voltage circuit breakers. The team confirmed this statement through reviews of the Circuit Breaker Corrective Maintenance History list and several DERs, which identified only one in-service breaker failure.

The team reviewed the root cause analysis for the in-service failure identified above to evaluate NMP2's root cause analysis process. The team found that the root cause analysis was thorough and well documented. The team also reviewed fourteen apparent cause evaluations for medium-voltage and low-voltage circuit breakers and found that they were thorough, well documented and contained appropriate recommended corrective actions.

c. Conclusions

The work requests and DERs were well documented, and that corrective actions were appropriate and timely. The team also concluded that the root cause evaluation and apparent cause evaluations were well documented, thorough, and contained appropriate recommended corrective actions.

M6 Maintenance Organization and Administration

M6.1 Operating Experience Review (OER) Program for Power Circuit Breakers

a. Inspection Scope (TI 2515/137)

The team reviewed Procedure QAP-ECA-15.02, "Review of Industry Operating Experience, " Revision 1, which established the lines of responsibility and the controls necessary for Nuclear Quality Assurance (NQA) organization to process industry operating experience documents. Documents reviewed under the OER program included NRC Bulletins and Information Notices (IN), various nuclear industry notifications, Service Information Letters (SIL) and Service Advice Letters (SAL) from GE Nuclear Energy. To assess the implementation of this program, the team reviewed the licensee's actions in response to selected OER documents listed in TI 2515/137 generically or specifically applicable to the type of switchgear used at NMP2.

b. Observations and Findings

OER Program Implementation for Medium-Voltage Breakers

The team's review of licensee's responses to medium-voltage-breaker-related OER documents indicated that the majority of them had been correctly classified or screened and then adequately addressed, many being incorporated into vendor manuals and into plant procedures as commitments.

However, the team found that Bulletin 74-9, and INs 83-50, 84-29, 84-46, 87-41, 88-42, 89-86, 90-41, 91-55, and 95-02 were either incorrectly classified as not applicable originally, or the reviews were narrowly focused, such that plant breakers other than the OER documented subject breakers that were potentially or actually susceptible to the problems described, were not considered. Some examples are as follows:

For Bulletin 74-9, the closing discharge roller problem was adequately addressed (affected breaker were never installed in NMP2), but the review failed to address the second issue in the bulletin, loose mounting bolts on the stationary auxiliary switch in the cubicle.

IN 83-50 alerts licensee of breakers failing to close on demand after racking in to the connected position. An ineffective review was evidenced by lack of procedural steps in post-maintenance test instructions to ensure that all breaker/cubicle electrical and mechanical interlocks were checked for proper operation following preventive maintenance and when the breaker was in the connected position. Such checks have been recently incorporated into preventive maintenance procedures, but not before there were two failures of Magne-Blast breakers (one in-service and one post-maintenance testing) to close on demand due to open interlock switches in 1995. The licensee recognized poor preventive maintenance procedures lacking check of the interlock switches in Maintenance Rule functional failure documents.

IN 84-46 dealt with position verification of racked in breakers. The example cited was an ITE Model 3 breaker. The licensee incorrectly evaluated the IN as not applicable because the reviewer believed NMP2 had no ITE Model 3 breakers, when this was the original ITE designation for what are now called ABB HK breakers which NMP2 does have. In addition, the reviewer failed to realize that the message of the IN was generically applicable to any type of breaker that can be racked out or down.

The IN 90-41 subjects included broken prop springs on Magne-Blast ML-13 mechanisms (also the subject of SAL 348.1) and broken prop pin snap rings due to prop misalignment. The issue of broken prop pin snap rings was incorrectly evaluated as not applicable simply because the example in the IN was a Type AMH (horizontal draw-out) Magne-Blast breaker. The reviewer failed to realize that the ML-13A mechanism in the AMH is internally identical to the ML-13 mechanism in the AM (vertical lift) Magne-Blast breakers that were used at NMP2. Therefore, no procedural steps to check for this problem specifically were added at that time. This issue was identified by the licensee and the recent procedures did prescribe inspecting the breaker in general for broken snap rings and the recent PM procedure prescribed checks for mechanism misalignment.

IN 91-55 alerted Magne-Blast users to problems with the use of the stationary auxiliary switch test link, i.e., the potential for bending of the clip in the breaker that operates the breaker's switch actuating plunger. This IN was originally incorrectly deemed not applicable because "a search of available databases" failed to identify the test link part number. The reviewer was not familiar with the breaker and its maintenance and did not consult appropriate personnel familiar with this issue. This could have prevented a functional failure in 1995 due to the very problem described in the IN. It was not until SAL 356.1 was reviewed in 1998 that the licensee recognized the earlier mistake.

IN 95-22 dealt with hardened grease due to age and contamination causing the failure to close of HK breakers and sluggish operation of some K-Line breakers, both of which NMP2 has in safety-related applications. However, the IN was erroneously classified as not applicable because another "search of available data bases" did not identify the subject breakers. This review failed to recognize equipment that was in the plant, and the generic applicability of the hardened grease problem. The issue was identified by licensee's Independent Safety Engineering Group (ISEG) during a self-assessment audit as discussed in Section 7.1 of this report.

<u>OER Program Implementation for Low-Voltage Breakers</u>

For NMP2's low-voltage switchgear equipment (600-Vac ABB K-Line), the team reviewed licensee responses to INs 80-31, 81-06, 85-58, 85-64, 87-61, 89-29, 89-45, 91-29, 95-22, 96-44, 96-44 Sup 1, and 98-03, applicable generically and/or specifically to ABB K-Line breakers. The team found that generally the licensee had adequately addressed the issues discussed in the applicable INs. For example, IN 81-06 dealt with failure of ITE model K-600 circuit breakers due to mismatch between the control wire size (#20 AWG) and mating lug size (for # 16-14 AWG

wire). The files indicated that the licensee had conducted inspections for mismatched wire size and lug size in 2NJS-US1 through US10 (nonsafety-related unit substations) and had taken appropriate corrective action. Regarding the safety-related unit substations, the licensee provided a copy of the Stone & Webster Engineering Corporation letter dated February 23, 1982, which stated that the breaker manufacturer would ensure that defect would not appear on these breakers when shipped. Another example, IN 58-58 and 58-58, Supp. 1, dealt with failure of GE type AK-2-25 reactor trip breakers. The files indicated that GE type AK-2 circuit breakers were not used in safety-related systems at NMP 2. All 600 volt draw-out circuit breakers were supplied by Gould Brown Boveri and did not contain integral under voltage trip coils, which was the cause of the deficiencies in GE Model AK-2 breakers. Additionally, the NMP2 did not utilize reactor trip breakers to initiate a scram. Hence, this IN is not applicable. The team found that this IN was addressed adequately.

However, there were cases among the responses to low-voltage breaker-related OER documents where the licensee's reviews were narrowly focused, and did not consider generic applicability of the problems discussed in the INs. In these cases, the review conclusions stated that the INs were "not applicable" based solely on that the particular breaker(s) used as examples of the problems in the INs, were not being used at NMP2. The licensee did not consider the potential implications of the IN for breakers that were used at NMP2.

For example, IN 96-44 and 96-44, Supp. 1 (failure of a reactor trip breaker from cracking of phenolic material in secondary contact assembly) was generically applicable to all breakers, but was narrowly evaluated. The team determined that the message of the IN was not fully realized and addressed.

Additionally, IN 98-03 discussed an event of premature tripping on over current of an ABB type K600S breaker due to leads reversal of a current transformer (CT) used to sense fault current. The licensee's review indicated that this IN was applicable and the issue had been addressed by DER 2-97-1534, which was issued in 1997 in response to a Part 21 notification. The licensee issued two work orders to visually inspect the CT sensor wiring on all safety-related K-line breakers to determine if the problem identified by the Part 21 notification existed. The licensee also revised their 600 Vac breaker load test procedure to include an inspection of the CT sensor wires. Based on the fact that NMP2 had not experienced any false tripping on the K-line breakers, and that NMP2 breakers were manufactured prior to 1995, the licensee concluded that this problem did not exist at NMP2. The licensee's review did not address if the CTs were installed upside down but were correctly terminated (same effect as reversing the leads) and if the incorrect terminations exist between CT sensor terminal blocks and solid state trip device terminal blocks as addressed in IN 98-03.

OER Program Procedure Review

The team found that Procedure QAP-ECA-15.02, "Review of Industry Operating Experience," Rev.1, did not include instructions to the reviewers to conduct more detail reviews and widen their scope for generic implications. The lack of such instructions allowed the OE reviews to be narrowly focused. The procedures also did not ensure that reviewers verify specific equipment applicability as well as generic applicability with personnel who were familiar with the plant's equipment and its maintenance. For example, the procedures did not ensure that superficial "searches of available databases," (a phrase used several times in the various review documents), were not relied on alone to determine if a particular type of equipment was in use at NMP2. The procedure did not require the reviewers to verify equipment types and models, by drawings or walkdowns, or by checking with system engineers or other knowledgeable staff.

The licensee issued two DERs (C-98-2855 and 2-98-2523) to address the team's concerns in their OER program.

c. Conclusions

The licensee's operating experience review (OER) program to review industry events and problems was weak. In many cases, the reviews were narrowly focused, without considering generic applicability. Some reviews were performed by personnel not familiar with plant equipment, resulting in inappropriate conclusions. Although some of the weak reviews were identified by the licensee in their self-assessment audits, the team identified additional examples. The past incomplete reviews missed the opportunities to prevent two breaker failures. The OER program procedure did not provide guidance for detail reviews to determine generic applicability of NRC INs.

M6.2 Vendor Interface Program

a. Inspection Scope (TI 2515/137)

The team reviewed procedures for maintaining vendor manuals, procedures for reviewing, evaluating and dispositioning vendor technical information, and procedures for maintaining periodic contact with vendors of key safety-related equipment outside the Nuclear Steam Supply System's (NSSS) scope of supply.

The team examined the licensee's circuit breaker vendor manual binders in which the various vendor technical documents (e.g., technical manuals, technical bulletins) related to a particular piece or type of equipment are supposed to be filed. The team also reviewed the records and correspondence relating to the licensee's periodic re-contact of safety-related breaker vendors. Finally the team reviewed the licensee's handling and disposition of vendor technical bulletins.

b. Observations and Findings

Vendor Technical Manuals

The licensee's self-assessment audits for NMP2 breaker maintenance program had identified that some vendor breaker manuals and/or their latest revisions were not in vendor manual binders. However, at the time of this inspection, the team observed these deficiencies had not been fully corrected.

The team's review of the vendor manual binders confirmed the licensee's self-assessment findings. The binders were poorly organized, incomplete and contained irrelevant materials, including manuals on equipment not used at NMP2. These conditions made it difficult to find up-to-date, accurate and applicable information in the manuals. The licensee maintenance personnel interviewed also stated that the binders were difficult to use. For example, NMP2 Vendor Manual Binder N20121 was titled "Low-Voltage Metal-Enclosed Power Switchgear Manual," yet it included manuals for ABB 15HK1000 13.8 kV equipment. The K-Line Maintenance and Surveillance Manual MS 3.1.1.9-2D was not the latest revision which was MS 3.1.1.9-2E. Outdated Instruction Book IB 9.1.7-4H for K3000/4000 breakers was still in the binder, as were IB 8.2.7-2, the old manual for 5HK breakers that were not used at NMP2, and IB 6.2.2.7-1G for 7.5HK500, 15HK500, and 15HK750 breakers were also not used at NMP2.

In addition, one of the Magne-Blast vendor manual binders, No. N20355, contained M26/M36 switchgear instruction book GEH-1802W; whereas GEH-1802X was the latest revision.

Vendor Technical Bulletins or Letters

The team found that many SALs that had been issued before NMP2 was built were not obtained or adequately handled by the plant's architect/engineer, Stone & Webster. It wasn't until 1997 when breaker maintenance personnel from NMP2 visited Philadelphia Electric Company in October 1997 for consultation on breaker maintenance issues that the NMP2 breaker maintenance personnel became aware of and obtained copies of several SALs (mostly earlier, but still relevant) applicable to NMP2 Magne-Blasts that they had never received.

Niagara Mohawk had not been a member of Electric Power Research Institute (EPRI) for some time and had rejoined EPRI in 1997 at which time the licensee could benefit from the Nuclear Maintenance Application Center (NMAC) and be eligible for membership in the applicable EPRI/NMAC-sponsored users groups. NMP2 sent a representative to the February 1998 meeting of the Low- and Medium-Voltage GE Breaker Users Groups at which time the plant obtained much useful information. Partly due to its recently increased awareness of and sensitivity to breaker aging

and maintenance issues, the licensee recognized its problem with the coordination of SALs and documented the issue in DER C-98-0790. During the review of the licensee's disposition of Magne-Blast-related SALs, the team observed that many SALs had not been reviewed and addressed until recently. In addition, some SALs were incorrectly classified as not applicable. Some examples are:

SAL 318.1 (also 312.1 and 318.1A and .2) dealt with Tufloc bushing replacement - determination that NMP2 had no Tufloc bushings in its Magne-Blasts when in fact the prop bushings were Tuflocs. The incorrect classification was based on erroneous vendor information. This was also discussed in Section M6.1 for response to IN 84-29.

SAL 327.1 discussed a needed cubicle interlock modification and cited the full switchgear model number. The reviewer, as a result of not reading the SAL carefully enough and not being sufficiently familiar with the equipment, mistook the switchgear model number for a breaker model number and declared the SAL to be not applicable.

Periodic Re-contact With Vendors of Key Safety-Related Equipment

The team found that the vendor equipment technical information program (VETIP) had been using form letters (with some follow-up phone calls) for periodic re-contact of breaker vendors to ensure receipt of all applicable technical information and manual revisions, etc., but this approach had not been fully effective for breakers in the past. A contributing factor was that appropriate locations, facilities or personnel had not always been contacted. For example, the breaker manufacturers on the "Unit 2 Generic Letter 90-03 Manufacturer List" were listed only as "General Electric" and "Brown Boveri." Just the name, General Electric, was insufficient information with which to contact the breaker manufacturing GE product departments and the appropriate persons in those departments, or GE Power Delivery Services Division of GE Nuclear Energy. The licensee stated that they had sent one of their form letters to GE Nuclear Energy in San Jose and the reply was a proposal for the GE Nuclear Energy subscription service.

The name Brown Boveri had been obsolete. The company has been Asea Brown Boveri, then just ABB for almost 10 years. The licensee's maintenance personnel had contacts in the ABB Service Company, but it wasn't until recently that the procurement staff responsible for GL 90-03 vendor re-contact wrote to the appropriate personnel at ABB Power Transmission and Distribution Company (Switchgear Division in Sanford Florida). However, the ABB Power T&D Company Breaker Division, the breaker manufacturer and publisher of the breaker manuals, was in Florence, South Carolina.

The team also noted that GL 90-03 Vendor Technical Interface Program Equipment and Vendor List still listed Brown Boveri as the vendor of 600 volt switchgear and no model numbers were listed. The 600-volt K-Line breakers were not listed nor were the 13.8 kV HK breakers or their switchgear listed. The only listing for 4.16 kV equipment was for the switchgear, Type M26, listing the manufacturer simply as General Electric. The 4.16 kV Magne-Blast breakers were not listed.

The licensee had documented problems with its vendor interface program in several DERs, including DERs C-98-2294, 2-98-1690 (this one discusses the failure to contact ABB and indicated that procurement had failed to contact ABB). The team observed that this was because the correct vendor name and location was not in the program. At the time of the inspection, the licensee was in the process of determining why their corrective action program failed to improve the breaker's vendor interface program in the several opportunities they had in the past to do so.

c. Conclusions

The licensee's vendor interface program for medium-voltage and low-voltage breakers was weak. The vendor manual binders were poorly organized, incomplete and contained irrelevant materials. The team also concluded that the licensee's "periodic re-contact" of breaker vendors was ineffective. There were cases where incorrect vendor department or inappropriate vendor personnel were contacted. Although many of the examples were identified by the licensee in their self-assessment audits, others were identified by the NRC team.

M6.3 Treatment of Power Circuit Breakers Under the Maintenance Rule

a. Inspection Scope (TI 2515/137)

The team examined the licensee's treatment of power circuit breakers under 10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," the Maintenance Rule (MR). The review included power circuit breaker scoping, carrying breakers under Section 50.65(a)(1) or (a)(2) of the MR, system classification of power circuit breakers, recognition of functional failures and maintenance preventable functional failures (MPFFs), appropriateness (as related to power circuit breakers) of system/train level performance criteria under (a)(2) of the MR, and the use of industry operating experience per (a)(3) of the MR.

b. Observations and Findings

The team found that the licensee's treatment of power circuit breakers under the MR was satisfactory and similar to other licensees inspected under TI 2515/137.

The MR scoping basis for breakers was sufficiently comprehensive. It was functionally based, using the standard five scoping criteria. For example, the reactor recirculation pump motor breakers (technically nonsafety-related) were in the MR scope because they were classified/treated as safety-related due to their important-to-safety ATWS trip function, and Technical Specifications requirements.

The licensee classified bus-feeder breakers, normally-closed bus-tie breakers, and transformer supply breakers for lower-voltage distribution or switchboard feeders for multiple systems as components of one of the various electric power distribution systems, e.g., the 13.8 kV system, the 4.16 kV system, the 600 Vac system, and the 125 Vdc system. All other individual load breakers, switchboard, or motor-control-center supply breakers, if all loads were for one particular system, were treated as components of that functional system, e.g., high pressure core spray (HPCS), residual heat removal (RHR), emergency diesel auxiliaries, etc.

In addition to MR performance monitoring, both load breakers and power distribution breakers were categorized according to a general class of breakers. For example, the licensee considered all 4.16 kV breakers (safety and non-safety) as one class. Then the licensee reviewed failures within a class to monitor for common-mode breaker problems across different plant systems. Failures within a class of breakers were supposed to prompt closer attention to those breakers even though the failures might not exceed their individual system performance criteria or reliability or availability thresholds.

According to MR information provided to the team, there were seven MPFFs (including safety- and nonsafety-related) in 1995 and 1996. However, among safety-related breakers, the licensee reported six functional failures of safety-related breakers (all Magne-Blasts) in the past five years. Two of these were deemed MPFFs. The other four were reasonably interpreted as not attributable to some deficiency in overhauls, preventive maintenance, and procurement. However, the licensee reported that their review of all MR functional failures (i.e., those tracked since implementation of the MR) indicated that none were attributable to design, manufacturing, or deficient vendor technical documentation.

One of the two MPFFs was due to some Magne-Blast-cubicle-stationary-auxiliary-switch (52STA) contacts (feeder breaker 2ENS*SWG101-13) that were found open during testing when they were supposed to be closed. The failure was caused by inappropriate use of the test link which bent the plunger operating clip on the breaker in July 1995. This subject was originally determined incorrectly to be not applicable because the "search of available databases" failed to turn up a particular test link part number, yet plant operators who use the test link (per Procedure N2-ELU-01) were apparently not consulted. The incorrect classification of IN 91-55 and the test link problem were not recognized by the licensee until its receipt and review of SAL 356.1 in 1998. The other MPFF was a failure of the emergency diesel generator (EG3) output breaker to close due to an open positive-interlock switch (52IS). The failure was considered maintenance preventable because the procedures at that time (1995) did not call for checking this switch (the current procedures did). Problems related to breaker cubicle interlocks not being made up after a breaker was racked in (or up in this case) to the connected position were discussed in NRC INs 83-50 and 84-46. As discussed in Section M6.1, IN 84-46 was incorrectly classified as being not applicable.

The safety-related breaker failures were in different systems and did not exceed the licensee's reliability or availability system level performance criteria in any given year. Accordingly, no safety-related system was being monitored under 50.65(a)(1) due to breaker failures. However, among all MR MPFFs, the licensee reported three failures of the 2EPW-P2 electric fire pump to start in 1996 due to the failure of its supply breaker to close on demand. In all three cases, the failure of the breaker to close was attributed to inadequate lubrication of the breaker during preventive maintenance. The deficiencies in the lubrication instructions that contributed to the inadequate lubrication had been corrected in the current versions of the procedure. The team confirmed that the current procedures contain adequate lubrication instructions. The other two breaker MPFFs, both involving nonsafety-related breakers, were both attributed to inadequate preventive maintenance, one due to inadequate or insufficiently frequent lubrication while the other due to an open-positive-interlock switch after the breaker was racked up into the connected position.

The use of industry operating experience as required by 50.65(a)(3) relative to breaker maintenance was discussed in Section M6.1 of this report. The two MPFFs in safety-related breakers discussed above could have been prevented by comprehensive review and appropriate disposition of the relevant OER documents.

c. Conclusions

The licensee's treatment of power circuit breakers under the MR was consistent with MR requirements and industry practices. The team also concluded that the licensee's close review of breaker performance by class associated with standard-MR-performance-monitoring had helped to identify and to provide prompt corrections of common breaker problems caused by inadequate preventive maintenance in the past.

M7 Quality Assurance in Maintenance Activities

M7.1 Self-Assessment Audit

a. Inspection Scope (TI 2515/137)

The licensee performed four self-assessment audits (two by the Independent Safety Engineering Group (ISEG) and two by the Quality Assurance (QA)) for the medium-voltage and low-voltage circuit breakers program at NMP2. The team reviewed these audits to determine the adequacy and the effectiveness of the licensee's self-assessment program in the breaker maintenance area.

b. Observations and Findings

The first ISEG audit was conducted (by one auditor) in March 1998, covering medium-voltage (4.16 kV and 13.8 kV) breakers. The audit resulted in the issuance of two DERs (2-98-0828 and 2-98-0829). The team reviewed DER 2-98-0828, which indicated that the lubrication and lubricant changes identified in vendor's SAL (Service Advise Letter) 354.1 had not been included in the licensee's breaker maintenance procedures. This DER was closed after the maintenance procedures were revised. DER 2-98-0829 reported that the latching pawl pivot pins for several breakers had not been replaced as recommended in SAL 358.1. The licensee had determined there was no immediate operability concern and planned to replace the affected pivot pins during the next opportunity. The DER was still open.

The second ISEG audit was conducted (also by one auditor) in May, 1998, covering 600 Vac and 125 Vdc breakers. The audit findings result in three DERs (2-98-1772, 1689, and 1690) being issued. The team reviewed DER 2-98-1772, which indicated that NMP2 did not overhaul its K-Line breakers in accordance with ABB Maintenance and Surveillance Manual MS 3.1.1.9-2D, which specified the breakers be overhauled at a maximum interval of 10 years. The licensee administratively closed this DER, transferring the corrective actions to DER 2-98-1689, which covered similar subject with broader scope. For DER 2-98-1689, the auditor identified that when the reviewer reviewed NRC IN 95-22 in 1995, the individual concluded that this IN was not applicable to NMP2, and failed to recognize that NMP2 had both ABB HK medium-voltage breakers and ABB K-Line low-voltage breakers. IN 95-22 discussed ABB breaker failures and reminded the user of ABB Maintenance and Surveillance Manual and the 10 year overhaul frequency. The licensee was still evaluating the resolution of this DER which was still open at the time of the inspection. DER 2-89-1690 reported that NMP2's GL 90-03 (maintenance manuals and instructions) program for ABB vendor manuals did not include the 10 CFR part 21 notifications concerning updated information on breaker lubrication, and other technical information. The licensee had resolved this issue and the DER was closed.

The team also reviewed the audit reports and found them of good quality.

The first QA audit (Surveillance 98-0063-2) was conducted in September 1998 to review and assess the DER and OER that were associated with the circuit breakers. This audit identified another example of inadequate review of operating experience. The reviewer for GE SAL 073-324.2 had incorrectly determined that this SAL was not applicable to NMP2 while it was in fact applicable. The licensee issued DER 2-98-2822 on September 21, 1998. At the time of this inspection, this DER was still being evaluated for resolution. The second QA audit (Surveillance 98-0078-C) was to assess the licensee's implementation of Generic Letters 83-28 and 90-03, pertaining to "Vendor Interface Program." This audit was still ongoing and the audit report was not yet written at the time of the inspection. However, the auditor initiated a DER (C-98-2845) and concluded that the vendor interface program at Nine Mile Point were not effective in assuring vendor information for safety-related components within the scope of GL 90-03 was complete, current, and controlled.

This DER was still being evaluated by the licensee and was still open.

In addition to the above audits, in preparation to this inspection, the licensee performed an extensive (line-by-line) review on each of the four breaker maintenance procedures (N2-ESP-EPS-5Y565, N2-EPM-GEN-V551, 5Y555, 5Y550). At the time of this inspection, the resolutions for the these DERs were still ongoing, and the DERs remained open.

c. Conclusions

The licensee's self-assessment audits for the medium-voltage and low-voltage breakers were good, resulting in many significant findings in the operating experience review and breaker vendor interface areas. The audit reports were of good quality. However, at the time of the inspection, the resolutions for most of the audit findings were not yet complete. Also, the team identified additional examples of problems in areas identified by the licensee as being weak.

M8 Miscellaneous Maintenance Issues

M8.1 Circuit Breaker Tracking System

a. Inspection Scope (TI 2515/137)

NMP2 had developed a Microsoft-Access database program to track various facets of circuit breaker status. The team observed the licensee's database program to determine what attributes of medium-voltage and low-voltage circuit breakers were being tracked and if the database program could be a valuable circuit breaker tracking tool.

b. Observations and Findings

The team observed the licensee's Microsoft-Access database program and found that all medium-voltage and low-voltage circuit breakers at Nine Mile Point Unit 2 had been entered into the system and could be tracked by their serial numbers. The database program provides as a minimum the following attributes for each circuit breaker:

- Circuit Breaker Manufacturer and Type
- Work History (When last refurbishment was completed)
- Circuit Breaker Location (past and present)
- Work Order Number if Appropriate
- Circuit Breaker Current and Voltage Rating
- Date that Most Recent Preventive Maintenance (PM) was Completed
- Date Circuit Breaker Went Into Service
- Current Load Receiving Power from the Circuit Breaker

The team found that appropriate attributes for each circuit breaker were included in the database. The team noted that the circuit breaker information entry and retrieval were easily accomplished when using the database program. Data modifications could also be accomplished easily, however, this could only be performed by authorized personnel. The team determined that the presentation of circuit breaker information on the computer screen was good, and that this database could be a valuable tool to the licensee in tracking and determining the status of any medium-voltage or low-voltage circuit breaker at NMP2.

c. Conclusions

The team concluded that the recently developed circuit breaker tracking system (database) at NMP2 provided good information on the circuit breakers and that this database could be a valuable tool to the licensee in tracking and determining the status of any medium-voltage or low-voltage circuit breaker at NMP2.

E8 Miscellaneous Engineering Issues

E8.1 Control Circuit Voltage Drop Calculations

a. Inspection Scope (TI 2515/137)

The team reviewed the licensee's control circuit voltage drop calculations to determine whether breaker operation was assured at minimum operating voltage as specified in the vendor's manual or minimum calculated voltage, whichever is the lowest.

b. Observation and Findings

The team noted that, at the time of the inspection, the licensee had only one calculation, EC-133, entitled, "Class 1E 4160V switchgear closing coil dc voltage drop verification," Rev. 0, dated January 31, 1986. The licensee could not provide calculations for Division 3 breakers (closing and tripping coils), 600 volt Class 1E K-line breakers (closing and tripping coils), Class 1E 4160 volt breaker's tripping coils, and 13.8 kV breaker trip coils that perform safety functions.

The team reviewed Calculation No. EC-133 to verify that electrically-operated breakers were operable at the calculated minimum available voltage at the closing coils. The design basis of the calculation was loss of offsite power with loss of coolant accident (LOOP/LOCA) and battery end of duty cycle voltage of 105 volts. The calculation was performed to determine the maximum voltage drop for the closing coils. The calculated worst-case voltage drop was 30.1 volts and the calculated minimum coil operating voltage was 74.9 (105 - 30.1) volts based on the battery end voltage of 105 volts. The calculation established 70 volts instead of 90 volts per vendor manual as the required minimum operating voltage for the closing coils. This was established based on testing two breakers at different control voltages. Testing determined that there was very little difference in current drawn by the closing coils at 70 volts (2.3 Amperes) and 90 volts (2.4 Amperes).

The calculation stated that the plunger force was proportional to current and determined that the difference in force is 4.2% which was within the tolerance and hence 70 volts was the required operating voltage. The team noted that the calculation concluded that the maximum voltage drop of 30.1 volts was acceptable without imposing any requirement of testing the breakers at 70 volts at a definite interval. Although the calculation contained conservatism, the team determined that it was weak because it did not bound certain conditions that may have affected the results of the calculation. For example, the voltage drop between the battery terminals and 4160 volt switchgear were not considered. Additionally, the calculation utilized control cable resistance at 40°C based on average ambient temperature of the plant instead of worst-case control cable temperature (considering the effect of control cables run in a tray with 40% fill).

In response to the team's concern, the licensee revised the above calculation. The revised calculation also included Division 3 breakers and determined that all Division 3 breakers had more than 101 volts. However, the licensee found that, based on a battery end-voltage of 105 volts, most of Divisions 1 and 2 breakers did not have 90 volts (vendor specified) at their closing coils. The licensee also found that six service water pump (SWP) breakers (2ENS*SWG 101-4, 6, and 8 and 2ENS*SWG 103-7, 9, and 11) had calculated voltages at the closing coils between 75.87 volts and 78.39 volts. Subsequently, the licensee performed an operability evaluation for all breakers with calculated voltages less than 90 volts. In the operability determination, the licensee used a battery operating voltage of 125 Vdc for the SWP breakers and 113 calculated end-voltage for the remaining breakers. The licensee's reason was that, following a design basis accident, the emergency diesel generator (EDG) would start within 10 seconds. The EDG would enable the battery charger of each division battery to operate and provide 125 Vdc to the emergency dc system. The first SWP would be sequenced onto the EDG at 32 seconds with more than 125 Vdc available on the dc system. The licensee also reasoned that, based on the battery voltage calculations two hour into the design basis event and four hour into the station blackout (SBO) condition, the station battery still had 113 volts. Under the conditions discussed above, the closing coils of all safety-related breakers would have more than 90 volts to complete their functions. The team agreed that these assumptions were reasonable.

In addition, the LOOP/LOCA test was performed during each refueling outage in accordance with plant Technical Specifications surveillance requirements and these tests were satisfactory, confirming the operability of the safety-related breakers.

The licensee completed testing of all SWP breakers on September 25 1998, demonstrating that the closing and tripping operations could be accomplished at less than 70 Vdc control voltage. For the remaining safety-related 4160 volt breakers, the licensee issued DER 2-98-2861 on September 25, 1998, and scheduled to
complete testing them by November 29, 1998, using 70 Vdc as the acceptance criteria. In addition, the licensee amended DER 2-98-2795 (which was issued earlier) to revise the maintenance procedure for future testing of all 4160 volt breakers at 70 Vdc.

For low-voltage breakers, the licensee performed a calculation, EC-197, "Class 1E 600 Volts Load Center Breakers Closing Coil Voltage Drop Verification." This calculation did not include the tripping coil voltages. The calculation addressed four breakers which controls motor loads. All other breakers were normally closed and stayed closed during a design basis event. This calculation used incorrect closing coil current (10 amperes instead of 0.7 ampere) and improper control circuit cable resistance (did not consider proper temperature of the cable). As a result, the calculated voltage were less than vendor specified minimum voltage of 100 volts. The licensee later revised the calculation using the correct coil current of 0.7 ampere and the resistance at proper cable temperature. The revised calculation showed that all breakers had more than 102 volts at the closing coils, which were above the vendor-specified voltage of 100 volts.

For the safety-related 13.8 kV breakers, the tripping function was safety-related, while the closing function was not. The licensee completed the control voltage drop calculation for their tripping circuits and determined that all tripping coils had more than the vendor-specified 70 Vdc.

The team reviewed the revised version of calculation EC-133, "Class 1E 4160V Switchgear Closing Coil DC Voltage Drop verification," Revision 3, dated October 2, 1998. This calculation confirmed that the worst-case calculated minimum voltage at the closing coils for safety-related 4160 V breakers was 75.87 Vdc, and that the control voltages at the tripping coils were above the vendor-specified 70 Vdc. The team also reviewed the final version of Calculation EC-197, "Class 1E 600 Volt Load Center Breakers Closing and Tripping Coil Voltage Drop Verification," Revision 0, dated October 2, 1998, and Calculation EC-198, "Class 1E 13.8 KV Switchgear Trip Coil DC Voltage Drop Verification," Revision 0, dated October 2, 1998, and found them acceptable.

In a telephone call on October 7, 1998, the licensee told the team that they had located a letter (NMP2L 0806), dated August 3, 1986, from Niagra Mohawk (C. V. Mangan to the NRC (R. W. Starostecki). The enclosure to this letter indicated that the licensee had completed at that time a Control Circuit Length Verification Study (calculations) for the breakers. However, the licensee was unable to locate the calculations, and therefore, the quality of these calculations could not be evaluated. The licensee issued a DER (2-98-3009) dated October 7, 1998, to either locate or reconstitute the control cable length verification report. The team reviewed the DER and the August 3, 1986, letter and determined that this condition involved a violation (quality assurance records) of minor significance and that this violation was not subject to formal enforcement action.

The team also verified the cable length of one circuit (2ENS*SWG102-5, Cubicle 3) and found it acceptable.

c. Conclusions

The licensee's control-circuit-voltage-drop calculations were weak. The calculations required several corrections during the team's reviews. The basis for assuring safety-related breakers had sufficient control-voltage for proper breaker operations was initially not well developed, and required the development of an operability determination and additional, revised testing of the breakers.

X1 Exit Meeting Summary

The team met with licensee personnel at the conclusion of the inspection on September 25, 1998, and summarized the scope of the inspection and the inspection results. The team also conduct a supplementary exit meeting in a telephone call on October 14, 1998, to Mr. G. Gresock. No proprietary materials were reviewed during this inspection. The licensee did not dispute the inspection findings at the meetings.

PARTIAL LIST OF PERSONS CONTACTED

Licensee

J. Conway	Vice President, Nuclear Engineering
R. Crandall	Systems Engineer, Unit 2
S. Doty	Maintenance Manager
G. Doyle	General Supervisor, Quality Services
K. Engelman	Maintenance Rule Manager, Unit 2
F. Fox	Maintenance Manager (Acting), Unit 2
D. Goodney	Supervisor Electrical Design, Unit 1
G. Gresock	Licensing
T. Hall	Maintenance Support, Unit 2
M. Herron	General Supervisor, Procurement
A. Julka	ISEG Director, Unit 2
M. Kalsi	NMPC - Engineer
J. Kinsley	Lead Systems Engineer
P. Mazzaferro	Technical Support Manager, Unit 1
S. Moryl	Maintenance Support
R. Rademacher	QA Manager
A. Ross	ISEG
D. Sandwick	Supervisor Electrical Design, Unit 2
M. Shanbhag	MATS
R. Smith	Plant Manager, Unit 1
A. Sterio	Supervisor Electrical Maintenance
J. Sullivan	Nuclear Procurement Manager
T. Syrell	Maintenance Rule Manager, Unit 1
K. Ward	Technical Support Manager, Unit 2
D. Wolniak	Licensing Manager
W. Yaeger	Engineering Services Manager

NRC

L. Doerflein	Chief, Branch 1, Region 1
B. Norris	Senior Resident Inspector
R. Skokowski	Resident Inspector

INSPECTION PROCEDURES USED

TI 2515/137 Inspection of Medium-Voltage and Low-Voltage Power Circuit Breakers

ITEMS OPENED, CLOSED AND DISCUSSED

None

LIST OF ACRONYMS USED

A	Ampere
ABB	Asea Brown Boveri
ATWS	Anticipated Transient Without SCRAM
C	Celsius
CFR	Code of Federal Regulations
CT	Current Transformer
dc	direct current
DER	Deviation Event Report
EDG	Emergency Diesel Generator
EPRI	Electric Power Research Institute
FME	Foreign Material Exclusion
GE	General Electric
GL	Generic Letter
HPCS	High Pressure Core Spray
ID	Identification
IN	Information Notice
ISEG	Independent Safety Evaluation Group
kV	Kilovolt
LOCA	Loss of Coolant Accident
LOOP	Loss of Offsite Power
LPCI	Low Pressure Coolant Injection
LPCS	Low Pressure Core Spray
MPFF	Maintenance Preventable Functional Failure
MR	Maintenance Rule
NMAC	Nuclear Maintenance Application Center
NMP2	Nine Mile Point Unit 2
NSSS	Nuclear Steam Supply System
NQA	Nuclear Quality Assurance
NRC	Nuclear Regulatory Commission
OER	Operating Experience Review

PM	Preventative Maintenance
QA	Quality Assurance
RHR	Residual Heat Removal
RFO	Refueling Outage
SAL	Service Advice Letters
SIL	Service Information Letter
SBO	Station Blackout
SWP	Service Water Pump
TI	Temporary Instruction
Vac	Volts Alternating Current
Vdc	Volts Direct Current
VETIP	Vendor Equipment Technical Information Program
V	Volts
WO	Work Order

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