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EXECUTIVE SUMMARY

Braidwood Nuclear Power Station, Units 1 and 2
NRC Inspection Reports 50-456/97018(DRS); 50-457/97018(DRS)

This inspection included a review of the licensee's implementation of 10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants." The report covers a one week on-site inspection by regional, resident, and Office of Nuclear Reactor Regulation inspectors, and a contractor from Idaho National Engineering and Environmental Laboratory.

In general, the program met the requirements of the maintenance rule (MR); however, issues were identified concerning the scoping of systems/functions and the inappropriate use of performance criteria. Two violations and three inspection follow-up items were identified.

Maintenance

- In general, structures, systems, and components (SSCs) were properly scoped into the MR program. However, a violation was identified concerning two system functions that were not properly scoped into the MR program. (Section M1.1)

- The process for assessing plant risk resulting from equipment out-of-service for on-line maintenance was determined to be good. The availability of three different sources of risk information was considered to be a strength of the program. (Section M1.5)

- The performance criteria for reliability and unavailability, although in some cases higher than the probabilistic risk assessment assumptions, were adequately justified through the use of a sensitivity study. In general, performance criteria had been established to effectively monitor system performance. However, one violation was identified concerning an inadequate reliability performance criterion and the inappropriate use of plant level performance criteria for four systems. (Section M1.6)

- The structural monitoring program was effective. Inspections adequately assessed the conditions of structures and corrective actions were initiated to correct deficiencies. (Section M1.6.b.4)

- The monitoring of functional failures against goals and performance criteria did not appear to be up-to-date for all systems. Although this may be due to the recent changes associated with the program, further review will be required to ensure adequate monitoring will occur in the future. (Sections M1.6.b.3, M2.1b.5, M2.1.b.10, and E4.1.b)

Quality Assurance

- The recent audit was critical of the MR program's acceptability. A number of issues were identified and corrective actions were implemented or planned to correct program deficiencies. The use of outside personnel provided independent insights into the MR program and added to the overall quality of the audit. (Section M7.1)

Engineering

- The system engineers were experienced and knowledgeable about their systems and their responsibilities with respect to the MR. (Section E4.1)

Report Details

Summary of Plant Status

The units were operating at approximately 100 percent power during the inspection.

Introduction

This inspection included a review of the licensee's implementation of 10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants." The report covers a one week on-site inspection by four regional inspectors, a resident inspector, and a consultant from Idaho National Engineering and Environmental Laboratory. Assistance and support were provided by the Quality Assurance, Vendor Inspection, and Maintenance Branch, Office of Nuclear Reactor Regulation (NRR).

I. Operations

O4 Operator Knowledge and Performance

O4.1 Operator Knowledge of Maintenance Rule

a. Inspection Scope (62706)

The inspectors interviewed four licensed operators including two shift managers, one unit supervisor, and one nuclear station operator to determine if they understood the general requirements of the maintenance rule (MR) and their particular duties and responsibilities for its implementation.

b. Observations and Findings

The operations personnel interviewed had a general knowledge of the MR and their role in its implementation. These personnel were knowledgeable of the responsibilities concerning the tracking of unavailability data and understood the difference between availability and operability as it applied to the technical specifications. A working knowledge was demonstrated for determining the risk significance of taking equipment out-of-service (OOS). Operations personnel also stated that implementation of the MR did not significantly impact other operator responsibilities and that they had received recent training on the MR.

c. Conclusions

The inspectors concluded that the individuals interviewed had the requisite knowledge necessary to fulfill their responsibilities concerning the MR.

II. Maintenance

M1 Conduct of Maintenance (62706, 62002)

M1.1 SSCs Included Within the Scope of the Rule

a. Inspection Scope

The inspectors reviewed the scoping documentation to determine if the appropriate structures, systems, and components (SSCs) were included within the MR program in accordance with 10 CFR 50.65(b). The inspectors used NRC Inspection Procedure (IP) 62706, "Maintenance Rule," Nuclear Management Resource Council (NUMARC) 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," and Regulatory Guide 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," as references during the inspection.

b. Observations and Findings

The scoping method was described in procedure BwAP 2300-2, "Maintenance Rule." The scoping criteria included whether the systems were safety-related, nonsafety-related systems that were relied upon to mitigate accidents or transients, were used in emergency operating procedures (EOPs), whose failure could prevent safety-related SSCs from fulfilling their safety-related function, or whose failure could cause a reactor trip or actuation of a safety-related system. Based on the recent MR program audit findings, a rescoping effort was conducted to ensure all systems and system functions were adequately addressed under the MR. The scoping and rescoping efforts were performed by system function.

In general, scoping of systems and system functions was good. The licensee considered a total of 144 systems during the scoping phase; of these, 106 systems were determined to be within the MR scope. Systems excluded from the MR were adequately justified. However, as of December 8, 1997, the inspectors did identify two system functions that were not within the scope of the MR as follows:

- Function IP-01, a nonsafety-related instrument power function that provided inverter trouble alarms in the main control room and was used in the EOPs.

- Function RD-02, a nonsafety-related rod drive system that provided reactor trip breaker indication in the main control room and was used in the EOPs.

10 CFR 50.65(b) established the scope of the monitoring program for selection of safety-related and nonsafety-related SSCs to be included within the MR program. The failure to adequately scope the system functions discussed above are considered examples of a violation of 10 CFR 50.65(b) (50-456/457-97018-01(DRS)). Based on this finding, the licensee included the above functions within scope of the MR and established appropriate performance criteria.

c. Conclusions

In general, SSC functions were properly scoped into the MR program. However, two scoping deficiencies were identified and considered a violation for failure to include all SSCs within the scope of the MR as required by 10 CFR 50.65(b).

M1.2 Safety (Risk) Determination, Risk Ranking, and Expert Panel

a. Inspection Scope

Paragraph (a)(1) of the MR requires that goals be commensurate with safety. Additionally, implementation of the MR using the guidance contained in NUMARC 93-01, required that safety be taken into account when setting performance criteria and monitoring under paragraph (a)(2) of the MR. This safety consideration was to be used to determine if the SSC should be monitored at the system, train, or plant level. The inspectors reviewed the methods and calculations that the licensee established for making these risk determinations. NUMARC 93-01 recommended the use of an expert panel to establish safety significance of SSCs by combining probabilistic risk assessments (PRA) insights with operations and maintenance experience, to compensate for the limitations of PRA modeling and importance measures. The inspectors reviewed the composition of the expert panel and the experience and qualifications of its members. The inspectors reviewed the licensee's expert panel process and the information available which documented the expert panel decisions. The inspectors interviewed several members of the expert panel to determine their knowledge of the MR and to understand the functioning of the panel.

b.1 Observations and Findings on the Expert Panel

The expert panel was composed of experienced personnel representing operations, maintenance, engineering, work control, and the site maintenance rule owner (SMRO). In addition, one expert panel member was knowledgeable of the Braidwood PRA. Expert panel activities were established and controlled by the BwAP 2300-2, Appendix I, "Maintenance Rule Expert Panel Charter." This charter established the qualifications for expert panel members, meeting frequency, and quorum requirements. The expert panel responsibilities included approving revisions to the MR program, SSC scoping additions or subtractions, SSC risk determinations, and reviewing (a)(1) goal setting and corrective action plans.

The inspectors observed the deliberations of the December 18, 1997, expert panel meeting. The agenda for the meeting included the risk determinations for the diesel generator (DG) rooms and main control room ventilation systems. The respective system engineer (SE) was present for the discussions. The deliberations and discussions were well-controlled and reflected a balanced evaluation by the panel, considering both risk and operational concerns.

c.1 Conclusions on Expert Panel

The expert panel was a well-balanced group of qualified, experienced personnel. The panel used PRA in conjunction with their experience base to accurately assess the safety significance of SSCs.

b.2 Observations and Findings on Risk Determinations

b.2.1 Analytical Risk Determining Methodology

The PRA input to the MR was an important aspect of the licensee's overall program. The Individual Plant Examination (IPE) was a large event tree model with support states, and the Westinghouse suite of computer codes was used to develop and quantify the model. The June 1994 IPE appeared to be acceptable for support of the MR. However, the Braidwood IPE reflected plant design, procedures, and plant-specific data up through December 1992. The licensee planned to issue an updated IPE in March 1998 and reflect changes as appropriate in the MR program.

The licensee's process for establishing the safety significance of SSCs within the MR scope was documented in the procedure BwAP 2300-2, Attachment C, "Establishing Risk-Significance of Maintenance Rule SSCs." This document was reviewed and found to adequately describe the process of determining safety significance. For SSCs modeled in the IPE, three importance measures were evaluated (core damage frequency (CDF) contribution, risk achievement worth, and risk reduction worth), as recommended in NUMARC 93-01. If a basic event's importance measure met one or more of the cut-off criteria, then the SSC associated with that basic event was judged to have high safety significance. The truncation level used in determining the importance measures was approximately 1E-15/year, which was low enough to ensure accurate estimates of importances.

b.2.2 Adequacy of Expert Panel Evaluations

For SSCs not modeled in the IPE, the expert panel used a Delphi approach, similar to that described in NUMARC 93-01. This approach considered how important each SSC was with respect to four accident response functions and six normal operation functions. Results from each function were weighted and summed to obtain a single importance number, normalized to a scale of one to ten. The expert panel chose a cut-off criterion of 1.85, to correspond with the importance result of a system judged to be borderline between high safety significant and low safety significant. The expert panel did not downgrade from high to low safety significance any SSCs the met either the IPE importance measure criteria or the Delphi criterion.

The inspectors questioned why the DG system was ranked high safety significant but the DG ventilation system was ranked low. In response to this question, the expert panel re-evaluated the ventilation system and reclassified it as high safety significant,

based on revised Delphi process results. The DG ventilation system, however, already had acceptable reliability and unavailability performance criteria in place that would be required for a high safety significant system.

c.2 Conclusions on Risk Determinations

The approach to establishing the risk ranking for SSCs within the scope of the MR was adequate.

M1.3 (a)(3) Periodic Evaluations

a. Inspection Scope

Paragraph (a)(3) of the MR requires that performance and condition monitoring activities, associated goals, and preventive maintenance activities be evaluated, taking into account where practical, industry-wide operating experience. This evaluation was required to be performed at least one time during each refueling cycle, not to exceed 24 months between evaluations. The inspectors reviewed the procedural guidelines for these evaluations.

b. Observations and Findings

The guidance for conducting periodic assessments were contained in procedure BwAP 2300-2, Attachment J, "Periodic Assessment of the Maintenance Rule." The procedure provided adequate guidance for preparing periodic assessments, which appeared to meet the requirements of 10 CFR 50.65(a)(3) and the intent of NUMARC 93-01, Sections 12 and 13.5. The licensee, however, had not yet performed a periodic assessment since the MR went into effect. The licensee intended to commence a dual unit assessment in January 1998. Since a periodic assessment was not performed, this is considered an inspection follow-up (IFI) (50-456/457-97018-02(DRS)) pending the licensee's completion of an assessment and subsequent review by the NRC.

c. Conclusions

The procedure for performing periodic assessments appeared to meet the requirements of the MR and the intent of the NUMARC implementing guidance. An assessment, however, had not yet been completed and will remain an open issue for future follow up.

M1.4 (a)(3) Balancing Reliability and Unavailability

a. Inspection Scope

Paragraph (a)(3) of the MR requires that adjustments be made where necessary to ensure that the objective of preventing failures through the performance of preventive maintenance (PM) was appropriately balanced against the objective of minimizing unavailability due to monitoring or PM.

b. Observations and Findings

Balancing of reliability and availability had not yet been performed because the periodic assessment had not yet been performed. The SMRO stated that PM practices for each system would be reviewed to ensure a balance between reliability and availability. The inspectors noted that demonstrating that an acceptable balance had been achieved would be difficult because roughly half of the systems were classified as (a)(1) due to performance criteria having been exceeded. Follow up on this issue will be performed in conjunction with the periodic assessment IFI identified in Section M1.3.

c. Conclusions

The acceptability of balancing of availability and reliability could not be determined because the periodic assessment had not yet been performed.

M1.5 (a)(3) On-line Maintenance Risk Assessments

a. Inspection Scope

Paragraph (a)(3) of the MR specified that when removing plant equipment from service the overall effect on performance of safety functions be taken into account. The guidance contained in NUMARC 93-01 required that an assessment method be developed to ensure that overall plant safety function capabilities were maintained when removing SSCs from service for PM or monitoring. The inspectors reviewed the procedures and discussed the process with the SMRO, plant operators, the PRA engineer performing on-line risk assessments, and planning and scheduling personnel.

b. Observations and Findings

The policy for determining plant safety when equipment was taken OOS was documented in Braidwood Policy Memo #110, "On-line Maintenance." While the plant was at power (modes 1 through 4), the policy was implemented by procedures BwAP 2200-10, "Conducting Risk Assessments of Planned On-line Maintenance Activities," and BwAP 2200-11, "Shift Guidance for On-line Emergent Work Control." When the plant was shutdown (modes 5 and 6), procedure BwAP 2200-9, "Shutdown Safety Management Program," was used.

The cycle manager was responsible for all risk assessments of equipment OOS while the plant was at power, except for emergent work occurring during the evening or night shifts or weekends, which was the responsibility of the shift manager. A 12-week schedule with specific work windows within each week was used for planning and scheduling on-line maintenance and testing. Risk was indicated by colors, with green corresponding to a conditional core damage probability (CCDP) of less then 1E-7, yellow corresponding to a CCDP of 1E-7 to 1E-6, orange corresponding to a CCDP of 1E-6 to 1E-5, and red corresponding to a CCDP greater than 1E-5 (or CDF greater than 1E-3/year). The cycle manager had two additional sources of information for determining on-line risk: a list of single component outages with associated risk colors,

and a risk matrix covering selected combinations of two-component outages. If none of the three sources covered the planned (or emergent) equipment outages, then the procedure required an analysis by PRA personnel.

The shutdown risk management process was based on the standard industry approach, using guidance from NUMARC, INPO, and EPRI. The ORAM program was used to evaluate the status of each of seven functional areas.

c. Conclusions

The process for assessing plant risk resulting from equipment OOS for on-line maintenance was determined to be good. The availability of three different sources of risk information was considered to be a strength of the licensee's program.

M1.6 (a)(1) Goal Setting and Monitoring and (a)(2) Preventive Maintenance

a. Inspection Scope

The inspectors reviewed program documents in order to evaluate the process established to set goals and monitor under (a)(1) and to verify that PM was effective under (a)(2) of the MR. The inspectors also discussed the program with appropriate plant personnel and reviewed the following systems:

(a)(1) systems	(a)(2) systems
Condensate Booster	Diesel Generators
Instrument Air	DC Power
Auxiliary Power System	Feedwater
Safety Injection	Auxiliary Building Floor Drains
Process Radiation Monitors	Switchgear Room HVAC
Auxiliary Building Heating, Ventilation, and Air-conditioning (HVAC)	Miscellaneous Electrical Equipment Room HVAC
Neutron Monitoring	

The inspectors reviewed each of these systems to verify that goals or performance criteria were established in accordance with safety, that industry-wide operating experience was taken into consideration where practical, that appropriate monitoring and trending were being performed, and that corrective actions were taken when an SSC failed to meet its goal or performance criteria or experienced a maintenance preventible functional failure (MPFF).

The process to evaluate onsite passive structures for inclusion under the MR was reviewed. Structures evaluated by the inspectors included buildings, enclosures, storage tanks, earthen structures, and passive components and materials housed therein. In addition, the inspectors assessed by what means performance of structures determined to be within scope were monitored for degradation.

b. Observations and Findings

Specific system or train level performance criteria were established for high safety significant and standby SSCs using the guidelines contained in NUMARC 93-01. Most of the specific performance criteria established were appropriate for monitoring the performance of systems. However, five examples were identified where the established performance criteria were not appropriate for demonstrating acceptable SSC performance.

b.1 Observations and Findings for Reliability and Unavailability Performance Criteria

Section 9.3.2 of NUMARC 93-01 recommended that high safety significant SSC performance criteria be set to assure that the availability and reliability assumptions used in the risk determining analysis (i.e., PRA) were maintained. The inspectors evaluated the performance criteria to determine if they had been adequately set under (a)(2) of the MR, consistent with the assumptions used to establish SSC safety significance. The inspectors noted instances where different values for unavailability and reliability performance criteria were utilized than what were used in the PRA.

A sensitivity study, BWR-97-0938-N, was performed to determine the impact on CDF from the unavailability performance criteria. The CDF increased 160%, which was an acceptable increase based on the additional licensee's evaluation. This evaluation determined that the analysis was conservative (SSCs would not all degrade simultaneously to the unavailability performance criteria limits) and that quarterly trending of actual CDF resulting from SSC unavailabilities would detect adverse trends before such limits would be reached. The licensee used the EPRI methodology for determining reliability performance criteria, based on IPE reliability values and a 5% criterion for selecting the number of functional failures. This approach was acceptable. Since the number of functional failures for one SSC was higher than allowed by the EPRI approach, that reliability performance criteria was also included in the sensitivity study. Therefore, the licensee's unavailability and reliability performance criteria were appropriately tied to the IPE.

In general, reliability and unavailability performance criteria had been established to adequately gauge the effectiveness of maintenance activities. Reliability and unavailability for most SSCs were monitored over a 24-month rolling cycle. As discussed below, one example was identified where reliability performance measures for a system were not adequate.

b.1.1 Observations and Findings for Auxiliary Building Floor Drains (Function WF-02) Performance Criteria:

The leak detection function for the auxiliary building floor drains was monitored by a reliability criterion of ≤ two functional failures per building floor elevation per two years, not to exceed four functional failures. However, the surveillance frequency for most of the leak detection sumps was five years. Consequently, even on the building floor elevations with the most leak detection sumps (ten), the performance criterion permitted

an excessive failure rate of 50%. Prior to December 5, 1997, the licensee had elected to classify the auxiliary building floor drains as (a)(2) for monitoring under the MR, based on system conformance to the above reliability performance criterion. The use of a flawed performance criterion as a basis for (a)(2) classification is considered an example of a violation of 10 CFR 50.65(a)(2) (50-456/457-97018-03(DRS)).

b.2 Observations and Findings for Plant Level Performance Criteria for Low Safety Significant Normally Operating SSCs:

Prior to December 5, 1997, five plant level criteria were established, which included the following: ≤ two unplanned manual or automatic reactor trips while critical per unit per two years; ≤ two safety system actuations per unit per two years; ≤ 4% unplanned capacity loss factor per unit per two years; ≤ two unplanned entries into higher level of risk monitoring per unit per outage period; and no entries into Unusual Event, Alert, Site Emergency, or General Emergency. These criteria were considered to be acceptable for monitoring those low safety significant normally operating SSCs whose failure would affect the criteria.

The inspectors identified that plant level performance criteria were inappropriately used for the four functions discussed below.

- Communications (Function CQ-01): Loss of communications would not directly affect a plant level criteria. Consequently, the use of plant level criteria for monitoring purposes and as a basis for (a)(2) classification was inappropriate. On December 13, 1997, the licensee acknowledged that monitoring under (a)(2) using plant level performance criteria was inappropriate.

- Turbine Over-Speed Protection (Function EH-03): Loss of the turbine over-speed protection function would not directly affect a plant level criteria unless an actual turbine over-speed event occurred resulting in catastrophic failure. The licensee acknowledged that the turbine over-speed protection function was not adequately monitored using plant level performance criteria.

- Cathodic Protection (Function GD-01): Although the loss of the cathodic protection function could result in degradation of other SSCs within the scope of the MR, loss of the function would not directly affect a plant level performance criteria. The licensee acknowledged that monitoring the cathodic protection function using plant level criteria was inappropriate, and identified that the existing surveillance program for cathodic protection was inadequate. By December 13, 1997, the expert panel recommended that cathodic protection be reclassified as (a)(1).

- Digital Rod Position Indication (Function PI-01): Loss of digital rod position indication would not directly affect a plant level performance criteria. The licensee acknowledged that the digital rod position indication function was not being effectively monitored using plant level performance criteria and established a reliability performance criterion of ≤ six functional failures per two years.

These functions were monitored solely under the plant level criteria as of December 5, 1997. Prior to December 5, 1997, the licensee had elected to monitor these functions under (a)(2) of the MR because no plant level performance criteria had been exceeded due to failures of these functions. However, failures of these functions would not consistently affect the plant level performance criteria. Consequently, the basis for the election to (a)(2) monitoring was flawed and is considered an example of a violation of 10 CFR 50.65 (50-456/457-97018-03(DRS)).

b.3 Observations and Findings for Goals Established for (a)(1) SSCs:

Appropriate goals and monitoring were established for the SSCs classified as (a)(1). Some weaknesses, however, were identified with respect to the goals established for the neutron monitoring system as discussed in Section M2.1.b.7. Corrective actions planned for (a)(1) SSCs appeared to be appropriate to improve performance and address the problems that led to the (a)(1) classification. In some cases, systems that had been classified as (a)(1) had been appropriately returned to (a)(2) status after corrective actions had been completed and performance met established goals.

Availability and reliability were being adequately monitored and tracked for most systems. However, for the process radiation monitoring system, the SE was unable to quantify the number of functional failures which had occurred. The SE clearly understood that the system reliability goals had been greatly exceeded but was unable to tell whether reliability remained steady, was improving, or was getting worse. At the time of the inspection, the system functions had recently been rescoped and failures had not yet been tabulated against the functions deemed within scope of the MR. Such tabulation was not required until the next monthly report. Consequently, the inspectors were not able to evaluate the effectiveness of monitoring against goals, especially for the process radiation monitoring system, during this inspection. The issue on the effectiveness of monitoring was also discussed in Sections M2.1b.5, M2.1.b.10, and E4.1.b. This is considered an IFI (50-456/457-97018-04(DRS)) pending further review of the licensee's effort to effectively monitor system performance.

b.4 Observations and Findings on Structures and Structure Monitoring

The monitoring of structures was delineated in accordance with corporate procedure NEP-17-03, "Structural Monitoring Program." The procedure was thorough and provided guidance for the selection, identification, and monitoring of structures within the scope of the MR. Structures were broken down into a total of 137 separate structural integrity functions. The scoping of structures was appropriate.

Because structures were passive in nature and considered always available, high safety significance was determined if the structure housed equipment whose unavailability in itself was considered safety significant. As a result of this definition of safety significance, all but two of the 137 structural functions were considered high safety significant. Structural reliability and performance criteria were based on functional failures related to the functional failure definition of a number of elements, such as, concrete, structural steel, equipment foundations, roofing, and isolation gaps.

A number of structural baseline walkdowns were completed, while the remaining baseline walkdowns were scheduled with a completion date of December 31, 1998. The walkdowns performed were thorough and problems were adequately documented. In many cases, photographs were taken to show the level of degradation for future evaluation. During various system walkdowns, the inspectors noted no structural problems that had not already been identified by the licensee.

A number of structures were being monitored under (a)(1) because the baseline walkdown had not been completed or due to problems identified with the structure. Problems noted included shrinkage cracks in masonry walls, masonry walls with missing blocks, isolation gap leakage, problems with seismic gaps, past problems with turbine building single ply membrane roof damage, and numerous problems encountered with hollow metal doors and roll-up doors. The action plans established were thorough and addressed the problems that resulted in the structure being placed in (a)(1).

c. Conclusions

The majority of performance criteria were acceptable. However, one example of an inappropriate performance criterion was identified and four examples of inappropriate use of plant level criteria for monitoring functions were identified. The performance criteria for reliability and unavailability, although in some cases higher than the PRA assumptions, were adequately justified through the use of a sensitivity study. Goals and monitoring for systems classified as (a)(1) were appropriate. The structural monitoring program was effective. Inspections adequately assessed the conditions of structures and adequate corrective actions were initiated to correct deficiencies.

M1.7 Use of Industry-wide Operating Experience

a. Inspection Scope

Paragraph (a)(1) of the MR states that goals shall be established commensurate with safety and, where practical, taking into account industry-wide operating experience (IOE). Paragraph (a)(3) of the MR states that performance and condition monitoring activities and associated goals and PM activities shall be evaluated at least every refueling cycle. The evaluation shall be conducted taking into account IOE. The inspectors reviewed the program to integrate IOE into the MR monitoring program.

b. Observations and Findings on Use of Industry-wide Operating Experience

The methodology for evaluating and initiating action for IOE information was to ensure that lessons learned were used to prevent occurrences of such events and to improve plant safety and reliability. Industry and corporate operating experiences were screened and, if applicable, processed for further evaluation and follow up. The MR program required reviewing IOE information for scoping the systems under the MR. Corporate procedure NSWP-A-06, "Operating Experience (OPEX)," controlled the processing of documents from INPO, NRC and Nuclear Network. The procedure NSWP-A-06 required the generation of a problem identification form (PIF), when an operability issue

was identified by the OPEX information. The licensee's review of OPEX information included a review for MR applicability, and if any items were applicable, the SMRO was notified for further follow up. The MR program required reviewing IOE when setting goals for (a)(1) systems, during performance of root cause analysis, and during the periodic assessments.

The inspectors noted that the inputs to NPRDS system was discontinued in January 1997, and a new system, "EPIX," was initiated. The NPRDS (EPIX) coordinator had started to input data to the new EPIX system, but had yet to learn how to retrieve data to provide a benefit to the plant engineers from the new system.

c. Conclusions for Use of Industry-wide Operating Experience

Adequate processes were in place to incorporate information from IOE into MR activities.

M2 Maintenance and Material Condition of Facilities and Equipment (61706, 71707)

M2.1 General System Review

a. Inspection Scope

The inspectors conducted a detailed examination of several systems from a MR perspective to assess the effectiveness of the program when it was applied to individual systems.

b.1 Observations and Findings for the Condensate Booster (CB) System

The CB system consisted of two high safety significant functions and three low safety significant functions, which were monitored by reliability and unavailability performance criteria. The system was being monitored under (a)(1) based on problems with pump bearing failures and ineffective pump discharge check valve design modifications. The inspectors determined that the licensee's corrective actions, condition monitoring, and goals to return the system to (a)(2) were acceptable.

b.2 Observations and Findings for the Instrument Air (IA) System

The IA system consisted of one high safety significant function and one low safety significant function, which were monitored by reliability and unavailability performance criteria for each of the system's three trains. The system was monitored under (a)(1) because the reliability performance criteria was exceeded due to seven MPFFs involving dryer switching failures in Unit 0 and two MPFFs in the other units. In addition, the Units 0 and 1 trains unavailable performance criteria was exceeded during 1997. The licensee developed adequate goals and an action plan that included replacement of Asco solenoid valves, rebuilding of supply and exhaust valves, annual cleaning of air receiver tanks, and to add new low point drains in the system.

b.3 Observations and Findings for the Auxiliary Power (AP) System

The AP system consisted of four high safety significant functions and two low safety significant functions, which were monitored by reliability performance criteria and no allowed bus unavailability. The system was monitored under (a)(1) because the reliability performance criteria was exceeded due to MPFFs of Westinghouse electrical breakers. Acceptable goals were set for both the DHP (4.16kV) and DS (480volt) type breakers. Action plans were developed to monitor breaker performance and to take corrective actions including refurbishing, replacement of levering-in devices and motor cut out switches in DHP breakers, and replacement of motor cut out switches in DS breakers. The corrective actions included a review of past PIFs and work requests.

The inspectors reviewed selected PIFs and noted that seven PIFs were issued for trip trigger and trip latch roller being out-of-tolerance during the period of May 1996 to October 1997. Although the out-of-tolerances did not cause functional failures of the breakers, the licensee had not reviewed these repetitive PIFs for any underlying root cause(s) and had not taken further corrective actions. This was considered a potential weakness in resolving PIF concerns. The vendor's evaluation of the breakers in the AP system indicated that the lubrication in the breakers was found to be stiff, and the operation became smoother after the breakers were cycled. The hardened grease appeared to result in failures of the spring release device, motor cut out switch, and the operating mechanism of the breakers. The inspectors noted that because these breakers were about 20 years old, the hardened grease could result in a potential common mode failure. This is considered an IFI (50-456/457-97018-05(DRS)) pending further inspector review of the license's actions concerning breaker problems.

b.4 Observations and Findings for the Safety Injection (SI) System

The SI system consisted of four high safety significant functions and seven low safety significant functions, which were monitored by reliability and unavailability performance criteria. The system was being monitored under (a)(1) due to relief valves failing to reseat. The licensee had established acceptable goals and had planned appropriate corrective actions for addressing problems associated with the relief valves. Most functional failures for the SI system had been appropriately evaluated. However, an event that had occurred on March 5, 1996, was inappropriately determined to not be maintenance preventable at the time. The event involved rendering a train of the SI system inoperable because improper isolation boundaries had been established for the maintenance activities on the other train. Although the event was not classified as maintenance preventable at the time, the event was considered as part of the decision to place the SI system under (a)(2) monitoring starting July 10, 1996. The decision process was adequately documented and deemed acceptable to the inspectors.

b.5 Observations and Findings for the Process Radiation Monitor (PR) System

The PR system consisted of two high safety significant functions and five low safety significant functions, which were monitored by reliability and unavailability performance criteria. The system was monitored under (a)(1) due to a number of functional failures.

The inspectors noted that the MR database listing of functional failures did not include 12 functional failures that had occurred with the PR system. This inconsistency was attributed to the numerous functional failures with the PR system, as well as an incompatibility between the current MR database and electronic PIF database. The licensee believed these inconsistencies were attributed to the recent MR program changes with the PR system. The inconsistencies in tracking of functional failures for this and other systems will be further reviewed by the IFI identified in Section M1.6.b.3. The goals established for the PR system were appropriate. However, establishing a goal of ≤ one functional failure per monitor per year appeared unrealistic based on the large numbers of functional failures encountered with the PR system. Problems with the material condition of the PR system have been previously noted by the licensee, as well as the NRC.

b.6 Observations and Findings for the Auxiliary Building Heating Ventilation and Air Conditioning (HVAC) System

The auxiliary building HVAC system consisted of one high safety significant function and eight low safety significant functions, which were monitored by reliability and unavailability performance criteria. The system was being monitored under (a)(1) because the reliability performance criteria was exceeded due to the number of ventilation fan functional failures. The problem with poor fan operation was attributed to the ventilation fans operating in the stall region for extended periods of time. This had caused fan blade failures and the subsequent failure of the ventilation fan. The fan failures root cause was attributed to original design. Corrective actions included modifications in the plenum region to reduce the probability that the fans would operate in the stall region and the procurement of forged blades that were less susceptible to failure when operated in the stall region. The inspector determined that the licensee's corrective actions and goals to return the system to (a)(2) were acceptable.

b.7 Observations and Findings for the Neutron Monitors and Nuclear Instrumentation System

The neutron monitors and nuclear instrumentation system consisted of four low safety significant functions, which were monitored by reliability and unavailability performance criteria. The system was being monitored under (a)(1) because the performance criteria for the post-accident neutron monitoring instruments was exceeded due to numerous signal isolator failures.

The post-accident neutron monitoring instruments had an availability performance criteria of ≤ 17 days unavailability per two years per channel and a reliability performance criteria of ≤ two functional failures per two years. However, the performance criteria bases defined a functional failure as a loss of both channels. Consequently, the reliability criteria provided little, if any, measure of channel reliability. Functionality at the channel level was required because the two channels were powered from separate power trains and loss of one train's power source could be assumed for a design basis accident. Although the reliability criteria was inadequate, the performance

criteria were acceptable because the post-accident neutron monitoring function was a low safety significant function and the availability performance criteria was acceptable as a stand alone criteria.

The goals for the post-accident neutron monitoring instrumentation were < three days unavailability per channel per rolling 12 months and ≤ one functional failure per rolling 12 months. As discussed above, channel reliability was not effectively measured because a functional failure was defined as the loss of both channels. In addition, the goals did not address the main cause of failures, i.e., signal isolator failures. Although the inspectors considered the goals to be weak, the goals were acceptable because the availability goals were sufficiently stringent to monitor reliability indirectly. The inspectors considered the corrective actions planned for the post-accident neutron monitoring instruments to be reasonable and acceptable.

b.8 Observations and Findings for the Diesel Generator (DG) System

The DG system consisted of three high safety significant functions and one low safety significant function, which were monitored by reliability and unavailability performance criteria. The system was being monitored under (a)(2). System performance was good and no additional functional failure concerns were identified.

The inspectors questioned the tracking of unavailability for the DG system as a result of a failure of the DG output breaker. According to the licensee's performance criteria, functional failures of 4kV breakers were monitored under the AP system, while unavailability would be tracked by the affected component's system. This criteria would require that breaker unavailability would be tracked under the DG system. On October 19, 1997, the output breaker failed to close during performance of the 1B DG operability monthly surveillance. The licensee's investigation revealed that there was a mechanical problem with the breaker that prevented its closure. Further investigation revealed that the breaker had last been manipulated during the manual SI test performed 17 days prior. The total unavailable time was calculated to be 414.9 hours; however, this unavailable time was not being tracked under the DG system. The licensee stated that, in evaluating the events that resulted in the DG exceeding the unavailability performance criteria, it was determined that no goals or corrective actions relative to the DG were necessary. The licensee concluded that the event did not indicate ineffective maintenance or poor performance of the DG system. Therefore, the goals and corrective actions were applied to the AP system. At the time of the DG output breaker failure, the performance criteria for the AP system was no functional failures and consequently, the one failure caused the AP system to be monitored under (a)(1). The inspectors determined that the licensee actions were appropriate.

b.9 Observations and Findings for the DC Power Storage and Distribution System

The DC power storage and distribution system consisted of two high safety significant functions and three low safety significant functions, which were monitored by reliability and unavailability performance criteria. The system was being monitored under (a)(2) .

System performance was good and no additional functional failures or unavailability concerns were identified.

b.10 Observations and Findings for the Main Feedwater (FW) System

The FW system consisted of four high safety significant functions and six low safety significant functions, which were monitored by reliability and unavailability performance criteria for both the system's pumps and valves. The system was recently placed under (a)(1) monitoring based on the failure of three different FW pump speed controllers, multiple failures of FW system valve 2FW035C to open, and a recent FW system water hammer event. The inspectors noted that the MR database listing of functional failures associated with the FW system was not consistent with problems identified in the PIF database. This inconsistency was attributed to the fact that many of these problems occurred fairly recently, and were due to incompatibilities between the current MR database and electronic PIF database as previously discussed. Due to the recent placement of the FW system under (a)(1), goals and corrective actions plans were not completely established. Corrective actions, however, were initiated to address the individual functional failures.

b.11 Observations and Findings for the Auxiliary Building Floor Drains System

The auxiliary building floor drains system consisted of one low safety significant function, which was monitored by a reliability performance criterion. The system was monitored under (a)(2). See Section M1.6.b.1.1 for further discussion of the performance criterion. Functional failures for the system had been appropriately identified.

b.12 Observation and Findings for the Switchgear Room HVAC System

The switchgear room HVAC system consisted of two low safety significant functions, which were monitored by a reliability performance criterion for each of the system's trains. The system was recently placed under (a)(1) monitoring because the reliability criterion was exceeded due to several fan trips and two failures of temperature indicating controllers. Due to the recent placing of the system under (a)(1), goals and corrective actions plans were not completely established

b.13 Observation and Findings for the Miscellaneous Electrical Equipment Room HVAC System

The miscellaneous electrical equipment room HVAC system consisted of one low safety significant function, which was monitored by reliability and unavailability performance criteria for each of the system's trains. The system was recently placed under (a)(1) monitoring because the system exceeded the revised train reliability performance criteria due to numerous fan trips and two failures of temperature indicating controllers. Due to the recent placing of the system under (a)(1), goals and corrective actions plans were not completely established.

c. Conclusions for General System Review

With noted exceptions, the inspectors concluded that the licensee was properly monitoring each SSC under (a)(1) or (a)(2) of the MR. The corrective actions, both in progress and planned, for SSCs in (a)(1) appeared adequate. The inspectors did not identify in the SSCs reviewed any MPFFs not previously identified. SSC functions for the systems reviewed were properly scoped under the MR. The root cause and corrective actions for breaker concerns will be reviewed during a subsequent inspection.

M2.2 Material Condition

a. Inspection Scope

In the course of verifying the implementation of the MR using NRC IP 62706, the inspectors performed walkdowns using NRC IP 71707, "Plant Operations," to examine the material condition of the systems listed in Section M1.6.

b. Observations and Findings

With minor exceptions, the systems were free of corrosion, oil leaks, water leaks, trash, and based upon external condition, appeared to be well maintained.

c. Conclusions

In general, the material condition of the systems examined was good.

M7 Quality Assurance in Maintenance Activities (40500)

M7.1 Licensee Self-Assessments of the Maintenance Rule Program

a. Inspection Scope

The inspectors reviewed the audit reports on the implementation of the MR program dated August 29, 1996 and October 8, 1997.

b. Observations and Findings

The 1996 audit concluded that the MR program met the requirements of the MR. However, the 1997 audit concluded that the MR program was unacceptable. The licensee stated the differences in conclusions was that the site did not keep up with changes in how the industry was acceptably implementing the MR. The 1997 audit identified a number of findings and recommendations to improve the MR program. The 1997 audit was conducted by a multi-disciplined team, which included MR technical consultants from other facilities. This approach provided an independent viewpoint, which added to the overall quality of the audit. Corrective actions were implemented or planned for the findings.

c. Conclusions

The recent audit was critical of the MR program's acceptability. A number of issues were identified and corrective actions were implemented or planned to correct program deficiencies. The use of outside personnel provided independent insights into the MR program and added to the overall quality of the audit.

M8 Miscellaneous Maintenance Issues

(Closed) Violation 50-456/457-97009-02(DRP): Violation issued for failing to effectively monitor performance of the post-accident neutron monitoring system to ensure performance was controlled through effective maintenance. The licensee developed acceptable performance criteria, determined that the post-accident neutron monitoring system should be monitored under (a)(1) of the MR, and developed acceptable goals and planned corrective actions. See Section M2.1.b.7 for further discussion of the post-accident neutron monitoring system. This violation is considered closed.

III. Engineering

E4 Engineering Staff Knowledge and Performance (62706)

E4.1 System Engineer's Knowledge of the Maintenance Rule

a. Inspection Scope (62706)

The inspectors interviewed SEs to assess their understanding of PRA, the MR, and associated responsibilities.

b. Observations and Findings

The SEs were experienced and knowledgeable about their systems and had an understanding of the MR. PRA familiarization in risk assessment and MR training were provided to the SEs. The SEs' responsibilities included functional failure determinations and the preparation of (a)(1) goals and corrective action plans. The SEs tracked the performance of their assigned systems and were familiar with the reliability and availability criteria and the goals required of their systems.

Functional failures were identified by SEs by reviewing the PIFs data base. However, sole reliance on the PIF data base had the potential that a SE could miss categorizing some of the functional failures because some failures were identified only in the action requests (ARs). For example, in September 1997 the licensee placed the emergency lighting system within the scope of the MR. On November 2, 1997, based on a historical review that included reviewing PIFs against the performance criteria, the licensee placed emergency lighting in (a)(2). However, on December 12, 1997, the licensee found that PIFs were not always initiated when an emergency light failed but that an AR would be issued to correct the problem. Consequently, some functional failures could be missed

if only PIFs were reviewed. The emergency lighting SE determined, through a review of ARs, that the system had a failure rate of 15 percent and therefore, exceeded the performance criteria of 10 percent. Subsequently, the licensee issued a PIF that placed the emergency lighting system under (a)(1) and documented the possibility of under estimating the number of function failures by reviewing only the PIF database .

c. Conclusions

The SEs were experienced and knowledgeable about their systems and responsibilities with respect to the MR. The licensee's actions to eliminate the possibility of improperly counting functional failures was acceptable.

V. Management Meetings

X1 Exit Meeting Summary

The inspectors discussed the progress of the inspection with licensee representatives on a daily basis and presented the inspection results to members of licensee management at the conclusion of the inspection on December 19, 1997. The licensee acknowledged the findings presented. The inspectors asked the licensee whether any materials examined during the inspection should be considered proprietary; none was identified.

PARTIAL LIST OF PERSONS CONTACTED

Licensee

K. Boyle, Cycle Manager, Work Planning
M. Cassidy, Regulatory Assurance - NRC Coordinator
J. Chojnicki, Operating Engineer
B. Claveau, Backup Expert Panel Member, Self-Assessment Coordinator
K. Devers, Component Engineer, NPRDS Coordinator (EPIX)
C. Dunn, System Engineering Department Supervisor
J. Hawley, Site PRA Analyst
M. Hurst, INPO Coordinator
Y. In, corporate PRA Engineer
J. Meister, Engineering Manager
A. Javorick, Corporate Maintenance Manager
M. Riegel, Quality and Safety Assessment Manager
A. Ronstadt, Station Maintenance Rule Owner
C. Sibley, Corporate Maintenance Rule Owner
T. Simpkin, Regulatory Assurance Supervisor
D. Skoza, Assistant System Engineering Department Supervisor
T. Tulon, Site Vice President

LIST OF INSPECTION PROCEDURES USED

IP 62706:	Maintenance Rule
IP 40500:	Effectiveness of Licensee Controls in Identifying, Resolving, and Preventing Problems
IP 71707:	Plant Operations
IP 62002:	Inspection of Structures, Passive Components, and Civil Engineering Features at Nuclear Power Plants

LIST OF ITEMS OPENED, CLOSED AND DISCUSSED

Opened

50-456/457-97018-01(DRS)	VIO	Maintenance Rule Scoping Deficiencies
50-456/457-97018-02(DRS)	IFI	Periodic Assessment Not Completed
50-456/457-97018-03(DRS)	VIO	Inappropriate use of Reliability and Plant Level PRA Performance Criteria
50-456/457-97018-04(DRS)	IFI	Functional Failures Not Always Properly Monitored
50-456/457-97018-05(DRS)	IFI	Root Cause Determination for Breakers Issues

Closed

50-456/457-97009-02(DRP)	VIO	Inappropriate Reliability Performance Criteria

LIST OF ACRONYMS USED

AP	Auxiliary Power
AR	Action Requests
CB	Condensate Booster
CCDP	Conditional Core Damage Probability
CDF	Core Damage Frequency
CFR	Code of Federal Regulations
DC	Direct Current
DG	Diesel Generator
DRP	Division of Reactor Projects
DRS	Division of Reactor Safety
EOP	Emergency Operating Procedure
EPRI	Electric Power Research Institute
FW	Feedwater
HVAC	Heating, Ventilation, and Air Conditioning
IA	Instrument Air
IFI	Inspection Follow-up Item
INEEL	Idaho National Engineering and Environmental Laboratory
INPO	Institute of Nuclear Power Operation
IOE	Industry-wide Operating Experience
IP	Inspection Procedure
IPE	Individual Plant Evaluation
MPFF	Maintenance Preventable Functional Failure
MR	Maintenance Rule
NUMARC	Nuclear Management Resource Council
NRC	Nuclear Regulatory Commission
NRR	Nuclear Reactor Regulation
OOS	Out-of-Service
OPEX	Operating Experience
PDR	Public Document Room
PIF	Problem Identification Form
PM	Preventive Maintenance
PR	Process Radiation Monitors
PRA	Probabilistic Risk Assessment
SE	System Engineer
SI	Safety Injection
SMRO	Site Maintenance Rule Owner
SSC	Structure, System, or Component
VIO	Violation

LIST OF DOCUMENTS REVIEWED

BwAP 2300-2, "Maintenance Rule," Revision 3

Braidwood Policy Memo #110, "On-line Maintenance," Revision 1

BwAP 2200-9, "Shutdown Safety Management Program," Revision 2

BwAP 2200-10, "Conducting Risk Assessments of Planned On-line Maintenance Activities," Revision 0

BwAP 2200-11, "Shift Guidance for On-line Emergent Work Control," Revision 0

COMED Procedure NSWP-A-06, "Operating Experience (OPEX)," Revision 0

COMED Procedure NSWP-A-15, "Integrated Reporting Program, Revision 1

COMED Procedure NEP-17-03, "Structural Monitoring Program ," Revision 0

Braidwood Nuclear Generating Station Units 1 and 2 Individual Plant Examination Submittal Report, June 1994

Braidwood Nuclear Generating Station Units 1 and 2 Individual Plant Examination of External Events for Severe Accident Vulnerabilities Submittal Report, June 1997

BRW-97-0938-N, "PSA Basis for Braidwood's Maintenance Rule Performance Criteria," October 16, 1997

Site Quality Verification Audit Report No. 20-96-16, "Maintenance Rule," August 29, 1996

Quality Audit Report, QAA 20-97-17, "Maintenance Rule," October 8, 1997

Braidwood Maintenance Rule Database, December 5, 1997