U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket No:	50-331
License No:	DPR-49
Report No:	50-331/97015(DRS)
Licensee:	IES Utilities Inc. 200 First Street S.E. P. O. Box 351 Cedar Rapids, IA 52406-0351
Facility:	Duane Arnold Energy Center (DAEC)
Location:	Palo, Iowa
Dates:	October 6-10, 1997
Inspectors:	Andrew Dunlop, Reactor Engineer (Team Leader), RIII Donald Jones, Reactor Engineer, RIII Ronald Langstaff, Reactor Engineer, RIII Rogelio Mendez, Reactor Engineer, RIII John Neisler, Reactor Engineer, RIII Adele DiBiasio, PRA Consultant, Brookhaven National Lab
Support Member:	Peter Balmain, Operations Engineer, NRR
Approved by:	James A. Gavula, Chief Engineering Specialists Branch 1 Division of Reactor Safety

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Duane Arnold Energy Center
NRC Inspection Report 50-331/97015

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 and Office of Nuclear Reactor Regulation inspectors, and a contractor from Brookhaven National Laboratory.

In general, the program met the requirements of the maintenance rule (MR); however, issues were identified concerning the use of reliability performance criteria and plant level performance criteria. One violation and one inspection follow-up item were identified.

Maintenance

- Structures, systems, and components (SSCs) were properly scoped into the MR program. The development of MR system basis documents was considered a good process to compile information regarding scoping and performance criteria and other pertinent information. Issues were identified concerning system boundaries definitions, repetitive maintenance preventible functional failures (MPFFs), and MPFF determinations.

- The risk assessment processes were an acceptable means of implementing the equipment out-of-service evaluation. The use of a probabilistic risk assessment (PRA) based tool by the scheduling group and a shutdown PRA in the scheduling and management of outages were viewed as a good commitment to online risk assessment.

- The performance criteria for reliability and unavailability, although in some cases higher than the PRA assumptions, were adequately justified through the use of sensitivity studies. In general, performance criteria had been established to effectively monitor equipments performance. However, a violation was identified because several examples were identified in which the established performance criteria were not effective for monitoring performance.

- The licensee had an effective structural monitoring program. Inspections adequately assessed the conditions of structures and corrective actions were initiated to correct deficiencies.

Quality Assurance

- The quality assurance audits identified a number of issues and recommendations to improve the MR program. The use of outside personnel provided independent insights into the MR program.

Engineering

- The system engineers were experienced and knowledgeable about their systems. Some system engineers, however, were not always cognizant of how the MR interfaced with their systems.

Report Details

Summary of Plant Status

The plant was 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 five regional inspectors and a consultant from Brookhaven National 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 two shift managers, one shift supervisor, one control room operator, and a nuclear station plant equipment 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

Operations personnel had a general knowledge of the MR and their role in its implementation. The operators stated that their duties included recording equipment out-of-service times and the use of the protected system matrix to evaluate emergent/fill-in maintenance activities.

The operators indicated that the MR increased plant personnel's awareness of high safety significant systems and improved work coordination during outages to limit out-of-service times. Because many of the MR requirements for online risk assessment were previously in place, the MR had minimal impact on their activities.

c. Conclusions

Operator knowledge was consistent with their responsibility for implementation of the MR. There was no indication that the MR detracted from the operators' ability to safely operate the plant.

II. Maintenance

M1 Conduct of Maintenance (62706)

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 their 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 DAEC MR program, Module 0, "Overview." The scoping effort was performed by system. The MR scope included safety-related systems and nonsafety-related systems that were relied upon to mitigate accidents or transients, were used in the emergency operating procedures (EOPs), could prevent safety-related SSCs from fulfilling their safety-related function, or could cause a reactor trip or actuation of a safety-related system.

In general, the scoping of systems was good. A total of 170 systems were reviewed during the scoping phase; of these, 107 systems were determined to be within the MR scope. Systems excluded from the MR scope were adequately justified. The inspectors did not identify any additional SSCs that should have been within the scope of the MR.

Basis documents were established for each SSC within the MR scope. The basis documents included the following: bases for performance criteria and safety significance, whether an SSC was in the EOPs, whether an SSC was a standby system, and identified system boundaries. Some of the system boundaries, however, were not well-documented. For example, although the licensee stated that the generator hydrogen system and the switchyard relay house were within the MR scope, they were not listed within the boundaries of a system basis document.

Additionally, several discrepancies were noted in the Module 0 document. For example, well water, reactor building closed cooling water, condenser, nitrogen system, traversing in-core probe, and non-nuclear instrumentation were misidentified as standby systems in Attachment 7. The licensee stated that they would review this area further and develop consistency among the MR documents.

c. Conclusions

The inspectors concluded that SSCs were properly scoped into the MR program. The development of MR system basis documents was considered a good process to compile information regarding scoping, performance criteria, and other pertinent information. However, boundaries definitions of some systems were not always clearly defined.

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, and 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, systems engineering, licensing, quality assurance, and the probalistic risk assessment group. In addition, one expert panel member was experienced in the review and evaluation of industry operating experience.

Expert panel activities were established and controlled by the MR program, Module 0, Attachment 4, "Expert Panel Charter." The program established the qualifications for expert panel members, meeting frequency, and established 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 plans.

The inspectors observed the deliberations of one expert panel meeting. The agenda included a number of issues identified during the inspection such as the safety determination of the condenser and turbine systems, and inadequate guidance in the governing procedures for the safety determination. 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 well-balanced group of qualified, experienced personnel. The panel used PRA in conjunction with their experience base to accurately assess, the risk significance of SSCs.

b.2 Observations and Findings on Risk Determinations

b.2.1 Analytical Risk Determining Methodology

Plant-specific PRA studies were used to rank SSCs with regard to their safety significance. These studies included the Duane Arnold Probabilistic Safety Assessment (PSA) and Probabilistic Shutdown Safety Assessment (PSSA). The plant-specific PSA model was a linked-fault-tree model, and Erin Engineering's REBECA computer code was used to quantify the presolved cutsets of the PSA model. The PSA, specifically for internal events and internal flooding, was based on a Level 1 PRA, which provided information on core damage frequency (CDF), and a complete Level 2 analysis of plant specific containment structural failure, including the large early release frequency (LERF). The risk ranking had originally been performed in 1994 using Revision 1 of the PSA, and was reevaluated following issuance of Revision 3B in 1996.

For the risk ranking process, the licensee staff used a truncation level of 3E-11 per reactor year. This was six orders of magnitude less than the overall CDF estimate of 1.5E-5 per reactor year. The truncation level used for the risk significance determination process was reasonable.

The general quality, scope (Level 1 and 2), and level of detail of the PSA were acceptable to support implementation of the MR. However, the PSA, although updated following the 1995 refueling outage to reflect plant configuration and operation, included plant-specific unavailability data that was generated in support of the IPE study in 1992, and generic unreliability data. Not having updated the PSA to reflect more recent plant data was considered by the inspectors to be a weakness in the implementation of the MR. At the time of the inspection, the licensee staff indicated that the PSA databases would be updated to support the MR following issuance of Revision 4 of the PSA later this year.

b.2.2 Adequacy of Expert Panel Evaluations

The process for establishing the safety significance of SSCs within the scope of the MR was documented in MR program, Module 2, "Assessing Risk Significance." The program did not adequately reflect the process used in determining SSCs' safety significance. The inspectors reviewed the expert panel meeting minutes, and two reports prepared in 1994 and 1996 by a contractor that provided input for the risk ranking. These were determined to adequately describe the safety significance determination process. The licensee stated the program document would be revised to reflect actual practice.

An expert panel process in conjunction with a PRA ranking methodology was used to determine the safety significance of SSCs. The expert panel identified a number of systems as high safety significant, even though they did not meet the safety significance criteria or were not included in the PSA. Of the 107 systems within the MR scope, the expert panel determined 48 systems were of high safety significance.

For SSCs modeled in the PSA, two importance measures, risk achievement worth (RAW) and Fussell-Vesely (F-V), were evaluated by the expert panel. The 90% CDF contribution criteria was then reviewed and no additional systems were determined to be safety significant. The licensee first evaluated the importance of PRA basic events relative to the RAW and F-V importance measures at both the component and system level, for CDF and LERF. If a basic event's importance measure met one or more of the importance measure criterion, then the SSC associated with that basic event was judged to be potentially of high safety significance. Three systems deemed high safety significant based on the PSA (fire protection, condenser, and turbine systems) were evaluated by the expert panel to be low safety significant. The basis for the safety significance determination for the fire protection system was reviewed and found acceptable. The licensee, however, determined that the safety determination bases were insufficient for the condenser and turbine, and the expert panel reclassified these systems during the inspection.

The expert panel determined the safety significance of SSCs required during plant shutdowns utilizing the PSSA. The Individual Plant Examination of External Events (IPEEE) such as fires, seismic, external flooding, and other events was not considered by the expert panel. Based on a limited review by the inspectors, no additional systems were expected to be reclassified as high safety significant. An action request (AR) was initiated to specifically address the IPEEE.

c.2 Conclusions on Risk Determinations

The approach to establishing the risk ranking for SSCs within the scope of the MR was adequate. However, weaknesses in that approach included the use of an outdated data in the PSA, inappropriate safety determination by the expert panel in the case of the condenser and turbine systems, and the safety determination process was not fully described in the program.

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, two periodic maintenance effectiveness reviews, and a monthly status report.

b. Observations and Findings

The MR program, Module 5, "Periodic Maintenance Effectiveness Review," provided guidance for preparing periodic evaluations, which met the requirements of 10 CFR 50.65(a)(3) and the intent of NUMARC 93-01. Periodic maintenance effectiveness reviews were completed following Cycle 13 and Cycle 14 refueling outages. In most cases the reviews contained adequate information to assess the MR program during the cycle, although some exceptions were noted. The Cycle 14 periodic maintenance effectiveness review concluded the reliability and unavailability performance criteria were properly balanced because the majority of systems met their performance criteria. However, this conclusion for the (a)(1) SSCs did not appear to be fully supported.

Subsequent discussions with the licensee identified the basis for this conclusion as discussed in paragraph M1.4 of this report. The Cycle 14 review also contained conflicting information as to whether the onsite power system remained in (a)(1) or had been returned to (a)(2).

Monthly MR monitoring and status reports were being performed to keep management informed of the status of (a)(1) SSCs. The reports discussed the history associated with each (a)(1) SSC, such as SSC problems, goals established to monitor SSC performance, and status of corrective actions to address SSC problems. The reports were considered a good process to keep plant management informed of MR issues between periodic maintenance effectiveness reviews.

c. Conclusions

The periodic maintenance effectiveness reviews met the MR requirements and the NUMARC implementing guidance, although some areas required further clarification.

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. The inspectors reviewed the Cycle 14 periodic maintenance effectiveness review to ensure this evaluation was performed as required by the MR.

b. Observations and Findings

Balancing reliability and availability consisted of monitoring SSC performance against the established performance criteria. If the performance criteria were met, then the criteria were considered balanced. For the cycle 14 periodic review, the licensee concluded that, overall, maintenance activities were successfully controlled to achieve a balancing of reliability and availability. The conclusion was based on most systems meeting their performance criteria. In addition, a risk profile was calculated that accounted for equipment unavailability for the cycle. The risk profile showed there were no instances where a CDF of 7E-5 per year was exceeded.

c. Conclusions

Maintenance activities successfully achieved a reliability and availability balance.

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 maintenance rule coordinator (MRC), plant operators, the PRA engineer performing online risk assessments, and planning and scheduling personnel.

b. Observations and Findings

The process for determining plant safety when equipment was taken out-of-service was documented in WPG-2, "On-Line Risk Management Guideline" and OMG-7, "Outage Risk Management Guidelines." Electric Power Research Institute's (EPRI's) Sentinel PRA software was used for online maintenance risk evaluations by the scheduling personnel. Presolved cutsets of the PSA model considering zero maintenance were used for the calculations of CDF, as well as additional cutsets generated when specific components' maintenance was not specifically modeled in the PSA. The program was also used to perform a qualitative or defense-in-depth evaluation, and to prioritize SSCs to be returned to service or remain in service based on their importance measures. If combinations of equipment were not contained in the library of cutsets, the PRA group would be consulted. For emergent issues, the operators utilized a "protected system matrix." The procedures required that the scheduler or PRA group be consulted if equipment combinations were not on the matrix. Some risk insights had been factored into the matrix, which contained 30 systems. The inspectors noted that the combination of the automatic depressurization system (ADS) and residual heat removal (RHR) system was prohibited by the matrix, while the combination of ADS and residual heat removal service water (RHRSW) system was not, although the resulting CDF was essentially the same for either combination. An AR was initiated to evaluate the matrix. The shift technical advisors (STAs) were currently being trained in the use of Sentinel to eventually replace the matrix in the control room.

Control room operator logs were reviewed and no out-of-service configurations with more than two high safety significant components simultaneously out-of-service were identified. Discussion with scheduling personnel indicated that such configurations were rare. The licensee's review of Cycle 14 did not identify any plant configurations that were considered orange or red by Sentinel (i.e., the CDF was maintained below 7E-5).

The procedure for evaluating shutdown risk required the PRA group to perform a shutdown risk assessment prior to the outage. The PRA group utilized EPRI's ORAM software, which was benchmarked against the PSSA, with favorable results. Insights were provided to outage management in the refueling outage schedule development to avoid higher risk evolutions. The 1996 refueling outage risk assessments were reviewed and found adequate.

c. Conclusions

The processes implemented were acceptable means of implementing the equipment out-of-service evaluation specified by (a)(3). The use of the PRA based tool by the scheduling group and the use of a shutdown PRA in the scheduling and management of outages were viewed as a good process to assess online risk.

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
Offsite Power System	Standby Diesel Generators
River Water Supply	Reactor Building Sumps
Onsite Power System	Containment Atmosphere Control System
Primary Containment	Standby Gas Treatment System
	High Pressure Coolant Injection
	Residual Heat Removal
	Well Water
	Control Building Heating, Ventilation and Air Conditioning (HVAC)
	Control Rod Drive Hydraulic

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 there in. In addition, the inspectors assessed by what means performance of structures determined to be within scope were monitored for degradation.

b. Observations and Findings

Guidance for establishing performance criteria was outlined in MR program, Module 3, "Performance Criteria Development." This document stated that the PSA was not used to establish the maximum limit for each performance criteria. Rather, the performance criteria were established using engineering judgement based on the relative SSC risk significance and using the emergency diesel generator (EDG) industry goals as a basis for the high safety significant SSCs. Performance criteria basis documents were prepared for each high safety significant and standby SSC. The PRA group reviewed and approved all performance criteria basis documents to ensure that the assumptions contained in the document relative to the PSA were accurate and the performance criteria were compatible with the PSA.

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, four examples were identified where the established performance criteria were not appropriate for demonstrating acceptable SSC performance. In addition, some discrepancies were identified with respect to the performance criteria basis documentation.

In addition to developing performance criteria, the licensee had established a more restrictive "alert" criteria for many systems to provide warning that equipment performance was nearing the performance criteria setpoints. At the time of the inspection, no systems were in this "alert" status.

b.1 Reliability and Unavailability Performance Criteria

Section 9.3.2 of NUMARC 93-01 recommended that risk significant SSC performance criteria be set to assure that the availability and reliability assumptions used in the risk determining analysis (i.e., PSA) 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 than what were used in the PSA had been utilized.

The unavailability performance criteria established for SSCs were based on the components risk significance (i.e., 2.5 percent for high , 5 percent for moderate and 7.5 percent for low or no risk significance SSCs). However, most of the unavailability performance criteria exceeded the PSA assumptions for SSCs modeled in the PSA and historical data. For example, the high pressure coolant injection (HPCI) system's performance unavailability criterion was less than or equal to 2.5 percent. The actual unavailability experienced was 1.1 percent and the PSA assumed 0.8 percent unavailability. The licensee had, however, performed a sensitivity study to ensure that the established performance criteria was acceptable considering its impact on the CDF or LERF. The baseline CDF for was 1.5E-5. The unavailability performance criteria increased the CDF by 81 percent to 2.7E-5, assuming that each system was simultaneously at the unavailability performance criteria. The LERF increased 17 percent. The risk-ranking process was reevaluated and the safety significance determination was not found to be sensitive to the maintenance unavailability.

Reliability performance was monitored against established criteria over a 3-year rolling cycle, and the acceptable number of MPFFs varied from system to system, with a minimum of 1 MPFF in 3-years for a number of high safety significant SSCs to a maximum of 15 EOP annunciator input failures per year for a low safety significant standby SSC. Based on the results of a licensee study, 16 systems were identified with reliability performance criteria above the PSA assumptions. The licensee reviewed each of the 16 systems and lowered the reliability performance criteria for 12. Adequate justifications were provided for the remaining systems. An additional sensitivity study was performed to ensure that the use of the reliability performance criteria was acceptable considering its impact on the CDF and LERF. Incorporating the reliability and unavailability performance criteria for all modeled systems into the PSA, CDF increased by 190 percent to 4.3E-5 and LERF increased by 632 percent to 8.34E-6. The large increase in the LERF was attributed to the reliability contribution from the torus-drywell vacuum breakers, which had a criterion of one MPFF in 3-years (4.05E-3 failures per demand) versus the PSA assumption of 1E-4 failures per demand. The risk-ranking process had not been reevaluated after this study. However, based on information provided during the inspection, the risk significance determination was not affected by the performance criteria selected.

The reliability criteria for several systems were determined to not be appropriate to adequately monitor system performance as discussed below.

b.1.1 Standby Gas Treatment (SBGT)

The reliability performance criteria for the SBGT system, a high safety significant SSC, was two functional failures over a rolling 3-year period. A functional failure was defined as a total loss of the SBGT function, i.e., loss of both trains, or inability to maintain the required vacuum. As defined, the performance criterion was system level, which was inadequate because SBGT system train functionality was required. Failures of individual SBGT trains were not tracked. For example, in July 1995, the "B" train SBGT exhaust fan tripped due to excessive moisture in the fan housing. Although the "B" train of SBGT would not have functioned, the failure was not tracked under the MR program due to the inadequate reliability performance criteria. Consequently, a violation was identified in that the licensee had not provided an adequate basis for (a)(2) classification (VIO 50-331/97015-01a(DRS)).

b.1.2 Fuel Handling Equipment

The reliability performance criterion established for fuel handling equipment, a low safety significant system, was one reportable event over a rolling 3-year period. Because the criterion was based on reportable events, the criterion had no predictive value and was inadequate for monitoring the equipment performance for the safety functions associated with fuel handling equipment. Consequently, a violation was identified in that the licensee had not provided an adequate basis for (a)(2) classification (VIO 50-331/97015-01b(DRS)).

b.2 Plant Level Performance Criteria for Low Safety Significant Normally Operating SSCs

Plant level performance criteria were established for low safety significant normally operating SSCs using the guidelines contained in NUMARC 93-01. The criteria included: 4.5 percent unplanned capacity loss factor in a 3-year period; 4 unplanned scrams in a 3-year period per 21000 hours critical; 1 unplanned EDG and emergency core cooling system (ECCS) safety system actuation in a 3-year period; 1 unplanned outage risk color change per cycle; 22 unplanned safety system actuation reportable events in a 3-year period; and 15 safety system failure reportable events in a 3-year period. Although the two criteria based on reportable events appeared to be high, the licensee stated that the criteria were based on industry averages. The inspectors considered the reportable events criteria acceptable because other criteria existed that more appropriately monitored plant level performance. The unplanned outage risk color change criterion was effective for monitoring reliability of systems during outages because a functional failure of a system or train being relied upon would result in an outage risk color change. The primary containment system had been placed in (a)(1) because the performance criterion for unplanned capability loss factor had been exceeded. (see paragraph M2.1.b.4.)

In general, the selection of SSCs for plant level monitoring was appropriate. However, two examples were identified in which plant level monitoring was not appropriate. In addition, the appropriateness of plant level monitoring for some instrumentation was in question. These examples are discussed below.

b.2.1 Reactor Building Sumps

Equipment performance for the reactor building sumps, a low safety significant system, was monitored against the unplanned capability loss plant level performance criterion. The sump system had functions of removing water and preventing flooding between ECCS compartments, although the sumps were not capable of mitigating flooding from large sources of leakage, such as pipe ruptures. Reactor building sump failures would only affect the unplanned capability loss factor if Technical Specification equipment became unavailable due to compartment flooding. As such, the plant level criterion was not appropriate for monitoring reactor building sump performance because the criterion had no predictive value. Consequently, a violation was identified in that the licensee had not provided an adequate basis for (a)(2) classification (VIO 50-331/97015-01c(DRS)).

b.2.2 Hydrogen-Oxygen (H_2O_2) Analyzers

No specific performance criteria had been established for the H_2O_2 analyzers, which were low safety significant SSCs. The hydrogen analysis portion of the analyzers was monitored under the annunciator system because the H_2O_2 analyzers actuated an annunciator upon high hydrogen levels. However, due to the definition of a functional failure for the annunciator system, a total loss of capability to alarm upon high hydrogen levels would be considered a functional failure, i.e., only a coincident loss of both H_2O_2 analyzer trains would be considered a functional failure. As defined, the hydrogen analysis function of the H_2O_2 analyzers was monitored under a system level performance criteria which was inadequate because train functionality was required. The oxygen analysis function of the H_2O_2 analyzers was only monitored against the plant level performance criteria of unplanned capability loss factor. However, the unplanned capability loss factor would only be affected if the failures resulted in a required shutdown due to extended inoperability. Consequently, a number of failures of the H_2O_2 analyzers were not tracked under the MR. The failures included:

- "B" train H_2O_2 analyzer loss of power due to breaker failures, September 1995.
- "B" train H_2O_2 analyzer oxygen indication affected due to resistor failure, October 1995.
- "A" train H_2O_2 analyzer hydrogen indications were off scale high, February 1996.
- "B" train H_2O_2 analyzer hydrogen reagent gas isolated due to a solenoid valve failure, June 1996.
- "B" train H_2O_2 analyzer hydrogen indication drifted significantly due to a resistor being barely connected, June 1996.
- "A" train H_2O_2 analyzer sample lines isolated due to failure of a relay, May 1997.
- "A" train H_2O_2 analyzer oxygen reagent gas was isolated due a maintenance activity, June 1997.
- Three instances where oxygen indication accuracy was out of tolerance beyond accepted limits: "B" train H_2O_2 analyzer November 1995, "B" train H_2O_2 analyzer August 1996, and "A" train H_2O_2 analyzer September 1996.

In addition to the reliability problems noted above, both trains of the H_2O_2 analyzers had experienced unavailability (based on limiting condition for operation time) greater than 8 percent. The failure to track the above H_2O_2 analyzers train failures demonstrated the inadequacy of the existing performance criteria. The use of system and plant level performance criteria were inappropriate because train functionality was required for the H_2O_2 analyzers. Consequently, a violation was identified in that the licensee had not provided an adequate basis for (a)(2) classification (VIO 50-331/97015-01d(DRS)).

b.2.3 Instrumentation

In general, no specific performance criteria were established for instrumentation that only provided indication to control room operators. However, aside from the H_2O_2 analyzers, no additional examples of instrumentation that lacked appropriate performance criteria were identified. Most instrumentation had functions other than indication and had appropriate performance criteria linked to the non-indication function. However, due to the methods used for tracking instrumentation, the potential existed that instrumentation necessary for accomplishing MR functions were not being appropriately monitored under existing performance criteria. The licensee agreed to review the issue of how performance criteria was established for control room instrumentation. The licensee's review of monitoring instrumentation will be tracked as an Inspection Follow-up Item (IFI 50-331/97015-02(DRS)).

b.3 Performance Criteria Bases Documentation

In general, the bases for system and plant level performance criteria were well-documented in performance criteria basis documents. However, several instances were identified where the documentation did not appear acceptable. These included:

- The performance criteria basis documents for reactor core isolation cooling, emergency service water, HPCI, and RHRSW systems stated that failures would only be counted when the systems were required by Technical Specifications. The inspectors questioned whether failures detected during outage surveillance testing would be consistently counted.

- The performance criteria basis documents for the 125 volt DC, 250 volt DC, and onsite power systems stated that failures due to the same cause would only be considered repetitive if the failures occurred to the same breaker. As stated, the licensee's definition for repetivtive failures was not consistent with the NRC's understanding of NUMARC 93-01 that repetitive failures are not limited to the same component, but are applicable to all components of the same make and model number. The licensee's actions were acceptable because, although some repetitive breaker failures had occurred (discussed in M2.1.b.3), the cause was identified and corrective actions implemented to prevent further similar occurances.

- The performance criteria basis document for the RHR system stated that unnecessary shutdown cooling isolations, which were reviewed and removed by operations personnel in a prompt manner, were not to be considered MPFFs. The licensee stated that the limitation was only intended to exclude those isolations when a spurious isolation occurred due mixing of cold and hot water when shutdown cooling was first initiated. The inspectors questioned whether isolations which occurred due to equipment failures or other maintenance preventable reasons would be captured due to the existing definition.

The inspectors did not identify any examples where a functional failure had occurred, but had not been appropriately classified due to the above discrepancies. The licensee agreed to revise the performance criteria basis documents to provide clarification for each of the cases noted above.

b.4 Goals Established for (a)(1) SSCs

Appropriate goals and monitoring were established for the SSCs classified as (a)(1). Corrective actions planned for (a)(1) SSCs appeared to be appropriate to improve performance and address the problems which led to the (a)(1) classification. In some cases, systems which 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.

b.5 Structures and Structure Monitoring

The structural monitoring program was delineated in MR program, Module 6, "Monitoring of Structures." The program listed the structures in the MR scope, structural evaluation guidance, inspection acceptance criteria, and personnel qualification requirements. Structural inspections were performed under the guidance of a registered professional engineer experienced in structural inspection and evaluation.

The MR structural baseline inspection performed by a contractor appeared adequate and well-documented. Discrepancies were documented and received further review and evaluation by the licensee's civil/structural engineering staff. Appropriate corrective actions were initiated for those items that did not meet the approved acceptance criteria. Three structures were not included in the Module 6 monitoring list, although the baseline walkdowns had been already completed on these structures. The licensee took immediate steps to include these structures in the list of monitored structures.

The inspectors performed a walkdown inspection of selected structures. No structural deficiencies that had not been identified by the contractor were noted. The inspectors observed that erosion at the well structures caused by the well flush pipe discharge had begun to migrate under the building floor slab. Although the erosion had not yet damaged the structure, the licensee representative agreed that corrective action was necessary and would be accomplished. Cracks radiating from the general service water piping floor penetration and in the wall on the 734 elevation showed evidence of groundwater intrusion into the turbine building basement. The licensee had scheduled repairs to be effected during the fall 1997 refueling outage.

c. Conclusions

The performance criteria for reliability and unavailability, although in some cases higher than the PSA assumptions, were adequately justified through the use of sensitivity studies. In general, performance criteria had been established to effectively monitor equipments performance. However, a violation was identified because several examples were identified in which the established performance criteria were not effective for monitoring performance. Goals and monitoring for systems classified as (a)(1) were appropriate. The licensee had an effective structural monitoring program. 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 in-house operating experiences were screened and, if applicable, processed as an AR for further evaluation. The MR program required reviewing IOE when setting goals for (a)(1) systems, during performance of root cause analysis, and during the periodic maintenance effectiveness reviews.

c. Conclusions for Use of Industry wide Operating Experience

Adequate processes were in place to incorporate information from IOE into goal development and periodic maintenance effectiveness reviews.

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 345/161 Kilovolt Offsite Power System

The offsite power system was a high safety significant system with performance criteria to monitor reliability and unavailability. The offsite power system was being monitored under (a)(1) because the standby transformer unavailability criterion was exceeded. The standby transformer failed to meet the performance criterion because a preventative maintenance work activity performed on a bushing resulted in the transformer being out-of-service longer than originally planned. Prior to this planned maintenance activity, the transformer had a low unavailability rate. The corrective actions and goals intended to return the system to (a)(2) were acceptable.

b.2 Observations and Findings for the River Water System (RWS)

The RWS was a high safety significant system with performance criteria to monitor reliability and unavailability. The RWS was being monitored under (a)(1) because the reliability performance criterion was exceeded. The MPFFs were attributed to problems with failures of the RWS pump circuit breakers. The licensee was performing a root cause analysis and had not established performance goals pending completion of the root cause analysis.

b.3 Observations and Findings for the 4 Kilovolt and 480 Volt AC Onsite Power System

The onsite power system was a high safety significant system with performance criteria to monitor reliability. Although the onsite power system was a high safety significant system, no unavailability performance criterion was specified. During the inspection, the MRC stated that unavailability of the onsite power system was tracked under the affected high safety significant systems. The inspectors did not identify any instances where unavailability time of the onsite power system was not tracked appropriately. The licensee agreed to revise the criteria basis document to clarify tracking of unavailability.

The onsite power system was being monitored under (a)(1) because the reliability performance criterion was exceeded. The MPFFs were attributed to problems with the control device and failures of the RWS breakers. The corrective actions and goals intended to return the system to (a)(2) were acceptable.

As stated in paragraph M1.6.b.3, the licensee took an apparent exception to the NUMARC 93-01 guidance for repetitive breaker MPFFs that were attributed to the same maintenance related cause. The licensee did not require establishing goals for repetitive MPFFs involving breakers unless it was the exact same breaker. The basis for this position was due to the large population of breakers being trended in the plant, similar failures of two breakers were not judged significant enough to warrant the actions of goal setting. There were four failures of 480 volt AC breakers due to problems with the control device close latch. Two failures resulted from the control device not being properly adjusted. After the second failure, the root cause was determined to be the PM that adjusted the control device to ensure it was set correctly caused wear on the nylon bushing resulting in the breaker failure. The other two failures involved the control device close latch being damaged by maintenance personnel when the breaker was being racked out. Corrective actions included building a cart to move the breakers. As a result of the breaker MPFFs , the onsite power system was placed in (a)(1) because the MPFF limit was exceed (as discussed in the previous paragraph). The inspectors determined that although goal setting for repetitive MPFFs was not established, proper actions were taken to correct the generic problem and repetitive failures of this type have not occurred again. The licensee indicated that criteria for documenting repetitive MPFFs would be revised to reflect the guidance in NUMARC 93-01.

b.4 Observations and Findings for the Primary Containment

The primary containment super-system was a high safety significant system with performance criteria to monitor the leak tightness of the primary containment isolation valves and their ability to close. The primary containment was being monitored under (a)(1) based on the unplanned loss capability plant level criteria being exceeded. The licensee's review concluded that one of the main reasons for the plant level criteria being exceeded resulted from forced outages to repair drywell cooler water line leakage. The primary containment itself had not exceeded any performance criteria.

b.5 Observations and Findings for the Standby Generator (SBDG) System

The SBDG was a high safety significant standby system with performance criteria to monitor reliability and unavailability. The SBDG system was being monitored under (a)(2). System performance was good and no concerns were identified.

b.6 Observations and Findings for the Reactor Building Sump System

The reactor building sump system was a low safety significant system and was monitored under (a)(2). As discussed in paragraph M1.6.b.2.1, the system was inappropriately monitored under a plant level criteria. Based on discussions with responsible engineer for the system, the reactor building sump system had periodically experienced failures of the sump pit level switches for rooms with safety related equipment and associated drain valves. However, these failures were not tracked under the MR because the plant level criteria was not affected.

b.7 Observations and Findings for the Containment Atmosphere Monitoring System (CACS)

The CACS was a low safety significant system and was monitored under (a)(2). The performance criteria monitored control valve failures and unavailability of the hard pipe venting capability. Four control valve failures had been experienced over the previous 3 years. The H_2O_2 analyzers, although part of CACS, were monitored under different performance criteria and discussed in paragraph M1.6.b.2.2.

b.8 Observations and Findings for Standby Gas Treatment System (SBGT)

The SBGT system was a high safety significant, standby system with performance criteria to monitor reliability and unavailability. As discussed in paragraph M1.6.b.1.1, the reliability criterion was inappropriately monitored on system level, which would require both SBGT trains to fail to count as a functional failure. At the expert panel meeting during the inspection, a decision was made to monitor the reliability criterion at the train level, and establish appropriate performance criteria. Based on this issue, the licensee reviewed previous action requests that identified two potential MPFFs.

b.9 Observations and Findings for the High Pressure Coolant Injection (HPCI) System

The HPCI system was a high safety significant standby system with performance criteria to monitor reliability and unavailability. The HPCI system was being monitored under (a)(2). System performance was good and no concerns were identified.

b.10 Observations and Findings for the Residual Heat Removal (RHR)

The RHR system was a high safety significant standby system with performance criteria to monitor reliability and unavailability. The RHR system was being monitored under (a)(2). No functional failures were attributed to RHR since 1993 and unavailability hours were well within the performance criteria.

b.11 Well Water System

The well water system was a low safety significant system monitored by plant level criteria. The well water system was considered risk significant during shutdown conditions due to potential support of fuel pool cooling. Under shutdown conditions, monitoring was by the outage risk color change criteria. The well water system was appropriately classified and monitoring by plant level criteria was acceptable.

b.12 Observations and Findings for Control Building HVAC

The control building HVAC system was a high safety significant standby system with performance criteria to monitor reliability and unavailability of various system components. The control building HVAC system was being monitored under (a)(2). The control building HVAC had previously been in (a)(1) due to unavailability of the two chillers. The high unavailability reflected lengthy outage times in 1992 and 1993. In 1996, following corrective actions and meeting goals established for unavailability, the system was returned to (a)(2).

b.13 Observations and Findings for the Control Rod Drive System (CRD)

The CRD system was a high safety significant system and was monitored under (a)(2). The performance criteria were established for CRD pumps unavailability, CRD pump reliability, and control rod reliability. No functional failures were identified for the CRD system.

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.

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 recent quality assurance (QA) audit on the implementation of the MR program conducted in August 1997, and several previous audits on the MR program.

b. Observations and Findings

The QA audits identified several good findings and a number of recommendations to improve the MR program. The recent QA audit was conducted by a multi-disciplined team, which included a technical consultant and an MRC from another facility. This approach provided an independent viewpoint, which added to the overall quality of the audit. Corrective actions were implemented for the findings and some of the recommendations, while other recommendations were being evaluated for their effect on the program. However, one recommendation concerning interpreting the NUMARC 93-01 guidance on repetitive MPFFs was inconsistent with the NRC's understanding of the issue as discussed in paragraph M1.6.b.3.

c. Conclusions

The QA audits identified a number of issues and corrective actions were implemented to correct program deficiencies, while recommendations were implemented or being evaluated to determine if program changes would improve the MR program. The use of outside personnel provided independent insights into the MR program.

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 system engineers (SEs) and managers to assess their understanding of PRA, the MR, and associated responsibilities.

b. Observations and Findings

The SEs were experienced and knowledgeable about their systems. Training on the MR and PRA familiarization were provided to the SEs. The SE responsibilities were to review ARs for MPFFs and to establish corrective action plans. Some SEs were not as knowledgeable in the requirements of the MR as noted in the following examples: an SE did not realize that one of his systems was tracked under the performance criteria of another system, an SE was not familiar with the reliability performance criteria for his system, an SE did not realize that a failure in control rod position indication would constitute an MPFF under the performance criteria for that system.

c. Conclusions

The SEs were experienced and knowledgeable about their systems. Some SEs, however, were not always cognizant of how the MR interfaced with their systems.

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 October 10, 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

R. Anderson, Manager, Outage and Support
J. Bjorseth, Maintenance Superintendent
D. Curtland, Operations Manager
J. Franz, Vice President Nuclear
R. Howe, Quality Assurance Engineer
M. Huting, Project Engineering Supervisor
K. Kleinheinz, On-line Scheduling Team Leader
T. Lanc, PRA Engineer
M. McDermott, Manager, Engineering
B. Morrell, Licensing
K. Peveler, Manager, Regulatory Performance
J. Prost, Maintenance Rule Coordinator
K. Putnam, Licensing Supervisor, Expert Panel Chairman
G. Van Middlesworth, Plant Manager

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

50-331/97015-01(DRS)	VIO	Inappropriate use of Reliability and Plant Level PRA Performance Criteria
50-331/97015-02(DRS)	IFI	Performance Criteria for Instrumentation used in EOPs

LIST OF ACRONYMS USED

AC	Alternating Current
ADS	Automatic Depressurization System
AR	Action Requests
CACS	Containment Atmosphere Monitoring System
CDF	Core Damage Frequency
CFR	Code of Federal Regulations
CRD	Control Rod Drive
DAEC	Duane Arnold Energy Center
DC	Direct Current
DRS	Division of Reactor Safety
ECCS	Emergency Core Cooling System
EDG	Emergency Diesel Generator
EOP	Emergency Operating Procedure
EPRI	Electric Power Research Institute
F-V	Fussell-Vesely
H_2O_2	Hydrogen-Oxygen
HPCI	High Pressure Coolant Injection
HVAC	Heating, Ventilation, and Air Conditioning
IFI	Inspection Follow-up Item
IOE	Industry Operating Experience
IP	Inspection Procedure
IPE	Individual Plant Evaluation
IPEEE	Individual Plant Examination of External Events
LCO	Limiting Condition for Operation
LERF	Large Early Release Frequency
MPFF	Maintenance Preventable Functional Failure
MR	Maintenance Rule
MRC	Maintenance Rule Coordinator
NUMARC	Nuclear Management Resource Council
NRC	Nuclear Regulatory Commission
NRR	Nuclear Reactor Regulation
PDR	Public Document Room
PM	Preventive Maintenance
PRA	Probabilistic Risk Assessment
PSA	Probabilistic Safety Assessment
PSSA	Probabilistic Shutdown Safety Assessment
QA	Quality Assurance
RAW	Risk Achievement Worth
RHR	Residual Heat Removal
RHRSW	Residual Heat Removal Service Water
RWS	River Water System
SBDG	Standby Diesel Generator
SBGT	Standby Gas Treatment
SE	System Engineer
SSC	Structure, System, or Component
STA	Shift Technical Advisor
VIO	Violation

LIST OF DOCUMENTS REVIEWED

DAEC Maintenance Rule Document
- Module 0, "Overview," Revision 2
- Module 1, "Scoping," Revision 0
- Module 2, "Assessing Risk Significance," Revision 0,
- Module 3, "Performance Criteria Development," Revision 1
- Module 4, "Monitoring Performance Criteria and Goal Setting," Revision 2
- Module 5, "Periodic Maintenance Effectiveness Review," Revision 1,
- Module 6, "Monitoring of Structures," Revision 0

Plant Level and System Level Performance Criteria Basis Documents

WPG-1, "Work Process Guidelines," Revision 2, May 28, 1997

WPG-2, "On-Line Risk Management Guideline," Revision 3, August 29, 1997

OMG-7, "Outage Risk Management Guidelines," Revision 5, June 20, 1997

ACP 102.1, "Review of Industry-Related Documents," Revision 9, April 28, 1997

ACP 114.5, "Action Request System," Revision 11, August 6, 1997

ACP 1208.2, "Equipment Performance Monitoring Program," Revision 7, February 12, 1997

ACP 114.3, "Root Cause Analysis," Revision 7, May 12, 1997

Original System-by-System Scoping Documentation, 1994-1996

QA Audit on Maintenance Rule, August 29, 1997

Periodic Maintenance Effectiveness Reviews, Cycle 13 and Cycle 14

Maintenance Rule Monitoring and Status Report, August 1997

Probabilistic Evaluation of Internal Flooding for Duane Arnold Energy Center, January 1995

Individual Plant Examination (IPE) for the Duane Arnold Energy Center, November 1993

Duane Arnold Probabilistic Safety Assessment (PSA), Rev. 3B

Probabilistic Shutdown Safety Assessment (PSSA)

ERIN Report C1249608-29676-9/11/97, "Validation of MPFF and Unavailability Performance Criteria"

ERIN Report C1249311-1768-10/11/94, "Prioritization of Systems, Structures, and Components."

ERIN Report C1249606-2843/2-1/9/97, "Maintenance Rule: On-Line Maintenance and Performance Criteria Assessment."

Memo from P. Wojtkiewicz to J. Probst, March 4, 1997, "Comparison of MPFF Performance Criteria to the PSA."