January 31, 2000

Mr. Nathan L. Haskell, Director
Licensing and Performance Assessment
Palisades Plant
27780 Blue Star Memorial Highway
Covert, MI 49043

SUBJECT: PALISADES PLANT - APPROVAL OF REVISED INCORE NEUTRON FLUX MONITORING CODE, PIDAL-3, AND INCORE DETECTOR CHANGES (TAC NO. MA8695)

Dear Mr. Haskell:

By letter dated April 21, 2000, as supplemented on August 11, August 31, November 3, 2000, and January 10, 2001, Consumers Energy Company submitted and discussed a report entitled "The [Palisades Incore Detector Algorithm] PIDAL-3 Full Core System," dated February 2000, describing changes to the incore neutron flux monitoring computer code, PIDAL-3, used at the Palisades Plant. The submittals discuss your decision to replace CASMO-3 with CASMO-4 for generating fuel cross-sections, eliminate seven detector strings located in the outer region of the low leakage core design, and decrease the minimum detector operability from 75 percent to 50 percent. You found that this decision does not involve changes to the Palisades Technical Specifications, but does change the PIDAL methodology as approved by Amendment No. 144 dated April 3, 1992, and subsequently addressed in a Nuclear Regulatory Commission (NRC) letter dated May 6, 1997. You requested that the NRC review and approve the PIDAL-3 report and the related changes in detector strings and operability.

The NRC staff has completed its review of your request. The enclosure is our safety evaluation which concludes that the proposed requests to use CASMO-4 in PIDAL-3, eliminate seven peripheral detectors, and reduce the minimum operability of incore detectors from 75 percent to 50 percent, are acceptable.

If you have questions regarding this letter, please contact me at (301) 415-3049 or by e-mail at dsh@nrc.gov.

Sincerely,

/RA/

Darl S. Hood, Senior Project Manager, Section 1
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-255

Enclosure: Safety Evaluation

cc w/encl: See next page

If you have questions regarding this letter, please contact me at (301) 415-3049 or by e-mail at dsh@nrc.gov.

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO REVISION OF THE PIDAL-3 IN-CORE MONITORING CODE

CONSUMERS ENERGY COMPANY

PALISADES PLANT

DOCKET NO. 50-255

1.0 INTRODUCTION

By letter dated April 21, 2000, as supplemented by letters dated August 11, August 31, November 3, 2000, and January 10, 2001, Consumers Energy Company (CEC and the licensee) submitted and discussed changes proposed for the incore monitoring of neutron flux as currently performed using the third generation of the Palisades Incore Detector Algorithm (PIDAL-3) full core monitoring system.[1] The changes replace CASMO-3 with CASMO-4 for fuel cross-section generation,[2] facilitate the transition from the PDQ/XTG methodology to the PIDAL-3 methodology, and incorporate the CASMO-4/SIMULATE-3 computer codes.[3] The changes also eliminate seven detectors strings and decrease the minimum detector operability from 75 percent to 50 percent.

PIDAL-3 was previously approved by the Nuclear Regulatory Commission (NRC) staff by letter and safety evaluation dated May 6, 1997. PIDAL-3 was a revision to the PIDAL methodology originally approved by the NRC in Amendment No. 144 to the Palisades Operating License, dated April 3, 1992. PIDAL-3 has three-dimensional capabilities and can be used to determine the reactor core power distribution, peaking factors, and local linear heat generation ratio on a full-core basis.

2.0 BACKGROUND

Palisades is a pressurized water reactor (PWR) utilizing a first-generation ABB Combustion Engineering (CE) nuclear steam supply system with two primary coolant loops. It has a unique core design consisting of 204 15x15 fuel assemblies and 45 cruciform control blades (control

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[1] PIDAL-3 is an on-line incore analysis program, developed by CEC, to determine (measure) the power distribution on a full-core basis.

[2] CASMO-3 (or CASMO-4) is an advanced two-dimensional transport theory infinite lattice fuel assembly burnup code, developed by Studsvik of America, Inc., to generate the fuel cross sections for SIMULATE-3.

[3] SIMULATE-3 is an advanced three-dimensional two-group diffusion theory nodal code, developed by Studsvik of America, Inc., to determine the theoretical power distribution and core characteristics on a full-core basis.

rods). The core power distribution is monitored by self-powered Rhodium (Rh) incore detectors in a maximum of 45 instrumented fuel assemblies. Each instrument location contains five axial Rh detectors (40 cm in length), equally spaced, with centers at 10, 30, 50, 70, and 90 percent of the active fuel height. Currently, only 43 incore locations are available because two locations are reserved for use by the reactor vessel level monitoring system. The incore instrumentation is further described in Section 7.6.2.4 of the Palisades Updated Final Safety Analysis Report.

The Rh detectors, of standard design for CE type incore monitoring systems, are manufactured by Reuter-Stokes of Canada. The current practice at Palisades is to replace all incore detectors each operating cycle. These Rh detectors, by a neutron-beta reaction, produce a current that is directly proportional to the incident neutron radiation at each detector location. This current flows through a load resistor, producing a voltage that is converted to a digital millivolt reading, and is then passed to the primary information processor (PIP) data-logger. The PIP logs the detector readings, computes the background and depletion sensitivity corrections, and provides these and other plant measured parameters to the incore analysis system computer.

Palisades was originally licensed with a technical specification (TS) requirement for minimum detector operability of 50 percent. At that time, the incore power distribution was determined using 1/8 core symmetry. The 50 percent operability requirement was later changed to 75 percent of the total possible detectors (i.e., previous TS 3.11.1a required the operability of “at least 160 of the 215 possible incore detectors”) to compensate for the change from 1/8 core symmetry to 1/4 core symmetry. Subsequently, following the NRC’s issuance of Amendment No.189 on November 30, 1999, CEC implemented the Improved Technical Specifications (ITS) conversion in late October 2000. In accordance with the ITS format, the previous requirement regarding incore detector operability was relocated to the TS Bases.

3.0 EVALUATION

3.1 Implementation of CASMO-4/SIMULATE-3

CEC’s submittal includes the latest revision to the PIDAL-3 methodology in which CASMO-3 replaces CASMO-4 for the generation of fuel cross-sections. This is in keeping with CEC’s decision to switch to ultra low leakage core designs, beginning with the current operating cycle (Cycle 15), and to maintain such a design for all subsequent operating cycles. The movement to ultra low leakage core designs made it increasingly difficult for CEC to adequately predict core power distributions with the old quarter-core PDG/XTG methodology. Furthermore, previous PDG/XTG quarter-core modeling limited the ability to accurately deal with asymmetric power anomalies such as would result from misaligned control rods. Consequently, expansion of the PIDAL methodology to include the full core CASMO-4 and SIMULATE-3 model both improved the modeling accuracy and provided a tool for monitoring large quadrant power tilts.

Although incorporating the new codes CASMO-4 and SIMULATE-3 into the PIDAL-3 methodology results in a reduction in the measurement uncertainties, CEC elected to retain the current measurement uncertainties given in Table 2.4-2, “Power Distribution Measurement

Uncertainty Factors," of the Palisades Core Operating Limits Report (COLR).[4] The NRC staff agrees that the uncertainties stated in COLR Table 2.4-2 bound the PIDAL-3 uncertainties. Thus, the NRC staff agrees that implementing CASMO-4/SIMULATE-3 represents an improvement and finds it to be acceptable. Also, on the basis of its review, the NRC staff agrees with the licensee's conclusion that the changes do not involve a change to the Palisades TS and do not require issuance of a license amendment.

3.2 Elimination of Seven Peripheral Detectors

The purpose of the incore monitoring system is to measure core wide peaking factors. This function ensures conformance with TS surveillances to maintain power distribution within predetermined acceptable limits. Peripheral detectors form a network of detectors that collectively contribute to a core-wide monitoring system. In an ultra low leakage core, such as that designed for Palisades Cycle 15 and beyond, the assemblies on the periphery are very low powered. Consequently, detectors in these regions (along the outside of the core) provide no significant data for the TS surveillance. As a result, CEC decided to eliminate seven detectors, beginning with Cycle 15. These peripheral detectors have non-qualified thermocouples, have no symmetric partner, and are no longer relied upon to provide pertinent benchmarking data in low flux regions of the core. CEC has six cycles of low leakage core data from Palisades's Cycles 9 through 14 using several different types of shield assemblies to compare against SIMULATE-3 predictions. In addition, the activation of these detectors is so low that they deplete less than 10 percent of their Rhodium per cycle. The NRC staff agrees with CEC that the seven peripheral detectors do not provide a necessary function for the ultra low leakage core design, and their elimination is, therefore, acceptable.

3.3 Decrease in Minimum Detector Operability

As discussed in Section 2.0 above, the Palisades core has 43 possible locations for incore instrumentation. Eliminating the 7 peripheral locations leaves the core with 36 locations (i.e., 36 strings of 5 detectors each) for a total of 180 detectors. Each core quadrant contains nine strings. As discussed in Technical Specification Bases 3.2.1, "To be considered OPERABLE, the Incore Alarm System must have at least 160 of the 215 possible incore detectors OPERABLE...."[5] Thus, after eliminating the 7 peripheral locations the total number of possible detectors (180) continues to exceed the number (160) needed for the Incore Alarm System to

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[4] At the time of CEC's letter of April 21, 2000, requesting NRC staff approval of the revised PIDAL-3 code, the table specifying power distribution measurement uncertainty factors was Table 3.23-3 of the Palisades Technical Specifications. Subsequently, as part of the conversion to the ITS format, this table was relocated to the Palisades COLR as Table 2.4-2. After the NRC issued Amendment No.189 on November 30, 1999, CEC implemented the ITS conversion in late October 2000.

[5] Technical Specification Bases 3.2.1 also states that "To be considered OPERABLE, the Incore Alarm System must have at least...2 incore detectors per axial level per core quadrant OPERABLE." Eliminating the seven detector locations has no significant effect on the ability to maintain at least two detectors operable per axial level in any core quadrant. Each core quadrant contains nine strings of five axially-spaced detectors, providing an ample margin for detector failures.

be considered operable. However, the number allowed to fail (i.e., the available operating margin) is reduced. CEC proposes to regain some operating margin by changing from 75 percent operability of 43 strings to 50 percent operability of 36 strings.

In support of this request, CEC performed numerous calculations to demonstrate that the 50 percent operability of the detectors is capable of adequately monitoring (uniform and non-uniform) incore power distributions. CEC performed calculations with large radial power tilts for 75 percent, 50 percent, and 25 percent of the detectors declared operable. Comparisons were made between measured and predicted parameters (for uniform power distributions), such as assembly radial power root-mean-square (RMS) deviations, assembly radial peaking factors (F_R^A), total radial peaking factors (F_R^T), and total peaking factors (F_Q). Xenon transients and rod drop incident data (non-uniform power distribution) were also compared to PIDAL-3 predicted results. In addition, analyses conducted by CEC using earlier versions of PIDAL for Cycles 5, 6, and 7 show that the uncertainties currently stated in the Palisades COLR (Table 2.4-2) bound the most recent PIDAL-3 uncertainties for Cycles 12, 13, and 14. Consequently, as a conservative measure, CEC has chosen to use the uncertainties associated with Cycles 5, 6, and 7 in the core calculation model, consistent with the existing COLR. On the basis of its review, the NRC staff agrees with the analyses as performed by CEC and finds the results to be acceptable. Therefore, the NRC staff concludes that the change to 50 percent operability is acceptable.

4.0 CONCLUSION

Based on the evaluation discussed above, and analysis of the results obtained by CEC, the NRC staff concludes that the proposed requests to implement CASMO-4 into PIDAL-3, eliminate the use of seven peripheral detectors, and change the minimum operability of incore detectors from 75 percent to 50 percent, are acceptable.

Principal Contributor: A. Attard

Date: January 31, 2001