Consumers Power
POWERING MICHIGAN'S PROGRESS
Palisades Nuclear Plant: 27780 Blue Star Memorial Highway, Covert, MI 49043

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Nuclear Regulatory Commission
Document Control Desk
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DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT - TECHNICAL SPECIFICATIONS CHANGE REQUEST - CONTROL ROD DRIVE MECHANISM TESTING FREQUENCY CHANGE

Enclosed is a request for a change to the Palisades Technical Specifications to reduce the required frequency for the surveillance test which requires moving each control rod. The proposed surveillance frequency is once each 92 days, rather than the currently required frequency of once every two weeks.

The following Attachments are included in support of this request:

1) Proposed Technical Specifications page

2) Existing Technical Specifications page marked to show the changes

3) Figures

4) History of CE Rack and Pinion Control Rod Drive Mechanism Failures

It is requested that this change request be effective upon approval.

Gerald B Slade
General Manager

CC Administrator, Region III, USNRC
Resident Inspector, Palisades

Attachments

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CONSUMERS POWER COMPANY
Docket 50-255
Request for Change to the Technical Specifications
License DPR-20

For the reasons given below, it is requested that the Technical Specifications contained in the Facility Operating License DPR-20, Docket 50-255, issued to Consumers Power Company on February 21, 1991, for the Palisades Plant be changed as described below:

I. Changes:

It is proposed that Table 4.2.2 of the Palisades Technical Specifications, Minimum Frequency for Equipment Tests, be changed as follows:

1. Change the surveillance interval for item 2, "Partial Movement of All Rods (Minimum of 6 in)" from once "Every Two Weeks" to once "Every 92 Days".

2. Delete the footnote to that table, which provides for reduced testing of CRD-20 and CRD-31 during the remainder of cycle 10.

3. Correct the FSAR references in that table to reflect the arrangement of the Palisades Updated FSAR.

II. Discussion:

Problem:

The existing Surveillance testing causes unnecessary wear on mechanical and electrical components of the Control Rod Drive Mechanisms (CRDMs) and accelerates development of excessive CRDM seal leakage without providing any compensating safety benefit.

NUREG 1366, Improvements to Technical Specifications Surveillance Requirements, used four criteria for screening surveillance requirements for potential improvement:

(1) The surveillance could lead to a plant transient.

(2) The surveillance results in unnecessary wear to equipment.

(3) The surveillance results in radiation exposure to plant personnel which is not justified by the safety significance of the surveillance.

(4) The surveillance places an unnecessary burden on plant personnel because the time required is not justified by the safety significance of the surveillance.

It will be argued below that the subject surveillance, moving each full length control rod every two weeks (rod exercising) causes unnecessary wear to equipment. It is plant practice to measure the collective CRDM seal leakage weekly. The measurement of CRDM leakage is made in the containment and involves radiation exposure to plant personnel. Increased leakage increased worker exposure.

At Palisades, the subject surveillance is unlikely to directly lead to a plant transient, as it might for other plants equipped with the newer Magnetic Jack design, and it does not involve an inordinate amount of time. However, the wear of CRDM seals, electrical contactors, and magnetic brakes, has often led to plant shutdowns and cooldowns in order to perform repairs. These maintenance cooldowns result in plant transients, additional wear on plant equipment, radiation exposure, over that required for power operation.

Proposed Solution:

Extending the surveillance interval for exercising the CRDMs will reduce the wear on the CRDM components without significantly affecting the assurance that the CRDMs and associated control rods can perform their safety function. In addition, less frequent testing will lessen the tendency to accelerate the leakage rate of a CRDM seal with higher than normal leakage.

Both NUREG 1366 (item 4.2.1), and NUREG 1432, Standard Technical Specifications - Combustion Engineering Plants (SR 3.1.5.5), suggest a 92 day interval for CRDM exercising. Both of these documents discuss Magnetic Jack type CRDMs which differ from the Palisades Rack and Pinion CRDMs in both the mechanism itself, the configuration of the control rods, and the placement of the control rods in the reactor core. The arguments for 92 day testing of Magnetic Jack mechanisms are not applicable to the Palisades CRDMs, but the conclusion that 92 days is an adequate surveillance interval at which to assure that the rods can be moved by their drives is valid for both CRDM styles.

Justification:

Any discussion of the function, detriments, or benefits of the rod exercising surveillance requirement as applied to the Palisades plant must rely, in part, on an understanding of the workings and arrangement of the CRDM and control rod. The arrangement at Palisades is unique.

Palisades fuel bundles and control rods are arranged as shown in Figure 3. The 45 cruciform control rods move vertically in channels between the fuel bundles. Zircalloy rub rails on the sides of the fuel bundles guide the rods and prevent their contacting the fuel rods or spacer grid. The total stroke of the control rods is about 131 inches. The active portion of the control rods is made of rectangular stainless steel tubes filled with a silver-indium-cadmium alloy and welded together to form the cruciform shape. The silver-indium-cadmium filler is significantly less subject to swelling from gas build-up or coolant in-leakage than boron-tetracarbide. Four of the rods have absorber only at their lower ends and were intended for flux shaping. These "Part Length" rods are not used at this time. They are fully withdrawn during reactor operation and, since they are not equipped with a clutch mechanism, do not insert on a reactor trip. The CRDMs for the part length rods are identical to those for the full length rods with the exception that they use a solid shaft in place of the clutch. A Palisades control rod is illustrated in Figure 4.

The Palisades CRDM is of the Rack and Pinion type. It is illustrated in Figures 1 and 2. One other CE plant, Fort Calhoun, is equipped with these mechanisms. Unlike Palisades, however, Fort Calhoun is equipped with five fingered Control Element Assemblies (CEAs) moving in guide tubes built into the fuel bundles, rather than cruciform control rods moving in channels between fuel bundles.

Palisades Rack and Pinion drives have a drive package containing a drive motor, position indication equipment, and a releasing clutch, which is outside the Primary Coolant System (PCS) boundary; and a drive shaft, right angle gear set, pinion gear, and rack, within the PCS boundary. The drive package is connected to the drive shaft through a mechanical seal, which forms the PCS pressure boundary.

The CRDM drive motor is connected to the drive shaft through a reduction gear. A spring engaged, electrically released brake is provided to prevent the control rod from drifting when the motor is not energized. The motor is a fractional horsepower, single phase, two speed motor, though only a single speed (46 inches per minute) is connected. The DC brake is energized through separate contacts on the motor contactor.

When the CRDMs are driven outward, the motor and brake are energized, and the motor drives through the gearbox, turning the clutch upper half. If the clutch is energized (engaged) the clutch lower half is also turned. A cam and roller assembly, concentrically located within the electric clutch, transmits torque in only one direction, and allows the motor to drive the rod inward even when the electric clutch is disengaged.

The lower half of the clutch is connected to the vertical drive shaft, which turns the horizontal pinion gear through a right angle bevel gear set. The pinion gear drives the rack up and down. The rack assembly is connected to the control rod.

The CRDM rack is guided by a support tube. The rack has a larger diameter section, called a buffer piston, at its upper end. The guide tube has a restricted diameter toward its lower end. In this restricted diameter region there is a close fit between the buffer piston and the guide tube. When the buffer piston enters this restricted diameter region, water trapped below it acts as a brake to slow the fall of the rod.

Just below the lower clutch jaw, a small gear set drives the primary position indication shaft. The primary position indication provides a digital rod position readout by use of a synchro transmitter, and six cam operated limit switches which are used for motor control and position indication lights. A secondary position indication system, using magnetic reed switches, is actuated by a magnet located in the connector nut at the top of the rack assembly.

When a reactor trip signal interrupts power to the CRDM clutch, the clutch jaws spring apart, and the control rod falls by gravity into the core. With the clutch disengaged, the CRDM parts below the clutch rotate separately from the gear motor and brake above the clutch. All CRDM parts below the clutch (lower clutch shaft, primary position shaft, mechanical seal, drive shaft, bevel gears, pinion gear, magnet for secondary position indication, and rack) move whenever the rod moves.

The sole CRDM safety function assumed in the analysis is to release the clutch and drop the rod on a reactor trip signal. The safety analyses assume that the most reactive rod remains fully withdrawn when a trip occurs.

The CRDM and rod control system provide a backup to the trip function by driving the full length control rods inward on a reactor trip signal, until they are fully inserted. This feature is referred to as "Rod Rundown". Functioning of the Rod Rundown feature in not assumed in the safety analyses. This feature is provided to insert a rod which has a faulty clutch or mechanical binding preventing free fall, but not preventing insertion by the motor.

Discussion of subject surveillance test, rod exercising:

The Palisades Technical Specifications do not provide a basis discussion for the subject surveillance, moving each full length control rod a minimum of 6 inches every two weeks (rod exercising). Surveillance testing is typically intended to verify that the tested equipment can perform one or more of its specified safety functions. It is assumed that rod exercising was intended to demonstrate the safety function of control rod insertion into the reactor core upon a reactor trip being generated by the Reactor Protective System (RPS). In order for a Palisades control rod to insert on a trip signal, the following actions must occur:

1) The RPS must de-energize the CRDM magnetic clutch,

2) The clutch jaws must separate,

3) The mechanical components supporting the control rod must move freely to allow the control rod to fall into the core under the influence of gravity.

Since dropping a control rod while at power is undesirable, actions 1 and 2 are tested only during shutdown conditions. The rod exercising is not intended to, and does not, test these actions.

Rod exercising does, to a limited extent, evaluate action 3, but satisfactory completion of rod exercising is neither necessary nor sufficient to ensure mechanical freedom over the full insertion distance. Mechanical binding in the lower, closer clearance region of the piston guide tube could slow or stop rod insertion despite adequate clearance existing in the upper region of the piston guide tube; a failure of the motor, brake, or control system could prevent satisfactory completion of rod exercising, but not affect its trip capability.

One idea originally considered, with regard to rod exercising, was to assure that the CRDM seal faces themselves do not bond. No particular bonding mechanism was proposed, however the faces are finely lapped, are constantly pressed together, are without relative motion (except when the rod is moved), and are in a warm acidic environment. At the time we had no reactor operating experience with static CRDM seals in this environment. Since that time we have accumulated over 20 years of experience with no evidence of any such bonding. While it could be suggested that the bi-weekly testing has prevented such bonding, several facets of our operating experience demonstrate that bonding does not occur:

1) The part length rods are fully withdrawn prior to reactor startup, are not exercised, and typically remain motionless throughout the operating cycle. They have shown no signs of seal face bonding either during operation or during disassembly for maintenance.

2) On several occasions the plant has operated for extended periods with one full length rod declared inoperable due to drive package or seal problems. Inoperable rods are typically not exercised. Never has such a rod failed to trip or shown other signs of seal bonding.

3) Disassembled CRDM seals typically show bright polished contact surfaces except in those areas eroded by continued severe leakage. There have been no signs of bonded or sticky seal faces due to corrosion or material migration.

When the rods are exercised, they are individually driven in 6 to 7 inches and then returned to their normal full out position. This action assures that the drive motor can move the rod, but only for a short distance where maximum piston to guide tube clearances exist. The minimum distance of travel is stated in the subject surveillance requirement; the maximum distance of travel is limited by the Technical Specification on control rod group alignment. The rod exercising test has never detected any of the occurrences where mechanical binding of mechanical components has prevented or excessively slowed full control rod insertion.

Rod exercising can, and has, detected problems with the drive motor, but drive motor problems do not affect the ability of the control rod to perform its safety function.

Due to the lack of an extensive basis description for the subject surveillance, it is not possible to determine the reasoning behind the original selection of biweekly rod exercising in the current Technical Specifications. This surveillance requirement is unchanged from the original issue of the Palisades Technical Specifications, so no separate safety evaluation is available. Typical surveillance intervals, both currently and at the time of Palisades initial licensing, are based on judgment rather than on explicit analyses. These judgments are typically based on precedent and operating experience, the conditions necessary to perform test, and the perceived (as opposed to probabilistic) importance of the tested safety function. Such judgments made today have the advantage of over twenty years of industry experience, which was not the case when Palisades was licensed. Today's judgment for rod exercising, as published in NUREGs 1366 and 1432, is that once "Every 92 Days" is preferable to once "Every Two Weeks."

The history of CRDM failures is discussed in attachment 4. These failures are separated into two categories, trip failures and drive failures. The trip failures are those which would have affected the ability of the control rod to fully insert, within the required time, upon a reactor trip. The drive failures are those where a control rod could not be moved by its CRDM motor. Drive failures do not suggest a trip failure.

Other testing which verifies control rod safety functions:

Rod drop time testing each refueling shutdown, in accordance with surveillance Table 4.2.2 item 1, verifies that each control rod reaches 90% insertion within 2.5 seconds when dropped from the full out position, by de-energizing the clutch. This test and the associated withdrawal verify that the electric clutch functions and that there is no significant mechanical binding of the CRDM, thus verifying the control rod's ability to perform its safety function.

Detriment of reduced testing:

Reduced frequency of control rod exercising might be construed to imply slightly reduced potential of detecting loss of trip capability, but no data exists to support this judgement.

Exercising could detect CRDM binding if it occurred in the upper few inches of travel, but this is the region of maximum clearance between guide tube and buffer piston. No record of binding in this region has been found.

Statistically, reduced testing frequency implies a longer period for development of undetected failures. Since all of the trip failures which have occurred are maintenance or assembly induced, and none are time related, the statistical inference seems inappropriate.

Since there are no known time related trip failure modes, since other required testing is required to be performed prior to operation when exercising is performed, and since rod exercising is ineffective in detecting potential trip failures, the impact on the probability of a control rod failing to trip is considered negligibly small.

Reduced frequency of control rod exercising does reduce the assurance of detecting loss of Rod Rundown and maneuvering capability prior to that capability being called upon, however, this reduction is offset by reduced probability of test-induced failure of these same capabilities. In addition, neither the Rod Rundown feature nor the ability to move control rods for power level maneuvering is an assumed feature of the safety analyses.

Benefits of reduced testing:

The primary benefit of extending the surveillance interval is that of reduced CRDM wear. Additional benefits are related to the reduction in the associated maintenance.

Wear occurs both due to additional CRDM travel distance and number of cycles. While these types of wear affect all parts of the CRDM and the associated control system, most of the observed wear-related difficulties affect the shaft seals, the motor brakes, and the electrical contactors.

A 15 month operating cycle might include one maintenance shutdown and one inadvertent trip. CRDM linear travel and number of on/off cycles have been estimated for such an operating cycle, due to startup and shutdowns (6 full 131 inch strokes), 92 day rod exercising (5 tests of 12-14 total inches each), and 14 day rod exercising (30 tests). Two full strokes and one on/off cycle were included for rod drop time testing. Rod motion due to power changes, other than startups and shutdowns, and crediting the startup/shutdown cycle as required testing were not considered. Each full withdrawal was assumed as five on/off cycles. Operating procedures call for stopping a minimum of once each 33 inches, thereby requiring 4 on/off cycles per 131 inches of withdrawal, and one additional on/off cycle was added for this "typical" CRDM to allow for more frequent stops of the regulating groups (21 out of 45 rods) during startups. Each exercise test was considered as 13 inches of travel and 2 on/off cycles.

CRDM Usage, per Regulating CRDM

Startup/Shutdown	92 day testing	14 day testing
1,048 inches	65 inches	420 inches
27 on/off cycles	10 on/off cycles	60 on/off cycles

The current exercising comprises a significant percentage of CRDM usage; the proposed interval would reduce that usage.

There is no absolute correlation of CRDM usage to CRDM wear, but operational experience shows that a significant number of required repairs involved electrical control contactors and motor brakes. Mechanical failures of these components comprise 70% of the Palisades CRDM drive failures listed in Table 2. These parts operate each on/off cycle, subjecting contactors to inductive arcing and brakes to frictional wear. A comparison of Palisades CRDM "inoperabilities" due to brake and motor contactor failures shows that the per CRDM failure rate was 49% higher for the full length rods, which are subject to the exercising requirement, than for the part length rods, which are not. Such a comparison does not prove that the failures are due to excessive exercising, but does suggest that the CRDMs subject to more cycling do exhibit more failures of brakes and contactors.

Operational experience has also shown a cause-and-effect correlation between exercising and increased seal leakage. General wear of the mechanical seal faces can only come from relative rotation of the seal faces due to CRDM travel, and this wear would probably occur most during the first inches of travel where lubrication may not have become established. A comparison of maintenance records for the years 1974 through 1992 shows that there was a 56% higher per CRDM incidence of seal replacement for full length rods, which are subject to the exercising requirement, than for the part length rods, which are not. While not conclusive, this correlates with the higher linear travel of the full length rods (1048 inches vs 1048 + 420 inches). Typically, significant measured collective CRDM leakage increases occur immediately following CRDM exercising. This is particularly evident at those times when a seal is leaking sufficiently for its leakoff temperature to be above normal.

Reduced testing of the CRDMs is expected to result in reduced CRDM maintenance. Access to the CRDMs requires a plant shutdown, and replacement of a CRDM seal requires a plant cooldown to Cold Shutdown and partially draining the Primary Coolant System, so reduced CRDM maintenance directly results in reduction of the following:

Plant power level transients,

Plant thermal cycles,

Actuations of plant safety systems (Auxiliary feedwater and shutdown cooling),

Exposure to plant conditions where the Primary Coolant Pumps and steam generators are not available for decay heat removal,

Radiation exposure to operations and maintenance personnel,

Generation of radioactive waste due to boration, dilution, and maintenance activities, and

Lost electrical generation.

Conclusion:

Reducing the frequency of control rod exercising will not significantly reduce the ability to detect failures of CRDM trip capability. The reduction in CRDM and control system wear will reduce plant transients, safety system usage, accumulated personnel radiation dose, and creation of radioactive waste. The benefits of reducing the rod exercising frequency are judged to outweigh the small to non-existent detriment.

III. Analysis of No Significant Hazards Consideration

Consumers Power Company finds the activities associated with this proposed Technical Specifications change involve no significant hazards and accordingly, a no significant hazards determination per 10 CFR 50.92(c) is justified. The following evaluation supports the finding that operation of the facility in accordance with the proposed change would not:

1. Involve a significant increase in the probability or consequences of an accident previously evaluated.

The proposed change to the Technical Specifications reduces the frequency of control rod exercising surveillance testing from bi-weekly to quarterly. The presumed intent of this surveillance is to provide assurance that the control rods are not mechanically bound so as to prevent their inserting into the core upon a reactor trip. The exercising of control rods is only capable of determining the ability of the CRDM motor to move the rods a small distance. While this rod motion does provide assurance that the control rod is not firmly mechanically bound at a fully withdrawn position, such binding has never occurred. When the reactor is operating at power, this small range of travel is where the CRDM clearances are the greatest so the test has little chance of detecting mechanical interference if it were to occur. The surveillance cannot, and was not intended to, detect failures in the electrical clutch which releases the control rod. Operating history has shown that other required testing, which is performed following any maintenance requiring disassembly of the CRDM pressure housing, has been able to detect nearly all mechanical problems which affect the control rod trip and insertion capability. Palisades operating history shows that the subject surveillance has never detected such a mechanical problem.

Since the subject surveillance, control rod exercising, has little probability of detecting the faults which it was intended to detect, and since other required testing can, and has, reliably detected such failures prior to entering the operating modes where rod exercising is required, reducing the frequency of control rod exercising will have no significant effect on the probability of reactor operation with a control rod which will not insert upon a reactor trip signal.

Therefore, operation of the facility in accordance with the proposed Technical Specifications would not result in a significant increase in the consequences of an accident previously evaluated.

2. <u>Create the possibility of a new or different kind of accident from any previously evaluated.</u>

The proposed change to Technical Specification alters only the frequency of a surveillance test. It does not alter the manner of testing or the manner in which any plant systems are operated.

Therefore, operation of the facility in accordance with the proposed Technical Specifications would not create the possibility of a new or different kind of accident from any previously evaluated.

3. <u>Involve a significant reduction in a margin of safety.</u>

The proposed change to the Technical Specifications does not significantly affect the probability of a control rod failing to insert (the only CRDM safety function assumed in the safety analyses), as discussed under question 1, above. The change is in agreement with the control rod exercising frequency required by the Standard Technical Specifications - Combustion Engineering Plants, NUREG 1432, Revision 0, and with the recommendations of "Improvements to Technical Specifications Surveillance Requirements, NUREG 1366.

Therefore, operation of the facility in accordance with the proposed change to the Technical Specifications would not involve a significant reduction in a margin of safety.

IV. Conclusion

The Palisades Plant Review Committee has reviewed this Technical Specifications Change Request and has determined that the change involves no significant hazards consideration. This change has been reviewed by the Nuclear Performance Assessment Department. A copy of this Technical Specifications Change Request has been sent to the State of Michigan official designated to receive such Amendments to the Operating License.

CONSUMERS POWER COMPANY

To the best of my knowledge, information and belief, the contents of this Technical Specifications Change Request are truthful and complete.

By David P. Hoffman
David P Hoffman, Vice President
Nuclear Operations

Sworn and subscribed to before me this 30th day of March 1993.

Beverly A. Avery
Beverly A. Avery, Notary Public
Jackson County, Michigan
My commission expires December 3, 1996