

AUG 30 1974

Docket No. 50-255

Consumers Power Company  
ATTN: Mr. R. C. Youngdahl  
Senior Vice President  
212 West Michigan Avenue  
Jackson, Michigan 49201

Gentlemen:

The Commission has issued the enclosed Amendment No. 10 to Facility License No. DPR-20 for the Palisades Plant. This amendment includes Change No. 14 to the Technical Specifications and is in response to your request dated August 28, 1974. It provides interim authority to conduct power operations necessary for the removal of chemical impurities in the steam generators. A copy of the related Safety Evaluation is enclosed.

Also enclosed is a copy of a notice relating to this action that has been transmitted to the Office of the Federal Register for publication. The notice announces issuance of Amendment No. 10 and that the Commission, in response to your request dated August 20, 1974, is considering the issuance of further amendments that would specify the conditions for the resumption of power operation of the Palisades Plant beyond the interim period of operation authorized by Amendment No. 10.

Sincerely,

Original signed by:  
Karl R. Goller

Karl R. Goller, Assistant Director  
for Operating Reactors  
Directorate of Licensing

Enclosures:

1. Amendment No. 10
2. Safety Evaluation Report
3. Federal Register Notice

cc w/ enclosures:  
See next page

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AUG 30 1974

Consumers Power Company

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CONSUMERS POWER COMPANY

DOCKET NO. 50-255

PALISADES PLANT

AMENDMENT TO PROVISIONAL OPERATING LICENSE

Amendment No. 10  
License No. DPR-20

1. The Atomic Energy Commission (the Commission) has found that:
  - A. The application for amendment by Consumers Power Company (the licensee) dated August 28, 1974, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended, and the Commission's rules and regulations set forth in 10 CFR Chapter I;
  - B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;
  - C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;
  - D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and
  - E. Prior public notice of this amendment is not required since the amendment does not involve a significant hazards consideration.
  
2. Accordingly, the license is amended by a change to the Technical Specifications as indicated in the attachment to this license amendment and Paragraph 3.B of Facility License No. DPR-20 is hereby amended to read as follows:

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**"B. Technical Specifications**

The Technical Specifications contained in Appendices A, B and C, as revised, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications, as revised by issued changes thereto through Change No. 14."

3. This license amendment is effective as of the date of its issuance.

FOR THE ATOMIC ENERGY COMMISSION

Original signed by:

Karl R. Goller

Karl R. Goller, Assistant Director  
for Operating Reactors  
Directorate of Licensing

Attachment:

Change No. 14 to Technical  
Specifications

Date of Issuance: AUG 30 1974

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ATTACHMENT TO LICENSE AMENDMENT NO. 10  
CHANGE NO. 14 TO THE TECHNICAL SPECIFICATIONS  
PROVISIONAL OPERATING LICENSE NO. DPR-20  
CONSUMERS POWER COMPANY  
PALISADES PLANT  
DOCKET NO. 50-255

Incorporate attached Appendix C - Interim Technical Specifications.

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APPENDIX C

TO

PROVISIONAL OPERATING LICENSE DPR-20

INTERIM TECHNICAL SPECIFICATIONS

FOR THE

PALISADES PLANT

CONSUMERS POWER COMPANY

DOCKET NO. 50-255

Date of Issuance: AUG 30 1974

INTERIM TECHNICAL SPECIFICATIONS

FOR OPERATION OF THE PALISADES PLANT

DOCKET NO. 50-255

The following specifications apply to facility operations for the purpose of removing chemical impurities from the steam generators to maintain the steam generators in a serviceable condition. These specifications are effective for 90 calendar days from the date of issuance of Amendment No. 10 at which time the reactor shall be placed in the hot shutdown condition unless a change to these Technical Specifications is issued before then.

The specifications in this appendix have precedence over requirements specified in Appendix A.

1. The facility may be operated at power levels not to exceed 60% of rated power (rated power is 2200 Mwt) for a period of 90 calendar days in keeping with the requirements of the flushing program proposed by the licensee's letter dated August 28, 1974, from R. C. Youngdahl to the Directorate of Licensing.
2. During performance of Low Power Physics Testing the primary system pressure shall be in the range of 415 psia to 1800 psia.
3. The reactor protection system trip setting limit for the High Pressurizer Pressure shall be  $1950 \pm 20$  psia with two, three, and four coolant pumps operating.
4. a. Maximum steam generator operating transient differential pressure shall not exceed 1530 psi.  
b. Maximum primary system hydrostatic test differential pressure shall be in accordance with the following table.

<u>Hydrostatic Test Pressure</u>	<u>Temperature</u>
1.10 Po + 50 psi	100°F
1.08 Po + 50 psi	200°F
1.06 Po + 50 psi	300°F
1.04 Po + 50 psi	400°F
1.02 Po + 50 psi	500°F

Where "Po" is the nominal operating pressure of 1800 psia and the test temperature is selected to be the lowest temperature consistent with applicable fracture toughness criteria for ferritic materials. Only 10 cycles are permitted.

- c. Primary side leak tests shall be conducted at normal operating pressure and temperature  $\leq 400^{\circ}\text{F}$ . If conducted above  $212^{\circ}\text{F}$ , the secondary side shall be filled to within the normal operating range and pressurized to a pressure corresponding to saturated pressure of the primary fluid temperature.
  - d. Maximum secondary hydrostatic test pressure shall not exceed 1250 psia. A minimum temperature of  $100^{\circ}\text{F}$  is required. Only 10 cycles are permitted.
  - e. Maximum secondary leak test pressure shall not exceed 1000 psia. A minimum temperature of  $100^{\circ}\text{F}$  is required.
  - f. In performing the tests identified in 4.d and 4.e above, the secondary pressure shall not exceed the primary pressure by more than 350 psi.
5. Whenever the primary coolant system is closed after it has been opened, the primary system shall be leak tested at not less than 1835 psig prior to the reactor being made critical.
  6. Prior to the initial criticality after the August 1973 facility shutdown, a primary system leak test shall be conducted with a pressure differential across the steam generator tubes of 1850 psi.
    - a. At the end of no more than 90 effective full power days or no more than six calendar months from the initial criticality after the August 1973 facility shutdown, whichever occurs first, an inspection of the steam generator tubes will be conducted in accordance with the requirements of Regulatory Guide 1.83, "Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes" (issued June 1974), as it applies to inspections after the baseline inspection.
    - b. Subsequent inspection will be made starting no later than the first refueling outage and continuing thereafter at a frequency no less than the inspection intervals specified in Regulatory Guide 1.83 (issued June 1974). Tube sampling requirements will be as identified in Regulatory Guide 1.83 (issued June 1974).
  7. Weekly reports on the progress of the steam generator flushing operations shall be submitted in writing to the Regional Office of the Directorate of Regulatory Operations and to the Directorate of Licensing.



UNITED STATES  
ATOMIC ENERGY COMMISSION

WASHINGTON, D.C. 20545

SAFETY EVALUATION BY THE DIRECTORATE OF LICENSING

SUPPORTING AMENDMENT NO. 10 TO DPR-20

(CHANGE NO. 14 TO TECHNICAL SPECIFICATIONS)

CONSUMERS POWER COMPANY

PALISADES PLANT

DOCKET NO. 50-255

A. Introduction

By letter dated August 20, 1974, Consumers Power Company (licensee) submitted a request for a change to the Technical Specifications (TS) of Provisional Operating License No. DPR-20, Docket No. 50-255. By letter dated August 28, 1974, the licensee requested authorization for limited power operation to conduct a flushing program required for removal of chemical impurities from the steam generators. The requests were the result of a review by the licensee of the upcoming return to service of the Palisades Plant after shutdown in August 1973 for repair of a leak in the "B" steam generator. The proposed change to the TS would revise Limiting Conditions for Operation (LCO) to account for the present condition of portions of steam generator tubes. The TS change request also includes incorporation of a steam generator inservice inspection program consistent with Regulatory Guide 1.83.

In the August 20, 1974 submittal, the licensee described the planned program for converting the secondary system water chemistry from phosphate treatment to a volatile chemistry treatment and the planned program for hot flushing at increasing power levels up to 100% of full power to remove the existing corrodent chemicals believed to be the cause of tube degradation.

This staff safety evaluation addresses the specific proposed changes to the LCO's and the proposed inservice inspection program as requested by the licensee. This safety evaluation is issued in support of the concurrent issuance of Amendment No. 10 which adopts Interim Technical Specifications, Appendix C, authorizing limited operation for the purpose of conducting a flushing program to remove chemical corrodents from the steam generators. In addition, it also considers the broader question of the present and projected

condition of the steam generators in the context of whether the return to power operation in the manner proposed by the licensee constitutes an undue risk to the health and safety of the public and whether additional limitations or restrictions on power operation should be imposed in view of the changed condition of the steam generators (i.e., with a significant number of the tubes removed from service by plugging and the deteriorated condition of a quantity of tubes remaining in service).

In the August 28, 1974 submittal, the licensee requested immediate authorization to initiate a hot flushing program to remove chemical corrodents. The licensee indicated that this authorization is needed without delay in order to continue with the program designed to remove corrodent chemicals from the steam generator and, thus, arrest the continuing attack and further deterioration of the steam generator tubes as soon as practicable.

While it is recognized that minor deviations from this proposed flushing program may become necessary to achieve effective flushing, the licensee's August 28, 1974 letter represents that in keeping with the limited objective of operation to remove chemical impurities the facility will be operated substantially in accordance with the following flushing program:

Normal steady state power operation will be conducted at a power level of approximately 30% of rated power or less (rated power is 2200 MWt). Power operation above a nominal 30% of rated power, solely to enhance chemical impurity removal, will be conducted at 40%, 50%, and 60% nominal power level plateaus for total hours of operation of 96, 96, and 144, respectively. Nominal power levels will be held at the plateaus described above for no more than approximately 24 successive hours. The initial increase to each power level above a nominal 30% power level will be at an average rate of approximately 5% per day. Subsequent increases in power level above a nominal 30% power level and decreases to a 30% power level will be at an average rate of approximately 6% per hour. The times required for increasing and decreasing power level above a nominal 30% power level will not be included in the total hours of operation allowed at the 40%, 50%, and 60% power plateaus in the above table. After each increase in power level above a nominal 30% power level, power will be reduced to no more than a nominal 30% power level for at least 24 hours.

The Interim Technical Specifications, in keeping with the requirements of the flushing program proposed by the licensee, limit power operation to 90 calendar days with an overall core power limit not to exceed 60% of rated power.

The technical evaluation of the material and structural adequacy of the steam generator tubes in their present condition is included as Attachment A to this report.

B. Effect of Plugging of Steam Generator Tubes on Core Flow

The plugging of the steam generator tubes results in a reduced primary side flow area through the steam generators and, hence, a slight reduction in reactor core flow rate. The licensee reported that Combustion Engineering's reevaluation of the expected core flow rate indicates a reduction of approximately 4.4% of the flow rate used in the Palisades Fuel Densification Analysis. This resulting flow rate is sufficient to provide acceptable margin of safety for normal operation at 100% power level and anticipated transients. The minimum flow rate required to preserve the 122% overpower margin is  $127.3 \times 10^6$  lb/hr. This compares to the predicted flow rate for the plugged condition of the steam generators of  $131.5 \times 10^6$  lb/hr.

Based on telephonic report from the licensee on August 30, 1974, the flow rate was measured during the 530°F hot flush to be  $132.6 \times 10^6$  lb/hr. Thus, since the measured flow rate exceeds the value of  $127.3 \times 10^6$  lb/hr, the minimum flow for safe plant operation has been shown.

C. The Proposed Technical Specification Changes

Because of the proposed operation with some tubes having localized thinning up to 50%, the licensee has proposed the following changes to the TS which in effect reduce pressure and differential pressure limits for the plant in order to maintain an adequate margin of safety.

1. Reduction of the nominal operating pressure from 2100 psia to 1800 psia.
2. Reduction of the limiting safety system setting for high primary system pressure from 2400 psia to 1950 psia.
3. Reduction of the maximum operating transient differential pressure across the tubes from primary to secondary side from 1980 psi to 1530 psi.

4. Revision to the required hydrostatic test pressures and leakage test pressures to reflect the new operating pressure and the test requirements of ASME Boiler and Pressure Vessel Code, Section XI (1971).
5. Adoption of an augmented inservice inspection program for the steam generators to provide assurance of continued integrity of the steam generator tubes over their service lifetime.

These changes will ensure that the operation of the plant will be limited to within the conditions used for the analyses previously discussed that demonstrate the acceptability of the integrity of the steam generator tubes for normal operation, anticipated transients, and accidents. We find that these changes are acceptable and that they provide sufficient margin of safety considering the inservice inspection recommendations of Regulatory Guide 1.83 which are incorporated as requirements with this change.

D. Proposed Authorization of 90 Day Limited Power Operation for Steam Generator Cleanup

As discussed in Attachment A, "Evaluation of Structural Adequacy of Palisades Steam Generators For Continued Service," we consider it necessary to remove the corrodents from the steam generators without delay to prevent further deterioration of the steam generator tubes. The licensee, by letter dated August 28, 1974, has requested authorization to operate under a limited power program that will produce what they believe is the necessary amount of power and power changes to conduct an efficient removal of chemical impurities from the steam generators. We concur that this type of operation is needed, as a minimum, in order to produce the necessary mixing and agitation of the crud deposits and subsequent removal of the corrodents. We conclude that there is no significant reduction in the margin of safety and no significant increase in the probability of a tube rupture since the plugging criteria provide more than sufficient margin for wastage, if any, that could occur during this 90-day period. We further conclude that the reduced power levels would reduce the consequences of any accidents that could occur below what has been previously analyzed, and that the probability of any such accident occurring during this 90-day time interval remains very small. For these reasons, we conclude that authorization of the limited operation proposed by the licensee, with incorporation in this interim period of the proposed TS changes discussed in the previous section of this evaluation, does not involve a significant hazards consideration. We also conclude that there is reasonable assurance that these activities can be conducted without endangering the health and safety of the public.

E. The Resumption of Power Operation Beyond the Interim Period

The licensee, in its August 20, 1974 request for changes to the TS, proposed amendments which would permit the continuation of the startup and inspection program and resumption of power operation beyond the interim period of operation authorized by Amendment No. 10. The Commission is considering issuance of an amendment that would authorize operation beyond the interim period. The proposed permanent amendment, if adopted in the form requested by the licensee in its application dated August 20, 1974, would be substantially identical to the interim amendment, excluding the 90-day and 60%-power limitations set forth therein.

F. Conclusions

We have concluded that authorization of the limited power operation described in the licensee's letter dated August 28, 1974, with the incorporation of Appendix C to the Provisional Operating License DPR-20, "Interim Technical Specifications for the Palisades Plant", does not involve a significant hazards consideration. We also conclude that there is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations and the issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public.

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Thomas V. Wambach  
Operating Reactors Branch #1  
Directorate of Licensing

Original signed by:  
Robert A. Purple  
Robert A. Purple, Chief  
Operating Reactors Branch #1  
Directorate of Licensing

Enclosure:  
Attachment A

Date: AUG 30 1974

**ATTACHMENT A**

**EVALUATION OF STRUCTURAL ADEQUACY OF  
PALISADES STEAM GENERATORS FOR CONTINUED SERVICE**

August 30, 1974  
Regulatory Staff  
U. S. Atomic Energy Commission

EVALUATION OF STRUCTURAL ADEQUACY OF  
PALISADES STEAM GENERATORS FOR CONTINUED SERVICE  
AUGUST 1974

I. INTRODUCTION

On January 15, 1973, after approximately 1 year of intermittent operation of the Palisades plant at less than full rated power, the first leak in the steam generator tubing developed. Eddy current inspection detected a general wastage attack in the U-bend area of all tubes in the first eleven rows from the divider plate. In this area, the intersection of the "bat-wing" divider strips tends to limit coolant flow to the tubing surface. All tubes in these first eleven rows were plugged, and the plant returned to service early in March 1973, and operated at essentially 100% rated power until August 11, 1973 when the facility was shut down because of excess steam generator leakage. The Palisades plant remained in the shutdown condition until August 1974.

From the original plant startup, a phosphate treatment of the secondary coolant was used. During the 5 months of full power operation, a problem of phosphate hideout was discovered, when the rate of additions of phosphates needed to maintain the bulk coolant at 25-30 ppm during operation at 100% rated power increased by more than 5 times the rate needed at <60% rated power. Further, during power reductions, large quantities of these phosphates reappeared as "inverse hideout," with the concentration in solution occasionally reaching >2000 ppm phosphate. This phosphate hideout is now believed

to be generally responsible for the observed wastage of the Inconel 600 steam generator tubing.

Eddy current measurements during September 1973 showed measurable wastage on nearly half the tubes in each steam generator. Based on burst tests on tubes with machined defects and on wasted tubes removed from the Palisades steam generators, Consumers Power and Combustion Engineering determined that wasted tubes could be permitted to continue in service provided eddy current measurements detected wastage less than 60% of the tubing wall thickness in depth. Consequently, all tubes with 60% or more wastage were plugged, and the plant prepared to return to service in May 1974.

During a preoperational hydrostatic test early in May, leaks developed in two tubes at a pressure differential of 200 psi. Reinspections of the steam generators showed that a substantial number of the tubes with wastage, as observed in September 1973, had increased wastage area and depth, and a new type of tube degradation had developed during the 9-month period of shutdown. The newly observed degradation occurred in the area between support plates in the upper portion of the hot leg of the tubes. Examination of tubes containing these areas of degradation revealed intergranular attack, accompanied by shallow pits, and located in areas in which a continuous scale deposit was present. From data taken from samples of tubes corroded intergranularly in the laboratory, a 40% through-wall intergranular

defect reported by eddy current measurements is 40 +5% as measured metallographically.

Because of the growth of the intergranular attack between June and July 1974, the licensee plugged all tubes suspected to contain any intergranular attack, as indicated by the size and shape of the signal. The lower limit of detection of this type of attack is considered by the licensee to be below 20% of the tubing wall. All tubes with wastage defects 50% or more of the tubing wall thickness were also plugged.

## II. CHANGE IN WATER CHEMISTRY

The licensee has proposed a shift to an all-volatile treatment of the secondary coolant to arrest the corrosion phenomena. In the July 9, 1974 submittal, Consumers Power estimated that as much as 2000 lbs. phosphates (as  $\text{Na}_2\text{HPO}_4$ ) and 1000 lbs. sulfur (as  $\text{Na}_2\text{SO}_3$ ) remain in each steam generator in some form. A warm water rinse in January 1974 removed 100-200 lbs. phosphate from each steam generator, along with 20 lbs. sulfur compounds and 400 lbs. suspended solids from each, and 23 lbs. copper from the "A" generator. A 400°F rinse, currently underway, had removed 200 lbs. phosphate and 15 lbs. sulfur by August 17. Obviously, much more of these chemicals remains in the generators, which must be removed to arrest the attack and prevent further deterioration of the steam generator tubing.

The licensee and his consultants at Battelle-Columbus laboratories have suggested that the intergranular attack is caused by a mixture of reduced forms of sulfur and sodium phosphates. They believe that the sulfur compounds can be dissolved, or, if in the acid form, volatilized during the 400°F rinse at several low-power operating plateaus during the ascent to power (described below). The soluble phosphorous compounds are also expected to be removed in this way according to the licensee.

### III. PROPOSED STARTUP PROGRAM

Because both the feedwater inlet and the blowdown outlet to the Palisades steam generators are not located directly near the tube sheet,\* adequate stirring or rinsing actions in these steam generators is not feasible without utilizing the steaming process itself. The steaming process, however, may promote deposition (hideout) of phosphates in the high steaming areas. For this reason, the licensee has proposed a step-wise return to power, with frequent reductions in power level to stir up and redissolve the phosphate-sulfide deposits for removal by blowdown. The licensee believes that, with each change (either increase or decrease) in steaming rate, additional phosphorous and sulfur compounds will dissolve or become suspended in the secondary water.

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\*The feedwater actually enters near the top, but is guided to the tube sheet area by shrouds.

Consequently, the licensee proposes a series of power operating "plateaus" in the startup procedure, following isothermal rinses at 400°F, 500°F, and 532°F. At each plateau the startup procedure will be interrupted until as many chemicals are removed as practicable, the power level reduced, and held until more chemicals are removed, and then the power raised to the next higher plateau. Plateaus are planned at 20%, 30%, 40%, 50%, and 60% power. The licensee believes that the 60% plateau needs to be reached to produce good stirring, and has noted that phosphate hideout phenomena and wastage attack were not severe at or below this power level. Once chemicals have been removed and the coolant meets the required specifications for the volatile treatment at this power level, the licensee proposes to continue the ascent to 100% rated power levels, again stepwise at 10% power intervals, with frequent reductions in power level to continue (if necessary) the shakedown of the deposits.

#### IV. SURVEILLANCE PROGRAM AND LEAKAGE DETECTION

Due to the uncertainty associated with detailed chemistry control following the shift from coordinated phosphate treatment to a volatile treatment and with the efficacy of above outlined startup procedure, the licensee will perform a hydrostatic pressure test of the steam generators at steam line break accident pressure differentials just before initiation of power operation. An inservice inspection is also planned not later than 90 efpd's of operation, or 6 months, whichever

comes first following the procedures specified in Regulatory Guide 1.83, "Inservice Inspection of PWR Steam Generators," dated June 1974. This Regulatory Guide states that:

"Every inspection subsequent to the baseline inspection should include all tubes which previously had defect indications (not including plugged tubes) and should also consider tubes in those areas (including the cold-leg side) where design and experience have indicated potential problems."

The licensee further states that a second inservice inspection following the positions in this Regulatory Guide will be performed at the next scheduled refueling outage, which will occur approximately 6 months after the first reinspection.

If a tube failure occurs prior to the first scheduled surveillance period, but subsequent to bringing the plant to power following the present outage, the licensee will perform an inspection in accordance with Regulatory Guide 1.83 unless sufficient information can be presented to gain AEC approval of alternative measures. If a tube failure occurs during the hot flush or during the leak test following the hot flush, and its cause is the rupture of an area with intergranular attack, the failure will be plugged, a retest conducted, and the plant prepared for ascent to the licensed power level.

The applicant has stated that primary-to-secondary leakage is readily detectable by the continuous gas monitor on the steam jet air ejector which will be set to alarm at 0.05 gpm primary-to-secondary leakage. The 0.05 gpm setting is based on previously experienced Xenon-133 concentrations in the primary coolant system at 100% power. During the initial start-up, however, until equilibrium Xenon-133 at 100% power is reached, the sensitivity of this alarm will not be as low as 0.05 gpm. To supplement this leakage detection monitor, grab samples will be taken daily and analyzed for primary-to-secondary leakage. Experience has shown that leakages approximately three gallons per day can be detected from these grab samples. From Iodine-131 measurements, a leakage rate of 150 gallons per day can be quantified in a six-hour sampling period following detection of the leakage.

V. REGULATORY EVALUATION

The Regulatory staff's evaluation of structural adequacy of Palisades steam generator tubes was performed in two parts:

- A. Evaluation of the steam generator tube integrity assuming arrested tube degradation, and
- B. Evaluation of possible further degradation of the material and its potential effect on steam generator tube integrity.

A. Evaluation of Steam Generator Tube Integrity

The Regulatory staff recommended to the licensee the conduct of an experimental program, including laboratory burst tests on artificially wasted tubes, to establish levels of tube degradation that would not compromise the capability of the Palisades steam generators to withstand the design basis loadings specified in the Palisades FSAR. The results of the experimental test program were submitted to the AEC by Consumers Power letters dated December 21, 1973 and February 15, 1974 in Report CEN-2(P) prepared by Combustion Engineering.

Characterization of the wasted areas for the experimental program was accomplished by removing tubes containing previously measured wastage from the Palisades "B" steam generator. The wasted portions of these tubes were set up in a test apparatus and pressurized to the bursting point. Concurrent with this effort, segments of nonwasted steam generator tubes were artificially wasted using discharge machining techniques to duplicate the configuration of typical tube wastage. After establishing good correlation between the bursting characteristics of the artificially wasted tubes and the actual wasted tubes, a burst testing program was initiated. Data from the tests of artificially wasted tubes were correlated with data obtained from several hundred burst tests to assure statistically significant results. Measured

burst pressures were recorded and analyzed for average and minimum burst pressures including lot-to-lot variations in tube materials at both room temperature and at 600°F.

The experimental program demonstrated that tubes with significant wastage still retain a substantial margin between burst pressure and the 1090 psi differential operating pressure (1800 psi primary side and 710 secondary side) established for resumption of steam generator service in the Palisades plant. For example, tubes with wastage of sixty-five percent were shown to have a minimum burst pressure of 7000 psi and tubes with wastage of seventy percent were shown to have a minimum burst pressure of 5400 psi. These values are considerably greater than a factor of 3 above the differential operating pressure of 1090 psi, as well as under a postulated loading of 1800 psi on primary side (corresponding to operating pressure of reactor coolant pressure boundary) and no loading on secondary side.

The burst test program also provided the data necessary to evaluate the maximum wastage consistent with meeting the service requirements defined by design bases for the Palisades steam generator tubes. Analyses performed by Combustion Engineering, Inc. demonstrated that the maximum allowable wastage would be seventy-three percent to meet the requirements for normal operation and seventy-five percent to withstand the loads that

would result from the postulated loss-of-coolant accident.

These values were determined on the basis of design stress limits specified in Section III of the ASME Boiler and Pressure Vessel Code for the tube materials used in the Palisades steam generator.

The Combustion Engineering analyses included a minimum reinforcement factor of 1.33 as determined from the burst test data. The reinforcement factor is the ratio of the calculated stress for a tube of uniform wall thickness equal to the remaining thickness at a wasted tube area to the calculated stress for the tube containing a localized thinning as derived from the burst test data. This reinforcement effect is attributed to the ability of the non-degraded material surrounding the wasted area to share an increased proportion of the load on the tube wall.

An independent analysis was performed by the Regulatory staff to assist in evaluating the acceptability of the Palisades steam generator tubes for continued service. The analysis was made for the conservative and limiting case of a tube with a local reduction of fifty percent along the entire tube length in contrast to the limited and distributed wastage found in the Palisades steam generator tubes. The results of the staff analysis show that the maximum stress levels for the limiting case do not exceed the elastic range (i.e., below the minimum yield strength) of the tube materials under the differential pressure range of

operating conditions. In consequence, the tubes with fifty percent wastage or less may be expected to experience only small elastic strains in service.

The Regulatory staff has taken the position that the tube plugging criterion applied to the Palisades steam generators for continued service should assure that (1) the tubes with detected wastage acceptable for service will not be stressed during the full range of normal reactor operation beyond the elastic range of tube material and (2) the factor of safety against failure by bursting under normal operating conditions is not less than 3 at any tube location where wastage has been detected. The factor of safety of 3 against ductile failure is consistent with the margin incorporated in the design rules of the ASME Code, Section III, under which rules the Palisades steam generators were built.

The licensee's analyses supplemented by an independent Regulatory staff analysis discussed above, supports the conclusion that the tube plugging criterion of 50 percent, provides, for this case of the Palisades steam generators, an adequate margin to assure operation of tubes with 50 percent or less wastage in the elastic range of material under loadings associated with normal operating conditions. The burst test program results demonstrate that the factor of safety against tube bursting for tubes with not more than 50 percent wastage is greater than 3 (as required by

Regulatory staff position) by a margin considered adequate to take into account uncertainties associated with the detection threshold of eddy current measurement techniques used, material property variations, and a limited degree of additional wastage which might occur before the isothermal flushing program proposed by the licensee is completed. The safety margin that is still available in the wasted tubes results, in large measure, from the fact that new steam generator tubes were manufactured with a wall thickness much greater than minimum thickness required by the design rules of ASME Code Section III. Numerous factors including fabrication procedures, installation and handling requirements, and standard tube sizes dictate the need to use tubes with heavier initial wall thickness than required by design rules.

The licensee's fifty percent tube plugging criterion is considered acceptable for continued service of the Palisades steam generators provided the requirements of Regulatory Guide 1.83 will be met at the next scheduled inservice inspection of the tubes. Although tube degradation during service has reduced the margins that were available at the beginning of plant life at Palisades, the tests and analyses performed confirm that margins adequate for continued service are still available provided that further tube degradation is arrested, by the licensee's isothermal flushing program

as must be confirmed by the next scheduled inservice inspection of the Palisades steam generator tubing.

B. Degradation of Tube Material

To assess the probable extent of further degradation of the tube material and its potential effect on plant safety during the proposed period of operation, the staff has reviewed the effect of change in water chemistry, the start-up program, and the surveillance program proposed by the licensee.

We agree with the licensee that the proposed volatile water chemistry treatment should substantially reduce, and may completely arrest, the wastage phenomena previously experienced in this plant. Our opinion is based on the conclusion of the Battelle report and on the available empirical data.

The Battelle report concludes that the "safest" fix at this time appears to be a switch to volatile chemistry with a 400°F isothermal flush at the next start-up. Pot boiler test performed by Combustion Engineering have shown that wastage attack can be arrested by converting from a phosphate to a volatile secondary water chemistry. Similar experience of a more nearly comparable nature has been obtained with the Shippingport reactor.

The licensee realizes that while the pot boiler laboratory tests are reassuring, the internals of a pot boiler do not duplicate

the conditions within the internals of the secondary side of a steam generator. With more complex internals, more sludge deposits develop which contain both phosphate and sulfur compounds. Special start-up procedures, therefore, have been developed to maximize the removal rate of phosphates and sulfur compounds.

Postoperating experience has shown that agitation of the secondary water through steaming of the steam generators is necessary to cause deposited compounds to be removed from their "hideout" state and become suspended or dissolved in the circulating feedwater. Some of these compounds will dissolve with heatup to about 400°F. Experience shows that with each change in steaming rate, additional amounts of phosphate and sulfur compounds will dissolve or become suspended in the feedwater. We concur with the licensee that these procedures should be implemented as soon as possible, since eddy-current-testing (ECT) has verified that corrosion attack continues with the steam generators in a cold shutdown condition.

While the change from coordinated phosphate to volatile chemistry control, combined with the isothermal flushing, should significantly reduce the observed corrosion rates, we believe that there is some probability of tubes with intergranular corrosion remaining unplugged. This condition could occur as a result of the approximately 20% detection threshold of eddy-current-testing

technique used and significant corrosion rates for intergranular attack observed in the cold shutdown condition.

To verify that the corrosion has been arrested, the licensee has proposed a surveillance and leakage detection program, described in Section IV above. The surveillance program calls for inspection intervals somewhat shorter than those recommended in Regulatory Guide 1.83 (issued June 1974) for the initial two inspections, although tube sampling and acceptance criteria recommended in Regulatory Guide 1.83 will be implemented. Subsequent inspections will fully conform to Regulatory Guide 1.83. The staff has reviewed the proposed surveillance program, including leakage detection methods, and believes that the program will provide an acceptable means to verify that corrosion has been arrested, or to identify any additional corrosion, should it occur, in a timely manner.

#### VI. CONCLUSIONS

Based on the observation that corrosion attack continues in the Palisades steam generator tubes while in a cold shutdown condition, and on the reasonable assurance that the change from coordinated phosphate to volatile chemistry control should arrest the corrosion attack, the Regulatory staff concurs with the licensee that it is advisable to return the plant to operation as soon as practicable.

Based on a detailed evaluation of the steam generator tube integrity and of the potential for continuing degradation of the tube material, the Regulatory staff concludes that the Palisades steam generators are acceptable for continued operation provided the requirements specified in the Regulatory Position of Section VII this report are met.

Specifically, the staff's evaluation has concluded that:

1. Stresses in the thinned regions of the steam generator tube walls accepted for service by the licensee's plugging criterion will be maintained below the code design stress limits during normal operation, transient or design basis accident conditions, by acceptable margins, and the factor of safety against tube bursting is greater than 3 under normal operation and transient conditions.
2. There is reasonable assurance that the secondary side water treatment program will reduce and eventually eliminate the cause of the observed tube corrosion.
3. Demonstrated capability exists to detect small amounts of steam generator tube leakage, to permit timely action should an unexpected increase in tube degradation develop in service.

4. Short-term surveillance program has the capability to verify that corrosion has been arrested, or to identify any additional corrosion, should it occur.

Our conclusions are based on the results of the burst and collapse pressure tests performed by Combustion Engineering both on simulated defects and on actual tubes removed from the Palisades plant, on the corrosion tests performed by Combustion Engineering, using the proposed volatile chemistry, on the testing and leakage surveillance program proposed by the applicant, and on the fact that the tube bundle can withstand loads associated with design basis accidents.

Further, the staff believes that the probability of intergranular defects causing service induced failures is low, for the following reasons:

- a. Eddy-current-testing (ECT) is believed to be sufficient sensitive to detect intergranular attack at the same level that it detects wastage attack ( $\leq 20\%$  reduction).
- b. All tubes having known intergranular ECT indications have been plugged.
- c. Undetected defects (under 20% reduction) should be arrested by the current high-temperature flush.

- d. The 1850 psia pressure test conducted prior to and after the hot flush produced no leaks.

## VII. REGULATORY POSITION

The Palisades steam generators, under the conditions where the structural integrity of some tubes having localized thinning up to 50 percent of the original wall thickness are acceptable for continued service provided that:

1. the normal operating primary pressure is reduced from 2100 psi to 1800 psi,
2. the limiting overpressure protection safety system setting for high primary system pressure is reduced from 2400 psi to 1950 psi,
3. the maximum differential pressure between primary and secondary side of steam generator tubes under normal operation is limited to approximately 1090 psi, and under upset operating transients, to 1530 psi,
4. the hydrostatic test pressures on both primary and secondary side are reduced to reflect the revised operating pressures, and the testing requirements of Section XI of the ASME Boiler and Pressure Vessel Code, (1971 Edition),

5. the inservice inspection program for the steam generator tubes conforms with the requirements of Regulatory Guide 1.83, "Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes," (issued June 1974).

UNITED STATES ATOMIC ENERGY COMMISSION

DOCKET NO. 50-255

CONSUMERS POWER COMPANY

NOTICE OF ISSUANCE OF AMENDMENT TO PROVISIONAL OPERATING LICENSE  
AND NOTICE OF PROPOSED ISSUANCE OF  
AMENDMENT TO PROVISIONAL OPERATING LICENSE

Notice is hereby given that the U.S. Atomic Energy Commission (the Commission) has issued Amendment No. 10 (the interim amendment) and is considering the issuance of a further amendment (the proposed permanent amendment) revising Technical Specifications for operation of the Palisades Nuclear Generating Plant (the facility) located in Covert Township, Van Buren County, Michigan.

On August 11, 1973, the facility was shut down because of excess steam generator leakage. Subsequent investigations by the licensee disclosed that the leakage was caused by steam generator tube corrosion which was, in turn, caused by sulphur and phosphate salts theretofore utilized by the licensee for steam generator water chemistry control. As a result of its investigations and analyses, the licensee adopted a program involving (1) plugging of damaged tubes in accordance with a specified plugging criterion, (2) removal of the corrodents through a flushing program, and (3) implementation of a different method of water chemistry control. The plugging of damaged tubes has been completed, and the removal of corrodents and the change in the method of water chemistry control are in progress.

The licensee has stated, and the Directorate of Regulation has determined, that the corrodent flushing program should proceed without delay in the interest of arresting the corrosion process with minimum additional damage.

The interim amendment, which was made effective upon issuance and will remain in effect for a limited period of 90 days from the date of issuance, revises the Technical Specifications by reducing allowable primary system pressure limits and differential pressure limits and by incorporating an augmented inservice inspection program for steam generators. The interim amendment imposes further a limitation of 60% on the maximum core power level.

The interim amendment authorizes the licensee to conduct the corrodent flushing program subject to the Technical Specifications, as revised. The licensee has represented that in keeping with the limited objective (flushing of corrodents) of initial operation, the facility will be operated substantially in accordance with guidelines which provide for an ascent from lower to higher power levels as the concentrations of the corrodents are reduced; limit cumulative operation at power plateaus above a nominal 30% power level; and require cycling of power levels such that periods of operation above a nominal 30% power level will be followed by periods of operation at levels not exceeding a nominal 30%.

The application for interim amendment, dated August 28, 1974, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations. The Commission has made, with respect to the interim amendment, appropriate findings as required by the Act and the Commission's rules and regulations in 10 CFR Chapter 1. These findings are set forth in the interim amendment.

The proposed permanent amendment would revise the Technical Specifications as appropriate to permit completion of the flushing program and, following a required shutdown and inspection, a return to normal facility operation. The proposed permanent amendment, if adopted in the form requested by the licensee in its application dated August 20, 1974, would be substantially identical to the interim amendment, excluding the 90-day and 60%-power limitations set forth therein.

Prior to the issuance of the proposed amendment, the Commission will have made the findings required by the Act and the Commission's regulations.

By October 9, 1974, the licensee may file a request for a hearing and any person whose interest may be affected by this proceeding may file a petition for leave to intervene. Requests for a hearing and petitions for leave to intervene shall be filed in accordance with the Commission's "Rules of Practice" in 10 CFR Part 2. If a request for a hearing or a petition for leave to intervene is filed within the time prescribed in this notice, the Commission will issue a notice of hearing or an appropriate order.

For further details with respect to this action, see (1) the licensee's Request for Change to the Technical Specifications dated August 20, 1974, and its letter to the Directorate of Licensing dated August 28, 1974, requesting interim Technical Specifications, (2) Amendment No. 10 to License No. DPR-20, with any attachments, and (3) the Commission's related Safety Evaluation. All of these items are available for public inspection at the Commission's Public Document Room, 1717 H Street, NW., Washington, D.C. and at the Kalamazoo Public Library, 315 South Rose Street, Kalamazoo, Michigan. As it becomes available, the Commission's Safety Evaluation related to operation beyond the 90-day interim period will be available at the above locations.

A copy of items (2) and (3), and of the Safety Evaluation related to operation beyond the 90-day interim period, when available, may be obtained upon request addressed to the U.S. Atomic Energy Commission, Washington, D.C. 20545, Attention: Deputy Director for Reactor Projects, Directorate of Licensing - Regulation.

Dated at Bethesda, Maryland, this **AUG 30 1974**

FOR THE ATOMIC ENERGY COMMISSION

Original signed by:  
**Robert A. Purple**

Robert A. Purple, Chief  
Operating Reactors Branch #1  
Directorate of Licensing

Amdt 8  
8/19/74  
Amdt 10  
8/30/74

PRELIMINARY DETERMINATION - NOTICING OF PROPOSED LICENSE AMENDMENT

Licensee: Consumers Power Company

Facility: Palisades Plant Docket No: 50-255

Request for: Changes to the Interim Special Technical Specifications  
for the Palisades Plant that would allow the use of a single, fresh  
fuel assembly in place of one that was damaged during a recent outage.

Request Date: April 18, 1974

- Recommended action: ( ) Pre-notice  
( x ) Post-notice  
( ) Determination delayed pending completion of Safety Evaluation

Basis for Recommendation: The change represents a core reloading of a single fuel assembly not significantly different from those used and analyzed for the previous core, there are no changes needed in the bases to the Technical Specifications, and the analytical methods used to demonstrate conformance with the bases were unchanged.

Concurrences				Approval	
OFFICE →	LPM <i>J</i>	BC <i>[Signature]</i>	AD/OR <i>KRG</i>	OGC <i>[Signature]</i>	DD/RF <i>[Signature]</i>
SURNAME →	DScott:dc	RAPurple	KRGoller		AGiambusso
DATE →	7/30/74	7/30/74	7/30/74	8/11/74	8/2/74