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REDUNDANT DECAY HEAT REMOVAL CAPABILITY, PALISADES NUCLEAR POWER PLANT

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NRC Research and/or Technical Assistance Report

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PRELIMINARY

U.S. Department of Energy
Idaho Operations Office • Idaho National Engineering Laboratory

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INTERIM REPORT

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PALISADES NUCLEAR POWER PLANT

April 1982

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Reliability and Statistics Branch
Engineering Analysis Division
EG&G Idaho, Inc.

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ABSTRACT

This EG&G Idaho, Inc. report reviews the technical specifications to establish the redundancy and the diversity of systems available for the removal of decay heat at the Palisades Nuclear Power Plant.

FOREWORD

This report is supplied as part of the "Selected Operating Reactor Issues Program (III)" being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Licensing, by EG&G Idaho, Inc., Reliability and Statistics Branch.

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REDUNDANT DECAY HEAT REMOVAL CAPABILITY

PALISADES NUCLEAR POWER PLANT

1.0 INTRODUCTION

A number of events have occurred at operating Pressurized Water Reactor (PWR) facilities where decay heat removal capability has been seriously degraded due to inadequate administrative controls during shutdown modes of operation. One of these events, described in IE Information Notice 80-20,[1] occurred at the Davis-Besse Station, Unit No. 1, on April 19, 1980. In IE Bulletin 80-12[2] dated May 9, 1980, licensees were requested to immediately implement administrative controls which would ensure that proper means are available to provide redundant methods of decay heat removal. While the function of the bulletin was to effect immediate action with regard to this problem, the NRC considered it necessary that an amendment be made to each license to provide for permanent long term assurance that redundancy in decay heat removal capability will be maintained. By the letter dated June 11, 1980,[3] all PWR licensees were requested to propose technical specification changes that provide for redundancy in decay heat removal capability in all modes of operation; to use the NRC model technical specifications to provide an acceptable solution to the concern; to include an appropriate safety analysis as a basis; and to submit the proposed technical specification changes along with the basis by October 11, 1980.

Consumers Power Company (CPCo) responded to IE Bulletin 80-12 on August 1, 1980.[4] On October 16, 1980,[5] CPCo determined that technical specification changes were not needed to provide for redundancy of the decay heat removal capability for all modes of operation of the Palisades Nuclear Power Plant.

2.0 REVIEW CRITERIA

The review criteria for this task are contained in the June 11, 1980 letter from the NRC to all PWR licensees. The NRC provided the model technical specifications[6] which identify the normal required redundant coolant

system and the required actions when redundant systems are not available for a typical two loop plant (Appendix A). The general review criteria are:

1. Two independent methods for decay heat removal are required in the units' technical specifications for each operating mode.

2. Periodic surveillance requirements should insure the operability of the systems.

The specific sections of the Standard Technical Specifications[6] for a Combustion Engineering unit that apply to this task are as follows:

3/4.4	Reactor Coolant System
3/4.4.1	Reactor Coolant System and Coolant Circulation

Startup and Power Operation (modes 1 & 2)

3.4.1.1	Limiting Conditions for Operation
4.4.1.1	Surveillance Requirement

Hot Standby (mode 3)

3.4.1.2	Limiting Conditions for Operation
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4.4.1.3.4	Surveillance Requirement

Refueling Operations (mode 6)

3.9.8.1	Limiting Condition for Operation
3.9.8.2	Limiting Condition for Operation
4.9.8.1	Surveillance Requirement
4.9.8.2	Surveillance Requirement

3.0 DISCUSSION AND EVALUATION

The Palisades Nuclear Power Plant is a two primary coolant loop Combustion Engineering PWR unit with 2 reactor coolant pumps per loop. Due to plant design, the existing technical specifications for this unit vary from the NRC model developed from Westinghouse standard technical specifications. The following discussion reviews the differences between the two different technical specifications (Standard and Palisades).

3.1 Startup and Power Operation--Modes 1 and 2

The model technical specifications require that both reactor coolant loops and all coolant pumps be operational. If these conditions are not met, the reactor is to be in Hot Standby (Mode 3) within 1 hour. The model technical specifications require verification that the required reactor coolant loops are in operation at least once per 12 hours.

The Palisades technical specifications require the operation of four reactor coolant pumps (except when 2 or 3 pump operation is permitted by Table 2.3.1, item 1) whenever the reactor is operated continuously at above 5% of rated power. Both steam generators are to be operable whenever the primary coolant is above 325°F. However, there is no requirement to verify operation of the reactor coolant pumps or the operability of the steam generators. Additionally, the Palisades technical specification permit 24 hours operation to restore the inoperable pump(s) before that Standby (Mode 3) is required, rather than 1 hour permitted in the model technical specifications.

3.2 Hot Standby--Mode 3

The model technical specifications require two coolant loops and at least one associated coolant pump for each loop to be operable and at least one of the coolant loops to be in operation during this operating mode.[a] If the two coolant loops are not operable and cannot be restored to operable status in 72 hours, the model technical specifications require the unit to be in Hot Shutdown (Mode 4 & 5) in 12 hours, suspend all operations involving a reduction in boron concentration in the coolant system and to initiate corrective action to return the inoperable coolant loop to operation. The model technical specifications require verification that at least one coolant pump is operable once per 7 days and at least one cooling loop is in operation at least once per 12 hours.

The Palisades technical specifications require both steam generators to be operable during this mode of operation. There is no requirement that any reactor coolant pump be operating if there is no change being made in the boron concentration of the reactor coolant. If the boron concentration is changing, one reactor coolant pump is required to be operating. This agrees with the model technical specifications. There is no requirement to verify operation of a reactor coolant loop or to verify the operable status of the non-operating pumps or of the steam generators, or to return a loop to operation if neither loop is operating.

3.3 Shutdown--Modes 4 & 5[b]

The model technical specifications for the shutdown modes require at least two loops that are capable of removing decay heat to be operable. Either the two reactor coolant loops (including at least one of their

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a. All reactor coolant pumps may be de-energized for up to 1 hour provided (1) no operations are permitted that would cause dilution of the reactor coolant system boron concentration, and (2) core outlet temperature is maintained at least 10°F below saturation temperature.

b. A reactor coolant pump shall not be started with one or more of the RCS cold leg temperatures less than or equal to (275°F) unless: (1) the pressurizer water volume is less than (900) cubic feet or (2) the secondary water temperature of each steam generator is less than (46)°F above each of the RCS cold leg temperatures.

associated coolant pumps and their associated steam generators) or the two shutdown cooling loops or one loop of each type must be operable.[a] The technical specifications also require one of the above loops to be operating.[b] If this criteria is not met and immediate corrective action does not restore the loop(s) to operable or operational status, the reactor is to be in Cold Shutdown within 20 hours and reduction of boron concentration operations are to be suspended (if no loop is in operation).

The Palisades technical specifications require both steam generators to be operable in mode 4, but not in mode 5. It is not clear that the steam generators are required in the transition from mode 5 to mode 4. However, they are required when the average reactor coolant temperature is greater than 325°F. Further requirements for these modes are that at least one primary coolant pump or one shutdown cooling pump be in operation, but only when a change in the boron concentration of the reactor coolant is being made. Safe shutdown heat exchangers are not required to be operable when using a shutdown cooling pump. Again, technical specifications do not verify operable status of the equipment or operation of the operating cooling loops.

3.4 Refueling--Mode 6

The model technical specifications require at least one shutdown cooling loop to be in operation. This is to be verified every 12 hours. With less than one shutdown cooling loop in operation, an increase in decay heat load is not permitted, nor is a reduction of boron concentration in the reactor coolant permitted. An exception is permitted for certain core alterations, where the shutdown coolant loop may be removed from operation for one hour out of an eight hour period. All containment atmosphere to outside atmosphere penetrations (purge and vent valves) must be closed within 4 hours of the loss of the required shutdown cooling loop. In this

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a. The normal or emergency power source may be inoperable in MODE 5.

b. All reactor coolant pumps and shutdown cooling pumps may be de-energized for up to 1 hour provided: (1) no operations are permitted that would cause dilution of the reactor coolant system boron concentration, and (2) core outlet temperature is maintained at least 10°F below saturation temperature.

mode, both shutdown cooling loops are to be determined to be operable whenever the water level above the top of the reactor pressure vessel flange is less than 23 feet, with immediate corrective action required if one loop is not operable.

The Palisades technical specifications require at least one shutdown cooling loop to be in operation for this mode of operation. The reactor coolant is required to be sampled once per shift to measure and maintain the boron concentration. There are appropriate action statements if these conditions are not met, however, there are no verification requirements on the operating shutdown cooling loop, or the operable status of both shutdown cooling loops.

It should be noted that the Palisades Nuclear Power Plant does not have two completely independent shutdown cooling loops. Either pump can utilize either heat exchanger, or the heat exchanger can be bypassed. Additionally, other lineups are available to effect Decay Heat Removal that are not covered by technical specification.[5] CPCo has not proposed technical specification amendments to insure redundancy in decay heat removal capability.

4.0 CONCLUSION

CPCo has not proposed modifications to techncial specifications. The existing technical specifications for the Palisades Nuclear Power Plant do not ensure redundancy in decay heat removal capacity for all modes of reactor operation.

5.0 REFERENCES

1. NRC IE Information Notice 80-20, May 9, 1980.
2. NRC IE Bulletin 80-12, May 9, 1980.
3. NRC Letter, D. G. Eisenhut, To All Operating Pressurized Water Reactors (PWR's), dated June 11, 1980.

4. CPCo Letter, D. P. Hoffman to J. G. Keppler, Region III, NRC, "IE Bulletin 80 12--Decay Heat Removal System," August 1, 1980.

5. CPCo Letter, D. P. Hoffman to Director of Nuclear Reactor Regulation, NRC, "Decay Heat Removal Technical Specification Changes," October 16, 1980.

6. Standard Technical Specifications for Combustion Engineering Pressurized Water Reactors, NUREG-0212, Rev. 1, Fall 1980.

7. Consumer Power Company, "Palisades Technical Specifications," Amendment 51, September 10, 1979.

APPENDIX A

MODEL TECHNICAL SPECIFICATIONS FOR REDUNDANT DECAY HEAT REMOVAL FOR COMBUSTION ENGINEERING PRESSURIZED WATER REACTORS (PWR's)

3/4.4 REACTOR COOLANT SYSTEM

3/4.4.1 REACTOR COOLANT LOOPS AND COOLANT CIRCULATION

STARTUP AND POWER OPERATION

LIMITING CONDITION FOR OPERATION

3.4.1.1 Both reactor coolant loops and both reactor coolant pumps in each loop shall be in operation.

APPLICABILITY: 1 and 2.*

ACTION:

With less than the above required reactor coolant pumps in operation, be in at least HOT STANDBY within 1 hour.

SURVEILLANCE REQUIREMENT

4.4.1.1 The above required reactor coolant loops shall be verified to be in operation and circulating reactor coolant at least once per 12 hours.

* See Special Test Exception 3.10.3.

REACTOR COOLANT SYSTEM

HOT STANDBY

LIMITING CONDITION FOR OPERATION

3.4.1.2 a. The reactor coolant loops listed below shall be OPERABLE:

1. Reactor Coolant Loop (A) and at least one associated reactor coolant pump,

2. Reactor Coolant Loop (B) and at least one associated reactor coolant pump,

b. At least one of the above Reactor Coolant Loops shall be in operation.*

APPLICABILITY: MODE 3

ACTION:

a. With less than the above required reactor coolant loops OPERABLE, restore the required loops to OPERABLE status within 72 hours or be in HOT SHUTDOWN within the next 12 hours.

b. With no reactor coolant loop in operation, suspend all operations involving a reduction in boron concentration of the Reactor Coolant System and immediately initiate corrective action to return the required loop to operation.

SURVEILLANCE REQUIREMENT

4.4.1.2.1 At least the above required reactor coolant pumps, if not in operation, shall be determined to be OPERABLE once per 7 days by verifying correct breaker alignments and indicated power availability.

4.4.1.2.2 At least one cooling loop shall be verified to be in operation and circulating reactor coolant at least once per 12 hours.

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* All reactor coolant pumps may be de-energized for up to 1 hour provided (1) no operations are permitted that would cause dilution of the reactor coolant system boron concentration, and (2) core outlet temperature is maintained at least 10°F below saturation temperature.

REACTOR COOLANT SYSTEM

SHUTDOWN

LIMITING CONDITION FOR OPERATION

3.4.1.3 a. At least two of the coolant loops listed below shall be OPERABLE:

1. Reactor Coolant Loop (A) and its associated steam generator and at least one associated reactor coolant pump,

2. Reactor Coolant Loop (B) and its associated steam generator and at least one associated reactor coolant pump,

3. Shutdown Cooling Loop (A)#

4. Shutdown Cooling Loop (B)#

b. At least one of the above coolant loops shall be in operation.*

APPLICABILITY: MODES 4** and 5**

ACTION:

a. With less than the above required loops OPERABLE, immediately initiate corrective action to return the required coolant loops to OPERABLE status as soon as possible; be in COLD SHUTDOWN within 20 hours.

b. With no coolant loop in operation, suspend all operations involving a reduction in boron concentration of the Reactor Coolant System and immediately initiate corrective action to return the required coolant loop to operation.

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* All reactor coolant pumps and decay heat removal pumps may be de-energized for up to 1 hour provided (1) no operations are permitted that would cause dilution of the reactor coolant system boron concentration, and (2) core outlet temperature is maintained at least 10°F below saturation temperature.

** A reactor coolant pump shall not be started with one or more of the RCS cold leg temperatures less than or equal to (275)°F unless (1) the pressurizer water volume is less than 900 cubic feet or (2) the secondary water temperature of each steam generator is less than 46°F above each of the RCS cold leg temperatures.

The normal or emergency power source may be inoperable in MODE 5.

SURVEILLANCE REQUIREMENT

4.4.1.3.1 The required residual heat removal loop(s) shall be determined OPERABLE per Specification 4.0.5.

4.4.1.3.2 The required reactor coolant pump(s), if not in operation, shall be determined to be OPERABLE once per 7 days by verifying correct breaker alignments and indicated power availability.

4.4.1.3.3 The required steam generator(s) shall be determined OPERABLE by verifying secondary side water level to be greater than or equal to ( )% at least once per 12 hours.

4.4.1.3.4 At least one coolant loop shall be verified to be in operation and circulating reactor coolant at least once per 12 hours.

REFUELING OPERATIONS

3/4.9.8 RESIDUAL HEAT REMOVAL AND COOLANT CIRCULATION

ALL WATER LEVELS

LIMITING CONDITION FOR OPERATION

3.9.8.1 At least one shutdown loop shall be in operation.

APPLICABILITY: MODE 6

ACTION:

a. With less than one shutdown cooling loop in operation, except as provided in b. below, suspend all operations involving an increase in the reactor decay heat load or a reduction in boron concentration of the Reactor Coolant System. Close all containment penetrations providing direct access from the containment atmosphere to the outside atmosphere within 4 hours.

b. The shutdown cooling loop may be removed from operation for up to 1 hour per 8 hour period during the performance of CORE ALTERATIONS in the vicinity of the reactor pressure vessel hot legs.

c. The provisions of Specification 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENT

4.9.8.1 At least one shutdown cooling loop shall be verified to be in operation and circulating reactor coolant at a flow rate of greater than or equal to (3000) gpm at least once per 4 hours.

REFUELING OPERATIONS

LOW WATER LEVEL

LIMITING CONDITION FOR OPERATION

3.9.8.2 Two independent shutdown cooling loops shall be OPERABLE.*

APPLICABILITY: MODE 6 when the water level above the top of the irradiated fuel assemblies seated within the reactor pressure vessel is less than 23 feet.

ACTION:

a. With less than the required shutdown cooling loops OPERABLE, immediately initiate corrective action to return loops to OPERABLE status as soon as possible.

b. The provisions of Specification 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENT

4.9.8.2 The required shutdown cooling loops shall be determined OPERABLE per Specification 4.0.5.

* The normal or emergency power source may be inoperable for each shutdown cooling loop.

BASES

3/4.4.1 REACTOR COOLANT LOOPS AND COOLANT CIRCULATION

The plant is designed to operate with both reactor coolant loops and associated reactor coolant pumps in operation, and maintain DNBR above 1.30 during all normal operations and anticipated transients.

In MODE 3, a single reactor coolant loop provides sufficient heat removal capability for removing decay heat; however, single failure considerations require that two loops be OPERABLE.

S 4 and 5, a single reactor coolant loop or shutdown cooling loop ..ides sufficient heat removal capability for removing decay heat; but single failure considerations require that at least two loops be OPERABLE. Thus, if the reactor coolant loops are not OPERABLE, this specification requires two shutdown cooling loops to be OPERABLE.

The operation of one Reactor Coolant Pump or one shutdown cooling pump provides adequate flow to ensure mixing, prevent stratification and produce gradual reactivity changes during boron concentration reductions in the Reactor Coolant System. The reactivity change rate associated with boron reductions will, therefore, be within the capability of operator recognition and control.

The restrictions on starting a Reactor Coolant Pump during MODES 4 and 5 with one or more RCS cold legs less than or equal to (275)°F are provided to prevent RCS pressure transients, caused by energy additions from the secondary system, which could exceed the limits of Appendix G to 10 CFR Part 50. The RCS will be protected against overpressure transients and will not exceed the limits of Appendix G by either (1) restricting the water volume in the pressurizer and thereby providing a volume for the primary coolant to expand into, or (2) by restricting starting of the RCPs to when the secondary water temperature of each steam generator is less than (46)°F above each of the RCS cold leg temperatures.

3/4.9.8 COOLANT CIRCULATION

The requirement that at least one shutdown cooling loop be in operation ensures that (1) sufficient cooling capacity is available to remove decay heat and maintain the water in the reactor pressure vessel below 140°F as required during the REFUELING MODE, and (2) sufficient coolant circulation is maintained through the reactor core to minimize the effect of a boron dilution incident and prevent boron stratification.

The requirement to have two shutdown cooling loops OPERABLE when there is less than 23 feet of water above the core, ensures that a single failure of the operating shutdown cooling loop will not result in a complete loss of decay heat removal capability. With the reactor vessel head removed and 23 feet of water above the core, a large heat sink is available for core cooling, thus, in the event of a failure of the operating shutdown cooling loop, adequate time is provided to initiate emergency procedures to cool the core.