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TECHNICAL SPECIFICATIONS FOR REDUNDANT DECAY HEAT REMOVAL CAPABILITY, THREE MILE ISLAND, UNIT NO. 1 (TMI-1)

NRC Research and/or Technical Assistance Rept

F. G. Farmer

PRELIMINARY

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

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INTERIM REPORT

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TECHNICAL SPECIFICATIONS FOR REDUNDANT DECAY HEAT REMOVAL CAPABILITY

THREE MILE ISLAND, UNIT NO. 1 (TMI-1)

Docket No. 50-289

April 1982

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

TAC No. 42127

ABSTRACT

In response to the D. G. Eisenhut letter dated June 11, 1980, GPU Nuclear replied that existing TMI-1 Technical Specifications are adequate and no new Technical Specifications are necessary to increase awareness of Decay Heat Removal system availability.

FOREWORD

This report is supplied as part of the "Selected Operating Reactors 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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TECHNICAL SPECIFICATIONS FOR REDUNDANT DECAY HEAT REMOVAL CAPABILITY

THREE MILE ISLAND, UNIT NO. 1 (TMI-1)

1.0 INTRODUCTION

A number of events have occurred at operating PWR facilties 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, Unit No. 1 plant, 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 of each license be made to provide for permanent long-term assurance that redundancy in decay heat removal capability will be maintained. By letter dated June 11, 1980,[3] all PWR licensees were requested to propose Technical Specifications (TS) changes that provide for redundancy in decay heat removal capability in all modes of operation; use the NRC model TS which provide an acceptable solution of the concern and include an appropriate safety analysis as a basis; and submit the proposed TS with the basis by October 11, 1980.

GPU Nuclear has proposed that the existing TMI-1 TS provide adequate redundancy in decay heat removal capability and do not require revision.[4]

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 (MTS)[5] which identify the normal required redundant coolant systems 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 plant TS for each operating mode.

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

3.0 DISCUSSION AND EVALUATION

Three Mile Island, Unit 1, is a two-loop, Babcock and Wilcox (B&W) PWR plant. The TMI-1 TS differ in format from the Nuclear Regulatory Commissions (NRC) MTS for B&W PWRs. Limiting conditions for operation start with Section 3 of the TMI-1 TS. Section 3 does not delineate the limiting conditions by applicable modes as in the MTS. The modes identified in this report are based on definitions found in Section 1 of TMI-1 TS. Similarly, section 4 of the TMI-1 TS do not define the surveillance requirements based on applicable modes.

3.1 Startup and Power Operation--Modes 1 and 2 ($T_{operating}$)

The TMI-1 TS require that both reactor coolant loops and both reactor coolant pumps in each loop be operating at startup or at full power.[6] With one coolant pump not in operation, the TMI-1 TS require a reduction to 75% of full operating power, in agreement with the MTS. Loss of a coolant pump automatically reduces setpoints for nuclear overpower based on flow and imbalance and nuclear overpower based on pump monitors; the TMI-1 TS do not require reduction of the nuclear overpower setpoint (power independent of any other parameter).

The TMI-1 TS do not require verification of pump and loop operation on a 12 hour basis, and do not require verification of the reactor protection system setpoint changes within four hours.

3.2 Hot Standby--Mode 3 (T_{ave}>525°F and K_{eff} = 1.00)

The TMI-1 TS permit operation with one reactor coolant pump in each loop idle for 24 hours; if the reactor is not returned to an acceptable

operating pump/loop condition within 24 hours, the reactor must be in Hot Shutdown within 12 hours. The TS also prohibit boron concentration reduction unless at least one reactor coolant or decay heat removal pump is circulating reactor coolant.

The TMI-1 TS do not include the surveillance requirements of MTS 4.4.1.2.1 and 4.4.1.2.2.

3.3 Shutdown--Mode 4 ($T_{AVG} \geq 525°F$), Mode 5 ($T_{AVG} \leq 200°F$), $K_{eff} \leq 0.99$

The TMI-1 TS require that both steam generators be operable, as well as the turbine-driven emergency feedwater pump and two half-sized motor-driven emergency feedwater pumps, when $T_{AVG} > 250°F$; there is, however, no requirement that at least one of the loops listed in MTS 3.4.1.3 be in operation, nor are operability requirements specified for $T_{AVG} \leq 250°F$.

The TMI-1 TS do not contain requirements for surveillance of the operability of the DHR, reactor coolant pumps or steam generator loops in Modes 4 and 5.

3.4 Refueling Operations--Mode 6

The TMI-1 TS require at least one DHR loop operating in Mode 6; there is no requirement that two independent DHR loops be operable in Mode 6 with less than 23 feet of water above the top of irradiated fuel assemblies. Neither is there a requirement to close all containment penetrations providing direct access from containment atmosphere to the outside atmosphere within four hours of loss of DHR loop operation.

The TMI-1 TS do not require surveillance of DHR loops as specified in MTS 4.9.8.1 and 4.9.8.2.

4.0 CONCLUSIONS

The TMI-1 TS do not agree with the MTS in the following areas:

(1) They do not follow the MTS format in defining the limiting conditions by applicable modes,

(2) They differ from the MTS in Modes 1 and 2 by not requiring reduction of nuclear power monitor setpoints when operating with less than four coolant pumps,

(3) They do not require having at least one coolant loop in operation in Modes 4 and 5,

(4) They do not require two DHR loops operable in mode 6 with less than 23 feet of water above irradiated fuel assemblies,

(5) They do not require closing of containment penetrations in Mode 6 with less than one DHR loop operating,

(6) They do not require the surveillance specified in the MTS in Modes 1 through 6.

5.0 REFERENCES

1. NRC Information Notice 80-20, May 8, 1980.
2. NRC IE Bulletin 80-12, May 1980.
3. NRC letter, D. G. Eisenhut, To All Operating Pressurized Water Reactors (PWR's), dated June 11, 1980.
4. GPU Nuclear letter, H. D. Hukill to NRC, J. F. Stolz, "Decay Heat Removal (DHR) Technical Specifications," dated January 26, 1982.
5. Standard Technical Specifications for Babcock and Wilcox Pressurized Water Reactors, NUREG-0103-Rev. 3, July 1979.
6. Technical Specifications for Three Mile Island, Unit 1, Amendment 41 to the Final Safety Analysis Report, dated April 16, 1973.

APPENDIX A

MODEL TECHNICAL SPECIFICATIONS FOR REDUNDANT DECAY HEAT REMOVAL
FOR BABCOCK & WILCOX PRESSURIZED WATER REACTORS (PWR's)

3/4.4 REACTOR COOLANT SYSTEM

3/4.4.1 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: MODES 1 and 2.*

ACTION:

With one reactor coolant pump not in operation, STARTUP and POWER OPERATION may be initiated and may proceed provided THERMAL POWER is restricted to less than ( )% of RATED THERMAL POWER and within 4 hours the setpoints for the following trips have been reduced to the values specified in Specification 2.2.1 for operation with three reactor coolant pumps operating:

1. (Nuclear Overpower).
2. (Nuclear Overpower based on RCS flow and AXIAL POWER IMBALANCE).
3. (Nuclear Overpower based on pump monitors).

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.

4.4.1.2 The Reactor Protective Instrumentation channels specified in the applicable ACTION statement above shall be verified to have had their trip setpoints changed to the values specified in Specification 2.2.1 for the applicable number of reactor coolant pumps operating either:

a. Within 4 hours after switching to a different pump combination if the switch is made while operating, or

b. Prior to reactor criticality if the switch is made while shutdown.

* See Special Test Exception 3.10.4.

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 its associated reactor coolant pump,

2. Reactor Coolant Loop (B) and its 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 action to return the required coolant 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.

* 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. Decay Heat Removal Loop (A),*

4. Decay Heat Removal 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 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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* The normal or emergency power source may be inoperable in MODE 5.

** 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.

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 level to be greater than or equal to (   )%.

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 residual heat removal (DHR) loop shall be in operation.

APPLICABILITY: MODE 6

ACTION:

a. With less than one DHR 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 DHR 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 DHR loop shall be verified to be in operation and circulating reactor coolant at a flow rate of greater than or equal to (2800) gpm at least once per 4 hours.

LOW WATER LEVEL

LIMITING CONDITION FOR OPERATION

3.9.8.2 Two independent DHR 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 DHR loops OPERABLE, immediately initiate corrective action to return the required 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 DHR loops shall be determined OPERABLE per Specification 4.0.5.

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

3/4.4.1 COOLANT LOOPS AND COOLANT CIRCULATION

The plant is designed to operate with both reactor coolant loops in operation, and maintain DNBR above (1.32/1.30) during all normal operations and anticipated transients. With one reactor coolant pump not in operation in one loop, THERMAL POWER is restricted by the Nuclear Overpower Based on RCS Flow and AXIAL POWER IMBALANCE and the Nuclear Overpower Based on Pump Monitors trip, ensuring that the DNBR will be maintained above (1.32/1.30) at the maximum possible THERMAL POWER for the number of reactor coolant pumps in operation or the local quality at the point of minimum DNBR equal to (22/15)%, whichever is more restrictive.

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.

In MODES 4 and 5, a single reactor coolant loop or DHR loop provides 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 DHR loops to be OPERABLE.

The operation of one Reactor Coolant Pump or one DHR 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 reduction will, therefore, be within the capability of operator recognition and control.

3/4.9.8 DECAY HEAT REMOVAL AND COOLANT CIRCULATION

The requirement that at least one DHR 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 DHR loops OPERABLE when there is less than 23 feet of water above the core ensures that a single failure of the operating DHR 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 DHR loop, adequate time is provided to initiate emergency procedures to cool the core.