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August 23, 1983
5211-83-232

Office of Nuclear Reactor Regulation
Attn: J. F. Stolz, Chief
Operating Reactor Branch No. 4
Dvision of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
Long Term EFW Mods (NUREG 0737 II.E.1.1)

In response to NUREG 0737 Item II.E.1.1 and as discussed in the meeting at TMI-1 on July 11, 1983 with members of your Staff and those of mine, enclosed please find a description of the modifications to the Emergency Feedwater (EFW) System to be completed prior to startup from the Cycle 6 refueling.

The purpose of these modifications is to upgrade the EFW system to a safety grade system in order to provide increased reliability in its capability to mitigate the effects of design basis accidents when the main feedwater system is not available. These modifications will be made in accordance with the requirements of NUREG 0578 Sections 2.1.7.a and 2.1.7.b, NUREG 0737 Sections II.E.1.1 and II.E.1.2, Atomic Safety and Licensing Board (ASLB) Partial Initial Decision Section II, Subsection Q, and using the acceptance criteria of Standard Review Plan Sections 9.2.6, 10.4.9 and associated Branch Technical position ASB 10-1 as principal guidance.

The modifications being implemented as part of this upgrade include mechanical system configuration changes, mechanical (seismic) and electrical (environmental) equipment qualification upgrades, changes to the control system for EFW components and seismic upgrade of piping sections in the Main Steam, Emergency Feedwater and Main Feedwater Systems.

Sincerely,

H. D. Hukill
Director, TMI-1

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HDH:LWH:vjf
cc: R. Conte, J. Van Vliet

EMERGENCY FEEDWATER SYSTEM LONG TERM
SAFETY GRADE MODIFICATIONS

I. INTRODUCTION

A. This document describes the functional, design, quality assurance, health and safety, and licensing requirements for the installation and operation of modifications to the Emergency Feedwater (EFW) System of Unit No. 1 of the Three Mile Island Nuclear Station (TMI-1).

B. The EFW System shall remain generally as presently configured with modifications to insure the addition of emergency feedwater to both OTSGs assuming a single active failure concurrent with loss of offsite power. In addition, the modified system shall be capable of providing controlled emergency feedwater flow to an intact OTSG for at least two hours without relying on alternating current (AC) power. Conversion of direct current (DC) from the station batteries to alternating current is acceptable for this application.

1. All automatic initiation features provided for the EFW system shall be retained. A new automatic EFW control system for controlling OTSG level independent of the Integrated Control System (ICS) shall be provided. In addition, the capability to manually control EFW flow and set an automatic level setpoint from the main control room shall be provided.

2. All the equipment required to initiate or control EFW or to realign the water source to the EFW pumps with the exception of valves EF-V4 and 5 shall be operable from the main control room.

3. A redundant control valve shall be installed in the flow path to each OTSG in parallel with the existing control valve. A normally open block valve shall be installed downstream of each control valve to provide additional isolation capability of EFW flow to an OTSG. A cavitating venturi has been provided in the EFW flow path to each OTSG to limit flow.

4. The installation and arrangement of cavitating venturis, control valves and block valves shall provide accessibility for plant maintenance, inservice inspection and operability of the components.

5. The installation and arrangement of electrical, instrumentation and control components shall provide testability of equipment and maintenance of electrical separation.

6. Mechanical, electrical, instrumentation and control components shall not be located in high energy line break jet zones unless they are shielded from such jets. Components shall be located such that they are not subject to damage from high energy pipe whip.

II. Mechanical Systems Requirements and Modifications

A. Requirements

1. Process piping design temperature and pressure shall be consistent with the original design basis of the EFW and related service systems as identified in GAI specification SP-5544 unless system modifications call for more stringent requirements.

2. All new piping which is part of the EFW system shall be designed, fabricated, inspected, tested and erected in accordance with ANSI B 31.1 "Power Piping Code".

3. Inspections required by ANSI B 31.1 shall be performed.

4. The seismic design criteria for the piping and support system shall be in accordance with Seismic Class I design bases as defined in GAI specifications SP-5544, item 2:15, "Plant Piping for TMI" and the TMI-1 FSAR. Seismic identification symbol shall be S-I.

5. Installation, erection and testing of all piping shall be in accordance with ASME Section XI.

6. Installed cleanness class shall be Class B in accordance with GPUNC Spec. 3050B-001.

7. All new valves and the cavitating venturis shall be designed and fabricated in accordance with ASME Section III, Class 3.

B. Modifications

1. Add Cavitating Venturis in each Once Through Steam Generator (OTSG) EFW Line. (Complete)

a. This modification has been implemented to limit the flow of EFW to a ruptured OTSG in order to ensure sufficient EFW flow to the intact OTSG and to limit the mass and energy release within the reactor building for overpressure prevention. The venturis will limit the flow to the OTSG in order to reduce excessive reactor coolant system (RCS) overcooling.

2. Provide Redundant Safety Grade EFW Control and Block Valves

a. This is being provided to prevent a single active failure from preventing the addition of EFW to an OTSG and to ensure the capability to isolate EFW flow to a ruptured OTSG.

b. The control valves shall have sufficient range to control the EFW flow to the OTSG(s) when the plant is being cooled and the OTSG(s) are being depressurized and the EFW flow requirement is less than that initially required.

c. The EFW system block valves shall normally be open, and in addition, the EFW initiating signals shall also provide an open signal to the block valves. Each valve shall be provided with an electric motor operator and shall fail "as is" on loss of power. The valves shall also have remote manual operation capability from the main control room.

III. Structural Requirements and Modifications

A. Requirements

1. All components which are part of the EFW System or which are required to act in support of this system shall be qualified for Safe Shutdown Earthquake (SSE) loadings to ensure structural integrity and functional operability of active components during and after an earthquake. All existing EFW system components shall be seismically qualified by analysis or by type tests if required. The qualification of new components shall be accomplished by either analysis or testing.

2. The structural design of the EFW system modifications shall be consistent with the original design basis of the EFW system and the related service systems as

identified in the TMI-1 FSAR and GAI specifications SP-5544 and SP-5661. Where practicable, all portions of the EFW system shall be installed indoors within Seismic Class S-I aircraft-hardened structures. All portions of the system required to perform the safety function shall be designed to Seismic Class S-I requirements.

3. Portions of the EFW system located outdoors shall be designed to Seismic Class S-I requirements and shall be designed to withstand the effects of the design basis natural phenomena identified in the TMI-1 FSAR Section 2.

4. All piping and valves shall be connected and supported in such a manner that any stress due to weight, thermal effects, internal piping conditions and external environment will be within the maximum allowable stresses required by the ANSI B. 31.1 "Power Piping Code".

5. Structural steel shall be designed in accordance with AISC-70 (including latest supplements) using ASTM-A36 steel, except weld unit stresses shall be as specified in Table 9.3.2.1 of AWS D1.1, -79 "Structural Steel Welding Code".

B. Modifications

1. Upgrade the EFW pumps recirculation line from recirculation control valves (EF-V-8A/B/C) to Condensate Storage Tank (CO-T1B) to Seismic Class I requirements.

   a. This modification will ensure that failure of this piping due to a seismic event shall not occur and thus prevent depletion of the required CST inventory for the EFW function.

2. Evaluate and modify the vent stacks for safety valves MS-V22A/B and atmospheric dump valves MS-V4A/B to Seismic Class I requirements.

   a. The vent stacks for safety relief valves MS-V-22A/B and atmospheric dump valves MS-V-4A/B are routed through the Intermediate Building floors. This modification will prevent the release of main steam to the Intermediate Building as a result of vent stack failure due to a seismic event. Therefore, this modification will reduce the possibility of overpressurization in the building and protect the Emergency Feedwater system components form the exposure to the hostile

environment and gravity missiles.

3. Intermediate Building Flood Protection from a Main Feedwater Line Break.

   a. This modification is being implemented to mitigate the effects of flooding due to a postulated main feedwater line break in the Intermediate Building by allowing water to flow into the tendon access gallery and portions of the alligator pit which are presently isolated. By removing the upper half of the "stop walls" in the alligator pit and opening entrance "A" and "C" to the tendon access gallery, the time required for water to flood EL. 295' in the Intermediate Building will be increased from 86 seconds to approximatey 25 minutes.

IV. Electrical Requirements and Modifications

A. Requirements

1. The electric power and control system shall be designed as a Class 1E system. Components of the system required to operate during a loss of all AC power (Station Blackout) shall be powered from the non-interruptable vital AC or DC buses.

2. Each train of EFW to each OTSG shall be powered from its associated power sources to facilitate safety grade initiation and control of EFW to each OTSG.

3. Electrical equipment shall be qualified in accordance with applicable sections of IEEE 323, IEEE 344, IEEE 382, and NUREG-0588 or the Division of Operating Reactor Guidelines appended to I.E. Bulletin 79-01B as appropriate.

B. Modifications

1. Provide a safey grade power supply to valves CO-V-111A/B and upgrade the cable routing for power supply to valves CO-V-14A/B to meet Seismic Class I requirements.

a. This modification shall provide the capability to isolate a damaged Condensate Storage Tank (CST) from the EFW system by closing COV-111A/B from the Main Control Room so that the intact CST will have sufficient water available for the EFW system function. Similarly, the ability to close CO-V-14A/B from the Main Control Room, will allow isolation of non-EFW functions from the CST.

These features will be used in conjunction with revised EFW plant operating procedures to close CO-V-14A/BV and CO-V-111A/B whenever there is an EFW initiation and the CST has reached the Technical Specification limit for EFW inventory.

2. Delete the existing cross connect between electrical busses that allows a control room operator to load both EFW pump motors onto a single diesel generator in order to ensure electrical separation of the busses. (Complete)

3. A review shall be conducted of the emergency power bus loadings to assure that changes in bus loadings resulting from these modifications will maintain the bus loadings within acceptable limits.

V. Instrumentation and Control Requirements and Modifications

A. Requirements

1. New control systems shall be installed to initate and regulate EFW flow. Control of EFW flow to each OTSG shall be independent of control for the other OTSG. Each control system shall be of Class 1E (safety grade) design. Electric power for the control systems shall be from safety grade uninterruptable sources.

2. The control systems shall be designed so that no single active failure will prevent delivery of the required emergency feedwater to an OTSG. Also, the probability of a single failure causing inadvertent injection of EFW into an OTSG shall be minimized.

3. The control system shall be designed to enable control of emergency feedwater for at least two hours during loss of all (on-site and off-site) alternative current (AC) power sources with the exception of the battery backed 120 VAC vital sources. During the loss of all AC

power condition for two hours, only the turbine driven emergency feedwater controls are required to be functional.

4. The design of the safety grade controls shall be in accordance with applicable sections of IEEE 308, IEEE 279 and its supplements and IEEE 379. System level manual initiation shall not be provided as recommended by IEEE-279. Instead, the system components shall be provided with a manual starting or control capability as appropriate for each component.

5. All cable routing of electrical and instrumentation shall be checked to comply with Appendix R of 10CFR50 (i.e., Fire Protection Evaluation).

6. The alligator pit flood detection system shall consist of level indication located in the alligator pit. Condenser hotwell low-low level alarm can be accomplished via the existing hotwell low-low level signals.

7. The EFW system shall receive automatic initiation signals for the following conditions:

   a. Loss of both Main Feedwater Pumps, or
   b. Loss of four (4) Reactor Coolant Pumps (RCP), or
   c. Feedwater line break as detected by high Main Steam to Feedwater differential pressure, or
   d. Low OTSG water level.

8. The EFW system block valves shall normally be open and, in addition, the EFW initiating signals shall also provide an open signal to the block valves. A control switch shall be provided for each block valve for remote operation from the control room. Direct indication of actual valve position shall also be provided in the control room.

9. The capability to manually control EFW flow from the control room shall be provided. This capability shall include features to allow independent control of each flow control valve and position indication from each control valve.

10. The capability of selecting an automatic level control setpoint shall also be provided.

11. The failure mode of the control valves shall be fail-closed on loss of either instrument air, electrical power, or control signal.

12. New steam generator level instruments external of ICS shall be provided for the following functions. Level is expressed as distance above the top of the lower tubesheet:

    a. Automatic control of EFW at 30" for the condition of at least one RCP operating and 240" for loss of all four RCP's.

    b. Initiation of EFW at a low-low OTSG water level of 18".

    c. High level alarm at 337".

    d. Low level alarm at 23".

    e. High-high level alarm to indicate OTSG overfilling. Alarm is to occur at a water level of 380".

    f. Isolation of main feedwater (MFW) on a high-high level of 370" (which is above the ICS high level limit control point of 346").

    g. Operator selected auto level setpoint for use following a LOCA.

13. In addition, the ICS shall utilize the instruments for the following purposes:

    a. OTSG level control during heat up
    b. High OTSG level limit during power operation
    c. Low OTSG level limit during power operation
    d. OTSG level control after the reactor trip.

14. The modification of the OTSG level instruments shall use the top of the lower tubesheet as a reference point and use the same measurement unit (i.e., inch). These instruments shall be compensated for process pressure and environmental temperature to aid plant startup and post trip level control.

15. Automatic EFW initiation signals for feedwater line break as detected by high main steam to feedwater differential pressure, or low OTSG water level shall be generated by using four (4) channels of level measurement and 2 out of 4 (2/4) logic for each actuation (Train A and B).

16. EFW control valve modulation shall utilize two (2) channels (one for each EFW control valve) of OTSG level measurement out of a total of four (4) channels. However, EFW initiation on low water level shall be dependent upon a 2 out of 4 (2/4) logic. Capability shall be provided to bypass this initiation from the main control room.

17. Main feedwater (MFW) control shall be performed by the existing Integrated Control System (ICS). Isolated fully compensated level signals from one (1) of the four (4) channels of level measurements shall be utilized by the ICS as described above. Main feedwater isolation upon high OTSG level shall be initiated by a 2 out of 4 (2/4) logic utilizing these same level signals. This shall be performed external of the ICS. Existing level instruments associated with ICS shall be removed.

18. Main feedwater isolation shall also be initiated on a feedwater line break utilizing a 2 out of 4 (2/4) logic based upon differential pressure between main steam and feedwater system and by the Main Steam Line Rupture Detection System (MSLRDS). The MSLRDS also utilizes a 2 out of four (2/4) logic for detection of main steam pressure below 600 psig.

19. Two (2) safety grade wide range OTSG level indications shall be provided in the control room for each OTSG.

20. A safety grade water level indication and low-low water level alarm shall be provided in the control room for each condensate storage tank.

21. All instrumentation independent of the ICS and control equipment shall be qualified for operability during a Safe Shutdown Earthquake and, when instruments are to be located in the Intermediate Building, for the environmental conditions existing in the Intermediate Building following a main steam line break.

B. Modifications

1. Deletion of the Main Steam Line Rupture Detection System (MSLRDS) Signals to the emergency feedwater control valves EF-V-30A/B. (Complete)

   The deletion of the MSLRDS signals to the EFW System improves the availability of the OTSG's as a heat sink

and improves the reliability and capability of EFW flow to the OTSG(s) during loss of normal feedwater flow.

2. Provide safety grade EFW initiation and main feedwater isolation on high main steam/feedwater differential pressure.

   High main steam pressure relative to main feedwater pressure is an indication of a main feedwater line rupture. This indication along with low OTSG level) anticipates failure of the secondary heat sink due to a main feedwater failure.

3. Provide a safety grade OTSG level instrumentation and signals for main feedwater (MFW) OTSG high water level isolation and OTSG low water level initiation of the EFW system.

   The isolation of main feedwater on OTSG high water level protects against OTSG overfilling caused by failure of the feedwater control system within the Integrated Control System (ICS).

4. The control system shall be of dual setpoint design with the setpoints dependent on whether or not the reactor coolant (RC) pumps are running.

   On loss of all four (4) reactor coolant (RC) pumps, the control system shall open and control the EFW flow control valves to maintain a higher OTSG water level setpoint as required to achieve reactor natural circulation cooling within the Reactor Coolant System (RCS). If at least one RC pump is operating, the control system shall control OTSG water level to a lower setpoint sufficient for forced circulation RCS cooling.

5. Provide a safety grade automatic control system independent of the Integrated Control System (ICS) that permits the Emergency Feedwater System to control OTSG level without control interaction with the main feedwater system.

6. Upgrade the controls for the Main Steam Line Rupture Detection System to safety grade such that a single failure of the control system will not prevent isolation when required. The probability of a single failure causing inadvertent actuation shall be minimized.

   The MSLRDS shall identify a ruptured OTSG when the main steam pressure falls below 600 psig and shall then automatically isolate the main feedwater to that OTSG.

8. Provide an overspeed trip alarm in the Main Control Room for the turbine driven emergency feedwater pump (TDEFWP) EF-P-1.

   This alarm will provide indication of a loss of a portion of the EFW system.

9. Provide an "alligator pit" flood detection alarm using safety grade components and a control grade main condenser hotwell low-low level alarm in the Main Control Room.

   This modification will provide an operator with a control room alarm indicating a possible main feedwater line break.

10. Evaluate the Emergency Feedwater and Engineered Safeguard (ES) Electrical Power, Control, and Instrumentation Cables that are presently routed through the alligator pit.

    The EFW and ES electrical power, control and instrumentation cables need to be evaluated to determine their capabilty of performing their safety function after a main feedwater line break incident and subsequent alligator pit flooding.

11. A portion of the existing EFW system controls is within the ICS. This interface is being replaced with the modification as identified in previous sections. OTSG level measurements associated with the EFW system shall be provided to the ICS through suitable isolation.

VI. Miscellaneous Criteria

A. Electrical and Control Equipment Environmental Qualification

Equipment which is part of the EFW system or which is required to act in support of this system and which is located in the Intermediate Building, shall either be upgraded to be qualified for the hostile environmental conditions resulting from a Main Steam Line Break (MSLB) in this building or be replaced with qualified equipment or be relocated to an environmentally acceptable location which is otherwise suitable for their safety function.

B. Maintenance

Maintenance of valves, instrumentation and controls shall be accomplished in accordance with manufacturer's instructions and recommendations. Pipe routing and equipment location shall be selected to facilitate maintenance and be consistent with the requirements of Section I.B.

C. Surveillance and In-Service Inspection

Inservice inspection requirements of ASME B&PV Code Section XI for system design and inspection apply to the design of these modifications.

The system shall be designed to allow functional testing of all new equipment during cold shutdown conditions. It shall also be designed to allow for periodic testing in accordance with the TMI-1 Technical Specifications, Section 4.9. The design shall be consistent with requirements of the TMI-1 Technical Specifications limiting conditions for operation of the turbine cycle, Section 3.4.

D. Interfacing Systems

These modifications require interfaces with the Main Feedwater, Main Steam, Condensate, Instrument Air and Class 1E electrical systems as specifically identified in previous sections.

Changes to any of these systems shall not degrade the ability of these systems or any other plant systems to perform their design functions.

E. Testing Requirement

Adequate provisions shall be made in the design of the system modifications to allow hydrostatic testing of the piping system, calibration of instrumentation, and functional testing of the controls and alarms.

F. Quality Assurance

This modification is classified as Important to Safety. Quality Assurance requirements shall be in accordance with the "Operational Quality Assurance Plan for Three Mile Island Nuclear Station, Unit 1," with specific requirements as indicated.

G. Human Factors

Human factors reviews of the man-machine interfaces shall be performed to aid in the development of the system modifications. The interface points of type, location and arrangement of controls and display, system labelling, alarm/warning system logic, maintenance requirements, and procedural guidelines shall be reviewed and documented.

H. ALARA

The design of this sytem shall implement ALARA concepts for both the construction activities and for the operating and maintenance aspects of these modifications. The ALARA impact of these modifications on other systems and personnel access shall also be considered in the design of these modifications.